Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Reconsideration of Beneficial Use Criteria and Piles; Notice of Data Availability
EPA–HQ–OLEM–2020–0463

PDF 3A: Coal Combustion Residuals (CCR) Distribution System

United States Environmental Protection Agency
Office of Land and Emergency Management

PDF 3A: Coal Combustion Residuals (CCR) Distribution System

EPA received data and information during the comment period on the "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles" (84 FR 40353, Aug., 14, 2019) ("August 2019 proposed rule"). Between May 2020 and August 2020, EPA also held ten stakeholder meetings with trade associations and their members, encompassing utilities, agricultural, wallboard, cement and concrete beneficial uses; CCR marketers; state environmental and transportation agencies; environmental organizations and private citizens. In follow up to the meetings, participants shared a variety of information with EPA. All the information EPA received is compiled into seven pdf files.

This file captures information relevant to the CCR distribution system. This file organizes the documents received across the following topic areas: (1) CCR Management and Storage for Beneficial Use, (2) Information about CCR Management and Placement On-Site at Utilities, and (3) Potential Impacts from CCR Management and Storage. The documents are listed in and can be directly accessed from the Table of Contents. EPA has added cover pages to each document to identify the document source and to provide instruction on accessing copyrighted content where applicable.

PDF 3A: Coal Combustion Residuals (CCR) Distribution System

TABLE OF CONTENTS

This Table of Contents is linked to search documents listed. Click any document title below to access it.

1. CCR Management and Storage for Beneficial Use

1.1. Portland Cement Association's (PCA) Response to the U.S. Environmental Protection Agency's (EPA) Request for Supplemental Documentation on the Cement Industry's Handling and Management of Coal Combustion Products (PCA, 2020)

1.2. PCA-Submitted Supporting Exhibits to the U.S. EPA's Information Request for Supplemental Documentation on the Cement Industry's Handling and Management of Coal Combustion Products (PCA, 2020)

1.3. Gypsum Association's Written Comments on EPA's August 2019 Proposed Rule; Docket No. EPA-HQ-OLEM-2018-0524 (Gypsum Association, 2020)

1.4. American Coal Ash Association (ACAA) Written Comments on EPA's August 2019 Proposed Rule; Docket No. EPA-HW-OLEM-2018-0524 (ACAA, 2019)

1.5. A Comprehensive Survey of Coal Ash Law and Commercialization: Its Environmental Risks, Disposal Regulation, and Beneficial Use Markets, National Association of Regulatory Utility Commissioners (NARUC, 2020)

1.6. Kansas City Fly Ash Safety Data Sheet (Kansas City Fly Ash, 2015)

1.7. Information from ACAA and CCR Marketers as Follow-Up to Stakeholder Engagement (2020)

2. Information Regarding CCR Management and Placement On-Site at Utilities

2.1. URL for EPA's List of Utility Compliance Websites (EPA, 2019)

2.2. Comments from the Hoosier Environmental Council (HEC) on EPA's August 2019 Proposed Rule; Docket No. EPA-HW-OLEM-2018-0524 (Hoosier Environmental Council, 2019)

2.2.1. Noblesville Generating Station Closure/Post-Closure Plan, Submitted to the Indiana Department of Environmental Management (IDEM), VFC #82582356 (Duke Energy Indiana, LLC, 2018)

2.2.2. Noblesville Generating Station Closure/Post-Closure Additional Information, Submitted to IDEM, VFC #82679884) (Duke Energy Indiana, LLC, 2019)

2.2.3. Noblesville Generating Station Closure Plan Addendum 1, Submitted to IDEM, VFC #82755832 (Duke Energy Indiana, LLC, 2019)

TABLE OF CONTENTS (Continued)

2.2.4. Noblesville Generating Station Closure/Post-Closure Approval and Requirements from IDEM, Sent to Duke Energy Indiana, LLC, VFC #82851197 (IDEM, 2019)

2.2.5. Noblesville Generating Station National Pollutant Discharge Elimination System (NPDES) Information, Submitted to IDEM, VFC #82858496 (Duke Energy Indiana, LLC, 2019)

2.2.6. Noblesville Generating Station Closure Implementation Plan Addendum 2, Prepared by ATC Group Services LLC for Duke Energy, VFC #82883999 (ATC Group, 2019)

2.3. Mark Hutson Report for Earthjustice: Responses to EPA Solicitation for Comments on EPA's August 2019 CCR Rule; Docket No. EPA-HW-OLEM-2018-0524 (Mark Hutson, Geo-Hydro, Inc., 2019)

2.3.1. Illinois Pollution Control Board Court Order for Midwest Generation Utility, as Referenced in 2.3, Mark Hutson Report for Earthjustice (2019)

3. Information Regarding Potential Impacts from CCR Management and Storage

3.1. Henry S. Cole & Associates, Inc. July 2020 Recommendations for Management of CCR (Cole, 2020)

3.2. Henry S. Cole & Associates, Inc. October 2019 Comments on EPA's August 2019 Proposed Rule; Docket No. EP-HW-OLEM-2018-0524 (Cole, 2019)

Section 1. CCR Management and Storage for Beneficial Use

1.1. Portland Cement Association's (PCA) Response to the U.S. Environmental Protection Agency's (EPA) Request for Supplemental Documentation on the Cement Industry's Handling and Management of Coal Combustion Products (PCA, 2020)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

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June 18, 2020

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Re: Response to EPA Request for Supplemental Documentation on the Cement Industry's Handling and Management of Coal Combustion Products

PCA very much appreciated the opportunity meet with staff during the teleconference on May 28, 2020 to discuss how the cement industry uses and manages Coal Combustions Products (CCPs) for beneficial use in the manufacture of portland cement and blended cements. As discussed during the teleconference and outlined in comments by PCA and multiple industry commenters, CCPs, including fly ash, bottom ash, and synthetic gypsum are highly sought after materials, used as direct replacements for a variety of other commodity ingredients and valued for their performance, sustainability, and economic benefits.[1]

During the call on May 28, 2020, EPA requested additional clarification and documentation of points raised in PCA's October 15, 2019 comments, to ensure that EPA's decision making reflects an accurate and complete understanding of the industry's use and management of CCPs, and the attendant risks and benefits to the environment.

As reflected in the administrative record and the materials and information provided herein, the cement industry has a long history of using CCPs as ingredients in cement, and the materials are handled in a manner consistent with other feedstocks, from delivery to inventory to pyroprocessing and cement finishing. In doing so, the cement industry not only provides better, more sustainable end products, it provides significant benefits to surrounding communities by reducing the need for land application or disposal – benefits well documented and quantified by EPA and third-party sources. To date, neither EPA nor commenters have provided any evidence that the industry's temporary storage of CCPs as inventory prior to use as a cement feedstock has

[1] See, e.g., *Comments Submitted by Charles Franklin, Vice President & Counsel Government Affairs, Portland Cement Association,* (October 15, 2019), (Available at Regulations.gov as Doc. No. EPA-HQ-OLEM-2018-0524-0166); *Comments Submitted by Michael LeMonds, Vice President, Land and Government Affairs, Holcim (US) Inc.,* (October 15, 2019), (Available at Regulations.gov as Doc. No. EPA-HQ-OLEM-2018-0524-0178; *Comments Submitted by Curtis D. Lesslie, Vice President, Environmental Affairs, Ash Grove Cement Company,* (October 15, 2020), (Available at Regulations.gov as Doc. No. EPA-HQ-OLEM-2018-0524-0174; *Comments Submitted by Travis J. Reed, Environmental Director, Argos USA,* (October 14, 2019), (Available at Regulations.gov as EPA-HQ-OLEM-2018-0524-0054.

lead to adverse environmental impacts or damage cases, let alone a reasonable probability of adverse effects on health or the environment.

For these reasons, EPA should retain or raise the beneficial use threshold for onsite storage of CCPs used in the manufacture of cement and other encapsulated products. The current beneficial use framework, established at 40 CFR 257.53, provides an incentive to CCP generators to market both new and legacy CCPs as commodity materials, and allows manufacturers to obtain and utilize these materials in lieu of less sustainable alternatives without triggering onerous and costly new regulatory obligations. Combined with a tonnage threshold adequate to maintain a reliable inventory for use in manufacturing, the current framework prevents accumulation of quantities that could create risk of adverse effects.

Neither the proposed rule and comment nor the filings from the pending litigation provide a compelling policy or legal rationale for revoking or reducing the current threshold. Indeed, based on EPA's own documentation, that threshold could and should be raised to at least 75,000 tons to accommodate the need for increased inventory due to increasing scarcity of such materials in some areas.

To assist EPA staff in their review of PCA's clarifying materials and requirements, the information is provided in separate categories of information. Supporting documents are referenced therein and provided as Exhibits in the attachment.

Extensive Documentation Exists to Substantiate the Business Value of Fly Ash, Bottom Ash, and Synthetic Gypsum as Beneficial Ingredients in Cement

As outlined in our October 15, 2019 comments, cement manufacturers use fly ash, bottom ash, and synthetic gypsum as replacements for virgin raw materials, including iron, clay, shale, bauxite, and gypsum in the cement manufacturing process.[2] These materials provide alumina, silica, and iron to the mix. The materials can be used as raw feed to make clinker in the kiln and in the finishing process to make cement. Use of CCPs provide numerous benefits in the cement manufacturing process, including:

- Improved burnability, resulting in lower burning temperatures and a reduction in fuel consumption
- Consistent clinker quality
- Reduced greenhouse gas, sulfur dioxide, hydrocarbon, and nitrogen oxide emissions

These and other benefits are well documented within government, industry, and academic literature. Relevant citations include:

[2] *See Comments Submitted by Charles Franklin, Vice President & Counsel Government Affairs, Portland Cement Association,* (October 15, 2019), Pages 4-5, (Available at Regulations.gov as Doc. No. EPA-HQ-OLEM-2018-0524-0166)

a. "Fly ash is rich in silica and alumina, and therefore a compatible component of cement raw feed. It can largely replace clay or shale in the original feed. . . . Typically, the composition of fly ash is similar to that of clay and shale except that it generally contains more alumina. [In] some cases, a high iron oxide content in fly ash can provide the sole source of iron required by the raw mix." PCA, *Innovations in Portland Cement Manufacturing*, Chapter 2.3, Use of Alternative Materials in Cement Manufacturing (April 3, 2011), pg. 221-222 (Exhibit A).

b. "Coal fly ash has been successfully used in Portland cement concrete (PCC) as a mineral admixture, and more recently as a component of blended cement, for nearly 60 years. … ASTM C595[(1)] defines two blended cement products in which fly ash has been added: 1) Portland-pozzolan cement (Type IP), containing 15 to 40 percent pozzolan, or 2) Pozzolan modified Portland cement (Type I-PM), containing less than 15 percent pozzolan." Federal Highway Administration (FHWA), *User Guidelines for Waste and Byproduct Materials in Pavement Construction: COAL FLY ASH*, (last visited June 1, 2020) (Exhibit B).

c. "Leading bottom ash applications are snow and ice control, as aggregate in lightweight concrete masonry units, *and raw feed material for production of Portland cement.*" FHWA, *User Guidelines for Waste and Byproduct Materials in Pavement Construction: Coal Bottom Ash* (last visited June 1, 2020)(Exhibit C).

"From 111 operating plants reporting in the PCA publication: 2010 U.S. and Canadian Portland Cement Industry: Plant Information Summary, 41 plants used blast furnace or iron slag as a raw material and 50 plants used fly ash or bottom ash from electric power plants. Other alternative materials used by portland cement plants in 2010 included . . .Synthetic gypsum," pg. 9-10. PCA, *2011 Report on Sustainable Manufacturing* (2011), 9-10) (Exhibit D).

"Clinker, the principle intermediate manufactured product within cement production, is typically produced from a combination of ingredients, including limestone (for calcium), coupled with smaller quantities of materials such as clay, iron ore, and sand (as sources of alumina, iron, and silica, respectively). So common are these building blocks that a wide variety of raw materials are suitable sources, and some sources, such clay and fly ash, may provide multiple chemical components. Cement plants are increasingly turning to industrial byproducts that otherwise would be discarded, once completing detailed analyses to determine the effects of using a byproduct on the manufacturing process, cement performance and facility emissions." PCA, *Environmental Product Declaration, Blended Cements* (per ASTM C595, ASTM C1157, AASHTO M 240 or CSA A3001), (June 1, 2016) (Exhibit D); see also PCA, Environmental Product Declaration, Portland Cements (per ASTM ASTM C150, ASTM C1157, AASHTO M 85 or CSA A3001) (June 1, 2016) (Exhibit E).

"In construction, a metric ton of fly ash used in cement and concrete can save the equivalent of a barrel of oil and can reduce carbon dioxide releases that may affect global warming. The use of CCP's saves landfill space. CCP's can replace clay, sand, limestone, gravel, and natural gypsum, thus preserving the Nation's natural resources and helping to save energy and other costs associated with mining." *U.S. Geological Survey, Coal Combustion Products*, Fact Sheet 076-01, Online Version 1.0, Journal of Cleaner Production, (January 1, 2018), last visited June 1, 2020) (Exhibit F).

d. "[N]ew applications of coal bottom ash (CBA) have become an interesting alternative to disposal. For instance, it could be used as a Portland cement constituent leading to more sustainable cement production by lowering energy consumption and raw material extracted from quarries." Christina Argiz, *Coal Bottom Ash for Portland Cement Production*, Advances in Materials Science and Engineering, 1-7. 10.1155/2017/6068286 (2017) (Exhibit G)

The use of CCPs in cement not only benefits the cement industry, it has documented benefits for the environment. Beyond the extensive discussion of these benefits already outlined in the Administrative Record for the 2015 Rule and PCA's 2019 Comments, one of EPA's own recent documents in a parallel rulemaking proceeding quantified the economical value of the environmental and human health benefits of using one ton of CCP in lieu of virgin fill materials at $2.28, compared with $69.90 for using that same ton of CCP in lieu of virgin materials in the production of portland cement, meaning that "every ton of CCR diverted from higher-value productive uses ... results in a corresponding reduction in the benefits of the beneficial use of CCR."[3]

Given these benefits, it is no surprise that the cement industry's proportion of beneficial use has increased under the 2015 beneficial use framework. From 2010 to 2017, cement's proportion of all beneficial use rose from 7.5 % to 12%. In 2017, the cement industry beneficially used around 4.5 million tons of fly (roughly 19 percent of all fly ash), roughly 33 percent of all bottom ash, and 2.3 million tons of synthetic gypsum, roughly 10 percent of all synthetic gypsum beneficially used in the US.[4]

1. Methods for CCP Procurement, Delivery, and Storage of CCPs

Cement facilities primarily receive CCPs via bulk truck or covered trailers, although facilities located along barge corridors may receive materials by ship or barge. Cement facilities contract with CCP suppliers to deliver these materials to the facility. Redacted examples of purchase

[3] EPA, *Regulatory Impact Analysis: EPA's 2019 RCRA Proposed Rule 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* (Feb. 2020), 4-3 (Available at Regulations.Gov as Doc. No. EPA-HQ-OLEM-2019-0173-0020 (Excerpt as Exhibit H).

[4] *See Comments Submitted by Thomas H. Adams, Executive Director, American Coal Ash Association*, (October 15, 2019), Page 15, (Available at Regulations.gov as Doc. No. EPA-HQ-OLEM-2019-0138 (Excerpt as Exhibit I)

agreements and specifications sheets, identifying supplier obligations to excavate, screen, sample, load, and transport the material from the generation source to the manufacturer's processing facility, are attached as Exhibits.

Once materials have been delivered to the manufacturer, the process for transferring CCPs and other manufacturing ingredients and additives will vary from company to company and facility to facility, depending on numerous factors, including facility design, size, layout, and space constraints, local climate and hydrology, and state and local permitting requirements. The cement industry manages CCPs in the same manner as analogous materials (i.e., other raw materials and solid fuels), and in a manner consistent with other industries that use a multitude of raw materials and industrial byproducts, many which are present in much larger quantities. There is no reason to believe, and no evidence to support, that the management of CCP in such a similar manner poses any greater risk than other raw materials, byproducts and solid fuels that are not encumbered by overly strict regulations.

The amendments as proposed may force cement plants, out of an abundance of caution and concern for potential arbitrary enforcement by regulatory agencies, to expend significant capital to modify how they manage and store CCPs while providing no discernable environmental benefit. Furthermore, the current proposed amendments provide no timeframe for making such modifications, which could put cement plants at risk of being perceived to be out of compliance on the effective date of the amendments. While every company has different practices for management of CCPs, all handle and store these materials in a manner consistent with their management of analogous materials and similar feedstocks and none are aware of documented cases of adverse environmental damage from releases of inventoried material. Based on a review of materials provided in the record, no such incidents have been reported by third party entities.

2. CCP Quality Requirements

It is essential that cement manufacturing facilities achieve the correct chemistry and product specifications when manufacturing cement. Any deviations in the chemistry of the raw feed used to make cement can result in off-spec product, equipment malfunctions, emissions exceedances, or other issues. As a result, cement manufacturing facilities must ensure that any raw material input is in strict conformity with the requirements of the process. The CCPs supplied to the facilities must meet strict quality requirements to prevent or minimize hazardous materials, debris, moisture, and other contaminants. The supply contracts specify the constituent parameters that the CCPs must meet. Exhibits J, K, L, and M provide examples of purchase agreements and specifications maintained by a facility for Fly Ash, Bottom Ash and Synthetic Gypsum.

Supporting Documents:

- Exhibits J, K, L, M – Sample CCP Purchase Contracts

To ensure that supplied materials meet the applicable specifications for use in cement, cement

manufacturing facilities either require or conduct laboratory analyses of CCPs. If materials do not meet these strict product specifications, cement manufacturing facilities will deny shipment to the facility. Exhibits N, O, P, Q, R, and S provide examples of specifications and lab analyses conducted and used by facilities when making decisions on accepting, rejecting, and using materials.

Supporting Documents:

- Exhibit N – Example Fly Ash Specification Requirements
- Exhibit O – Example Synthetic Gypsum Specification Requirements
- Exhibit P – Example of Chemical Content Specifications
- Exhibit Q – Example Synthetic Gypsum Chemical Content Specifications
- Exhibit R – Example of Failing Fly Ash Report (Refer to Exhibit N)
- Exhibit S – Example of Passing Fly Ash Report (Refer to Exhibit N)

3. Examples of Safety Data Sheets for fly ash, bottom ash, and/or synthetic gypsum

Cement Manufacturers are regulated by the Mine Safety and Health Administration (MSHA) rather than the Occupational Safety and Health Administration (OSHA), and thus are not obligated to maintain safety data sheets as a regulatory requirement. MSHA rules provide a parallel set of regulatory health and safety requirements for facilities designed to protect miners and employees, including restrictions on dust and other health hazards. Nevertheless, companies retain SDSs for materials procured for use in the cement manufacturing process, including fly ash, bottom ash, and synthetic gypsum. We have provided examples of SDSs maintained for CCPs by manufacturers for inventoried CCPs as Exhibit T in the attachment.

Supporting Documents:

- Exhibit T – Fly Ash MSDS, Bituminous Coal Fly and Bottom Ash MSDS, Synthetic Gypsum MSDS, and Coal Fly Ash MSDS

4. Documentation of Accounting of CCPs

Cement manufacturing facilities closely track the quantities of CCPs delivered, consumed, and remaining in inventory, as they would for analogous materials and other critical inputs in the cement manufacturing process including sand, bauxite, limestone, clay, shale, and natural gypsum. While the specific policies and procedures for managing inventory varies from company to company and site to site, Exhibits U, V, W, X, and Y provide examples of documents used to track and manage CCPs used onsite.

Supporting Documents:

- Exhibit U – Example Cement Plant Daily Materials Report
- Exhibit V – Example Daily Operating Report

- Exhibit W – Example Feedstock Usage
- Exhibit X – Fly Ash Receiving Ticket
- Exhibit Y – Example Additive Variable Tracking Report

5. Environmental, Health, and Safety Requirements for CCP Storage Piles

Cement manufacturing facilities are heavily regulated facilities, subject to extensive permitting requirements and environmental control requirements to control releases to air and water, and worker health and safety requirements to protect miners and employees. Facilities must comply dust suppression measures under their Title V Permits and stormwater control requirements under NPDES Permits to mitigate environmental impacts of CCP storage, just as they would for any other material storage. If CCPs are stored in a silo, the silo is equipped with a dust collector and that dust collector is included in the permit and subject to all applicable regulations. Any CCP storage piles are subject to regulations for storage piles, such as limiting any fugitive emissions from wind erosion, covering the piles, or applying dust suppressant to the top of the piles. For stormwater permits, state agencies will review the types of materials exposed to stormwater and make a determination about what constituents should be monitored at stormwater outfalls. Where releases to groundwater are a concern, states may impose additional measures to address potential releases. An excerpted example of requirements imposed under one such state permit is attached as Exhibit Z.

- Exhibit Z - Example Title V Permit Provision

Conclusion

PCA appreciates the opportunity to provide additional information for EPA in their continued consideration of the CCR Beneficial Use Proposed Rule. Please let us know if you need any additional information. You can contact me at 202-719-1977 or cfranklin@cement.org.

Regards,

Charles Franklin
Vice President and Counsel, Government Affairs

1.2. PCA-Submitted Supporting Exhibits to the U.S. EPA's Information Request for Supplemental Documentation on the Cement Industry's Handling and Management of Coal Combustion Products (PCA, 2020)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

Exhibit A

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 221

Table 2.3.17. Microscopic Observations of Clinkers Containing Catalyst Fines vs. Control

Clinker	Color	Alite size, µm	Belite size, µm	Interstitials, µm
Catalyst fines	black/tan	20-30, some cannibalized and decomposed	20-30, round to slightly irregular, some ragged	C_3A <10, porosity high
Control	tan	15–30	25–30, round	C_3A <15

Table 2.3.18. Strength of Cement from Catalyst Fines Clinker vs. Control

Cement	Compressive strength, MPa		
	3-day	7-day	28-day
Catalyst fines	18.3	31.6	44.5
Control	21.3	32.0	44.7

Fly Ash

Fly ash is produced from coal-fired power plants. Approximately 70 million tons of fly ash are produced annually in the U.S. This quantity will increase provided there is a corresponding increase in the number of coal-fired power plants.

Historically, less than 40% of this fly ash was used as a marketable product. A major use of fly ash is as a supplementary cementitious material in concrete. Increasingly stringent environmental regulations especially with regard to mercury emissions may reduce the quantity of suitable fly ash available for that use. Fly ash that is not beneficially utilized is typically discarded. Figure 2.3.6 shows piles of preconditioned (with lime) waste fly ash prior to landfilling. This practice is common in rural areas of the United States where transportation costs (to supply fly ash to urban concrete producers) are high and landfill costs are low.

Figure 2.3.6. Waste fly ash generated at a coal-fired power plant.

Fly ash is rich in silica and alumina, and therefore a compatible component of cement raw feed. It can largely replace clay or shale in the original feed. Typically, the composition of fly ash is similar to that of clay and shale except that it generally contains more alumina.

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 222

However, in some cases, a high iron oxide content in fly ash can provide the sole source of iron required by the raw mix.

A number of cement plants in the U.S. have used fly ash as a component of raw feed. Plant types, use rate, and mode of fly ash addition are given Table 2.3.19. Approximately 4 to 6 million tons of fly ash were used as raw feed in the United States in 2007.

Table 2.3.19. Plant Types, Fly Ash Addition, and Mode of Use in U.S. Cement Plants

Plant type	Use level	Mode of fly ash addition
Dry	3%	Blended with clay/sand and fed into raw mill
Wet	8%	Added to clay at wash mill prior to feeing into raw mill
Wet	Varies	For Type I/II cement: Fly ash used as Al_2O_3 source For Type III clinker: Fly ash used as Al_2O_3, SiO_2, and Fe_2O_3, source.
Wet	1%	Blended with raw mix
Dry	5.5%	Fed into raw mill discharge riser duct and then blended with final kiln feed

In each of these plants, the use of fly ash in raw kiln feed produced normal clinkers showing satisfactory amounts and distribution of of C_3S, C_2S, C_3A, C_4AF, and interstitial phase in the final clinkers.

Everett (1995) reported using fly ash and iron ore tailings to completely eliminate the use of shale at one of the largest cement plants in North America. The practice successfully reduced the generation of cement kiln dust (CKD). Prior to the transition, the shale used at the plant was oil-bearing and contained about 5% sulfur. The use of this shale caused the plant to generate a large amount of CKD. By using appropriate proportions of fly ash (as a source of alumina) and iron ore (as a source of iron oxide), the shale was replaced and the CKD was reduced by at lest 50% while producing a low-alkali cement. Additionally, a significant reduction in both SO_2 and hydrocarbon emissions was realized.

The Ålborg Portland cement plant in Rørdal, Denmark, insufflated 10% fly ash directly into the burning zone (Miller 1980). The clinker was of good quality, showing normal phase distribution. Later in 1988, an improvement in the feeding system coupled with installation of a modern precalciner plant by Ålborg, further increased the use of fly ash to 24% in the raw feed without any detrimental effects either to the quality of the clinker or to the environment (Borgholm and Nielsen 1989). Reportedly, 2.3 million tons of fly ash have been processed, of which more than 50% were consumed as a raw feed component in cement manufacture (Borgholm 1992).

Two wet process plants in Belgium also used fly ash. Favorable change in slurry moisture, decreased dust loss, and reduced energy consumption were realized. Although the clinker showed an increased homogeneity of the major phases, it appeared overburned and hard to grind, causing

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 223

grinding energy to increase. It is possible that the overburning was partly caused by a failure to adequately compensate for the fuel value potentially present in the fly ash. Also, burnability may have improved and these effects may not have been compensated for in kiln operation.

A Japanese cement plant used silica-rich fly ashes as a partial substitute for clay in raw kiln feed (Mori 1982). A treatment plant at the Takehara power station was installed to control the fly ash composition and create a sustainable supply to produce cement clinker. The chemical compositions of the two fly ashes (A and B) and the clay used in the raw mix are given in Table 2.3.20. The fly ash replaced 20% to 40% clay depending on the compositional compatibility.

Table 2.3.20. Composition of Fly Ashes and Clay, Mass %

Material	SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	LOI
Fly ash A	51.0	26.2	7.1	5.5	1.5	3.9
Fly ash B	51.3	27.0	6.8	5.4	1.5	4.1
Clay	62.4	17.2	1.5	6.3	2.2	7.4

Harada (1991) also reported a case study of recovery and utilization of fly ash and its major use in clinker manufacture. Fly ash replaced clay in the cement raw mix. No problems were encountered either with the granularity or with the presence of limited unburned carbon in the fly ash.

Mullick and Ahluwalia (1992) reported the use of fly ash in Indian cement manufacturing. The composition of the fly ashes used was close to that of clay, which was replaced fully or partially in the cement raw mix. Gore and others (1992) replaced 6% clay with fly ash in a wet process raw feed. The modification in the raw feed brought about by fly ash gave several material, operational, and energy benefits. Lime combinability of the raw mix with and without the fly ash addition is shown in Figure 2.3.7.

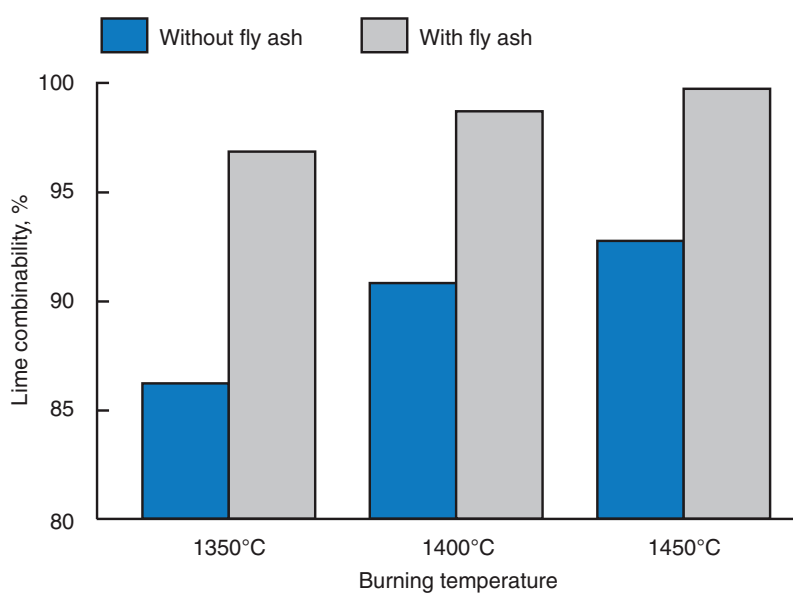

Figure 2.3.7. Lime combinability of the raw mix with and without the fly ash addition.

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 224

Kelly (1994) reported that control of the lime saturation factor, silica ratio, and alumina ratio for a target clinker was superior when raw mixes contained fly ash as compared to an equivalent amount of shale. This was demonstrated by replacing shale with 3.2% fly ash. The addition of fly ash also enhanced the C_3A level of clinker, with equivalent C_3S and C_2S contents, as shown in Table 2.3.21.

Table 2.3.21. Raw Mix Parameters and Clinker Phases with and without Fly Ash Additions

Raw mix composition	Silica modulus	Lime saturation factor	Alumina modulus	C_3S	C_2S	C_3A
With fly ash	3.1	95	1.5	62.4	17.2	6.6
Without fly ash	3.1	94.0	1.1	62.4	17.8	3.5

The early-age strength gain of cement prepared from these clinkers was superior to that of the control. In addition, an increased C_3A content allowed more opportunity to optimize the early setting and strength properties of cement. This increased opportunity occurred because gypsum could be added to the clinker over a wider range of concentrations during the finish grinding.

In general, the following processing, operational, and product benefits are observed from the use of fly ash as a component in cement raw kiln feed:

- Improved burnability, resulting in lower burning temperatures and a savings in fuel
- Increased clinker production
- No apparent deterioration in clinker quality
- Reduced SO_2, hydrocarbon, and NO_X emissions (in the wet process) for some plants and fly ashes
- Reduced generation of cement kiln dust

Since fly ash is a free-flowing particulate material, readily mixed and blended, additional benefits include:

- Reduced material processing cost
- Reduced dusting due to reduced comminution of raw materials

However, some noteworthy adverse effects of using fly ash are also reported. Some fly ashes cause reduced plasticity of the feed slurry in the wet process, while in a dry process plant, the fly ash resulted in an increased volatilization of alkalis that can cause blockages in preheaters. The overall alkali content was higher in the fly ash mixes than that of the control.

High-Carbon Fly Ash

With the installation of low-NO_X burners and other emission-reducing measures at coal-fired power plants, increasing amounts of high-carbon fly ashes are generated throughout the U.S. Although, several companies have developed processes to remove carbon from the fly ash; this is not practical for all high carbon fly ash.

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 225

High carbon fly ash offers two major benefits to the cement manufacturing process. First, the fly ash can partially replace raw materials such as shale and clay (as discussed above), and second, the carbon content of the fly ash can provide a fuel supplement during the clinker-firing process. Bhatty and others (in various papers from 2000 through 2003) demonstrated the use of a fly ash containing varying amounts of unburned carbon up to 20%. Multiple demonstrations performed from several hours to several days in preheater, precalciner, and long-dry process plants were conducted. In all of the demonstrations, the high-carbon fly ash was blended with the raw materials (crushed limestone and a small amount of shale) and ground into raw feed. With the high carbon fly ash, the kilns commonly operated in a more efficient, stable, and predictable manner.

The composition of the fly ash used in one of the demonstrations at a suspension preheater plant is shown in Table 2.3.22. In this demonstration, the composition of the raw feed was targeted to the normal raw feed. The fly ash composition and that of other raw materials (limestone and shale) limited the fly ash substitution amount to 6%. The total heat content (calorific value) of the ash was estimated to be greater than 740 kJ/kg, corresponding to an anticipated energy contribution from the fly ash of 67 kJ/kg of clinker. Consequently, the cement plant realized a fuel savings of nearly 4%, and an increase in clinker production of almost 10%.

Characteristics of clinker produced during the demonstration as evaluated by XRF, XRD, and free-lime tests are shown in Table 2.3.23. The XRF analysis indicates lower sulfate and alkalies in the fly ash clinker than in the control. Figure 2.3.8 shows the major phase distribution in the clinker.

Table 2.3.22. Oxide Composition of the High-Carbon Fly Ash, Mass %

Analyte	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O*	K_2O*	TiO_2	LOI
Mass %	42.95	15.46	7.1	4.47	1.3	0.49	1.88	2.5	1.08	20.8

*Composite contains 3.53% Na_2O equivalent alkalis, and has moisture content of 0.33%.

Table 2.3.23. Select Oxide Composition of Clinkers, Mass %

Analyte	Before demonstration	During demonstration
SiO_2	20.07	21.57
Al_2O_3	5.45	5.98
Fe_2O_3	2.49	2.59
CaO	64.09	64.60
MgO	2.44	2.47
SO_3	2.43	0.59
Na_2O	0.40	0.39
K_2O	1.28	0.56
Loss on Ignition (950°C)	0.10	0.09
Alkalies as Na_2O	1.24	0.76
Free Lime	2.98	0.44

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 226

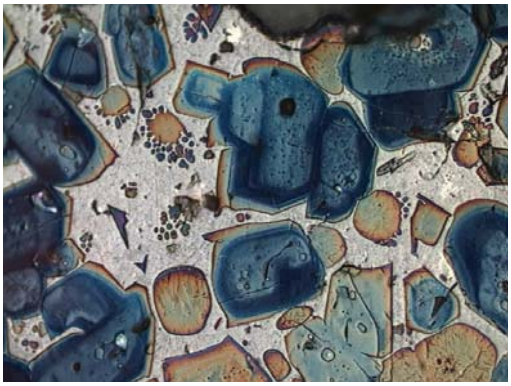

Figure 2.3.8. Clinker produced from raw feed containing high-carbon fly ash, showing typical major clinker phases.

Test results and ASTM C150 standard physical requirements for cements presented in Table 2.3.24 showed that the demonstration cement is comparable to the normally produced cement of the plant.

A similar study for Electric Power Research Institute (EPRI) was carried out by Bhatty and others (1998) on several high-carbon fly ashes (carbon ranging from 6% to 16%) produced similar results. The ashes were used as a component for raw feeds collected from cement plants across the U.S. Clinkers and cement were produced from these mixes and tested. The data indicated that clinkers had normal formation and distribution of the major clinker phases, and the cement had strength and setting properties comparable to those produced at the actual cement plants.

A cement plant in Canada has also used up to 10% high-carbon fly ash as a raw kiln feed component. The primary motivation for the plant is fuel savings.

Table 2.3.24. ASTM C150 Data for Cements Produced Before and During the Demonstration

Cement	Compressive strength, MPa			Air content, %	Time of set, minutes		Autoclave expansion, %
	3-day	7-day	28-day		Initial	Final	
Before	25.9	31.0	40.5	7.8	85	180	0.12
During	25.2	28.9	41.9	8.1	105	210	0.07

Bottom Ash

Bottom ash is also a by-product from coal-fired power plants. Typically, a bottom ash is composed of partially fused coarse-sized particles. The ash is rich in silica, iron, and alumina and is suitable as a replacement for shale and clay, and iron (as a corrective material) in cement raw feed. Compositions of select bottom ashes are shown in Table 2.3.25.

In the long dry and preheater cement manufacturing processes, bottom ash is generally blended with the raw mix prior to grinding. In the wet process, however, the bottom ash and clay are combined during the clay-wash process and added to the raw feed. Bottom ash is typically added as 2% to 5% of the raw feed, and produces clinkers showing satisfactory distribution of C_3S, C_2S, C_3A, C_4AF, and interstitial phase. The cements also display acceptable chemical and physical properties.

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 227

Table 2.3.25. Composition of Bottom Ashes, Mass %

Bottom ash	SiO_2	Al_2O_3	CaO	Fe_2O_3	SO_3	MgO	LOI
A	41.5	16.8	3.8	28.9	0.7	0.9	4.3
B	42.8	18.3	5.0	24.6	0.7	0.9	4.4

Ponded Ash

Pond ash is generally a mixture of fly ash and bottom ash from coal-fired power plants. The material is generally sluiced and stored in ponds. Millions of tons of ash have accumulated in ponds; Figure 2.3.9 shows one of the ponds holding ash generated from a power plant in the United States.

Figure 2.3.9. Ponded combustion wastes from a coal fired power plant.

Singh and others (1995) used ponded ash as a reactive component in the raw mix in a vertical shaft kiln. Use of 4% pond ash gave optimum performance during the kiln operation. Composition of the pond ash used is shown in Table 2.3.26. The material is expected to reduce alkali contents more than the original material as a result of the aqueous leaching of alkalies. The ash also contained a high carbon content. The raw feed mixture containing fly ash was nodulized prior to firing.

The clinker produced was of acceptable quality and was easier to grind. This resulted in a savings in grinding energy. High carbon pond ashes are particularly well suited to shaft kiln operations where the fuel is typically incorporated into the raw feed. The use of ash also realized an improvement in clinker quality, energy conservation, and cement production for the plant. The partial composition of clinker produced with and without pond ash is shown in Table 2.3.27.

Chap. 2.3.qxd: Chap. 2.3.qxd 4/3/11 2:01 PM Page 228

Table 2.3.26. Composition of Pond Ash Used in Cement Operation, Mass %

Analyte	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	LOI
Mass %	49.6	22.0	4.5	2.2	0.6	17.4

Table 2.3.27. Composition of Clinkers from Raw Mixes With and Without Pond Ash

Clinker	Phase distribution, mass %				Free lime, mass %
	C_3S	C_2S	C_3A	C_4AF	
With Pond Ash	48.7	20.6	9.9	14.6	1.6
Without Pond Ash	40.5	28.5	8.9	14.0	2.8

Table 2.3.28. Strength and Setting Data of Cements from Raw Mix With and Without Pond Ash

Cement	Compressive strength, MPa				Setting time, min.	
	1-day	3-day	7-day	28-day	Initial	Final
With Pond Ash	19.0	30.5	40.0	48.5	140	235
Without Pond Ash	18.0	26.0	34.2	45.0	135	230

As expected, the strength properties of cement made with pond ash clinkers were better than the control clinker because of higher C_3S content. Setting properties were comparable. Strength and setting data is shown in Table 2.3.28.

Coal Processing Wastes

Coal processing waste, also known as coal prep waste, is generated by washing coal to remove much of the non-combustible portion. Several million tons of this material are generated in the U.S. each year. Most of this material is discarded. Figure 2.3.10 shows a typical coal prep waste disposal site.

Figure 2.3.10. Landfill of coal prep-waste next to a coal mine.

Depending on the coal source and the washing process, significant amounts of carbon can be contained in the coal prep waste. Coal prep wastes investigated by Bhatty and others (2003, 2006) had fuel values ranging from 4000 to 11000 Btu/lb and variable ash contents from 10 to 60%, depending on the source.

Bhatty and others (2003, 2006) conducted two large-scale demonstrations using coal prep waste. In both cases, the coal prep waste was blended and burned with the plant coal. Moisture contents were high enough (approximately 25%) that the coal prep waste required air drying prior to use. To facilitate this, the coal prep waste was spread out on the ground by heavy equipment. This adequately dried the coal prep waste, although the coal prep waste could also have been forcibly air dried. In the first demonstration, coal prep waste replaced 10% of the plant coal.

Exhibit B

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202-366-4000

Federal Highway Administration Research and Technology
Coordinating, Developing, and Delivering Highway Transportation Innovations

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User Guidelines for Waste and Byproduct Materials in Pavement Construction

[Embankment or Fill] [Stabilized Base] [Flowable Fill] [Material Description] [Asphalt Concrete]

COAL FLY ASH **User Guideline**

Portland Cement Concrete

INTRODUCTION

Coal fly ash has been successfully used in Portland cement concrete (PCC) as a mineral admixture, and more recently as a component of blended cement, for nearly 60 years. As an admixture, fly ash functions as either a partial replacement for, or an addition to, Portland cement and is added directly into ready-mix concrete at the batch plant. Fly ash can also be interground with cement clinker or blended with Portland cement to produce blended cements. ASTM C595[(1)] defines two blended cement products in which fly ash has been added: 1) Portland-pozzolan cement (Type IP), containing 15 to 40 percent pozzolan, or 2) Pozzolan modified Portland cement (Type I-PM), containing less than 15 percent pozzolan.

ASTM C618 defines two classes of fly ash for use in concrete: 1) Class F, usually derived from the burning of anthracite or bituminous coal, and 2) Class C, usually derived from the burning of lignite or subbituminous coal.[(2)] ASTM C618 also delineates requirements for the physical, chemical, and mechanical properties for these two classes of fly ash. Class F fly ash is pozzolanic, with little or no cementing value alone. Class C fly ash has self-cementing properties as well as pozzolanic properties.

PERFORMANCE RECORD

A 1992 survey of all 50 state transportation agencies indicated that 40 states have had experience in the use of fly ash as a mineral admixture in concrete, usually as a partial replacement for Portland cement, although a number of states have also used blended Portland-pozzolan cement. Virtually all 40 of these states have used fly ash in concrete pavements and shoulders. This same survey indicated that 44 states had specifications for the use of fly ash as a partial replacement for Portland cement in concrete.[(3)]

At the time of this survey, at least eight states did not permit the use of fly ash in either bridge deck or structural concrete. A number of states also did not permit the use of fly ash in white concrete items, such as curbs, sidewalks, and median barriers, and two states (Arkansas and New Mexico) reported questionable performance experience: Arkansas had temporarily discontinued the use of fly ash in bridge deck concrete,

and New Mexico had a temporary moratorium on the use of Class C fly ash in concrete, pending further investigation.[4]

The principal benefits ascribed to the use of fly ash in concrete include enhanced workability due to spherical fly ash particles, reduced bleeding and less water demand, increased ultimate strength, reduced permeability and chloride ion penetration, lower heat of hydration, greater resistance to sulfate attack, greater resistance to alkali-aggregate reactivity, and reduced drying shrinkage.[5]

The main precautions usually associated with the use of fly ash in concrete include somewhat slower early strength development, extended initial setting time, possible difficulty in controlling air content, seasonal limitations during winter months, and quality control of fly ash sources.[5]

The use of Class F fly ash usually results in slower early strength development, but the use of Class C fly ash does not and may even enhance early strength development.

MATERIAL PROCESSING REQUIREMENTS

Source Control

To ensure the quality of fly ash for use in PCC, the following sources of ash should be avoided:

- Ash from a peaking plant instead of a base loaded plant.
- Ash from plants burning different coals or blends of coal.
- Ash from plants burning other fuels (wood chips, tires, trash) blended with coal.
- Ash from plants using oil as a supplementary fuel.
- Ash from plants using precipitator additives, such as ammonia.
- Ash from start-up or shut-down phases of operation.
- Ash from plants not operating at a "steady state."
- Ash that is handled and stored using a wet system.

The net result of all these restrictions is that only a relatively low percentage (25 to 30 percent, at most) of all the coal fly ash produced annually is even potentially suitable for use in PCC.

Drying or Conditioning

When used in blended cement or as a partial replacement for Portland cement in ready-mix concrete, fly ash must be in a dry form and as such requires no processing. When used as a raw feed material for the production of Portland cement, either dry or conditioned ash can be used.

Quality Control

Fly ash used in concrete should be as consistent and uniform as possible. Fly ash to be used in concrete should be monitored by a quality assurance/quality control (QA/QC) program that complies with the recommended procedures in ASTM C311.[6] These procedures establish standards for methods of sampling and frequency of performing tests for fineness, loss on ignition (LOI), specific gravity, and pozzolanic activity such that the consistency of a fly ash source can be certified.

Many state transportation agencies, through their own program of sampling and testing, have been able to prequalify sources of fly ash within their own state (or from nearby states) for acceptance in ready-mixed concrete. Prequalification of fly ashes from different sources provides an agency with a certain level of confidence in the event fly ashes from different sources are to be used in the same project.

ENGINEERING PROPERTIES

Some of the engineering properties of fly ash that are of particular interest when fly ash is used as an admixture or a cement addition to PCC mixes include fineness, LOI, chemical composition, moisture content, and pozzolanic activity. Most specifying agencies refer to ASTM C618[2] when citing acceptance criteria for the use of fly ash in concrete.

Fineness: Fineness is the primary physical characteristic of fly ash that relates to pozzolanic activity. As the fineness increases, the pozzolanic activity can be expected to increase. Current specifications include a requirement for the maximum allowable percentage retained on a 0.045 mm (No. 325) sieve when wet sieved.

ASTM C618 specifies a maximum of 34 percent retained on a 0.045 mm (No. 325) sieve. Fineness can also be assessed by methods that estimate specific surface area, such as the Blaine air permeability test[7] commonly used for Portland cement.

Pozzolanic Activity (Chemical Composition and Mineralogy):Pozzolanic activity refers to the ability of the silica and alumina components of fly ash to react with available calcium and/or magnesium from the hydration products of Portland cement. ASTM C618 requires that the pozzolanic activity index with Portland cement, as determined in accordance with ASTM C311,[6] be a minimum of 75 percent of the average 28-day compressive strength of control mixes made with Portland cement.

Loss on Ignition: Many state transportation departments specify a maximum LOI value that does not exceed 3 or 4 percent, even though the ASTM criteria is a maximum LOI content of 6 percent.[2] This is because carbon contents (reflected by LOI) higher than 3 to 4 percent have an adverse effect on air entrainment.

Fly ashes must have a low enough LOI (usually less than 3.0 percent) to satisfy ready-mix concrete producers, who are concerned about product quality and the control of air-entraining admixtures. Furthermore, consistent LOI values are almost as important as low LOI values to ready-mix producers, who are most concerned with consistent and predictable quality.

Moisture Content: ASTM C618 specifies a maximum allowable moisture content of 3.0 percent.

Some of the properties of fly ash-concrete mixes that are of particular interest include mix workability, time of setting, bleeding, pumpability, strength development, heat of hydration, permeability, resistance to freeze-thaw, sulfate resistance, and alkali-silica reactivity.

Workability: At a given water-cement ratio, the spherical shape of most fly ash particles permits greater workability than with conventional concrete mixes. When fly ash is used, the absolute volume of cement plus fly ash usually exceeds that of cement in conventional concrete mixes. The increased ratio of solids volume to water volume produces a paste with improved plasticity and more cohesiveness.[8]

Time of Setting: When replacing up to 25 percent of the Portland cement in concrete, all Class F fly ashes and most Class C fly ashes increase the time of setting. However, some Class C fly ashes may have little effect on, or possibly even decrease, the time of setting. Delays in setting time will probably be more pronounced, compared with conventional concrete mixes, during the cooler or colder months.[8]

Bleeding: Bleeding is usually reduced because of the greater volume of fines and lower required water content for a given degree of workability.[8]

Pumpability: Pumpability is increased by the same characteristics affecting workability, specifically, the lubricating effect of the spherical fly ash particles and the increased ratio of solids to liquid that makes the concrete less prone to segregation.[8]

Strength Development: Previous studies of fly ash concrete mixes have generally confirmed that most mixes that contain Class F fly ash that replaces Portland cement at a 1:1 (equal weight) ratio gain compressive strength, as well as tensile strength, more slowly than conventional concrete mixes for up to as long as 60 to 90 days. Beyond 60 to 90 days, Class F fly ash concrete mixes will ultimately exceed the strength of conventional PCC mixes.[5] For mixes with replacement ratios from 1.1 to 1.5:1 by weight of Class F fly ash to the Portland cement that is being replaced, 28-day strength development is approximately equal to that of conventional concrete.

Class C fly ashes often exhibit a higher rate of reaction at early ages than Class F fly ashes. Some Class C fly ashes are as effective as Portland cement in developing 28-day strength.[9] Both Class F and Class C fly ashes are beneficial in the production of high-strength concrete. However, the American Concrete Institute (ACI) recommends that Class F fly ash replace from 15 to 25 percent of the Portland cement and Class C fly ash replace from 20 to 35 percent.[10]

Heat of Hydration: The initial impetus for using fly ash in concrete stemmed from the fact that the more slowly reacting fly ash generates less heat per unit of time than the hydration of the faster reacting Portland cement. Thus, the temperature rise in large masses of concrete (such as dams) can be significantly reduced if fly ash is substituted for cement, since more of the heat can be dissipated as it develops. Not only is the risk of thermal cracking reduced, but greater ultimate strength is attained in concrete with fly ash because of the pozzolanic reaction.[8] Class F fly ashes are generally more effective than Class C fly ashes in reducing the heat of hydration.

Permeability: Fly ash reacting with available lime and alkalies generates additional cementitious compounds that act to block bleed channels, filling pore space and reducing the permeability of the hardened concrete.[5] The pozzolanic reaction consumes calcium hydroxide ($Ca(OH)_2$), which is leachable, replacing it with insoluble calcium silicate hydrates (CSH).[8] The increased volume of fines and reduced water content also play a role.

Resistance to Freeze-Thaw: As with all concretes, the resistance of fly ash concrete to damage from freezing and thawing depends on the adequacy of the air void system, as well as other factors, such as strength development, climate, and the use of deicer salts. Special attention must be given to attaining the proper amount of entrained air and air void distribution. Once fly ash concrete has developed adequate strength, no significant differences in concrete durability have usually been observed.[8] There should be no more tendency for fly ash concrete to scale in freezing and thawing exposures than conventional concrete, provided the fly ash concrete has achieved its design strength and has the proper air void system.

Sulfate Resistance: Class F fly ash will generally improve the sulfate resistance of any concrete mixture in which it is included.[11] Some Class C fly ashes may improve sulfate resistance, while others may actually reduce sulfate resistance[12] and accelerate deterioration.[13] Class C fly ashes should be individually tested before use in a sulfate environment. The relative resistance of fly ash to sulfate deterioration is reportedly a function of the ratio of calcium oxide to iron oxide.[12]

Alkali-Silica Reactivity: Class F fly ash has been effective in inhibiting or reducing expansive reactions resulting from the alkali-silica reaction. In theory, the reaction between the very small particles of amorphous silica glass in the fly ash and the alkalis in the Portland cement, as well as the fly ash, ties up the alkalis in a nonexpansive calcium-alkali-silica gel, preventing them from reacting with silica in aggregates, which can result in expansive reactions. However, because some fly ashes (including some Class C fly ashes) may have appreciable amounts of soluble alkalis, it is necessary to test materials to be used in the field to ensure that expansion due to alkali-silica reactivity will be reduced to safe levels.[8]

Fly ash, especially Class F fly ash, is effective in three ways in substantially reducing alkali-silica expansion: 1) it produces a denser, less permeable concrete; 2) when used as a cement replacement it reduces total alkali content by reducing the Portland cement; and 3) alkalis react with fly ash instead of reactive silica aggregates.[14] Class F fly ashes are probably more effective than Class C fly ashes because of their higher silica content, which can react with alkalis. Users of Class C fly ash are cautioned to carefully evaluate the long-term volume stability of concrete mixes in the laboratory prior to field use, with ASTM C441[15] as a suggested method of test.

DESIGN CONSIDERATIONS

Mix Design

Concrete mixes are designed by selecting the proportions of the mix components that will develop the required strength, produce a workable consistency concrete that can be handled and placed easily, attain sufficient durability under exposure to in-service environmental conditions, and be economical. Procedures for proportioning fly ash concrete mixes differ slightly from those for conventional concrete mixes. Basic mix design guidelines for normal concrete [16] and high-strength concrete are provided by ACI.[10]

One mix design approach commonly used in proportioning fly ash concrete mixes is to use a mix design with all Portland cement, remove some of the Portland cement, and then add fly ash to compensate for the cement that is removed. Class C fly ash is usually substituted at a 1:1 ratio. Class F fly ash may also be substituted at a 1:1 ratio, but is sometimes specified at a 1.25:1 ratio, and in some cases may even be substituted at a 1.5:1 ratio.[5] There are some states that require that fly ash be added in certain mixes with no reduction in cement content.

The percentage of Class F fly ash used as a percent of total cementitious material in typical highway pavement or structural concrete mixes usually ranges from 15 to 25 percent by weight.[5] This percentage usually ranges from 20 to 35 percent when Class C fly ash is used.[10]

Mix design procedures for normal, as well as high-strength, concrete involve a determination of the total weight of cementitious materials (cement plus fly ash) for each trial mixture that is being investigated in the laboratory. The ACI mix proportioning guidelines recommend a separate trial mix for each 5-percent increment in the replacement of Portland cement by fly ash. If fly ash is to replace Portland cement on an equal weight (1:1) basis, the total weight of cementitious material in each trial mix will remain the same. However, because of

Exhibit C

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User Guidelines for Waste and Byproduct Materials in Pavement Construction

[Asphalt Concrete] [Granular Base] [Stabilized Base]

COAL BOTTOM ASH/ BOILER SLAG — **Material Description**

ORIGIN

Coal bottom ash and boiler slag are the coarse, granular, incombustible by-products that are collected from the bottom of furnaces that burn coal for the generation of steam, the production of electric power, or both. The majority of these coal by-products are produced at coal-fired electric utility generating stations, although considerable bottom ash and/or boiler slag are also produced from many smaller industrial or institutional coal-fired boilers and from coal-burning independent power production facilities. The type of by-product (i.e., bottom ash or boiler slag) produced depends on the type of furnace used to burn the coal.

Bottom Ash

The most common type of coal-burning furnace in the electric utility industry is the dry, bottom pulverized coal boiler. When pulverized coal is burned in a dry, bottom boiler, about 80 percent of the unburned material or ash is entrained in the flue gas and is captured and recovered as fly ash. The remaining 20 percent of the ash is dry bottom ash, a dark gray, granular, porous, predominantly sand size minus 12.7mm (½ in) material that is collected in a water-filled hopper at the bottom of the furnace.(1) When a sufficient amount of bottom ash drops into the hopper, it is removed by means of high-pressure water jets and conveyed by sluiceways either to a disposal pond or to a decant basin for dewatering, crushing, and stockpiling for disposal or use.(2) During 1996, the utility industry generated 14.5 million metric tons (16.1 million tons) of bottom ash.(3)

Boiler Slag

There are two types of wet-bottom boilers: the slag-tap boiler and the cyclone boiler. The slag-tap boiler burns pulverized coal and the cyclone boiler burns crushed coal. In each type, the bottom ash is kept in a molten state and tapped off as a liquid. Both boiler types have a solid base with an orifice that can be opened to permit the molten ash that has collected at the base to flow into the ash hopper below. The ash hopper in wet-bottom furnaces contains quenching water. When the molten slag comes in contact with the quenching water, it

fractures instantly, crystallizes, and forms pellets. The resulting boiler slag, often referred to as "black beauty," is a coarse, hard, black, angular, glassy material.

When pulverized coal is burned in a slag-tap furnace, as much as 50 percent of the ash is retained in the furnace as boiler slag. In a cyclone furnace, which burns crushed coal, some 70 to 80 percent of the ash is retained as boiler slag, with only 20 to 30 percent leaving the furnace in the form of fly ash.[1]

Wet-bottom boiler slag is a term that describes the molten condition of the ash as it is drawn from the bottom of the slag-tap or cyclone furnaces. At intervals, high-pressure water jets wash the boiler slag from the hopper pit into a sluiceway which is then conveys it to a collection basin for dewatering, possible crushing or screening, and either disposal or reuse.[4] During 1995, the utility industry in the United States generated 2.3 million metric tons (2.6 million tons) of boiler slag.[1]

A general diagram depicting the production and processing operations associated with bottom ash and boiler slag management is presented in Figure 4-1.

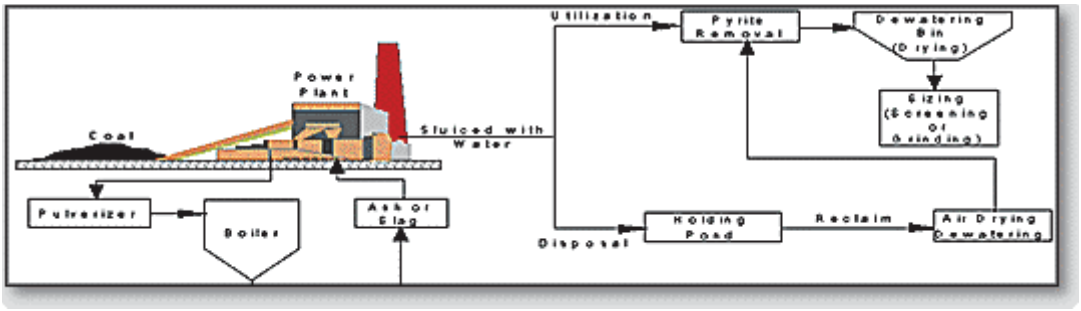

Figure 4-1. Production and processing of bottom ash or boiler slag.

Additional information on the use of bottom ash and/or boiler slag can be obtained from:

American Coal Ash Association (ACAA)
2760 Eisenhower Avenue, Suite 304
Alexandria, Virginia 22314

Electric Power Research Institute
3412 Hillview Road
Palo Alto, California 94304

CURRENT MANAGEMENT OPTIONS

Recycling

According to recent statistics on coal combustion by-product utilization, 30.3 percent of all bottom ash and 93.3 percent of all boiler slag produced in 1996 were utilized. Leading bottom ash applications are snow and ice control, as aggregate in lightweight concrete masonry units, and raw feed material for production of Portland cement. Bottom ash has also been used as a road base and subbase aggregate, structural fill material[5], and as fine aggregate in asphalt paving and flowable fill. Leading boiler slag applications are blasting grit, roofing shingle granules, and snow and ice control. Boiler slag has also been used as an aggregate in asphalt paving, as a structural fill,[5]and in road base and subbase applications.[2]

The U.S. EPA is presently undertaking a study of power plant wastes prior to disposal by the utility. It is possible that EPA's study on mixed power plant wastes could have a regulatory impact on beneficial use or reuse of any mixed materials. It is anticipated that this investigation will be completed in 1998.

Disposal

Discarded bottom ash and boiler slag are either landfilled or sluiced to storage lagoons. When sluiced to storage lagoons, the bottom ash or boiler slag is usually combined with fly ash. This blended fly ash and bottom ash or boiler slag are referred to as ponded ash. Approximately 30 percent of all coal ash is handled wet and disposed of as ponded ash.[3]

Ponded ash is potentially useable, but variable in its characteristics because of its manner of disposal. Because of differences in the unit weight of fly ash and bottom ash or boiler slag, the coarser bottom ash or boiler slag particles settle first and the finer fly ash remains in suspension longer. Ponded ash can be reclaimed and stockpiled, during which time it can be dewatered. Under favorable drying conditions, ponded ash may be dewatered into a range of moisture that will be within the vicinity of its optimum moisture content. The higher the percentage of bottom ash or boiler slag there is in ponded ash, the easier it is to dewater and the greater its potential for reuse. Reclaimed ponded ash has been used in stabilized base or subbase mixes and in embankment construction, and can also be used as fine aggregate or filler material in flowable fill.

MARKET SOURCES

Although electric utility companies produce ash at their coal-fired power plants, most utilities do not handle, dispose of, or sell the ash that they produce. For the most part, management of bottom ash or boiler slag is contracted out to ash marketing firms or to local hauling contractors. There are approximately 50 commercial ash marketing firms operating throughout the United States, in all states except Hawaii. In addition to commercial ash marketing organizations, certain coal-burning electric utility companies have a formal ash marketing program of their own. Most coal-burning electric utility companies currently employ an ash marketing specialist, who is responsible for monitoring ash generation, quality, use or disposal, and for interfacing with the ash marketers or brokers who are under contract to the utility companies.

HIGHWAY USES AND PROCESSING REQUIREMENTS

Asphalt Concrete Aggregate (Bottom Ash and Boiler Slag)

Both bottom ash and boiler slag have been used as fine aggregate substitute in hot mix asphalt wearing surfaces and base courses, and emulsified asphalt cold mix wearing surfaces and base courses. Because of the "popcorn," clinkerlike low durability nature of some bottom ash particles, bottom ash has been used more frequently in base courses than wearing surfaces. Boiler slag has been used in wearing surfaces, base courses and asphalt surface treatment or seal coat applications. There are no known uses of bottom ash in asphalt surface treatment or seal coat applications.

Screening of oversized particles and blending with other aggregates will typically be required to use bottom ash and boiler slag in paving applications. Pyrites that may be present in the bottom ash should also be removed (with electromagnets) prior to use. Pyrites (iron sulfide) are volumetrically unstable, expansive, and produce a reddish stain when exposed to water over an extended time period.

Granular Base (Bottom Ash and Boiler Slag)

Both bottom ash and boiler slag have occasionally been used as unbound aggregate or granular base material for pavement construction. Bottom ash and boiler slag are considered fine aggregates in this use. To meet required specifications, the bottom ash or slag may need to be blended with other natural aggregates prior to its use as a base or subbase material. Screening or grinding may also be necessary prior to use, particularly for the bottom ash, where large particle sizes, typically greater than 19 mm (3/4 in), are present in the ash.

Stabilized Base Aggregate (Bottom Ash and Boiler Slag)

Bottom ash and boiler slag have been used in stabilized base applications. Stabilized base or subbase mixtures contain a blend of an aggregate and cementitious materials that bind the aggregates, providing the mixture with greater bearing strength. Types of cementitious materials typically used include Portland cement, cement kiln dust, or pozzolans with activators, such as lime, cement kiln dusts, and lime kiln dusts. When constructing a stabilized base using either bottom ash or boiler slag, both moisture control and proper sizing are required. Deleterious materials such as pyrites should also be removed.

Embankment or Backfill Material (Mainly Bottom Ash)

Bottom ash and ponded ash have been used as structural fill materials for the construction of highway embankments and/or the backfilling of abutments, retaining walls, or trenches. These materials may also be used as pipe bedding in lieu of sand or pea gravel. To be suitable for these applications, the bottom ash or ponded ash must be at or reasonably close to its optimum moisture content, free of pyrites and/or "popcorn" like particles, and must be non-corrosive. Reclaimed ponded ash must be stockpiled and adequately dewatered prior to use. Bottom ash may require screening or grinding to remove or reduce oversize materials (greater than 19 mm (3/4 in) in size.

Flowable Fill Aggregate (Mainly Bottom Ash)

Bottom ash has been used as an aggregate material in flowable fill mixes. Ponded ash also has the potential for being reclaimed and used in flowable fill. Since most flowable fill mixes involve the development of comparatively low compressive strength (in order to be able to be excavated at a later time, if necessary), no advance processing of bottom ash or ponded ash is needed. Neither bottom ash nor ponded ash needs to be at any particular moisture content to be used in flowable fill mixes because the amount of water in the mix can be adjusted in order to provide the desired flowability.

MATERIAL PROPERTIES

Physical Properties

Bottom ashes have angular particles with a very porous surface texture. Bottom ash particles range in size from a fine gravel to a fine sand with very low percentages of silt-clay sized particles. The ash is usually a well-graded material, although variations in particle size distribution may be encountered in ash samples taken from the same power plant at different times. Bottom ash is predominantly sand-sized, usually with 50 to 90 percent passing a 4.75 mm (No. 4) sieve, 10 to 60 percent passing a 0.42 mm (No. 40) sieve, 0 to 10 percent passing a 0.075 mm (No. 200) sieve, and a top size usually ranging from 19 mm (3/4 in) to 38.1 mm (1-1/2 in). Table 4-1 compares the typical gradations of bottom ash and boiler slag.

Table 4-1. Particle size distribution of bottom ash and boiler slag.[4]
(percent by weight passing)

	Bottom Ash			Boiler Slag		
Sieve Size	**Glasgow, WV**	**New Haven, WV**	**Moundsville, WV**	**Willow Island, WV**	**Rockdale, TX**	**Moundsville, WV**
38 mm (1-1/2 in)	100	99	100	100	100	100
19 mm (3/4 in)	100	95	100	100	100	100
9.5 mm (3/8 in)	100	87	73	99	100	97
4.75 mm (No. 4)	90	77	52	97	99	90
2.36 mm (No. 8)	80	57	32	85	88	62
1.18 mm (No. 16)	72	42	17	46	42	16
0.60 mm (No. 30)	65	29	10	23	10	4
0.30 mm (No. 50)	56	19	5	12	5	2
0.15 mm (No. 100)	35	15	2	6	2	1
0.075 mm (No. 200)	9	4	1	4	1	0.5

Boiler slags are predominantly single-sized and within a range of 5.0 to 0.5 mm (No. 4 to No. 40 sieve). Ordinarily, boiler slags have a smooth surface texture, but if gases are trapped in the slag as it is tapped from the furnace, the quenched slag will become somewhat vesicular or porous. Boiler slag from the burning of lignite or subbituminous coal tends to be more porous than that of the eastern bituminous coals.[6] Boiler slag is essentially a coarse to medium sand with 90 to 100 percent passing a 4.75 mm (No. 4) sieve, 40 to 60 percent passing a 2.0 mm (No. 10) sieve, 10 percent or less passing a 0.42 mm (No. 40) sieve, and 5 percent or less passing a 0.075 mm (No. 200) sieve.[4] The specific gravity of the dry bottom ash is a function of chemical composition, with higher carbon content resulting in lower specific gravity. Bottom ash with a low specific gravity has a porous or vesicular texture, a characteristic of popcorn particles that readily degrade under loading or compaction.[7] Table 4-2 lists some typical physical properties of bottom ash and boiler slags.

Table 4-2. Typical physical properties of bottom ash and boiler slag.

Property	Bottom Ash	Boiler Slag
Specific Gravity[6]	2.1 - 2.7	2.3 - 2.9
Dry Unit Weight[6]	720 - 1600 kg/m^3 (45 - 100 lb/ft^3)	960 - 1440 kg/m^3 (60 - 90 lb/ft^3)
Plasticity[6]	None	None
Absorption[4]	0.8 - 2.0%	0.3 - 1.1%

Chemical Properties

Bottom ash and boiler slag are composed principally of silica, alumina, and iron, with smaller percentages of calcium, magnesium, sulfates, and other compounds. The composition of the bottom ash or boiler slag particles is controlled primarily by the source of the coal and not by the type of furnace. Table4-3 presents a chemical analysis of selected samples of bottom ash and boiler slag from different coal types and different regions.

Table 4-3. Chemical composition of selected bottom ash and boiler slag samples (percent by weight).[4]

Ash Type:	Bottom Ash					Boiler Slag		
Coal Type:	Bituminous			Sub-bituminous	Lignite	Bituminous		Lignite
Location	West Virginia		Ohio	Texas		West Virginia		North Dakota
SiO_2	53.6	45.9	47.1	45.4	70.0	48.9	53.6	40.5
Al_2O_3	28.3	25.1	28.3	19.3	15.9	21.9	22.7	13.8
Fe_sO_3	5.8	14.3	10.7	9.7	2.0	14.3	10.3	14.2
CaO	0.4	1.4	0.4	15.3	6.0	1.4	1.4	22.4
MgO	4.2	5.2	5.2	3.1	1.9	5.2	5.2	5.6
Na_2O	1.0	0.7	0.8	1.0	0.6	0.7	1.2	1.7
K_2O	0.3	0.2	0.2	-	0.1	0.1	0.1	1.1

Bottom ash or boiler slag derived from lignite or sub-bituminous coals has a higher percentage of calcium than the bottom ash or boiler slag from anthracite or bituminous coals. Although sulfate is not shown in Table 4-2, it is usually very low (less than 1.0 percent), unless pyrites have not been removed from the bottom ash or boiler slag.

Due to the salt content and, in some cases, the low pH of bottom ash and boiler slag, these materials could exhibit corrosive properties. When using bottom ash or boiler slag in an embankment, backfill, subbase, or even possibly in a base course, the potential for corrosion of metal structures that may come in contact with the material is of concern and should be investigated prior to use.

Corrosivity indicator tests normally used to evaluate bottom ash or boiler slag are pH, electrical resistivity, soluble chloride content, and soluble sulfate content. Materials are judged to be noncorrosive if the pH exceeds 5.5, the electrical resistivity is greater than 1,500 ohm-centimeters, the soluble chloride content is less than 200 parts per million (ppm), or the soluble sulfate content is less than 1,000 parts per million (ppm).[8]

Mechanical Properties

Table 4-4 lists some typical values for bottom ash and boiler slag compaction characteristics (maximum dry density and optimum moisture), durability characteristics (Los Angeles abrasion and sodium soundness), shear strength and bearing strength characteristics (friction angle and), and permeability.

The maximum dry density values of bottom ash and boiler slag are usually from 10 to 25 percent lower than that of naturally occurring granular materials. The optimum moisture content values of bottom ash and boiler slag are both higher than those of naturally occurring granular materials, with bottom ash being considerably higher in optimum moisture content than boiler slag.

Boiler slag usually exhibits less abrasion loss and soundness loss than bottom ash because of its glassy surface texture and lower porosity.[9] In some power plants, coal pyrites are disposed of with the bottom ash or boiler slag. In such cases, some pyrite or soluble sulfate is contained in the bottom ash or boiler slag,[9] which

may be reflected in higher sodium sulfate soundness loss values. Reported friction angle values are within the same range as those for sand and other conventional fine aggregate sources.[7]

Table 4-4. Typical mechanical properties of bottom ash and boiler slag.

Property	Bottom Ash	Boiler Slag
Maximum Dry Density kg/m^3 (lb/ft^3)[7]	1210 - 1620 (75 - 100)	1330 - 1650 (82 - 102)
Optimum Moisture Content, %[7]	Usually <20 12 - 24 range	8 - 20
Los Angeles Abrasion Loss %[4]	30 - 50	24 - 48
Sodium Sulfate Soundness Loss %[4]	1.5 - 10	1 - 9
Shear Strength (Friction Angle)[6]	38 - 42° 32 - 45° (<9.5 mm size)	38 - 42° 36 - 46° (<9.5 mm size)
California Bearing Ratio (CBR) %[6]	40 - 70	40 - 70
Permeability Coefficient cm/sec[6]	10^{-2} - 10^{-3}	10^{-2} - 10^{-3}

California Bearing Ratio values are comparable to those of high-quality gravel base materials. Dry bottom ash and boiler slag can both be expected to have permeability coefficients that are within approximately the same range[7] The permeability is related to the percent fines (minus 0.075 mm or No. 200 sieve) of the material.

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Page Owner: Office of Research, Development, and Technology, Office of Safety, RDT

TRT Terms: Waste products as road materials--Handbooks, manuals, etc, Pavements, Asphalt concrete--Design and construction--Handbooks, manuals, etc, Pavements, Concrete--Design and construction--Handbooks, manuals, etc, Pavements--Additives--Handbooks, manuals, etc, Fills (Earthwork)--Design and construction--Handbooks, manuals, etc, Roads--Base courses--Design and construction--Handbooks, manuals, etc, Wastes, Environmental impacts, Recycling
Scheduled Update: Archive - No Update needed

This page last modified on 03/08/2016

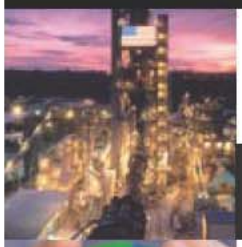
Exhibit D

PCA
Portland Cement Association

REPORT ON SUSTAINABLE MANUFACTURING

CONTENTS

LETTER FROM THE CHAIRMAN - PG. 2

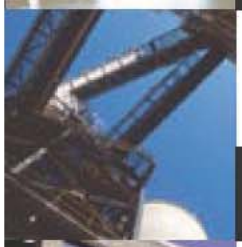


1 CEMENT, CONCRETE & VOLUNTARY GOALS PG. 3

2 SUSTAINABLE PRACTICES PG. 9

3 ENVIRONMENTAL PERFORMANCE PG. 13

4 COMMUNITY INVOLVEMENT PG. 18



5 WORKPLACE HEALTH & SAFETY PG. 20

6 SUSTAINABLE CONCRETE CONSTRUCTION PG. 22

Innovation

This category recognizes the development and application of innovative technologies and techniques relevant to environmental protection or energy efficiency.

Energy Efficiency

This category focuses on energy planning, applications of efficient technologies and practices, and climate change mitigation efforts.

Overall Environmental Excellence

A facility that demonstrates excellence in several or each of the above categories is recognized with this award.

2 SUSTAINABLE PRACTICES

RAW MATERIALS

Note: No cement plants in Alaska and Hawaii

For its raw material, cement utilizes four elements for its manufacture: calcium, silicon, aluminum, and iron. The most common combination of ingredients is limestone (for calcium), coupled with much smaller quantities of clay, iron ore, and sand (as sources of alumina, iron, and silica, respectively).

So common are these elements that a wide variety of raw materials are suitable. Cement is made with everything from sea shells and shale to industrial byproducts such as blast-furnace slag from steel plants and fly ash from coal-fired electric power plants. Cement plants are increasingly turning to industrial byproducts that otherwise would be discarded. After completing detailed analyses to determine the effects on product chemistry and facility emissions, many cement plants can utilize byproducts in the manufacture of clinker.

From 111 operating plants reporting in the PCA publication: 2010 U.S. and Canadian Portland Cement Industry: Plant Information Summary, 41 plants used blast furnace or iron slag as a raw material and 50 plants used fly ash or bottom ash from electric power plants.

Other alternative materials used by portland cement plants in 2010 included:

- Foundry sand
- Mill scale
- Synthetic gypsum

Exhibit E

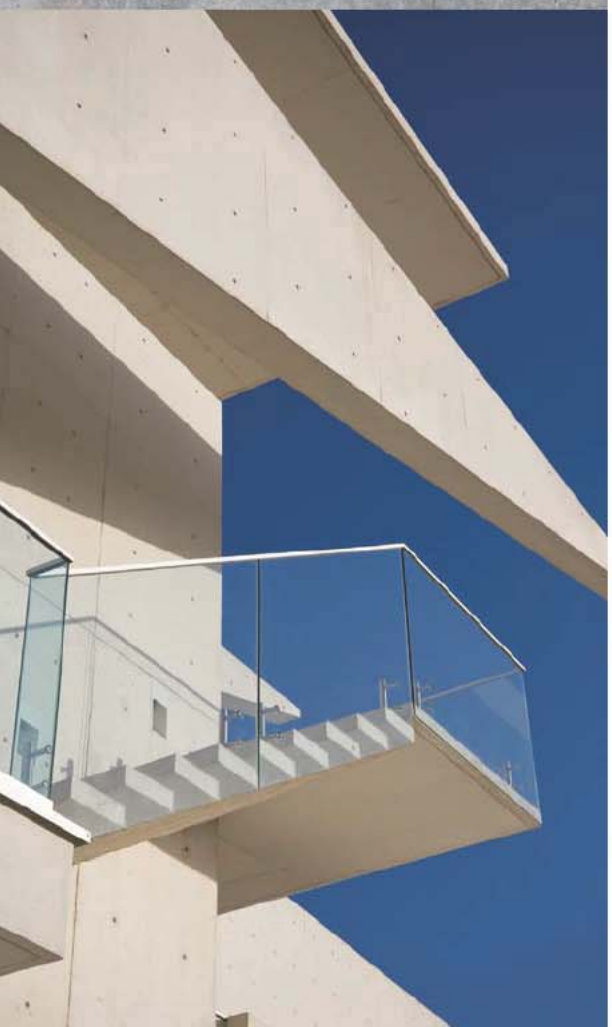
PCA
America's Cement Manufacturers™

ASTM INTERNATIONAL

ENVIRONMENTAL PRODUCT DECLARATION

Blended Cements

(per ASTM C595, ASTM C1157, AASHTO M 240 or CSA A3001)



Committed to Sustainability

The United States cement industry is dedicated to manufacturing a superior product while constantly improving energy efficiency, minimizing emissions, and reducing environmental impacts.

This Environmental Product Declaration (EPD) was developed to document the environmental impacts of our products. Inside, you will find ASTM-certified, ISO-compliant information on cement's environmental footprint, including energy use and global warming potential. This is intended for business-to-business communication.

Our goal is to balance society's need for cement products with stewardship of the air, land, and water along with conservation of energy and natural resources.

Cement or Concrete?

Cement is actually an ingredient of concrete. It is the fine powder that, when mixed with water, sand, and gravel or crushed stone, forms the rock-like mass known as concrete.

Cement acts as the binding agent or glue. A chemical reaction called hydration is triggered when water and cement are mixed in the right proportions. This reaction causes the cement to harden and bind the aggregate into a solid mass.

When freshly mixed, concrete can be molded into almost any form. Yet when hardened, its strength and durability often exceed that of natural stone.

ASTM Certification page

This document is a Type III industry-average Environmental Product Declaration (EPD) describing blended hydraulic cement produced in the United States (US). A list of cement production facilities who participated in the development of this EPD is included in Appendix A. The results of the underlying Life Cycle Assessment (LCA) are computed with the *U.S. version of the WBCSD-CSI tool for EPDs of concrete and cement* (WBCSD-CSI 2016).

The EPD is certified by ASTM to conform to the Product Category Rule (PCR) referenced below, as well as to the requirements of ISO 14025 (ISO 2006a) and ISO 21930 (ISO 2007). ASTM also verifies that the life cycle assessment (LCA) upon which it is based conforms to the requirements of ISO 14040 (ISO 2006b).

DECLARATION HOLDER	Portland Cement Association 5420 Old Orchard Road, Skokie, IL, USA, 60077-1083 — www.cement.org
DECLARATION NUMBER	EPD 033
DECLARED PRODUCT	Blended hydraulic cement
REFERENCE PCR	ASTM Product Category Rule for *Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements.*
PROGRAM OPERATOR	ASTM International 100 Barr Harbor Drive, West Conshohocken, PA, USA, 19428-2959 — www.astm.org
DATE OF ISSUE	June 1, 2016
PERIOD OF VALIDITY	June 1, 2016 to May 31, 2021
NOTES	The EPD results are computed using the *U.S. version of WBCSD-CSI tool for EPDs of concrete and cement* (https://concrete-epd-tool.org).

EPD Verification			
This EPD has been certified by an independent, external verifier in accordance with ISO 14025.			
Christopher Surak Director of Certification Services ASTM	Date verified May 27, 2016	Jamie Meil Research Principal Athena Sustainable Materials Institute	Date verified May 27, 2016

PCR Information	
Program Operator	ASTM International
Reference PCR	Product Category Rules For Preparing An Environmental Product Declaration For Portland, Blended Hydraulic, Masonry, Mortar and Plastic (Stucco) Cements
Date of Issue	September 2, 2014
PCR Review was conducted by:	Nick Santero, PE International (rebranded as thinkstep), Chairperson Hamid Farzam, Cemex Anthony Fiorato, Consultant

PCA
America's Cement Manufacturers™

ASTM INTERNATIONAL

ENVIRONMENTAL PRODUCT DECLARATION

Portland Cements

(per ASTM C150, ASTM C1157, AASHTO M 85 or CSA A3001)

Committed to Sustainability

The United States cement industry is dedicated to manufacturing a superior product while constantly improving energy efficiency, minimizing emissions, and reducing environmental impacts.

This Environmental Product Declaration (EPD) was developed to document the environmental impacts of our products. Inside, you will find ASTM-certified, ISO-compliant information on cement's environmental footprint, including energy use and global warming potential. This is intended for business-to-business communication.

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When freshly mixed, concrete can be molded into almost any form. Yet when hardened, its strength and durability often exceed that of natural stone.

ASTM Certification page

This document is a Type III industry-average Environmental Product Declaration (EPD) describing portland cement produced in the United States (US). A list of cement production facilities who participated in the development of this EPD is included in Appendix A. The results of the underlying Life Cycle Assessment (LCA) are computed with the *U.S. version of WBCSD-CSI tool for EPDs of concrete and cement* (WBCSD-CSI 2016).

The EPD is certified by ASTM to conform to the Product Category Rule (PCR) referenced below, as well as to the requirements of ISO 14025 (ISO 2006a) and ISO 21930 (ISO 2007). ASTM also verifies that the life cycle assessment (LCA) upon which it is based conforms to the requirements of ISO 14040 (ISO 2006b).

DECLARATION HOLDER	Portland Cement Association 5420 Old Orchard Road, Skokie, IL, USA, 60077-1083 — www.cement.org
DECLARATION NUMBER	EPD 035
DECLARED PRODUCT	Portland cement
REFERENCE PCR	ASTM Product Category Rule for *Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements.*
PROGRAM OPERATOR	ASTM International 100 Barr Harbor Drive, West Conshohocken, PA, USA, 19428-2959 — www.astm.org
DATE OF ISSUE	June 1, 2016
PERIOD OF VALIDITY	June 1, 2016 to May 31, 2021
NOTES	The EPD results are computed using the *U.S. version of WBCSD-CSI tool for EPDs of concrete and cement* (https://concrete-epd-tool.org).

EPD Verification			
This EPD has been certified by an independent, external verifier in accordance with ISO 14025.			
Christopher Surak Director of Certification Services ASTM	Date verified May 27, 2016	Jamie Meil Research Principal Athena Sustainable Materials Institute	Date verified May 27, 2016

PCR Information	
Program Operator	ASTM International
Reference PCR	Product Category Rules For Preparing An Environmental Product Declaration For Portland, Blended Hydraulic, Masonry, Mortar and Plastic (Stucco) Cements
Date of Issue	September 2, 2014
PCR Review was conducted by:	Nick Santero, PE International (rebranded as thinkstep), Chairperson Hamid Farzam, Cemex Anthony Fiorato, Consultant

Description of the product

The product under evaluation is portland cement as defined by ASTM C219 and specified in ASTM C150, ASTM C1157, AASHTO M 85 or CSA A3001.

Figure 1. portland cement

> A hydraulic cement produced by pulverizing clinker, consisting essentially of crystalline hydraulic calcium silicates, and usually containing one or more of the following: water, calcium sulfate, up to 5% limestone, and processing additions. (ASTM C219)

All cement products are composed of specific combinations of calcium, silica, iron and alumina and small amounts of additives to achieve a desired profile of properties (e.g., strength, color). Clinker, the principle intermediate manufactured product within cement production, is typically produced from a combination of ingredients, including limestone (for calcium), coupled with smaller quantities of materials such as clay, iron ore, and sand (as sources of alumina, iron, and silica, respectively). So common are these building blocks that a wide variety of raw materials are suitable sources, and some sources, such clay and fly ash, may provide multiple chemical components. Cement plants are increasingly turning to industrial byproducts that otherwise would be discarded, once completing detailed analyses to determine the effects of using a byproduct on the manufacturing process, cement performance and facility emissions.

Example sources of calcium, silica, iron and alumina are as follows:

Calcium sources – Chalk, clay, marble, seashells, shale, blast furnace slag

Silica sources – Clay, fly ash, loess, marl, ore washings, rice hull ash, sandstone, slag

Iron sources – Blast furnace flue dust, clay, mill scale, ore washings, shale

Alumina sources – Alumina ore refuse, clay, copper slag, fly ash, shale

The U.S. industry average portland cement, as found by this study, is 92.2% clinker by weight. Table 1 describes the cement's composition by specific material resources.

Table 1. Material composition of the U.S. industry average portland cement per mass of cement product.

Cement ingredient[a]	Portion of cement product (by weight)
Clinker	92.2%
Gypsum	4.63%
Uncalcined limestone	1.86%
Other materials	<1.0% each

[a] It should be noted that while all portland cement products contain the ingredients listed above, the average cement production data computed for this EPD represents the weighted average use of all materials by all participating plants. The data should not be interpreted to mean that the ratios presented in this table is the formulation for all portland cement products.

Exhibit F

Coal Combustion Products

Coal-burning powerplants, which supply more than half of U.S. electricity, also generate coal combustion products, which can be both a resource and a disposal problem. The U.S. Geological Survey collaborates with the American Coal Ash Association in preparing its annual report on coal combustion products (Kalyoncu, 2000). This Fact Sheet answers questions about present and potential uses of coal combustion products.

What are coal combustion products?

Coal combustion products (CCP's) are the inorganic residues that remain after pulverized coal is burned. Coarse particles (bottom ash and boiler slag) settle to the bottom of the combustion chamber), and the fine portion (fly ash, fig. 1) is removed from the flue gas by electrostatic precipitators or other gas-scrubbing systems.

Because of concerns about air quality and acid rain, the U.S. Congress passed the Clean Air Act Amendments of 1990 (Public Law 101–549), which included stringent restrictions on sulfur oxide emissions. Most electric utilities in the Eastern and Midwestern States use bituminous coal having high sulfur contents of 2–3.5 percent. In order to meet the emission standards, many utilities have installed flue-gas-desulfurization (FGD) equipment. The FGD products are included in coal combustion products. The components of CCP's are as follows: fly ash, 57 percent; FGD products, 24 percent; bottom ash, 16 percent; and boiler slag, 3 percent.

What is flue gas desulfurization?

Flue gas desulfurization is a chemical process to remove sulfur oxides from the flue gas at coal-burning powerplants. Many FGD methods have been developed to varying stages of applicability (Radian Corp., 1983). Their goal is to chemically combine the sulfur gases released in coal combustion by reacting them with a sorbent, such as limestone (calcium carbonate, $CaCO_3$), lime (calcium oxide, CaO), or ammonia (NH_3). Of the FGD systems in the United States, 90 percent use limestone or lime as the sorbent (fig. 2). As the flue gas comes in contact with the slurry of calcium salts, sulfur dioxide (SO_2) reacts with the calcium to form hydrous calcium sulfate ($CaSO_4 \cdot 2H_20$, gypsum).

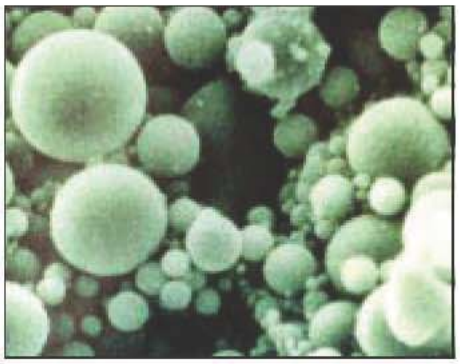

Figure 1. Fly ash from powerplants contains tiny ceramic spheres, typically ranging in diameter from 5 to 75 micrometers, which are called cenospheres; they have many uses. Scanning electron photomicrograph from the American Coal Ash Association.

What quantities of CCP's are generated?

About 100 million metric tons (Mt) of CCP's are generated annually by U.S. coal-burning electric utilities.

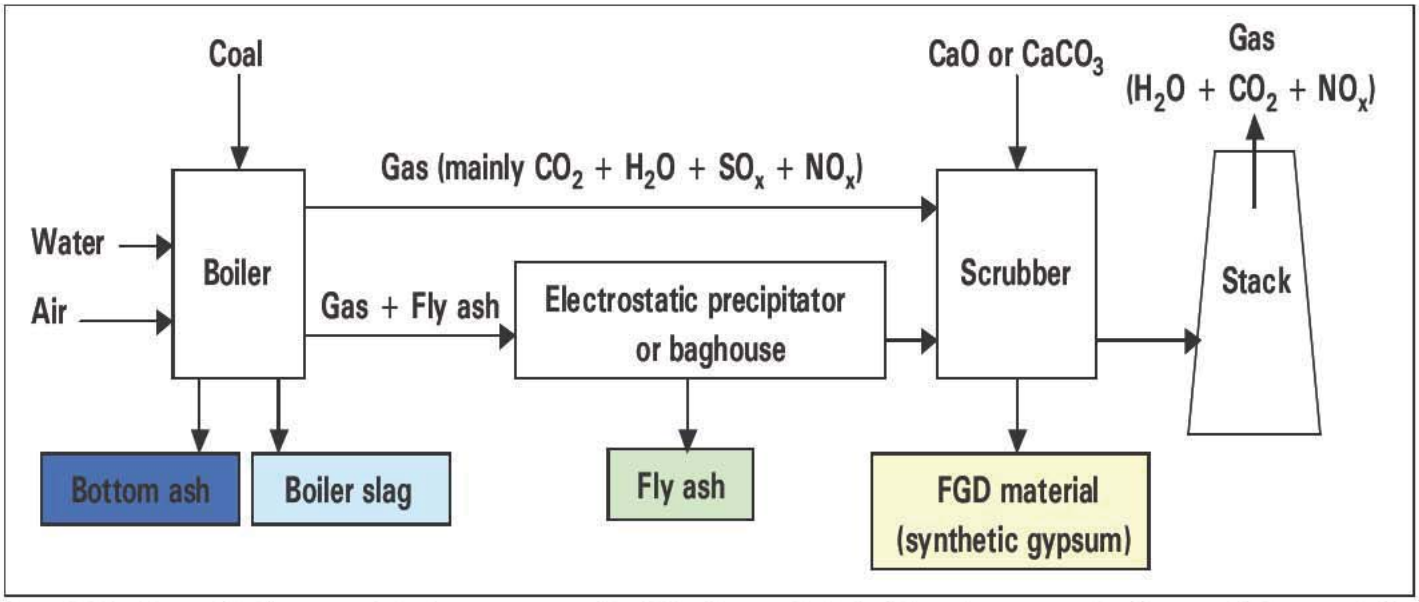

Figure 2. Flow diagram of the flue-gas-desulfurization process based on lime (CaO) or limestone ($CaCO_3$), which are the sorbents used by 90 percent of FGD systems in the United States.

Figure 3. Amounts of coal combustion products used in the United States, 1995 99. Data from the American Coal Ash Association.

What are the uses for CCP's?

In the United States in 1999, approximately 30 percent of CCP's were used rather than discarded. The use of CCP's has increased over the years and reached 30 Mt in 1999 (fig. 3). Fly ash is the most used CCP; in 1999, it made up about 64 percent of the total CCP's used (fig. 4). CCP's are used, in decreasing tonnage, in cement and concrete, structural fill, road bases, agriculture, and other applications. Components of CCP's have different chemical and physical properties that make them suitable for different applications (Kalyoncu, 2000):

- About 57 Mt of fly ash was produced in 1999, and about 19 Mt was used. The main uses were in concrete, structural fill, and waste stabilization.
- About 15 Mt of bottom ash was produced in 1999, and about 5 Mt was used. The main uses were in structural fill, snow and ice control, road bases, and concrete.
- About 22 Mt of FGD material was produced in 1999, and about 4 Mt was used, mostly in wallboard manufacture.
- About 2.6 Mt of boiler slag was produced in 1999, and about 2.1 Mt was used, predominantly in blasting grit and roofing applications.

What structural applications use fly ash?

Fly ash is added to cement and concrete and is used in many large-scale construction projects. Fly ash is a vital component in high-strength concrete in buildings that grace the skylines of major U.S. cities. Fly ash concrete is used in the decks and piers of many highway bridges. Concrete pavements containing fly ash are very durable and cost effective. Between 1950 and 1970, concrete with fly ash contents as high as 50 percent was used in an estimated 100 major dam construction projects. In the construction of Hungry Horse Dam in 1953, for example, 120,000 metric tons of fly ash were used (fig. 5).

What are the benefits of using CCP's in all applications?

Use of CCP's offers significant environmental and economic benefits. Their long history of successful applications attests to the environmental acceptability of CCP's. When CCP's are used, natural resources can last longer and mining costs can be reduced. In 1999, the productive use of 30 Mt of CCP's saved $620 million in disposal costs and about 350 acres of landfill space and generated $150 million in sales, bringing total benefits to $770 million.

. . . in cement and concrete?

The largest use of CCP's (mostly fly ash) is in cement and concrete. The CCP's displace portland cement and significantly reduce emissions of carbon dioxide (CO_2), a greenhouse gas that may be associated with global warming. Portland cement manufacture requires the burning of fossil fuels and decomposition of carbonates, which release large amounts of carbon dioxide into the atmosphere. Use of CCP's can potentially reduce carbon dioxide emissions by 10–14 Mt annually. In 1998, 10.5 Mt of fly ash was used in cement and concrete, replacing 7 Mt of portland cement and thereby reducing carbon dioxide emissions by 7 Mt.

. . . in mine reclamation?

Large cavities left by underground mining make the ground susceptible to subsidence. Acid water draining from some underground mines reaches surface streams and lowers the pH, causing serious ecological damage. Demonstration projects have shown that injection of alkaline CCP's into abandoned mines can

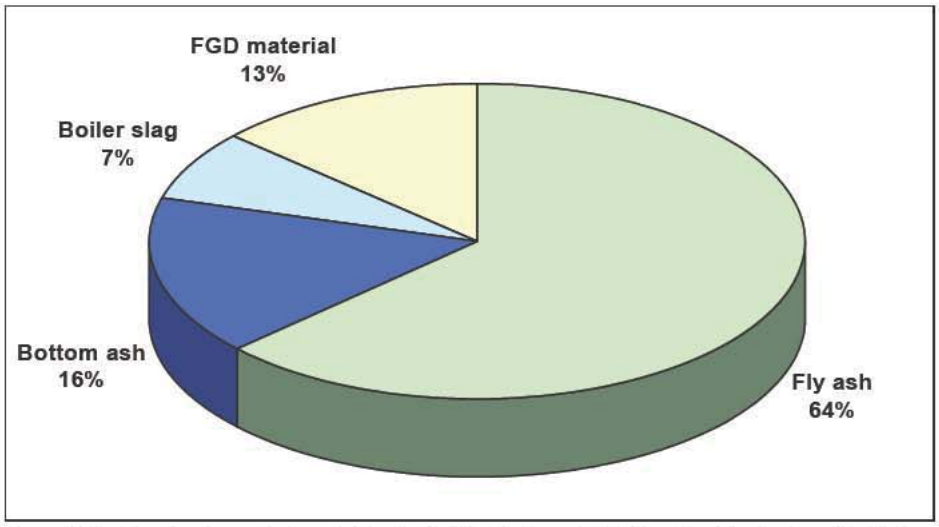

Figure 4. Coal combustion product use by type in the United States, 1999. Data from the American Coal Ash Association.

help control subsidence and abate acid mine drainage.

. . . in wallboard manufacture?

In 1999, about 2.8 Mt of synthetic gypsum produced as FGD material by electric utilities went into wallboard manufacture. The synthetic gypsum meets and often exceeds the specifications for wallboard manufacture. Some wallboard plants that will use 100 percent synthetic gypsum are being built and some have started production (Drake, 1997; Olson, 2000). In 1999, synthetic gypsum accounted for about 17 percent of the total gypsum used in wallboard manufacture, and this figure is expected to increase.

How can cenospheres in fly ash be used?

Fly ash contains tiny, hollow, particulate ceramic spheres, typically ranging in diameter from 5 to 75 micrometers, which are called cenospheres (fig. 1). They exhibit some unique properties, such as high energy absorption, which results in protection against electromagnetic interference. They are used as fillers in composite materials, in insulations, and in paints. A potential application of cenospheres is as heat-reflecting coatings for rooftops. Widespread use of such coatings could lower average city temperatures in summer and reduce the need for air conditioning.

How can ammonium sulfate FGD's be used in agriculture?

A flue-gas-desulfurization method popular in Europe uses ammonia (NH_3) as the sorbent; the FGD product is ammonium sulfate ($(NH_4)_2SO_4$). Sulfate is the preferred form of sulfur readily assimilated by crops, and ammonium sulfate is the ideal sulfate compound for soil supplements because it also provides nitrogen from the ammonium. The use of ammonium sulfate in large-scale fertilizer formulations has been growing gradually. This growth provides a market for FGD products and could make FGD processes based on ammonia attractive alternatives to the processes based on lime and limestone.

The estimated worldwide annual shortage of almost 11 Mt of elemental sulfur for agricultural applications could be supplied by 45 Mt of ammonium sulfate (Ellison, 1999). This much FGD product could result from 170,000 megawatt-hours (MWh) of electricity production if plants burned coal containing 2.5–3 percent sulfur. A relatively large powerplant generates 1,000 MWh of electricity per year. Thus, 170 large powerplants burning high-sulfur coal and using FGD methods based on ammonia could produce the amount of ammonium sulfate needed for proper plant nutrition.

Figure 5. Hungry Horse Dam, Montana, is a thick-arch structure that was built between 1948 and 1953 with concrete containing 120,000 metric tons of fly ash. The use of coal fly ash in cement and concrete displaces portland cement. Photograph from the U.S. Bureau of Reclamation.

What research is being done?

Recent environmental regulations have forced electric utilities to use low-NO_X burners ("low-NO_X" is a designation for burners that greatly reduce nitrogen oxide emissions). These burners leave some coal unburned, which leads to higher free carbon contents in fly ash and makes the ash unsuitable for use in cement and concrete applications. Many powerplants that previously could earn revenue from selling the fly ash have had to pay for its disposal. However, a novel technology, developed at Pennsylvania State University, can separate the unburned coal from the fly ash and may soon eliminate this problem. Moreover, the coal from the separation process is activated under steam at 850°C and can be used in water and gas purification.

Utilities will continue to look for pollution-prevention technologies that will yield smaller quantities of FGD products that will be purer and have higher value than those presently produced. An example is the Basin Electric Cooperative's Dakota Gasification plant in Beulah, N. Dak., where a wet ammonia-based FGD process is used for SO_2 removal in combustion of otherwise unsalable fuels derived from gasification of lignite. The resulting ammonium sulfate is sold and used as a sulfur blending stock in fertilizer production.

Research efforts to find new applications and increase the use of CCP's continue. Researchers at the University of Southern Illinois at Carbondale are working on the design for utility poles made of CCP's and organic binders. The researchers expect that the final product will be comparable to or even superior to the traditional creosote-coated wooden poles. In addition to eliminating the need for weatherproofing with creosote, which pollutes rainwater runoff, the CCP poles would be fireproof and termiteproof, would be cheaper to install, and would be more resistant to damage by humans and animals. It is estimated that 250,000 poles averaging 30–40 feet (9–12 meters)

in height and another million poles 15–30 feet (4.5–9 meters) in height are used annually in the Midwestern United States alone. Replacing wooden poles with CCP poles could double the use of fly ash while sparing millions of trees annually.

What are the barriers to CCP use?

There are many technical, economic, regulatory, and institutional barriers to increased use of CCP's. A lack of standards and guidelines for specific applications heads the list of technical barriers. Transportation costs lead the economic barriers, which limit the shipment of CCP's to within about a 50-mile (80-kilometer) radius of the powerplants.

The industry's ability to recycle CCP's may be limited by more restrictive environmental controls. In April 2000, the U.S. Environmental Protection Agency (EPA) stated that the use of CCP's does not warrant regulatory oversight but left the door open to stricter regulation of CCP's in the future. A few weeks later, the EPA nearly issued a ruling that would have classified CCP's as hazardous wastes under the Resource Conservation and Recovery Act (RCRA). In May 2000, the EPA reaffirmed its position that CCP's are nonhazardous.

Environmental regulation may also lead to the generation of lower quality, less usable CCP's. As mentioned above, the required use of low-NO_X burners has resulted in fly ash having an unburned coal content that makes it unsuitable for concrete; until new technologies are applied, this fly ash must be used in other products or disposed of.

Other barriers to CCP use are the RCRA designation of CCP's as solid wastes, regardless of their composition, even when they are used as resources rather than disposed of; the lack of governmental incentive; and the lack of education among the user groups (engineers, contractors, and regulators).

With industry and government cooperation, steps toward increasing CCP use can include (1) establishing a research and development infrastructure to address the technical barriers to CCP use and to design innovative FGD methods and (2) providing objective scientific information.

What is the bottom line?

Coal combustion products have many economic and environmentally safe uses. For example, in construction, a metric ton of fly ash used in cement and concrete can save the equivalent of a barrel of oil and can reduce carbon dioxide releases that may affect global warming. The use of CCP's saves landfill space. CCP's can replace clay, sand, limestone, gravel, and natural gypsum, thus preserving the Nation's natural resources and helping to save energy and other costs associated with mining.

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Exhibit G

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Research Article

Coal Bottom Ash for Portland Cement Production

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Because of industrialization growth, the amount of coal power plant wastes has increased very rapidly. Particularly, the disposal of coal bottom ash (CBA) is becoming an increasing concern for many countries because of the increasing volume generated, the costs of operating landfill sites, and its potential hazardous effects. Therefore, new applications of coal bottom ash (CBA) have become an interesting alternative to disposal. For instance, it could be used as a Portland cement constituent leading to more sustainable cement production by lowering energy consumption and raw material extracted from quarries. Coal fly and bottom ashes are formed together in the same boiler; however, the size and shape of these ashes are very different, and hence their effect on the chemical composition as well as on the mineralogical phases must be studied. Coal bottom ash was ground. Later, both ashes were compared from a physical, mechanical, and chemical point of view to evaluate the potential use of coal bottom ash as a new Portland cement constituent. Both ashes, produced by the same electrical power plant, generally present similar chemical composition and compressive strength and contribute to the refill of mortar capillary pores with the reaction products leading to a redistribution of the pore size.

1. Introduction

For electrical power generation by coal combustion to become sustainable, the reuse of coal combustion by-products such as bottom ash is necessary. But also, coal bottom ash (CBA) used as a Portland cement constituent will help in more sustainable cement production by lowering energy and raw material consumption. The European Union is promoting the improvement of resource efficiency and the reduction of the climate and environmental impacts, through enhancing waste reuse and recycling according to the waste hierarchy of the European Waste Framework Directive 2008/98/EC [1].

Currently, the total worldwide cement production is over 4.0 billion tonnes [2] which provides more than 6% of total global warming CO_2 emissions. Currently, climatic change is one of the biggest challenges facing the world, and some industrial by-products such as coal fly ash, silica fume, and granulated blast furnace slag are being used as Portland cement constituents because this means a decrease of CO_2 emissions. Likewise, their disposal as industrial residues in landfill is avoided. Therefore, blended cements are part of the sustainable development strategy of the cement industry and also they allow improving the properties of the final concrete. It is well known that concretes made of blended cements have good durability [3, 4]. This fact will promote the demand for such kind of cement.

Industrial by-products usage reduces energy consumption during cement production, lowers CO_2 emissions, and, finally, makes waste management more efficient. Then, new Portland cement constituents as ground coal bottom ash should be assessed and evaluated for use in the mentioned blended cements.

Bottom ash and fly ash are by-products formed in coal-fired electrical power stations. Fly ash applications in mortars and concretes were presented elsewhere [5]. Mainly, fly ash is used as a Portland cement constituent, as a supplementary cementitious material (SCM) in concrete, replacing fine aggregates, as a subbase material in motorways, and in other useful ways [5, 6]. On the other hand, coal bottom ash is used as sand in concretes, among other minor applications, or disposed of in landfills [7]. Park [8] has recently found that the characteristics of coal ash reuse are determined more

Table 1: Chemical composition of raw materials: coal bottom ash (BA), coal fly ash (FA), and cement (%).

Oxides	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Ti_2O_5	P_2O_5	LOI	IR*	Cl^-
Cement	20.9	4.3	3.5	62.7	1.9	3.4	0.9	0.25	0.10	3.7	1.04	0.023
FA	50.5	28.9	4.7	5.0	1.8	0.21	0.8	1.56	0.76	3.6	71.3	0.000
BA	52.2	27.5	6.0	5.9	1.7	0.13	0.6	1.53	0.74	1.8	75.7	0.001

*Insoluble residue determined by the Na_2CO_3 method (European standard EN 196-2:2013).

Table 2: Bottom ash (BA) with fly ash (FA) and cement (CEM I 42.5 N) mixes.

Cement mix	Raw material	Fly ash + bottom ash mix codification					
		α	β	γ	δ	λ	Ω
CEM I	Fly ash	0%					
	Bottom ash	0%					
	Cement	100%					
CEM II/A-V	Fly ash		10%	9%	8%	5%	0%
	Bottom ash		0%	1%	2%	5%	10%
	Cement		90%	90%	90%	90%	90%
CEM II/B-V	Fly ash		25%	22,5%	20%	12,5%	0%
	Bottom ash		0%	2,5%	5%	12,5%	25%
	Cement		75%	75%	75%	75%	75%
CEM IV/A (V)	Fly ash		35%	31,5%	28%	17,5%	0%
	Bottom ash		0%	3,5%	7%	17,5%	35%
	Cement		65%	65%	65%	65%	65%

by business decision-making behaviors than by market or institutional factors.

Coal fly ash pozzolanicity is a property resulting from its content of silica, alumina, and iron oxide, but also fly ash presents a filler effect in mortars and concretes. In some concretes, the filler effect can be more significant than the pozzolanic one [9].

According to Kiattikomol et al. [10], the most important parameter affecting the fly ash pozzolanicity is its fineness, even more than its chemical composition. The fly ash fineness effect on compressive strength has been previously reported [10–12]. Ground fly ash mortars showed a higher early strength than mortars produced with coarse ashes. In consequence, a ground bottom ash, similar to a ground fly ash, can help to get denser mortars and concretes.

In this paper, physical, chemical, and mechanical properties of the coal bottom ash mortars are compared to those of coal fly ash mortars for assessing the use of ground bottom ash as a new cement constituent.

2. Method and Materials

The influence of ground coal bottom ash on the properties of the mortars was examined by means of testing mechanical and physical properties of ground coal bottom ash in comparison with coal fly ash mortars.

2.1. Materials. Cement type CEM I 42.5 N according to the EN 197-1:2011 [13] and coal bottom ash and coal fly ash collected from the same coal-fired power plant were used as the main constituents in the proposed new cement mixes. Table 1 shows the chemical characteristics of the coal bottom ash, coal fly ash, and cement.

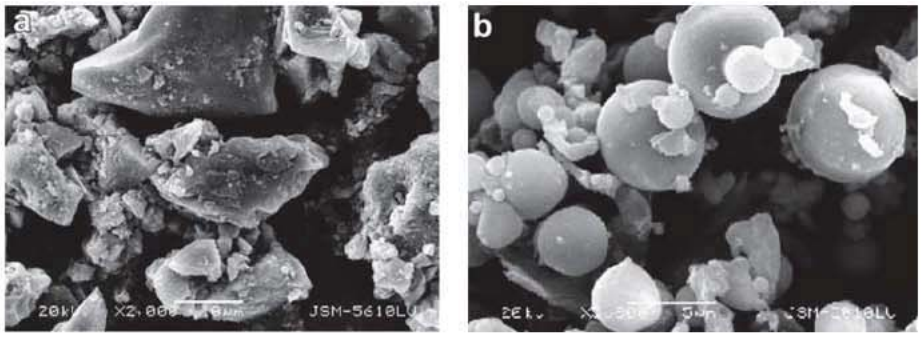
The specific surface Blaine of the cement was 4,050 m^2/kg; fineness of the collected coal fly ash was 3,976 m^2/kg. The coal bottom ash was ground in a ball mill up to a Blaine fineness of 3,463 m^2/kg, similar to that of the Portland cement (5–8% residue on 45 μm sieve).

Several coal fly and ground coal bottom ashes were mixed in the laboratory using a powder mixer. The different ground coal bottom ash and coal fly ash mixes are shown in Table 2.

Finally, the reference cement, CEM I 42.5 N, was partially replaced by the ash mixes mentioned in Table 2. The mix proportion of the laboratory-made cements in the research was chosen for fly ash blended cements according to EN 197-1:2011 [13]. That is to say, laboratory blended cements with similar compositions to the CEM II/A-V, CEM II/B-V, and CEM IV/A (V) standardized cements according to the European standard EN 197-1:2011 were made.

Tested mortars were made with a cement/sand ratio of 1 : 3 and a water : cement ratio of 0.5. Distilled water was used. Standard sand was also employed according to the European standard EN 196-1:2016 [14]. The mixing, moulding, and curing procedures are detailed also in the European standard EN 196-1:2016.

2.2. Testing. Compressive strength tests were performed according to the European standard EN 196-1:2016 [14]. Setting times and soundness were determined according to the European standard EN 196-3:2005 + A1:2008 [15]. Also, mercury intrusion porosimetry (MIP) tests were performed to determine the pore size distribution (PSD).



(a) (b)

FIGURE 1: SEM images of coal bottom ash (a) and coal fly ash (b).

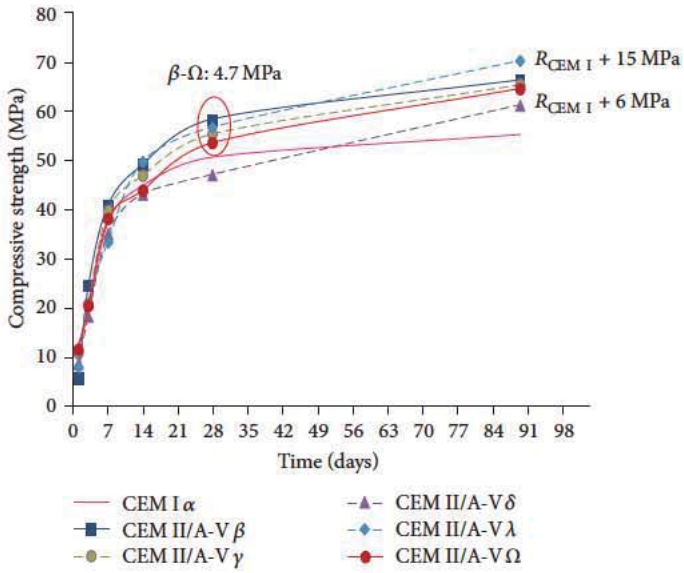


FIGURE 2: CEM II/A-V compressive strength (MPa).

3. Results and Discussions

Results of physical, chemical, and mechanical properties of the coal bottom ash mortars in comparison to CEM I and coal fly ash mortars are discussed below.

3.1. Characteristics of Coal Bottom Ash (BA) and Coal Fly Ash (FA). The chemical compositions in the coal bottom ash belong to the CaO-SiO_2-Al_2O_3-Fe_2O_3 system (Table 1). Therefore, they belong to the family of the common supplementary cementitious materials (SCM) used in cement-based products. Coal bottom ash is formed in the same incinerator as coal fly ash. Therefore, a similar chemical composition was expected in both.

Coal bottom ash is denser than coal fly ash, contributing to the low loss on ignition (LOI) in the first one (Table 1). Such loss on ignition is mainly due to unburned coal particles.

Figure 1 illustrates SEM photographs of the ground coal bottom ash and coal fly ash. The surface of coal bottom ash has irregular particles, whereas coal fly ash is characterized by a more uniform distribution of spherical grains with a fairly smooth surface. The spherical shape is probably produced because the particles of fly ash usually experience higher temperatures and such spherical shape is formed due to the shrinkage of the liquid phase.

3.2. Results of Mechanical Strength. Compressive strength of mortars measured at 1, 3, 7, 14, 28, and 90 days is presented in Figures 2, 3, and 4 for CEM II/A-V, CEM II/B-V, and CEM IV/A (V), respectively.

As shown in Figures 2, 3, and 4, the compressive strength of the mortar specimens at 28 days decreased gradually with increasing of coal bottom ash or fly bottom ash or mixes of them.

The mortars' early strength decreases when the ground coal bottom or fly ash content is over 10%. As expected, the coal bottom ash activity as well as the coal fly ash cement activity is lower at early ages. Thus, both ashes delay the cement hydration as the content is increased.

CEM IV/A (V), with 35% replacement of cement by coal ash in mortars, showed worse strength evolution than

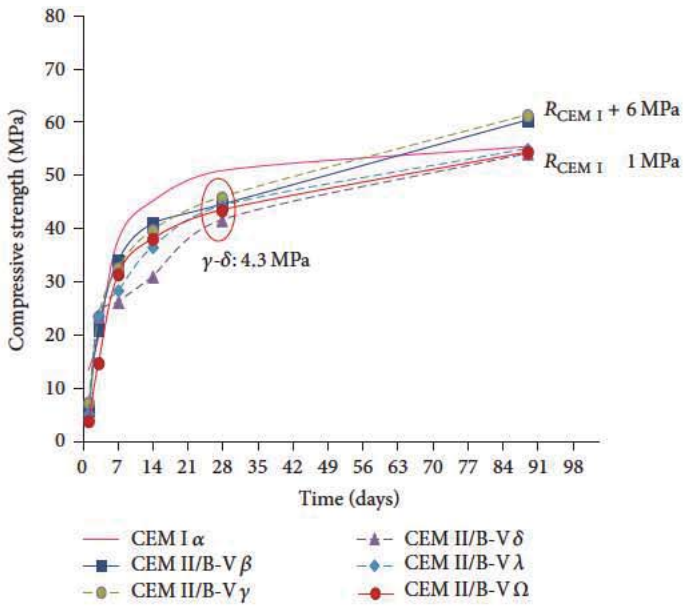


FIGURE 3: CEM II/B-V compressive strength (MPa).

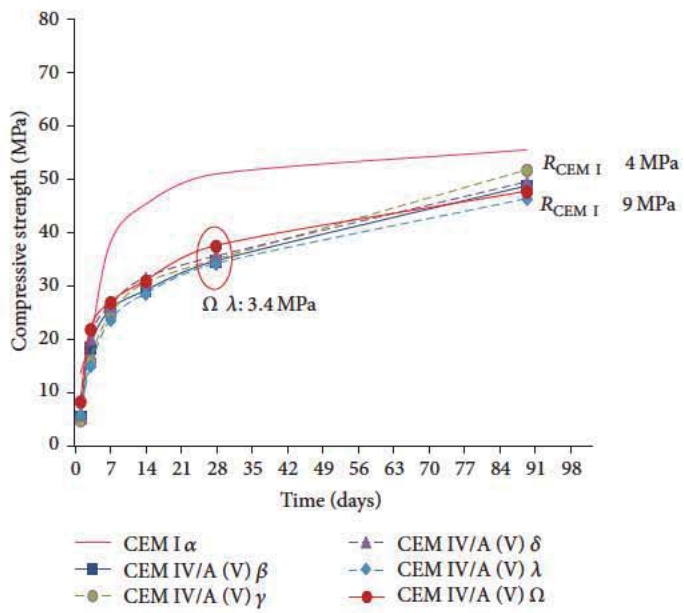


FIGURE 4: CEM IV/A (V) compressive strength (MPa).

CEM II/A-V and CEM II/B-V mortars. Its twenty-eight-day compressive strength is slightly over 32.5 MPa, which is the lower limit for the 32.5 strength class established in the European standard EN 197-1:2011 [13]. This fact suggests that the upper limit for coal bottom ash replacement of cement to ensure the compressive strength performance is around 35%. In particular, the 28-day compressive strength of CEM IV/A (V) Ω, with coal bottom ash, is higher than CEM IV/A (V) β, with coal fly ash (Figure 4). In consequence, it is evident that coal bottom and fly ashes have a certain pozzolanic activity, but a lower reactivity than the reference cement CEM I 45.5 N, and, therefore, both ashes lead to retardation of cement hydration. From Figure 4, it can be said that the differences between coal fly ash and coal bottom ash are not significant.

3.3. Mercury Intrusion Porosimetry (MIP). Figure 5 shows the mercury intrusion porosimetry (MIP) results at seven days, while Figure 6 shows such results at 28 days. Both ashes contribute to the refill of the mortar capillary pores with the pozzolanic reaction products leading to a redistribution of the pore size. After 28 days of curing, the mortar with ashes showed flatter PSD curves than at seven days. This particular pore size distribution contributes to a good

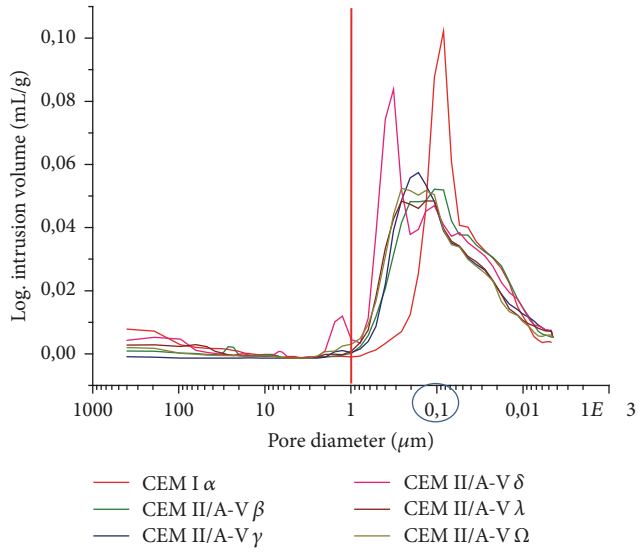


Figure 5: Mercury intrusion porosimetry (MIP) results at seven days.

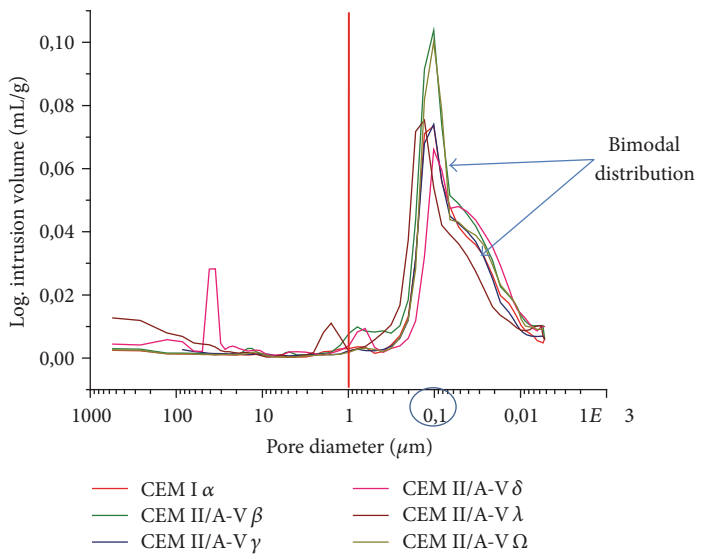


Figure 6: Mercury intrusion porosimetry (MIP) results at 28 days.

durable performance of the blended mortars. The use of coal bottom ash or coal fly ash does not make any difference.

3.4. Water Demand for Normal Consistency and Setting Time. The water demand for normal consistency in CEM II/A-V and CEM II/B-V cement pastes is lower than that of the reference cement CEM I 42.5 N (Figure 7). Comparing the blended cement pastes, it can be observed that the water demand for normal consistency increases when the amount of ashes increases in the cement independently of the type of ash used (Figure 7). However, the incorporation of coal bottom ash in CEM IV/A (V) cement pastes increases the water demand for normal consistency. This effect increases with the amount of coal bottom ash in the cement pastes, that is, cement pastes from γ to Ω.

With regard to the initial and final setting times, generally, the more the ashes in the cement, the longer the setting times recorded. Setting times of CEM II/A-V cement pastes, with only 10% of ashes in the binder mix, are quite similar to those of the CEM I 42.5 N. In CEM II/B-V cement pastes, the reduction of the setting times is clearer in comparison to the reference mortar (Figure 8), and CEM IV/A (V) cement pastes showed the longest setting times.

With relation to the type of coal ash employed, the bottom ash cements (Ω) evidenced shorter setting times than fly ash cements (β) as shown in Figure 8. This could be due to the higher amount of cement hydration retarders in the coal fly ash such as ZnO, Pb_2O, Cu_2O, and Cd_2O [16].

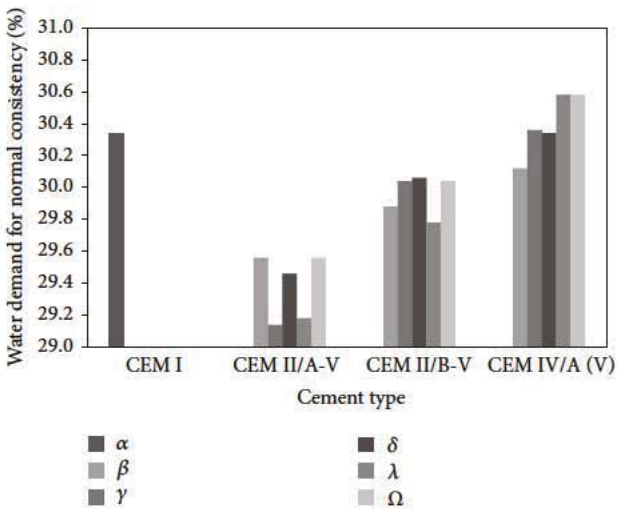


FIGURE 7: Water demand for normal consistency of the cement pastes.

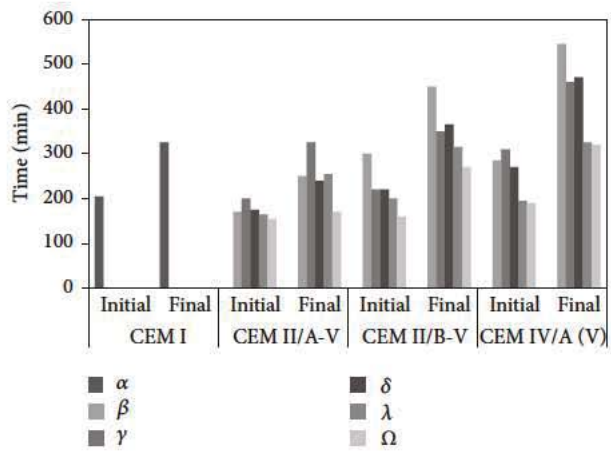


FIGURE 8: Setting time of the cement pastes.

3.5. Soundness. Soundness results go from 0.25 to 1.75 mm. It is evident that the more the ashes used, the more the soundness found in the cement paste. Such effect increases from CEM II/A-V to CEM IV/A (V) cement paste. Also, when the amount of bottom ash increases in the cement paste (from β to Ω), its expansion gets longer (Figure 9).

4. Conclusions

Ground coal bottom ash and coal fly ash produced by the same electrical power plant were tested in order to investigate the possible application of the ground coal bottom ash in Portland cement production. The clinker/cement factor has a direct impact on CO_2 emissions; in other words, the lower the clinker/cement ratio, the lesser the CO_2 emissions. Then, one of the most viable approaches to reduce CO_2 emissions is the study of the viability of new cement constituents as the ground coal bottom ash.

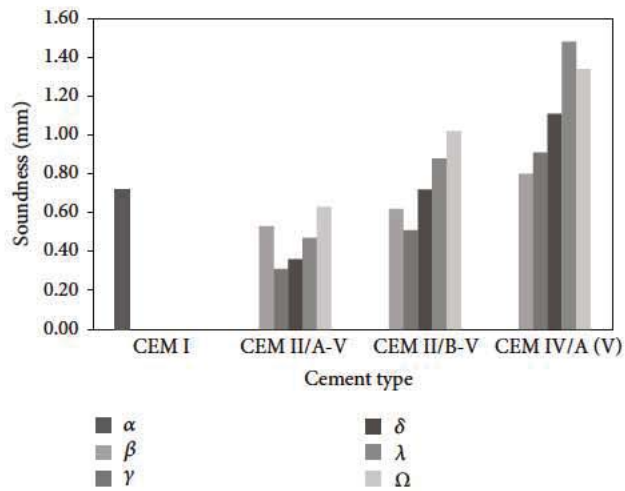


FIGURE 9: Soundness of the cement pastes.

Based on the presented analysis, the following conclusions can be drawn:

(i) Ground coal bottom ash and coal fly ash produced by the same electrical power plant present similar chemical composition. In particular, coal bottom ash has a lower loss on ignition than coal fly ash. This parameter is mainly attributed to unburned coal particles.

(ii) Ground coal bottom ash mortars, in general, showed compressive strength performances similar to those of coal fly ash cement-based materials. Activity is lower at early ages; therefore, the compressive strength of the mortar specimens at 28 days decreased gradually with the increasing of ground coal bottom ash or fly bottom ash or mixes of them.

(iii) From the mercury intrusion porosimetry (MIP), it can be concluded that both ashes contribute to the refill of the mortar capillary pores with the pozzolanic reaction products leading to a redistribution of the pore size. This PSD curve is flatter at 28 days than at seven days of curing.

(iv) The water demand for normal consistency increases when the amount of ashes increases in the cement independently of the type of ash used.

Consequently, ground coal bottom ash alone or mixed with coal fly ash is suitable to be used in cement production as a new main component in the Portland cement standards.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors wish to acknowledge IECA for financial support (AU 23-10 Contract: "Durable Physicochemical Characterization of Cement-Based Materials with Industrial By-Products").

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Exhibit H

Regulatory Impact Analysis

EPA's 2019 RCRA Proposed Rule 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

U.S. Environmental Protection Agency (EPA)
Office of Resource Conservation and Recovery (ORCR)
1200 Pennsylvania Avenue NW (Mailstop 5305P)
Washington DC, 20460 USA

February 2020

Table of Contents

Executive Summary **1**

Chapter 1. Background: The Need for Revising the 2015 RCRA Final Rule Regulating Coal Combustion Landfills and Surface Impoundments at Electric Utility Power Plants **1**

Chapter 2. Affected Universe and Baseline Costs **2-1**

2.1 Affected Electric Utility Facilities 2-1

2.1.1 Original Baseline: 2015 CCR Regulatory Impact Analysis Universe 2-2

2.1.2 2018 Phase One Final Rule Universe 2-2

2.1.3 2019 Proposed Part A and Part B Rule Universe 2-2

2.2 Changes to Baseline Closure Process under Proposed Part B Rule Provisions 2-5

2.3 Planned Closure of CCR Units at Affected Electric Utility Facilities 2-7

3.2.1 Potential Impacts on Planned Closure Timelines due to the December 2, 2019 Published Proposed Part A Rule 2-8

2.4 Baseline Costs 2-9

Chapter 3. ..... **3-1**

Estimated Costs and Cost Savings Under the Proposed Part B Rule **3-1**

3.1 Costs and Cost Savings Associated with Provision 1: Alternate Liner Demonstration 3-2

3.1.1 Application to Submit an Alternate Liner Demonstration 3-4

3.1.2 Demonstration of Suitability of Existing Liner 3-4

3.1.3 Cost Savings due to Closure Delays for Units with Accepted Demonstrations 3-5

3.2 Provision 2: Use of CCR in Units Subject to Forced Closure 3-8

3.2.1 Summary of Provision 2 Co-Proposed Options 3-9

3.2.2 Universe of Facilities and Units Likely to Change Practices Under Provision 2 3-11

3.2.3 Costs and Cost Savings Associated with Co-Proposed Option 1: Use of CCR during closure of a unit under an approved closure plan 3-15

3.2.4 Costs and Cost Savings Associated with Provision 2, Co-Proposed Option 2: Beneficially using CCR during closure of a unit 3-24

3.3 Costs and Cost Savings Associated with Provision 3: Closure of CCR Units by Removal of CCR 3-35

for this hypothetical facility, Provision 2 may not result in decreased beneficial use, and therefore no impacts on human health and environmental benefits associated with beneficial use.

However, a different hypothetical facility may be located in a low-demand area, or may have closure costs that are high due to the size and structure of the unit. Given the CCR placement prohibition associated with the cease receipt of CCR deadline in the baseline, as well as the full array of pollution controls required for CCR management units, this facility may still choose, under the baseline, to make its CCR available for beneficial use, to the extent that doing so results in a lower per-ton CCR management cost than disposing of the CCR in either its existing (non-subject to forced closure) units, or off site. Under Provision 2, the facility will be able to compare the per-ton cost of disposing the CCR in its unit(s) subject to forced closure to selling the CCR for off-site beneficial use. If the former is lower than the latter, the facility may choose to re-orient its CCR into its unit(s) subject to forced closure rather than continue to make it available for off-site beneficial use. In this instance, off-site beneficial use, including potentially some high-value uses with considerable environmental benefits, will decrease, as will the corresponding human health and environmental benefits.

The RIA for the 2015 CCR Rule estimated annualized human health and environmental benefits associated with avoided air pollution and resource use from a projected increased in beneficial use due to the changes in the cost of disposal under the rule. The annualized value of these benefits is approximately $21.9 million under a seven percent discount rate (2013$). Note that this figure is not adjusted to account for universe updates that have taken place since the 2015 CCR Rule went into effect, including closure of a number of facilities and implementation of state regulations requiring clean closure. As a result, the 2015 analysis may underestimate current benefits associated with this aspect of the 2015 CCR Rule, due to increased availability of ash from clean closing units, or may overestimate these benefits due to an overall reduction in CCR generation since 2015.[48]

According to information provided by American Coal Ash Association, CCR is currently being used in impoundment closure activities. ACAA production and use survey data indicate that 434,675 short tons of CCR were used in "CCR pond closure activities" in 2016, increasing to 4,469,130 short tons (approximately six percent of all CCR beneficial use) in 2017, and decreasing to 3,227,295 short tons (approximately five percent of all CCR beneficial use) in 2018. The 2015 CCR RIA estimated a per-ton environmental and human health benefit of the beneficial use of CCR associated with the avoided use of virgin materials, e.g., the benefit of using one ton CCR in lieu of virgin materials in the production of portland cement was estimated at $69.90 (2011 dollars). That RIA similarly estimated the environmental and human health benefit of using one ton of CCR in lieu of virgin fill materials as $2.28. Therefore, every ton of

[48] See filings and testimony associated with the verified petition of Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. with the Indiana Utility Regulatory Commission, filed August 14, 2019, Cause No. 45280. These filings and testimony indicate that CCR removed from clean-closing units can be beneficially-used after excavation.

CCR diverted from higher-value productive uses as a result of Provision 2 results in a corresponding reduction in the benefits of the beneficial use of CCR. While Provision 2, Co-Proposed Option 2 may nominally result in increased quantities of CCR dedicated to "beneficial use" overall, the placement of CCR in units subject to forced closure as "fill" is a lower-value use. As a result, the environmental benefits anticipated in the 2015 estimate will most likely decrease. Moreover it is not self-evident that use of CCR as fill will replace the use of virgin materials ton-for-ton or whether other, less materials-intensive closure options may be more economical, such as clean closure and re-purposing of the excavated ash towards higher-value beneficial uses.

Elimination of the annualized estimate of roughly $20 million in beneficial-use-related benefits (under a seven percent discount rate, 2013$) reflects one potential estimate of the potential impacts associated with Provision 2. If Provision 2 results in a reallocation of sufficient material away from high-end, off-site uses, it could eliminate some or all beneficial use-related benefits driven by the 2015 CCR Rule. To the extent that Provision 2 results in only a partial decrease in off-site beneficial use relative to the increases estimated in the 2015 CCR Rule, and affects only the lower-value uses (fill), the effects on the beneficial-use-related benefits of the 2015 CCR rule may be modest.

Provision 2, Co-Proposed Option 2 places fewer restrictions on the placement of CCR in units subject to forced closure than Co-Proposed Option 1 (see **Section 3.2**). Therefore, potential reductions in human health and environmental benefits due to decreases in beneficial use will potentially be greater under Co-Proposed Option 2 than Co-Proposed Option 1.

Exhibit I

American Coal Ash Association Phone: 720-870-7897
38800 Country Club Drive Fax: 720-870-7889
Farmington Hills, MI 48331 Internet: www.ACAA-USA.org
Email: info@acaa-usa.org

2017 Coal Combustion Product (CCP) Production & Use Survey Report

Beneficial Utilization versus Production Totals (Short Tons)

2017 CCP Categories	Fly Ash	Bottom Ash	Boiler Slag	FGD Gypsum	FGD Material Wet Scrubbers	FGD Material Dry Scrubbers	FGD Other	FBC Ash	CCP Production / Utilization Totals
Total CCPs Produced by Category	**38,189,790**	**9,655,931**	**2,574,673**	**32,707,136**	**11,311,344**	**2,454,818**	**6,293**	**14,469,553**	**111,369,538**
Total CCPs Used by Category	**24,095,590**	**4,839,420**	**1,570,375**	**22,839,385**	**3,905,009**	**382,048**	**2,407**	**14,134,477**	**71,768,712**
1. Concrete/Concrete Products /Grout	14,065,791	785,527	0	67,009	0	0	0	0	14,918,326
2. Blended Cement/ Feed for Clinker	4,579,724	1,622,612	132,183	2,317,445	0	51	0	0	8,652,015
3. Flowable Fill	86,379	0	0	0	0	0	0	0	86,379
4. Structural Fills/Embankments	465,653	871,875	0	0	0	0	0	0	1,337,529
5. Road Base/Sub-base	674,155	159,084	0	2,460	0	11,931	0	0	847,630
6. Soil Modification/Stabilization	360,796	48,876	0	0	0	0	0	0	409,673
7. Mineral Filler in Asphalt	59,317	0	0	0	0	7,019	0	0	66,336
8. Snow and Ice Control	69,192	276,989	4,220	0	0	0	0	0	350,402
9. Blasting Grit/Roofing Granules	0	17,705	1,412,685	44,981	0	0	0	0	1,475,371
10. Mining Applications	901,181	232,110	0	927,949	3,905,009	202,092	0	14,037,913	20,206,254
11. Gypsum Panel Products (formerly Wallboard)	0	0	0	15,859,606	0	0	0	0	15,859,606
12. Waste Stabilization/Solidification	1,065,993	48,964	0	3,026	0	114,646	0	96,564	1,329,193
13. Agriculture	0	0	0	1,157,877	0	35,121	0	0	1,192,998
14. Aggregate	0	10,237	21,287	0	0	0	0	0	31,524
15. Oil/Gas Field Services	78,716	0	0	0	0	11,188	0	0	89,905
16. CCR Pond Closure Activities	1,468,203	730,600	0	2,270,326	0	0	0	0	4,469,130
17. Miscellaneous/Other	220,489	34,840	0	188,705	0	0	2,407	0	446,442

Summary Utilization to Production Rate

CCP Categories	Fly Ash	Bottom Ash	Boiler Slag	FGD Gypsum	FGD Material Wet Scrubbers	FGD Material Dry Scrubbers	FGD Other	FBC Ash	CCP Utilization Total
Totals by CCP Type/Application	24,095,590	4,839,420	1,570,375	22,839,385	3,905,009	382,048	2,407	14,134,477	**71,768,712**
Category Use to Production Rate (%)	**63.09%**	**50.12%**	**60.99%**	**69.83%**	**34.52%**	**15.56%**	**38.25%**	**97.68%**	**64.44%**
2017 Cenospheres Sold (Pounds)	147,958								
CCPs Imported in 2016 (Short Tons)	0								
CCPs Exported in 2016 (Short Tons)	0								

Data in this survey represents 145.20701 GWs of Name Plate rating of the total industry wide approximate 263.0478 GW capacity based on EIA's July 2017 Electric Power Monthly.

Exhibit J

MASTER AGREEMENT FOR THE PURCHASE AND SALE OF GOODS (POND ASH)

This Master Agreement for the Purchase and Sale of Goods (the "Agreement") is entered into as of January 1, 2016 by and between [redacted] (hereinafter "Buyer"), having its principal place of business at [redacted] and [redacted] (hereinafter "Seller"), having its principal place of business at [redacted].

In consideration of the mutual promises contained herein and other consideration, the sufficiency of which is hereby acknowledged, the parties hereby agree as follows:

1. Term. [redacted]

2. Purchase and Sale of Pond Ash. Buyer hereby agrees to purchase from Seller, and Seller agrees to sell and deliver to Buyer, pond ash ("Ash") at the prices and in the quantities stated on **Exhibit A** attached hereto and made a part hereof and pursuant to the other terms and conditions stated on any subsequent Purchase Order issued by Buyer and accepted by Seller (each a "Purchase Order"). Buyer agrees to use the Ash in connection with its cement manufacturing operations and for no other purpose and agrees not to resell the Ash without Seller's prior written approval. All purchases and sales of Ash shall be governed by this Agreement and the applicable Purchase Order. In the event of a conflict between the terms and conditions of the applicable Purchase Order and any invoice, bill of lading or the provisions contained herein, the Purchase Order shall govern.

3. Non-Exclusivity. [redacted]

4. Delivery. All Ash shall be delivered to Buyer's cement plant located a[redacted] ("Buyer's Plant"). At Buyer's sole discretion, Ash shipped in excess of the quantity specified in the Purchase Order will be returned at Seller's expense, and any costs associated with the initial shipping of excess quantities shall be paid by Seller and may be offset by Buyer from any amount due Seller. Seller shall notify Buyer promptly of any actual or anticipated delays in supplying the Ash. Seller shall use commercially reasonable efforts to

coordinate its delivery of the Ash so as to not disrupt, interrupt or delay Buyer's ongoing operations.

5. Risk of Loss; Title. Title to, risk of loss of, and responsibility for any and all Ash purchased by Buyer hereunder shall pass to Buyer upon delivery to Buyer's Plant.

6. Quality; Defective Product. All Ash shall conform to the quality requirements set forth in **Exhibit A**. All Ash found to be nonconforming ("Defective Product") will be replaced without expense to Buyer or, at the option of Buyer; Seller will refund the price of all such Defective Product. Seller will be given an opportunity to verify the defect. In the event Seller fails to commence reasonable measures to replace Defective Product within five (5) business days after notice, Buyer may undertake such action and charge the cost to Seller. Buyer shall return rejected Defective Product to Seller at Seller's expense. Buyer will not be required to return Defective Product prior to replacement. THE PARTIES AGREE THAT ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED AND EXCLUDED.

[redacted]

8. Compliance with Laws; Safety. Seller represents that it is and will remain in compliance with all local, state, and federal laws, rules, regulations, safety policies, guidelines and recommendations that apply to the Ash. Seller will provide training and general safety practices and procedures to its employees, and relevant training material to suppliers and subcontractors as required by applicable law. Seller will immediately notify Buyer of any accidents, complaints, or other issues affecting Seller's performance of its obligations under this Agreement. Seller will at all times use reasonable care and diligence, safeguard against accidents, damages and injuries to persons or property, and comply with all applicable safety measures, including but not limited to the following provisions, and in the event Seller fails to adhere thereto, Buyer may, in its sole discretion, suspend or terminate this Agreement immediately upon notice:

a. all safety equipment provided by Seller to its employees, agents, representatives, suppliers and subcontractors, and employees of the latter, must comply with applicable

Exhibit K

POND ASH UTILIZATION AGREEMENT

BETWEEN

[redacted]

AND

[redacted]

[redacted]

THIS POND ASH UTILIZATION AGREEMENT (hereinafter the "Agreement") is made and entered into as of the 16th day of May, ~~2016~~ 2017 (the "Effective Date"), by and between [redacted] having its principal offices at [redacted] th its principal offices at [redacted] and wholly-owned by [redacted] Inc.

RECITALS

A. Whereas [redacted] desires an economical and environmentally beneficial use for the coal combustions residuals from the ash pond at [redacted]

B. Whereas, [redacted] desires to receive Pond Ash from [redacted] for the use in its cement productions;

C. [redacted] desires to provide the Pond Ash to [redacted] and

D. Whereas, the parties believe [redacted] use of the Pond Ash to be both an economical and environmentally beneficial use of the Pond Ash:

For mutual consideration, which the parties hereby acknowledge, the parties agree as follows:

AGREEMENT

1. **Supply:**

   a. [redacted] shall make Pond Ash available to [redacted] each calendar year and shall be responsible for excavating, screening, sampling, loading and transporting Pond Ash from [redacted] coal fired generating station to [redacted] at its designated process facility i [redacted] provided, however, that this tonnage may be reduced as necessary (including the cessation of deliveries) based

on [redacted] access to available Pond Ash. The Pond Ash will be transported by vehicle which, as of the time of the execution of this Agreement, requires its operator to have a Class A [redacted] License.

b. [redacted] will provide quality testing of samples of the Pond Ash on an as needed basis and will confirm samples meet quality specification requirements prior to shipment. [redacted] will perform any necessary quality testing upon delivery.

2. **Utilization:** [redacted] shall receive a minimum of [redacted] (US) wet tons of screened Pond Ash per calendar year contingent upon [redacted] making such quantities available in a ratable manner over the year. Should [redacted] satisfy said ratable requirement, and [redacted] fail to take the minimum quantity as set forth above [redacted] shall pay [redacted] a fee of [redacted] (US) wet ton under [redacted] it fails to receive. Notwithstanding the foregoing, in no event shall [redacted] be penalized for its failure to take any tons short of its minimum requirement to the extent such failure is the result of or arising from changes to Environmental rules, changes to local, state or federal legislation, changes in regulations, or laws prohibiting the use of Coal Combustion Residuals (CCR) in the production of building material or products or if the Pond Ash does not conform to allowable specifications. The parties hereto expressly agree and acknowledge that [redacted] actual damage arising from [redacted] failure to receive the minimum quantity of Pond Ash would be extremely difficult or impractical to ascertain, and that the fees above represents the parties' reasonable estimate of such damages. Such payment is not intended as a forfeiture or penalty, but is intended as liquidated damages.

3. **Quality:** [redacted] shall supply screened Pond Ash that conforms to specifications set forth in Exhibit A and has an average moisture content of less than [redacted]% moisture. The Pond Ash will only be screened to remove all trash and debris larger than 1" in diameter; [redacted] HERBY MAKES NO OTHER WARRANTY EXPRESSED OR IMPLIED, INCLUDING WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

4. **Pricing; Invoices; Payment:** [redacted] shall deliver screened Pond Ash to [redacted] at a [redacted] days after [redacted] receives and confirms such invoice. [redacted] agree that [redacted] is providing the screened Pond Ash as a useful product or intermediate to [redacted] market value. [redacted] consider the screened Pond Ash to be a valuable product or intermediate and of beneficial use. [redacted] is not selling, nor is [redacted] buying the screened Pond Ash for disposal.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed by their duly authorized representatives as of this day and year first above written.

[redacted]

By

[redacted]

By:

EXHIBIT A

Ash Quality Specifications

Quality:

Parameters	Specification
Size	No dimension > 1"
Moisture [%]	< 25
SiO_2 [%]	> 43.0
Al_2O_3 [%]	> 22
Fe_2O_3[%]	6.0 - 12.0
NaEq = (Na_2O + 0.658 * K_2O)	< 2.4
LOI [%]	< 17
Chloride [ppm]	< 300
SO_3 [%]	< 1.0
Hg [ppb]	< 300
Other specifications	
Material must not be a hazardous waste and/or radioactive.	
Material must be free of foreign debris.	
Material must not cause an increase in dioxin-furan or TOC emission values in the pyro-process.	
For new sources, material must pass expulsion testing as evaluated by Environ Manager.	
For new sources, the supplier must provide a recent TCLP analysis for evaluation by Environ Manager.	

Exhibit L

[redacted] PURCHASE/SALE AGREEMENT
SECTION 1 : COMMERCIAL TERMS
REFERENCE N° : [redacted]

SELLER	[redacted] USA
BUYER	[redacted] USA
DURATION	This Contract is entered into as of [redacted] and shall cover the shipment to be loaded [redacted]
PRODUCT	Conditioned Ash
QUALITY	Such Conditioned Ash will be meeting with the specifications set forth in Appendix I hereto. Only Conditioned Ash meeting with the characteristics set forth in the present clause free of any foreign material shall be loaded [redacted] In the event that the product is proved not to meet the parameters set out in Appendix I, the parties will mutually agree the financial impact on the Buyer and settle accordingly.
PACKING	In bulk
VOLUME - shipment size - independent surveyor	The Seller undertakes to sell and the Buyer to purchase max [redacted] (+/-10% at Seller's option) The volume is to be shipped in 1 (one) shipment of max [redacted] (+/- 10% at Seller's option) To be mutually agreed
ORIGIN	[redacted]
TESTING & SAMPLING - independent surveyor (As per Clause 3.1 of Section 2) - independent laboratory (As per Clause 3.6 of Section 2)	 To be nominated by Seller To be mutually agreed
SELLING TERMS	[redacted]
PRICE	$[redacted] (USD) / MT

mba 1/14 DS RR DS

[redacted] PURCHASE/SALE AGREEMENT
SECTION 1 : COMMERCIAL TERMS
REFERENCE N° : [redacted]

[redacted]

6. Weight:
   a. To determine the quantity of the shipment, the Independent Surveyor paid by the Seller shall carry out a draft survey of the [redacted] Final draft survey to be completed within 4 (four) hours after completion of loading, thereafter laytime shall continue until such time as the draft survey is completed and the final quantity agreed between the Independent Surveyor and the [redacted]
   b. The Independent Surveyor's report on weight at the port of

MOA 7/14 DS RR DS

loading shall be mentioned on the Bill of Lading which will be issued accordingly.

c. BUYER will also employ an Independent Surveyor at [redacted] to issue a Draft Survey Report. Discrepancies of under [redacted] MT will be averaged evenly based upon the two Draft Survey Reports at the [redacted] Discrepancies exceeding [redacted] MT will be resolved by mutual discussion between the Seller and the Buyer.

7. Compliance:

Seller and the Buyer, their subsidiaries and their respective directors and officers, to the knowledge of the Seller and Buyer respectively, their employees and agents, are in compliance with all applicable Sanctions in all material respects.

[redacted]

Clause 3.6 of the General Conditions shall read: In case of a difference between the result obtained by the Buyer and the result of the Shipper's laboratory, or the Shipper's quality certificates, then the samples retained by the independent surveyor may be sent to a mutually agreeable laboratory for comparative testing. The result of the independent laboratory test shall be final and conclusive (in the absence of manifest error) in respect of the question whether the Product fulfills the agreed quality requirements of the Contract

Clause 3.8 of the General Conditions shall read: Any dicrepency shall be notified by the Buyer to the Seller in writing by telefax or e-mail within 3 business days of receipt of the results of the comparative testing obtained in

Umoa 8/14 DS RR DS

[redacted] PURCHASE/SALE AGREEMENT
SECTION 1 : COMMERCIAL TERMS
REFERENCE N° : [redacted]

Typical Analysis - Appendix I

Parameter	Unit	#	Average	St. dev.	Minimum	Maximum
SiO2	%	221	62,8	3,6	53,4	71,7
Al2O3	%	221	23,5	2,6	19,0	30,9
Fe2O3	%	221	5,0	0,7	3,5	6,9
CaO-total	%	221	3,8	1,1	1,8	8,5
CaO-free	%	32	0,3	0,2	0,0	0,9
MgO	%	221	3,1	1,0	1,0	6,9
Na2O	%	221	0,5	0,2	0,2	0,9
K2O	%	221	2,0	0,3	1,2	2,9
TiO2	%	221	1,1	0,2	0,8	1,5
P2O5	%	221	1,0	0,3	0,2	2,2
Na-eq	-	221	1,8	0,3	1,1	2,6
LOI	%	221	2,9	0,9	1,0	5,7
<45µm	%	221	73,9	5,0	53,0	85,1
Cu	mg/kg	221	89	22	26	162
Pb	mg/kg	221	55	15	20	122
Zn	mg/kg	221	127	34	63	241

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Exhibit M

ASH SALES CONFIRMATION

Buyer: [redacted] Cement Company [redacted]

Seller: [redacted]

This confirms the agreement entered into to be effective as of the 3rd day of July, 2019 (the "Effective Date"), by and between [redacted] ("Seller") and [redacted] Cement Company [redacted] ("Buyer"), individually a "Party" and collectively the "Parties", regarding the sale and purchase of Ash (as defined below herein) under the terms specified herein.

This Ash Sales Confirmation (the "Confirmation"), and the General Terms and Conditions ("GTC") that are attached hereto or transmitted herewith and which will supplement and are incorporated into this Confirmation, may be referred to herein as the "Agreement". Any capitalized term used in this Agreement and not defined in the Section in which it appears will have the meaning set forth in Section 1 of the GTC. In the event of any conflict between this Confirmation and the GTC, the terms of this Confirmation will prevail. Notwithstanding any other agreement between the Parties to the contrary, any terms and conditions proposed by Buyer that purport to modify, supplement or amend this Agreement will not be binding upon Seller unless Seller has expressly agreed to such terms and conditions in writing.

Product: "Ash" (sometimes referred to herein as the "Product") means individually and collectively Fly Ash and Bottom Ash. "Fly Ash" means fine solid particles of noncombustible ash which are produced from the combustion of coal in steam electric generating plants and collected from the flue gas by means of electrostatic precipitators; including ash which is collected in the economizer's hoppers. "Bottom Ash" means agglomerated noncombustible ash particles which are produced from the combustion of coal in steam electric generating plants that are too large to be carried in the flue gases and are therefore collected in an ash hopper at the bottom of the furnace.

Term: [redacted]

Quantity: Product supplied and purchased hereunder on a Non-firm (as defined below), "as needed", "as available" basis. "Non-firm" means that delivery or receipt of the Product may be interrupted by either Party for any reason or for no reason at all without liability on the part of either Party. For the avoidance of doubt, each of Buyer and Seller acknowledges and agrees that (1) there are no minimum quantity purchase and sale obligations of any kind under this Agreement with respect to either Party and (2) each of Buyer and Seller hereby expressly waives any and all claims it may otherwise have had arising out of and/or relating to the other Party's failure to purchase, accept, sell or deliver, as applicable, any minimum quantity of Product, under contract, at law or in equity, including any "cover damages" under the applicable uniform commercial code.

Source: The Ash that is purchased and sold hereunder may be "as-produced" conditioned Ash or may be Ash that has been reclaimed from an Ash Basin, from the Station, as determined in Seller's sole discretion; provided that such

JMM 7/3/19

[redacted]

Ash conforms with the Quality Specifications. Seller will provide Buyer with prior notice if any Ash will be reclaimed from an Ash Basin. "Station" or "Source" means [redacted]

Delivery Point: Seller or its contractor, as applicable, will load the Product directly into the trucks. Title to, risk of loss and responsibility for the Product, will pass from Seller to Buyer as the Product is loaded into Buyer's or its contractor's trucks at the Source.

Representative Quality: All Product purchased and sold hereunder is purchased and sold "as is", "where is" and "with all faults".

Price: For each Ton of Product loaded into the trucks at the Source Buyer will pay to Seller a Contract Price of [redacted] ("Contract Price".) In good and valuable consideration for the Product that is sold and delivered by Seller and purchased and accepted by Buyer pursuant to this Agreement, Buyer will be solely responsible to provide and pay for all transportation of the Product from the Source to Buyer's destination, at Buyer's sole cost and expense.

Taxes: [redacted]

Transportation: Buyer is responsible for (1) providing the trucks or other equipment necessary to transport the Product from the Source to Buyer's destination, (2) all contracts necessary for the truck transportation of the Product, (3) and payments to Buyer's truck or other transportation contractor(s).

Buyer and all Buyer contractors who perform any of the transportation services hereunder shall, at all times while at a Source site, comply with the environmental, health, safety and security practices and procedures prescribed by [redacted] and provided to Buyer (verbally or in writing) or posted at the Station with respect to such Station and the transportation of the Product, including without limitation the Screening Measures, Safe Work Practices, CCP Requirements, and fitness-for-duty requirements, as each of the foregoing may from time to time be modified, amended, superseded or replaced (collectively the "Station Rules"). Buyer will advise its employees or contractors, as applicable, of the Station Rules and secure their consent in a form satisfactory to [redacted] will make a copy of the Station Rules available to Buyer upon request.

Buyer shall comply, and shall cause all of its contractors to comply, with all applicable laws, rules and regulations relating to the transportation of the Product, and Buyer must give all applicable notices with respect to, and in accordance with, any applicable laws, rules and regulations.

Safety Data Sheets: Seller will provide Buyer with a Safety Data Sheet ("SDS") for the Ash. Buyer acknowledges that the SDS is for informational purposes only and is not a

7/3/19

[redacted]

Billing and Payment:

Seller will prepare one or more written report(s) indicating information for each truck load of Product Delivered to Buyer including:
Date of Delivery, Source, Trucking receipt number, gross weight (lbs), tare weight (lbs), net weight (lbs), net weight (tons) Contract Price (per ton) and total amount due to Seller for such Product. Seller's written report ("Delivery Report") and, if necessary, invoice will be submitted to Buyer by no later than the fifteenth (15th) day of each month following the month of Delivery of the Product to which it relates.

If applicable, Buyer will pay the invoice on a net thirty (30) days basis, subject to timely receipt of the Delivery Report.

[redacted]

Exhibit N

[redacted]

[redacted] Cement Company

Maximum Chemical Content for Supplement Raw Material Requirements - Fly Ash

As Of 2/14/2017

Chemical Name	Silica Oxide (Sand)	Aluminum Oxide	Ferric Oxide	Calcium Oxide	Magnesium Oxide	Sulfur Trioxide	Sodium Oxide	Potassium Oxide	Chlorine	Titanium Dioxide	Zinc Oxide	Phosphorus Pentoxide	Strontium Oxide	Manganese Oxide	Mercury	Chrome	Loss on Ignition	Moisture
Chemical Symbol	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl	TiO_2	ZnO	P_2O_5	SrO	Mn_2O_3	Hg	Cr Comp.	LOI	H_2O
Maximum Content	60.0%	50.0%	10.0%	10.0%	1.5%	1.0%	0.5%	3.5%	0.5%	1.0%	1.0%	0.5%	0.5%	6.0%	*375ppb	**TBD	15.0%	20.0%
Minimum Content	--	20.0%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0%

***Mercury content averaged over a 30 day period.**
****TBD= To Be Determined (our MSDS states less than .05% in cement)**

Al_2O_3/Fe_2O_3 must be greater than 1.6
No pesticides
No Foreign material including but not limited to trash/metal/wood etc
The utilization of any supplemental material be limited by its unique chemistry.
Low concentrations of Na2O, K2O, and MgO are positive attributes.

Exhibit O

Synthetic Gypsum Specification Example

	Acceptable product	Single Shipment Reject Limits	Reference Method
Free Moisture	10% max	12% max	Dried @ 43.3C
CaSO4*2H2O	92% min	92% min	
SO3	38% min	38% min	
CaSO4*1/2H2O	1.0% max	2.0% Max	TGA
SiO2	1.0% max	1.5% max	
Fly Ash	1.0% max	1.5% max	
Water Soluble Salts			Specific Ion Electrode
Cl	400 ppm max	400 ppm max	
Particle Size	1” max	1” max	

Exhibit P

OBJECTIVE

Plant requires chemical and mineralogical analysis of a potential gypsum source.

Plant received the following samples:

[redacted]

METHODOLOGY

The following methods were employed for these analyses:

1. Sample preparation for heavy metals besides mercury:
    a. Hot block digestion with nitric and hydrochloric acids.
    b. Method Number: EPA 3050b.
2. Mercury Analysis:
    Thermal decomposition and amalgamation: (EPA 7473)
3. Chloride Analysis:
    a. Preparation in accordance with ASTM C114
    b. Analysis by ion chromatography
4. Oxide Analysis:
    In accordance with ASTM C114, fused bead XRF
5. Mineral phase / gypsum purity:
    Quantitative X-ray diffraction (Bruker D8)
6. Free moisture:
    In accordance with ASTM C471 – two hours at 45deg C.

RESULTS

[redacted]		
SiO_2	%	1.5
Al_2O_3	%	0.3
Fe_2O_3	%	0.37
CaO	%	42.6
MgO	%	0.3
SO_3	%	54.92
LOI	%	7.40
Na_2O	%	0.00
K_2O	%	0.06
Na_2O Eqv:	%	0.04
SrO	%	0.04
TiO_2	%	0.00
P_2O_5	%	0.00
ZnO	%	0.01
Mn_2O_3	%	0.000
Free Moisture	%	5.8
Total Moisture	%	20.0
Chloride	%	0.011

Oxide values are measured and reported on an ignited basis.

Free moisture was determined in accordance with ASTM C471 (Standard Test Methods for Chemical Analysis of Gypsum). Samples were heated in a laboratory oven for 2 hours at 45deg C and the loss was recorded. The value is often referred to as the air dried loss.

Total moisture reflects the weight loss at two hours in a laboratory oven at 100deg C.

Mineralogy:

		[redacted]
Quartz	%	0.1
Gypsum	%	97.2
Calcite	%	0.4
Dolomite	%	2.3

X-ray diffraction indicates the material nearly pure gypsum. There are no indications of anhydrite or sulfite in the material. The inclusion of quartz, calcite, and dolomite this syn gyp is typical for both naturally occurring and synthetic gypsum.

Generated diffractogram:

[redacted] Syn Gyp

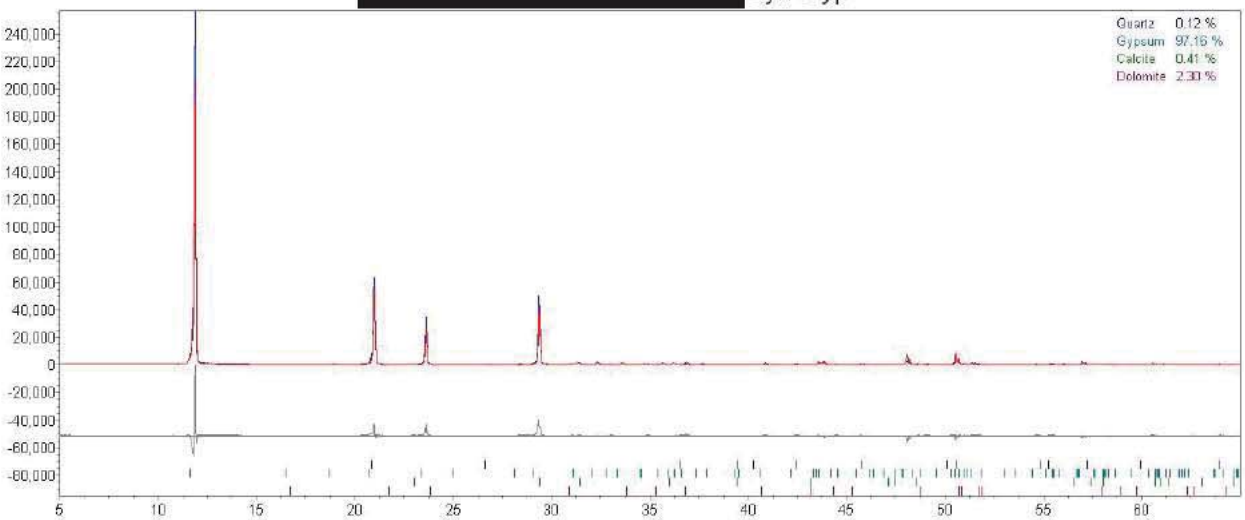

Exhibit Q

OBJECTIVE

Plant has requested chemical and metals data for bottom ash material.

Plant received the following samples:
[redacted] Bottom Ash (ID [redacted])

METHODOLOGY

The following methods were employed for these analyses:

1. Sample preparation for heavy metals besides mercury:
    a. Hot block digestion with nitric and hydrochloric acids.
    b. Method Number: EPA 3050b.
2. Heavy Metals Analysis (other than mercury):
    a. Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).
    b. Method Number: EPA 6010b.
3. Mercury Analysis:
    Thermal decomposition and amalgamation: (EPA 7473)
4. Chloride Analysis:
    a. Preparation in accordance with ASTM C114
    b. Analysis by ion chromatography
5. Oxide Analysis:
    In accordance with ASTM C114, fused bead XRF
6. Total Organic Carbon (TOC)
    Quantitative infrared spectroscopy after digestion in acid
7. Sulfide
    a. Total Sulfur determined by combustion IR (Eltra CS)
    b. Sulfate sulfur determined by ICP-OES
    c. Sulfide calculated by difference.

RESULTS

[redacted]

SiO_2	%	45.6	Silver (Ag)	ppm	<5.0
Al_2O_3	%	20.8	Arsenic (As)	ppm	21
Fe_2O_3	%	24.43	Barium (Ba)	ppm	93
CaO	%	4.0	Beryllium (Be)	ppm	2.0
MgO	%	1.1	Cadmium (Cd)	ppm	<1.0
SO_3	%	0.20	Cobalt (Co)	ppm	7.8
LOI	%	3.72	Chromium (Cr)	ppm	57
Na_2O	%	0.53	Copper (Cu)	ppm	64
K_2O	%	2.03	Mercury (Hg)	ppm	0.013
Na_2O Eqv:	%	1.87	Nickel (Ni)	ppm	27
SrO	%	0.05	Lead (Pb)	ppm	<10
TiO_2	%	1.16	Antimony (Sb)	ppm	<15
P_2O_5	%	0.13	Selenium (Se)	ppm	<15
ZnO	%	0.02	Tin (Sn)	ppm	<15
Mn_2O_3	%	0.029	Thallium (Tl)	ppm	<15
Moisture	%	16.4	Vanadium (V)	ppm	62
			Zinc (Zn)	ppm	39
TOC	%	1.62			
Cl	%	<0.005			
Sulfide	%	0.041			

Oxide values are measured and reported on an ignited basis.

Exhibit R

[redacted] Cement
US
[redacted] #19020801
[redacted] FLY ASH - FROM [redacted]

EXAMPLE OF ASH NOT TO SPECIFICATION AND NOT ACCEPTED

2/18/2019 7:33:58AM
Calculated by UniQuant
Thermo Fisher Scientific

Refer to Exhibit N

ARL OPT-369 Rh 50kV LiF200 InSb AX06

Method	: UQ	Measured on	: 2/14/2019 2:08:16PM
Kappa List	: AnySample	X-ray Path:	: Vacuum
Shapes & ImpFc	: Teflon	Film Type	: None
Calculated as	: Oxides	Collimator Mask	: 29 mm
Case Number	: 0 = All known	Viewed Diameter	= 29.00 mm
		Viewed Area	= 660.52 mm2
		Viewed Mass	= 4000.00 mg
Reporting Level	> 10 ppm and wt% > 2 Est.Err.	Sample Height	= 0.00 mm

Ratio of Al2O3/ Fe2O3 < 1.6
Not to spec

Compound	Wt%	Est.Error	Element	Wt%	Est.Error
SiO2	25.01	0.22	Si	11.69	0.10
Al2O3	15.45	0.18	Al	8.17	0.10
Fe2O3	13.55	0.17	Fe	9.48	0.12
CaO	4.16	0.10	Ca	2.98	0.07
SO3	3.38	0.09	Sx	1.35	0.04
K2O	1.17	0.05	K	0.970	0.04
MgO	0.837	0.042	Mg	0.505	0.025
TiO2	0.703	0.035	Ti	0.421	0.021
Na2O	0.194	0.019	Na	0.144	0.014
P2O5	0.188	0.0094	Px	0.0819	0.0041
SrO	0.0689	0.0034	Sr	0.0583	0.0029
CdO	0.0538	0.025	Cd	0.0471	0.022
BaO	0.0468	0.0071	Ba	0.0419	0.0064
Cr2O3	0.0322	0.0016	Cr	0.0220	0.0011
V2O5	0.0321	0.0017	V	0.0180	0.0010
ZrO2	0.0235	0.0015	Zr	0.0174	0.0011
RuO4	0.0227	0.0070	Ru	0.0173	0.0053
MnO	0.0227	0.0011	Mn	0.0176	0.0009
Sm2O3	0.0186	0.0060	Sm	0.0160	0.0051
CuO	0.0183	0.0027	Cu	0.0146	0.0022
Co3O4	0.0175	0.0013	Co	0.0129	0.0010
Tb4O7	0.0174	0.0055	Tb	0.0148	0.0047
NiO	0.0131	0.0008	Ni	0.0103	0.0007
ZnO	0.0125	0.0006	Zn	0.0100	0.0005
WO3	0.0081	0.0022	W	0.0064	0.0017
Y2O3	0.0071	0.0010	Y	0.0056	0.0007
Rb2O	0.0067	0.0007	Rb	0.0062	0.0006
PuO2	0.0062	0.0030	Pu	0.0055	0.0027
Nd2O3	0.0052	0.0022	Nd	0.0044	0.0018
SeO2	0.0051	0.0008	Se	0.0037	0.0006
Ga2O3	0.0051	0.0006	Ga	0.0038	0.0005
Br	0.0031	0.0006	Br	0.0031	0.0006
GeO2	0.0028	0.0008	Ge	0.0019	0.0005
Nb2O5	0.0027	0.0011	Nb	0.0019	0.0008
Sc2O3	0.0022	0.0011	Sc	0.0014	0.0007

Known Concentration = 34.90 LOI
Sum Weight% before normalization to 100% = 90.9 %
Total Weight% Oxygen = 28.94

D/S = 0.090 C,H,N mixt.

LOI > 15%; not to spec

Hg = 1575.29 ug/kg

Excessive mercury not to specification

Exhibit S

EXAMPLE OF ASH MEETING SPECIFICATION AND ACCEPTED

[redacted] Cement
US

4/2/2020 8:24:33AM
Calculated by UniQuant
Thermo Fisher Scientific

[redacted] **FLY ASH - LOAD 2**

MOIST 22.63%

Refer to Exhibit N

ARL OPT-369 Rh 50kV LiF200 InSb AX06

Method	: UQ	Measured on	: 4/1/2020 7:10:22PM
Kappa List	: AnySample	X-ray Path:	: Vacuum
Shapes & ImpFc	: Teflon	Film Type	: None
Calculated as	: Oxides	Collimator Mask	: 29 mm
Case Number	: 0 = All known	Viewed Diameter	= 29.00 mm
		Viewed Area	= 660.52 mm2
		Viewed Mass	= 4000.00 mg
Reporting Level	> 10 ppm and wt% > 2 Est.Err.	Sample Height	= 0.00 mm

Compound	Wt%	Est.Error	Element	Wt%	Est.Error
SiO2	46.53	0.25	Si	21.76	0.12
Al2O3	26.00	0.22	Al	13.76	0.12
Fe2O3	9.21	0.14	Fe	6.44	0.10
K2O	2.84	0.08	K	2.36	0.07
CaO	1.84	0.07	Ca	1.32	0.05
SO3	1.37	0.06	Sx	0.550	0.02
TiO2	1.05	0.05	Ti	0.632	0.03
MgO	0.965	0.048	Mg	0.582	0.029
P2O5	0.548	0.027	Px	0.239	0.012
Na2O	0.357	0.024	Na	0.265	0.018
BaO	0.153	0.0090	Ba	0.137	0.0081
SrO	0.0876	0.0044	Sr	0.0741	0.0037
MnO	0.0443	0.0022	Mn	0.0343	0.0017
ZrO2	0.0363	0.0018	Zr	0.0269	0.0013
V2O5	0.0300	0.0022	V	0.0168	0.0012
CuO	0.0255	0.0028	Cu	0.0203	0.0022
Cr2O3	0.0249	0.0014	Cr	0.0171	0.0010
Sm2O3	0.0170	0.0046	Sm	0.0147	0.0040
Co3O4	0.0163	0.0010	Co	0.0120	0.0007
Rb2O	0.0152	0.0008	Rb	0.0139	0.0007
NiO	0.0141	0.0008	Ni	0.0111	0.0006
ZnO	0.0139	0.0007	Zn	0.0112	0.0006
CeO2	0.0130	0.0046	Ce	0.0106	0.0038
La2O3	0.0127	0.0027	La	0.0108	0.0023
Tb4O7	0.0113	0.0040	Tb	0.0096	0.0034
As2O3	0.0111	0.0043	As	0.0084	0.0032
Y2O3	0.0104	0.0010	Y	0.0082	0.0008
Nd2O3	0.0086	0.0025	Nd	0.0073	0.0021
WO3	0.0075	0.0023	W	0.0060	0.0018
PbO	0.0057	0.0018	Pb	0.0053	0.0017
Gd2O3	0.0055	0.0022	Gd	0.0048	0.0019
Sc2O3	0.0045	0.0012	Sc	0.0030	0.0008
Ga2O3	0.0039	0.0007	Ga	0.0029	0.0005
Nb2O5	0.0022	0.0011	Nb	0.0015	0.0008
SeO2	0.0019	0.0008	Se	0.0014	0.0006
GeO2	0.0015	0.0008	Ge	0.0011	0.0005

Known Concentration = 8.70 LOI

D/S = 0.090 C,H,N mixt.

Sum Weight% before normalization to 100% = 93.5 %

Total Weight% Oxygen = 42.93

Hg = 250.6071 ug/kg

Exhibit T

SAFETY DATA SHEET

SECTION I – Product and Company Identification

1.1 Product Identifier
Product Form: Mixture
Product Name: [redacted]
Synonyms: Ash, coal ash, bituminous coal fly ash
1.2 Intended Use of the Product:
Fly ash may be used as filler for cement, concrete and concrete products, and other construction materials
1.3 Name, Address and Telephone of the Responsible Party

[redacted]

1.4 Emergency Telephone Number
[redacted]

SECTION II – Hazards Identification

2.1 Classification of the Substance or Mixture
This mixture as produced has not recently been assessed and/or tested for its physical, health and environmental hazards, but hazards are inferred through similarity to other products of similar composition.

Acute
Skin irritation, Category 3 H316
Eye irritation, Category 2B H320
Respiratory tract irritation, Category H335
Chronic
May cause damage to lungs H373
Other
If crystalline silica (quartz) is present, Carc. Category 1A H350

2.2 Label Elements
GHS-US Labeling

Hazard Pictograms (GHS-US)

Chronic Health Hazard

Signal Word: Danger

Hazard Statements
Causes mild skin irritation
Causes eye irritation
May cause respiratory irritation
May cause damage to lungs through prolonged or repeated inhalation exposure
May cause cancer if crystalline silica (quartz) is present

Precautionary Statements - Prevention
Keep container tightly closed or covered, P233
Avoid breathing dust, P261
Wash thoroughly after handling, P264
Use only outdoors or in a well-ventilated area, P271
Precautionary Statements - Response
If in Eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do so. Continue rinsing. If eye irritation persists, get medical advice/attention. P305 + P351 + P338 + P337.

[redacted]y Ash and Bottom Ash (Ash)

Safety Data Sheet

According To Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules And Regulations

Revision Date: 04/21/2015 Date of issue: 12/18/2014 Supersedes Date: 03/01/2014 Version: 1.0

SECTION 1: IDENTIFICATION

1.1. Product Identifier

Product Form: Mixture

Product Name: [redacted] Fly Ash and Bottom Ash (Ash)

Synonyms: Coal Fly Ash, Class F Fly Ash, Class C Fly Ash, Type CI Fly Ash, Type CH Fly Ash, Type F Fly Ash, Lignite Coal Fly Ash, Subbituminous Coal Fly Ash, Anthracite Coal Fly Ash, Bituminous Coal Fly Ash, Bottom Ash, Ash

1.2. Intended Use of the Product

Fly Ash and Bottom Ash are used as a supplementary cementitious or pozzolanic material for cement, concrete and concrete products. It is also used in soil stabilization and as filler in asphalt and other products that are widely used in construction.

1.3. Name, Address, and Telephone of the Responsible Party

Company

[redacted]

1.4. Emergency Telephone Number

Emergency Number : [redacted])

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the Substance or Mixture

Classification (GHS-US)

Eye Irrit. 2B H320

Carc. 1A H350

STOT RE 1 H372

Full text of H-phrases: see section 16

2.2. Label Elements

GHS-US Labeling

Hazard Pictograms (GHS-US) :

GHS08

Signal Word (GHS-US) : Danger

Hazard Statements (GHS-US) : H320 - Causes eye irritation.
H350 - May cause cancer (Inhalation).
H372 - Causes damage to organs through prolonged or repeated exposure.

Precautionary Statements (GHS-US) : P201 - Obtain special instructions before use.
P202 - Do not handle until all safety precautions have been read and understood.
P260 - Do not breathe dust.
P264 - Wash hands, forearms, and exposed areas thoroughly after handling.
P270 - Do not eat, drink or smoke when using this product.
P280 - Wear eye protection, protective clothing, protective gloves, and respiratory protection.
P305+P351+P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308+P313 - If exposed or concerned: Get medical advice/attention.
P337+P313 - If eye irritation persists: Get medical advice/attention.
P405 - Store locked up.
P501 - Dispose of contents/container in accordance with local, regional, national, territorial, provincial, and international regulations.

[redacted]

Safety Data Sheet

Coal Fly Ash

1. Identification

TRADE NAME (AS LABELED): Coal Fly Ash.

SYNONYMS: Coal Fly Ash, Coal Power Boiler Fly Ash.

PRODUCT USES: Commonly used as an additive in concrete and cement products.

CHEMICAL NAME/CLASS: Process by-product.

MANUFACTURER'S NAME:
ADDRESS:
EMERGENCY PHONE: (800) 424-9300 (CHEMTREC)
BUSINESS PHONE:

2. Hazard(s) Identification

Signal Word: DANGER
Coal Fly Ash - CAS# 68131-74-8

GHS Classification/Category	Hazard Statement(s)	Pictogram
HEALTH Carcinogenicity- Category 1A Specific Target Organ Toxicity - Repeated Exposure, Inhalation (Category 1)	May Cause Cancer May Cause Damage to The Respiratory System Through Prolonged or Repeated Exposures If Inhaled	
Eye Damage/Irritation- Category 1 Skin Corrosion/Irritation- Category 2	Causes Serious Eye Damage Causes Skin Irritation	

2. Hazard Identification (cont'd.)

OTHER CLASSIFICATIONS Combustible Dust (OSHA Defined Hazard)	If small particles accumulate during further processing, handling, or by other means, may form combustible dust concentrations in air	None

Precautionary Statements:

PREVENTION STATEMENTS**:** Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear gloves, clothing, eye, face and respiratory protection. Avoid breathing dust or mists. Use only outdoors or in a well-ventilated area. Store away from other materials. Contaminated clothing should not be taken out of the workplace. Avoid release to the environment.

RESPONSE STATEMENTS**:** If in eyes rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do, continue rinsing. If eye irritation persists get medical attention. If swallowed, rinse mouth. If inhaled remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a poison center or doctor/physician if you feel unwell. Rinse skin with water/shower, continue rinsing. If skin irritation or rash occurs, get medical advice/attention. Take off contaminated clothing and wash before reuse. Wash hands after handling.

DISPOSAL: Dispose of in accordance with Federal, state and local regulations.

Ingredients of Unknown Acute Toxicity (>1%): Not applicable.

3. Composition/ Information Ingredients

Component	CAS#	EC#	Wt %
Aluminosilicates	1327-36-2		<95
Calcium Oxide (CaO)	1305-78-8	215-138-9	1-30
Silica, Crystalline Quartz (SiO_2)	14808-60-7	238-878-4	< 6
Potassium oxide (K_2O)	12136-45-7		<3
Magnesium Oxide (MgO)	1309-48-4	215-171-9	1-8
Ferric oxide (Fe_2O_3)	1309-37-1	215-168-2	1-2

4. First-Aid Measures

Ingestion: Give 1-2 glasses of water if person is conscious. Never give anything by mouth to person who becomes unconscious, consult physician.

Eye Contact: Immediately flush eyes with large amounts of temperate water for 15 minutes. May cause serious damage to the eyes, especially if heated. Contact medical support immediately if product contacts the eyes.

Skin Contact: May cause irritation, and reddening. Remove contaminated clothes. Get medical help if irritation or burns are present after washing.

Skin Absorption: Product is not known to be absorbed through the skin.

Inhalation: Inhalation may cause respiratory tract irritation and difficulty breathing. Symptoms may include coughing, burning, difficulty breathing and shortness of breath. Remove exposed person to fresh air. Consult physician if symptoms persist.

Symptoms or Effects:

4. First-Aid Measures (cont'd.)

Acute Symptoms/Effects – Causes irritation to the lungs, eyes and skin and may cause damage to the lungs (silicosis and/or cancer) through prolonged or repeated exposure via inhalation. Individuals with previous lung disease (e.g., bronchitis, fibrosis, emphysema or chronic obstructive pulmonary disease (COPD) who inhale fly ash may report an aggravation of these conditions.

Delayed Symptoms/Effects – Lung effects may be delayed in onset. See Section 11 for additional information on chronic effects.

5. Fire-fighting Measures

Extinguishing Media and Restrictions: Use sand, fine water mist or fog spray on smoldering fly ash. Calcium oxide may react with water to form corrosive calcium hydroxide, with evolution of heat.

Specific Hazards, Anticipated Combustion Products: Oxides of iron, calcium and aluminum.

Autoignition Temperature: 450° – 5,000°F, (232° – 2760°C) depending upon the degree of incompletely combusted organic material in the ash.

Special Firefighting Equipment/Procedures: Avoid using a high-pressure stream of water directed at smoldering fly ash. This may cause a flare up. Areas of accumulated fly ash may retain heat for extended periods of time.

Unusual Fire and Explosion Hazards: Depending on moisture content, and more importantly, particle diameter and airborne concentration, fly ash in a contained area may explode in the presence of an ignition source. Fly ash may similarly deflagrate (combustion without detonation like an explosion) if ignited in an open or loosely contained area. Completely combusted (pure) fly ash is expected to have an extremely low potential for explosion, even under typical dust explosion conditions (i.e., high airborne concentrations in the presence of an ignition source). However, fly ash containing some degree of incompletely combusted matter (as low as 7 % in some instances) is expected to present the potential for explosion when a high airborne dust concentration comes in contact with an ignition source. The LEL for this fly ash product is an unknown variable and is dependent upon the degree of incompletely combusted organic material in the product. Use good housekeeping to prevent accumulations of material. Avoid conditions that generate significant quantities of airborne dust.

NFPA Rating (Scale 0-4): **Health =** 3 **Fire =** 0 **Reactivity =** 0

6. Accidental Release Measures

Steps to be Taken In Case Material Is Released or Spilled: Fly ash may be vacuumed or shoveled for recovery or disposal. Avoid generating dusty conditions and provide good ventilation. Use NIOSH-approved filtering facepiece respirator ("dust mask") and goggles where ventilation is not possible or inadequate. Wear appropriate personal protective apparel as described in section 8 if contact with the ash is expected. See unusual fire and explosion hazards above in section 5.

7. Handling and Storage

Precautions to be Taken In Handling and Storage: When wet, fly ash may become corrosive (pH > 12). Use proper personal protective equipment (gloves and goggles) when handling. Loading and unloading fly ash may generate excessive airborne ash dust. Keep bulk and bagged ash dry until used. Stack bagged material in a secure manner to prevent falling. Bagged ash is heavy and poses risks such as sprains and strains to the back, arms, shoulders and legs during lifting and mixing. Handle with care and use appropriate control measures. This product may present an engulfment hazard. To prevent burial or suffocation, do not enter a confined space such as a silo, bin, bulk truck, or other storage container or vessel that stores or contains ash. Ash can build up or adhere to the walls of a confined space. The ash can release, collapse or fall unexpectedly. Areas of accumulated fly ash may retain heat for extended periods of time. Use appropriate heat resistant protective equipment if needed when contact with accumulated fly ash is possible.

8. Exposure Control Measures/ Personal Protection

Exposure Limits/Guidelines:

Name	CAS#	Agency	Exposure Limits	Comments
Calcium Oxide	1305-78-8	OSHA ACGIH	PEL-TWA 5 mg/m^3 TLV-TWA 2 mg/m^3	None None
Silica-Amorphous	7631-86-9	OSHA	PEL-TWA 80 $mg/m^3/\%SiO_2$	Total Particulate
Silica, Crystalline Quartz[A]	1408-60-7	OSHA OSHA ACGIH	30 $mg/m^3/(\%SiO_2 + 2)$ 0.05 mg/m^3 0.025 mg/m^3	Total particulate Respirable fraction Respirable fraction
Aluminum Oxide	1344-28-1	OSHA OSHA ACGIH	PEL-TWA 15 mg/m^3 PEL-TWA 5 mg/m^3 TLV-TWA 1 mg/m^3	Respirable fraction
Magnesium Oxide	1309-48-4	OSHA ACGIH	PEL-TWA 15 mg/m^3 TLV-TWA 10 mg/m^3	Respirable fraction
Iron oxide	1309-37-1	OSHA ACGIH	PEL-TWA 10 mg/m^3 TLV-TWA 5 mg/m^3	Total particulate
Particulates not otherwise		OSHA	PEL – TWA 15 mg/m^3 PEL – TWA 5 mg/m^3	Total particulate Respirable fraction

[A]Depending on the combustion conditions and temperatures, a portion of the silica in the fly ash may be converted to the cristobalite form of silica.
Note: Fly ash components may vary depending on the source and type of coal used.

Personal Protective Equipment:

RESPIRATORY PROTECTION – The use of a NIOSH-approved filtering face piece respirator ("dust mask") and goggles or a full face respirator with appropriate cartridges is recommended when handling product. In particular, ensure that the proper level of respiratory equipment is selected in the event that crystalline silica exposure limits may be exceeded. Use respiratory protection in accordance with regulatory requirements such as the OSHA respiratory protection standard 29CFR 1910.134 following a determination of risk from potential exposures. Eye irritation may become an issue at elevated levels.

PROTECTIVE GLOVES – Cloth, canvas, or leather gloves are recommended when handling the dry product to minimize potential mechanical irritation. If product becomes wet, neoprene, butyl, or nitrile gloves are recommended. Prevent spillage of material inside gloves and avoid abrasion at contact points.

EYE PROTECTION – Chemical goggles are recommended when handling this product OTHER PROTECTIVE CLOTHING OR EQUIPMENT – Protective clothing with long sleeves or disposable outer garments may be desirable in extremely dusty areas. Prevent spillage of material inside boots and avoid abrasion at contact points.

WORK/HYGIENE PRACTICES – Carefully sweep, or vacuum areas where fly ash has settled to avoid excessive accumulation. Minimize blowdown or other practices that generate high airborne dust concentrations. The use of barrier skin cream may prevent skin irritation in susceptible individuals. Wash hands before breaks and at the end of workday.

Ventilation:

LOCAL EXHAUST – LOCAL EXHAUST – Provide local exhaust as needed so that exposure limits are met. Use with adequate ventilation to ensure exposure levels are maintained below the limits provided (see section 8). Use local exhaust ventilation, and process enclosure if necessary, to control airborne dust. Ventilation to control dust should be considered where potential explosive concentrations and ignition sources are present. The design and operation of any exhaust system should consider the possibility of explosive concentrations of coal ash dust within the system. See "SPECIAL" section below.

8. Exposure Control Measures/Personal Protection (cont'd.)

MECHANICAL (GENERAL) – Provide general ventilation in processing and storage areas so that exposure limits are met.

SPECIAL – Ensure that exhaust ventilation and material transport systems involved in handling this product contain explosion relief vents or suppression systems designed and operated in accordance with applicable standards if the operating conditions justify their use.

9. Physical/Chemical Properties

Physical Description/Odor: Coal fly ash is a solid, grey/black powder with a sulfur like odor. It is the residual material from the burning of a combination of coal fuels.

Auto-ignition temperature:	Not available
Boiling Point (@ 760 mm Hg):	Not applicable
Decomposition temperature:	Not available
Evaporation Rate (Butyl Acetate = 1):	Not applicable
Freezing Point:	Not available
Flash Point:	Not available
Flammability:	Not available
Melting Point:	Not available
Evaporation Rate:	Not applicable
Partition Coefficient (n-octonal/water):	Not available
Odor Threshold:	Not available
pH:	8.5-12 in H_2O
Solubility in Water (% by weight):	Not available
Specific Gravity (H_2O = 1):	Not applicable
Upper/Lower Explosive Limits:	Not available
Vapor Density (air = 1; 1 atm):	Not applicable
Relative Density:	Not available
Vapor Pressure (mm Hg):	Not applicable
Viscosity:	Not applicable
% Volatile by Volume [@ 70°F (21°C)]:	Not available

10. Stability and Reactivity

Reactivity: Not applicable.
Hazardous Polymerization: ☐ May occur ☒ Will not occur
Stability: ☐ Unstable ☒ Stable
Conditions to Avoid: Avoid contact with oxidizing agents and water.
Incompatibility (Materials to Avoid): Moisture, oxidizing agents, acids, halogens and alcohols.
Hazardous Decomposition or By-Products: Oxides of iron, calcium and aluminum.
Hazardous Polymerization: ☐ May occur ☒ Will not occur
Sensitivity to Mechanical Impact: Not applicable.
Sensitivity to Static Discharge: No information available.

11. Toxicological Information

Likely Route(s) of Exposure:

☐ Ingestion:

11. Toxicological Information (cont'd.)

- ☒ Skin:
- ☒ Inhalation:
- ☒ Eye:

Signs and Symptoms of Exposure:

Acute Health Hazards: Causes irritation to the lungs, eyes and skin and may cause damage to the lungs (silicosis and/or cancer) through prolonged or repeated exposure via inhalation.

Chronic Health Hazards: Prolonged inhalation of crystalline silica may result in silicosis, a disabling pulmonary fibrosis characterized by fibrotic changes and miliary nodules in the lungs, a dry cough, shortness of breath, emphysema, decreased chest expansion, and increased susceptibility to tuberculosis. In advanced stages, loss of appetite, pleuritic pain. Advanced silicosis may result in death due to cardiac failure or destruction of lung tissue.

Carcinogenicity:

IARC: Listed by IARC – Contains crystalline silica, Group 1, carcinogenic to humans.
NTP: Listed by NTP – Contains crystalline silica, known to be a human carcinogen.
OSHA: Listed by OSHA – No

Acute toxicity: Not determined for compound as a whole.

Components:

Crystalline quartz:
Carcinogen status: IARC and NTP: Known Human Carcinogen, see section 2 above.

Calcium oxide:
Oral LD50 Rat: 72 mg/kg; Inhalation 60 µg/kg.

Aluminum oxide:
No LD50/LC50 information found relating to normal routes of occupational exposure.

Manganese:
Oral LD50 Rat: > 3478 mg/kg.

Iron oxide:
Oral LD50 Rat: >10000 mg/kg.

Target Organs: Eyes, skin and respiratory system.

Aspiration Hazard: Not applicable.

Reproductive effects: No information available.

Teratogenic effects: No information available.

Mutagenic effects: No information available.

12. Ecological Information

Ecotoxicity: The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms.

Biopersistance and Degradability: No information available.

Bioaccumulation: No information available.

Soil Mobility: No information available.

Other Adverse Effects: NA

13. Disposal Considerations

Waste Disposal Method: Dry land disposal is acceptable in most jurisdictions. Areas of accumulated fly ash may retain heat for extended periods of time, so be sure that this condition does not create a fire hazard. Fly ash will become corrosive in the presence of water. Do not dispose in areas of high ground water or where surface runoff is adjacent to waterways. It is, however, the user's responsibility to determine at the time of disposal whether the product meets EPA RCRA (or other applicable regulations) criteria for hazardous waste. Follow applicable federal, state, and local regulations.

14. Transport Information

Mode: (Air, Land, water) Not regulated as a hazardous material by the U.S. Department of Transportation. Not listed as a hazardous material in Canadian Transportation of Dangerous Goods (TDG) regulations.

Proper Shipping Name:	NA
Hazard Class:	NA
UN/NA ID Number:	NA
Packing Group:	NA
Label/Placard Required:	NA

15. Regulatory Information

TSCA: Fly ash is listed on the TSCA inventory. All individual chemical components are on the TSCA inventory as well.
CERCLA: Fly ash is not listed as a CERCLA hazardous substance.
DSL: Fly ash is listed on the Canadian Domestic Substance List (DSL) inventory. All individual chemical components are on the DSL inventory as well.
OSHA: Fly ash and all chemical components are considered by OSHA to be hazardous substances and should be included in the employer's hazard communication program.
STATE RIGHT-TO-KNOW:
Warning: This material may contain varying concentrations of crystalline quartz (airborne concentrations of respirable size), a substance known to the State of California to cause cancer.
Massachusetts – Quartz silica, aluminum oxide and calcium oxide are listed on the Right to Know List.
Pennsylvania – Quartz silica, aluminum oxide and calcium oxide are listed on Pennsylvania's Appendix A – Hazardous Substance List.
SARA 313 Information: This product does not contain any chemical ingredient (s) with known CAS numbers that exceed the threshold reporting levels established by SARA Title III, section 313 and 40 CFR section 372.
SARA 311/312 Hazard Category: This product has been reviewed according the EPA "Hazard Categories: promulgated under SARA Title III, Sections 311 and 312 and is considered, under applicable definitions, to meet the following categories:

An immediate (acute) health hazard	Yes
A delayed (chronic) health hazard	Yes
A fire hazard	No
A reactivity hazard	No
A sudden release hazard	No

16. Additional Information

Date Prepared: 02/26/2013
Date Revised: 08/17/2018
Prepared By: [redacted] Safety and Health Department.
[redacted] **SDS available** [redacted] www.westrock.com
Disclaimer:
The information and data herein are believed to be accurate and have been compiled by WestRock Safety and Occupational Health professionals from external sources believed to be reliable. WestRock provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose and use in compliance with all applicable laws and standards. WestRock will not be liable for claims relating to any party's use of or reliance on information and data contained herein.

16. Additional Information (cont'd.)

Definition of Common Terms:

ACGIH	=	American Conference of Governmental Industrial Hygienists
C	=	Ceiling Limit
CAS#	=	Chemical Abstracts System Number
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act
DOT	=	U. S. Department of Transportation
DSL	=	Canada-Domestic Substance List
EC50	=	Effective concentration that inhibits the endpoint to 50% of control population
EC#	=	European Commission Number
ENCS	=	Japanese Existing and New Chemical Substances List
EPA	=	U.S. Environmental Protection Agency
IARC	=	International Agency for Research on Cancer
IATA	=	International Air Transport Association
IMDG	=	International Maritime Dangerous Goods
LC50	=	Concentration in air resulting in death to 50% of experimental animals
LCLo	=	Lowest concentration in air resulting in death
LD50	=	Administered dose resulting in death to 50% of experimental animals
LDLo	=	Lowest dose resulting in death
LEL	=	Lower Explosive Limit
LFL	=	Lower Flammable Limit
MSHA	=	Mine Safety and Health Administration
NA	=	Not Applicable
NIOSH	=	National Institute for Occupational Safety and Health
NFPA	=	National Fire Protection Association
NPRI	=	Canada- National Pollution Release Inventory
NTP	=	National Toxicology Program
OSHA	=	Occupational Safety and Health Administration
PEL	=	Permissible Exposure Limit
PNOR	=	Particulate Not Otherwise Regulated
PNOS	=	Particulate Not Otherwise Stated
RCRA	=	Resource Conservation and Recovery Act
REACH	=	Registration, Evaluation, Authorisation and Restriction of Chemicals
STEL	=	Short-Term Exposure Limit (15 minutes)
STP	=	Standard Temperature and Pressure
TCLo	=	Lowest concentration in air resulting in a toxic effect
TDG	=	Canadian Transportation of Dangerous Goods
TDLo	=	Lowest dose resulting in a toxic effect
TLV	=	Threshold Limit Value
TSCA	=	Toxic Substance Control Act
TWA	=	Time-Weighted Average (8 hours)
UFL	=	Upper Flammable Limit
WHMIS	=	Canada-Workplace Hazardous Materials Information System

SAFETY DATA SHEET

1. Identification

Product identifier Gypsum (Calcium Sulfate Dihydrate)

Other means of identification None.

Recommended use Industrial use.

Recommended restrictions -

Manufacturer/Importer/Supplier/Distributor information

Operating company

Operating company

Operating company

Operating company

2. Hazard(s) identification

Physical hazards Not classified.

Health hazards

Carcinogenicity	Category 1A
Specific target organ toxicity, repeated exposure	Category 2 (Lung)

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement May cause cancer. May cause damage to organs (Lung) through prolonged or repeated exposure.

Precautionary statement

Prevention Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe dust. Wear protective gloves/protective clothing/eye protection/face protection.

Response If exposed or concerned: Get medical advice/attention.

Storage Store locked up if a potential inhalation exposure hazard exists.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information None.

3. Composition/information on ingredients

Mixtures

Exhibit U

Material Inventory Production Report
April 30, 2020

Quarry:

Material	Measure	Produced/Received			Consumed/Shipped			Inventory
		Current	M-T-D	Y-T-D	Current	M-T-D	Y-T-D	Current
Limestone Overburden	Cubic Yds.							
Shale Overburden	Cubic Yds.							
Production Clay	Tons							
Limestone Quarry Rock	Tons							
Shale Quarry Rock	Tons							

Raw Mix Materials:

Material	Measure	Produced/Received			Consumed/Shipped			Inventory
		Current	M-T-D	Y-T-D	Current	M-T-D	Y-T-D	Current
Mix Rock (East Stack)	Tons							
Mix Rock (West Stack)	Tons							
High Calcium Limestone	Tons							
Natural Sand	Tons							
Foundry Sand	Tons							
Mill Scale / Slag	Tons							
Raw Ash	Tons	2,209.7	12,575	33,799	346.4	10,601	34,703	**2,774**
Kaolin / Bauxite	Tons							

Kiln Feed Production:

Material	Measure	Produced/Received			Consumed/Shipped			Inventory
		Current	M-T-D	Y-T-D	Current	M-T-D	Y-T-D	Current
#2 Fuel Oil	Gallons							
Reject Rock	Tons							
Kiln Feed	Tons							

Clinker Production:

Material	Measure	Production/Received			Consumed/Shipped			Inventory
		Current	M-T-D	Y-T-D	Current	M-T-D	Y-T-D	Current
Natural Gas	K Cubic Ft.							
Coal	Tons							
Sawdust	Tons							
Hydrated Kiln Lime	Tons							
Cement Kiln Dust - Process	Tons							
Cement Kiln Dust - Landfill	Tons							
Clinker - Silos	Tons							
Clinker - Gallery	Tons							
Clinker - Outside	Tons							
Clinker - Other	Tons							
Total Clinker	**Tons**							

Finish Mill Additives:

Material	Measure	Produced/Received			Consumed/Shipped			Inventory
		Current	M-T-D	Y-T-D	Current	M-T-D	Y-T-D	Current
Natural Gypsum	Tons							
Synthetic Gypsum	Tons	159.6	2,287	21,307	204 3	4,583	18,092	**9,491**
Grinding Aid Strength	Tons							
Grinding Aid	Tons							
Masonry Rock	Tons							
Hydrated Mill Lime	Tons							
Ultra-Plas	Tons							
Buff Pigment	Tons							
Straw Pigment	Tons							
Finished - Cement Kiln Dust	Tons							

Cement Production:

Material		Produced/Received			Consumed/Shipped			Inventory
		Current	M-T-D	Y-T-D	Current	M-T-D	Y-T-D	Current
/II - Bulk	Tons							
/II - Package	Tons							
CGH - Bulk	Tons							
III - Bulk	Tons							
1L - Bulk	Tons							
S-Masonry	Tons							
N-Masonry - Package	Tons							
S-Buff Masonry - Package	Tons							
S-Straw Masonry - Package	Tons							
Total Bulk	**Tons**							
Total Package	**Tons**							
Total Cement	**Tons**							

Comments

Exhibit V

Daily Operating Report For: 12/31/2019

Produced/Puchased vs. Used/Sold vs. Inventory

		Produced Today	Produced MTD	Produced YTD	Used Today	Used MTD	UsedYTD	Inventory
Quarry	Marl							
TOTAL	QUARRY							

		Purchased Today	Purchased MTD	Puchased YTD	Used Today	Used MTD	Used YTD	Inventory
Additive	Blast Sand	[redacted]						0
	Calcium Carbonate	[redacted]						2
	Clay	[redacted]						0
	Conditioned Ash	869.89	15,556.64	215,679.96	7,248.00	21,115.39	218,224.75	5,573.34
	Kaolin	[redacted]						
	Limestone	[redacted]						
	Sand	[redacted]						
	Synthetic Gypsum	176.57	5,598.84	62,873.71	2,681.98	5,197.05	62,336.04	7,029.23
	FMs Marl	[redacted]						
	Dust	[redacted]						
	IRM Iron	[redacted]						
	Nucor Iron	[redacted]						
TOTAL	ADDITIVE	[redacted]						

		Produced Today	Produced MTD	Produced YTD	Used Today	Used MTD	Used YTD	Inventory
Raw Mill	Raw Mix Produced	[redacted]						
TOTAL	RAW MILL	[redacted]						

		Produced Today	Produced MTD	Produced YTD	Used Today	Used MTD	Used YTD	Inventory
Clinker	Type I/III Clinker	[redacted]						
	Weathered Clinker	[redacted]						
TOTAL	CLINKER	[redacted]						

Exhibit W

Feedstock Usage - 2019

metric tonnes

Raw Mix	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Limestone (Marl)	[redacted]									
Sand	[redacted]									
Ash	16,996	15,537	15,225	21,786	18,636	23,191	20,898	20,481	10,414	18,755
Clay	[redacted]									
Iron (IRM)	[redacted]									
other										
other										

Cement	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Clinker consumed	[redacted]									
Synthetic Gypsum	4,165	8,638	4,453	4,888	7,033	7,619	4,989	6,068	4,414	5,194
Limestone	[redacted]									
Ash	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
other-CKD	[redacted]									
other-Additives	[redacted]									
other										

Nov	Dec
[redacted]	
15,190	21,115
[redacted]	

Nov	Dec
[redacted]	
3,842	5,197
[redacted]	
NA	NA
[redacted]	

Exhibit X

[redacted]

Date: 6 6 20 № 66444

Material Delivered – Circle One:

ASH	CLINKER	SAND	[redacted]
COAL	IRON ORE (Mill Scale)	SYN GYP	TIRES
LIMESTONE	other: _____		other: _____

Carrier / Trucking Co : [redacted]

Customer/Vendor Name: [redacted]

DRIVER NAME: [redacted]

BOL # [redacted]

TRUCK # [redacted] TRAILER # [redacted]

*****For Tire Delivery/Pickup Only *****

Inbound Trailer # _____ Delivered to: Lot #: _____

Outbound Trailer # _____ Picked up from: Lot #: _____

GROSS WEIGHT (Full) 79 900

TARE WEIGHT (Empty) 29 160

Date/Time:	6/5/2020 12:49:34PM
Ticket #:	29,635
Truck Co :	[redacted]
Truck #:	[redacted]
Product:	ASH BASIN
PO #:	
Destination:	[redacted]
Source:	[redacted]
Gross:	80,020 LBS
Tare:	29,160 LBS
Net:	50,860 LBS 25.43 TONS

REPRINT

Exhibit Y

Additive to Raw Mix Variable Cost

		Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cement Production	kt	[redacted]												[redacted]
Clinker Production	kt	[redacted]												[redacted]
Raw Meal Production (wet)	kt	[redacted]												[redacted]
Raw Meal Production (dry)	kt	[redacted]												[redacted]
% Mix - dry														
Marl	%	[redacted]												
Flyash	%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	12.80%	
Iron Ore	%	[redacted]												
Sand	%	[redacted]												
Alumina	%	[redacted]												
Total	%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
% Moisture														
Marl	%	[redacted]												
Flyash	%	20.00%	20.00%	20.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	20.00%	20.00%	20.00%	
Iron Ore	%	[redacted]												
Sand	%	[redacted]												
Alumina	%	[redacted]												
Wet tons														
Marl	kt	[redacted]												[redacted]
Flyash	kt	16,996	15,537	15,225	21,786	18,636	23,191	20,898	20,481	10,414	18,755	15,190	21,115	218,225
Iron Ore	kt	[redacted]												[redacted]
Sand	kt	[redacted]												[redacted]
Alumina	kt	[redacted]												[redacted]
Total	kt	[redacted]												[redacted]
% Mix -wet														
Marl	%	[redacted]												[redacted]
Flyash	%	12.64%	13.30%	15.54%	13.78%	12.16%	16.48%	12.47%	13.42%	15.51%	12.26%	14.03%	16.97%	13.86%
Iron Ore	%	[redacted]												[redacted]
Sand	%	[redacted]												[redacted]
Alumina	%	[redacted]												[redacted]
Total	%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Exhibit Z

C. LIMITATIONS, MONITORING AND REPORTING CONDITIONS

(S.C. Regulation 61-62.1, Section II; S.C. Regulation 61-62.70.6.a.3.i.B)

<table>
<tr><th>Condition Number</th><th>Conditions</th></tr>
<tr><td>C.15</td><td>
Emission Unit ID: 12
Equipment ID: All

In accordance with SC Regulation 61-62.5, Standard 7, the limits for PM emissions have been determined to be the following:
<table>
<tr><th>Process</th><th>Limits for PM</th></tr>
<tr><td>Storage Piles</td><td>Best management practices consisting of natural moisture, water sprays, or covered storage.</td></tr>
</table>
A comprehensive facility wide assessment and control plan of all fugitive dust emissions has been submitted and approved by the Department. The owner/operator shall review and assess the fugitive dust control plan every 6-months. Subsequent updates to the plan shall be submitted to the Director of the Air Permitting Division for review and approval semiannually.
</td></tr>
<tr><td>C.16</td><td>
Emission Unit ID: 13
Equipment ID: 3RM100, 3CN, 4CN213, 4KL280

In accordance with SC Regulation 61-62.5, Standard 3 – Waste Combustion and Reduction, the emissions from each Kiln, Precalciner, and In/line Raw Mill shall not exceed the following:

1. 6.0×10^{-3} lb Nickel/million BTU total heat input
2. 1.0×10^{-4} lb Cadmium/million BTU total heat input
3. 7.4×10^{-4} lb Chromium/million BTU total heat input
4. 1.7×10^{-3} lb Arsenic/million BTU total heat input
5. 5.0×10^{-3} lb Lead/million BTU total heat input
6. 0.45 lb Hydrochloric Acid/million BTU total heat input

In accordance with SC Regulation 61-62.5, Standard 3 – Waste Combustion and Reduction, Section V – Waste Analysis, the owner/operator shall for each representative waste stream or each waste batch/shipment (inconsistent in composition) that is to be fired in the kiln as alternative fuel, ensure that the following waste analyses are conducted:

1. Classify that the waste is non-hazardous, utilizing the SC Hazardous Waste Management Regulation 61-79.261.
2. Analyze the waste for heat value (Btu/gal and/or Btu/lb), total halogens, percent Nitrogen and percent Sulfur.
3. Analyze the waste for Nickel, Cadmium, Chromium, Arsenic, Lead and Chlorine (HCl).

The owner/operator shall conduct a performance test of the In-Line Kiln/Raw Mill#1 and its
</td></tr>
</table>

1.3. Gypsum Association's Written Comments on EPA's August 2019 Proposed Rule; Docket No. EPA-HQ-OLEM-2018-0524 (Gypsum Association, 2020)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

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** In cooperation with Trench, Rossi e Watanabe Advogados

August 07, 2020

Via Email
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Ms. Rita Chow
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U.S. Environmental Protection Agency
Mail Code 5301P
One Potomac Yard (Potomac Yard South)
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Re: CCR Stakeholder Engagement; Gypsum Association Written Comments; Proposed CCR Rule; Docket No. EPA-HQ-OLEM-2018-0524

Dear Ms. Chow:

Enclosed are written comments prepared by the Gypsum Association as a follow-up to the CCR Stakeholder Engagement meeting on June 4, 2020, as well as the public comments that the Gypsum Association submitted on EPA's proposed rule entitled *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use and Piles* (Docket No. EPA-HQ-OLEM-2018-0524). Please let us know if you have any questions or need any additional information. We appreciate the continued opportunity to engage with EPA on this Proposed Rule.

Very truly yours,

Jessica Wicha

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Cc: Steve Meima, Gypsum Association
Susan Hines, Gypsum Association
David Hackett, Baker & McKenzie

On June 4, 2020, the Gypsum Association participated in a telephone call with representatives of the U.S. Environmental Protection Agency ("EPA" or "Agency") to discuss the beneficial use and management of FGD gypsum.[1] The Gypsum Association understands that this was one of several stakeholder calls that EPA is convening related to its proposed rule entitled *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use and Piles* (Docket No. EPA-HQ-OLEM-2018-0524) ("Proposed CCR Rule"). At the end of the call, the Gypsum Association agreed to provide certain additional information regarding the beneficial use and management of FGD gypsum, which is set forth below.

I. OVERVIEW

The Gypsum Association has actively participated in EPA's rulemaking efforts related to the regulation of coal combustion residuals ("CCRs"), dating back 10 years. During the 2010 rulemaking, the Gypsum Association submitted extensive comments to explain the unique characteristics of FGD gypsum and its appropriate regulatory treatment as a raw material for use in the manufacturing of FGD gypsum panels and not as a waste. These comments included a technical assessment conducted by ARCADIS supporting the conclusion that FGD gypsum does not present a risk to human health or the environment, and were supplemented with several meetings with Agency representatives. Following the issuance of the Proposed CCR Rule in 2019, the Gypsum Association again met with EPA and prepared detailed written comments explaining why FGD gypsum is a valuable raw material product, not a waste, and therefore should not be regulated as a CCR under the Resource Conservation and Recovery Act ("RCRA").

The written comments provided herein underscore the Gypsum Association's consistent position that FGD gypsum that is produced for the manufacturing of gypsum panels is materially different from other CCRs and therefore warrants regulatory treatment in the final CCR rule reflective of its unique nature. Unlike other CCRs, such FGD gypsum is not a by-product material that has stumbled upon a new use. "Panel-grade" FGD gypsum is the output of a deliberative manufacturing process that requires significant investment by the electric utility in order to produce a material that meets precise product specifications. Gypsum panel manufacturers pay utilities for this product and manage it as the valuable raw material that it is. As such, FGD gypsum clearly is not a waste and falls entirely outside of the

[1] For purposes of these written comments, as well as the public comments submitted by the Gypsum Association in 2010 and 2019, "FGD gypsum" refers to FGD gypsum that has been processed by utilities to remove impurities and meet specific product specifications such that it is suitable for the manufacture of FGD gypsum panels. This raw material is different from, and the Gypsum Association provides no comment on, other FGD gypsum material that has not been processed in such a manner. This processing is discussed further in Section II(A) herein.

regulatory scope of RCRA. Moreover, as explained in ARCADIS' 2010 technical report, which is provided as Attachment A to these written comments, there are no known environmental damage cases involving FGD gypsum and no identified environmental or human health risks presented by the material. Indeed, FGD gypsum presents no greater risk than natural gypsum, which has been approved by the Food and Drug Administration ("FDA") for use in food products. This remains true today and further emphasizes the fact that RCRA regulation of FGD gypsum is wholly inappropriate.

II. FGD GYPSUM IS A MANUFACTURED RAW MATERIAL PRODUCT AND NOT A WASTE

The Gypsum Association's public comments that were submitted to EPA in 2010 and 2019 carefully walk through the process that electric utilities must undergo in order to manufacture FGD gypsum that is suitable for use in FGD gypsum panel manufacturing. This process is outlined again below. However, the following points cannot be overstated. First, not all utilities manufacture FGD gypsum. Economic investment is required to retrofit a utility's equipment to produce FGD gypsum. Therefore, it is a considered business decision for a utility to make the requisite operational changes to manufacture this material. Second, FGD gypsum is the product of a multi-stage manufacturing process and each stage of that process produces a material with very different characteristics. Flue gas is substantially different from FGD sludge which is different from unwashed FGD gypsum which is different from washed FGD gypsum. The utility must complete the entire manufacturing process to produce "FGD gypsum" that can be used for the production of gypsum panels. Third, utilities manufacture FGD gypsum in accordance with precise product specifications provided by the gypsum panel manufacturer. These specifications are detailed in contracts between the parties and ensure that the material meets specific criteria to be of sufficient quality to be used as a raw material in gypsum panel production. All of these points support the fact that FGD gypsum is a valuable raw material product and not a waste material; it is not properly subject to RCRA regulation.

A. FGD Gypsum is the Product of a Multi-Step Process in Accordance with Product Specifications

As mentioned, FGD gypsum is manufactured by utilities in a multi-step process to meet precise specifications contractually identified by the gypsum panel companies. Each stage of the process produces a material with different characteristics. The utility must complete the entire process in order to produce a material that is suitable for use as FGD gypsum for gypsum panel manufacturing. This process is depicted in Figure 1. It begins with scrubbers within the absorber handling flue gas produced by the burning of coal. This is an important distinction from other CCRs, such as boiler slag, bottom ash, and fly ash. FGD gypsum is not a direct coal residue. Bottom ash and boiler slag accumulate in and are

removed from the coal combustion boiler (furnace). Fly ash is a fine, light-weight particulate that is captured as it flies up from the boiler. FGD gypsum, by contrast, is specifically manufactured using a controlled process that uses the flue gas to create a manufactured material via a sequence of processes, the final stage of which is washing.

The production process for FGD gypsum begins by passing the flue gas through a water-based solution that contains fine-ground lime or limestone particulate. The process scrubs the sulfur dioxide (SO_2) from the flue gas within the absorber by reaction with the lime or limestone, producing a calcium sulfite ($CaSO_3$) sludge also referred to as FGD sludge. The sludge material is either placed in a landfill or further refined to become a material suitable for use in the manufacture of gypsum panels. In addition to being the first step in creating FGD gypsum, EPA has acknowledged that scrubbing the flue gas to remove the sulfur dioxide helps to mitigate the release of one of the primary causes of acid rain. *See* "Reducing Acid Rain," U.S. Environmental Protection Agency, *avail. at* http://www.epa.gov/acidrain/reducing/.

In the second production step, the sludge is oxidized by forcing clean, compressed air through it in an oxidation vessel. The oxidation process converts the calcium sulfite sludge to calcium sulfate ($CaSO_4$), creating slurry that is often referred to as "unwashed" FGD gypsum. Unwashed FGD gypsum is not suitable for use in manufacturing gypsum panels and is not the subject of the Gypsum Association's comments.

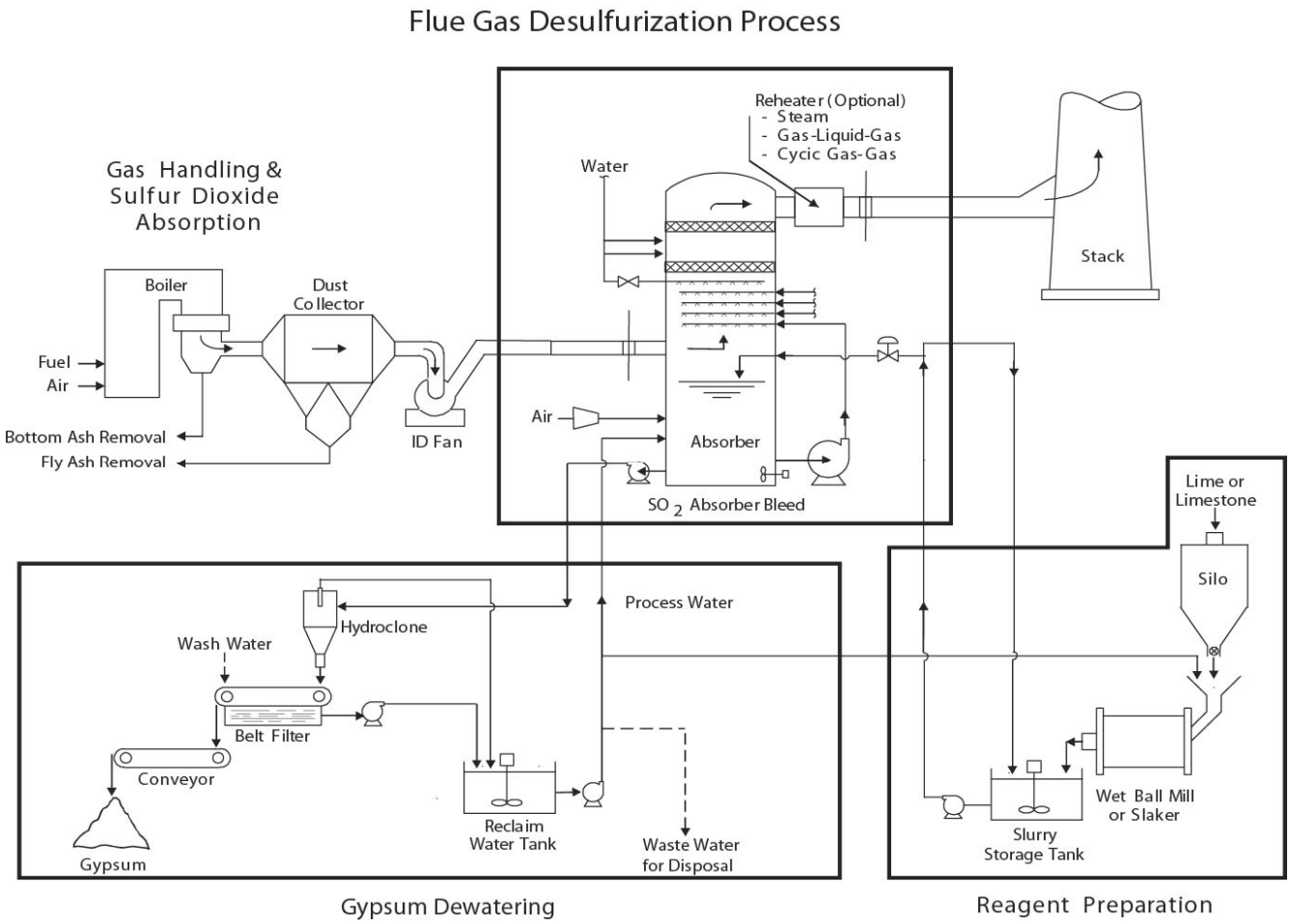
Further refinement of the unwashed gypsum occurs when the gypsum crystals are concentrated and separated from fine materials in hydroclones. The hydroclone underflow, which contains the concentrated gypsum stream, is delivered to the belt filter for dewatering and washing. The hydroclone overflow is returned to the process as water make-up.

In the final stage, the gypsum is "washed" using a vacuum filtering system to remove chlorides and salts and additional surface moisture. The removal of these impurities creates a high-quality gypsum material (*i.e.,* FGD gypsum) that is suitable for use in manufacturing gypsum panels. This final processing step is critical to the production of panel-grade FGD gypsum and distinguishes this raw material from unwashed FGD gypsum, which may be sent for disposal. The dried, high-quality, panel-grade FGD gypsum or "washed gypsum" is then transferred to a gypsum panel manufacturing facility for incorporation in the gypsum panel manufacturing process.

While product specifications for FGD gypsum vary by FGD gypsum panel manufacturer and are proprietary and confidential to each manufacturing company, this material generally speaking must meet specific criteria in order for it to be sufficiently pure to be used as a raw material in the manufacture of

gypsum panel products, which includes parameters related to moisture content, chloride concentration, and purity of calcium sulfate. *See* "O&M Feature: FGD Gypsum Issues," Power Engineering, *avail. at* https://www.power-eng.com/2007/11/01/o-amp-m-feature-fgd-gypsum-issues/.

FIGURE 1



III. FGD GYPSUM IS MANAGED AS A VALUABLE RAW MATERIAL PRODUCT BY THE GYPSUM PANEL MANUFACTURER

Once FGD gypsum is manufactured by a utility, it is handled, analyzed, and financially tracked by gypsum panel manufacturers in the same manner as - if not more rigorously than - all other raw materials sourced for the production of wallboard. FGD gypsum is the gypsum panel manufacturer's largest raw material for its largest product, and it is managed accordingly. This raw material is of such financial significance to the gypsum panel business - accounting for ten percent or more of the total operating expenses of a manufacturing plant - that companies have in place interdisciplinary teams,

corporate protocols and procedures, and well-developed systems to ensure that FGD gypsum is carefully stored, accurately tracked, and properly financially accounted.

A. Sourcing the Raw Material

Gypsum panel manufacturers devote considerable time and expense sourcing FGD gypsum, as supply has become a challenge due to changing market trends. Again, not every utility manufactures FGD gypsum. Once suppliers are identified, the gypsum panel manufacturer engages in arms-length contractual negotiations with the utility related to price, quality, terms of delivery and quantity of the FGD gypsum. Although there is variation across companies as to how those contracts are tracked, it is not uncommon for these supply agreements to be entered into an electronic business enterprise system, such as SAP or ERP. Gypsum panel manufacturing facilities then use that electronic system to place purchase orders ("POs"), as is commonly done for the sourcing of any other gypsum panel ingredient. Often, specific administrative personnel are assigned to manage this process in accordance with corporate standard operating procedures, which ensures that price, quantity, delivery method, and freight costs are closely and systematically tracked. Given the importance of FGD gypsum to the FGD gypsum panel manufacturing process and variation in modes of transport, some manufacturers supplement this automated practice with manual data entry, which ensures an even greater degree of accuracy. [2]

B. Financially Tracking the Raw Material

Because of the magnitude of FGD gypsum purchases, which typically represent ten percent or more of all operating expenses at a gypsum panel manufacturing facility, this raw material is subject to strict financial controls from the time it is received from the utility through its use in gypsum panel products. Upon receipt by the gypsum panel manufacturer, the FGD gypsum is booked similar to other purchased raw materials, reflected as an asset on the company's balance sheet and included in financial statements. Working closely with plant operational personnel, company financial and accounting teams record and carefully track the company's FGD gypsum financial position in accordance with accounting principles and company-specific protocols. Plant personnel are trained in recording and entering FGD information in the company's electronic tracking systems, which is reviewed by financial managers on a continuous basis.

As a precious and expensive commodity that is fundamental to the production of gypsum panel products, FGD gypsum is the subject of enhanced review and valuation. For instance, companies employ safeguards and assessments in addition to the automated tracking process to corroborate the financial

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[2] Provided as Attachment B to these written comments is a sample spreadsheet that a member company uses to track this information at each of its manufacturing facilities.

system inventory accounting of the material. Additionally, the amount and cost of FGD gypsum is the subject of frequent internal reports, including regular updates to senior management, and careful financial accounting.

C. Storing and Managing the Raw Material

Upon receipt at the gypsum panel manufacturing facility, the FGD gypsum material is stored in on-site piles. The material is routinely tested throughout storage to ensure it meets the manufacturer's proprietary product specifications. The specific frequency of this testing depends on the company and the company's familiarity with the utility producing the FGD gypsum.[3] Responsibility for handling any material that is determined to be off-spec depends on the terms of the contract with the utility; in some cases the utility must come and retrieve the material, as many gypsum panel manufacturers do not allow delivery of material that does not meet contractual specifications. In other cases the gypsum panel manufacturer must manage the material. Either way, off-spec material cannot be used for gypsum panel manufacturing and must be properly managed by the appropriate party.

The FGD gypsum storage piles are "live" piles with the size and shape of the piles continually changing as material is added from utility shipments and subsequently removed for use in the FGD gypsum panel manufacturing process. Although these piles are never drawn down to zero as that would not reflect prudent inventory management, FGD gypsum inventory is closely monitored on a regular, often weekly and even daily, basis. Specific inventory assessment procedures vary by company, but many companies rely on their business enterprise system software, mentioned above, to keep close tabs on inventory, with quantities automatically deducted from the total stock as each batch of FGD gypsum panels are manufactured. Production personnel are often responsible for inputting this production information into the online system, again in accordance with company standard operating procedures. As previously discussed, this information along with the data entered at the time of receipt of the FGD gypsum, is provided to and reviewed by the company's financial and accounting teams to ensure proper accounting of the amount and cost of this material.

Because of the financial and operational significance of FGD gypsum, in addition to electronic tracking of inventory based on the amount of FGD gypsum purchased from the utility and then used in production of FGD gypsum panels, manufacturers invest significant resources and time in monitoring their stockpiles. These monitoring methods can include drone flyovers, sophisticated laser equipment, aerial surveys, and weigh belts, which corroborate the electronic tracking inventory. This supplemental information is then compared against the inventory data in the electronic system and adjustments are

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[3] This reliance on facility expertise to determine the regularity of product testing is similar to reliance on generator knowledge to determine if a waste is hazardous. *See* 40 C.F.R. 262.11(d)(1)

made, as needed. As mentioned, proper inventory management is necessary to effectively run the manufacturing process and to report and project financial results. Since FGD gypsum is recorded as an asset on gypsum panel manufacturers' balance sheets, their working capital fluctuates based on the amount of FGD gypsum stored onsite. As such, this inventory information is regularly reviewed directly by senior level management to ensure any discrepancies are promptly addressed.

Gypsum panel manufacturers manage their on-site storage piles in accordance with proper inventory management practices, as well as a range of federal, state and local environmental regulatory requirements, including Clean Air Act permits, Clean Air Act fugitive dust control plans, Clean Water Act stormwater permits, Clean Water Act stormwater pollution prevention plans, state groundwater protection plans, and other state-specific permits (*e.g.*, Florida environmental resource permits). Dust suppression and stormwater best management practices are two key regulatory drivers that complement company inventory management practices to prevent material loss. Ultimately, FGD gypsum is too valuable to the gypsum panel manufacturer to lose and the material is tracked and managed accordingly.

IV. FGD GYPSUM DOES NOT PRESENT A RISK TO HUMAN HEALTH OR THE ENVIRONMENT

For the reasons provided above and as detailed in the Gypsum Association's 2010 and 2019 public comments, FGD gypsum is materially distinct from other CCRs, is clearly a raw material product and not a waste, and therefore falls outside of the regulatory scope of RCRA. Nevertheless, it is also important to recall the extensive technical work conducted by ARCADIS in connection with the Gypsum Association's 2010 public comments, which dispels any concerns about the risk posed by FGD gypsum. The ARCADIS report is provided in full as Attachment A to these written comments. As discussed in the attached report, ARCADIS reviewed all publicly available data regarding FGD gypsum to evaluate risk to human health and the environment. ARCADIS also reviewed the 2010 proposed CCR rule and underlying data produced by EPA to determine if they affected ARCADIS' analysis or conclusions, including metals analysis, damage cases, and risk assessments conducted by EPA based on data from leaching studies and the proven damage cases. This review culminated in a conclusion by ARCADIS that FGD gypsum simply does not pose an environmental or human health concern. To the contrary, FGD gypsum presents no greater risk than natural gypsum, which often meets the FDA specifications for GRAS.[4] As of 2010, all available data confirmed the safety of FGD gypsum. Moreover, the Gypsum

[4] The FDA has listed calcium sulfate (*i.e.,*, gypsum) as Generally Recognized as Safe ("GRAS"). 21 C.F.R. 184.1230. GRAS identifies food substances that are not subject to premarket review and approval by the FDA and are safe for use in levels that do not exceed good manufacturing practices. The gypsum uses recognized by FDA include: dietary source of calcium, conditioning water in beer, and an ingredient in wine, toothpaste, canned vegetables, flour, ice cream, cheese and other foods. *See* 21 C.F.R. 184.1230(c), (d).

Association is not aware of any environmental incidents or issues related to the transfer, management, or use of FGD gypsum since ARCADIS' review.

V. CONCLUSION

The Gypsum Association appreciates the opportunity to provide these written comments to EPA as it works to finalize the Proposed CCR Rule. The record that the Gypsum Association has created over the past ten years resoundingly supports excluding FGD gypsum from RCRA regulation. FGD gypsum is a material that is deliberately manufactured by electric utilities pursuant to contractual arrangements with gypsum panel manufacturers in accordance with precise product specifications. The FGD gypsum output is the primary raw material in the manufacture of gypsum panel products and is carefully managed by gypsum panel manufacturers. Comprehensive inventory management protocols are in place at each gypsum panel manufacturing facility to maintain the economic value of this material and to ensure compliance with pre-existing federal, state and local environmental regulations that apply to the storage and handling of this raw material. What is more, FGD gypsum simply does not present a risk to human health or the environment. For all of these reasons, the Gypsum Association continues to request that FGD gypsum be specifically excluded from RCRA regulation under 40 C.F.R. 261.4(a). In the absence of an explicit exemption, then the Gypsum Association requests that detailed language be added to the preamble to make clear that FGD gypsum is not a CCR subject to RCRA regulation, consistent with the Gypsum Association's 2019 public comments regarding the Proposed CCR Rule.

ATTACHMENT A

[2010 ARCADIS Report]

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Chicago, IL 60601

ENVIRONMENT

Subject:
Review of Washed FGD Gypsum

Date:
November 19, 2010

Contact:
Daniel C. O'Neill

Phone:
810.225.1901

Email:
daniel.oneill@arcadis-us.com

Dear Mr. Hackett:

As requested, ARCADIS prepared this summary of the two assessments conducted on behalf of the Gypsum Association which evaluated flue gas desulfurization (FGD) gypsum. The first assessment, conducted in 2009, used publicly available information to review the environmental and health risks of washed FGD gypsum. The second assessment, conducted in 2010, involved a technical evaluation of information and data used by the U.S. Environmental Protection Agency (USEPA) in its proposed regulation of Coal Combustion Residuals (CCRs) published in the Federal Register on Monday June 21, 2010 (Proposed CCR Rule).[1]

In 2009, ARCADIS was first tasked with reviewing all publicly available data regarding washed FGD gypsum to determine whether washed FGD gypsum poses a risk to human health or the environment. In order to accomplish this review ARCADIS undertook the following:

- Reviewed relevant literature from multiple sources including ARCADIS, USEPA, and various universities to identify and assess the published results for total concentrations of individual metals in FGD scrubber sludge, unwashed FGD gypsum, washed FGD gypsum, and natural gypsum.

[1] 75 Fed. Reg. 35128 (June 21, 2010).

- Compared and analyzed those results to various benchmarks including risk-based screening levels ("RBSLs") for soil.

- Reviewed relevant literature from various sources including ARCADIS, USEPA, and various universities to identify and assess the published results for leaching of metals from various FGD materials using a variety of leaching procedures (Toxicity Characteristic Leaching Procedure ("TCLP") and non-TCLP procedures).

- Analyzed and compared those results to RBSLs, benchmarks and standards for drinking water.

- Evaluated common uses for gypsum, including in food, and compared applicable specifications to washed FGD gypsum.

In 2010, the Gypsum Association retained ARCADIS to review the Proposed CCR Rule and underlying data to determine whether they affected ARCADIS' conclusions from the 2009 assessment. In order to respond to this request, ARCADIS reviewed the three proposed bases upon which USEPA relies in proposing to regulate CCRs:

- Metals analysis, including leachate results from leaching procedures developed by Vanderbilt University.

- USEPA's proven damage cases.

- Risk assessments conducted by USEPA based on data from leaching studies and the proven damage cases.

Both the 2009 and the 2010 assessments conducted by ARCADIS focused on washed FGD gypsum because that is the product used to manufacture wallboard and potentially falls within the scope of the Proposed CCR Rule. ARCADIS' review of the information resulted in the following conclusions:

- Based on review of information presented by the USEPA and the cited damage cases listed in the Federal Register, the use of washed FGD gypsum does not pose a threat to human health or the environment nor has it historically posed a threat to the environment.

- USEPA's Proposed CCR Rule does not present any data or scientifically-defensible argument suggesting that washed FGD gypsum poses a threat to human health and the environment.

- The leach testing developed by Vanderbilt University and used by the USEPA in connection with the Proposed CCR Rule, has not been evaluated on validity for assessing different solid wastes and may not be appropriate for evaluating the potential leaching threat from washed FGD gypsum.

- The leach testing data used by the USEPA was taken from the extreme limits of the testing protocol, outside the limits of the "plausible management conditions" suggested by the USEPA, and do not in any way represent a realistic application of conditions that are representative of the behavior of washed FGD gypsum in the environment.

- Based on TCLP testing results, washed FGD gypsum is not a RCRA hazardous waste – it does not exhibit the ignitability, corrosivity, or reactivity hazardous characteristics and USEPA did not reference any scientifically valid toxicity data.

- Washed FGD gypsum contains lower or comparable concentrations of heavy metals to naturally occurring mined gypsum.

- Washed FGD Gypsum contains lower concentrations of heavy metals than the direct contact USEPA Regional Screening Levels (RSLs) for residential soils and other relevant benchmarks.

- None of the damage cases cited by the USEPA involved washed FGD gypsum. No cases were presented which documented damage caused by washed FGD gypsum, and therefore damage from washed FGD cannot be documented or inferred.

- The risk assumptions used to evaluate the risks from combustion residuals in general are not appropriate for washed FGD gypsum. The highest concentrations reported from leaching assays that are reasonably applicable to environmental conditions do not show washed FGD gypsum is a potential problem to the environment.

In the following sections, ARCADIS discusses its evaluation of residual metals in washed FGD gypsum, analysis for leaching procedures used to generate some of the data presented to support the Proposed CCR Rule, evaluation of the relevance of the potential damage cases presented by USEPA to support the Proposed CCR Rule, and analysis of the two risk assessment provided by USEPA to support the Proposed Rule

I. 2009 Review of FGD Gypsum Metals Analysis from Publically Available Information

A. Total Metals

The results of ARCADIS' review of total metals in FGD gypsum are presented in Tables 1 and 2. These Tables were developed from data presented in the summary of literature referenced below the tables. The maximum concentrations of metals reported to be present in washed FGD gypsum and natural gypsum were either consistent with background concentrations or much lower than USEPA preliminary remedial action goals (PRGs) for residential or agricultural soil. Exponent[2] reported that in addition to the findings for soils, because the metals in work place air were also less than PRGs, the exposure pathways for all media were considered incomplete, and thus present no threat to human health and the environment.

Some of ARCADIS' key findings from review of the trace metals data include that trace elemental concentrations in washed FGD gypsum are:

- Present at levels comparable to natural gypsum, which in some cases meets FDA specifications for use as a food additive. The FDA has listed Calcium Sulfate (Gypsum) as Generally Recognized as Safe (GRAS)[3]. GRAS is a food substance that is not subject to premarket review and approval by the FDA, and is qualified to be safe for use in foods at levels that do not exceed good manufacturing practices. The gypsum uses recognized by the FDA include:
    - Dietary source of calcium.
    - Condition water used in brewing beer.
    - Controlling tartness and clarifying wine.
    - An ingredient in toothpaste, canned vegetables, flour, bread, ice cream, cheese and other foods.

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[2] *Lack of Complete Exposure Pathways for Metals in Natural and FGD Gypsum, Yost, Lisa et. Al. Human and Ecological Risk Assessments*.

[3] 21 C.F.R. § 184.1230.

- Present at levels that would be acceptable for residential soil, based on comparison to residential direct contact Regional Screening Levels (RSLs)[4] and benchmarks (Table 1). In fact, concentrations of trace metals were between 5 times and 7500 times lower than their respective RSLs.

- Present at levels protective of groundwater used as drinking water if generated in soil (based on comparison to drinking water criteria and standards adjusted with default dilution factors).

- When compared to related materials we find that

  - Trace metals in washed FGD gypsum are generally similar or less than the same metals in natural, mined gypsum (Table 2).

  - Trace metals in washed FGD gypsum are generally similar or less than the same metals in unwashed FGD gypsum (Table 3).

  - Trace metals in washed FGD gypsum are generally much less than the same metals in scrubber sludge (Table 4).

Conclusion for 2009 Total Metals Analysis

Based on the above, ARCADIS concluded that the concentrations of total trace metals in washed FGD gypsum poses no threat to human health or the environment.

B. Metals From Leaching Results

Trace metal concentrations in solution form extraction based testing are affected by the pH of the solution of the extracting solution. Titration to an extreme pH will liberate metals from any solid matrix. Because the natural pH of washed FGD gypsum is the pH to which this material will most likely be exposed, a comparison of the concentrations leached at the natural pH was included along with the review of the concentrations leached at pH between 5 and 9. Based on the literature review, the following observations regarding concentrations of trace metals in leach testing extracts were made (Tables 6-8).

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[4] U.S. Environmental Protection Agency (USEPA). May. 2009. http://www.epa.gov/region9/superfund/prg/

- At the natural pH of washed FGD gypsum, all trace metals except selenium were below RBSLs and benchmarks (3 to 1000 times lower). Selenium was approximately 2 times higher which is well within commonly used default dilution-attenuation factors.

- All trace metals at the natural pH were well within commonly used default dilution – attenuation factors.

- At pH between 5 and 9, all trace metals except three (cadmium, cobalt and selenium) were below RBSLs and benchmarks (up to 1000 times lower), and all were well within commonly used default dilution – attenuation factors.

- All trace metals, except two (cobalt and selenium), in the TCLP extract were below RBSLs, standards and benchmarks (2 to 8 times lower), and all were well within commonly used default dilution – attenuation factors.

Conclusion for 2009 Leachate Analysis

Based on the above, ARCADIS concluded that the concentrations of metals reported to be solution from extraction based testing of washed FGD gypsum present no threat to groundwater from washed FGD being placed in the environment.

Table1. Comparison of Constituent Levels in FGD Gypsum to Residential Soil Screening Levels

Element	Concentration (mg/kg)			Exceed Screening Levels?
	Washed (a)	Residential Soil Screening Level		
Antimony	2.1	31	b	No
Arsenic	3.8	5.2	c	No
Barium	52.8	15,000	b	No
Cadmium	0.4	70	b	No
Chromium (CrIII)	18	120,000	b	No
Cobalt	3.3	23	b	No
Copper	0.95	3,100	b	No
Lead	11.5	400	b	No
Mercury	0.95	5.6	b	No
Molybdenum	4.6	390	b	No
Nickel	0.83	1,500	b	No
Selenium	2.6	390	b	No
Thallium	0.7	5.1	d	No
Zinc	3.08	23,000	b	No

a) Concentrations shown are maximum concentrations for each material.

b) Direct contact RSLs are from May 2010 version of USEPA's Regional Screening Level Tables (http://www.epa.gov/region9/superfund/prg/)

c) The background soil concentrations for the conterminous United States (geometric mean). From Dragun and Chekiri. 2005. Elements in North American Soils. 2nd Ed. Amherst Scientific Publishers, Amherst, Massachusetts.

d) Direct contact RSLs are from April 2009 version of the RSL tables. Screening levels not included in the May 2010 Tables

Table 2. Total Concentrations of Trace Metals: Washed vs. Natural

Element	Concentration (mg/kg)	
	Washed (a)	Natural (a)
Antimony	2.1	0.53
Arsenic	3.8	13.4
Barium	52.8	218
Cadmium	0.4	0.494
Chromium (CrIII)	18	10.2
Cobalt	3.3	32.7
Copper	0.95	97.9
Lead	11.5	38.4
Mercury	0.95	0.0844
Molybdenum	4.6	51.4
Nickel	0.83	18.3
Selenium	2.6	<3
Thallium	0.7	0.316
Zinc	3.08	288

a) Concentrations shown are maximum concentrations for each material.

Table 3. Total Concentration of Trace Metals: Washed vs. Unwashed

Element	Concentration (mg/kg)	
	Washed (a)	Unwashed (a)
Antimony	2.1	5.8
Arsenic	3.8	3.4
Barium	52.8	118
Cadmium	0.4	0.3
Chromium (CrIII)	18	55.2
Cobalt	3.3	2.03
Copper	0.95	5.05
Lead	11.5	2.59
Mercury	0.95	1.46
Molybdenum	4.6	2.44
Nickel	0.83	6.28
Selenium	2.6	25
Thallium	0.7	0.6
Zinc	3.08	22.6

a) Concentrations shown are maximum concentrations for each material.

Table 4. Total Concentrations of Trace Metals: Washed vs. Scrubber Sludge

Element	Concentration (mg/kg)	
	Washed (a)	Scrubber Sludge (a)
Antimony	2.1	15
Arsenic	3.8	40
Barium	52.8	2,500
Cadmium	0.4	1.5
Chromium (CrIII)	18	350
Cobalt	3.3	40
Copper	0.95	--
Lead	11.5	30
Mercury	0.95	0.6
Molybdenum	4.6	30
Nickel	0.83	--
Selenium	2.6	4
Thallium	0.7	12
Zinc	3.08	--

a) Concentrations shown are maximum concentrations for each material.

Table 5. Total Concentrations of Trace Metals: Washed, Unwashed and Scrubber Sludge

Element	Concentration (mg/kg)		
	Washed (a)	Unwashed (a)	Scrubber Sludge (a)
Antimony	2.1	5.8	15
Arsenic	3.8	3.4	40
Barium	52.8	118	2,500
Cadmium	0.4	0.3	1.5
Chromium (CrIII)	18	55.2	350
Cobalt	3.3	2.03	40
Copper	0.95	5.05	--
Lead	11.5	2.59	30
Mercury	0.95	1.46	0.6
Molybdenum	4.6	2.44	30
Nickel	0.83	6.28	--
Selenium	2.6	25	4
Thallium	0.7	0.6	12
Zinc	3.08	22.6	--

a) Concentrations shown are maximum concentrations for each material.

Table 6. Comparison of FGD Gypsum Leachate to Screening Levels and Standards: Natural pH

Element	Concentration (ug/L)		
	FGD Gypsum Leachate	Screening Level	
Antimony	0.6	6	MCL
Arsenic	2	10	MCL
Barium	80	2,000	MCL
Cadmium	2	5	MCL
Chromium (CrIII)	4	100	MCL
Cobalt	2	11	Tap RSL
Copper	--	1,300	AL
Lead	0.1	15	AL
Mercury	0.002	2	MCL
Molybdenum	11	200	DWEL
Nickel	--	700	DWEL
Selenium	90	50	MCL
Thallium	0.3	2	MCL
Zinc	--	5,000	SMCL

DWEL - Drinking Water
Equivalent Level
MCL - Maximum Contaminant Level
SMCL - Secondary MCL
Tap RSL - USEPA Regional Screening Level for Tap Water
AL - Action Level

Table 7. Washed FGD Gypsum vs. Screening Levels and Standards: Range of pH

Element	Concentration (ug/L)		
	FGD Gypsum Leachate	Screening Level	
Antimony	3	6	MCL
Arsenic	10	10	MCL
Barium	700	2,000	MCL
Cadmium	9	5	MCL
Chromium (CrIII)	11	100	MCL
Cobalt	20	11	Tap RSL
Copper	NA	1,300	AL
Lead	0.14	15	AL
Mercury	0.002	2	MCL
Molybdenum	20	200	DWEL
Nickel	NA	700	DWEL
Selenium	200	50	MCL
Thallium	0.315	2	MCL
Zinc	NA	5,000	SMCL

DWEL - Drinking Water Equivalent Level
MCL - Maximum Contaminant Level
SMCL - Secondary MCL
Tap RSL - USEPA Regional Screening Level for Tap Water
AL - Action Level

Table 8. Washed FGD Gypsum vs. Screening Levels and Standards: Leachate Produced via TCLP

Element	Concentration (ug/L)		
	FGD Gypsum Leachate	Screening Level	
Antimony	NA	6	MCL
Arsenic	5	10	MCL
Barium	NA	2,000	MCL
Cadmium	10.9	5	MCL
Chromium (CrIII)	13	100	MCL
Cobalt	NA	11	Tap RSL
Copper	NA	1,300	AL
Lead	1.8	15	AL
Mercury	<0.3	2	MCL
Molybdenum	NA	200	DWEL
Nickel	NA	700	DWEL
Selenium	334	50	MCL
Thallium	NA	2	MCL
Zinc	NA	5,000	SMCL

DWEL - Drinking Water Equivalent Level
MCL - Maximum Contaminant Level
SMCL - Secondary MCL
Tap RSL - USEPA Regional Screening Level for Tap Water
AL - Action Level

Table 9. Comparison of leachate produced over a range of pH

Element	Concentration (ug/L)	
	Washed	Unwashed
Antimony	3	10
Arsenic	10	10
Barium	700	800
Cadmium	9	40
Chromium (CrIII)	11	30
Cobalt	20	40
Copper	NA	NA
Lead	0.14	2
Mercury	0.002	1
Molybdenum	20	30
Nickel	NA	NA
Selenium	200	2000
Thallium	0.315	4
Zinc	NA	NA

References for Data in Tables:

- Screening levels promulgated by USEPA.
- E. Alvarez-Ayuso, X. Querol, and A. Thomas, “Environmental impact of a coal combustion- desulphurization plant: abatement capacity of desulphurization process and environmental characterization of combustion by-products,” 65 Chemosphere 2009-17 (Dec. 2006).
- C.L. Kairies, K.T. Schroeder, and C.R. Cardone, “Mercury in gypsum produced from flue gas desulfurization,” 85 Fuel 2530-36 (2006).
- Phase IV: Summary of analytical results for phase III of the trace metals database project, Frontier GeoSciences Inc. (FCS), 2008.
- F. Sanchez et al., “Characterization of coal combustion residues from electric utilities using wet scrubbers for multi-pollutant control,” EPA 600/R-08/077 (July 2008).

- Jessica Sanderson et al., "Fate of Mercury in Synthetic Gypsum Used for Wallboard Production," USG Corp. Report for U.S. Department of Energy (Aug. 2005).]

- Katerina Dontsova et al., "Gypsum for agricultural use in Ohio-sources and quality of available products," Ohio State University Extension Fact Sheet ANR-20-05.

II. 2010 Review of Metals Analysis, Damage Cases, and Risk Assessments Cited by USEPA in its Proposed CCR Rule

In 2010, the Gypsum Association requested ARCADIS to review the Proposed CCR Rule and underlying data to determine whether this information affected ARCADIS' 2009 conclusion that washed FGD gypsum does not pose a human health or environmental risk. ARCADIS therefore reviewed the three bases upon which USEPA relies in proposing to regulate CCRs:

- Metals analysis, including leachate results from leaching procedures developed by Vanderbilt University.

- USEPA's proven damage cases.

- Risk assessments conducted by USEPA based on data from leaching studies and the proven damage cases.

A. Leaching Procedures

In response to concerns raised by the USEPA's Science Advisory Board and the National Academy of Sciences over the use of single-point pH tests, the USEPA selected a leaching test method based on research conducted at Vanderbilt University and the Energy Research Center in the Netherlands[5] (Framework). The primary leaching test methods employed by USEPA were from research conducted by Vanderbilt University (75 Fed. Reg. at 35139 n.10) and similar methods evaluating leaching at different pH values (75 Fed. Reg. at 35139 n.11). The leaching methods used involved extractions of particle sized reduced material at different pH values ranging from 2-13 and at a liquid to solid ratio of 10 milliliters (mL) extractant/gram

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[5] *Kosson, D.S.; Van Der Sloot, H.A.; Sanchez, F.; Garrabrants, A.c., An Integrated for Evaluating Leaching in Waste Management and Utilization of Secondary Materials*

(g) of dry sample; and, extractions of particle size reduced material over a range of liquid to solid (LS) ratios (i.e., 10, 5, 2, 1, and 0.5 mL/g dry material).

The Framework described three tiers of assessment to address waste management questions: Tier 1- screening based on assessment (availability); Tier 2 – equilibrium based assessment (over a range of pH and LS conditions); and Tier 3 – Mass transfer based assessment. The study conducted by the USEPA was reported in *Characterization of Coal Combustion Residues from electric Utilities-Leaching and Characterization Data December 2009* (December 2009 report), and in Table 5 of the June 21, 2010 Federal Register. The leaching tests used to generate the reported data from the leaching Framework were Solubility and Release as a Function of pH (SR 002.1) and Solubility and Release as a Function of the Liquid-Solid Ratio (LS) (SR003.1). These methods were designed to obtain solubility and release data as a function of pH and to estimate pore water conditions by assessing the leaching mode controlling release (equilibrium or mass transfer). Another method was described in the Framework, but not used, is MT001.1 – mass transfer rate (monolithic and compacted granular materials). Unlike the Toxicity Characteristic Leaching Procedure (TCLP), which is cited in the USEPA regulations as the appropriate test for determining toxicity, the Framework has not undergone any of the normal steps associated with regulatory rulemaking such as public-notice or normal peer review.

A better approach to the leach test would have been for USEPA to first confirm its applicability to FGD gypsum, rather than assuming one test fits all with no verification. Determining the applicability of the test to FGD gypsum, prior to using the test and reporting the results as justification for regulations, would have been the appropriate application of basic scientific methods. Recognizing the unique nature of FGD gypsum to develop a more accurate test has been done before. One example is that the procedure for measuring moisture content required adjustment from 105° C to 60° C in order to account for the dehydration effects the drying has on gypsum[6]. This correction for the drying effect on gypsum was known by the USEPA and was used.

As mentioned above, the study conducted by the USEPA involved extracting FGD gypsum at pH values between 2 and 13 at the various liquid to solid ratios. Metals released at very low pH (e.g., pH 2 and 3) and high pH (11, 12, and 13) are extremely unrealistic and are likely irrelevant to any management scenario regarding FGD gypsum. The USEPA states in the Proposed CCR Rule that the pH levels used

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[6] *ASTM Method D 2261-80.*

in the leaching study represent the range of pH conditions expected to be found in actual disposal. Yet, results from the EPRI study of pH in leachate from 29 CCR management sites reported that pH levels ranged between 4 and 12 for fly ash and, except for one sample, between 6 and 10.4 for FGD[7]. No samples were reported to be as low as pH 2 or greater than 12, the range allegedly used by the USEPA as representative of the range of pH conditions to be expected.

The second study relied upon by USEPA, a 2000 Agency study[8] that examined landfill leachate, reported the following pH ranges for the different waste management scenarios:

- Municipal solid waste landfills – pH range of 5.88 to 8.29
- Construction and demolition landfills – pH range of 6.20 to7.70
- Industrial co-disposal landfills – pH range of 5.63 to 7.59
- Hazardous waste landfills – pH range of 3.17 to 11.8

FGD gypsum is not RCRA hazardous. Using the pH range for hazardous waste disposal is therefore not an appropriate management scenario for FGD gypsum. Based on the 2000 USEPA study, a reasonable pH range for FGD gypsum would be 5.88 to 8.29, which is four orders of magnitude less than the high end of the 5.4 to 12.4 range used by the Agency.

Summary of concerns with the leaching test methodology used by the USEPA:

- The methodology has not been peer reviewed.
- It looks at conditions that do not simulate conditions into which washed FGD gypsum will ever be placed.

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[7] *EPRI (2006) Characterization of Field Leachates at Coal Combustion product management Sites: Arsenic, Selenium, Chromium, and Mercury Speciation, EPRI Report Number 1012578.*

[8] *Characterization and Evaluation of Landfill Leachate, Draft Report*, EPA Report 68-W6-0068 (Sept. 2000).

- The methodology was never assessed based on types of materials to be analyzed.

- The methodology utilized pH ranges beyond those to which FGD gypsum would be exposed.

B. Framework Leach Testing Results

USEPA compared the data from the leaching test results directly to risk based screening levels (RBSLs) and made the determination that FGD gypsum may present a risk to the environment. The comparison of the results directly to a standard in this manner is inappropriate and goes beyond the stated limits of the test. As pointed out by Susan Thornloe (USEPA) in the January 17,' 2006 Region 5 Workshop in Chicago, the data can be used to develop a probabilistic assessment of release under field conditions to identify potential management practices of concern. ARCADIS was not able to locate a probabilistic assessment conducted by the USEPA using the reported leach data to arrive at the statement of potential threat to the environment from FGD gypsum. The application of laboratory testing results to environmental end points of concern should be done through models that represent environmental processes, such as, transport to groundwater, exposure to humans via drinking water, and toxicity of released constituents. The leaching studies in the Framework were not developed to estimate the amount of constituent that may reach an aquifer or drinking water well, and thus are not representative of a risk to an environmental receptor. In fact to suggest that there is such a risk, goes beyond the premise of the test which was to provide insights into the physical-chemical mechanisms controlling constituent leaching, and which when used in conjunction with mass transfer and geochemical speciation, and transport modeling, can provide estimates of constituent leaching under a variety of environmental management conditions.

In order to answer the question of impact to an environmental receptor, several interrelated assessments including attenuation of the constituents of concern as they migrate from the waste through groundwater to the receptor, are required (December 2009). There was no attempt made to determine through appropriate environmental modeling techniques that metals contained in FGD gypsum will impact groundwater, and migrate to a receptor. Therefore, USEPA's statement that the results of the leaching tests conducted on FGD gypsum resulted in identification of "potential concern," and requires regulating, is not scientifically valid.

The leaching test cited was not designed to simulate what happens to a material when placed into the environment and the data cannot validly be used in a manner of

direct comparison to RBSLS for purposes of determining impact, as was done by the USEPA. Using the data from the results of the leach testing in conjunction with models would follow the scenarios described by Kosson in the development of the Framework that dilution and attenuation factors must be considered in the interpretation of the leach results. These factors when used in the overall conceptual model for a specific management scenario will serve to more accurately estimate concentrations of metals that are likely to be encountered in any plausible management scenario, such as stored piles of FGD gypsum, or even in impoundments at the pH levels reported in the EPRI study. This more representative methodology is appropriate for consideration if a determination that a material poses a threat to the environment is to be made, and follows the premise of the Framework.

The Framework, while broadly applicable, was viewed as needing more development work regarding specific applications, including database for field conditions and waste types, and data interpretation and decision making, as pointed out by Sanchez et al.[9] If this further development work was conducted, ARCADIS has not been able to identify that work. The leaching studies made no attempt to estimate the amount of constituent that may reach an aquifer or drinking water well. There is no indication that metals contained in FGD gypsum will impact groundwater, and therefore, the statement by the USEPA of potential concern is not scientifically valid. The USEPA appears to have skipped all the steps suggested by the developers of the test to be necessary for estimating impact to the environment from use of the leach testing and has chosen to move forward as if none of these steps was required as a part of a sound scientific process.

The data summarized in Table 5 of the Proposed CCR Rule were taken from the information presented in the December 2009 report. This report includes results from both unwashed and washed FGD gypsum. However, the data reported on Table 5 does not address FGD gypsum as distinct from other CCRs. The data summarized on this table reports ranges of concentrations that include both washed FGD gypsum and unwashed FGD gypsum. This is troublesome because as documented in these comments, FGD gypsum is distinct from other CCRs and does not pose a risk to human health or the environment.

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[9] *Characterization of Mercury Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control. F. Sanchez, R. Keeney, D. Kosson, R. Delapp, and S. Thornloe USEPA, January 2006.*

The Proposed CCR Rule states that the summary presented in Table 5 is based on the leach results from the evaluation of 20 FGD gypsums across the plausible management pH range of 5.4 to 12.4. Additionally, it is pointed out that at the upper end of the leachate concentration ranges exceed the Toxic Characteristic (TC) value for selenium[10].

The sample for selenium reported to have exceeded the TC value is labeled as unwashed gypsum on page 143 of the December 2009 study. This same sample was labeled as both washed and unwashed in the appendices for the 2009 study. Therefore, the nature of this sample is not clear. Additionally, it is uncertain how many other samples are mislabeled.

Another sample (AaAW) of washed FGD gypsum was reported to have exceeded the TC for selenium. Further examination of the results for this sample reveals the TC was exceeded at pH 2 and above pH 12 (Appendix F to December 2009 report). These extreme pH values are not part of any plausible management scenario for FGD gypsum and go beyond the pH ranges of 5.4 and 12.4 listed as the limits of the summary on table 5. The concentration of arsenic reported to be 1200 micrograms per liter (µg/L) on Table 5 is from AaAW at pH 2 and pH 12. Again, this range is beyond the pH ranges of 5.4 and 12.4 listed as the limits of the summary on Table 5 and of course beyond any plausible management scenario for washed FGD gypsum.

Except for one sample of washed FGD gypsum taken from facility SAW, all the shaded values in Table 5 were taken from the extreme end of the testing and beyond any plausible management scenario for washed FGD gypsum, classified by the USEPA as being between pH 5.4 and 12.4. Analytical results from a sample collected from facility SAW were reported to contain greater than10 µg/L arsenic, which is the MCL for arsenic. However, the results for this sample are suspect because of the 11 results provided, eight report the same 15 µg/L concentration across a pH range of 3 to 11. The fact that the results do not vary in concentration as the pH changes, as would be expected, strongly suggests that the data are invalid. This sample appears not only to be anomalous to the other washed FGD gypsum sample results, but also because the lack of response to changes in pH causes its validity to be questioned.

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[10] 75 Fed. Reg. at 35140.

Summary of Concerns with the Leach Test Results from the Framework

- Sample results in Table 5 were mislabeled and taken from testing conducted beyond the plausible pH range of 5.4 to 12.4 stated by the USEPA to be the plausible management scenario.
- The results were inappropriately compared to RBSLs.
- The results reported in Table 5 included samples that were not washed FGD gypsum.

Conclusion of 2010 Leach Testing Results

Based on the above review, ARCADIS has concluded that the results do not demonstrate that washed FGD gypsum presents a threat to human health and the environment due to release of trace metals into the environment.

C. Potential Damage Cases

EPA refers to 27 cases of proven damages to groundwater and surface water and 40 cases of potential damage to support the proposed changes to the RCRA regulations. All of the damage cases involve disposal sites where CCRs have been placed in different types of waste management facilities. Yet, none of the referenced potential damage cases involve washed FGD gypsum. The only damage case that even mentions washed FGD material is Case Study #63: Conesville Fixed FGD Sludge Landfill, Ohio[11]. None of the damage cases, including the Conesville case, involved washed FGD gypsum. At the Conesville site, FGD *sludge* was used in an attempt to stabilize fly ash. Originally, USEPA did not include this site as a potential damage case because there was inconclusive evidence documenting a potential threat to the environment from the impoundment. After further review, USEPA added the site due to the environmental concerns arising from the facility's continued disposal of fly ash, not FGD sludge or gypsum, in the landfill. Groundwater monitoring wells up and down gradient were used to evaluate potential environmental impacts. However, since selenium was found in both up gradient and down gradient wells, selenium levels were attributed to background concentrations. USEPA does not present any information about the impact of individual CCR sources

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[11] *Coal Combustion Waste Damage Case Assessments*, U.S. Environmental Protection Agency, 54 (July 2007), Docket No. EPA-HQ-RCRA-2006-0796-0015.

within the landfill and provides no indication or suggestion that washed FGD gypsum is of any potential concern.

In summary, there are no data connecting washed FGD gypsum to any damage cases cited by the USEPA.

D. Risk Assessments

USEPA references two draft risk assessments (RAs) to demonstrate that regulation of CCRs under the Proposed CCR Rule is needed. One RA, "Human and Ecological Risk Assessment of Coal Combustion Wastes," evaluates the potential for constituents to leach from waste management units and degrade groundwater and surface water.[12] The second RA, "Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills, Draft," evaluates the potential for inhalation of particulate combustion residuals.[13] Both RAs evaluate combustion residuals in a general way and are based on broad generalizations and conservative assumptions. They do not demonstrate that all of the wastes and materials that may be included in CCRs should be regulated as proposed. Rather, they support the general case that there is benefit to upgrading landfills and surface impoundment containments and controls where these wastes are combined. Neither RA provides an analysis that can be used to evaluate risks and hazards associated with washed FGD gypsum.

Washed FGD gypsum is a product and is segregated, cleaned, and prepared for specific reuses. Chemically it is calcium sulfate with very low levels of residual constituents. Its composition, including levels of residual constituents, is comparable to natural gypsum[14] (see Table 2), and it is used in the same ways that natural gypsum is used. CCR components vary significantly in physical characteristics,

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[12] USEPA. 2010. DRAFT. "Human and Ecological Risk Assessment of Coal Combustion Wastes". Office of Solid Waste and Emergency Response. Office of Resource Conservation and Recovery. Regulation Identifier Number (RIN) 2050-AE81. April.

[13] USEPA. 2010. "Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills, Draft." Office of Solid Waste and Emergency Response, May.

[14] USEPA. 2008. Agricultural Uses for Flue Gas Desulfurization (FGD) Gypsum. March. EPA530-F-08-009. www.epa.gov/osw.

residual constituents (concentrations and character) and the potential to impact environmental media and/or pose risks to human health or the environment. Washed FGD gypsum has lower levels of residual constituents than other CCRs (see Tables 3, 4, and 5) and is not reasonably grouped with other CCRs for the purposes of evaluating risks to human health or the environment. The RAs completed for CCRs do not evaluate the differences between CCRs and do not evaluate risks associated with washed FGD gypsum. Accordingly, the conclusions provided in the RAs do not apply to washed FGD gypsum.[15] The analysis provided in the RAs cannot reasonably be used to evaluate potential risks associated with handling, storing and use of washed FGD gypsum in wallboard or other encapsulated or unencapsulated uses. The analysis provided in the RAs cannot be used to demonstrate that the use of washed FGD gypsum: 1) to enhance soil properties or crop yields, 2) as fill in roads, or 3) for restructuring the landscape poses a concern for the environment or human health. Washed FGD gypsum should not be regulated as a hazardous or special waste under these provisions.

The following sections provide a brief discussion of specific issues associated with each draft RA.

1. **Evaluation of USEPA's "Human and Ecological Risk Assessment of Coal Combustion Wastes" for Applicability to Washed FGD Gypsum."**

The draft RA titled "Human and Ecological Risk Assessment of Coal Combustion Wastes"[16] evaluates potential human health risks and hazards associated with constituents in coal combustion wastes (CCWs) (i.e., fly ash, bottom ash, FGD sludge, fluidized bed combustion [FBC] fly ash, and FBC bed ash) leaching from landfills (unlined, clay lined, and composite lined) and surface impoundments (unlined, clay lined, and composite lined) and degrading groundwater and surface water. USEPA states, "This risk assessment was designed and implemented to identify and quantify human health and ecological risks that may result from groundwater contamination from current management practices for high-volume

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[15] Lisa J. Yost, 1 Scott S. Shock,' Stewart E. Holm,' Yvette W. Lowney, 4 and Jessica J. Noggles. 2010. Lack of Complete Exposure Pathways for Metals in Natural and FGD Gypsum. Human and Ecological Risk Assessment, 16: 317-339.

[16] USEPA. 2010. DRAFT. "Human and Ecological Risk Assessment of Coal Combustion Wastes". Office of Solid Waste and Emergency Response. Office of Resource Conservation and Recovery. Regulation Identifier Number (RIN) 2050-AE81. April.

CCWs." The RA does not evaluate risks specifically associated with washed FGD gypsum.

The analysis was based on broad assumptions about the character of the waste, potential to leach, and predicted migration from source areas to points of compliance using computer-based models to estimate risks. RA results and conclusions are presented in terms of risks and hazards associated with leaching from particular types of waste management units and degrading groundwater and surface water; the RA does not focus on waste types or classifications. Based on the "high-end" exposure assessment (90th percentile), risks were not acceptable for both unlined and clay-lined landfills and unlined and clay lined surface impoundments. Composite lined units were within the acceptable range. Based on the "typical" exposure assessment (50th percentile), risks were not acceptable for unlined landfills and unlined and clay lined surface impoundments. However, scenarios and assumptions used to evaluate risks associated with particular waste management units should not be used to evaluate potential risks and hazards associated with specific products and reuses of washed FGD gypsum.

The data used in the RA do not segregate or provide an analysis for washed FGD gypsum, which contains significantly lower concentrations of residual contaminant than CCRs or other products. Constituents evaluated in the RA were identified based on data and information collected to characterize whole waste and waste leachate from approximately 140 waste disposal sites across the US. Wastes were grouped into three categories: conventional CCWs (ash not otherwise specified, fly ash, bottom ash and slag, and FGD sludge); co-disposed ash and coal refuse; and FBC waste (ash not otherwise specified, fly ash, bottom and bed ash, and combined fly ash and bottom ash) (see Table 2-1 in USEPA's RA). Residual constituent levels within these groups and categories within the groups are reasonably anticipated to be significantly higher than washed FGD gypsum, as washed FGD gypsum is segregated, cleaned, and prepared for specific reuses.

- Trace metals in washed FGD gypsum are generally similar or less than the same metals in natural mined gypsum (see Table 2).

- Trace metals in washed and unwashed FGD gypsum generally exist at much less than the levels of the same metals in FGD scrubber sludge (see Tables 4 and 5).

In sum, the RA neglects to evaluate washed FGD gypsum whatsoever, and accordingly do not evidence in any way, environmental risks associated with washed FGD gypsum.

2. Evaluation of USEPA's "Inhalation of Fugitive Dust: A Screening Assessment of the Risk Posed by Coal Combustion Waste Landfills"

In May 2010, the USEPA released the draft RA entitled *"Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills, Draft.*[17] As with the groundwater RA discussed above, this RA only addresses CCW as uncharacterized particulate matter and does not directly evaluate washed FGD gypsum. The RA presents a conservative screening analysis of risks associated with predicted levels of inhalable and respirable particulate (particulate matter less than 10 µm [PM10] and particulate matter less than 2.5 µm [PM2.5]) from CCW landfills. Fugitive dust concentrations were estimated by USEPA based on emission factor equations and a screening air dispersion model. Predicted levels were evaluated by comparison to the National Ambient Air Quality Standards (NAAQS) for particulate matter.

- The RA reports that fugitive dust from the CCW landfills would result in an exceedance of the 24-hour NAAQS for PM10. According to the RA, this indicates that risks from fugitive dust cannot be screened out if no dust controls are applied before closure of these landfills. ARCADIS reviewed this RA, and has determined that the RA's conclusions are inappropriate for washed FGD gypsum because the physical properties of washed FGD gypsum are not accurately represented and the assumptions in the RA are unreasonably conservative.

(a) Particle Size

Particle size for washed FGD gypsum is a function of the scrubbing process selected by the power plants (based on information received from wallboard manufacturing companies). However, washed FGD gypsum purchased for reuse in wallboard is generally comprised of particles that typically average greater than 30 µm diameter with a narrow distribution of size fractions. Some sources generate washed FGD gypsum greater than 50 µm, while others generate average particle sizes of greater than 100 µm. PM10 and PM2.5 account for a very small fraction of the washed FGD gypsum purchased for reuse in wallboards while the Assessment assumes that 100% of the particulate is PM10. The actual emissions associated with PM10 and PM2.5 for washed FGD gypsum-containing CCW therefore would be significantly less than those estimated in the RA.

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[17] USEPA. 2010. *Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills (Draft)*.

(b) *Moisture Content*

The initial analysis presented in the RA evaluates dry-handled CCW emitted into the air by loading, transport, unloading, and wind erosion without fugitive dust control measures. FGD gypsum does not qualify as "dry handled CCW" since it is typically conditioned prior to transport and storage to minimize dusting. The resulting typical moisture content of these materials ranges from 6% and 25% and would greatly limit fugitive dust emissions. Additionally, conditioning with water would aid in compaction of CCW and may display thixotropic properties thus further reducing dust emissions.

(c) *Emission Factor*

The PM10 and PM2.5 emission factors estimated in the Assessment are based on the equation for "Continuous Fugitive/Windblown Dust Emissions" in USEPA's Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants".[18] The emission factors were based on material silt content, days of precipitation greater than 45 millimeter (mm) and the percent time with a mean wind speed exceeding 5.4 meters per second (m/s). The example presented in the USEPA 1992a document conservatively assumed a silt content of 50%, zero days of rain greater than 45 mm, and 20% time with a wind speed over 5.4 m/s. Although it is acknowledged that a 50% silt content is conservative[19], the Assessment utilized an even higher silt content of 80%. Both of these silt content values exceed those for washed FGD gypsum as discussed in the particle size discussion, and result in an emission factor that is overly conservative and has no relevance to washed FGD gypsum. In addition, the assumptions that there would be zero days of rain greater than 45 mm and 20% time with a wind speed over 5.4 m/s are highly conservative and not relevant to average conditions in most, if not all, locations in the United States. As a point of reference, the average annual number of rainy days in the United States is approximately 38 days[20] and the median wind speed is less than 4

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[18] USEPA 1992a. *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants.* EPA-454/R-92-024.

[19] USEPA 1992a. p. 4-11

[20] WeatherBill, Inc. 2007 *Precipitation Averages, Seasonality, Volatility and Trends in the United States.* .p. 3.

m/s[21]. Therefore, the emission factor used in this study results in a value that is unjustifiably conservative.

(d) *Air Dispersion Modeling*

The SCREEN3 model was used to conduct a screening level air dispersion analysis of dust emissions from landfills. A number of conservative assumptions were used that significantly overestimate dust concentrations including the following:

- Meteorological Data: SCREEN3 utilizes worst-case meteorological data that assumes low wind speeds and thereby limits dispersion (i.e., higher concentrations near the emission source)[22]. This conflicts with the assumption of the relatively high percentage of wind speeds above 5.4 m/s used in the emission factor estimate as described in the above section.

- Emission Source Height: The model assumed the landfill would be dug into the ground instead of elevated. This assumption would overestimate resulting air concentrations where the landfill is not dug into the ground. The RA acknowledges that modeling for an elevated landfill would generate lower particulate matter emissions for nearby receptors. Appendix C of the study indicates modeling for a landfill 10 meters in height would result in a reduction of approximately 40% in air concentrations (USEPA 2010).

- Averaging Time: SCREEN3 outputs are reported in maximum 1-hour air concentrations. In order to extrapolate to a longer timeframe, a multiplier should be applied to account for a longer averaging period. For instance, to extrapolate to a 24-hour average, the USEPA recommends using a multiplier of 0.4 (USEPA 1992b)[23]. However, the RA compares the raw SCREEN3 results without any adjustments to the 24-hour average NAAQS. This is not consistent with USEPA policy used nationwide for air impact assessments in all USEPA programs.

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[21] NCDC. 2008. Average Wind Speed Through 2002. Available at: http://www.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html.

[22] USEPA. 1995. *SCREEN3 Model User's Guide.* EPA-450/R-95-004 p. 44.

[23] USEPA. 1992b. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, p. 15.

Conclusion for Air Inhalation RA

The RA concludes there is a potential problem with uncontrolled emissions through dry handling of CCWs and states: "Indeed, it was found that there is not only a possibility, but a strong likelihood that dry-handling would lead to the NAAQS being exceeded absent fugitive dust controls."[24] The RA further states that, for the median exposure scenario, particulate levels would violate the 24-hour NAAQS by nearly two orders of magnitude. Based on factors discussed above, ARCADIS believes that the reported air concentration in the RA represents an overly conservative value that is inappropriate to compare to a 24-hour average NAAQS value. Therefore, the conclusions provided in the Assessment are not applicable for washed FGD gypsum.

III. Summary

Based on review of available literature regarding washed FGD Gypsum, and the data and studies presented by the USEPA in the Proposed CCR Rule, ARCADIS has concluded that there is no scientifically defensible information that supports concluding that washed FGD gypsum poses a potential threat to human health and the environment. Therefore, there is no need or basis for regulation of washed FGD gypsum.

Sincerely,

ARCADIS

Daniel C. O'Neill
Sr. Vice President

Copies:
Richard Bartelt, ARCADIS
Betty Locey, ARCADIS

[24] USEPA. 2010. p.7.

1.4. American Coal Ash Association (ACAA) Written Comments on EPA's August 2019 Proposed Rule; Docket No. EPA-HW-OLEM-2018-0524 (ACAA, 2019)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

October 15, 2019

US Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Via Online Submission to: *http://www.regulations.gov*

Attention: Docket ID No. EPA-HQ-OLEM-2018-0524

Re: Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles

The American Coal Ash Association ("ACAA") respectfully submits the following comments regarding U.S. Environmental Protection Agency's ("EPA's") proposed reconsideration of beneficial use criteria and piles related to coal combustion residuals ("CCRs") from electric utilities.

ACAA was established in 1968 as a trade organization devoted to beneficial use of the materials created when coal is burned to generate electricity. Our members comprise the world's foremost experts on coal ash (fly ash and bottom ash), boiler slag, flue gas desulfurization ("FGD") gypsum (aka "synthetic" gypsum), and other FGD materials captured by emissions controls. ACAA's mission is to advance the management and use of these coal combustion products ("CCPs") in ways that are: environmentally responsible; technically sound; commercially competitive; and supportive of a sustainable global community.

A note on terminology: CCRs is a term adopted by EPA in its 2015 Final Rule regulating disposal of the solid materials produced by coal combustion for the generation of electricity. CCPs is a term (also previously used by EPA) referring to the same family of materials when utilized in a beneficial use setting. Popular media often refer to the same family of materials generically as "coal ash." These comments use the term "CCR" to refer to the materials in a disposal setting and "CCPs" to refer to the same materials in a beneficial use setting.

Summary

In seeking to correct simple factual and policy errors related to the definition of beneficial use contained in its 2015 Final Rule for the disposal of CCRs, EPA has now proposed regulatory changes that are unwarranted, unsupported by fact or analysis, and that would erect substantial new barriers to legitimate beneficial use applications that EPA is bound by purpose, statute, and administration policy to encourage. EPA's proposals related to beneficial use and piles are, in short, astonishing for their lack of justification and potential for damaging activities that safely and effectively utilize large volumes of CCPs for the benefit of the environment. If enacted, EPA's proposals will result in significant regulatory compliance burdens and lower beneficial use of CCPs without achieving any demonstrable benefit to the environment.

Background

About Coal Combustion Products Beneficial Use

Coal remains the fuel source for approximately one-third of electricity generation in the United States and produces large volumes of solid coal combustion products — primarily ash and synthetic gypsum from emissions control devices. There are many good reasons to view coal combustion products as a resource, rather than a waste. Beneficial use conserves natural resources and saves energy. In many cases, products made with CCPs perform better than products made without it. For instance, coal fly ash makes concrete stronger and more durable. It also reduces the need to manufacture cement, resulting in significant reductions in greenhouse gas emissions – about 14 million tons in 2017 alone. Major uses of coal combustion products include concrete, cement kiln feed for clinker and finish grinding, gypsum wallboard, blasting grit, roofing granules, and a variety of geotechnical and agricultural applications.

ACAA has conducted a survey quantifying the production and use of CCPs in the United States each year since 1966. Data is compiled by directly surveying electric utilities and utilizing additional data produced by the U.S. Energy Information Administration. The survey's results have been widely utilized by federal agencies including EPA and U.S. Geological Survey.

According to ACAA's most recent survey (See Appendix A) 64 percent of the CCPs produced during 2017 were beneficially used – establishing a new record and marking the third consecutive year that more than half of the CCPs produced in the United States were beneficially used rather than disposed.

ACAA's November 2010 comments on EPA's original Proposed Rule for regulating CCR disposal (See Appendix B) contain detailed descriptions of various coal combustion product types and their beneficial use applications, as well as references to numerous consensus-derived engineering specifications governing their use.

Impact of CCR Disposal Regulations on Beneficial Use

Decades of EPA activities under both Democrat and Republican administrations – including Reports to Congress in 1988 and 1999; Regulatory Determinations in 1993 and 2000; and the 2015 Final Rule now under consideration for revision – all concluded that beneficial use should be exempt from regulation. But even though beneficial use itself is exempt from regulation, CCR disposal regulations (and regulatory uncertainty related to CCR disposal regulations) have significant impacts on beneficial use activities.

For example, the volume of CCP utilization stalled between 2009 and 2013 as EPA pursued a protracted rulemaking process that posed the threat of a "hazardous waste" designation for CCRs that are disposed. Even though beneficial use was exempt from the proposed regulation, ash producers, specifiers and users restricted coal ash use in light of the regulatory uncertainty and often negative publicity surrounding EPA's activities. In 2014, EPA began signaling that the "hazardous waste" designation proposal was off the table and in December 2014 finalized CCR disposal regulations under the non-hazardous section of federal law. Ash utilization began to increase again once regulatory certainty was restored. Analysis of CCP production and use trends by the American Road and Transportation Builders Association (See Appendix C) demonstrated that the 2009-2013 performance was not linked to an economic downturn inasmuch as every previous recession saw CCP utilization increase as users sought out more economical materials.

According to ACAA Production and Use Surveys, CCP utilization remained below 2008 levels for the five consecutive years of regulatory uncertainty concluding in 2013. If those five years had simply remained equal with 2008's utilization, 26.4 million tons less coal ash would have been disposed in landfills and impoundments.

EPA initiatives can also create positive impacts on CCP beneficial use. For instance, a program led by EPA was in place during the most rapid expansion of coal combustion products beneficial use in history. The Coal Combustion Products Partnership (C2P2 program) was a cooperative effort between EPA, American Coal Ash Association, Utility Solid Waste Activities Group, U.S. Department of Energy, Federal Highway Administration, Electric Power Research Institute, and U.S. Department of Agriculture Agricultural Research Service to promote beneficial use of CCPs as an environmentally preferable alternative to disposal. The initiative included a challenge program, various barrier breaking activities, and development of coal combustion products utilization workshops. In 2000, when EPA issued a Final Regulatory Determination that CCPs should be regulated under "non-hazardous" RCRA Subtitle D and subsequently initiated the C2P2 program, beneficial use volume was 32.1 million tons. Just eight years later, beneficial use volume had nearly doubled to 60.6 million tons. However, EPA abruptly terminated this successful C2P2 program after it initiated the aforementioned CCR disposal rulemaking.

EPA Has an Obligation to Encourage Beneficial Use

EPA is bound by purpose, statute, and agency precedent to encourage beneficial use and consider impacts on beneficial use in the development of its CCR disposal regulations.

EPA's statement of purpose includes the following objectives:

- That "federal laws protecting human health and the environment are enforced fairly and effectively;
- environmental protection is an integral consideration in U.S. policies concerning natural resources, human health, economic growth, energy, transportation, agriculture, industry, and international trade, and these factors are similarly considered in establishing environmental policy;
- environmental protection contributes to making our communities and ecosystems diverse, sustainable and economically productive; and
- the United States plays a leadership role in working with other nations to protect the global environment."

The beneficial use of CCPs is fully integrated in many sectors of the U.S. economy, including natural resources, energy, transportation, agriculture, and manufacturing settings. Beneficial use of CCPs is a key component in improving the sustainability and economic productivity of these industries. If it is EPA's objective to use environmental policy to encourage sustainability and economic productivity, then it cannot ignore the impacts on a sector that accounts for the management of more than 60 percent of a large resource base, even if the primary focus of the rule proposal is disposal.

The original rulemaking docket for EPA's CCR disposal regulations contains numerous statements concerning beneficial use by international entities, as well as statements by professional standards setting organizations whose standards are globally adopted. These statements make it clear that EPA's decisions on CCR disposal regulations affect beneficial use worldwide. Excluding consideration of

beneficial use impacts of regulatory policy is counter to EPA's purpose to provide an international leadership role.

It is also important to remember that EPA's CCR disposal regulations are under the authority of the Resource Conservation and Recovery Act ("RCRA"). In its findings establishing RCRA, Congress stated: "The Congress finds with respect to materials, that— (1) millions of tons of recoverable material which could be used are needlessly buried each year; (2) methods are available to separate usable materials from solid waste; and (3) the recovery and conservation of such materials can reduce the dependence of the United States on foreign resources and reduce the deficit in its balance of payments." (Solid Waste Disposal Act, Section 1002 (c).)

Furthermore, Congress stated specific objectives for encouraging materials recovery and reuse throughout Section 1003 of the Solid Waste Disposal Act.

If EPA fails to consider impacts on materials recovery and beneficial use from CCR disposal rulemaking activities, the agency will be in direct opposition to the letter and spirit of the Act from which it derives its rulemaking authority.

A Voluminous Record Supports Beneficial Use as a Preferred Management Alternative

In its 2015 Final Rule for CCR disposal, EPA expressly elected to preserve the regulatory exemption for beneficial use, stating:

> "As EPA stated in the May 2000 Regulatory Determination, 'In the [Report to Congress], we were not able to identify damage cases associated with these types of beneficial uses, nor do we now believe that these uses of coal combustion wastes present a significant risk to human health and the environment. While some commenters disagreed with our findings, no data or other support for the commenters' position was provided, nor was any information provided to show risk or damage associated with agricultural use. Therefore, we conclude that none of the beneficial uses of coal combustion wastes listed above pose risks of concern.' (See 65 FR 32230.) EPA noted that since the original Regulatory Determination, the Agency had found no data or other information to indicate that existing efforts of states, EPA, and other federal agencies had been inadequate to address the environmental issues associated with the beneficial use of CCR that were originally identified in the Regulatory Determination."

For decades EPA has expressly supported CCP beneficial use. "EPA encourages the beneficial use of coal ash in an appropriate and protective manner, because this practice can produce positive environmental, economic, and product benefits such as:

- reduced use of virgin resources,
- lower greenhouse gas emissions,
- reduced cost of coal ash disposal, and
- improved strength and durability of materials."

(See: https://www.epa.gov/coalash/coal-ash-reuse)

EPA Has an Obligation Not to Enact Unnecessary and Burdensome Regulation

Executive Order 13771 entitled "Reducing Regulation and Controlling Regulatory Costs" was issued by President Donald J. Trump in 2017. It directs all agencies to repeal at least two existing regulations for each new regulation issued in FY 2017 and thereafter. It further directs agencies that the "total

incremental costs of all regulations should be no greater than zero" in FY 2017. For FY 2018 and beyond, the director of the Office of Management and Budget (OMB) is to provide agencies with a total amount of incremental costs that will be allowed.

"12,400-tons" Issue

Regulatory Background

In preserving the beneficial use exemption in its 2015 Final Rule for CCR disposal, EPA expressed a concern that the exemption could be used to evade disposal regulations by conducting "sham beneficial use." To prevent this, EPA established a definition of beneficial use with four criteria:

> "(1) The CCR must provide a functional benefit;
>
> (2) the CCR must substitute for the use of a virgin materials, conserving natural resources that would otherwise need to be obtained through practices such as extraction;
>
> (3) the use of the CCR must meet relevant product specifications, regulatory standards, or design standards, when available, and where such specifications or standards have not been established, CCR may not be used in excess quantities; and
>
> (4) when unencapsulated use of CCR involves placement on the land of 12,400 tons or more in non-roadway applications, the user must demonstrate and keep records, and provide such documentation upon request, that environmental releases to groundwater, surface water, soil, and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil, and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use."

The fourth criterion was clearly focused on large volume, landfill-like activities that could be presented as structural fill applications. In the 2015 rulemaking record, EPA identified that "seven proven damage cases associated with unencapsulated uses have occurred, in which large quantities of unencapsulated CCR were used indiscriminately to re-grade the landscape or to fill old quarries or gravel pits." As reviewed by EPA, all damage cases were related to rock quarries or sand mine pits where blasting induced fractured rock or sand provide pathways for contaminants of concerns to travel. Sand pits and blasted rock quarries (non-cohesive minerals) have unique characteristics that are not similar to cohesive soil mine sites. Placement of CCR in quarries or gravel pits was expressly forbidden under the 2015 Final Rule, leaving only large quantity indiscriminate placement as a potential concern.

In its 2015 Final Rule, EPA was explicit in pointing out that many "unencapsulated" uses differ significantly from the structural fill application:

> "EPA acknowledged in the proposal that unencapsulated uses generally presented more difficult issues than encapsulated uses. CCR can leach toxic metals at levels of concern, so depending on the characteristics of the CCR, the amount of material placed, how it is placed, and the site conditions, there is a potential for environmental concern. However, EPA cannot extrapolate from the risk assessments conducted to evaluate the management practices associated with CCR landfills and CCR surface impoundments, because the exposure patterns are too dissimilar:

> the amounts and manner involved with beneficial use are very different than the thousands, if not millions of tons of CCR that are mounded in a single concentrated location in a landfill. And the potential exposures are entirely unlike surface impoundments, where CCR is managed with water under a hydraulic head, which promotes more rapid leaching of contaminants. By contrast "beneficial uses," even unencapsulated uses, are typically subject to engineering specifications, and for certain uses, federal oversight, and material requirements. For example, fly ash used as a stabilized base course in highway construction is subject to both regulatory standards under the U.S. Department of Transportation (DOT) and the Federal Highway Administration (FHA), and engineering specifications, such as the ASTM C 593 test for compaction, the ASTM D 560 freezing and thawing test, and a seven day compressive strength above 2760 (400 psi). (See 75 FR 35163-35165 for additional examples.)
>
> In 1999, EPA conducted a risk assessment of certain agricultural uses of CCR, since this was considered the most likely to raise human health or environmental concerns. EPA estimated the risks associated with such uses to be within the range of 1×10-6. These results as well as EPA's conclusion that the use of CCR in agricultural settings was the most likely use to raise concerns, caused EPA to conclude that none of the beneficial uses identified in the 2000 Regulatory Determination warranted federal regulation, because 'we were not able to identify damage cases associated with these types of beneficial uses, nor do we now believe that these uses of coal combustion wastes present a significant risk to human health or the environment.' (65 FR 32230, May 22, 2000.)"

Nevertheless, in its fourth beneficial use definition criterion, EPA constructed what amounted to a "bigger than the smallest landfill test." If an unencapsulated, non-roadway, placement on the ground exceeded the size of the smallest landfill EPA presented in the rulemaking record, then a project owner would be expected to demonstrate that the environmental impact would not warrant regulation as a landfill.

The problem was that the number EPA chose as corresponding to the smallest landfill – 12,400 tons – was a mathematical error created when a landfill operator reported a volume in cubic yards, rather than the cubic feet EPA requested. When the error was reported to EPA (See Appendix D), the agency chose to ignore the error and leave the 12,400-ton value in place despite its non-conformance with the regulatory theory constructed to establish it.

Analysis of EPA's Current Proposal

Instead of simply correcting its math error, EPA now presents a startling example of regulatory mission creep. Without presenting any new damage cases or scientific analysis, EPA now proposes to:

- Justify its original number by creating from the whole cloth a completely different rationale based on state-level beneficial use regulations, or

- Jettison the volumetric restriction entirely and require environmental demonstrations for any sized project based on site location criteria that were developed for disposal facilities designed to contain hundreds of thousands or millions of tons of material, and

- Potentially dramatically expand the number of exempt beneficial use applications subjected to increased regulatory costs and requirements, despite the fact that EPA presents no demonstration that there is an environmental cause for concern.

Before commenting on these proposed approaches, it is worth pointing out that the beneficial use activities EPA is now de facto seeking to regulate (in spite of a justified regulatory exemption) are activities that have been conducted in the United States for decades. According to ACAA production and use survey data, 188.7 million tons of CCPs have been placed in structural fill applications since 1980. This large volume of projects has not resulted in damage cases precisely for the reasons EPA noted in its 2015 Final Rule. States already regulate these types of beneficial uses and consensus-based engineering standards are in place to establish best practices.

In its current proposal, EPA lists several differing state regulations of structural fill activities in an attempt to justify a small volumetric threshold. (It's as if EPA is simply trying to reverse engineer a rationale that will get the agency to a number it wants rather than presenting a defensible rationale and allowing a justifiable number to emerge.) But in advancing these examples, EPA proves a different point: These activities are already overseen by professional state environmental regulators with intimate knowledge of local geologic and meteorological conditions. In the absence of damage cases or scientific analysis, and in the presence of these existing regulations, what is the point of establishing another layer of "one-size-fits-all" regulation?

The proposal to use disposal site location criteria is even more burdensome. As noted previously, these site location criteria were developed for facilities containing hundreds of thousands or millions of tons of material, but EPA now proposes to apply them to ostensibly exempt activities as small as a single ton. Furthermore, switching from a volumetric approach to a site location criteria approach moves far astray from the original regulatory objective of preventing "large quantity indiscriminate placement." It would, in fact, sweep in low volume, extensively studied, and highly environmentally beneficial practices such as the use of synthetic gypsum in agriculture.

The most jaw-dropping aspect of EPA's current proposal is the agency soliciting comment "on whether the environmental analysis of the beneficial use definition's fourth criterion should be demonstrated in all cases rather than limiting the fourth criterion to only the largest or most environmentally concerning beneficial use circumstances. Under such an approach, every unencapsulated beneficial use of CCR in non-roadway applications would have to make an appropriate environmental demonstration of whether releases to environmental media from the beneficial use are likely to be of concern."

EPA's proposal to potentially extend environmental demonstration requirements to all unencapsulated beneficial uses is completely without justification and stands in direct conflict with the entire rulemaking record. It should also be noted that the "encapsulated-unencapsulated" construct is an invention of the 2015 Final Rule and the terminology is not the product of any professional consensus process. In fact, EPA makes fundamental errors in its encapsulation classifications of some CCP beneficial uses. (For instance, EPA considers controlled low strength material, also known as flowable fill, as an "unencapsulated" application despite it being the product of a cementitious process that binds CCP constituents in a solid matrix that minimizes mobilization into the surrounding environment.) Vastly expanding regulatory oversight based on arbitrarily defined terms represents a classic example of shifting goal posts and is one more example of the mission creep embodied in the current proposal.

EPA's economic analysis underlying the current proposal presents a highly unrealistic evaluation of the costs of complying with the proposed changes. The analysis suggests that the cost of determining whether a project is in a site location criteria restricted area will be less than $596 and that the cost of conducting an environmental evaluation, if required, will be $2,773. This is in spite of the fact that EPA's description of site location criteria consumes two full pages of the Federal Register and the agency's recommended "Methodology for Evaluating the Beneficial Use of Industrial Non-Hazardous Secondary Materials" requires planning and scoping, impact analysis including comparisons with analogous products, and potentially screening analysis and risk modeling stages. In addition to grossly underestimating the cost of undertaking such an evaluation, EPA's economic analysis vastly underestimates the number of sites that may have to perform evaluations if EPA requires such actions for all unencapsulated beneficial uses. Finally, it is telling that the EPA's economic analysis makes no attempt whatsoever to quantify economic benefits of the proposed changes. (It is ACAA's opinion that there are none to quantify.)

In the end, the woefully deficient economic analysis proffered by EPA may turn out to be correct from one perspective: The total industry-wide cost of conducting demonstrations will likely be low because users will simply opt not to undertake the effort and will consign ever greater volumes of CCPs to disposal. (Of course, an honest economic assessment would take into account the corresponding increase in disposal costs and increased costs of sourcing virgin materials.)

Preferred Alternatives

ACAA encourages EPA to reject the unwarranted and harmful regulatory mission creep presented in the current proposal and return to the following paradigm warranted by the rulemaking record:

> Beneficial use is exempt from regulation. The beneficial use definition is intended to prevent disposal from masquerading as beneficial use, particularly as it pertains to large quantity indiscriminate placement of CCRs on the land.

ACAA's preferred approaches to accomplishing this goal are, in order of preference:

1. **Eliminate the fourth beneficial use definition criterion entirely**. The first three beneficial use definition criteria are sufficient to prevent the "large quantity," "indiscriminate" placement concerns that motivated the inclusion of a beneficial use definition. The third criterion's requirement to comply with "product specifications, regulatory standards, or design standards, when available" will be effective given the wide deployment of such specifications and standards. In the event that such specifications or standards have not been established, the third criterion's requirement that "CCR may not be used in excess quantities" will suffice. EPA's own survey of existing state-level beneficial use regulations shows that these applications do not lack for oversight. The continuing lack of damage cases for activities that have successfully utilized tens of millions of tons of materials over decades is an indication that this is not a matter of urgent regulatory concern.

2. **Just fix the math.** If EPA is willing to stand by its original "if it looks like a landfill, it might be a landfill" rationale, then simply correcting the "smallest landfill" threshold for conducting evaluations is in order. The real smallest landfill in EPA's rulemaking record is approximately 74,800 tons.

3. **Require CCP structural fills to conform with ASTM standards.** ASTM E-2277 Standard Guide for Design and Construction of Coal Ash Structural Fills defines industry best practices and incorporates appropriate site location criteria. ASTM standards are derived from a consensus process that allows participation by all concerned parties and are regularly reviewed to ensure that they utilize the most current science. ASTM standards have been adopted, by incorporation or by reference, in many federal, state, and municipal government regulations.

4. **Develop new, <u>appropriate</u> site location criteria with a volumetric threshold to trigger environmental evaluations.** EPA acknowledges in its current proposal that its 2014 Risk Assessment modeling CCR landfills makes it "difficult to extrapolate the landfill data to unencapsulated uses and to identify a numerical cutoff for proximity or size at which these uses will start to pose concern. Therefore, EPA concluded these data cannot be used directly to select national beneficial use criteria." Just as a landfill risk assessment is not applicable to beneficial use applications, landfill site location criteria are not applicable to beneficial use applications. If EPA is determined to implement a site location criteria approach not already provided in consensus standards such as ASTM E-2277, then the agency should undertake new risk assessment activities to determine and support an appropriate approach that includes a determination of the volume at which CCP beneficial use applications may cause concern warranting evaluation.

"Piles" Issue

Regulatory Background

EPA's 2015 Final Rule for CCR disposal included a disparity in how "piles" of CCPs staged for future beneficial use would be treated under the regulation. "Piles" located on utility sites were treated as disposal, while "piles" located just across the fence were simply subjected to the beneficial use definition criteria. No justification was given for this disparity.

Similar to the "12,400-tons" issue, the "piles" issue represents an opportunity for a simple policy correction that EPA has instead chosen to turn into a significant expansion of regulatory intrusion into a justifiably exempt activity.

The presumed regulatory objective of addressing "piles" in the first place is similar to the regulatory objective of the fourth beneficial use definition criterion: to prevent disposal activities from masquerading as beneficial use or to prevent excessive quantities of CCPs from being speculatively stored for beneficial use. As with the "12,400-tons" issue, the rulemaking record contains no damage cases or scientific analysis to justify a regulatory concern related to the practice of staging CCPs for beneficial use.

Analysis of EPA Proposal

EPA's current proposal characterizes these activities as "storage" rather than disposal or beneficial use and makes no distinction regarding the location. While ACAA supports EPA's actions toward making the regulatory treatment consistent regardless of location, EPA's proposed conditions for storage are over-reaching for operations related to an activity that is purportedly exempt from regulation.

EPA's proposal appears to incorporate a fundamental misunderstanding of the purpose of CCP storage. Storage is an integral step in a beneficial use value chain. End users will not utilize CCPs unless they are confident that adequate supplies will be available when they need them. Therefore, the goal of CCP storage is to ensure uninterrupted supply for users. The need for adequate CCP storage is only increasing as CCP production by coal-fueled power plants becomes more sporadic in the face of changing electricity dispatch trends.

EPA's current proposal includes over-reaching reporting requirements such as requiring copies of purchase orders to document that storage piles are being used. Not only are such reporting requirements impractical (most cement, concrete, and synthetic gypsum markets do not operate on purchase order systems,) they create new barriers to beneficial use. CCP users will be less likely to incorporate the products in their projects if they are required to share proprietary business information or take on time-consuming paperwork.

Not only would the proposed rule disincentivize the beneficial user of the CCP from taking the material, it would also disincentivize the producer of the CCP, either newly produced or recovered from a landfill or impoundment, from making the CCP available, as there would be a real or perceived potential liability to the producer for how the CCP is stored, handled and used by the beneficial user. If the producer of the CCP cannot have some level of assurance that they are not going to have the liability of ash storage at a beneficial use site, they may likely choose to dispose of the material in a new CCR landfill at a much greater expense, that will likely be passed on to electrical rate payers, than to take on the potential liability for a different site. This would be contradictory to some state laws that require utilities that are closing or removing older CCR landfills or impoundments to make the recovered materials available for beneficial use.

EPA's current proposal also creates an added layer of regulation for most storage facilities that are already subject to water and air permit requirements of state and local authorities.

Preferred Alternative

ACAA encourages EPA to remember the objective of preventing disposal activities from masquerading as beneficial use and preventing excessive quantities of CCPs from being speculatively stored for beneficial use. In the absence of damage cases or scientific analysis, it is not appropriate to speculate that storage activities may be responsible for harmful releases to the environment.

ACAA recommends a categorical exemption of reporting requirements for storage that is containerized, not in direct contact with the ground, or located on properties already subject to other regulatory controls such as NPDES and facility air permits.

Verifying a storage site's status as an active, working facility can be demonstrated by its proximity to working end-use locations such as cement kilns, concrete plants, wallboard manufacturing plants, or other manufacturing facilities. For storage sites not located in the immediate proximity of the end use, record-keeping should be limited to minimally burdensome reporting requirements documenting gross annual receipts and shipments of CCPs.

Conclusions

How did EPA go from needing to correct simple rulemaking errors to proposing a vast expansion of evaluation and reporting requirements on a host of beneficial use activities that EPA itself has repeatedly concluded should be exempt from regulation?

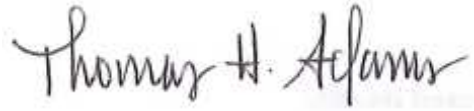
EPA had an opportunity to correct simple errors of fact and policy equity in its 2015 CCR disposal rule. Instead, the Agency now threatens to compound these errors with a poorly conceived proposal that is unsupported by science or law.

In spite of statutory and policy considerations that should compel EPA to support and incentivize beneficial use activities as a preferred alternative to disposal, EPA's current proposal erects significant new barriers to those practices. If EPA enacts these proposals, the United States will see:

- More CCRs disposed.
- More natural resources consumed.
- More water, fossil fuels, electricity, and other resources consumed as virgin natural resources are extracted.
- Increased manufacturing costs.

Any environmental benefits to be achieved by erecting these barriers to beneficial use are at best speculative and non-quantifiable and more likely, simply non-existent.

Respectfully submitted,



Thomas H. Adams
Executive Director

Appendices

Appendix A – American Coal Ash Association Coal Combustion Products 2017 Production and Use Survey

Appendix B – American Coal Ash Association Comments on Hazardous and Solid Waste Management System; Identification and Listing of Special Waste, Disposal of Coal Combustion Residuals from Electric Utilities (DOCKET ID NO EPA-HQ-RCRA-2009-0640) November 2010

Appendix C – American Road and Transportation Builders Association, "Production and Use of Coal Combustion Products in the U.S., Historical Market Analysis," May 2015

Appendix D – Letter Identifying Computational Error Requiring Correction of Coal Combustion Residuals Rule, April 1, 2015

Appendix A

For Immediate Release

Contact: **American Coal Ash Association**
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Coal Ash Recycling Reaches Record 64 Percent Amid Shifting Production and Use Patterns

November 13, 2018, **Washington, D.C.** – Sixty-four percent of the coal ash produced during 2017 was recycled – establishing a new record and marking the third consecutive year that more than half of the coal ash produced in the United States was beneficially used rather than disposed.

"The trend for coal ash beneficial use continues to be very positive," said Thomas H. Adams, executive director of the American Coal Ash Association ("ACAA") – an organization that advances the environmentally responsible and technically sound use of coal ash as an alternative to disposal. "For the fourth straight year, we have seen significant improvement in the beneficial use rate. We look forward to continuing to grow these practices that conserve natural resources, make products that are more durable, and dramatically reduce the need for landfills."

According to ACAA's just-released "Production and Use Survey," 71.8 million tons of coal combustion products were beneficially used in 2017 out of 111.3 million tons that were produced. The rate of ash utilization increased from 56 percent to 64.4 percent and the total volume of material utilized increased by 11.6 million tons. Coal ash production volume increased 4 percent from 2016 levels.

"Coal ash" is a generic term that encompasses several Coal Combustion Products (CCP) that can be beneficially used in a wide variety of applications. Highlights of CCP production and use in 2017 include:

- Use of coal fly ash in concrete remained approximately level with the prior year at 14.1 million tons. Concrete producers and consumers indicated a desire to use more fly ash, but several regional markets were affected by shifting supply dynamics associated with closures of coal-fueled power plants. Fly ash improves concrete durability and significantly reduces greenhouse gas emissions associated with concrete production.

- Utilization of a key "non-ash" coal combustion product increased significantly. Synthetic gypsum is a byproduct of flue gas desulphurization units, also known as "scrubbers," located at coal-fueled power plants. Use of synthetic gypsum in panel products (i.e. wallboard) increased 60 percent to 15.9 million tons in 2017. The large increase is attributed to lower than usual synthetic gypsum shipments reported in the prior year and growth in wallboard production.

- Synthetic gypsum use in agricultural applications – in which the gypsum improves soil conditions and prevents harmful runoff of fertilizers – also increased 50 percent to 1.2 million tons. Part of this growth is attributed to a large new synthetic gypsum source entering the market.

- Use of CCP in pond closure activities increased dramatically from 435,000 tons in 2016 to 4.5 million tons in 2017 as utilities ramped up compliance with environmental regulations that effectively require an end to the practice of wet disposal. Fly ash, bottom ash, and synthetic gypsum were all used in construction of new permanent disposal facilities.

- Use of fly ash and bottom ash in structural fills continued a multi-year decline, decreasing 72 percent to 1.3 million tons.

- Production of boiler slag increased 18 percent. Approximately 1.4 million tons of boiler slag was utilized in the production of blasting grit and roofing granules.

- Approximately 148,000 pounds of cenospheres were sold in 2017, up from zero in the prior year. Cenospheres are a very valuable form of ash mainly harvested from wet disposal impoundments.

"As America's electricity grid changes, the coal ash beneficial use industry is evolving as well," said Adams. "As we work diligently to utilize the 36 percent of coal combustion products that are still disposed annually, our industry is also taking significant strides in developing strategies for improving the quality and availability of these materials."

Adams explained that increasing beneficial use requires ash marketers to ensure that products are consistent and available when customers need them – requiring large investments in technology and logistics. Additionally, the coal ash beneficial use industry is actively deploying technologies and strategies for harvesting coal ash materials that were previously disposed.

About Coal Ash Recycling

Coal is the fuel source for approximately one-third of electricity generation in America and produces large volumes of solid coal combustion products — primarily ash and synthetic gypsum from emissions control devices.

There are many good reasons to view coal combustion products as a resource, rather than a waste. Recycling them conserves natural resources and saves energy. In many cases, products made with CCPs perform better than products made without it. For instance, coal fly ash makes concrete stronger and more durable. It also reduces the need to manufacture cement, resulting in significant reductions in greenhouse gas emissions – about 14 million tons in 2017 alone.

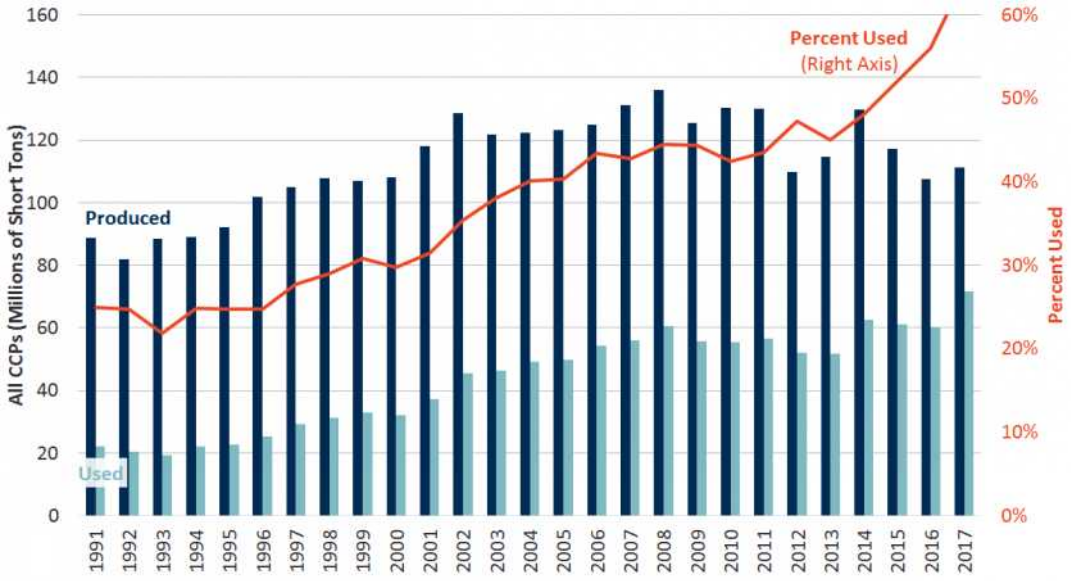
Major uses of coal combustion products include concrete, gypsum wallboard, blasting grit, roofing granules, and a variety of geotechnical and agricultural applications.

About ACAA's Production and Use Survey

The American Coal Ash Association has conducted a survey quantifying the production and use of coal combustion products in the United States each year since 1966. Data is compiled by directly surveying electric utilities and utilizing additional data produced by the U.S. Energy Information Administration. The survey's results have been widely utilized by federal agencies including the U.S. Environmental Protection Agency and U.S. Geological Survey.

A summary of overall production and use data since 1991 is represented by the chart below. A complete copy of the 2017 survey results is on the final page.

All CCPs Production and Use with Percent



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2017 Coal Combustion Product (CCP) Production & Use Survey Report

Beneficial Utilization versus Production Totals (Short Tons)

2017 CCP Categories	Fly Ash	Bottom Ash	Boiler Slag	FGD Gypsum	FGD Material Wet Scrubbers	FGD Material Dry Scrubbers	FGD Other	FBC Ash	CCP Production / Utilization Totals
Total CCPs Produced by Category	**38,189,790**	**9,655,931**	**2,574,673**	**32,707,136**	**11,311,344**	**2,454,818**	**6,293**	**14,469,553**	**111,369,538**
Total CCPs Used by Category	**24,095,590**	**4,839,420**	**1,570,375**	**22,839,385**	**3,905,009**	**382,048**	**2,407**	**14,134,477**	**71,768,712**
1. Concrete/Concrete Products /Grout	14,065,791	785,527	0	67,009	0	0	0	0	14,918,326
2. Blended Cement/ Feed for Clinker	4,579,724	1,622,612	132,183	2,317,445	0	51	0	0	8,652,015
3. Flowable Fill	86,379	0	0	0	0	0	0	0	86,379
4. Structural Fills/Embankments	465,653	871,875	0	0	0	0	0	0	1,337,529
5. Road Base/Sub-base	674,155	159,084	0	2,460	0	11,931	0	0	847,630
6. Soil Modification/Stabilization	360,796	48,876	0	0	0	0	0	0	409,673
7. Mineral Filler in Asphalt	59,317	0	0	0	0	7,019	0	0	66,336
8. Snow and Ice Control	69,192	276,989	4,220	0	0	0	0	0	350,402
9. Blasting Grit/Roofing Granules	0	17,705	1,412,685	44,981	0	0	0	0	1,475,371
10. Mining Applications	901,181	232,110	0	927,949	3,905,009	202,092	0	14,037,913	20,206,254
11. Gypsum Panel Products (formerly Wallboard)	0	0	0	15,859,606	0	0	0	0	15,859,606
12. Waste Stabilization/Solidification	1,065,993	48,964	0	3,026	0	114,646	0	96,564	1,329,193
13. Agriculture	0	0	0	1,157,877	0	35,121	0	0	1,192,998
14. Aggregate	0	10,237	21,287	0	0	0	0	0	31,524
15. Oil/Gas Field Services	78,716	0	0	0	0	11,188	0	0	89,905
16. CCR Pond Closure Activities	1,468,203	730,600	0	2,270,326	0	0	0	0	4,469,130
17. Miscellaneous/Other	220,489	34,840	0	188,705	0	0	2,407	0	446,442

Summary Utilization to Production Rate

CCP Categories	Fly Ash	Bottom Ash	Boiler Slag	FGD Gypsum	FGD Material Wet Scrubbers	FGD Material Dry Scrubbers	FGD Other	FBC Ash	CCP Utilization Total
Totals by CCP Type/Application	24,095,590	4,839,420	1,570,375	22,839,385	3,905,009	382,048	2,407	14,134,477	**71,768,712**
Category Use to Production Rate (%)	**63.09%**	**50.12%**	**60.99%**	**69.83%**	**34.52%**	**15.56%**	**38.25%**	**97.68%**	**64.44%**
2017 Cenospheres Sold (Pounds)	147,958	**Data in this survey represents 145.20701 GWs of Name Plate rating of the total industry wide approximate 263.0478 GW capacity based on EIA's July 2017 Electric Power Monthly.**							
CCPs Imported in 2016 (Short Tons)	0								
CCPs Exported in 2016 (Short Tons)	0								

Appendix B

ACAA American Coal Ash Association

Advancing the management and use of coal combustion products.

November 18, 2010

Administrator Lisa P. Jackson
US Environmental Protection Agency
EPA West, Room 3334
1301 Constitution Avenue N.W.
Washington, DC 20460

Re: Hazardous Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities Docket, Attention Docket IDNo.,EPA-HQ-RCRA-2009-0640.

Dear Administrator Jackson:

Enclosed please find the comments of the membership of the American Coal Ash Association (ACAA) on the referenced document. Included in this submittal are numerous references and attachments including discs with relevant materials in support of these comments.

This package represents the work product of volunteers who dedicated over 14,000 hours since the proposal was published on June 21, 2010 to inform the EPA as to the impacts of the proposed rule on the beneficial use. In addition our members have invested thousands of hours responding as individual entities. The beneficial use industry is providing detailed, factual information vital to the rulemaking process.

The ACAA supports regulation of coal ash disposal under Subtitle D of the Resource Conservation and Recovery Act of 1976. We also support an amendment to RCRA to provide enforcement authority of Subtitle D regulation of coal ash disposal if Congress and the President would consider such an amendment. *We oppose any form of Subtitle C regulation of coal ash disposal as such a regulation will devastate the beneficial use industry.* This submittal details the devastation resulting from any form of Subtitle C regulation.

The ACAA stands ready to resume collaborative efforts with the EPA to encourage the safe beneficial use of coal combustion products.

Sincerely,

Thomas H. Adams

Thomas H. Adams
Executive Director

Enclosures

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COMMENTS TO HAZARDOUS AND SOLID WASTE MANAGEMENT SYSTEM; IDENTIFICATION AND LISTING OF SPECIAL WASTE; DISPOSAL OF COAL COMBUSTION RESIDUALS FROM ELECTRIC UTILITIES (DOCKET ID NO EPA-HQ-RCRA-2009-0640)

TABLE OF CONTENTS

		Page
SECTION I – ACAA: WHO WE ARE		**1**
SECTION II – EXECUTIVE SUMMARY		**2**
SECTION III – BENEFICIAL USES AND BENEFITS		**3**
a	CCP Types	3
b	CCP Utilization Options	6
c	Industry Standard Setting Organizations: ASTM and AASHTO	19
d	Federal Agency Use Support	20
e	CCP Utilization Data	23
f	Benefits of Using CCPs	26
SECTION IV – BARRIERS		**29**
a	Barriers to Use	29
b	Lack of Correlation to Disposal Costs	31
c	Correlation to Regulatory Barriers	32
SECTION V – STIGMA IMPACTS		**34**
a	Impacts to Participants in Coal Ash Market	34
b	Manufacturers of Competitive Products Using EPA's Determination	37
c	Stigma Impacts Are Already Occurring	38
d	Economic Analysis	39
e	Subtitle D versus Subtitle C	41
SECTION VI – BENEFICIAL USE: ENCAPSULATED USES		**43**
a	Introduction	43
b	Overview of Concerns - Encapsulated Beneficial Uses	44
c	How Encapsulated Is Ultimately Defined	45
d	Stigma Impacts to Encapsulated Beneficial Uses	49
e	No Documented Damage Cases for Beneficial Uses Identified	55
f	Conclusions	56
SECTION VII – BENEFICIAL USE: FLOWABLE FILL		**56**
a	Introduction	56

b Clarification that Flowable Fill Constitutes an "Encapsulated" Use is Needed..... 57
c CCPs are Bound in the Mixture..... 57
d Use of Fly Ash in Flowable Fill Satisfies EPA's Definition of a Beneficial Use..... 58
e How Flowable Fill is Used..... 60
f Stigma Impacts that EPA's Decision Could Have..... 61
g Conclusions..... 62

SECTION VIII – BENEFICIAL USE: STRUCTURAL FILL..... 63
a Introduction..... 63
b Properly Used Structural Fill is a Beneficial Use..... 64
c Recommendations as to Regulations or Standards..... 74
d Response to EPA's Specific Damage Cases..... 81
e Conclusion..... 85

SECTION IX – BENEFICIAL USE: GEOTECHNICAL AND UNENCAPSULATED USES..... 91
a Introduction..... 91
b ACAA Recommendations..... 94
c Technical and Public Policy Rationale for Recommendations... 99
d Discussion of Geotechnical and Unencapsulated Use Applications: Subgrade Fill..... 102
e Discussion of Geotechnical and Unencapsulated Use Applications: Soil Stabilization and Asphalt Pavement Recycling..... 108
f Discussion of Geotechnical and Unencapsulated Use Applications: Surface Applications..... 117
g Discussion of Geotechnical and Unencapsulated Use Applications: Feedlot, Dairy, or Livestock Pen Stabilization... 122
h Discussion of Geotechnical and Unencapsulated Use Applications: Waste Stabilization and Solidification Application..... 125
i Why Concrete and Concrete Products Cannot Use 100% of US CCP Production..... 129

SECTION X – BENEFICIAL USE: AGRICULTURAL APPLICATIONS (FGD GYPSUM)..... 147
a Introduction..... 147
b Use of FGD Gypsum in Agriculture is a Legitimate Beneficial Use..... 147
c FGD Gypsum used in Agriculture Produces Measurable Economic Value..... 150

d **Current Testing Protocols are Adequate for FGD Gypsum used in Agriculture..... 151**
e **Site Specific Standards are NOT Necessary for FGD Gypsum used in Agriculture..... 151**
f **Regulation under RCRA Subtitle D or C..... 153**
g **The Stigma Impact of a Hazardous Designation will be Severe 154**
h **State Regulation of FGD Gypsum used in Agriculture is Universal and Comprehensive..... 155**
i **Extensive Research has been Conducted by USDA and Others 166**

SECTION XI – BENEFICIAL USE: MINEFILLS AND MINE LAND RECLAMATION..... 167
a **Background and Introduction – There is a Long History of Successful Mine Land Reclamation Using CCBs in Many Mining States..... 167**
b **Examples of Beneficial Use/Mine Land Reclamation at Mines 170**
c **EPA's Proposed Rule Excludes Mines? – EPA Needs to Clarify..... 172**
d **Definitional Issues - Need Clarification Mines Are Excluded... 173**
e **Impacts..... 176**
f **Mines, Quarries, Pits: The Reuse Of CCP Ash To Properly Reclaim Any Current Or Past Man Made Land Void, (Including But Not Limited To Mines, Quarries, Sand And Gravel Pits) Is Beneficial to the Environment And Society..... 179**
g **EPA Should Defer CCP Regulation at Mines to OSM – EPA Should Listen to OSM Concerns with Subtitle C..... 182**
h **Various Federal Agency Findings: Including the EPA, OSM, and the National Academy of Sciences Indicate That a RCRA D Classification of Ash Is Justified and That Government Should Promote CCR Use or Remove Impediments to Its Use..... 184**
i. **State Agencies Findings And Reports: States Currently Have Regulations In Place That Have Been Developed Over Time (After Conducting Unbiased Scientific Studies And Sampling) And Include Scientific Based Procedures To Properly Address Ash Management Issues In Fact, Pennsylvania's Ash Regulations have been cited As "Model Regulations" By EPA..... 188**
j **Stakeholders: EPA Has Received Correspondence From Various Congressional Leaders And Industry-Government Stakeholders Representing Hundreds Of Millions Of Citizens And Jobs Stating That A "Hazardous" Determination For Coal Ash Is Illogical, Unnecessary, And Will Have A Negative Impact On Jobs And Beneficial Recycling -Reuse..... 192**

k **Hazardous Stigma: The Stigma of Declaring Ash a Hazardous Waste Is Not Hypothetical It is both Incorrect and Naive To Believe That EPA's Actions and Proposed Ash Rule "Does Not Address" Ash Placement in Mines... If EPA Further Declares Ash a Subtitle C RCRA Hazardous Substance It Will Have A Direct Grave Negative Impact on Past, Current, and Future Beneficial Use Of Ash For Mine Placement And/Or Reclamation..... 192**

l **Damage Cases: Health Officials And EPA Have Repeatedly Reported "No Adverse Impact To Human Health"; Due To Accidental Exposure To Ash Accordingly It Appears That The Alleged CCR "Proven Damage" Cases Cited By EPA Do Not Provide A Sufficient Or Scientific Basis To Propose Ash As Hazardous..... 198**

m **Summary..... 200**

SECTION XII – TESTING METHODOLOGY..... 201

SECTION XIII – CONCLUSION..... 203

ACAA American Coal Ash Association

Advancing the management and use of coal combustion products.

COMMENTS TO HAZARDOUS AND SOLID WASTE MANAGEMENT SYSTEM; IDENTIFICATION AND LISTING OF SPECIAL WASTE; DISPOSAL OF COAL COMBUSTION RESIDUALS FROM ELECTRIC UTILITIES

(DOCKET ID NO. EPA-HQ-RCRA-2009-0640)

Section I – ACAA: Who We Are

The American Coal Ash Association (ACAA) was established more than 40 years ago, in 1968, as a trade organization devoted to recycling the materials created when coal is burned to produce electricity. Our members comprise the world's foremost experts on coal ash (fly ash and bottom ash), and boiler slag, flue gas desulfurization gypsum or "synthetic" gypsum, and other "FGD" materials captured by emissions controls. While other organizations focus on disposal issues, ACAA's mission is to advance the management and use of coal combustion products (CCPs) in ways that are: environmentally responsible; technically sound; commercially competitive; and supportive of a sustainable global community.

EPA requested comments on many facets of beneficial use in its Proposed Rule. ACAA in its continuing effort to work with EPA, established several task teams to respond to the Proposed rule. Approximately 14,100 volunteer hours were spent reading, digesting, and responding to the Proposed Rule. These task teams assembled ACAA membership from a diverse array of its stakeholders: academic professors and scientists, scientists within businesses associated with CCPs, former regulators, consultants, engineers, cement companies, fly ash marketers, CCP technology companies, international representatives within the CCP industry and utility representatives. The following teams worked on providing substantive comments and responsive answers to questions or statements in the Proposed Rule: (a) the Encapsulated Team which focused on products including concrete, bricks, block, wallboard, and cement uses; (b) the Flowable Fill Team which focused on flowable fill and why it should constitute an encapsulated use; (c) the Structural Fill Team which focused on use in larger scale fill projects; (d) the Geo-technical Team which focused on number of uses including but not limited to base course, subbase or subgrade fill for the construction of a paved federal, state or municipal roadways, transportation facility embankments, and bridge abutment backfills not associated with road riparian crossings; (e) the Agricultural Gypsum Team which focused on applications of synthetic gypsum for agricultural use; and (f) the Mining Team which focused on sand and

gravel mining, limestone mines and other types of mining applications. ACAA hopes that EPA will, with an open mind and due deliberation, carefully consider and weigh the data submitted herein to reach the right conclusion as EPA is not expert in the CCP marketplace and can easily ruin years of hard work and one of America's greatest recycling stories in history.

Section II – Executive Summary

ACAA on behalf of its more than 150 commercial, industrial and academic members of the beneficial use and recycling industry which includes most of the large volume by-products of coal combustion, Coal Combustion Residuals (CCRs), supports a national standard for the management of CCRs under subtitle D of the Resource Conservation and Recovery Act (RCRA). ACAA has prepared comprehensive comments for EPA that details the beneficial use and recycling of CCRs and the significant success story that this industry has become. This success is the result of decades of work by a diverse industry based on serious academic research, analytical testing, regulatory acceptance and finally market approval. This industry has enjoyed partnership and broad support of federal and state governmental regulatory agencies including USEPA. The ultimate acceptance by commercial markets and commerce is supported by non-hazardous solid waste EPA regulatory determinations in 1993 and 2000 and an extensive review by the National Science Foundation. It was upon the regulatory certainty created by these findings that the markets based their acceptance allowing the industry to flourish. Reversal of EPAs regulatory position in order to provide federal jurisdiction of the management and disposal facilities, in light of the impoundment collapse at TVA's Kingston power station in December 2008 is unnecessary and will devastate the robust and diverse beneficial use and recycling industry because management under RCRA C will taint these materials as hazardous creating serious barriers and a "stigma" of hazardous liability.

These comments will describe the substantial technical, environmental and economic benefits that this industry contributes. The construction and construction materials industry will incur harm when fly ash and other CCRs can no longer be used to enhance performance or be substituted for a more expensive raw material. Several independent national and international building standards organizations have contacted EPA directly to inform of this situation and the impacts. The positive contribution that CCR recycling makes toward greenhouse gas reduction and solid waste disposal will be lost if a RCRA subtitle C determination is pursued due to reduced material available from liability concerns and reduced recycling opportunities as market acceptance continues to wane. Evidence of the markets tolerance of the negative stigma created by a hazardous label is already being reported and documented. Finally, the economic impacts higher handling and disposal costs, and the withdrawal of a valuable lost cost ingredient to many commercial and industrial processes will drive finished product prices up negative impacting projects and markets. All this negative activity is at a time when the US economy is struggling.

The proposed management of CCRs as a hazardous "Special" waste is creating a very real negative stigma or negative perception at all levels of the market which is already being felt by individuals and companies engaged in these markets. ACAA and its members have provided

real tangible evidence, throughout the public hearing process. These examples will be reviewed and discussed in detail as well as an evaluation of EPA's incorrect rationalization that a subtitle C determination would actually enhance beneficial and recycling efforts. Time is the enemy of this industry and the companies that support and develop beneficial use and recycling as the mere possibility that a RCRA subtitle C option is being considered is having a negative effect on many ACAA members in addition to the recent downturn in the economy. Commercial financing for projects that include CCRs has become very difficult to qualify for. An extended period of review by EPA to consider all the comments received to date are feared to create an irreversible effect on this industry.

ACAA strongly believes the technical similarities' and differences between a RCRA subtitle C and subtitle D scenarios are small or do not exist, that disposal under either are adequately protective of human health and the environment and that the advantage gained under a subtitle D rule will be felt years earlier. A quicker implementation of adequate subtitle D management and disposal requirements is the tangible improvement that ACAA believes valuable. ACAA is prepared to support EPA through legislative or regulatory process to expedite a subtitle D implementation.

ACAA through the tireless devotion and effort of a volunteer membership has prepared a comprehensive review and discussion of 3 of the most significant beneficial use categories including encapsulated uses (ready mix concrete, portland cement, synthetic gypsum wallboard and mineral fillers), geotechnical uses (well-conceived – designed – constructed structural fills and soil modification) and the agricultural application of FGD synthetic gypsum as a soil modifier. ACAA has also prepared a review and discussion of the use of CCRs as a minefill alternative with recommendations. Finally ACAA has reviewed the various test methods which are available to evaluate CCRs (and other regulated wastes or by-products) with suggestions and comments.

The overwhelming technical, legal, economic and practical arguments included in these comments support implementation of a national standard for the management and disposal of all coal combustion residuals under a subtitle D program within RCRA that will allow the continued use of these valuable materials without regulatory cloud or stigma.

Section III – Beneficial Uses and Benefits

a. CCP Types

CCPs are engineering materials that are similar in use to virgin, processed and manufactured materials. CCPs are the residuals produced from the combustion of coal.

Ash is the non-combustible mineral portion of coal. Purchasers of coal typically specify the maximum percentage of ash that will be allowed in delivered coal. After the coal is combusted, the residual ash must be collected and either disposed or used for a beneficial purpose. Ash

content varies from one coal source to another independent of coal rank.[1] Higher rank coals typically contain higher percentages of ash at the mine mouth, but are often "washed" to reduce ash content prior to delivery to utilities. Post combustion ash takes the form of:

- **Fly Ash** - ash that exits a combustion chamber in the flue gas and is captured by air pollution control equipment, such as electrostatic precipitators (ESPs), baghouses and wet scrubbers. Fly ash is the consistency of powder and is typically a pozzolan. A pozzolan is defined as "Siliceous or siliceous and aluminous materials that in themselves possess little or no cementitious value but will, in finely divided form and in the presence of water, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties."[2]

- **Bottom Ash** - agglomerated ash particles formed in pulverized coal furnaces that are too large to be carried in the flue gases and impinge on the furnace walls or fall through open grates to an ash hopper at the bottom of the furnace. Bottom ash is typically grey to black in color, is quite angular and has a porous surface structure. Bottom ash is used as an aggregate, as feed stock for cement manufacturing or in construction applications in lieu of other constituents (such as sand and gravel).

- **Cenospheres** – A cenosphere is a lightweight, inert, hollow sphere filled with inert air or gas that is produced as a byproduct of coal combustion. The color of cenospheres varies from gray to almost white and their density is about 0.4-0.8 g/cm^3, which makes them very buoyant. Cenospheres are hard and rigid, light, waterproof and insulative. This makes them highly useful in a variety of products, notably fillers, such as in cement to produce low density concrete in metal matrices to make strong but lightweight composite materials.

Concrete-quality fly ash is classified into two types as outlined below.

- **Class C Fly Ash** - fly ash, which meets criteria defined in ASTM C 618, for use in concrete. Specifically, the combined total of Silicon Dioxide, Iron Oxide and Aluminum Oxide is higher than 50% for a Class C designation. Most Class C fly ash is derived from sub-bituminous coal. It is often brown or tan in color. Some Class C fly ashes also exhibit self-hardening properties in the presence of moisture.

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†Accompanying ACAA's submission, as hand delivered, are several electronic folders containing documents referenced in this submission, as well as other relevant documents. Where the documents referenced in the footnotes provide especially pertinent information and therefore warrant review (and are not a book or protected by copyright), copies of the documents are provided herewith in the accompanying electronic folder entitled "Footnotes – Docs." This folder contains a document with a list of the footnotes to which documents are linked. Please click on the footnotes listed in that document to review the referenced documents.

[1] G.E. Dolbear & Associates, *Coal Science,* undated.

[2] U.S. Office of Surface Mining.

- **Class F Fly Ash** - fly ash, which meets criteria defined in ASTM C 618, for use in concrete. Specifically, the combined total of Silicon Dioxide, Iron Oxide and Aluminum Oxide is higher than 70% for a Class F designation. Most Class F fly ash is derived from bituminous and lignite coals. It is normally gray or black in color.

In addition to ash, other solid residuals may be produced during the coal combustion process. These include:

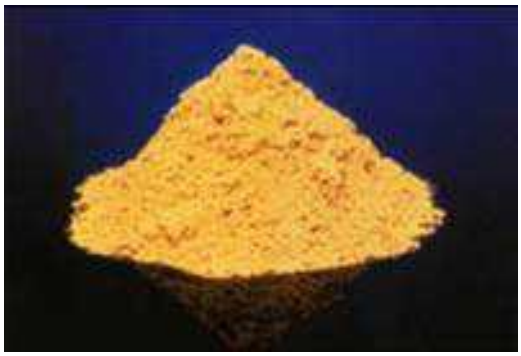
- **Boiler Slag** - a molten ash collected at the base of slag tap and cyclone furnaces that is quenched with water and shatters into black, angular particles having a smooth, glassy appearance. Boiler slag is in high demand for beneficial use (blasting grit, roofing granules, etc.), but supplies are decreasing because of the retirement from service of aging power plants that produce boiler slag.

- **FGD material** – a product of a flue gas desulphurization process typically using a high-calcium sorbent, such as lime or limestone. Sodium-based sorbent and high-calcium coal fly ashes are also used in some FGD systems. The physical nature of these materials varies from a wet thixotropic sludge to a dry powdered material, depending on the process.

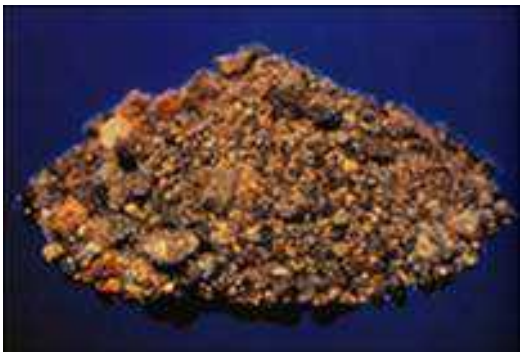
Wet thixotropic sludge is usually produced from a lime-based reagent wet scrubbing process and is predominantly calcium sulfite. It is the end product of dewatering equipment, such as vacuum filters or centrifuges, although it can be the end product of a sedimentation pond. This dewatered end product is usually stabilized by mixing it with lime and fly ash or other materials for disposal in landfills. (There are systems where the end product is not dewatered but is highly concentrated in solids as the underflow from a thickener. It is then mixed with fly ash and another material and pumped to a surface impoundment for disposal.)

The wet product from a limestone-based reagent wet scrubbing processes is predominantly calcium sulfate, which is gypsum. This material readily dewaters and there are systems in use where the slurry is transported to a pond and construction equipment is used to excavate and stockpile the gypsum

The production of commercial grade FGD gypsum used for wallboard manufacturing usually requires forced oxidation either in or external to the scrubbers, followed by dewatering with filtration equipment such as vacuum filters or centrifuges and placement in sedimentation ponds. The dry material from dry scrubbers that is captured in a baghouse along with fly ash consists of a mixture of sulfites and sulfates. This powdered material is referred to as dry FGD ash, dry FGD Material, lime spray dryer ash, lime spray dryer or lime spray dryer residue.



Fly Ash



Bottom Ash

Boiler Slag

FGD Material

b. CCP Utilization Options

Decades of experience and numerous successful utilization projects have fostered commercial and governmental acceptance and knowledge of the use of CCPs as construction materials. The principal use has been in concrete. Substantial amounts have also been used in structural fills, soil stabilization, asphalt mixes and cement manufacturing. Bottom ash has been used as pavement base, pipe bedding, skid control and in block manufacturing. Boiler slag applications include sand blasting grits, roofing granules, and skid control and as a raw material in cement manufacturing. More recently, FBC materials and FGD materials have been used in structural fills, pavement base and backfills. FGD gypsum produced via a wet-limestone, forced-oxidation scrubber can be used as a direct replacement for mined gypsum in the production of wallboard, in agricultural applications and/or as a post-kiln additive in cement production.

More detailed descriptions of various CCP uses include:

- **Concrete Production Applications**

The largest volume use of CCPs is in cement and concrete applications. Fly ash is used as a mineral admixture for ready mixed concrete production and in the manufacture of cements, aggregates, blocks, precast pipes, panels and other structures, aerated concrete, asphalt and concrete pavements, base and sub-base construction. Bottom ash is used in cement-treated

base and sub-base, and as an aggregate for concrete block. Boiler slag is used in the manufacture of asphalt for flexible pavement systems.

- **Mineral Admixture in Concrete**

Coal fly ash, like cement and volcanic ash, is comprised of oxide compounds found in limestone, iron ore, silica sand and clay. The amount of fly ash in typical structural concrete applications ranges from 10% to 40%, by weight of total cementitious material, with up to 70% in massive walls, girders and dams. Fly ash for use in concrete is available in virtually every location in the United States, including Hawaii and Puerto Rico. Fly ash also is traded internationally.

Fly ash as a concrete admixture can be added during the concrete batching process or directly to the cement. When utilized in the concrete batching process, fly ash is added along with portland cement, sand, gravel and water to the specific proportions determined in the concrete mix design. Fly ash is typically used as a replacement for 10% to 40% of the cement content. Class F fly ash is sometimes added to portland cement at the cement manufacturing plant to produce Type IP, portland-pozzolan cement (see below).

- **Cement Manufacturing**

Fly ash, bottom ash and boiler slag have all been used as raw materials in the manufacture of cement. Fly ash is used because it contains silica, alumina, calcium and iron oxides needed in portland cement feed stocks. Portland cement is prepared in a two-step process. Initially, raw materials are heated to around 3000°F, blended and fused in a cement kiln to produce a substance called clinker. Next, the clinker and additives are ground to a fine powder to produce portland cement. Fly ash may be added at either step in the manufacturing process. Certain FGD products can also added into the finished cement as a replacement for natural gypsum.

In the case where the fly ash is added to cement clinker during or after the grinding process, portland-pozzolan cement is produced. The resulting product, Type IP cement, must conform to ASTM standard C 595 and may contain 15% to 40% fly ash. The composition, properties and behavior of the cement determine the proportions blended. Pozzolans are compounds that react with lime that is generated during the cement hydration process to produce additional cementitious compounds. These reactions increase strength and impart other beneficial properties to the concrete. FGD gypsum can also be added to portland cement at rates of up to 5% at the manufacturing plant to prevent cement flash setting.

- **Concrete Block and Other Precast Concrete Product Manufacturing**

Fly ash is used in manufacturing concrete blocks to add plasticity to the concrete mixture and improve the quality of the blocks. Ash addition produces blocks with better texture and corners and increased mold life. Typically, ash replaces 20% to 30% of the cement. However, at block plants where steam curing is used, ash addition rates may be as much as 50%.

CCPs can be used as lightweight aggregate for the production of precast concrete products, such as concrete masonry units and other concrete, where a low density material is beneficial in reducing weight or loading. The principal use of lightweight aggregates is for block and structural or precast concrete where low unit weight of the end product may be an important factor in the design of the structure. Lightweight aggregate normally has a density of around 50 to 70 pounds per cubic foot. These aggregates typically need to be non-staining and non-reactive because of their use in structural and architectural applications where appearance is important. Conformance to ASTM C 330 or ASTM C 331 is usually a requirement.

Bottom ash is a common source of lightweight aggregate for use in concrete blocks. Select, screened, low-density material that is durable and will not degrade during handling is often used in this application. Many bottom ashes conform to the density and gradation requirements of ASTM C 331.

Fly ash lightweight aggregates are commercially produced from firing or chemical-bonding processes. Exceptionally durable and lightweight aggregate has been produced from fly ash and municipal wastewater sludge or paper mill sludge, providing a viable outlet for multiple materials that would otherwise be disposed. Lightweight aggregate has been produced from high calcium fly ash that has been conditioned, spread and allowed to cure. After initial curing the material is excavated and graded prior to additional curing and use.

- **Aerated Concrete**

This versatile building material, currently produced at approximately 240 plants in 40 countries, is now being introduced into the United States. When fly ash is utilized, the product, consisting of roughly 70% fly ash plus water, cement, lime and aluminum powder, is a porous, lightweight material that offers excellent insulating properties and strength and is resistant to fire, sound, mildew and insects. It can be easily sawed, drilled, screwed and nailed with ordinary carpentry tools. Given the international acceptance this product has received, aerated concrete could become a significant outlet for the beneficial use of fly ash in the U.S.

- **Paving (Concrete and Asphalt)**

CCPs have been successfully used for decades as a component in both portland cement concrete pavements and asphaltic concrete pavements. The materials can be utilized through the entire pavement structure from the sub-base course to the topping course. The use of CCPs provides a superior performing structure, as well as a cost-effective measure for state departments of transportation. In most states, the use of CCPs in the construction of pavements is a normal part of the standard construction specifications.[3]

Lime-fly ash (LFA) mixtures are blends of hydrated lime and fly ash mixed in-situ with native materials or blended with crushed stone or other aggregate. LFA mixtures have been used as

[3] *Fly Ash Facts for Highway Engineers,* U.S. Federal Highway Administration Report # FHWA-IF-03-019.

base and sub-base beneath flexible asphalt pavements. The mixtures are blended in a central mixing plant or in place, compacted, cured and topped with an asphalt wearing surface. The superior strength and durability of LFA mixtures as compared to aggregate alone, allows LFA mixtures to serve as an economic alternative to conventional pavement in many situations. These pavements have been most widely used by state and local highway departments in the Midwestern United States. In some states, self-cementing Class C fly ash is used in a similar manner, eliminating the need for hydrated lime. This technique is widely used for soil stabilization, especially in the mid-west, Texas, and mountain states.

Cement treated bottom ash has been used as a substitute for conventional crushed stone or gravel base course for secondary roads. This product has been especially useful in locations where bottom ash is plentiful and natural aggregates are relatively scarce or expensive. Though not as widely used as LFA mixtures, this product has proven to be a practical application of CCPs in some locales.

Fly ash performs as a mineral admixture in portland cement concrete paving in the same manner as ready mixed concrete.

Asphalt pavement normally consists of a blend of asphalt, coarse aggregate and a fine grain-sized additive, commonly referred to as mineral filler. Fly ash has been used since the early 1930s as a mineral filler in asphalt mixes. Many fly ashes have chemical and physical characteristics, particularly low plasticity, which are suitable for use in this application. Specifications normally allow up to 12% carbon content and a grain size of 70% to 100% passing a #200 sieve. Often, fly ashes that do not meet specifications for use in concrete or other applications will comply with these requirements and be acceptable as mineral filler in asphalt.

Blends of boiler slag and cationic emulsified asphalt have been demonstrated as a practical surface pavement for service road and low volume secondary roads in rural areas. This material has the advantage of low cost and flexibility. It can be mixed and stockpiled for later use, even during periods of cold and inclement weather when conventional asphalt may not be available.

Fly ash mixed with lime or portland cement and/or self-cementing Class C fly ash alone has been used as a binder to recycle secondary road pavements. The pulverized, recycled pavement is combined with the fly ash mixture, compacted to ten inches or more, and then covered with a thin asphalt or tar and chip surface. This process offers the benefit of significant cost savings over conventional methods because additional aggregate is not imported to reconstruct the pavement.

- **Manufacturing Applications**

CCPs have been used as ingredients in producing manufactured products as raw materials, as aggregates and as additives to the final products. Principal uses in this category are as fillers, lightweight aggregates or components in the manufacture of various products.

- **Roofing Granules**

A major use of boiler slag is roofing granules – the hard, fine aggregate used to surface shingles and other roofing products. Several properties of boiler slag make it a preferred material for this use, including natural dark color, hardness and resistance to ultraviolet radiation. Its glassy composition makes it durable and resistant to oxidation and weathering, thus producing a long-lasting surface.

- **Wallboard**

Gypsum ($CaSO_4 \bullet 2H_2O$) based wallboard is a common building material in the United States for residential and commercial construction. Generally, wallboard is manufactured by pulverizing natural gypsum rock and laminating the gypsum with a multi-layered paper surface. While natural gypsum is mined in many areas of North America, its supply is limited.

FGD residues from wet lime and limestone scrubbers have been effectively utilized for the production of wallboard. FGD residues from these installation are primarily gypsum ($CaSO_4 \bullet 2H_2O$), although some FGD residues will contain impurities, such as fly ash, carbon, calcium sulfite ($CaSO_3$) and other compounds of calcium and sulfur.

The wallboard industry takes into account several critical variables when considering synthetic gypsum, such as FGD residue, for use in their product. The criteria includes: 1) FGD gypsum should contain from 98% to 99% gypsum ($CaSO_4 \bullet 2H_2O$); 2) calcium sulfite (CaO_3) is not desirable because in substantial quantities it can change the crystallization and adversely modify the stucco-slurry fed to the wallboard manufacturing line; 3) crystal shape and size should be short and stubby with lengths approaching 100 microns; 4) water soluble salt components should be limited to prevent delamination of the paper layers from the gypsum core; and 5) fly ash content should be limited to 2% to prevent discoloration, adverse crystallization and improper board forming as a result of the fly ash's pozzolanic properties.

FGD residues from wet lime scrubbers may have the proper chemical makeup to meet these criteria; however, the FGD residue from this type of installation requires substantial drying before use. FGD residues from other calcium-based scrubber systems typically have high levels of calcium sulfite ($CaSO_3$). Forced oxidation technologies exist to convert the calcium sulfite ($CaSO_3$) to calcium sulfate ($CaSO_4$).

- **Filler in Paints, Plastics and Ceramics**

Fly ash, particularly cenospheres, has been used in blends of plastics and paints as a mineral filler to enhance mixture properties and/or to reduce the cost of materials. Cenospheres are primarily hollow fly ash spheres and are often referred to as "floaters" because, with a specific gravity in a range from 60% to 80% of that for water, they are naturally buoyant. Cenospheres can reduce the weight of manufactured products. They also can reduce the cost of some

products by reducing the amount of resin that is needed, due to their low ratio of surface area to volume. Industries that have benefited from the use of cenospheres as fillers are sporting goods, specialty cements and PVC flooring, among others.

The fly ash that is used as filler may be processed or unprocessed, depending upon the properties needed for a specific product. The major advantage that fly ash and cenospheres have over other fillers is their spherical shape which enables them to fill and flow much more readily than other fillers such as clay or calcium carbonate. Due to the high temperatures at which these CCPs are produced, they are better able to withstand high-temperature manufacturing processes. Ash has been used in a wide range of plastic products for industrial, commercial and domestic purposes.

Fly ash, other than cenospheres, has a specific gravity in a range from 1.8 to 2.8 times that of water. Compared to cenospheres, a typical fly ash used in filler applications has diameters in a more narrow range, that are smaller on average. Due to their solid spherical nature, fly ash fillers can withstand extreme pressures. Industries that have benefited from the use of fly ash as a filler are adhesives, grouting, plastics, engineered lumber and composites, ceramics, paints, explosives and automotive.

The use of fly ash in the plastics industry is expanding. Incorporating fly ash in the manufacture of polyvinyl chloride (PVC) pipe improves the productivity factors and lowers the raw material cost. It is the spherical nature of fly ash that improves production rates in these pipe extrusions. Automobile manufacturers also take advantage of the properties of fly ash by introducing the material into their products. The durability and strength of vinyl floor coverings are improved with fly ash, the weight of the finished product is decreased and the raw material costs are reduced.

Cenospheres are utilized in low-density paints for exotic applications, including aircraft carrier deck coatings and as filler in automobile undercoatings. In addition to reduced material costs, the crucial properties of improved flowability and very light weight provide specific advantages.

Some of the more innovative developments for cenospheres and solid fly ash particles are emerging in the aerospace industry. For example, silver-coated cenospheres are used to fill voids which create radar echoes in the stealth aircraft. Lightweight composites utilizing fly ash provide the needed weight reduction with no loss in rigidity or strength.

- **Metallurgical Applications**

CCPs are used by the steel industry for many applications. Coal fly ash and bottom ash can be used as insulating cover material to retain heat in ladles of molten steel. These ladle insulators should be flowable and coarse, have a low bulk density and have a wide particle-size distribution. Fly ashes with such characteristics generally are produced by coal-fueled stoker boilers.

Most of the newer steel mills in the United States use electric arc furnaces to melt scrap iron and refine it for making specialty products. These furnaces use carbon electrodes charged with an electric current to heat the scrap in a refractory-lined furnace. Both the carbon rods and refractory material are consumed in the process and are very expensive to replace. To prolong the life of these components, a coarse high-carbon fly ash is injected into the slag, an accumulation of impurities that float at the surface of the molten steel. The combustion of the carbon in the ash generates carbon monoxide and other gases that "foam" the slag. Foamy slag prolongs the life of the carbon rods and the refractory by insulating the region on the carbon rods and refractory where the surface of the molten steel meets the atmosphere. Additionally, foamy slag promotes the movement of impurities from the molten steel into the slag. Important characteristics for slag foamers are carbon content greater than 50%, a low percentage of fines, a high degree of coarseness, a good particle-size distribution and a bulk density of greater than 40 pounds per cubic foot. Small coal-fueled stoker boilers readily produce ash of this quality.

The high melting point and strength characteristics of CCPs make them highly suitable for applications as sintered tiles. Cenospheres as well as denser fly ashes, are used to produce insulating refractory compounds for the steel industry.

Composites of aluminum and fly ash particles have been developed using standard foundry techniques. Additions of solid and hollow particles of fly ash have been successful in reducing the material cost and density of aluminum castings while increasing their performance. Mechanical properties of aluminum-fly ash composites show that the composite possesses superior abrasion resistance, higher hardness, higher compressive strength and elastic modulus, compared to the parent matrix. Composites containing up to 55% fly ash on a volume basis have been developed. Additionally, cast composites of aluminum and fly ash have been successfully extruded using commercial technology, suggesting even more opportunities for use. The production of fly ash and aluminum composites could make existing foundries more competitive by increasing the market potential for aluminum in applications that traditionally have been dominated by steel. Examples of such markets include both the automotive and the electromechanical machinery industries.

- **Explosives Manufacturing**

Another application for cenospheres is in explosive manufacturing. Cenospheres provide a stable medium for introducing controlled air voids, a requirement for reliable detonation. Recent research has shown that coated particles of fly ash or fly ash in combination with FGD gypsum can be added to certain types of fertilizer-based explosives to mitigate explosions.

- **Geotechnical Applications**

Geotechnical applications for CCPs for projects such as highways, airports, commercial land developments and public infrastructure systems constitute a substantial portion of construction activities. In addition to concrete, CCPs have been successfully used in geotechnical projects in

several ways, including flowable fill, grouts, roller compacted concrete, soil stabilization, construction bedding, backfill and structural fill/embankments.

- **Flowable Fill**

Mixtures of fly ash, cement and water have been used as construction backfill in areas where conventional backfilling may be difficult or undesirable. These fluid mixtures flow into areas to be filled and result in a fill with properties equal to, or exceeding, traditional backfill materials. A mixture of fly ash, water, sand and a small amount of cement is typical. In some cases where Class C fly ash is used, no cement is required. The savings in using flowable fills results from the reduction in time, equipment and manpower needed, and the superior performance, as compared to conventional materials. Flowable fills are especially useful in restricted areas where access for placement and compaction is difficult, and where minimal subsequent settlement is desired. Flowable fills are particularly well suited for filling utility trench excavations under streets in urban locations, abandoned pipelines, in emergency repairs for water systems and other applications where quick set times and load bearing is important.

- **Grouting**

Grout is used to strengthen or decrease permeability of structures and subsurface strata by filling voids, and cementing cracks, fissures and other openings. Fly ash adds several useful properties to grout mixes. The fine, uniform particle size, spherical shape and pozzolanic activity of fly ash are all useful qualities. Grouts containing fly ash have been employed in filling abandoned mine openings to prevent ground subsidence and in oil wells. Ash use in oil well grouting dates back to 1949. In this application, pumpability, less bleeding and lower heat of hydration with fly ash grouts are particularly desirable properties. The American Petroleum Institute has a standard specification for this use of fly ash.[4]

- **Roller Compacted Concrete**

Roller compacted concrete (RCC) is a fill material that is placed using conventional earthmoving equipment, such as dump trucks, bulldozers and vibratory compactors. RCC mixes are used for mass concrete in dams, thick pavement bases and similar applications. These mixtures are used in mass concrete applications where material is placed using earth moving equipment to reduce the placement and forming costs that are normally associated with standard concrete construction methods. RCC mixes have a lower water content and higher ash content than conventional concrete mixes.

Fly ash, as well as other CCPs, is a major component of roller compacted concrete and contributes to the strength and cost-effectiveness of the material. Prominent RCC dam building projects utilizing fly ash include the U.S. Bureau of Reclamation's Upper Stillwater Dam in Utah and the San Diego Water Authority's Olivenhain Dam in California. Almost 200,000 tons of

[4] American Petroleum Institute, Specification Number 10.

Class F fly ash was used in the Utah project and approximately 150,000 tons was used in the California project.

- **Soil Stabilization**

Fly ash has been used to supplement or replace portland cement or lime in soil stabilization applications. When ash is used as an ingredient, standardized mix design procedures have been developed. Design specifications typically include compaction moisture content, strength and dimensional stability criteria. Procedures for curing, placement and other considerations are typically included. Specifications for fly ash use in soil stabilization have been adopted by several government agencies, including the Federal Aviation Administration, Federal Highway Administration, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and many state departments of transportation.

- **Construction Bedding**

Bottom ash is widely used as fill to provide support beneath slabs and small structures, and as pipe bedding. Bottom ash is often the preferred material for these uses because it is easily spread and compacted, is not sensitive to moisture content variations, drains readily and forms a stable base.

- **Backfill**

The qualities that make bottom ash a preferred material for construction bedding also make it desirable as a backfill material for small areas. Bottom ash is uniform, well graded, drains readily, is not sensitive to moisture variations and is relatively lightweight compared to many natural materials. Bottom ash can be handled, placed and compacted using the same techniques as other natural granular materials.

- **Structural Fills/Embankments**

CCPs are a lightweight material for constructing fills. In this application, CCPs have been used to convert sites with unsuitable topography into valuable, productive property. These materials can be placed, spread and compacted using the same equipment as conventional fill materials. Placement to a controlled density and configuration can produce stable fills for site developments, roadways, parking areas and building construction.

In the United States, the use of CCPs in structural fills dates back to at least 1971. Since then, several million tons have been used in successful land development projects. These sites include housing developments, shopping malls, industrial parks and other types of commercial, residential and industrial developments. Transportation costs and material availability normally determine if CCPs are a practical alternative to competing native materials. When available in sufficient quantities within competitive haul distances, CCPs have proven to be an excellent material for creating structural fills. While the most common material used for structural fills

has been Class F fly ash, bottom ash, FBC ash, stabilized FGD materials and other types of CCPs have also been successfully used as structural fills.

ASTM E 2277-03 "Standard Guide for Design and Construction of Coal Ash Structural Fills" is a specification standard covering the use of CCPs in structural fill applications. The standard provides a guideline to assure that CCPs used in structural fills conform to a specified range of physical and chemical properties, and behavior. Conformity assures that a consistent, high quality product is produced.

Many state transportation departments are taking advantage of the beneficial properties and low cost of CCPs to construct roadway embankments, eliminating the need for traditional cut-and-fill designs, which often involve excavation. After concrete, structural fills are now the largest volume use of CCPs in the United States.

Use of CCPs in highway embankments has been more prevalent in Europe and in urban projects in the United States where availability of local virgin borrow materials are limited.

- **Agricultural Applications**

Large quantities of CCPs can be utilized for applications in the agricultural industry. The chemical and physical characteristics of CCPs provide many properties that are needed for the production of crops. CCPs could be used to replace or augment some of the fertilizers and additives used by farmers today.

- **Soil Amendment**

CCPs can be used to improve agricultural soils utilizing both chemical and physical properties of the materials. Chemical benefits result from supplying essential plant nutrients for growth (such as supplying boron to a boron-deficient soil) or by changing the chemical nature of the soil to make it a more favorable medium for plant growth (such as increasing soil pH or decreasing aluminum toxicity). Examples of physical benefits include increases in water-holding capacity when fly ash is added to coarse-textured soils and increased water infiltration and soil aggregation resulting from the application of FGD gypsum.

Many CCPs have appreciable levels of elemental calcium and sulfur, nutrients essential to the growth of all plants and crops. FGD residue may be pelletized for efficient handling and distribution onto the fields. Crops such as peanuts, sweet and Irish potatoes and evergreens can benefit from the application of FGD residue. The FGD residue is made up primarily of calcium sulfate ($CaSO_4$) and calcium sulfite ($CaSO_3$), which are soluble forms of calcium, and is available in a product which is pH-neutral, neither acidic nor alkaline. In the case of peanuts, large amounts of available calcium are required by the plant during a certain period of growth known as pegging. If the calcium is not available during this period, the harvest of peanuts will have "pops", or vacant shells, thus severely detracting from the value of the crop.

- **Conversion of Salty Soils**

Gypsum ($CaSO_4 \bullet 2H_2O$) from an FGD system can be used in the conversion of salty soils to more productive soils. The gypsum is used for exchanging Ca^{2+} for Na^{+} on the soil exchange complex and removing bicarbonates from soil solution. Several tons of gypsum per acre are usually used. The gypsum must be thoroughly mixed with the soil and not simply plowed under.

- **Potting, Compost and Landscape Soils**

Fly ash, bottom ash and FGD residues can be used in the production of potting soil mixtures and in composting of yard waste to provide growing media. When used in this application, CCPs may provide air- and water-holding capacity, micro- and macro-nutrients and improved texture. These CCPs can be added to peat moss, humus, compost or pine bark mixtures to produce high quality soils. In some parts of the Southern US, bottom ash is blended into clay soils to improve porosity and reduce surface runoff. The "green roof" industry uses bottom ash as a component of growing media for roof-top greenery.

- **Soil from Stabilized Wastewater Biosolids**

Dewatered biosolids from wastewater treatment plants can be combined with high calcium oxide (CaO) CCPs or a mixture of Class F CCPs and cement kiln dust, lime or lime kiln dust to produce a safe and high quality soil. CCPs fine particle size and the available alkalinity of the CaO provide the characteristics to dry the biosolids, pasteurize pathogens, reduce odors and provide a granular soil-like consistency. The stabilized product has valuable levels of calcium carbonate, nitrogen, organics, micro- and macro-nutrients and residual bio-activity. The stabilized product has many applications in the agricultural industry as liming material, soil conditioner, fertilizer and landscaping soil.

- **Feedlot Applications**

CCPs in several forms have been used to demonstrate improved soil conditions at livestock feedlots. Soil stabilized with fly ash and FGD materials have been used to improve the feedlot environment, reducing animal stress and improving health.

- **Environmental Management Applications**

The physical and chemical characteristics of many CCPs, along with their availability in dry, conditioned or slurry form, make CCPs useful in certain applications dealing with environmental and waste management.

- **Coal Refuse and Mine Fire Abatement**

In several coal-mining regions, spontaneous combustion and other factors, such as lightning strikes, have created challenges with smoldering coal refuse piles and deep-mine fires. Fly ash

slurry is often used to fill voids and to isolate and cool combustion areas in burning refuse piles. Both ponded ash and conditioned ash have been used in this application. Ash is mixed with additional water at the site to form a slurry and injected into the fire zone through pipes and boreholes.

For deep-mine fires, dry fly ash pneumatically injected has commonly been used to directly extinguish burning areas and to create barriers of incombustible material.

- **Mine Subsidence and Acid Mine Drainage Mitigation**

Large quantities of fly ash and FGD materials have been used to stop or prevent surface subsidence above mined areas. Dry fly ash injected pneumatically, slurried fly ash or FGD material and fly ash/cement grouts have all been used to fill sub-surface voids from abandoned mines to protect industrial, commercial, public and residential developments from mine subsidence damage. When alkaline ash is used in these applications, a reduction or elimination of acid mine drainage may also result. Alkaline fly ash, and mixtures of fly ash and FGD materials, have been used successfully in projects to control acid mine drainage from deep mines. ASTM E 2278 provides explicit guidance on revegetation and mitigation of acid mine drainage using CCPs.

- **Surface Mine Reclamation**

Surface mined areas and mine refuse piles have several characteristics that make reclamation difficult. Various properties of these spoil materials interfere with plant growth, including coarse texture and poor water-holding capacity, dense compacted surfaces, the presence of acidic materials and the lack of sufficient nutrients. These problems are aggravated when erosion and accelerated surface runoff further prevent the successful establishment of vegetation on the disturbed area.

Direct application of fly ash has several beneficial properties that can aid in the successful establishment of vegetation as part of a reclamation program. The addition of fly ash to surface soils improves the physical characteristics of the soil; the fine material in the fly ash creates a better-graded soil texture. This change improves the water-holding capacity of the soil and serves as a medium for supporting vegetation. Fly ash also provides nutrients and, in the case of alkaline fly ashes, neutralizes acidity. Fly ash typically is added at the rate of 100 to 400 tons per acre to mine spoils as part of revegetation programs. ASTM E 2243 provides explicit guidance on the use of CCPs for surface mine re-contouring and highwall reclamation.

- **Landfill Cover**

Fly ash and bottom ash are used at some municipal waste landfills as daily and intermediate cover, and as a component of final cover. The fine grain size of these materials makes them a practical substitute cover material in locations where suitable natural soil materials are unavailable or scarce.

- **Waste Stabilization**

Fly ash and fluidized bed combustion ashes are an excellent material for use in stabilizing and solidifying biological and industrial sludges, as well as liquid wastes from industrial processes and wastewater treatment. Sludges and liquids from hazardous waste management and site cleanups have also been stabilized using fly ash. Liquid wastes and sludges are difficult to handle and transport due to their unstable nature. Addition of dry fly ash alone, or in combination with lime, kiln dust or portland cement, dries, thickens and stabilizes these materials, and makes them more manageable. Cementitious reactions that occur upon curing are also a benefit of using these ashes as a solidifying and stabilizing agent. These reactions tend to reduce the leachability of metals and other substances that may be contained in the sludge and pose environmental concerns. Pozzolans, such as fly ash, have been recognized by the U.S. Environmental Protection Agency as the preferred material for stabilizing certain metal-bearing wastes.

- **Skid Control**

One of the major uses of bottom ash and boiler slag is as an agent to prevent skidding on icy roadways in winter. These CCPs are widely used by highway departments for this purpose in regions where inclement winter weather makes driving hazardous. The dark color of bottom ash and boiler slag aids in the melting process and tends to keep the abrasive particles on the icy surface where they are needed. Bottom ash and boiler slag are superior to sand or crushed stone for this use. The free-draining nature of boiler slag reduces problems of freezing and clumping in stockpiles. Also, bottom ash and boiler slag are non-corrosive to vehicles, roadway structures and pavements, and are not environmentally sensitive like chemical de-icing agents.

- **Blasting Grit**

Processing boiler slag to produce roofing granules also generates a well-graded material suitable for grit used in sand blasting. The hard, durable and angular nature of boiler slag, combined with its relatively low cost, makes it an ideal material for use as an abrasive. The processing provides a range of gradations that conform to various grit specifications. Due to the hardness and durability of boiler slag particles, and the low free silica content, as compared to sand, boiler slag is widely used in this application. Low silica content also helps reduce health risks to workers who may otherwise be exposed to development of silicosis.

- **Marine Applications**

CCPs processed in several forms have been used in demonstration projects for marine rehabilitation. Stabilized blocks of fly ash and FGD materials have been used to construct artificial reefs suitable for supporting marine life. Other materials formed into small saucer-shaped units have been used to promote the development of oyster beds.

- **Pond Liners**

CCPs in several forms have been used in demonstration projects to construct pond liners made of natural soils and fly ash or FGD materials for the construction of waste storage ponds at utility sites.

- **Emerging Applications**

Several other important applications of CCPs also exist that are not readily categorized and a wide array of potential use applications exist at various stages of development, including: mitigating explosions from ammonium nitrate explosives by using FGD gypsum and other FGD residues; removing nutrients from storm water using bottom ash; horticultural applications combining bottom ash with yard waste to amend heavy clay soils; artificial aggregates for road base and construction applications manufactured utilizing Class C ash; lightweight aggregates for concrete manufactured utilizing spray dryer ash; re-vegetation of mine sites utilizing FGD gypsum and some ashes; odor control of poultry and swine wastes utilizing FGD gypsum; and others.

c. Industry Standard Setting Organizations: ASTM and AASHTO

A wide array of specifications and use guidelines have been adopted by standard setting organizations and regulatory agencies, placing CCPs on par with virgin and manufactured materials for product acceptability. Both the American Society for Testing and Materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO) have developed CCP related standards. Key specifications and use guidelines include:

- **ASTM C 618** and **AASHTO M 295** are the standards for the use of fly ash as a concrete additive when cementitious or pozzolanic properties are desired. These standards provide a guideline to assure that fly ash used as a concrete admixture conforms to a specified range of physical and chemical properties and behavior. Conformity assures that a consistent, high quality product is produced.

- Particle size of fly ash is normally determined using the standard procedures of **ASTM D 422** or **AASHTO T 88**. The specific gravity of fly ash ranges from 2.1 to 2.9; boiler slag and bottom ash specific gravity normally ranges from 2.3 to 3.0. The procedures of **ASTM D 554** or **AASHTO T 100** are commonly used to determine fly ash specific gravity. Compacted fly ash and bottom ash usually have dry densities in the range of 70 to 110 pounds per cubic foot. Standard test procedures **ASTM D 698** and **D 1557** and **AASHTO T 99** and **T 180** are commonly used to define the compaction behavior of fly ash.

- There are numerous ASTM standards that establish CCP specifications and characteristics for specific manufacturing and engineering uses. While the following

list is not all-inclusive, it typically represents ASTM standards that are widely recognized by designers, specifiers and regulators:

- **ASTM C 593** - Standard specification for fly ash and other pozzolans for use with lime for soil stabilization.

- **ASTM C 595** - Standard specification for blended hydraulic cements.

- **ASTM C 1157** - Standard performance standard for blended hydraulic cement.

- **ASTM D 5239** - Standard practice for characterizing fly ash for use in soil stabilization.

- **ASTM D 5759** - Standard guide for characterization of coal fly ash and clean coal combustion ash for potential uses.

- **ASTM E 2277-03** – Standard guide for Design and Construction of Coal Ash Structural Fills.

- **ASTM E 2278** – Standard guide for the use of CCPs for Surface Mine Reclamation, Revegetation and Mitigation of Acid Mine Drainage.

- **ASTM E 2243-02** – Standard guide for the use of CCPs for Surface Mine Reclamation, Recontouring and Highwall Reclamation.

Additionally, the American Concrete Institute (ACI) maintains several technical committees and reports addressing use of both Class F and Class C fly ash in cement and concrete applications.

- **ACI 232** – Fly Ash and natural Pozzolans in Concrete
- **ACI 229** – Controlled Low Strength Materials
- **ACI** – Soil Cement
- **ACI 207** – Mass Concrete
- **ACI 211** – Proportions Concrete Mixtures.

d. Federal Agency Use Support

The U.S. federal government has also promoted CCP utilization as a construction material through a variety of initiatives, including:

- **Initial Procurement Guidelines.** In 1983, the U.S. Environmental Protection Agency promulgated the first federal procurement guideline requiring agencies using federal funds to implement a preference program favoring the purchase of cement and

concrete containing fly ash. EPA also published a summary of information pertaining to CCP use in an environmental fact sheet, *Guideline for Purchasing Cement and Concrete Containing Fly Ash*.[5]

- **Executive Order.** In 1993, President Clinton issued Executive Order No. 12873, *Federal Acquisition, Recycling and Waste Prevention*,[6] directing federal agencies to develop affirmative procurement programs for environmentally preferable products and requiring EPA to issue guidance on principles agencies should use in making determinations for the preference and purchase of environmentally preferable products.

- **Comprehensive Procurement Guidelines.** In 1997, as part of its continuing program to promote the use of recovered materials, EPA adopted the "Comprehensive Guideline for the Procurement of Products Containing Recovered Materials"[7] and its companion piece, the "Recovered Materials Advisory Notice" (RMAN). The CPG designates 24 recycled-content products for which government procuring agencies need to develop affirmative procurement programs. The RMAN provides recommendations for purchasing products designated in the CPG. These guidelines require all federal agencies and all state and local government agencies and contractors that use federal funds to implement a preference program favoring the purchase of such environmentally preferable products. Concrete and cement containing coal fly ash were the first of these products designated for federal purchasing in 1983.

- **Environmental Protection Agency Coal Combustion Products Partnership.** In 2003, the EPA, in partnership with the U.S. Department of Energy and the Federal Highway Administration (later joined by the U.S. Department of Agriculture), created the Coal Combustion Products Partnership – or C^2P^2 – program to actively promote the beneficial use of CCPs and the environmental benefits that result from their use. Through the program, EPA has set a goal of 50% utilization of CCPs by 2011. More than 200 companies and organizations have joined the C^2P^2 program, which conducts workshops, publishes technical materials and case studies, reviews state regulations and standards for CCP management, sponsors an awards program for best practices, and undertakes other activities. More information about the C^2P^2 program can be found at www.epa.gov/epawaste/partnerships/c2p2/index.htm. The website also identifies a number of specific environmental benefits (the same benefits that ACAA is concerned EPA is now disregarding), including greenhouse and energy benefits, benefits from reducing the landfilling of CCPs, and reducing the need to mine virgin materials, as well as significant performance and economic benefits.

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[5] EPA/530-SW-91-086, January 1992.
[6] *58 Federal Register* 54911, October 22, 1993.
[7] 62 *Federal Register* 60961-60974, November 13, 1997.

- **Department of Energy Research Support.** Beginning in 1985, the U.S. Department of Energy's National Energy Technology Laboratory sponsored the Coal Ash Resources Research Consortium – an international consortium of industry and government representatives, scientists, and engineers focused on advancing coal ash utilization. In 1998 the Combustion Byproducts Recycling Consortium was formed with DOE sponsorship. Oversight of the program was administered by West Virginia University. Since its formation, the CBRC has funded 52 projects in excess of $10 million ($5,973,861 in federal funds and more than $4,775,313 in cost share). As a result, many of the CBRC's technologies have been selected for large-scale demonstrations, with several technologies generating results that have been adopted as agency policy or adopted by industry as commercial processes. DOE was one of the original C^2P^2 sponsors in 2003.

- **Federal Highway Administration Usage Guidelines.** The Federal Highway Administration – in cooperation with the U.S. Environmental Protection Agency and other organizations – has published two CCP use guidelines: *Fly Ash Facts for Highway Engineers*[8] (first published in 1986) and *Using Coal Ash in Highway Construction: A Guide to Benefits and Impacts.*[9] The FHWA was one of the original C^2P^2 sponsors in 2003.

- **Army Corps of Engineers Specifications.** The first large-volume use of CCPs was by the U.S. Army Corps of Engineers in construction of the Hungry Horse Dam in 1949. The Corps has since built several dams using fly ash and continues to perform research on utilization of fly ash. Many Army Corps specifications for military and civil construction projects provide for fly ash use in concrete.[10] The Army Corps also allows fly ash use in sub-grade stabilization, embankments, levee construction, flowable fill, soil amendment and asphalt filler.

- **US Department of Agriculture.** The U.S. Department of Agriculture conducts research on a variety of beneficial uses for CCPs. The USDA became a C^2P^2 sponsor in 2005. Prior to that time, USDA sponsored significant field research on the use of CCPs, predominantly, FGD gypsum, in agriculture. The EPA and USDA have jointly funded research on the environmental impact of CCP leachates from agricultural settings.

- **Other Federal Agency Support.** Federal Aviation Administration standards allow fly ash use in certain concrete products.[11] The Office of Surface Mining studies

[8] Federal Highway Administration Report # FHWA-IF-03-019.
[9] Environmental Protection Agency Report # EPA-530-K-05-002.
[10] *US Army Corps of Engineers, Technical Letter 1110-1-127, 17 August 1984.*
[11] *Standards for Specifying Construction of Supports*, AC 150/5370-10A, February 17, 1989.

utilization of fly ash in mine reclamation. The U.S. Bureau of Reclamation was an early adopter of coal ash technology in the construction of concrete dams.

e. CCP Utilization Data

Beginning in 1966 the American Coal Ash Association (ACAA) initiated an annual survey of production and use of various coal combustion products (CCPs). This voluntary survey was sent to members of ACAA and other non-member utilities. Only electric utilities were included in the survey at first, but beginning in 2007, data from independent power producers in Pennsylvania was included in response to a request from EPA Region 3 which was attempting to track CCP beneficial use within that region. The organization, ARIPPA, represents most of these independent power producers and has provided this data for the last three surveys.

Since not all electric utilities are represented by actual data, ACAA established a process early on to estimate the CCP production and utilization for utilities that did not respond to ACAA's survey or those that were not sent survey forms. Typically, each year ACAA was able to obtain accurate coal burn figures from DOE's Energy Information Agency or other sources. Over time, it became clear that coal burn information for the utilities that actually provided ACAA data was very close to the DOE data for these same firms. Therefore, for companies that did not provide ACAA CCP production and use data, a method of extrapolating this information from national coal burn data was established. This extrapolation method has been used since the mid-1990s and all data is reported in short tons except for cenospheres, described below. Survey factors include: 1) the types of coal consumed to generate electricity, (i.e., bituminous, sub-bituminous and lignite); the method of combustion (i.e., the boiler system used); and 3), and the type of resulting CCPs produced: [i.e. fly ash, bottom ash, boiler slag, flue-gas desulfurization (FGD) materials, fluidized-bed combustion (FBC) ash and cenospheres]. Other factors considered when estimating utilization include seasonal demands for coal-fuel generated electricity due to weather conditions, plant outages or shutdowns, changing industry standards or specifications, government regulations and world-wide production and demand for CCPs.

Additionally, ACAA compares our data with other outside sources to help confirm the accuracy of CCPs used in commerce. Data from the Labor Department, Portland Cement Association, US Geological Survey, construction and manufacturing trade associations and similar sources are reviewed to validate ACAA's estimated uses for fly ash, for example, in concrete products or FGD gypsum in wallboard manufacturing. Whereas it is not possible to validate all CCP categories or end-uses, ACAA is confident that the data reported annually accurately indicates trends and represents some of the best estimates available nationally for production and use.

In 1966 approximately 25.2 million tons of CCPs were produced and the utilization for that year was 3.1 million tons, or roughly 12.3%. By 1994, production had increased to 88.99 million tons and utilization to 22.08 million tons that year, 24.8%. In 1998, CCP production had risen to 107.7 million tons and utilization for the 12 applications tracked was 29%, or 31.2 million tons. In 2004, the year after the EPA established the Coal Combustion Products Partnership (C^2P^2), total production was estimated to be 122.4 million tons and utilization had reached 40% (or 49

million tons). In 2008, the last full year of C^2P^2, CCP production was estimated at 136 million tons with 60.59 million tons used resulting in the highest utilization rate to that date, 44.53%. Between 1966 and 2009, the number of applications tracked by ACAA grew to a total of fifteen different categories: concrete/concrete products/grout; bended cement/raw feed for clinker; flowable fill; structural fill/embankments; road base/sub-base; soil modification/stabilization; mineral filler in asphalt; snow and ice control; blasting grit/roofing granules; mining applications; gypsum panel products; waste stabilization/solidification; agriculture; aggregate and miscellaneous or other uses. The four types of CCPs produced in 1966 were fly ash, bottom ash and boiler slag and flue gas desulfurization materials (tracked as one category).

In 2009, the types of CCPs reported on the survey include fly ash, bottom ash, boiler slag, FGD gypsum; FGD material from wet scrubbers; FGD material from dry scrubbers; FGD other and FBC (fluidized bed combustion) ashes. Also reported are cenospheres, a sub-set of fly ash, which is a high-value material, used for the manufacture of paints, plastics, metal alloys and other applications. Particular note should be paid to the production units for cenospheres as the volume of this material is reported in pounds, not tons. It is assumed that all cenospheres collected are used. Definitions of terms commonly found in the CCP industry are found in American Society for Testing and Materials (ASTM) Standard E 2201, "Standard Terminology for Coal Combustion Products."

ACAA just recently published the 2009 production and use survey report which can be accessed by going to this link: http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3. Voluntary responses for 2009 represented approximately 64.7 % of all U. S. coal-fueled utility plant megawatt name plate capacity. This is just slightly less than 2008's 68% response rate. Annual CCP production in 2009 was almost 2 million tons less than 2008 and utilization declined this year to 41.6% as compared to 44.53 % in 2008. We believe the downturn in CCP utilization was due to two primary factors: 1) the downturn in the economy; and 2) stigmatization of CCPs resulting from rumors of soon-to-be-released EPA proposed regulations. Housing and other construction starts were much lower in 2009 as compared to 2008, with cement kilns and wallboard plants operating at reduced levels. With the marked decrease of utility coal consumption (10% lower in 2009 as compared to 2008) and an adjusted corresponding decrease in CCP production, it is not surprising to see the following reductions in utilization of CCPs that were reported.

Fly ash beneficial use saw a significant decrease in utilization especially in concrete and concrete products. A drop of 2.7 million tons was seen this year over 2008. As mentioned before, this reflects a reduction in construction activities across the nation. Cement kiln products were down in 2009 because demand for portland cement was much less than the previous year. In 2009, approximately 9.7 million tons of fly ash was used in concrete products as compared to more than 12.5 million tons in 2008. Fly ash continues to be the most widely used CCP, with respondents reporting its use in twelve of the fifteen survey application categories. Fly ash was consumed primarily in concrete products, structural fills, waste stabilization and raw feed as clinker for cement production.

Flue gas desulfurization (FGD) gypsum remained the second highest used CCP when compared to fly ash when both totals are compared. Approximately 50% of the estimated 18 million tons produced, or 9 million tons, were used for beneficial purposes. This decline of nearly 1.5 million tons was largely attributable to a reduction in the manufacture of wallboard and panel products (7.2 million tons in 2009 as compared to 8.5 million in 2008). Because of increase of installed flue gas desulfurization emission control systems, production numbers were 500,000 tons higher than in 2008 and this upward trend should continue into the next decade. It is estimated that FGD gypsum production could reach as high as 40 to 50 million tons by 2020.

Bottom ash utilization was 7.2 million tons or 40.7% of the total 16.6 million tons produced. This is a very modest drop of approximately 0.1% from 2008 figures. Bottom ash was primarily used in structural fills, road base, raw feed for portland cement clinker, aggregates, mining applications and snow and ice control.

Production of FBC ash reported in 2009 was more than 12.5 million tons, of which nearly 75% was produced by independent power producers located in Pennsylvania (ARIPPA). The majority of this ash is used in mine reclamation activities (re-contouring, treatment of acid mine drainage, and land restoration). In 2005, the EPA and industry set a goal for national utilization rate of CCPs of 50% in 2011. In the EPA's proposed rulemaking they indicated that it may recommend in the future to remove mining activities from their list of beneficial uses. *If mining activities were taken out of this year's survey, the national utilization rate for CCPs would only be 30.5% as compared to the 41.6% reported by including this significant beneficial use.* The utilization rate for FBC ash is reported as 93.8% in 2009.

Boiler slag, although produced in relatively small numbers (1.8 million tons in 2009), reported the third highest use percentage among regularly reported categories. Over 84% of boiler slag produced is used for applications such as blasting grit, roofing granules, aggregates and as mineral filler in asphalt. The availability of boiler slag will gradually be reduced with the continuing retirement of cyclone and slag-tap boiler units.

Until this year, ACAA's forty-four years of CCP surveys have reflected steady growth of beneficial use. This year's decline marks a possible change that may not be reversible. While largely attributed to a downturn in the economy, ACAA firmly believes the uncertainly around proposed EPA rulemaking has had an adverse impact on utilization in 2010 and beyond. If the EPA goes forward with the promulgating final regulations that classify coal combustion residuals (CCRs) as a "special waste" ACAA expects to see a dramatic stigmatization of CCPs. In 2010, utilities, marketers and end-users have already reported that some utilities are withholding CCPs from the marketplace because of concerns about potential liabilities. ACAA members and end-users have reported numerous examples of loss-of-market in 2010.

In a worst case scenario, ACAA is of the opinion that beneficial use will drop dramatically if a special waste designation is applied to CCRs destined for disposal. Since fly ash, bottom ash and other CCPs are virtually the same when used beneficially or when disposed, utility generators are concerned that lawsuits or potential misuse of CCPs would take away all

incentives to use CCPs in many of the applications tracked above. Already credible sources are suggesting that CCPs could become the next asbestos litigation example. Billions of dollars have been spent settling claims of adverse health and environmental damages from the widespread use of asbestos from the late 19th century until the middle 20th century. We believe that the EPA, in its proposed rulemaking, has separated utilization into two vague categories, "encapsulated" and unencapsulated." "Encapsulated" uses include the use of fly ash in concrete products and the use of FGD gypsum in wallboard and panel products. "Unencapsulated" uses, according to the Agency, include structural fills, flowable fills and land applications such as in agriculture and snow and ice control. Whereas the EPA has endorsed selected "encapsulated" uses in the proposed rulemaking, it suggests that "unencapsulated" uses should be restricted or eliminated. ACAA estimates that less than 24 million tons of the CCPs reported in 2009 would have fallen under the "encapsulated" uses terminology. **This would have resulted in a national utilization rate of less than 9% as compared to the 41.3 % reported in this survey.**

The absolutely necessary trend that was emerging between the mid-1990s and 2010 has been increased sustainable construction practices. Green building and the recognition of the need to reduce our carbon footprint resulted in many examples of reduction, reuse and recycling of industrial materials. The EPA was leading many efforts in this direction through support of the Resource Conservation Challenge, the issuance of publications supporting the incorporation of industrial materials in many construction applications and through the C^2P^2 program, to name a few. Reducing greenhouse gas emissions by incorporating, for example fly ash in concrete provides a measurable CO_2 offset which was clearly quantified and recognized in the EPA's "Report to Congress: Study on Increasing the Usage of Recovered Mineral Components in Federally Funded Projects Involving Procurement of Cement or Concrete to Address the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users." (EPA530-R-08-007 dated June 3, 2008). In addition, the EPA has endorsed the use of fly ash in concrete through the Comprehensive Procurement Guidelines beginning in the mid-1980's.

To risk eliminating the significant positive aspects that CCPs provide to sustainability is neither scientifically based nor logical. Increasing the volumes of CCPs that will be disposed by eliminating markets for them through the labeling of CCRs as a special waste under RCRA Subtitle C will be devastating to the beneficial use industry and the nation. There is already much evidence of electric utilities withholding their CCPs from land applications and "unencapsulated uses" for fear of potential liability claims. If these CCPs will require disposal in the future, many states will not permit this additional landfill space and power plants may be forced to close.

f. Benefits of Using CCPs

1. *Performance Benefits*

As noted above, CCPs frequently enhance the performance of the end products in which they are utilized. Concrete is the most prevalent example. The addition of fly ash produces concrete

with higher ultimate strength, improved workability, reduced bleeding, reduced heat of hydration, reduced permeability, increased resistance to sulfate attack, increased resistance to alkali-silica reactivity (ASR), lowered costs, reduced shrinkage, and increased durability.[12]

The performance benefits of using coal fly ash in concrete are the result of both mechanical and chemical properties of the material. Mechanically, coal ash particles are small, glassy spheres of varying sizes, allowing them to fill tiny voids between aggregate and cement particles. In addition to filling the voids, the spherical shape of fly ash gives it a ball bearing effect, allowing concrete mixes to utilize less water.

Chemically, fly ash is a pozzolan which reacts with free lime produced during the hydration of cement to produce a greater volume of durable binder within the concrete mix. The combination of these mechanical and chemical properties creates concrete that is stronger, less permeable to water, and therefore more durable.

2. *Environmental Benefits*

Fly ash utilization, especially in concrete, has significant environmental benefits including: (1) increasing the life of concrete roads and structures by improving concrete durability, (2) net reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace manufactured cement, (3) reduction in amount of coal combustion products that must be disposed in landfills, and (4) conservation of other natural resources and materials.[13]

The Electric Power Research Institute during 2009 sponsored a study to quantify the environmental benefits from CCP utilization.[14] The study – conducted by the Recycled Materials Resource Center at the University of Wisconsin at Madison – applied life cycle analysis methodologies to quantify the benefits of using CCPs in sustainable construction.

The analysis focused on fly ash, bottom ash, and FGD gypsum and their most common applications. Comparisons were made between energy consumption, water use, and greenhouse gas emissions associated with conventional materials and procedures and those employing CCPs. The analysis showed significant societal benefits are obtained by using CCPs in sustainable construction in lieu of natural resources (e.g., limestone for portland cement, rock gypsum, etc.) Using 2007 CCP use data, energy consumption was reduced by 162 trillion BTUs, water consumption was reduced by 32 billion gallons, and GHG emissions were reduced by 11 million tons CO_2 equivalent.

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[12] U.S. Federal Highway Administration report FHWA-IF-03-019, *Fly Ash Facts for Highway Engineers.*
[13] Id.
[14] *Quantifying the Benefits of Using Coal Combustion Products in Sustainable Construction*. EPRI, Palo Alto, CA 1020552. Draft Final Report, December 2009.

In comparative terms, the reduction in energy consumption is commensurate with the energy consumed by 1.7 million homes (a large U.S. city), the water saved is equal to 31% of the annual domestic water use in California, and the reduction in greenhouse gas emissions is comparable to removing 2 million automobiles from the roadway.

The study also identified benefits achieved by avoiding disposal: 3.7 trillion BTUs of energy are saved (≈ 38,600 households) and CO_2 equivalent emissions are reduced by 0.3 million tons (≈ 46,300 automobiles) by not disposing CCPs in landfills.

Moreover, there are currently 21 hazardous waste facilities permitted in the U.S., many of which are located nowhere near CCP generating facilities. As the disposal capacity at each of these facilities is limited, in addition the drastic increase in materials to be disposed of, where will such materials go? The construction of new sites would be costly, if even possible, given the widespread public opposition to disposal facilities in most communities, especially a hazardous waste facility.

Organizations that promote and establish standards for sustainable construction have recognized the role CCPs can play in improving the environmental performance of structures. Building with concrete that contains fly ash can contribute to earning points in the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program, and similar rating systems, which recognize sustainable use of materials, land, water, and energy, as well as ergonomics and innovative design.

3. *Economic Benefits*

An Economic Assessment of Coal Combustion Products utilization published by the American Coal Council in January 2010 identified economic benefits of CCP utilization divided into three categories: Direct Utilization Industry Economic Activity; Avoided Cost of Disposal; and Economic Savings from Utilization of Recovered Materials[15].

The study identified the following annual economic benefits from the utilization of these materials as an alternative to disposing of them as waste:

Revenues from the Sale of CCPs for Utilization	$ 1,028,761,000
Avoided Costs of Disposal	$ 412,800,000
Savings from Use as Sustainable Building Materials	$ 5,000,000,000 to $10,000,000,000

Total Economic Impact: $6.4 billion to $11.4 billion

[15] *The Value of Coal Combustion Products: An Economic Assessment of CCP Utilization for the U.S. Economy*, American Coal Council, Washington, DC, January 2010.

Section IV – Barriers

a. Barriers to Use

1. *Liability – Producers of CCPs*

The beneficial use of coal combustion products, however, must overcome a number of barriers. The first barrier is found at the source – the utility generating CCPs. A decision is taken to dispose of CCPs or to find a market that will consume the material.

CCP disposal, whether into disposal facilities, or into beneficial use markets, is not a core business function. Therefore, many utilities enter into contracts with specialized ash marketing/management firms. These firms are then responsible for managing the CCPs. When CCPs can be sold into beneficial use markets, these firms will realize profits as they are being paid by the utility to manage disposal and again by the sale of the material to a user. Currently, the status of CCPs does not cause a concern to the utility industry as it is not considered a hazardous waste. Therefore, there are no concerns over tort claims from beneficial use.

Should a Subtitle C rule of any kind be promulgated by EPA, utilities will reassess their liability exposure. Costs for disposal of CCPs are generally recoverable in the rate structures for regulated utilities. Costs for defending tort claims are not generally recoverable. Each utility will need to assess their willingness to release custody of a material considered to be a "hazardous waste" into numerous beneficial use markets exposing their firm to potential tort claims, especially when such materials can simply be disposed of.

This decision will cause the utility/ash manager relationship to change significantly, should the utility even decide to allow continued beneficial use under a Subtitle C rule. Contracts will be rewritten to reflect the new status of the material under EPA regulation. Changes to these contracts will include issues of shared liability and/or indemnification which will effectively sever the utility/ash manager relationship as most ash managers do not have the financial resources to assume liabilities which may arise from managing a hazardous waste. Should EPA promulgate a Subtitle D rule for disposal activities, this concern is not germane.

Once a CCP manager executes a contract with a generator, the challenges of managing disposal activities and initiating beneficial use activities begins.

2. *Standard Setting Bodies (ASTM International and ACI)*

Beneficial use opportunities are highly dependent on economic activity. The lone exception is the agricultural use of flue gas desulfurization (FGD) gypsum. Therefore the first barrier to beneficial use is the state of the economy, specifically the construction markets. CCPs must compete in the market on the basis of technical merits and economic viability. For each beneficial use, constructors have more than one material available. Therefore the first

challenge is to demonstrate viability to compete. This process begins with approval by specifying entities. Those charged with determining which materials will be allowed to be used must be convinced that the CCPs proposed meet technical requirements for the application.

Standards setting organizations such as ASTM International and the American Concrete Institute (ACI) have expressed concerns over the continued use of fly ash in their technical documents if EPA promulgates any type of Subtitle C rule. Specifically, ASTM Committee C 09 advised EPA that language would be added to ASTM C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete, advising that the material was considered to be a hazardous waste under certain conditions. Safety warnings are included in many ASTM documents in order help protect the reader. ASTM Committee C 09 expressed concern that such a warning would have a chilling effect on continued use of fly ash in concrete.

The ACI has also expressed specific concerns over the continued inclusion of fly ash in the Building Code Requirements for Structural Concrete. This code is used in virtually every state of the U.S. and in numerous foreign countries. The primary purpose of the code is to protect public safety. By definition the code could not continue to allow the use of a material considered to be a hazardous waste in certain settings. Since fly ash is referenced in 106 documents published by ACI continued inclusion in specifications for concrete construction projects of all types would be in great jeopardy.

These examples from ASTM International and the ACI demonstrate the major damage to current markets and creation of new barriers to beneficial use that would result from a Subtitle C rule. Engineers rely on these types of organizations to provide technical guidance in the selection of materials and methods. If technical societies are not completely comfortable with the safe use of any material, they have an obligation to inform the users of their codes, standards, and specifications.

3. *Liability – Designers, Specifiers, Users, and Owners*

Acceptance by market segments of CCPs also depends on the extent of any exposure to liability claims. Designers, specifiers, users, and owners are not willing to use products and/or processes that increase the likelihood that tort claims will be made against them regardless of the evidence of actual damage. The mere threat of litigation is sufficient to drive potential users to other products which do not share the same potential. Designating CCPs as "hazardous waste" casts a shadow of doubt on the safety of these products in the mind of consumers. There is real market concern that creative liability claims will be made against projects that include CCPs should a Subtitle C rule be promulgated.

By way of example, the concrete industry experienced extensive litigation beginning in the 1990's popularly referred to as the "Sulfate Wars."[16] This litigation was centered in southern California. While no damage was ever entered into evidence in any of the cases brought to

[16] Concrete Products magazine, September 1, 2003.

court, over $1 billion was paid to plaintiffs before a court ruled against a group of plaintiffs effectively removing the incentives to file suit. Each and every suit had to be defended creating significant legal expense for the defendants. Frequently liability insurance carriers made settlement agreements to avoid the cost of litigating these claims.

Exposure to this kind of tort activity makes users reluctant to consider initiating or continuing beneficial use of any CCPs. Alternate materials are available and the rational consumer will select the option without potential liability claims looming. Professional liability for designers, general liability for users and owners, and workers compensation liability are examples of areas which could be adversely affected by a Subtitle C regulation. Without the protection provided by liability insurance policies, or if the premiums for coverage become too expensive, CCP use will be avoided.

b. Lack of Correlation to Disposal Costs

EPA suggests in its proposal that, as disposal of CCPs becomes more expensive, generators will have more incentive to invest in products and processes that encourage beneficial use of CCPs. Currently, beneficiation of CCPs, particularly for use in concrete, is not widespread due to the differential in the cost of beneficiation and disposal.

Beneficiation is primarily focused on reducing and/or controlling the carbon content of ash to make it technically feasible to consider use in concrete mixtures which will be exposed to freezing and thawing environments. Use of this equipment makes CCPs of marginal and/or inconsistent quality acceptable to concrete producers. The agency suggests driving disposal costs higher will incent investment in beneficiation creating a higher quality product more valuable to the user resulting in revenue to the generator off-setting the expense for investing in beneficiation equipment. It should be noted that many power plants do not need beneficiation equipment to produce CCPs acceptable to the concrete markets.

Further, as the quality and consistency of CCPs improves, the markets will recognize this fact and be more willing to use more CCPs and at higher market prices. In some markets, such as structural fill, base stabilization, waste stabilization, and mine fill, beneficiated ash has no value. The quality improvements resulting from beneficiating have no bearing on use in the markets. Since these applications account for almost 50% of the beneficial use reported in 2008[17], this concept as advanced by the agency has no impact.

In the case of another large segment of CCP beneficial use, flue gas desulfurization gypsum used in wallboard manufacture, no beneficiation is needed as this product is more pure than the mined gypsum and is successfully used in the state received directly from the power plant. This market accounts for another 15% of CCP beneficial use[18].

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[17] American Coal Ash Association 2008 CCP Production and Use Survey.
[18] American Coal Ash Association 2008 CCP Production and Use Survey.

Only the concrete products market would be amenable to paying increased prices for beneficiated CCPs. However, as the price of fly ash approaches the price for portland cement and other supplementary cementitious materials, such as slag cement, concrete producers begin to evaluate performance benefits in light of challenges in handling and customer acceptance. Currently fly ash pricing generally is in the range of 60% to 70% of the pricing for portland cement, making fly ash a more economical product for the producers. However there are challenges which must be overcome by the user. Fly ash use by a concrete producer requires additional storage capacity at a concrete batch plant. Concrete producers have limited storage capacity and strive to maximize this capacity with products that will deliver profit while satisfying market demand. Dedicating storage space to fly ash in a concrete plant must be justified by improvement to the cost structure. Also, concrete producers must adjust their concrete mixtures to accommodate the characteristics imparted by the inclusion of fly ash in a concrete mixture. This often requires the addition of chemical admixtures increasing the cost of materials for a batch of concrete. These factors will affect the decision of a concrete producer when considering how much he or she is willing to pay for fly ash.

Another factor affecting the correlation to disposal costs is the expense for storage of CCPs until markets are available. Some CCPs can be stored in exposure to the elements without degradation of quality for the intended final use. Others, like fly ash, must be stored in dry environments creating much more expensive storage units, generally silos or domed structures. To create storage large enough to significantly increase beneficial use versus disposal is expensive. Storage capacities of 25,000 tons of fly ash are considered minimal to impact the marketing of fly ash. The cost of creating storage and operation of distribution facilities will be a major factor in evaluation of disposal versus beneficial use costs.

Finally, the relationship between disposal costs and revenue potential is meaningless without a customer to purchase and use CCPs. If a hazardous waste rule is promulgated, we believe consumers, specifiers, and owners will reject products made with CCPs rendering EPA's suggestion that higher disposal costs will result in increased investment in beneficial use moot. No customer means no market.

c. Correlation to Regulatory Barriers

Following the 2000 Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels the beneficial use rate of coal combustion products increased from 29% in 2000 to 44% in 2008[19]. The increase in the beneficial use rate resulted from a number of factors. The most important factor was the certainty of the status of coal combustion products. following the 2000 Notice of Regulatory Determination. In this determination, EPA states that "[w]*ith the exception of minefilling as described above, we have decided that national regulation under subtitle C or subtitle D is not warranted for any of the other beneficial uses of coal combustion wastes. We have reached this decision because: (a) We have not identified any other beneficial uses that are likely to present significant risks to human health or the environment; and (b) no*

[19] American Coal Ash Association 2000 and 2008 CCP Production and Use Surveys.

documented cases of damage to human health or the environment have been identified. Additionally, we do not want to place any unnecessary barriers on the beneficial uses of coal combustion wastes so they can be use in applications that conserve natural resources and reduce disposal costs."

This statement provided the clarity and certainty that CCP beneficial use was not considered to be a threat to human health or the environment and users could rely on this information when selecting products. In the five years preceding this ruling, beneficial use varied in a range of 25% to 30% in markets with robust economic activity[20]. During the period when the US economy was in some distress, particularly following the September 11, 2001 terrorist attacks on the US, beneficial use began a steady increase, primarily due to the certainty of the regulatory status of CCPs. This increase peaked at approximately 44% in 2008[21]. In 2009 beneficial use decreased in part due to a weak economy. In 2010 the US economy shows little sign of significant economic recovery thus offering little or no opportunity for the progress in beneficial use to resume its progress. As noted in other portions of this document, markets are also being adversely affected because the regulatory status of CCPs has been made uncertain by EPA rulemaking once again.

Further doubt about the future of beneficial use is created by the fact that some states restrict or disallow the beneficial use of a material determined to be a hazardous waste for beneficial use. While these restrictions exist in many forms ranging from statutory restriction to policy restriction to specification restriction, they have the same effect. In fact, ACAA has contacted several states that have indicated that beneficial use of CCPs would not be permitted under their current regulations if CCPs were to be designated "hazardous," even if only for the purpose of disposal. Materials with a long history of beneficial use without a single damage case will be removed from markets in states with such restriction. This loss of beneficial use will be a direct result of any form of EPA determination that CCPs are hazardous waste under certain circumstances. By EPA fiat, states benefitting from the use of CCPs will be faced with a substantial increase in disposal volumes of commercially valuable materials.

Furthermore, multiple federal reports, conferences provided federal agencies, and statements by federal agencies clearly recognize the barrier this imposes. For example:

- In the U.S. Department of Energy's 1993 Report to Congress titled "Barriers to the Increased Utilization of Coal Combustion/Desulfurization By-Products by Government and Commercial Sectors," the agency identified "restrictive regulation of fly ash as a solid waste" as a significant institutional barrier to CCP utilization.

- In a 1998 update to the DOE report, the Energy and Environmental Research Center reported that adoption of beneficial use guidelines by states continued to be impeded in some areas by an "overly cautious approach."

[20] American Coal Ash Association 1995 to 1999 CCP Production and Use Surveys.
[21] American Coal Ash Association 2008 CCP Production and Use Survey.

- Beginning in 2002, at beneficial use summits sponsored by EPA and hosted by EPA regional offices, a recurring theme discussed at these summits was the barrier that was found in many states by regulating industrial byproducts, including CCPs, as "wastes" rather than products. The perception that a waste could not have the same characteristics or benefits as a virgin material were cited in many presentations given by members of industry, state agencies and end-users.

- In the International Energy Agency's January 2005 report on "Benefits and Barriers in Coal Ash Utilisation," the Agency writes that "Fly ash utilisation is hindered where it is regarded as a waste or by-product."

- In June 2008, EPA issued its Study on Increasing the Usage of Recovered Mineral Components in Federally Funded Projects Involving Procurement of Cement or Concrete to Address the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. In Table 6-1 of this report, EPA lists a number of barriers that affect the potential for increased use of fly ash in concrete, the focus of this report. At the same time, EPA also identified several ways to reduce these barriers, including encouraging beneficial use through programs such as the C^2P^2 initiative.

- On October 7, 2008, EPA issued a new final rule that streamlines regulation of hazardous secondary materials to encourage beneficial recycling and help conserve resources. In explaining the rule change, EPA wrote: "By removing unnecessary regulatory controls, EPA expects to make it easier and more cost-effective to safely recycle hazardous secondary material." These actions recognize that hazardous waste designations impose requirements that create significant barriers to efficient recycling. Furthermore, the streamlining of regulations under the October 2008 final rule only pertains to recycling on-site or under tightly controlled conditions and would not be responsive to the widely dispersed beneficial use pathways that have been developed for CCPs.

Section V – Stigma Impacts[22]

a. Impacts to Participants in Coal Ash Market

Exempting coal ash beneficial use from environmental regulation does not exempt coal ash beneficial use from market forces. Regulating coal ash as a hazardous waste when disposed will unnecessarily stigmatize the resource and interfere with efforts to recycle it at every level.

[22] In addition to the document reflected in the footnotes herein, ACAA has included with this comment submission a number of other documents reflecting stigma impacts. They are provided in the folder titled "Section V – Stigma Impacts."

The existence of environmental, performance and economic advantages does not mean that using coal ash is easy. Significant investments must be made to be able to transport and deliver materials to users at the minute they need it. Users must be educated in how to properly utilize the materials and they must understand the materials' safety and efficacy. Today's utilization rate for coal ash in the United States is approximately 44 percent and is the product of more than three decades of efforts to identify and meet the needs of the following participants in coal ash use:

- **Ash Producers.** Typically utilities that consume coal to generate electricity, ash producers are faced with a decision regarding whether to dispose of coal ash or reuse it. Disposal activities are usually carried out on the power plant site by the utility itself or a contractor. Since reusing coal ash is not considered a core function by most utilities, specialized "ash marketers" are usually engaged to perform those services on behalf of the utilities that desire a reuse program.

  If coal ash is designated a "hazardous waste" when disposed, ash producers will be faced with this question: "This material is 'hazardous' on my own property, so am I willing to take the risk of turning it over to a third party who will market it into applications where it will be used in thousands of locations in the surrounding community?" Coal ash sales revenues are not a significant source of income for most ash producers and many ash producers will simply pass increased disposal costs on to their customers in the form of higher prices for energy. As is mentioned above, increased disposal costs would generally be recoverable in the rate structures for regulated utilities, while litigation expenses would not be recoverable. Rather than risk additional future changes in regulation or lawsuits from enterprising personal injury attorneys, ash producers will likely elect to choose disposal over reuse. If that is the case, all of the small businesses about to be described will be left without a product to use.

- **Ash Marketers.** These marketing companies range in size from very small (fewer than 5 employees) to medium sized divisions of larger companies. They carry out a range of activities that includes transporting ash to customer markets and storing it prior to distribution, providing education and technical support to product specifiers and end users, and providing quality control and customer service.

  If coal ash is designated a "hazardous waste" when disposed, ash marketers will face significant challenges in both the operations of their businesses and the outlook for customer relations.

  From an operational point of view, the U.S. Environmental Protection Agency claims that it will continue to support "legitimate" beneficial uses in the event of a "hazardous when disposed" designation, but cannot answer ash marketer questions such as these: If a small quantity of ash spills during delivery, does it become a 'hazardous waste' for disposal purposes? Does ash transportation and handling

equipment need to be placarded as 'hazardous waste?' What additional training and personal protection equipment will be required for workers handling coal ash? What will happen to insurance and workers compensation rates? All of these questions (and there are many more) represent significant challenges for small and mid-sized businesses.

From a customer relations point of view, many of the same operational questions will afflict the concrete producers and manufacturers that purchase coal ash from marketers – making them reluctant to continue using the material. Coal ash users have alternatives to using coal ash and can choose to eliminate its use.

- **Ash Technology Developers and Providers.** A segment of the coal ash industry comprised primarily of small businesses can be described as ash technology developers and providers. Some of these companies are concerned with developing and deploying technologies for improving the quality and marketability of coal ash for traditional uses. One example is providers of technologies to remove residual carbon from fly ash in order to make it suitable for use in concrete. Other small companies are engaged in developing and deploying technologies for utilizing coal ash in new applications. Examples include fly ash brick manufacturers or technologies that may use fly ash in sequestering greenhouse gas emissions.

  If coal ash is designated as "hazardous waste" when disposed, ash technology providers and developers will face significant new customer objections and barriers to raising capital for development activities. Even in advance of enactment of any rule, companies in this sector have reported slowdowns in financing activities and customer purchases attributed to the regulatory uncertainty presented by EPA's draft rulemaking proposal.

- **Product Specifiers.** A key link in the coal ash industry chain is comprised of entities that never actually purchase or handle the material, but play a pivotal role in whether or how it gets used. Product specifiers – including architects, engineers and their industry standards setting organizations – create specifications that either require or prohibit the use of coal ash. In determining specifications, these entities consider the effect of the material on finished product performance and human health and safety.

  If coal ash is designated a "hazardous waste" when disposed, product specifiers will face the same potential operational and liability concerns previously described for ash producers and marketers. Additionally, standard setting organizations such as the ACI and ASTM have already indicated in letters to EPA that their obligations to protect human health would require them to remove from specifications any materials that are determined to be a hazardous substance in another setting.

- **Ash Users.** Ash users are the entities that actually use coal ash as an ingredient in other products. Examples include ready mixed concrete producers and other product manufacturers, many of which are small businesses with less than 50 employees.

  If coal ash is designated a "hazardous waste" when disposed, ash users will face the same potential operational and liability concerns previously described for ash producers and marketers. In order to avoid added operational costs and potential liabilities, many users may elect simply to quit using coal ash. In almost every example of coal ash use, coal ash replaces another material that is accessible without a hazardous regulatory stigma. In cases where coal ash is used for specific engineering purposes, such as mitigating reactive aggregates in concrete, competitive products are available at much higher costs, but without potential liabilities.

  In the Proposed Rule, EPA cites examples of other industries in which materials designated as "hazardous" have been successfully recycled. None of EPA's examples, however, are analogous to coal ash – which is used without undergoing additional processing and is placed in products that come into direct contact with end users. EPA's examples also concern materials that are sold to sophisticated users accustomed to handling hazardous materials. Coal ash users do not have this level of experience and capability.

- **End Users.** End users are the people who actually purchase and use finished products containing coal ash – in other words, anyone who uses a home, school, office building, driveway, etc. This final link in the coal ash industry chain is the least likely to be informed regarding characteristics of materials and the most likely to become confused and concerned by a "hazardous when disposed" regulatory designation.

  If coal ash is designated a "hazardous waste" when disposed, end users will likely demand products that contain no "hazardous" substances. This phenomenon is already being seen even in advance of EPA enacting any new rules. The drumbeat of the phrase "toxic ash" in news stories about EPA's rulemaking effort has resulted in many ready mixed concrete producers receiving calls from customers asking for fly ash to be eliminated from their concrete. The Los Angeles Unified School District has eliminated coal ash from its concrete specification pending resolution of the EPA rulemaking. New examples are arising every day.

b. Manufacturers of Competitive Products Using EPA's Determination

Manufacturers of competitive products are also beginning to step in to fan flames of doubt for end users. Advertisements warning against products containing "hazardous waste" have

appeared. Potentially even more damaging is “behind the scenes” misinformation by competitors that will be impossible to identify or rebut. For example, the Expanded Shale, Clay and Slate Institute (an organization representing direct competitors to the use of CCPs) joined forces with the block manufacturers to speak out against continued use of construction materials containing CCPS, stating in the Johnson Concrete Newsletter, "[t]he **LIABILITY ISSUES** are too great for specifiers, manufacturers, contractors and end users to allow this waste material to be used in building construction materials of any type" (emphasis is in the original article)[23].

c. Stigma Impacts Are Already Occurring

Quantitative evidence of hazardous waste stigma affecting coal ash utilization already exists, even in advance of enactment of an EPA rule. Just the discussion of a potential hazardous designation in the context of this proposed rulemaking has begun to affect beneficial use markets in myriad ways. For instance:

- Annual production and use statistics compiled by the American Coal Ash Association in 2009 showed a drop in annual utilization growth that defies previous trends. Ash utilization has been growing steadily in the United States, even in soft markets for building materials, but this recent turn-around is concurrent with EPA’s rulemaking and publicity regarding the potentially “hazardous” nature of coal ash[24].

- Surveys conducted by numerous organizations have established that “stigma” is a serious concern to people who specify and use coal ash. Member surveys by the ACI and National Ready Mixed Concrete Association both indicated that participants in these industries believe that coal ash utilization will decrease if EPA designates the material “hazardous when disposed.” Public opinion research sponsored by ash marketer Headwaters Inc. and conducted by international survey research firm Harris Interactive produced similar findings in polling of ash use specifiers, users, contractors, and the general public.

Qualitative evidence of stigma is also beginning to mount. Although only a small sampling of the impacts being felt, the electronic folder title "Section V – Stigma Impacts" that is being submitted with this document still provides a significant amount qualitative evidence. By way of example:

- Numerous instances of coal ash specifiers or users removing ash from projects in response to this EPA rulemaking, such as the actions by the Los Angeles Unified School District and bid rejection by Mortenson Construction.

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[23] Vol. 2, Issue 3, Dec. 2009.

[24] American Coal Ash Association. 2008 and 2009 Combustion Products (CCP) Production and Use Reports. ACAA. Aurora, CO. 2010 (See http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3).

- At EPA's series of public hearings on this rulemaking, the Agency heard testimony from numerous consumers who were frightened by the discussion of "toxic ash" and questioned why the material would be allowed in applications such as concrete.

- Also at EPA's public hearings, the Agency heard testimony from companies that sell products competing with products containing coal ash, arguing for a hazardous waste designation, which would give them a competitive advantage because stigma is real. Examples of competitor stigma creation already taking place include silica blasting grit manufacturers labeling boiler slag blasting grit as hazardous, clay brick manufacturers attacking fly ash brick manufacturers as hazardous, lightweight concrete block manufacturers advertising their products as containing no hazardous bottom ash, and others.

- Also at EPA's public hearings and in comments submitted to this rulemaking docket, the opinions of people who actually specify and use coal ash have overwhelmingly agreed that stigma is a real and crippling threat to the continued viability of coal ash recycling.

- Uncertainty surrounding the future regulatory status of coal ash has also already had a chilling effect on projects that would support increased beneficial use. Providers of technologies that improve the quality and marketability of coal ash have testified to EPA and before Congress that ash quality improvement projects have been halted by utilities in the wake of this rulemaking. Furthermore, ash marketers have reported increasing demands by utilities for indemnification against any claims that may arise from the market utilization of coal ash.

d. Economic Analysis

The Regulatory Impact Analysis (RIA) of a Subtitle C regulation suggested by the EPA is based on seriously flawed assumptions. The basis of the agency's argument is that coal combustion product (CCP) utilization will increase as disposal costs increase. Generators will elect to invest in beneficiating CCP and subsidizing marketing support functions such as storage and transportation. EPA assumes these costs will be significantly lower than the costs to send CCP to disposal. By making CCP characteristics more acceptable to the various markets, utilization will continue to increase at a rate similar to historical levels from the current baseline with no federal disposal regulation. Also, while it is expected that the stigma created by hazardous waste regulations will have a detrimental effect on utilization in the short term, the stigma effect will vanish as markets come to understand the agency's intentions.

Among the fallacies with these assumptions are the following points.

Some states have regulations which prohibit the beneficial use of substances deemed to be hazardous wastes. These restrictions exist in statutes, regulations, and specifications. While a comprehensive list of the states with such restrictions has not been generated by the EPA for

consideration in this rulemaking, it is believed that Colorado, Delaware, Florida, Georgia, Maryland, Michigan, Montana, North Carolina, North Dakota, Pennsylvania, Tennessee, Texas, Virginia, and Wyoming are among the states with such a restriction. There may be more states that should be included in this listing. In these states, beneficial use of *all* types will cease if a Subtitle C rule is promulgated. It is irresponsible for the EPA to proceed with any kind of RIA without having researched this issue.

The RIA does not take into account the possibility that some generators will elect not to allow any beneficial use due to liability concerns under a Subtitle C rule. Generators taking this position may well elect to permanently suspend beneficial use programs in order to limit exposure to class action lawsuits and other tort activity. Generally disposal costs are recoverable in utility rate structures while costs for defending class action and tort claims are not. It is entirely logical to factor in the distinct possibility that some current generators will elect to exit beneficial use markets either due to fear of liability exposure or inability to create contracts with marketing entities over placement of liability responsibility.

An important EPA assumption is that no change will be forthcoming from liability insurance carriers under Subtitle C regulation. While the insurance industry is reluctant to issue a preemptive statement in this matter, it has been noted in trade publications such as Engineering News-Record[25] that the CCP regulation has the potential to create similar market impacts as experienced with asbestos. Should the insurance industry respond to CCP regulation in a similar fashion, owners, designers, and contractors will no longer be able to include CCP in their projects due to exclusion from liability insurance coverage.

EPA claims that the practical transportation radius for commercially competitive sales will expand by almost 100% under "avoided disposal cost incentives" of a Subtitle C rule. This simply does not reflect market realities. Simply expanding the practical logistical capability by some sort of underwriting of transportation costs does not create a market. Assuming that the newly-reached markets will embrace a CCP just because it is available is naïve. Markets have unique ways of accepting or rejecting materials. Factors such as technical abilities, customer acceptance, reliability of supply, and competitive alternatives offer significant barriers to entry. Currently CCP is transported great distances when necessary. For example, to meet market demand, fly ash has been shipped from Texas to California and from North Dakota to Colorado. California markets are supplied on a routine basis from Arizona, Utah, and Wyoming. Flue gas defulfurization (FGD) gypsum used for wallboard production has virtually no sensitivity to this assumption. Mined gypsum must be transported significant distances to wall board plants. In many cases wallboard plants are co-located with generating facilities or are located much closer to generating facilities than gypsum mines. There is nothing that avoided disposal costs incentives can do to impact this market segment. These examples clearly demonstrate why distance from source to market cannot be assumed to be a basis for estimating increased consumption.

[25] *Fly Ash Looms as the 'New Asbestos.'* Engineering News-Record, April 12, 2010.

Pricing of CCP for most markets is very important. Lower prices enable CCP to compete with other materials. For example, when competing with mined aggregates for geotechnical use, price is a primary determinant. The use of flue gas desulfurization (FGD) gypsum in agriculture is also price-sensitive. But the agency has expressed concerns about these beneficial uses and has called large structural fill "disposal" rather than a beneficial use. It is not rational to include analysis of the impact of avoided disposal costs serving to underwrite markets the agency has marked for elimination.

However, there are other markets for which price is not as important. For example, the use of fly ash for mitigation of alkali-silica reaction (ASR) in concrete is the primary tool for such mitigation. Other techniques exist but are much more expensive. Therefore a low price for fly ash is not a critical factor when ASR mitigation is a critical performance concern. Underwriting marketing costs for this beneficial use will have no practical effect on the quantities used as this market segment already has expressed its preference for fly ash as its primary mitigation tool. Conversely it cannot be assumed that investment in beneficiation of CCP will result in higher revenue. The primary market for beneficiation is use in concrete products. Fly ash is generally priced at 60% to 70% of portland cement pricing. In many cases fly ash is used to lower the cost of producing concrete. As the price of fly ash begins to approach that of portland cement, the economic incentive to use fly ash begins to diminish. Since there are practical considerations in the handling of fly ash in concrete plants, such as storage, transportation, and quality control monitoring, the attraction of using fly ash begins to fade as the margin between portland cement and fly ash decreases. Beneficiated CCP for concrete products will not result in significant increase in sales revenue.

Finally, the RIA ignores the fact that the quantity of fly ash available suitable for encapsulated uses such as concrete has been steadily decreasing as pollution control equipment is added to generating facilities. Processes to control emissions such as mercury, sulfur dioxide, and nitrous oxide have rendered some CCP unsuitable for use in encapsulated applications. Therefore, the use of this type of CCP is only suitable for unencapsulated uses which will suffer due to the stigma of a Subtitle C rule and which EPA has targeted for elimination.

In summary, we have chosen not to challenge to numbers detailed in the RIA as these numbers are based on serious deficits in information such as state regulatory barriers, and lack of understanding the realities between supply and demand in CCP markets. To realistically project future CCP use under a Subtitle C, these important flaws must be corrected.

c. Subtitle D versus Subtitle C

In December of 2009, ASTM sent EPA a letter urging EPA not to propose regulation of fly ash under Subtitle C of RCRA[26]. ACAA met with EPA prior to and after EPA's receipt of the ASTM letter. EPA expressed great concern with ASTM's stance and thought the ASTM organization was premature to take such a stance projecting distress in the markets due to proposed or final

[26] Letter from ASTM International to EPA, December 22, 2009.

rules that would designate fly ash as a hazardous waste. EPA believed the agency's past precedent of crafting regulations under the Subtitle C realm would win the day – well crafted regulations would increase beneficial use. ACAA advised EPA that it was mistaken and that Subtitle D was the only way beneficial use would survive and thrive.

In response, ACAA did many "firsts." ACAA hired its first environmental lawyer to try to assist ACAA in analyzing the regulatory schemes that EPA was discussing and to assist ACAA in discussing EPA's regulatory vision and how CCP recycling and jobs would not survive in the markets we work within. ACAA passed its first resolution. The resolution supported additional regulation on disposal under Subtitle D[27].

ACAA also submitted letters from individuals and organizations expressing that a Subtitle C regulation would reduce beneficial use and would affect the market, even during the proposed rulemaking. EPA consistently told ACAA that these letters were not persuasive because the letters expressed opinions. EPA needed concrete proof of stigma or harm. ACAA was told there is no evidence of harm during the proposed rulemaking let alone after the rule goes final.

ACAA, however, pointed out a number of problems and provided several concrete examples. Specifically, ACAA pointed out that the CCP recycling industry has worked for decades to build this industry and words like "toxic" and "hazardous" will quickly erode public confidence and affect use of CCPs, even in encapsulated uses. ACAA also informed EPA that, if EPA favors encapsulated uses, which EPA is not proposing to regulate, EPA should work with ACAA, ENGOs, and other trade organizations (ACI, ICRI, NRMCA) to minimize the negative impacts during the pendency of the draft rulemaking process so that jobs, CCP recyclers, small businesses, American innovation and investment are not impacted. In response, EPA went into a virtual black out period with regard to its willingness to have senior level personnel meet with ACAA.

Contrary to EPA's continued assertion that ACAA had not provided EPA any concrete evidence of harm, ACAA sent EPA some early concrete examples available during the earliest days of EPA expressing its intent to pursue further regulation (the number of which have risen drastically since). As noted before, the Los Angeles Unified School District has stopped using fly ash in concrete during the pendency of the rulemaking. Many more examples of stress within our industry were shared with EPA. None of these attempts dissuaded EPA policy level political appointees from its belief that Subtitle C, affecting only CCRs destined for disposal, would work.

When asked by Congressman Heath Shuler at a Subcommittee hearing, why EPA isn't seeking direct enforcement authority under Subtitle D so that it can achieve tighter environmental standards for disposal of CCRs but not impact the CCP recycling industry, EPA maintained (even after examples were shared with EPA) that its proposed Subtitle C regulations had not been shown to have an impact or create a stigma. ACAA seeks to work with EPA but it remains difficult to work with an Agency that will not recognize that it is wrong. EPA's proposed rulemaking is already affecting our markets, our customers, our jobs and the environment.

[27] March 3, 2010 Resolution of the American Coal Ash Association.

Please see the attached listing of stigma examples as a peak into our world. There are more examples each and every day this Subtitle C option remains on the table. If EPA continues to think, that stigma isn't real, and maintains that we hear you ACAA and CCP recyclers but we disagree, the Agency's is being arbitrary and capricious. It has asked ACAA to do many "firsts" yet the Agency hasn't tried to walk a day in our footsteps even after our opinions and those of numerous DOTs have been presented, as well as, the numerous concrete examples that have been orally relayed and presented in writing.

Section VI – Beneficial Use: Encapsulated Uses

a. Introduction

EPA is proposing to regulate coal combustion residuals (CCRs)[28] under one of two general approaches: 1) Subtitle C of the Resource Conservation and Recovery Act (which regulates hazardous wastes) or 2) Subtitle D of the Resource Conservation and Recovery Act (which applies to nonhazardous solid wastes). Although supportive of increased regulation on disposal of CCRs, the ACAA is adamantly opposed to regulation of CCRs under Subtitle C because of the inherent negative characterization of coal combustion products (CCPs) as "hazardous"[29] that accompanies such a decision.

Composed of members from across a number of industry sectors, ACAA was established in 1968 as the National Ash Association to advance the management and use of coal CCPs in ways that are environmentally responsible, technically sound, commercially competitive, and supportive of a sustainable global community. These comments and documents have been prepared by the ACAA's members who independently and as an organization have been studying these issues since well before the Bevill Exemption even went into effect in 1980. Accordingly, this organization and its members possess a wealth of experience, technical knowledge, and economic understanding that we hope EPA will consider in its decision making.

The beneficial and responsible use of CCPs is one of America's greatest recycling success stories. The use of CCPs implements the concepts of use, reuses, recover and recycle - the basic tenants of sustainability. Some CCPs require no processing prior to incorporation into products. Others hold value such that recovering them from impoundments or dry landfills provides an incentive

[28] ACAA does not and will not comment on the scope, complexity or language of CCR disposal regulations. ACAA supports EPA's efforts to increase regulation of the disposal of CCRs in landfills and ponds. ACAA supports the USWAG comments in this regard. ACAA notes that in EPA's zeal to increase such regulation, it encourage and promote environmentally friendly and safe recycling in landfills and ponds as ACAA's member s have innovative solutions to reduce waste in such vessels. ACAA's sole focus is on beneficial re-use. Therefore, hereinafter for all beneficial uses for purposes of these comments will be referred to as CCPs. ACAA notes that the EPA's proposed rulemaking is not consistent in its references to CCPs versus CCRs. This has further confused the CCP markets and hindered CCP beneficial uses during the pendency of this rulemaking.

[29] Even if labeled "special waste" or if EPA tries to distinguish between what it deems beneficial uses and other uses, the underlying determination, regardless of how it is titled, is still the same – an unwarranted and unnecessary determination that such materials are "hazardous."

for this type of activity. For other CCPs, their use as substitutes for other materials, permits the offsets of green house gas emissions. For example, the use of fly ash instead of portland cement in concrete makes a measurable contribution to energy savings and C02 reduction. In the EPA's Report to Congress, "Study on Increasing the Usage of Recovered Mineral Components in Federally Funded Projects Involving Procurement of Cement or Concrete to Address the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users" in June of 2008, Tables 3-3, 3-4 and 3-5 provided measurable impacts associated with the substitution of fly ash for portland cement in concrete. EPA's calculated that for each ton of fly ash used in concrete saved 4696 megajoules of energy and 376 liters of water, as well as, 718,000 grams of avoided greenhouse gases. These savings represented more than $129 savings in overall energy costs per ton. This EPA data reflects the commonly accepted calculation that each ton of fly ash used in concrete substituted for a ton of portland cement in concrete, avoids the release of one ton of CO_2 that would have been released during the production of an equivalent amount of portland cement.

Using this calculation, since 2000, the use of fly ash in concrete products has accounted for the avoidance of 127,801,392 tons of greenhouse gases and energy savings of $1,648,637,956. If one were to add the savings, both from avoided greenhouse gases and energy for the use of other CCPs in just concrete products (such as 5,694,789 tons of bottom ash and 4,161,046 tons of FGD gypsum) there are other significant savings. Between 2000 and 2009, 23,250,618 tons of fly ash and 5,115,021 tons of bottom ash were used as raw feed for the production of portland cement clinker. This means that an equivalent amount of natural materials (shale, marl or other rock) were not extracted, crushed or refined for raw feed. These are huge tonnages noting the tremendous success of the use, reuse or recycling of CCPs. These encapsulated use savings do not take into account additional important benefits such as: a) drastically reducing the need for raw materials, c) reducing additional energy needs in obtaining and processing virgin or alternative CCP materials, d) less need for additional landfill capacity.

Contrary to the EPA's determination that regulation under Subtitle C could actually promote additional uses, the reality is that regulating CCRs under Subtitle C will have a drastic negative impact on the beneficial use of CCPs. In fact, as noted further herein, the CCP beneficial industry is already experiencing these impacts simply due to the possibility that EPA may choose to regulate such materials under Subtitle C. The purpose of this section of the ACAA comments is to provide comments, data, and other information specific to "encapsulated" uses of CCPs and the significant impacts (contrary to EPA's assertion that use in this sector would increase) that a determination to regulate CCRs under Subtitle C will have on this segment of beneficial uses, uses that the EPA acknowledges should continue to be promoted.

b. Overview of Concerns - Encapsulated Beneficial Uses

Although EPA has been studying this issue since 1980, has issued multiple reports/determinations, and, in May of 2000, issued its final regulatory determination concerning beneficial uses, the currently proposed rule marks the first time that the EPA attempts to make a distinction between "encapsulated" and "unencapsulated" beneficial uses

of CCPs. The ACAA and its members are concerned because 1) even though EPA distinguishes between these two types of uses, it fails to define either, 2) the current language indicates that EPA may take an overly restrictive view of what constitutes an encapsulated use, and 3) contrary to EPA's recitations otherwise, characterization of CCRs as "hazardous" will have a tremendous deleterious effect on CCP “encapsulated” products that fall in EPA’s proposed restrictive definition of encapsulated.

c. How Encapsulated Is Ultimately Defined

In general, encapsulation can be of several types:

(i) physically incorporated within a product or material of structural integrity; or

(ii) chemically or mechanically bound within a product or material of structural integrity; or

(iii) relatively inert, glass-like or crystalline in nature through vitrification, devitrification or other heating processes; or

(iv) otherwise relatively immobile and resistant to leaching through chemical or physical processes; or

(v) isolated from external effects.

The ACAA maintains that where used responsibly and consistent with ASTM or other sound, consensus standards, each of the above methods or types of encapsulation satisfy EPA's concern over the potential for trace materials that may be contained in CCPs to leach into the environment, particularly groundwater. Therefore, if EPA goes down the same route to pursue defining "encapsulated", EPA should define “encapsulated” broadly enough to include the above methods or types of encapsulation. Products that only exist today as “encapsulated” shouldn’t be cited as examples by the EPA except as illustrative of how each process uses same so that innovation isn’t stifled. Damage cases don’t exist for these types of materials so EPA’s attempt to ‘over-reach” into regulating these commodities isn’t warranted. ACAA does not agree with EPA’s approach to regulate CCPs or the very narrow definition of “encapsulated uses” set forth in the Proposed Rule.

ACAA is extremely worried that EPA dismissed market impacts to the CCP recycling industry; thinking it knew better than ACAA and others who conduct business domestically and abroad in the beneficial use industry everyday. In other sections of ACAA’s comments, we cite examples of EPA’s hubris. EPA has done considerable damage to our industry via its proposal to include a CCR Subtitle C option. The manner in which EPA proceeds will set the course of market recovery, the elimination or creation of additional jobs in this arena, opportunities for further investment and innovation or instead, economic disaster to this industry. CCPs in “encapsulated uses” don’t need to be defined or regulated by EPA!

As can be seen from the attached letter from the United Kingdom, international precedent further supports ACAA's assertion that CCPs can be negatively impacted by associating beneficial use with waste categorizations[30]. Categorization of CCPs as a "waste" in the UK has negatively affected beneficial use, increased litigation, and added more volumes to landfills. Moreover, a defined and broad interpretation of beneficial CCPs usage is being embraced in the UK. EPA should look at these international precedents as it finalizes its approach for CCPs. The Canadian, Israeli and Australian letters further confirm that EPA needs to adjust its regulatory stance to view CCPs as a resource rather than a "waste."[31, 32, 33] Attaching waste to any facet of the CCP value chain will further lessen confidence and usage. Significant international precedent exists that proceeding to regulate CCPs and/or CCRs as a waste rather than a resource will result in decreased usage, unwarranted litigation and further exportation of U.S. jobs. Below we have highlighted these international precedent further.

As the United States appears poised to impose significant regulatory requirements, including potential classification of coal ash as a hazardous waste, the United Kingdom is poised to reverse course. The United Kingdom has already learned the lessons that the ACAA is emphasizing this country will experience depending on EPA's ultimate decision. The United Kingdom has experienced the drastic drop in continued beneficial uses of CCPs and the resulting increase in demands on landfill capacity. Although time will tell as to whether the changes the United Kingdom is now implementing will be sufficient, their experience to date is a real world example of the significant impacts that the EPA's final decision could have.

In the United Kingdom, coal ash is currently classified as a waste product, and therefore is highly regulated (similar to what the EPA is proposing). As a result, about half of the coal ash generated in the United Kingdom is being disposed of in landfills while the other half is being recycled. To promote further beneficial use of such materials and reduce the disposal of these materials in landfills, the United Kingdom's Waste Protocol Project has unveiled a new protocol entitled The Pulverised Fuel Ash Quality Protocol ("the Protocol"), which will change the current classification from a waste[34].

Instead of focusing on a blanket classification of coal ash, this new protocol is set to improve regulations directed at use and quality, thereby addressing the concerns as to how such materials are used while eliminating the stigma that currently exists due to the classification of such materials as a waste under the United Kingdom's system. The Protocol distinguishes between bound and unbound applications, as opposed to encapsulated and unencapsulated. Interpreting bound applications more broadly than the EPA indicates it will define encapsulated uses, the United Kingdom expressly includes flowable fill uses as a bound application. For

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[30] Letter from United Kingdom Quality Ash Association to PMI Ash Technologies, LLC, October 11, 2010.
[31] Letter from Jim Caruth to EPA, November 16, 2010.
[32] Letter from National Coal Ash Board (Israel) to EPA, November 10, 2010.
[33] Letter from ASH Development Association of Australia to EPA, 2010.
[34] *New QP to Alter Standards for Fuel Ashes*, BMweek, Oct. 12, 2010, http://www.bmweek.com/index.php/fly-ash-a-slag/9384-new-qp-to-alter-standards-for-fuel-ashes.

example, Section 4 of the Protocol includes hydraulically bound mixtures used in capping, sub-base and road base, and ground stabilization[35]. Furthermore, the United Kingdom's Environmental Agency is currently collecting data to determine if a Quality Control Protocol should be developed that would similarly provide for unbound uses, such as for structural fill or in embankments. This determination is set to be finalized in 2011[36].

The financial analysis for the changes that are being implemented now (not including the potential addition of unbound applications in 2011) indicates that this change will contribute £110 million to the country's economy in its first decade. Their analysis also determined that it will divert approximately 3,128,000 tons of waste materials from landfills, save approximately 4,410,000 tons of raw material due to substitution with recycled materials, and save 162,000 tons of carbon in the initial decade[37].

Again, this is the real world experience that the United Kingdom has faced and ultimately caused them to reverse course. This is not a theoretical financial analysis based on assumptions and calculations. The ACAA therefore urges EPA to strongly consider the United Kingdom's history. These materials do not need regulation. They need the markets to know how they can be used to ensure the use is beneficial. If EPA overreaches and regulates this material as a hazardous waste, international precedent has shown usage is affected. The ACAA is also including herewith a copy of a letter from the United Kingdom Quality Ash Association in response to the EPA's proposed rules[38].

Regulating CCRs under Subtitle C will kill the domestic CCP beneficial use market. Attached and further highlighted below are examples of entities in the U.S. who have, during the pendency of the rulemaking, taken supply of CCP "encapsulated" material away from the market or experienced other forms of stigma[39]. In a letter to Matt Hale, dated March 25, 2009, ACAA told EPA prior to issuance of the proposed rule that CCP beneficial use market impacts would happen. These examples will be significantly exacerbated should EPA continue to turn a blind eye to the CCP beneficial use community by finalizing a rule categorizing and regulating CCRs as a special **waste** under Subtitle C:

- An ash marketer advised EPA that the LA Unified School District removed fly ash from concrete mixes during the pendency of this rulemaking. ACAA was concerned when EPA's response to this early submission was that it was an isolated case[40].

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[35] U.K. Envtl. Agency, The Quality Protocol for the Production of Pulverised Fuel Ash ((PFA) and Furnace Bottom Ash (FBA) for Use in Construction and Manufacturing (2010).
[36] U.K. Envtl. Agency, Position Statement: The Environmental Regulation of the Production and Use of Pulverised Fuel Ash (PFA) and Furnace Bottom Ash (FBA) (October 2010).
[37] *New QP to Alter Standards for Fuel Ashes*, BMweek, Oct. 12, 2010, http://www.bmweek.com/index.php/fly-ash-a-slag/9384-new-qp-to-alter-standards-for-fuel-ashes.
[38] Letter from United Kingdom Quality Ash Association to PMI Ash Technologies, LLC, October 11, 2010.
[39] Letter from David Goss of DCGoss LLC to EPA, November 16, 2010.
[40] Email from Boral Material Technologies, Inc. to EPA, July 13, 2010 (with Attached Memo. from L.A. Unified School District).

- Fly ash is removed from concrete for a dam project by the Marquette Board of Light and Power. There are two key points that ACAA prior to this rulemaking discussed with EPA. One, EPA's proposed rule has eroded the public confidence that fly ash in concrete is safe. Two, due to a complicated point of generation concept in the proposed rule, EPA has created anxiety that "encapsulated uses of CCPs" will be hazardous waste at the end of life[41, 42, 43].

- Cenospheres are suspended from use in encapsulated building, refractory and recreational products[44].

- Fly ash is prohibited from flatwork[45].

Additionally, included is information reflecting where a company's lease is being changed, in case CCP is categorized as "hazardous," to require a new deposit that is three times the level of the existing deposit or a Letter of Credit. ACAA is also submitting direct testimony from Pittsburgh Mineral and Environmental Technology, Inc. as but one example of the inability to obtain financing due to the uncertainty that CCPs may somehow be categorized as "hazardous." Included is information concerning a bank's refusal to renew a company loan. In this instance, the bank ordered a Phase I, as is customary. Although the previous Phase I's had always found no Recognized Environmental Conditions (REC), the latest one included the use of CCPs in developing the property as an REC, and the bank ultimately refused to renew the loan. Other information that we have been provided discusses where the bank has changed its indemnification provisions in case CCPs are somehow categorized as "hazardous." Moreover, Insurance adjusters are likely to raise premiums on insurance policies associated with operations that use or process CCPs. Additionally, professional engineers and contractors that use such materials will likely see their premiums rise or exclusions/prohibitions added to their policies. As Mark Bryant on behalf of the ACAA has explained at both the August 30, 2010 meeting in Arlington and the October 27, 2010 meeting in Knoxville, this is but a minuscule number of examples of businesses, often small businesses, that are already being impacted[46].

ACAA has already submitted these and other explicit examples into EPA's administrative the record, has appended many to this comment letter and/or had presented at the seven public

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[41] Letter from Mineral Resource Technologies, Inc. (A CEMEX Company) to EPA.
[42] Memorandum from Headwaters Resources to Mike Adams, June 24, 2010.
[43] *Fly Ash Health Concerns*, GreenBuildingAdvisor.com, November 4, 2010, http://www.greenbuildingadvisor.com/community/forum/green-products-and-materials/18738/fly-ash-health-concern.
[44] Ryan Brownhill of Sphere One, Inc. Testimony.
[45] Mortenson Construction Project Specifications (rejection of bid), May 5, 2010.
[46] A) Email from Bob Carter, 2010 (lease renewal issue); B) Letter from PMET to EPA, October 4, 2010 (absence of available financing); C) Email from Bob Waldrop of Full Circle Solutions, Inc., October 6, 2010 (loan renewal issue); Email from David Short of Willis Carolinas, September 24, 2010 (loan indemnification issue); D) Mark Bryant (ACAA) Testimony on Proposed Coal Combustion Residual Regulations, Arlington, VA Meeting, August 30, 2010; E) Mark Bryant (ACAA) Testimony on Proposed Coal Combustion Residual Regulations, Knoxville, TN Meeting, October 27, 2010.

hearings. ACAA believes that these examples should tell EPA that the U.S. CCP beneficial use market is responding and will respond as the UK, Australian, Canadian and Israeli letters warn:

- EPA will devastate the CCP beneficial use market should it regulate CCRs as a "special waste" under Subtitle C; and,

- CCPs should be a resource which should **not** be regulated by EPA unless warranted by science or experiential factors. ACAA does not believe that any of these factors warrant additional CCP regulation. Guidance documents working with stakeholders like states and ASTM is a better path. EPA should not overreach in this regulation. It isn't warranted.

d. Stigma Impacts to Encapsulated Beneficial Uses

1. Encapsulated Uses

Even before the Kyoto Protocol was signed, CCP utilization in "encapsulated products" like concrete was internationally recognized as being sustainable. Ash and gypsum utilization in "encapsulated" products encompass all three elements of sustainability**:** the social, economical and environmental components. With regard to fly ash in concrete, every ton of CCP that is used:

- **Socially**: Conserves landfill space to equal 455 days of solid waste produced by the average American.

- **Economically:** Saves enough energy to provide electricity to an average American home for 24 days.

- **Environmentally:** Reduces CO_2 emissions equal to two months of emissions from an automobile.

Considering the relative stage of the CO_2 market, there is a plethora of examples of ACAA members have reduced millions of tons of CO_2 in internationally recognized settings and domestic regulatory and voluntary CO_2 frameworks. The list of CCP sustainable benefits and beneficial uses is long and impressive. ACAA members are key partners and stakeholders in making EPA's vision for a carbon constrained economy thrive. We provide green jobs, encourage investment and provide a bridge to a new energy diversity.

Focusing on encapsulated beneficial uses, CCPs allow buildings to be designed to last a thousand years, concrete highways designed to last 80 plus years, and concrete bridges with design lives of 100 years. CCPs make concrete blocks that have better structural integrity and are significantly lighter, thereby reducing transportation costs, demand for raw materials, and allowing for greater flexibility in design and construction. CCPs are used in grout, in portland

cement, as raw feed for cement clinkers, in bricks, as mineral filler in asphaltic concrete, in gypsum wallboard, in geopolymers, in roofing tiles, in engineered lumber products, and as filler in certain metal and plastic products, among other encapsulated uses.

One fear ACAA has with EPA's proposed regulation is that EPA and others in the Executive Branch view this regulation as a tool in an energy policy arsenal to eliminate coal. The ENGOs understand this issue and have stated that the ENGOs are willing to sacrifice beneficial encapsulated uses to further burden coal with a goal of eliminating coal from the American energy diversity mix. We as a society will have coal for sometime and the numerous benefits of safe recycling shouldn't be traded away like some worthless commodity – safe recycling - is a necessity. ACAA desires tougher and enforceable regulation of fly ash disposal. To no avail, we have approached EPA and ENGOs to work on legislative solutions that allow EPA to enforce tougher CCR regulations under Subtitle D.

EPA seems to be in the same policy camp with the ENGOs – the CCP beneficial use industry will be a victim in a set of regulations to respond to a fly ash disposal incident that was not at all related to the constituents in the ash at Kingston. One example of EPA's blind spot to the plight of the CCP beneficial use industry is shown by EPA's determination to deny our assertion that stigma is real. In EPA 's initial draft proposed rulemaking that was released for interagency review (as opposed to the one that was ultimately published in the Federal Register), EPA seemed set on a path to regulate CCRs under Subtitle C without the Subtitle D option. Prior to issuance of the June 2010 proposed rulemaking, EPA had been told by ASTM, ACI, and ACAA that a stigma will attach and harm encapsulated beneficial uses. After the proposed rule was issued, the National Ready Mix Concrete Association (NRMCA's) in its statement to the House Small Business Subcommittee on Rural Development, Entrepreneurship and Trade on July 22, 2010, further stated that regulation of CCRs under Subtitle C would significantly impact the use of fly ash in concrete. At that hearing Robert A. Garbini, PE. and President of NRMCA testified to the importance of CCPs as a resource[47]:

> "In 2008 alone, the concrete industry used 15.8 million tons of fly ash in the manufacturing of concrete. It is estimated that the concrete industry could increase its current use to above 30 million tons per year by 2020 which would reduce the concrete industry's carbon footprint by 20%. This would help the ready mixed concrete industry attain the Environmental Protections Agency's (EPA) and Obama administration's desired goal of reducing, in part, CO_2 emissions by at least 17% by 2020."

Despite these messages before and after issuance of the proposed rule which were clear and direct, EPA's has not acknowledged that it should and must consider the financial impacts upon "encapsulated" beneficial use in this rulemaking. In answering a direct question at a July 22, 2010 Small Business in Recycling Industry hearing, EPA's staff, Lisa Feldt, had no good response

[47] Robert Gabrini (Pres. NRMCA) Testimony to House Small Business Subcommittee on Rural Development, Entrepreneurship and Trade, July 22, 2010.

to Congressman Heath Shuler when asked why isn't EPA in its proposed rulemaking taking into account the financial impact upon the CCP beneficial use industry. EPA claims that since the financial impact to the CCP beneficial use industry is not a direct impact, EPA does not need to include the impact. Congressman Shuler challenged EPA based upon the precise wording of the Executive Order[48].

ACAA believes that EPA **must** include negative impacts to the CCP beneficial use industry(job loss – already starting; lost investment and business, etc.,) in its Regulatory Impact Analysis and re-do all of its underlying assumptions or at least run another scenario that the "encapsulated" beneficial use market will not and cannot absorb and grow for the reasons set forth herein. Equally disconcerting is EPA's inclusion of financial savings. EPA projections justify the proposed rule based on a scenario that increased cost under a Subtitle C scenario will increase "encapsulated' beneficial use. As stated in other parts of this letter, this is a spurious argument. While there are many reasons to evaluate the U.S. energy policy, using coal ash as a lever against the generation of coal-fueled electricity does not recognize the reality that coal will remain part of the energy mix in the US for many years until alternatives can be placed in service. . EPA should not use this rulemaking to legislate energy policy. The collateral impacts of a Subtitle C regulation being used to regulate CCRs as a "special waste" destined for disposal are substantial and must be analyzed.

The record is clear that EPA's underlying financial assumptions warrant re-examination. Dick Stehly, President of the American Concrete Institute, in response to a question at the July 22, 2010 Small Business in Recycling Industry hearing by Congressman Heath Shuler stated that he is aware that should EPA move ahead with a final rule that designates CCRs as a special waste, a movement will occur within ACI to remove fly ash from the 318 Building Code Requirements[49]. EPA can choose to deny the stigma but removal of fly ash from the Building Code is another genuine example of the stigma associated with a hazardous label. It is a move that the beneficial CCP markets will not recover from. Products using CCPs are required to meet standards outside of EPA's control. When those organizations have spoken and indicated that further movement by EPA down a Subtitle C path will decimate the CCP beneficial use industry, its jobs, its contribution to the local tax base, etc., EPA should listen and not just respond with requests for "concrete stigma examples". Whether EPA chooses to call this stigma or collateral damage, it is real. ACAA believes there are other Subtitle D regulatory options that allow for strong enforceable environmental regulations on CCR disposal and ACAA will work to put such measures in place.

2. *Stigma doesn't just affect future use; Subtitle C impacts continuation of current "encapsulated volumes*

ACAA met with EPA prior to the proposed rulemaking and shared with EPA contractual language that will create force majeure events in existing contracts if EPA designates fly ash as

[48] Executive Order No. 12866, 58 *Federal Register* 51735, October 4, 1993.
[49] Letter from American Engineering Testing, Inc. to Rep. Heath Shuler, July 22, 2010.

hazardous waste under Subtitle C. Since fly ash is used in concrete and many building codes prohibit the use of hazardous waste, a specific carve out for such a designation is commercially foreseen. ACAA wanted EPA to better understand that EPA's regulations need to take into account the impact of standards outside of its control and expertise. ACAA shared this information while at the same time stressing that no damage cases exist for "encapsulated" uses therefore EPA's goal to regulate CCRs needed to include due consideration for collateral damage that the CCP beneficial use industry would sustain. EPA stated that it is in favor of "encapsulated" beneficial use, it desires such uses to increase and projects under a Subtitle C designation such uses will increase. Once again, EPA's assumption doesn't mesh with the reality that current encapsulated use contracts which ACAA has shared with EPA, including force majeure language specifically tailored to address EPA potential designation of fly ash as a hazardous waste. Legal suits may ensue to determine if CCRs as a "special waste" destined for disposal equates to the wording of the clause, but rest assured the environment will lose and usage of fly ash in concrete will be severely impacted[50]. A former senior vice president of the second largest domestic ash marketer testified at EPA's Charlotte hearing that job loss was real due to this rulemaking. It happened to him. He further stated that based on his numerous years in the CCP beneficial use industry, fly ash usage in concrete, would not occur if EPA promulgates a Subtitle C CCR rule. This person had no current allegiance to anyone in ACAA or our industry[51]. EPA should not look at growth in CCP "encapsulated" uses from a Subtitle C designation, it should look at significant loss due to the unique contracting provisions which exist and the stigmatization already being seen. EPA's analysis is severely flawed and must be re-examined.

Moreover, not only will usage be impacted due to unique force majeure clauses which exist in CCP beneficial use contracts but these current contracts don't envision complex issues associated with Subtitle C liability and insurance requirements. For example, due to the "hazardous" nature of CCRs under a Subtitle C scheme, CCP beneficial users are being asked to obtain additional environmental insurance and increase indemnities[52, 53]. Banks are starting to raise questions during environmental investigations as loans renew or new loans are proposed to fund CCP related activities[54]. These concerns are unwarranted based on actual science but are instead the results of misinformation and misperceptions by the public. The CCP beneficial use industry cannot support these unnecessary types of additional unrealistic requirements. These factors also are not factored into EPA's underlying assumptions of CCP encapsulated use growth. These must be re-examined.

Finally, EPA's proposed rulemaking has nullified any forward movement to grow re-use of fly ash in encapsulated products like concrete. Normally the CCP beneficial re-use sector has multiple deals percolating as the market grows to reuse fly ash in concrete. No deals are or

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[50] Peltier, Robert, *Ash Me No Questions*, Coal Power, October 7, 2010, http://www.coalpowermag.com/commentary/Ash-Me-No-Questions_281.html.
[51] Testimony of Paul Bieber.
[52] Letter from McDonald Farms Enterprises, Inc., September 2, 2010.
[53] Email from David Short of Willis Carolinas, September 24, 2010.
[54] Email from Bob Waldrop of Full Circle Solutions, October 6, 2010.

have been on-going since the rulemaking was proposed. This rulemaking proposal has also affected the investment communities willingness to loan money to businesses in our sector[55]. Jobs are created by building silos, transfer stations, buying equipment, building beneficiation facilities, converting wallboard factories to re-use synthetic gypsum, building green brick plants, etc. Our CCP beneficial use industry can be part of the engine that grows America but it will require EPA to implement strong regulations under Subtitle D and not under Subtitle C.

3. *Contributory factors which have enhanced stigma impacts on encapsulated products during the rulemaking*

Considering that concrete is only second to water as the world's most consumed product, the sustainable properties of concrete with CCPs are impressive[56]. Government agencies specify and use CCPs in their buildings, including structures in which the EPA currently resides. The EPA "walked the walk" and "talked the talk" and lead by example to propel beneficial use of CCP's into public mainstream. Utilization of CCP's grew with the EPA's Combustion Products Partnership program (C^2P^2) from 38% in 2003 to 44.5% in 2008. However in May 2010, the EPA suspended its participation in the C^2P^2 program and removed the program's pages from its website without notifying any of its other partners. In a July 21, 2010, letter from Mathy Stanislaus to Tom Adams, EPA states,"… While EPA does not want to negatively impact the legitimate beneficial use of CCRs…" Since the retraction of the C^2P^2 program, many within the Green Building movement have questioned whether green LEED credit should be given to or even embrace fly ash containing concrete[57].

4. *Realities of Stigma Impacts*

The unquestionable reality, however, is that a decision by EPA to regulate CCRs for disposal under Subtitle C even as a "special waste" has and will create a significant stigma for even those most narrowly defined encapsulated beneficial uses of CCPs. EPA is simply wrong in its belief that regulating such materials under Subtitle C will somehow increase small volume demands for such materials. No matter how one analyzes or interprets or misinterprets the data to try to alleviate this concern, the reality is that people are going to be reluctant to employ a material that the EPA has characterized as hazardous, even if the EPA creates some exception or exemption or tries to employ a different label. This was abundantly clear by the many comments made by citizens at EPA's public hearings on the proposed rulemaking. In Denver, one women stated, if the EPA knows that coal ash is toxic, then is should simply be banned, period!

Either it is a hazardous material, or it is not a hazardous material. If such materials are deemed to be "hazardous," then how is it that they are not hazardous if used in certain applications? Does this not necessarily create a slippery slope that will lead to additional regulations, with the

[55] Letter from PMET to EPA, October 4, 2010
[56] Idekar, Jason, *New Fly Ash Regulations Threaten Sustainable Concrete*, Oregon State University, August 12, 2010.
[57] *Fly Ash: More Questions than Answers from EPA*, Healthy Building News, May 19, 2010.

ultimate result that it will no longer be worth the effort, expense, and risk to use coal ash as opposed to virgin materials? As the Earth Justice has so clearly explained, “a hazardous waste by any other name is a hazardous waste.” [Can we get the cite for this]

Moreover, nearly every example in the Preamble of beneficial uses suggested by the Agency of Subtitle C materials that are acceptable, none of these uses are in the residential sector. As CCPs are widely used in the construction industry and the same materials are generally used for commercial and residential construction. The stigma and liability of beneficially using in a residential setting a material that is designated as a "special" or "hazardous" Subtitle C waste will significantly reduce the use of these materials in the construction industry as a whole. Moreover, as explained above, should EPA promulgate a final rule regulating CCRs as a special waste under Subtitle C, ACI has signaled that it will start a process to consider removing the material from the Building Code. This should be a serious warning to the EPA on the reality that beneficial use will be restrained by a Subtitle designation. This possible ACI action should not be taken lightly

Public perception is key in the recycling of any industrial by-product. If the Subtitle C disposal approach is adopted, the FGD gypsum wallboard, block, and fly ash concrete markets, among others, will suffer significantly because the general public is going to question that, if the material is so unsafe so as to require it to be disposed as a hazardous waste, then why would one want to put up wallboard in a home or hospital, construct a driveway, or construct a foundation in their home with the same materials. Moreover, if such materials are classified as hazardous, one can be guaranteed that a significant amount of litigation will follow. Aside from triggering health and environmental claims, owners experiencing problems not relating to CCPs will find ways to blame the CCPs, working with creative attorneys to sue CCP generators and marketers, as the Chinese drywall issue so clearly demonstrated.

In the NRMCA’s) statement to the House Small Business Subcommittee on Rural Development, Entrepreneurship and Trade on July 22, 2010, Robert A. Garbini, testified the following: “If fly ash concrete bound for disposal is classified as hazardous or special waste, then ready mixed concrete producers are unlikely to use fly ash in their concrete.”[58] Block manufacturers have already joined forces with the Expanded Shale, Clay and Slate Institute to speak out against continued use of construction materials containing CCPS. As they state in the Johnson Concrete Newsletter (Vol. 2, Issue 3, Dec. 2009), "[t]he **LIABILITY ISSUES** are too great for specifiers, manufacturers, contractors and end users to allow this waste material to be used in building construction materials of any type." (emphasis is in the original article) Use of construction materials containing CCPs is already appearing as the basis for rejecting bids for construction and development projects[59], and other companies are warranting that the materials used do not contain CCPs[60]. Similarly, certain banks are already reluctant to make loans for buildings

[58] Robert Gabrini (Pres. NRMCA) Testimony to House Small Business Subcommittee on Rural Development, Entrepreneurship and Trade, July 22, 2010.
[59] Mortenson Construction Project Specifications (rejection of bid), May 5, 2010.
[60] Adams Products Company Price Quote, July 29, 2010.

containing such materials, in some instances imposing onerous indemnification requirements and in other simply denying the loan[61, 62]. This is already happening. So how is it even defensible that EPA can continue to promote certain beneficial uses while also generally regulating CCRS under Subtitle C?

As noted in our introduction, the quantity of CCPs that is actually used in such encapsulated products is large and the apparent impact that this stigmatization issue is already having on even the most narrow categorization of encapsulated uses is disconcerting. Although some of this decrease reflects the economic downturn, documents and anecdotal evidence, such as those mentioned above, indicate that these numbers also reflect the impacts already being experienced due merely to the EPA's consideration of treating such materials as a hazardous waste.

Aside from the significant stigma related impacts that the EPA seems to ignore, certain of EPA's other assumptions appear to be incorrect as well. Specifically, EPA incorrectly assumes that the potential market volumes for CCPs in areas such as in concrete are open ended. This is not true. First,, EPA's analysis assumes the highest usage year for the CCP beneficial use market – 2005. Also, many markets have more CCP supply than demand. There is no room for the growth that EPA employs in its analysis. For example, the wallboard market is already saturated. In many instances, there is an oversupply of fly ash vis-à-vis the current concrete market. In many instances, fly ash will need additional investment to be of the stable quality for use in concrete. Financiers and technology companies demand certainty in the regulatory market before capital will be approved to invest in such projects. Impacts in this arena are already evident as discussed in Pittsburgh Minerals & Environment letter dated October 4, 2010, where plant financing for purposes of making a superior structural product has evaporated as a result to this rulemaking[63].

e. No Documented Damage Cases for Beneficial Uses Identified

It is also important to note, that even though the potential impacts to continued use of CCPs in encapsulated beneficial uses would be significant should EPA choose to regulate such materials under Subtitle C, even EPA acknowledges the minimal risk, if any, associated with such uses. Specifically, none of the damage cases listed by the EPA in the preamble involve encapsulated beneficial uses. In fact, page 35154 of the Proposed Rule states "[t]o date, EPA has still seen no evidence of damages from the beneficial uses of CCRs that EPA identified in its original Regulatory Determination." By regulating CCPs under Subtitle D, EPA would best be able to impose the additional regulations they desire, while continuing to promote responsible uses, instead of all such uses being lumped into one stigmatized group.

[61] Email from David Short of Willis Carolinas, September 24, 2010.
[62] Email from Bob Waldrop of Full Circle Solutions, October 6, 2010.
[63] Letter from PMET to EPA, October 4, 2010.

f. Conclusions

USEPA's basis for revisiting its May 2000 regulatory determination was driven by the surface impoundment retaining wall failing at Kingston's TVA site. We **do not** understand why the failure of a poorly designed or poorly maintained dike should prompt a reconsideration of the waste classification of coal ash. The toxicity of the coal ash that was released had nothing to do with the damage caused. Similar damage could have resulted if the dike had been holding back plain water. There being no evidence of detriment to human health and the environment from CCPs at Kingston by the USEPA, Tennessee Department of Health, and Oakridge National Laboratories, we see **no logical** reason to make any regulatory determination change[64].

Furthermore, such materials can easily be regulated in a manner that better promotes responsible use, management, and disposal of CCPs without unnecessarily threatening the ongoing recycling of such materials. Between the two approaches being proposed by the EPA, the only option that could accomplish both of these goals is to regulate CCPS under Subtitle D, not under Subtitle C.

Section VII – Beneficial Use: Flowable Fill

a. Introduction

Flowable fill is an engineered, low strength fill material (also called a controlled low strength material, or CLSM) containing water, fly ash, sand, and portland cement. It is self-leveling, self-compacting and non-settling and is used in lieu of compacted earth or granular fill, especially in highway projects or repairs and utility repairs such as repairs to sewer lines or other underground infrastructure.

Flowable fill is delivered in a slurry form that resembles very workable concrete and provides for an in-place product that is equivalent to a high-quality compacted soil without the use of compaction equipment and related labor. The flowable nature of the product is derived from the spherical particle shape of fly ash when mixed with enough water to lubricate the particle surfaces. Some flowable fill materials are made of just self cementing fly ash (Class C) combined with other fly ash or with granular material such as sand or quarry fines. However, in each situation, the matrix resulting from the cementitious nature of the portland cement and/or the fly ash result in a material that is largely impervious and that, in a hardened state (within hours of placement), readily sheds water and acts as a barrier to moisture ingress. This characteristic "binds" the constituents within the mix design.

[64] *TVA Coal Ash Release Public Health Assessment*. Tennessee Department of Health. Final Release. September 2010.

b. Clarification that Flowable Fill Constitutes an "Encapsulated" Use is Needed

In the preamble of the proposed rulemaking, EPA talks about the term "coal combustion residuals," or CCRs, as being fly ash, bottom ash, boiler slag and flue gas desulfurization materials **destined for disposal** (Page 35130). However on page 35129, EPA states that the use of "coal combustion products" (CCPs) that provide a functional benefit, that is replaces the use of an alternative material, conserving natural resources that would otherwise need to be obtained through practices such as extraction, and meets relevant product specifications and regulatory standards would be considered "beneficial use." Then on page 35222, EPA states that they are seeking comments on whether or not certain uses of "CCRs" (such as those involving unencapsulated uses) require tighter control. This seems to equate CCPs to CCRs. This contradictory use of the term "CCRs" when the term "CCPs" is more appropriate makes providing comments more difficult.

Secondly, the definition of "unencapsulated" is not clearly spelled out in the rulemaking. Examples of "encapsulated uses" such as fly ash in concrete or FGD materials in wallboard, leaves doubt in a commenter's mind as to the category within which certain beneficial uses fall?

On the EPA website: http://www.epa.gov/epawaste/nonhaz/industrial/special/fossil/ccr-rule/ccrfaq.htm a number of questions are addressed. Question 30 states: "Is flowable fill considered an encapsulated or an unencapsulated beneficial use?" The answer given is: "Similar to other beneficial uses, flowable fill and controlled, low-strength concrete would not be regulated under the proposed rules. For the purposes of the proposed rules, however, EPA considers these to be unencapsulated products and requests comments, information and data about these uses." This interpretation outside the published proposed rulemaking seems incorrect.

c. CCPs are Bound in the Mixture

Without a definition of "encapsulated" and "unencapsulated," ACAA would argue that the terms "bound" and "unbound" are more accurate. "Bound" applications are those where the constituents, including heavy metals found in CCPs, are retained in the final products and are not likely to be released into the environment.

Studies of the ability of portland cement concrete to release gasses or to leach heavy metals (such as mercury) out of the concrete clearly demonstrate this is very unlikely[65]. Other studies, such as studies conducted by Dr. V. M. Malhotra, further demonstrate that the constituents in fly ash are largely bound up in the concrete matrix and not released[66]. The Portland Cement Association has developed an extensive bibliography of studies and papers (forty separate

[65] Electric Power Research Institute. "Mercury Release from Concretes Containing Fly Ash and Powder Activated Carbon Sorbents." EPRI. Palo Alto, CA. Technical Resource bulletin, June 2008.
[66] American Concrete International. "Seventh CANMET/ACI International Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete, Volume 1." Paper SP-199. ACI International, Farmington Hills, MI. 2001.

studies are cited) further showing that the leaching of constituents from concrete containing fly ash pose almost no risk to the environment[67]. These are cases when the constituents are "bound" within the concrete matrix. In another series of studies described in the National Cooperative Highway Research Program, an assessment was made of the leaching of heavy metals from "controlled low strength materials" (CLSM). It concluded that "[s]imilarly, no significant problems were cited regarding the leaching of CLSM constituent materials (e.g., heavy metals from fly ash or foundry sand) into the surrounding environment."[68]

To consider flowable fill (also known as CLSM) to be an "unencapsulated" use ignores the fact that most flowable fills containing fly ash also contain portland cement. Some flowable fill materials are made of just self cementing fly ash (Class C) combined with other fly ash or with granular material such as sand or quarry fines, which generates a similar cementitious end result. In each situation, the matrix resulting from the cementitious nature of the portland cement and/or the fly ash result in a material that is largely impervious and that, in a hardened state (within hours of placement), readily sheds water and acts as a barrier to moisture ingress. This characteristic "binds" the constituents within the mix design.

d. Use of Fly Ash in Flowable Fill Satisfies EPA's Definition of a Beneficial Use

Applying the definition of beneficial uses set forth by EPA in the Proposed Rule, it is clear that flowable fill satisfies the criteria provided. Flowable fill meets relevant product specifications and regulatory standards, provides a significant functional benefit, and serves as a substitute for virgin materials (in addition to other environmental benefits).

Use of fly ash in flowable fill is well studied, and standards and specifications concerning such are well developed. Historically, fly ash-based flowable fill mix designs were developed in the early 1990s. A series of technical reports were published by Cincinnati Gas & Electric (CGE) in 1992 that reported on research conducted between 1990 and 1992[69]. These reports were some of the earliest to address CLSM use in Ohio. Another extensive study was performed by CGE in 1994. This study evaluated mix designs, pavement performance, economic advantages, life-cycle advantages and other technical considerations[70]. Conferences held in 1995[71] and in

[67] Portland Cement Association. "Leachability of Concrete Containing Fly Ash." PCA Library Bibliography Series No. 39 (LB39). Portland Cement Association. Skokie, IL. 2009.
[68] Transportation Research Board of the National Academies. "Development of a Recommended Practice for Use of Controlled Low-Strength Material in Highway Construction." NCHRP Report 597. Transportation Research Board. Washington, DC. 2008.
[69] Cincinnati Gas & Electric Company. "An Assemblage of Five Research Reports on the Subject of Controlled Low Strength Material (CLSM)." Published by Brewer & Associates. Maumee, OH. June 23, 1992.
[70] Cincinnati Gas & Electric Company. "The Georgetown, Ohio Controlled Low Strength Materials – Controlled Pavement Base (CLSM-CPB) Research Project." Published by Brewer & Associates. Maumee, Ohio, April 15, 1994.
[71] American Concrete Institute. "Proceedings Workshop on Flowable Slurry Containing Fly Ash and Other Mineral By-Products and Special Session on Coal Ash Research in Progress." ACI International. Farmington Hills, MI. June 1995.

1997[72] provided contractors, specifiers, designers and engineers technical information on the use of flowable fill material, including those incorporating flay ash and other CCPs. The American Concrete Institute has published standard ACI 229 pertaining to CLSM that provides technical guidance on the design and placement of flowable fill, including that containing fly ash[73]. There are numerous American Society for Testing and Materials (ASTM) standards that pertain to CLSM and address the use of fly ash and other CCPs in mix designs. ACI and ASTM specifications for CLSM products include performance oriented and prescriptive information. The reason the use of fly ash in flowable fill is well studied and the applicable standards and specifications are well developed is because state and federal agencies such as highway departments, utility companies, and others are well aware of the extensive list of positive benefits associated with such materials. A listing of a number of the positive benefits attributed to the use of flowable fill can be found in Table 1.1 in ACI 229R. Among the number of quantifiable benefits flowable fill containing fly ash is:

> Readily available, easy to deliver, easy to place, versatile, strong and durable, can be excavated easily, requires less inspection, allows fast return to traffic, will not settle, reduces excavation costs, improves worker safety, allows all-weather construction, reduces equipment needs, requires no storage and makes use of an industrial byproduct.[74]

When self cementing fly ash is used instead of portland cement the designer is avoiding the production of and costs associated with the manufacture of portland cement. Fly ash is typically half the price of ordinary portland cement and in large projects, the savings can be substantial. Not having to produce portland cement also can avoid the release of CO_2 from that manufacturing process, reducing the total greenhouse gas emissions from the cement industry. Furthermore, other CCPs such as bottom ash and boiler slag may be used instead of sand or fine gained fillers that would be provided by mining, crushing and processing. This saves energy and allows these natural materials to be used in other applications.

Fly ash based flowable fill also adds significant value by reducing time needed for a repair. The rapid setting of fly ash based mixes allows construction projects to be completed more quickly than those using portland cement based products. A self cementing fly ash flowable fill can achieve desired strength within an hour or less whereas portland cement based designs often require nearly 24 hours to achieve their design strengths. CCP based mixes allow pavers to cover road cuts or utility trenches quickly permitting streets and roads to be restored to service in a matter of hours, rather than a day or longer.

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[72] American Society for Testing and Materials. "The Design and Application of Controlled Low-Strength Materials (Flowable Fill)." Proceedings from the "Design and Applications of Controlled Low-Strength Materials (Flowable Fill) Symposium held in St. Louis, MO June 19-20, 1997. ASTM International. West Conshohocken, PA. 1998. STP 1331.

[73] American Concrete Institute. "ACI 229R-99, Controlled Low Strength Materials (Reapproved 2005)." ACI International. Farmington Hills, MI. 2004.

[74] Id. Table 1.1.

e. How Flowable Fill is Used

We believe that the questions EPA is raising related to flowable fill as an "unencapsulated" use is based on lack of understanding of how flowable fill is used and performs. Flowable fill is predominantly used to backfill utility work or construction projects where the CLSM is below surface and typically covered with pavement, concrete or other material. As is mentioned above, it provides excellent fill material that is strong, durable, and self-settling and requires considerably less time and equipment than other fill material such as soils or flowable fill containing only portland cement.

There are almost no examples where the flowable fill serves as a surface cover, thus it is protected from direct contact with rain, snow or other surface moisture. For example in Colorado, the most common uses for fly ash based flowable fill are in repairs to utility services, especially by local water districts. It is common for a water district in the Denver area to actually specify the use of flowable fill to accomplish a timely repair of a failed underground water component. A broken pipe, a leaking vault or similar incident requires the water district to excavate and repair or replace the failed component. In most cases, Denver area water districts require their paving contractors to use flowable fill to expedite the repaving of any site that carries vehicular traffic. Once the component has been repaired, a local flowable fill contractor provides a fly ash based product that is placed to within a specified number of inches of the surface. The rapid setting flowable fill quickly hardens allowing asphalt patches to be laid permitting the surface roadway to be returned to traffic within an hour.

It is also important to note that these repairs using fly ash based flowable fill are "required" by water districts or municipalities. In other words, the safety of the mix design is not questioned as experience has shown absolutely no adverse environmental impact to using the material. What has been clearly shown is that the placed fly ash flowable fill hardens due to its cementitious properties and forms a nearly impermeable barrier. This prevents ground water or moisture from penetrating the side walls or base of the flowable fill material. The pavement overhead further prevents water from coming in contact with the CLSM. Even when water comes in contact with the fly ash based material, as in the case of pavement failure, the flowable fill retains its hardened form and does not dissolve or disintegrate. Simply stated, water flows around the hardened flowable fill.

Compressive strengths for most projects range between 100 and 1200 psi. When filling abandoned water structures, such as sewer lines, large diameter pipes or vaults, the compressive strengths are often higher. Colorado organizations that specify fly ash based flowable fill include the City of Denver, Jefferson County, City of Centennial, Southgate Water & Sanitation Districts, Willows Water District, Meadowbrook Water District, Willowbrook Water & Sanitation District, Lakehurst Water & Sanitation District and Platte Canyon Water & Sanitation District.

In Texas, Ohio, Georgia and other states, flowable fill performs essentially the same functions, although mix designs will vary. Where self-cementing fly ash is not available, portland cement

is used as the cementitious material. Flowable fill is a preferred material used by cities and other local or state agencies. The ease of delivery, the rapid set time, the economic value of the product and other factors have resulted in an annual use (in 2009) of over 400,000 tons[75]. The Recycled Materials Resource Center (RMRC) is a federally funded research organization that evaluates the use of industrial byproducts in highway projects. The RMRC has evaluated the environmental consequences of using fly ash based flowable fill in their "User Guidelines for Byproducts and Secondary Use Materials in Pavement Construction[76]. Their discussion includes the following statements:

> ENVIRONMENTAL CONSIDERATIONS
>
> Leaching of substance from fly ash flowable fill can occur due to the permeation of liquid through the fill. Low hydraulic conductivity of flowable fill reduces the rate at which water permeates and trace elements leach from flowable fill. Flowable fill containing fly ash is typically designed to maximize fly ash content while at the same time meeting strength requirements. Larger concentrations of fly ash correlate to a larger potential to leach trace elements. Extraction procedure toxicity test results on leachate samples from flowable fill indicate that the leachate is not hazardous.[77] In a separate study on high fly ash content mixes, leachate from fly ash flowable fill was below the enforcement standards of the Wisconsin Department of Natural Resources ground-water quality standards and met practically all of the drinking water standards.[78]

f. Stigma Impacts that EPA's Decision Could Have

Another issue of concern is the potential negative impact that the characterization of CCPs as somehow "hazardous" would have, even if under some other title, such as "special waste." Fly ash or CCP based flowable fills are found in any parts of the United States. The 414,000 tons of CCPs used in flowable fill does not necessarily include fly ash used by ready-mix contractors that do not respond to ACAA's request for information for the association's annual utilization survey. Most of the contractors are small businesses with fewer than fifty employees and with three to fifteen mixing trucks. The concern these contractors raise most frequently is what to do when small amounts of fly ash or other CCPs are spilled during the loading of storage silos or during transfer from silos to trucks. For those firms that use all CCPs in their mix design, does this mix now require disposing of as a hazardous waste when excess amounts are produced that cannot be used at the job site? At least two contractors in Colorado, Flash Fill Services and

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[75] American Coal Ash Association. "2009 Combustion Products (CCP) Production and Use Report." ACAA. Aurora, CO. 2010 (See http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3).

[76] Recycled Materials Resource Center. "User Guidelines for Byproducts and Secondary Use Materials in Pavement Construction." A website based document at http://www.rmrc.unh.edu/tools/uguidelines/cfa56.asp.

[77] Türkel S. "Long-term Compressive Strength and Some Other Properties of Controlled Low Strength Materials Made with Pozzolanic Cement and Class C Fly Ash." Journal of Hazardous Materials. 2006 9/1;137(1):261-6.

[78] Naik TR, Singh SS, Ramme BW. "Performance and Leaching Assessment of Flowable Slurry." Journal of Environmental Engineering. 2001;127(4):359-68.

Son-Fill, LLC have been told by the marketer that supplies them fly ash that the CCP producer utility has expressed concerns about the implications of EPA's rulemaking on the allocation of risks and liabilities associated with the use of a regulatory ambiguous material. This ambiguity has complicated the contractual relationships between the utility, the CCP marketer, the CCP product producer, and the end use purchaser.

Flash Fill Services has also been contacted by a number of their previous customers who have asked if Flash Fill Services is going to discontinue using fly ash "now that the EPA says it's hazardous." This is an example of the stigma that has been applied to fly ash by the news media and the public who do not understand the technical or environmental details of using a fly ash based product.

At the public hearing held by EPA in Denver on September 2, many members of the public expressed their complete opposition to any beneficial use for products containing fly ash or other CCPs (or CCRs). As one citizen stated, "If the EPA knows that fly ash contains toxins then it should be prohibited – period." What this person does not understand is that the toxins and heavy metals that she was concerned about are found in natural materials and other manufactured products, as well.

The Sierra Club was particularly effective in Denver raising alarming concerns about CCRs in a full color advertisement in the Denver Post on September 1. This organization has devoted extensive space on its website to messages about "toxic coal ash."

This public perception, which is based on opposition to coal-fueled electric generation, makes doing business as an industrial recycler very challenging. Unlike well-funded activist groups, the average flowable fill contractor cannot spend thousands of dollars defending their use of a product which has been shown to be benign when used in CLSM.

g. Conclusions

It seems clear from the discussions above, that flowable fill, a type of CLSM, clearly meets the requirement of beneficial use. As discussed above there are many technical reports, standards and other studies that address the use of CCPs in flowable fill. These documents describe performance or prescriptive requirements that ensure that CCP based flowable is a legitimate construction material. CLSM versatility allows fly ash based flowable fill to be used as bedding and backfill for utility trenches, paving subbase, backfill for bridge abutments or structural foundations and to fill such as abandoned tanks, basements, tunnels, sewers or other underground structures. There are both economic advantages (lower cost) and environmental benefits (reduced greenhouse gas emissions, reduction of mining and processing of raw materials no known adverse impact to the environment). The binding up of the constituents found in fly ash or other CCPs in the flowable fill matrix allow these CCPs to be used in "unencapsulated" uses, which ACAA believes should actually be considered bound or "encapsulated" uses. There are no known damage cases cited by EPA or environmental activist organizations for flowable fill. The majority of contractors that produce, place and use fly ash

based flowable fill products are small businesses that could be severely impacted if CCPs are ruled as special wastes for the purposes of disposal. EPA should consider the continued use of flowable fill containing CCPs to be a sound, beneficial use.

Section VIII – Beneficial Use: Structural Fill

a. Introduction

ACAA believes the exclusion of engineered structural fills as a beneficial use is inappropriate and is contrary to actual experience in the field. We recognize that there are a very limited number of examples where CCPs were placed in sand and/or gravel quarries where the site conditions and project implementation allowed impact on groundwater. However, there are a large number of engineered structural fills as described by our comments contained here, which demonstrate that CCPs can be beneficially used as a replacement for borrow fill materials with no adverse environmental impact. CCPs can be successfully used as fill materials in large scale projects or in re-contouring the land without posing risks to the environment.
ACAA does support the establishment of federal guidelines for best practices to apply to engineered structural fills. We support the use of the types of criteria found in consensus standards, state or local regulations and those best management practices that have been developed by professional engineers in concert with end-users. The accompanying folder of documents titled "Section VIII – Structural Fill" contains an extensive listing of these standards and guidance documents[79]. Our position on this point is contingent, however, on the EPA using RCRA Subtitle D for its determination on managing CCPs in the future. A Subtitle C rule would essentially eliminate CCPs from all structural fills due to industry concerns around potential liability.

The two structural fill damage cases cited by the EPA in the proposed rulemaking (Gambrills and the Town of Pines) were somewhat unique and do not reflect the most common practices used to construct structural fills. Existing state and federal regulations are dealing with corrective actions for those two sites.

EPA also refers to another potential damage case; the Battlefield Golf Course, as part of its reasoning for excluding structural fills as beneficial uses. ACAA believes that this is the only actual structural fill that the EPA has correctly cited. We believe that the placement of CCRs at the sites in Maryland (Gambrills) and Indiana (Pines) were not constructed in the manner that industry supports today and should not be considered structural fills for the purposes of rulemaking. ACAA further notes that the actual data does not show that the Battlefield Golf course has caused adverse impact offsite. Therefore, to suggest that large scale structural fills cannot be constructed safely, using the Battlefield Golf Course as an example, is neither logical nor correct. EPA's own data shows that no adverse off-site environmental impact has occurred. We also note that the extent of study by EPA of this project did not include an evaluation of

[79] Please see folder of reference documents titled "Section VIII – Structural Fill" included with this comment submission, which provides a number of additional documents specific to this use and discussion.

whether or not the construction and subsequent modifications were done in accordance with applicable state regulations. The Battlefield Golf Course situation is further discussed in the below section ("Recommendations as to Regulations or Standards") providing ACAA's recommendations concerning the use of CCPS as structural fill. Other beneficial fills constructed in compliance with Virginia regulations have proven to have no adverse impact to groundwater or surface waters.

We believe the history of well-designed and implemented engineered structural fills demonstrate that CCPs can serve as a valuable resource in avoiding disturbing native ground to secure borrow soils where fill materials are needed to establish a final grade for a project site that meets the need of the proposed final use. As will be seen in our discussion below, the very questions that the EPA is raising, such as the need for site characterization and characterization of the CCRs themselves are fundamental to the construction of fills across the United States. Technical guidance provided by the ASTM, many state regulations and certainly by best management practices endorsed by ACAA requires that fundamental engineering evaluations be conducted for any project using CCPs as fill materials. The detailed listing of consensus standards, technical guidance, reports, research data and case studies related to the use of CCPs in structural fills support the bona fide and deliberate uses of CCPs in construction, not disposal. These guidance documents are widely available and have been used by contractors and project owners for many years. The information contained in these references pertain to soil conditions, leaching data, evaluation and assessment techniques and methods of characterizing sites and materials. The application of technical guidance and best management practices makes the use of CCPs a legitimate beneficial use and should not be excluded by the EPA in future rulemaking.

As noted below, ACAA members are active in a process with EPRI and ASTM to update, and potentially create new tools and standards that pertain to site and materials characterization relevant to CCPs used in structural fills. The changes being proposed will incorporate many of the environmental considerations that outside critics have said are lacking when CCPs are used in these types of projects.

Throughout the proposed rulemaking, EPA has requested comments on various aspects of CCP use. Table VIII-1 addresses the specific comments that ACAA views as related to use of CCPs as structural fills.

b. Properly Used Structural Fill is a Beneficial Use

1. Overview

As stated in the proposed rulemaking, the EPA, in 2000, determined that beneficial purposes for CCPs included waste stabilization and beneficial construction applications, such as road bed and structural fill. However, in the preamble of the proposed rule, the EPA has excluded from the definition of beneficial uses, situations where coal combustion residuals (CCRs) are placed as fill in sand and gravel pits or used for large scale projects such as for restructuring the

landscape. ACAA takes the position that a structural fill is a legitimate beneficial use when an engineered fill uses CCPs in conjunction with or in lieu of virgin materials to raise and change the surface elevation of an area and to provide ground support beneath building foundations or to construct various embankments. Engineered structural fills are typically constructed in layers of uniform thickness or homogeneity and, where appropriate, compacted to a desired unit of density in a manner that will control the compressibility, strength, and/or hydraulic conductivity of the placed material as required in order to meet the engineering specifications. The primary areas where CCPs have historically been used as structural fill include:

- Development of land for commercial and industrial use
- Transportation facility embankments (highway, rail, airport, marine, etc.)
- Selected bridge abutment backfills.
- Sight, sound and safety berms for screening, sound attenuation and physical protection

As described in greater detail below, in each of the situations, the finished project provides a legitimate beneficial use that provides a net societal benefit, improving or providing functions that were previously unsuitable for use until the structural fill was completed. The use of CCPs is a replacement for the soils or alternate fill material that would require excavation and import from a borrow site.

2. *Historic Use, Geographic Footprint, and Supporting Data*

The use of CCPs for structural fill applications is widespread throughout the United States. Some of the earliest uses for CCPs in structural fills began in the 1970s as reported extensively by the National Ash Association (NAA) in Technical Bulletins and through workshops hosted by NAA at West Virginia University. The NAA (later the American Coal Ash Association) held bi-annual symposiums of beneficial uses for CCPs beginning in 1968 and at each symposium, case studies of geotechnical applications, including structural fills were included. In 1979, the Electric Power Research Institute (EPRI) issued a new handbook "Fly Ash Structural Fill Handbook" (Report EA-1281).[80] This document contained detailed information on materials characteristics, test and analytical methods, and types of embankments and structural backfills. Subsequently, in 1988, EPRI published "High Volume Fly Ash Utilization Projects in the United States and Canada" (Report CS-4446, Second Edition)[81]. This lengthy document identified more than 170 projects of which approximately half described the use of CCPs in embankments related to highway construction. At the same time, EPRI was conducting a number of demonstration projects in Maryland, Kansas, Michigan, and Georgia that used CCPs in

[80] Electric Power Research Institute. Fly Ash Structural Fill Handbook. EPRI. Palo alto, CA December, 1979 EA-1281.

[81] Electric Power Research Institute. High-Volume Fly Ash Utilization Projects in the United States and Canada: (Final Report, Second Edition). EPRI. Palo Alto, CA. March, 1988. CS-4446.

geotechnical applications such as pavement base course and structural fills. In October 1988, EPRI issued "Fly Ash Construction Manual for Road and Site Applications" (CS-5981, Volumes 1 and 2)[82]. The technical discussions about using CCPs in the geotechnical projects covered in these two volumes further documented design considerations and construction techniques. The historical documentation prepared by EPRI clearly demonstrates that the industry did not consider structural fills to be some form of disposal, but rather an accepted engineering practice that would achieve specific technical performance and allow incorporation of CCPs and other power plant materials into civil engineering projects.

As the result of these many projects, the geotechnical community recognized a need for standardized guidance that would address the technical, construction and environmental issues pertaining to the use of CCPs in geotechnical projects. First issued in 1995 by ASTM as a provisional standard, "Provisional Standard Guide for the Use of Coal Combustion Fly Ash in Structural Fills" (PS23-95), was provided to the engineering community to give specific technical and design guidance on the use of CCPs in structural fills that reflected the field experience seen in the previous two decades. PS23-95 was extensively revised and re-issued in May 1997, as ASTM E1861-97 "Standard Guide for Use of Coal Combustion By-Products in Structural Fills." The revisions were made based on data and experience obtained when using CCPs in highway and fill projects across the United States. Similarly, E1861 was superseded in 2003 with ASTM E2277-03. The revision was again based on increased field experience and development of best management practices for CCPs in geotechnical projects. Again, all these technical documents published by ASTM require (or required) specific engineering practices for the use of CCPs in engineered structural fills and do not condone "indiscriminant" placement of CCPs into "projects similar to disposal." ASTM is in a continual process of updating and revising consensus guidance in order to address better methods of engineering and placement of materials, including CCPs in engineered structural fills. ACAA recognizes the need to further incorporate best management practices into technical guidance documents. Later in our comments we have specific suggestions on how this might be done.

Today, sectors utilizing CCPs for structural fill applications include state DOTs, county and city road districts, and private/commercial construction. The use of structural fill has progressively grown in the United States over the years (see Figure 2) due to more and more excavation and construction companies realizing the favorable engineering properties of the material. By adhering to standard construction guidelines such as the ASTM and other documents cited above, achieving high strength structural fills with CCPs is a safe and beneficial use.

[82] Electric Power Research Institute. "Fly Ash Construction Manual for Road and Site Applications: Volume 1 - Specification Guidelines (Final Report)." EPRI. Palo Alto, CA. October, 1988. CS-5981. Vol. 1 and 2.

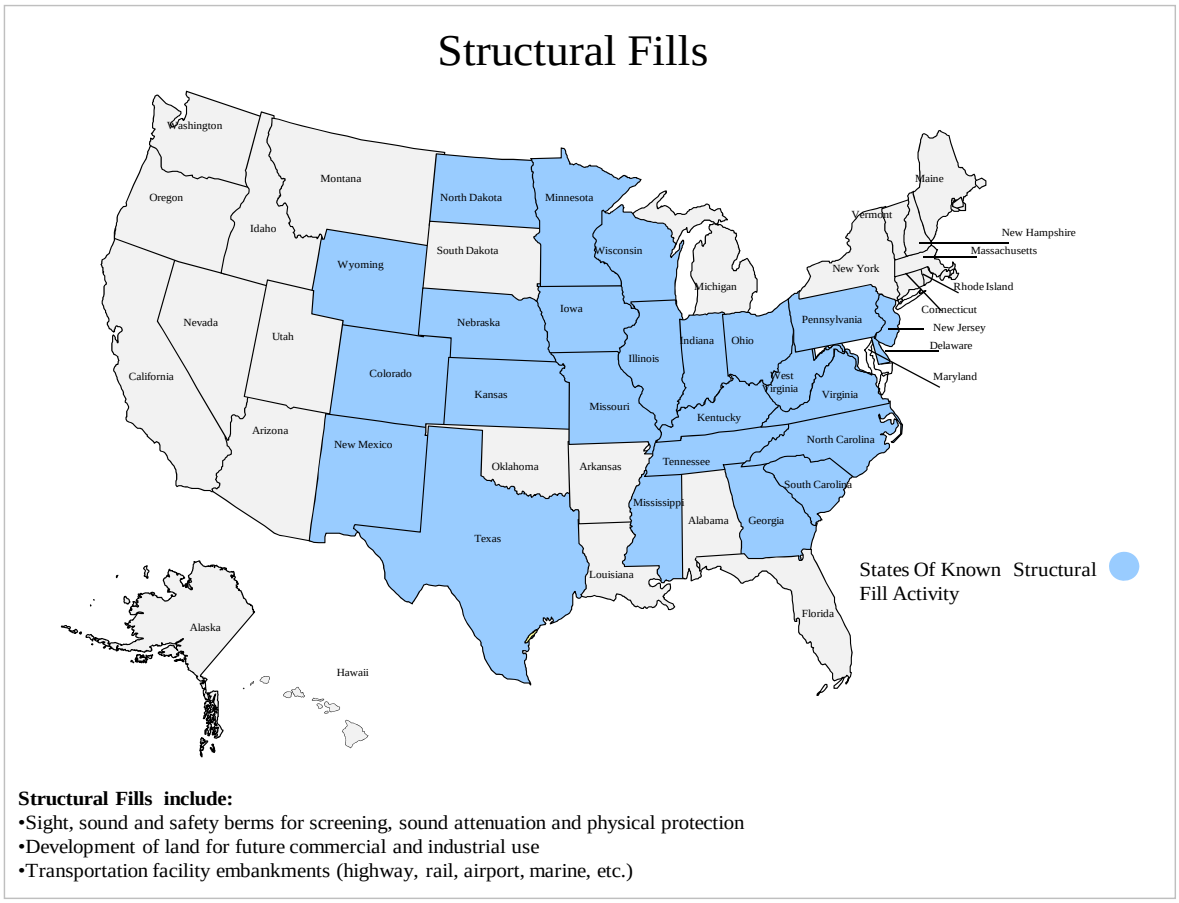

Figure 1. Locations of Known Structural Fills

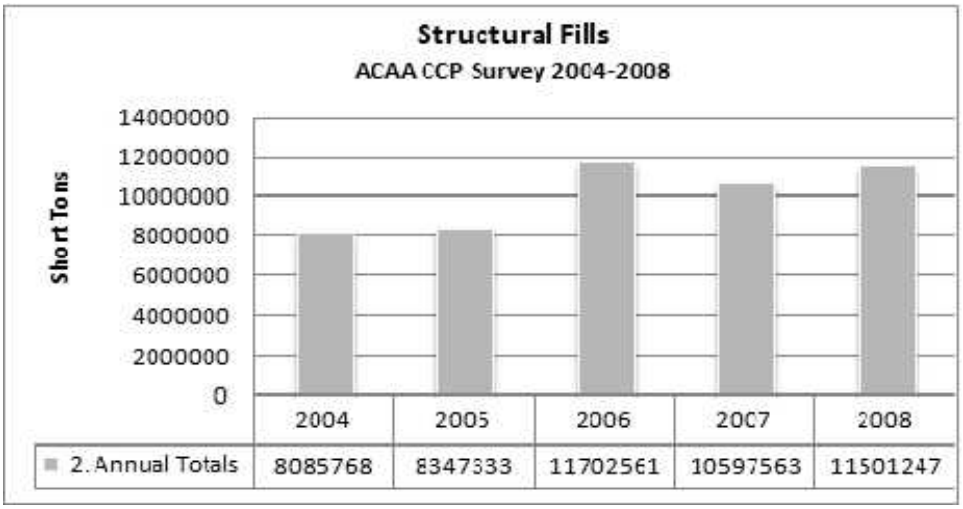

Figure 2. Estimated Annual Volumes of CCPs Used in Structural Fills 2004-2008

3. *Examples of Uses*

The use of CCPs as structural fill has been widely demonstrated to be a safe and beneficial use throughout the United States. The technical data contained in field reports and the sampling of groundwater near various projects has shown that when both the site and the CCPs are appropriately characterized for the conditions and intended use of the land, there is no adverse environmental impact. The US EPA, Federal Highway Administration (FHWA), State DOT's, public and private universities, and state and federal agencies have studied and evaluated the uses of CCPs and have concluded that the material has favorable geotechnical properties for structural fill. As the result of these studies and research, standards and technical guidance has been developed by organizations such as ASTM, The Portland Cement Association (PCA), the FHWA, the Recycled Materials Resource Center (RMRC), the American Concrete Institute (ACI), the American Association of State Transportation and Highway Officials (AASHTO), and individual states have provided standards and guidance documents that are generally used for the construction of CCP structural fills. References 1, 3, 4, 5, 11, 12, 14, 15, 16, 17, 24, 30, 32, 34, 35, 38, 39, 40, 42, 43, 50, 59, 61, 72, 76, 79, 80, 87, 89, 93, and 97 included in the accompanying folder titled "Section VIII – Structural Fill" are examples of these standards and guidance as well as summary reports of the techniques for placement and construction of structural fills using CCPs.

Proper material assessment, project location criteria, and construction procedures ensure safe and successful projects. Below is a listing of four general categories of geotechnical applications where the use of CCPs is commonplace:

1. **Development of Land for Commercial and Industrial Use.** This includes development projects that require the final grade to be elevated to meet the elevations of arterial roadways and provide topography for subsequent building construction.

2. **Transportation Facility Embankments (Highway, Rail, Airport, Marine, Etc.).** These uses tend to be larger projects but have been studied extensively with positive results and recommendations (research and studies attached).

3. **Bridge Abutment Backfills NOT Associated with Road Riparian Crossings.** Bridge abutments over rivers, creeks, or any other waterway do NOT meet the project location criteria for a structural fill CCPs beneficial reuse project.

4. **Sight, Sound and Safety Berms for Screening, Sound Attenuation and Physical Protection.** Eliminating the sight and sound of busy highways by placing berms along the road has a huge benefit to commercial, industrial or residential areas nearby. Other small businesses such as gun clubs require safety berms surrounding their property and CCPs has been studied to be a favorable material for such use.

The following photos depict a typical engineered structural project in which the site is prepared by removing and stockpiling topsoil and then compacting the subbase as determined appropriate for the land's intended use. Next the ash in placed, normally in lifts of defined

thickness according to soil performance required. In some cases, the ash and soil are tilled in together to form a more homogeneous mix. Equipment is then used to achieve the density required. The finished site is covered with pavement or soil as designed. ASTM E2277 outlines in far more technical detail the brief steps described here.

Figure 1
Site preparation: strip topsoil and compact subbase.

Figure 2
CCP placement: CCPs placed in specified lifts.

Figure 3
CCP compaction: multiple passes with roller to achieve 95% standard proctor.

Figure 4
Final cover: CCPs are covered with asphalt or other wear surface.

4. *General Benefits to the Public and Environment*

Benefits of utilizing CCPs for structural fill include:

- minimizing land disturbance and associated run-off while conserving natural resources,
- improving land improvements to help communities attract businesses and jobs, thus increasing local tax rolls, and

- reducing CO_2 emissions from mining or excavation of borrow materials by eliminating the need to grub/clear land or to extract and process native materials that would otherwise be required for the structural fill. In some cases, the distance from the power plant may actually be less than required to transport natural materials.

CCPs reuse for structural fill also minimizes the amount of ash that would otherwise be sent to a landfill. In the years 2004 through 2008, just under 50 million tons of CCPs was utilized in structural fill applications (see Figure 2). Without this reuse it would have all gone into a landfill. Reducing the need for disposal allows landfill space to be conserved for waste streams that cannot be easily recycled.

In cases when the structural fill for a project represents a large percentage of the overall project costs, CCPs utilization can have a huge impact on the viability of the project. Using CCPs instead of native soils can have such a reduction in overall project costs that the project can often times occur much sooner than otherwise would have been possible. In some cases projects are constructed that may never have been possible without the use of CCPs as structural fill. For example, a small business owner may want to expand a building or create more parking area for additional equipment. The business owner may not move forward on a project due to the expense but with CCPs substituting for native fill material, the project becomes economically viable and the small business owner can expand his business. For taxpayers, this type of saving means that transportation entities can reduce expenses allowing tight construction dollars to go further than had all natural materials been used instead of CCPs.

Whereas the EPA cites the Battlefield Golf Course as a potential damage case, ACAA again does not believe this is true. EPA's own data does not indicate that environmental damage has occurred off-site, adjacent to the golf course. When originally planned and constructed, the project did not call for ponds onsite. It was recognized that coastal plain could provide challenges when planning for separation of the finished project and groundwater. After the project was completed, the new owners created ponds that penetrated the CCP material used and measurement of water in those ponds have shown higher than expected levels of some minerals. However, there has been some question as to the test methods that were used to "identify" the alleged damage caused by CCPs in these ponds.

The Battlefield Golf Course was not the only large scale fill project in the state. Another project constructed in Virginia with over 970,000 tons of CCPs has monitored groundwater and surface waters surrounding the site for over six years. No contamination has been found at this site.

It is not appropriate to draw conclusions from a single site (Battlefield) and to say that this example represents all large scale fills. Many other projects in states ranging from Colorado, to Pennsylvania, to North Carolina have successfully used CCPs in significant amounts and have seen no adverse environmental impact.

5. *Environmental and Engineering Beneficial Use Guidelines*

In the proposed rulemaking, the EPA states "…there are cases where large quantities of CCRs have been 'used' indiscriminately as 'unencapsulated fill' and '…EPA has concluded that these practices raise significant environmental concerns.' " ACAA is not certain what constitutes "large quantities" but in many typical highway construction projects, large quantities may be hundreds of thousands of tons. However, we are not aware of any damage cases or adverse environmental impact that has been seen from structural fills that have adhered to technical guidance provided by organizations such as the FHWA, EPRI, ASTM, RMRC, or state specific technical guidance such as that described below. Proper technical and environmental guidelines are critical in planning and constructing successful structural fill projects with CCPs. References 18, 21, 22, 24, 30, 49, 55, 57, 58, 60, 65, 66, 67, 68, 69, 74, 81, 82 and 83 included in the accompanying folder titled "Section VIII – Structural Fill" provide documented studies and analyses of CCPs and their environmental impact when used in structural fills. The common conclusions these studies provide is there is virtually no adverse environmental impact seen when properly constructed.

As discussed previously, ASTM Standard E2277-03 addresses important criteria that should be followed whenever constructing structural fill projects using CCPs. In addition, ACAA members recognize that generally accepted best management practices are necessary when planning and designing structural fills. Several states, such as Wisconsin and Virginia, have developed environmental guidance for evaluating the suitability of a site prior to construction of a CCP structural fill. Furthermore, ACAA believes that the use of a licensed professional engineer to review and approve structural fill projects is an appropriate method to ensure adequate planning and implementation is undertaken.

The following table identifies a number of sources that can be used in planning and constructing structural fills.

Criteria	Engineered Structural Fill Recommended Standards
Material Assessment	• Appropriate physical & chemical characteristics ASTM Guidelines for Characterization of CCP as Structural Fill material – may vary according to specific material • Leachability as measured by TCLP or other appropriate testing protocol
Locational Criteria	• Proper separation from groundwater, surface water, water supply wells, wetlands, floodplains, and private residences • Materials shall be used in a manner that does not: o Adversely impact wetlands o Have detrimental effect on surface water o Have detrimental effect on groundwater quality • Applicable state and local land use and environmental guidance

Criteria	Engineered Structural Fill Recommended Standards
Design & Construction Standards	• Placement and compaction requirements, such as ASTM E2277 • QA/QC tests and documentation • Slope and cover requirements • Proper engineering practices and guidelines dependent upon final use • Run-on, run-off controls • Project sequencing

Post Project Monitoring and Reporting	• Annual reporting to the State Agency, including:
	  ○ Listing of projects completed, including quantities of CCPs utilized
	  ○ Results of the materials assessment
	• Additional monitoring requirements may be applicable, depending on the material, location of the project, and size of the fill project

Table 1

ACAA believes that using the standards and guidance listed above, using best management practices, and consulting technical references, such as those provided in the accompanying folder titled "Section VIII – Structural Fill," clearly show that properly designed and executed structural fill projects are not "indiscriminate unencapsulated" fills.

At page 35165 of the Proposed Rule, EPA questions whether or not leaching assessment tools should be used in conjunction with beneficial uses. Due to the wide variations in climate, hydrology, geology, topography, soil characteristics, final property use, exposures to rainfall or ground water and construction techniques, ACAA does not believe that a single test procedure can be used for all structural fills. As we are recommending in Section VIII below, we see a need for a site and materials characterization process that allows for address the many variables that a project may encounter when CCPs are used for embankments and structural fills. Soil composition and type, groundwater location and many other factors influence the method of using and placing CCPs. The use of models or tests that predict site conditions (synthetic precipitation leaching procedures, synthetic ground water leaching procedures and extraction tests) may be the best methods to determine actual performance of the material at a specific site. We do not believe that draft SW 846 procedures alone should be used to attempt to determine the behavior of CCPs in structural fills. Not all materials will respond in the environment as project through SW 846 draft procedures 1313, 1314, 1315, and/or 1316. The judgment as to the proper leach procedures should be part of the materials and site characterization process identified by designers, engineers and environmental professionals. State regulations may require different or other test protocols.

c. Recommendations as to Regulations or Standards

The approach by states to regulate CCPs for structural fill projects varies considerably. Below is a sampling of some states with a summary of the regulations involved in these projects.

- **Illinois.** The Illinois Environmental Protection Act 415 ILCS 5/3.135 allows for the use of CCPs as structural fill. Section a-8 defines structural fill as a beneficial use and includes material testing and assessment, project location criteria, cover requirements, and notification requirements.

- **Indiana.** The State of Indiana allows the use of CCPs for structural fill by including an exemption in legislative chapter IC-13-19-3. The Chapter is titled "Powers and Duties Concerning Solid Waste and Hazardous Waste Management" and subsection 13-19-3-3 includes the uses in which CCPs may be utilized in order to be "prohibited from regulation". Under 13-19-3-3(2)(E), structural fill is listed as an acceptable use "when combined with cement, sand, or water to produce a controlled strength fill material." It is interesting to note that as early as 1990, Indiana was allowing the use of bottom ash in highway embankments. One study concluded, "Results of the Indiana leaching method test show that the effects of bottom ash on the quality of groundwater are minimal."[83]

- **Ohio.** Ohio Environmental Protection Agency (OEPA) has published draft beneficial reuse rules in the Administrative Code 3745-525-801 through 3745-525-811. OEPA is currently in the second phase of receiving public comments on the draft and their Web site currently states a new draft will be available and review in early 2010. The draft includes a process for material leachate sampling and testing, project location criteria, acceptable uses based on leachate results, and acceptable coverage based on leachate results. Additional requirements include professional engineering design drawings, accepted engineering practices, certification statement, and no enforcement actions pending on the generator.

- **Pennsylvania.** Pennsylvania's Residual Waste Provisions (Rules) exclude CCPs from the definition of solid waste when beneficially used in accordance with Pennsylvania Department of Environmental Protection (PADEP) standards and criteria. Subchapter H of the PA Code, Chapter 287, Section 661 of the Rules defines structural fill as a beneficial use for CCPs. Permitting is waived so long as a sixty-day notification to the PADEP includes a project schedule, construction plans, and specifications signed and stamped by a licensed engineer; stability analysis if necessary; CCPs volume to be utilized; leaching analysis; and an acknowledgement statement signed by the project owner. Additional requirements include project location criteria, cover requirements, and placement and compaction specifications.

[83] Huang, Wei-Hsing. "The Use of Bottom Ash in Highway Embankments, Subgrades and Subbases." Joint Highway Research Project: Final Report. Federal Highway Administration. (FHWA/IN/JHRP-90/4. Purdue University. West Lafayette, IN. February 13, 1990.

- **Texas.** Texas Commission of Environmental Quality (TCEQ) issued a guidance letter in 1995 that CCPs are recognized as a material and not considered a solid waste. This letter was instituted as an agency rule in 2001 and has been the key to the overwhelming success the state of Texas maintains in CCP utilization year after year. This is now referred to as the seven-waste criteria rule (30 Texas Administrative Code (TAC) Chapter 335). Since the new guidelines have been in place by TCEQ, Texas recycles more CCPs than any other state. Texas alone utilizes 60%–70% of in-state produced CCPs annually. The use of CCPs in embankments and other highway uses is common.

- **Virginia.** The Virginia Department of Environmental Quality (VDEQ) regulates the beneficial reuse of CCPs under the Virginia Administrative Code Title 9, Chapter 85, "Coal Combustion Byproduct Regulations." This Code provides, "…standards for siting, design, construction, operation, and administrative procedures pertaining to their use, reuse, or reclamation." Violations of this Code are considered to be operating an unpermitted facility and would require a permit or risk additional action by the VDEQ including remediation and/or civil charges and penalties. Virginia formed a stakeholders group in 2008 to review the then current guidance that allowed the use of CCPs in structural fills. As a result of that stakeholder review, a number of locational issues were identified to be addressed by future proposed regulations. As of the date of this letter, those regulations have not been formally published but the guidance provided by these future rules and those from other states are to be addressed as described in Section V below. It should be noted that Virginia's Department of Environmental Quality has objected to the proposed regulation of CCPs as special waste under Subtitle C. One of their objections is that "Defining coal ash as a hazardous waste will either eliminate or drastically reduce appropriate beneficial reuse."[84] In Virginia, several million tons of CCPs have been successfully recycled as structural fill with no adverse environmental impacts.

- **Wisconsin.** The Wisconsin Department of Natural Resources (WDNR) regulates under Chapter NR 538 "Beneficial Use of Industrial Byproducts". This program is likely one of the most progressive reuse programs in the country and includes specific performance criteria, a process for material characterization and categorization, project location criteria, defined acceptable uses based on material categorization, and reporting and monitoring specifications. The WDNR is opposed to subtitle C regulation and supports a subtitle D regulation that would allow them to continue their successful and well-established beneficial reuse program. However, the use of a process like NR 538 may not always be necessary and may be inappropriate for other states based on their unique climate, topography, hydrology or regulatory framework. Depending on the size of the project, its final end use and other factors, much less comprehensive reviews may be entirely satisfactory.

[84] Virginia Department of Environmental Quality letter, David Paylor to Lisa Jackson, dated September 30, 2009.

Many other states do not have explicit guidance that directly pertains to the use of CCPs, but instead, through their local land use policies, require design information to be submitted to the governing authority for review prior to commencement of a project. For example, in Colorado it is common for a project manager to submit to the Colorado Department of Public Health and Environment (CDPHE) site characterization information and a technical discussion of the characteristics for the CCPs to be used for structural fill projects. Upon completion of the CDPHE review, the local county then reviews the project and, if supported by CDPHE findings, issues the necessary permits for construction. Projects in Colorado that have followed this process include the construction of railroad embankments, the reclamation of land that has permitted the construction of commercial businesses, and new pavement areas. The Colorado Department of Transportation has found that the technique of blending coal fly ash with native soils improves soil performance for highway construction projects. Improvements of almost 20 percentage points to the R value of the soils have been achieved at some sites.[85] The design considerations were achieved by following then current ASTM E1861.

It should be noted that many states with significant coal-fired generation are taking the initiatives to regulate these beneficial use practices. U.S. EPA should encourage other states with large coal-fired generation infrastructure to develop similar, but state-specific guidelines, by documenting successful case studies and the sharing of best practices. However, since the use of CCPs is very similar to other materials, not all states have found a need to address the use of CCPs separately. Organizations such as AASHTO, ACI, ASTM, PCA, the Transportation Research Board (TRB), the FHWA, and others have issued technical standards or guidance that include fly ash when combined with other products, such as portland cement and lime to stabilize soils or construct structural fills. This is considered a common building practice and does not raise concern. This plethora of technical information contained in the accompanying folder titled "Section VIII – Structural Fill" is regularly used by industry and contractors to ensure design and construction methods using CCPs are correct and protective of the environment. Despite the criticism by some activist groups, CCPs are well managed and required to meet demanding technical requirements when used to construct fills, embankments, and other geotechnical uses.

ACAA recognizes that site characterization is essential prior to the development of design and subsequent placement requirements. We support at least five basic steps which involve evaluation prior to the beginning of a structural fill using CCPs. These steps pertain to any size project as the review process may allow smaller projects to be readily approved more quickly than large projects. The five steps, which are essentially part of a risk analysis, include, but are not limited to the following:

1. Development of a comprehensive statement of the purpose of the project itself. This statement normally includes a clear understanding of the purpose of the project, such as to recontouring an existing site in order to permit development of

[85] Colorado Department of Transportation. "Coal Ash Used for Highway Base." Milestones. Denver, CO. March/April, 1999.

new commercial or industrial properties. It may call for the development of planned space suitable for vegetation, recreational, or parking use. In many cases the statement identifies the end user's authority to use the land as envisioned following completion of the project. It is not uncommon for local communities to have land developed for future use which the community itself will own or manage. The purpose statement may also identify limitations to future use because CCPs are contained within the project. For example, the end purpose may require a cap or paved surface or not permit the penetration of the area filled with CCPs for wells or water structures. This is an area where ACAA believes there is a need to revise existing or create new consensus standards.

2. Characterization of the CCPs includes review of the levels of heavy metals or other constituents in the CCPs as well as reviews of the site's soils and natural characteristics. It is not uncommon to find that background levels of metals may be the same or higher than the CCPs proposed to be used. The soil types found on the site will be compared to the granular characteristics of the local materials to identify any necessary soil modifications that may be required to achieve the end use desired. Specific density or compaction criteria may be required to ensure that construction subsequent to completion of the project is adequate.

3. Identification of locational constraints that, if not followed, could have a potential adverse impact on the local environment. Included in this review would be hydrology (seasonal groundwater table, wetlands, flood plains, off-site water bodies or streams, potential groundwater infiltration from below or adjacent areas to the fill, run on and run off controls, etc.), local receptors (human and animal) that might be potentially affected, off-sets from wells, and other factors that need to be considered prior to and during construction. Prohibition of ponds or lagoons on top of structural fills may also be a consideration. Incorporating appropriate state regulations into best management practices or new or revised standards would provide a valuable source of guidance for this subject.

4. Measures required during construction that will ensure protection of human health and the environment. Many of these requirements will be met by implementing ASTM E2277. Additionally, depending upon the size of the project, if may be appropriate to do construction in phases to reduce the total area needing protection over the course of construction. This step also includes determining how the final surface area will be constructed. For example, the types and depth of cover material and vegetation should be identified if the area is not planned to be developed immediately. However, if the erection of buildings, placement of transportation structures, or paving of the surface will follow completion of the fill, then the final cover of the site may need different management. Revisions to existing or new standards could further clarify this area of consideration.

5. Following completion of the project, it is recommended that a deed be recorded with the local land use jurisdiction that clearly describes the use of CCPs, their

footprint and characteristics, placement locations, or similar information to ensure that future developers or property owners have access to that information. This subject, too, should be addressed by revising or creating new consensus standards.

In 2009, the Utility Solid Waste Activities Group (USWAG) submitted a letter to then Director of the Office of Resource Conservation and Recovery, Matt Hale, offering the guidance that USWAG provides its members when they are considering structural fill projects.[86] The attachment to that letter outlines many of the same process steps described in the paragraphs above. USWAG's letter suggests that at a time when modeling is required to determine potential groundwater impact, models such as the EPA's IWEM[87] or EPRI's MYGRT[88] are typically sufficient. USWAG also recommends that planers and end users consider other activities such as contractor performance standards, communications and community outreach, contingency plans for unplanned excursions, and other factors that may be completely appropriate for some projects, but not necessarily all structural fills.

ACAA members participating with ASTM Committee E50 and Subcommittee E50.03 are preparing recommended changes to ASTM E2277 as well as the potential to create a new standard(s) that will incorporate best management practices, the principles of site characterization described above, recommendations from the USWAG letter, and appropriate state and other organizational guidance that better describes the planning and design of CCP structural fills. Using the ASTM process allows individuals from outside the CCP industry to have an active role in developing guidance that address site and materials characterization as well as other factors that make for successful CCP-based structural fills. EPRI is also developing a risk analysis framework with a decision tree that would further enhance designing and constructing structural fills. ACAA believes that this EPRI risk evaluation will become part of the ASTM standards development process. [89]

In the proposed rulemaking, the EPA asserts there are situations where large quantities of CCRs have been used "indiscriminately" as unencapsulated, general fill. ACAA does not believe that structural fills constructed under the guidelines of ASTM E2277 or utilizing best management practices to be "indiscriminate." The specific steps of site and material characterization combined with technical processes to determine soil strength, hydraulic conductivity, resistivity, structural performance, placement techniques and environmental are not indiscriminate activities.

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[86] Utility Solid Waste Activities Group. Letter from James Roewer to Matt Hale (US EPA) Director of Resource Conservation and Recovery. May 4, 2009.

[87] U.S. Environmental Protection Agency. Industrial Waste Management Evaluation Model (IWEM) Technical Background Document. Office of Solid Waste and Emergency Preparedness. EPA530-R-02-012. 2002.

[88] Electric Power Research Institute. "MYGRT Version 3.1, Groundwater Protection and Coal Combustion Products & Management Program." EPRI. Palo Alto, CA. 1010066.

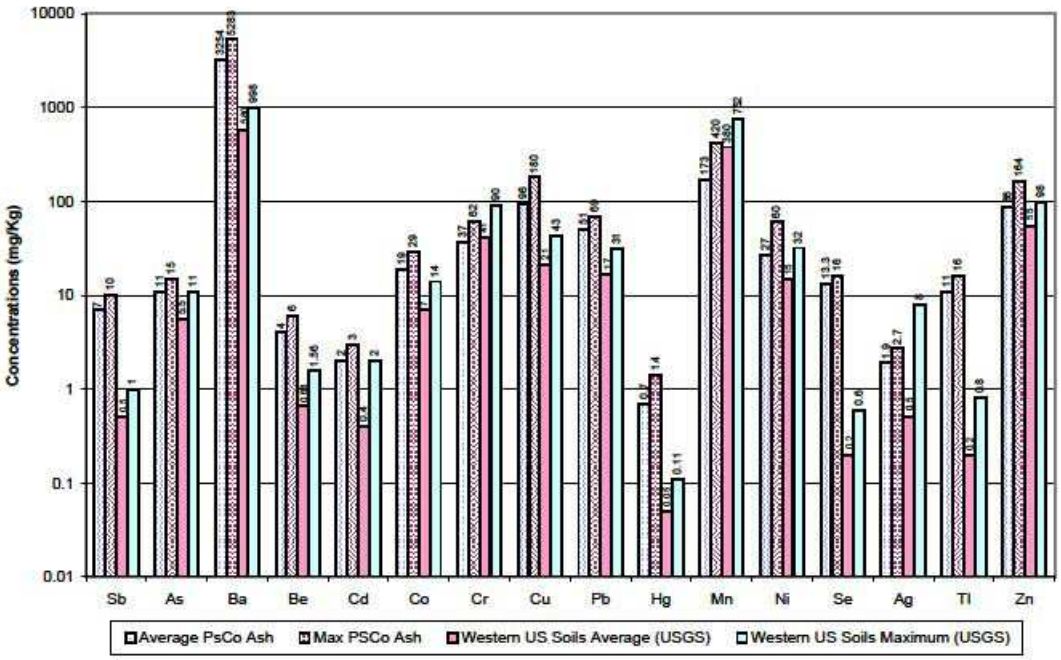
[89] Electric Power Research Institute. "Working Draft 'Screening Analysis for Environmental Evaluation of Small to Moderate Size Structural Fill Projects.'" Not available for public review or dissemination. October.

Furthermore, to question the use of CCPs in "large-scale" placement projects as being similar to disposal under the disguise of beneficial use is an over-simplification and generalization without merit. The term "large-scale" alone does not define a structural fill. Not all structural fills use the quantities of CCPs that were used in the examples of Gambrills, Pines and Battlefield Golf Course. The volume of CCPs required to successfully complete a project must be evaluated based on the total size of the project and the performance to be achieved. For some projects, a large-scale project may number a few thousand tons and for others, over the course of several years, a project may use more than a million tons. However, some projects cover large areas, such as a lengthy road construction project, where the aggregate total of CCPs might be hundreds of thousands of tons used in separate fills along many miles of road way. Although the EPA is not considering the use of CCPs in mine reclamation to be covered by the proposed rulemaking, projects in Pennsylvania have restored thousands of acres of damaged mine lands to habitable condition. In some cases, the use of CCPs has improved groundwater conditions by mitigating acid mine drainage or adverse water conditions. The state has fully sanctioned the use of millions of tons of CCPs over the course of many years in what are essentially structural fills (see Pennsylvania Department of Environmental Protection report "Coal Ash Beneficial Use in Mine Reclamation and Mine Drainage - Remediation in Pennsylvania" published in 2004[90]). The success of this program makes it clear that many large-scale reclamation projects can be conducted safely with positive environmental impact.

The impact on the environment by a project using CCPs is not alone determined by the chemical content of the metals found in CCPs themselves. The techniques of blending, compaction, and providing specific permeability criteria permit CCPs to be used in many climates without adverse impact upon groundwater or adjacent water sources. The attached chart depicts typical western soil samples as compared to ash from power plants in Colorado. Although this is information specific to the western United States, it is indicative of the need to compare ash characteristics to native soils and their metal content.

[90] Pennsylvania Department of Environmental Protection. "Coal Ash Beneficial Use in Mine Reclamation and Mine Drainage Remediation in Pennsylvania." State Book Store. Harrisburg, PA. 2004.

Figure 1 - Trace Metal Concentrations in Ash and Soil



trace metals.xls

As noted in Figure 1, in most cases, native soils had concentrations of trace elements and metals similar to the CCPs. Thus, to infer large scale projects will necessarily have an adverse impact on surrounding land is not based on fact. Furthermore, in many structural fill projects, the surface of the land will be paved or constructed upon, preventing the ingress or percolation of water into the fill. Modeling has shown predictability of leachate from fill materials below a roadway can be accurately estimated. Using the HYDRUS2D model, developed by Drs. Apul (University of Toledo), Gardner IRMC) and Eighmy (RMRC), research has shown that dynamic hydrological and geochemical conditions in a highway environment can be assessed to estimate release of contaminants from secondary industrial byproducts, including CCPs.[91] This is true for materials directly below the wear surface or those contained in embankments and fills.

In early 2000, the Combustion Byproducts Recycling Consortium (CBRC) a DOE funded research group, supported a demonstration project in Colorado where two test sites were filed with 400 tons of two types of Class F fly ash in a former gravel quarry.

[91] Apul, Defne, Gardner, Kevin and Eighmy, Taylor. "Computer Modeling and CCPs: Computer Modeling as a Tool to Evaluate Potential Environmental Impacts of Coal combustion Byproducts and Other Secondary Materials Used in Road and Embankment Construction." Ash at Work. American Coal Ash Association; Aurora, CO. Summer/Fall 2005.

The ash was placed seven feet below the water table, with a fifteen foot native soil divider separating the two trenches. Twelve groundwater monitoring wells were installed up, cross and down gradient of the trenches at spacings of 10, 20, 40 and 50 feet. Point of Compliance was at 50 feet, and an additional well was placed 120 feet down gradient. Groundwater monitoring was conducted weekly the first month, monthly to the end of the first quarter and quarterly until project termination. Surface and groundwater samples were analyzed for 29 elements and ions such as alkalinity, chloride, fluoride, nitrate and sulfate. The project was approved by the State of Colorado and Weld County. Analytical data generated from the field study indicated that the leaching characteristics of coal ash used in the study were relatively benign. Boron was the most mobile and prevalent constituent of concern. Molybdenum, sulfate, selenium, chloride and fluoride had elevated concentrations in water samples obtained from the ash; however, the levels associated with all these elements or ions dropped to below regulatory or background levels within a month of the ash placement. In spring 2010, samples were again collected down-gradient. No discernable change was seen since the termination of the project nearly eight years ago. This study does not mean that every site will experience such benign groundwater impacts, but it indicates that material and site specific characteristics should be evaluated rather than simply imposing a national ban on such placements[92].

In September 2010, EPRI published a technical report, "Comparisons of Coal Combustion Products to Other Common Materials."[93] This report is publically available at no cost on EPRI's website. The report compares CCPs to other materials such as soils and rocks, fertilizers, metal slags, spent foundry sands, and biosolids. Charts depicting the trace element concentrations of CCPs are included. Where available, leachate data was also provided. The report concludes, "Concentration ranges of trace constituents in fly ash, bottom ash and FGD gypsum typically fall below the EPA residential soil screening levels and industrial soil screening levels for ingestion and dermal exposure, except arsenic. Many other materials, including uncontaminated soils and other beneficially used materials also commonly exceed these screening levels for arsenic. CCPs did not exceed any hazardous waste limits in toxicity characteristic leaching procedure test data for the samples evaluated by EPRI from 50 power plant sites."

d. Response to EPA's Specific Damage Cases

1. *Existing Industry Standards for CCPs in Structural Fills Promote their Sound Use*

As discussed in more detail above, there are numerous standards that have been developed to address the use of CCPs in structural fills. The first was a handbook authored by the Electric Power Research Institute (EPRI) in 1979, "Fly Ash Structural Fill Handbook." The first ASTM standard was issued in 1995 and updated and reissued in 1997, and again in 2003. Standards

[92] Adams, Joby and James Warner. "Field Scale Study Results for the Beneficial Use of Coal Ash as Fill Material in Saturated Conditions – Varra Coal Ash Burial Project Weld County, Colorado." Final Report April 15, 2001 – August 31, 2002. CBRC Project #CBRCW02. CGRS, Inc. Fort Collins, CO.

[93] Electric Power Research Institute. "Comparison of Coal Combustion Products to Other Common Materials: Chemical Characteristics." Final Report, September 2010. EPRI. Palo Alto, CA. 1020556.

and technical guidance are now available from a variety of sources (ASTM, PCA, FHWA, RMRC, ACI, AASHTO, and individual states).

2. *Damages Case Definitions*

In a 2007 report titled "Coal Combustion Waste Damage Case Assessments," EPA identified 67 cases of CCP management with groundwater or surface water impacts that it categorized as "potential" or "proven" damage cases. As defined in the preamble of the proposed rule, "potential damage cases" are those where there is a documented exceedance of a federal primary drinking water standard or maximum contaminant level (MCL) in groundwater beneath or close to the waste management unit; these are cases where exceedances have not been demonstrated at a sufficient distance from the unit to pose a human health concern. A "proven damage case" is one where there are documented exceedances of an MCL or other health-based standard at a sufficient distance from a source such that it could cause a human health concern, or where a scientific study has documented damage to human health or the environment, or where there has been an administrative ruling with an explicit finding of a damage to human health or the environment.

It should be noted here that in the context of human health, the "damage" as defined by EPA relates to the concentrations of constituents in groundwater relative to a standard (e.g., MCL). The presence of an exceedance of an MCL in groundwater off-site of a waste management unit, or even in an off-site drinking water well, may result in that situation being classified as a damage case, but it does not mean that actual damage to human health has occurred. Drinking water standards are generally set by EPA and state agencies based on very conservative estimates of constituent toxicity and are generally set to be lower than levels that would be calculated to be safe for daily exposure even over a lifetime.

3. *Damages Cases that Relate to Beneficial Uses*

The damage cases that EPA cites in its 2007 report that potentially relate to beneficial use are listed and summarized in Table 1 for proven damage cases and Table 2 for the potential damage cases (damage case numbering as provided in EPA's report). The information for each case was obtained from an EPRI report entitled "Evaluation of Coal Combustion Product Damage Cases, Volumes 1 and 2" (EPRI Technical Reports Nos. 1020553 and 1020554; available at www.epri.com), that collected and evaluated data pertaining to each of the damage cases identified by EPA.

With the exception of one case, the damage cases all relate to the use of CCPs as fill for quarries. None of these cases represent "indiscriminant" uses of CCPs – all were used for a specific purpose, to reclaim a quarry, or to provide road base and fill to support roads. These activities occurred from as early as 1940 through the 1970's, with two of the potential damage cases active in the 1980's and 1990's. Note that industry standards for various types of structural fill projects, as described above, were not developed until the late 1990's and beyond. Thus the use of CCP's as fill in these cases predates the development of industry standards for their use.

It is also instructive to note that remediation has been completed or is on-going for all of these damage cases, mainly under state authority, but in two instances with federal oversight. Only two of the six proven damage cases indicate that drinking water was impacted by the filling activities, as evidenced by the provision of municipal water as a remedial action. These proven and potential damage cases were identified, investigated, and remediation conducted (and in many cases completed) without the involvement of a federal regulatory program such as that contemplated by EPA under Subtitle C in this proposed rule-making. Thus it is clear that the potential or proven damage from these instances of historic use of CCPs for quarry fill have been identified and addressed under existing state authorities or under existing federal authority. The damage cases do not indicate a need nor provide support for providing direct federal regulatory authority for CCP regulation under a Subtitle C proposal. These cases do demonstrate that current and even historic state programs have adequately addressed environmental impact from these sites.

In the preamble, EPA identifies several other damage cases that were not included in the 2007 report. One of these is the TVA Kingston facility; this damage case is due to a structural failure and not an environmental failure. It is inappropriate to invoke a Subtitle C hazardous waste regulatory program on the basis of this case; as a structural failure, it can be addressed by dam safety programs. Another additional case is the Battlefield Golf Course in Chesapeake, VA; EPA's own evaluation of this case indicates that there are no off-site impacts to groundwater and, thus, it is not classified as a proven damage case. Finally, EPA identifies the BBSS Quarry in Gambrills, MD as a new proven damage case and uses it to support their position that large scale structural fills are not legitimate beneficial uses. The comments being submitted by Constellation Energy on the proposed rule provides more detail on this case.

Table 1. Proven Damage Cases as Identified by EPA (1997) that Relate to Beneficial Use

2. City of Beverly/Vitale Brothers Fly Ash Pit, Massachusetts
- Sand & gravel quarry – 18 acres
- Operation mid-1950's to mid-1970's
- Remediation performed
- Closed under state program
- No indication of drinking water impacts

6. Yorktown Power Station, Chisman Creek Disposal Site, Virginia
- Sand & gravel quarry – 27 acres
- Operation 1957 to mid-1970's
- Added to National Priorities List (NPL), remediation performed, ROD signed
- Alternate water supply provided to 55 homes

14. Highway 59 Landfill, Wisconsin
- Gravel quarry – 23 acres
- Operation between 1969 and 1978
- Remediation performed
- Alternate water supply provided to 10 homes and 4 commercial buildings
- State oversight
- No indication of drinking water impacts

17. Port Washington Facility, Wisconsin
- Limestone quarry – 15 acres – 735,000 yd^3

- Operation in 1940's and 1950's
- Remediation performed
- EPRI evaluation concluded that there is no evidence that this is a proven damage case; exceedances were on-site and off-site well was not above MCLs

18. North Lansing Landfill, Michigan

- Sand & gravel quarry – 27 acres – 1 million yd^3
- Licensed for disposal of inert materials – Operation between 1980 and 1997
- Remediation on-going
- State oversight
- No indication of drinking water impacts – urban area

19. Yard 520 Landfill (Brown's Landfill), Township of Pines, Indiana

- Coal ash landfill permitted by the state – 45 acres
- Older area of landfill is unlined, newer area is clay-lined on bottom and sides
- Operation in unlined landfill area between 1960's and 1980's
- Coal ash was used as road base and fill in areas of the town in the 1970's
- Remedial Investigation conducted under federal Administrative Order; process on-going; landfill has been closed under state program
- Municipal water was provided to approximately 250 addresses

Table 2. Potential Damage Cases as Identified by EPA (1997) that Relate to Beneficial Use

25. K.R. Rezendes South Main Street Ash Landfill, Massachusetts

- Sand & gravel quarry – 31.5 acres – 2.5 million tons
- Operation 1975 through 2001
- Remediation (capping) on-going
- State oversight
- No drinking water impacts

58. Miamiview Landfill, Ohio

- Sand & gravel quarry – 100 acres (with clay liner)
- Constructed in 1983 as reclamation project
- Closed and capped in 1996
- No drinking water impacts

62. Lemberger Landfill, Wisconsin

- Gravel pit – 21-acre municipal solid waste (MSW) landfill – ash used as daily cover
- Open dump from 1940 to 1970 – permitted for MSW with ash as cover in 1969
- On the NPL in 1984
- Remediation completed in 1996
- No drinking water impacts

4. <u>Evaluation of the CCW Risk Assessment with Respect to Beneficial Uses</u>

EPA has used its report "Human and Ecological Risk Assessment of Coal Combustion Wastes" (CCW Risk Assessment) to support a Subtitle C listing for CCPs under the Resource Conservation and Recovery Act (RCRA). As noted in comments submitted on this rulemaking by the Utility Solid Waste Activities Group (USWAG), the numerous fundamental flaws in the EPA's probabilistic CCW Risk Assessment preclude it from being able to be used to support a Subtitle C, hazardous waste, listing. These flaws, as detailed in the USWAG comments, result in a risk assessment that contemplates unrealistic exposure scenarios and grossly overestimates risks.

However, even in this context, the CCW Risk Assessment can provide some perspective on the beneficial use of CCPs in large structural fills. Of the CCP management scenarios evaluated by the CCW Risk Assessment, the "Conventional CCW Landfill" scenario is most germane to structural fills. Given the inappropriate scenarios and assumptions used in the risk assessment, the potential risk associated with an unlined CCW landfill are still only slightly above EPA's target excess lifetime cancer risk range of 1 in one million to 1 in ten thousand (for example, at the 90th percentile, arsenic risks for the drinking water pathway for an unlined CCW landfill range from 2 in ten thousand to 4 in ten thousand). Conventional CCW landfill sizes included in EPA's risk assessment ranged from a low of 80,000 yd3 (approximately 40,000 tons) to a high of 22,262,030 yd3 (approximately 40,000 tons 17,200,000 tons). This range, and especially the upper end of the range, is expected to be higher than the range of amounts of materials used in structural fills. For example, where information on mass is available for the damage cases presented on Tables 1 and 2, the amounts are in the mid-to low end of the CCW landfill range. Thus the source term for evaluation of the potential impact to groundwater would be lower, and the resulting risks would also be expected to be lower, and likely within EPA's target risk range.

Therefore, it would not be expected that risks in excess of regulatory targets would be demonstrated for structural fill project, even using EPA's unrealistic risk and exposure scenarios.

e. Conclusion

This summary of some of the beneficial reuse programs that exist in the United States illustrates the widespread approval regulators have given to the use of CCPs in structural fill. Adhering to consensus standards and accepted best management practices allows regulators the assurance that projects are performed in a manner that will ensure protection of public health and the environment. ACAA believes it is inappropriate to assume that large-scale structural fills are the same as disposal. Engineering practices employed by designers of almost all CCP structural fills require complete evaluation of the sites and the materials to be used and the potential environmental impact that may be seen. Characterization of the site and CCPs prior to commencing a project can identify the precautions and considerations that need to be incorporated into a structural fill. Such a process, potentially to be addressed through new or revised consensus standards, will also ensure that the proposed land use is properly determined and that CCPs are, in fact, appropriate for the project. This is not an indiscriminant practice and is instead a genuine beneficial use of materials that might otherwise have to be disposed. Conservation of natural resources through the use of CCPs in structural fills in defensible from a technical, social, economic, and environmental perspective. Implementation of consensus standards and best management practices as outlined in this letter can assure the continued safe use of CCPs. Background soils, climatology, and end use of the land all are factors that must be considered when using CCPs no matter what the size of the project. To eliminate the use of CCPs through an EPA regulatory process would be to preclude a sustainable construction practice favored by many states and regulators. It is essential to provide more opportunity for the technically sound, environmentally protective methods of beneficial use for CCPs and to prevent them from being disposed. A determination that CCRs

would have to be managed as a special waste under RCRA Subtitle C in the future would eliminate that majority of all structural fills. The management of CCRs under RCRA Subtitle D would provide the same protection of public health and environment as Subtitle C and would allow this important beneficial use for CCPs to continue.

Throughout the proposed rulemaking, EPA has requested comments on various aspects of CCP use. Table VIII-1 addresses those specific comments that ACAA views as concerning the use of CCPs as structural fill.

RESPONSES TO SPECIFIC QUESTIONS POSED BY THE EPA

Table VIII-1
Responses to Specific Questions Posed by the EPA

FR Page No.	EPA Question	ACAA Answer
35148	EPA makes it clear that CCRs in sand and gravel pits, quarries, and other large fill operations is not beneficial use, but disposal. As such, it would be regulated under whichever option is finalized. EPA solicits comments, however, on whether unencapsulated uses of CCRs warrant tighter federal control.	The presumption that the use of CCPs to reclaim sand and gravel quarries is not a beneficial use is flawed. While sand and gravel quarries have been used to dispose of CCPs it is not correct to assume that with proper engineering and environmental standards that CCPs cannot be used beneficially to reclaim quarries for uses such as recreational areas, commercial or industrial use, or to aesthetically improve the characteristics of the land.
35161	The Agency solicits information and data on these and other approaches [defining beneficial use or developing detailed guidance on beneficial use] that EPA could take in identifying when uses of CCRs constitute a "beneficial use," and consequently will remain exempt.	The recommendations provided in ACAA's comments on geotechnical beneficial uses submitted separately provide relevant guidance to be used in developing standards for the use of ash in geotechnical projects. As discussed on Pages 73-80, a number of states provide explicit guidance on the use of CCPs in structural fills which they consider to be a beneficial use.
35161	Today's proposed rule explicitly removes these types of uses [sand & gravel pits, landscape regarding] from the category of beneficial use, such that they would be subject to the management standards that EPA finally promulgates. EPA also seeks information and data on whether it should take a similar approach in today's proposal to unencapsulated uses of CCRs, such as the placement of unencapsulated CCRs on the land, e.g., agricultural uses.	ACAA addresses encapsulated uses in Section VI. For some structural fill projects, site-detailed specific assessments may be necessary depending upon geological and other environment considerations and the volume of fill. The recommendations discussed on Pages 73-80 above provide specific suggestions that may appropriately pertain to structural fills.
35161	EPA is also soliciting comment on whether the Agency should promulgate standards allowing such uses, on a site-specific basis, based on a site-specific risk assessment, taking into consideration, inter alia, the CCRs character and composition, their leaching potential under the range of conditions under which CCRs will be managed, and the context in which the CCRs will be applied, such as location, volume, rate of application, and proximity to water.	See our comments on Pages 70–80 of this letter.
35161	EPA solicits comment on whether an alternative approach is appropriate, particularly for unencapsulated uses of CCRs on the land.	This issue is addressed in Section VI addressing encapsulated uses.

FR Page No.	EPA Question	ACAA Answer
35162	EPA is requesting information and data on the appropriate means of characterizing beneficial uses that are both protective of human health and the environment and provide benefits.	The use of CCPs for unencapsulated projects constitute beneficial use if they are constructed or applied in a manner consistent with the protection of public health and the environment, good engineering practice, and are consistent with the goal of preserving natural resources, conserving energy and reducing or eliminating the need to dispose of CCPs in landfills as described in Section IX to these comments addressing geotechnical and unencapsulated uses.
35162	EPA is also requesting information and data demonstrating where the federal and state programs are or have been inadequate in being environmentally protective and, conversely, where states have, or are developing, increasingly effective beneficial use programs.	Beneficial use regulations related to structural fills vary considerably with some examples provided on Pages 73-80 of this letter.
35163	EPA solicits comments on appropriate criteria to distinguish between legitimate beneficial uses and inappropriate operations, such as, for example, a comparison to features associated with relatively small landfills used by the utility industry, and whether characteristics of the materials would allow their safe use for a particular application in a particular setting (i.e., characterize both the materials for the presence of leachable metals and the area where the materials will be placed).	With proper engineering, large-scale structural fills can be successfully completed without adverse environmental impact. Our discussion through the body of this letter provides explanations as to ACAA's position. Many of the references included in the accompanying folder ("Section VIII – Structural Fill") support this conclusion as demonstrated by research and case studies provided or referenced in that folder.
35163	Accordingly, in this section, the Agency presents information on the issues on which it is specifically soliciting comment. First, we identify the array of environmental issues associated with unencapsulated uses. CCRs can leach toxic metals at levels of concern, so depending on the characteristics of the CCR, the amount of material placed, how it is placed, and the site conditions, there is a potential for environmental concern.	ACAA has provided specific environmental and engineering standards for structural fills and recommends further guidance be developed to properly assess potential environmental impact using a risk based process. See Pages 73–80 of this letter.
35164	While EPA does not want to negatively impact the legitimate beneficial use of CCRs unnecessarily, we are also aware of the need to fully consider the risks, management practices, state controls, research, and any other pertinent information. Thus, to help EPA determine whether to revise its approach and regulate, for example, unencapsulated uses of CCRs on the land, we solicit comments on whether to regulate, and if so, the most appropriate regulatory approach to be taken.	In its proposal, EPA has suggested that it may regulate the unencapsulated uses of CCPs either through Subtitle C or Subtitle D of RCRA. The rationale given to regulate beneficial use as presented in its proposal is based upon so-called damage cases that occurred many years ago, and infers that these practices that occurred years ago reflect the current state of the beneficial use of coal ash in the United States. ACAA recognizes the fact that some states may not have those procedures in place that follow the recommended practices outlined above for all structural fills to ensure proper engineering procedures and safeguards to the environment from beneficial use. We are not aware of any states that have reported damage to the environment or negatively impacted public health that warrants the regulation of the beneficial use of coal ash by Subtitle C of RCRA. If EPA finds it necessary to regulate the beneficial use of CCPs, the only acceptable and reasonable approach would be through Subtitle D of RCRA.

FR Page No.	EPA Question	ACAA Answer
35165	We would like comment on whether persons should be required to use a leaching assessment tool in combination with the Draft SW-846 leaching test methods described in Section I. F. 2 and other tools (e.g. USEPA's Industrial Waste Management Evaluation Model (IWEM)) to aid prospective beneficial users in calculating potential release rates over a specified period of time for a range of management scenarios, including use in engineering and commercial applications using problematic assessment modeling.	Although EPA has indicated that the toxicity characteristic leaching procedure (TCLP) may not be appropriate to properly characterize leaching in unencapsulated uses, it has not demonstrated that the use of TCLP to characterize CCPs in properly designed projects where appropriate environmental and engineering considerations have resulted in damage to the environment or impacted public health. As is set forth in our above discussion, we believe there are a number of adequate and accurate test protocols and models that con be use to assess potential impacts. Simple screening tools such as TCLP can and still should be used with other available leach tests such as ASTM D3987 and the synthetic precipitation leaching procedure (SPLP) to better understand the characteristics of CCP uses in structural fill projects. Until it can be demonstrated that new leach tests proposed by EPA or the use of groundwater models are superior to existing procedures, based on actual ground truth data, or groundwater monitoring on actual projects, existing leach procedures should be used in concert with properly designed projects.
35165	If EPA determines that regulations are needed, should EPA consider removing the Bevill exemption for such unencapsulated uses and regulate these under RCRA subtitle C or should EPA develop regulations under RCRA subtitle D?	The Bevill exemption should be preserved with the addition of those beneficial uses recommended by ACAA. CCPs should not be regulated under Subtitle C of RCRA unless the specific CCP has been tested to be hazardous under the existing TCLP procedures. The EPA should provide guidance to states and encourage them to develop beneficial programs consistent with recommendations by ACAA.
35165	If regulations are developed, should they cover specific practices, for example, restricting fill operations to those that moisten and compact fly ash in layers to attain 95% of the standard Proctor maximum dry density value and provide a drainage layer? Are such construction practices largely followed now?	Engineering practices to implement beneficial use projects should be commensurate with the spatial and volume size of the use, structural considerations, and geologic site conditions. Some small and less complicated projects may not require that optimum moisture and in-field density be achieved to 95% of standard Proctor. Existing ASTM standards provide sufficient construction guidance for structural fills using CCPs that address compaction and other placement criteria. Other standards and specifications contained in the accompanying folder ("Section VIII – Structural Fill") further provide technical guidance on placement and performance.

FR Page No.	EPA Question	ACAA Answer
35165	Should the EPA exclude unencapsulated uses in direct contact with water bodies (including the seasonal high groundwater table) from beneficial use?	Our discussion on Page 81 cites an example where no adverse impact was seen when CCPs were replaced directly in contact with groundwater. The Commonwealth of Pennsylvania has numerous examples of CCPs used in water-filled sites to mitigate existing environmental damage, especially when remediating acid mine drainage. Specific characterization of materials and the site where they will be placed should be made on a case-by-case determination and not banned without and sound, scientifically based evaluation.
35222	Whether certain uses of CCRs (e.g., uses involving unencapsulated uses of CCRs) warrant tighter control and why such tighter control is necessary.	In some structural fills, individual assessments may be necessary to evaluate proper engineering construction practices that may require liners or other controls in situations where geologic or other environmental conditions dictate their use. See our discussions on Pages 73–80.
35222	If EPA determines that regulations are needed for the beneficial use of CCRs, should EPA consider removing the Bevill exemption for such uses and regulate these uses under RCRA subtitle C, develop regulations under RCRA subtitle D or some other statutory authority, such as under the Toxic Substances Control Act?	If EPA determines it must regulate the beneficial use of CCPs, it should do so under RCRA Subtitle D without removing the Bevill exemption for such uses. The use of Subtitle D for the regulation of municipal landfills has proven to be successful.
35222	Whether the Agency should promulgate standards allowing uses on the land, on a site-specific basis, based on site-specific risk assessments, taking into consideration the composition of CCRs, their leaching potential under the range of conditions under which CCRs would be managed, and the context in which CCRs would be applied, such as location, volume, rate of application, and proximity to water.	For those beneficial use projects, such as certain structural fills, that may require site specific assessments, tools are currently available to assist states in determining the necessary engineering practices and environmental performance requirements.

Section IX – Beneficial Use: Geotechnical and Unencapsulated Uses

a. Introduction

The purpose of this report is to provide comments on EPA's proposal and request for beneficial use information by providing data and rationale that support a flexible, cost effective, and technically sound approach to beneficially using CCPs for geotechnical or unencapsulated uses that are protective of public health and the environment, and that preserve resources, conserve energy, and reduce or eliminate the need to landfill CCRs.

The United States Environmental Protection Agency (EPA) is proposing for the first time to regulate coal combustion residuals (CCRs) under either Subtitle C or Subtitle D of the Resource Conservation and Recovery Act (RCRA). CCRs are also referred to in this document as coal combustion products (CCPs) when used in beneficial applications. EPA's proposal addresses the regulation of the land disposal of CCRs and requests information on beneficial use applications. The purpose of this American Coal Ash Association (ACAA) document is to comment on the proposals and to respond to EPA's questions that specifically address the beneficial uses of CCRs that are referred to by EPA as "Unencapsulated Uses."

The primary basis upon which EPA is proposing a change in the regulatory structure of CCRs is the failure of a surface impoundment retaining wall in Kingston, TN, in December 2008. EPA has also referenced cases of where CCRs were placed in sand and gravel quarries and in a few projects that they refer to as large structural fills that, in their opinion, have negatively impacted the environment and that provide further support to regulate CCPs under a federal framework, despite the fact that most of these examples were constructed many years ago and are generally regarded by industry as improperly engineered projects. These cases are addressed in a separate submittal by ACAA.

EPA has classified beneficial uses of CCPs into two categories: "Encapsulated" and "Unencapsulated." EPA defines "Encapsulated Uses" as those beneficial uses in which the CCPs are chemically and physically bound into a matrix, such as fly ash as a replacement for portland cement in concrete or flue gas desulfurization (FGD) gypsum as a replacement for mined gypsum in wallboard. EPA states that it believes that "encapsulated" uses are safe and should be exempt from the disposal regulation. However, EPA is not as confident that the applications for CCPs that it terms "unencapsulated" uses are safe, and requests information from commenters, which include the coal ash industry, academia, and state regulatory authorities.

In its May 2000 Regulatory Determination, EPA broadly listed the categories of "unencapsulated" uses as road bed, structural fill, soil stabilization, snow and ice control, and waste stabilization. In this comment document, ACAA refines and addresses the following categories of "unencapsulated" use. ACAA refers to them as Geotechnical Applications because, with the exception of the listed Surface Applications and Feedlot Stabilization, the uses are, in the opinion of ACAA, "encapsulated" below pavement or other structures and undergo a physical and/or chemical hydration reaction. The Geotechnical Applications are as follows:

- **Subgrade fills** that serve as support under buildings, roads, parking lots and storage areas, typically with thicknesses of six inches to four feet.

- **Soil and base stabilization** for the improvement of soils through strengthening, drying, control of shrinkage and swelling problems, and for in situ recycling of deteriorated asphalt pavement into new base course.
- **Surface applications** encompass a wide variety of smaller volume applications including chip seal coatings on rural roads; skid control on icy pavements; bottom ash and slag (i.e. "cinders") on low traffic volume parking areas and roads, high school running tracks, walking and biking trails, and equestrian trails; and decorative stone.
- **Feedlot, dairy and livestock pen stabilization** to control mud and improve drainage and animal health; and gravel road stabilization to control dust and mud.
- **Waste stabilization and solidification** to treat contaminated and waste materials, and to solidify sludges.

ACAA members have been engaged in the beneficial use of CCPs for more than 40 years, and we believe that we are very well qualified to make recommendations regarding regulatory details of CCP use. ACAA believes that implementing the following recommendations will serve to preserve and increase CCR/CCP beneficial use, and provides sound rationale for each in the body of this comment document:

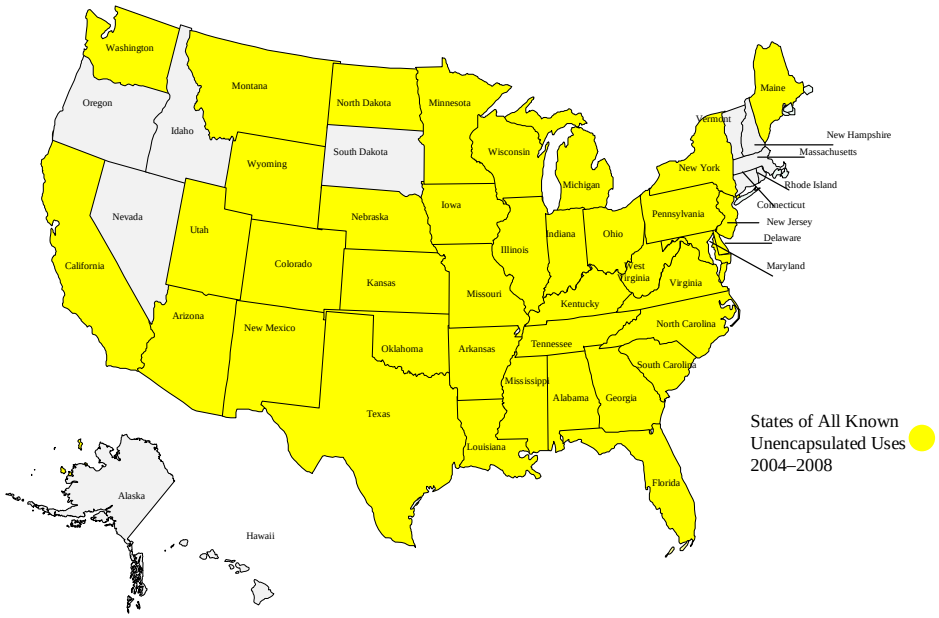
- First and most important, ACAA recommends that EPA **not** classify and regulate CCRs/CCPs under Subtitle C of RCRA, whether for disposal purposes only or otherwise. The hazardous waste stigma carries a liability aversion and is too great to take the risk of destroying the recycling markets that have taken many years to build.
- ACAA recommends that the geotechnical uses for CCPs that are discussed in this comment document be specifically listed and included as acceptable uses for CCPs in any regulatory action proposed by EPA.
- ACAA recommends that the states be allowed and encouraged to continue their regulation of beneficial reuse of CCPs. EPA should support state permit programs that are designed to provide revenue for beneficial use programs. The Wisconsin Department of Natural Resources Chapter NR 538 Beneficial Use of Industrial Byproducts (NR 538) program is a model of an effective regulatory framework that encourages high utilization rates of CCPs.
- ACAA recommends that EPA establish a new set of Federal Procurement Guidelines that mandate the use of CCPs in the geotechnical applications discussed in this report in any projects receiving federal funds in amounts greater than $10,000.
- ACAA recommends that EPA re-establish its Coal Combustion Products Partnership (C^2P^2) Program, and expand it to provide guidance to states through conferences or regionally organized training programs.

- ACAA recommends that if EPA decides that national standards for beneficial use are necessary, then ACAA should be included in the process to create the environmental and engineering criteria for a national program.
- ACAA recommends that CCPs undergo periodic characterization testing as appropriate for the specific use, and that locational criteria be applied as needed.
- Finally, the geotechnical uses discussed in this comment document should be self-implementing, with annual reporting made to the appropriate state agencies. These uses tend to be smaller in terms of volumes of CCPs, and no impacts on health or the environment from these uses have been reported. Guidance is provided in ASTM International (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) documents, and applications are governed in many cases by Department of Transportation (DOT) specifications. Adherence to locational restrictions and engineering guidelines are sufficient to assure environmental safety. Detailed review should be required for only the high-volume structural fills.

If the United States is to increase utilization rates of CCPs, it is essential that the geotechnical applications be preserved and encouraged. There is not enough concrete produced in the United States to make use of all production of CCPs and not all CCPs meet the specifications required for use in concrete products. In 2008, only 14.0 million tons of fly ash were used in the production of concrete, concrete products, and cement clinker. This was only 10.3% of the 136 million tons of CCPs produced, and only 30.1% of the CCPs put to use that year. Geotechnical uses are technically sound, economically viable, and environmentally safe. They can help to fill the gap in utilization rates until such time as more exotic uses for coal ash are developed and become economically competitive.

Figure ES-5 shows that the so-called “Unencapsulated Uses” are on record as having been practiced in 39 of the 50 states. The table shows tonnages of CCPs reported to ACAA as having gone into these geotechnical applications during these years.

A Subtitle C designation for CCPs—even if for disposal purposes only—will destroy the recycling markets that have taken so many years to build. Architects, engineers, and owners will discontinue specifying CCPs in various applications because of concerns for liability. Utilities may decide to discontinue the sales of CCPs because of liabilities that may arise from class action lawsuits. Considerable public relations damage has already occurred, as evidenced by news reports that continually refer to CCPs (or coal ash) as toxic and hazardous. We believe the comments contained in this letter are based on sound technical and scientific principles and the recommendations provided will ensure that public health and the environment are protected.



2004	2005	2006	2007	2008	Totals 2004–2008
14,083,397	15,922,215	17,508,737	16,729,094	19,040,699	83,284,142

Figure ES-5
Map of all known unencapsulated uses of CCPs from 2004 to 2008. The units in the table are short tons.

b. ACAA Recommendations

1. *Bevill Exemption/May 2000 Regulatory Determination*

In its proposal, EPA did not change its May 2000 Regulatory Determination relative to beneficial uses, but asked whether the Bevill exemption should be retained for certain beneficial uses, specifically unencapsulated uses. EPA also asked whether potential refinements could be made to the beneficial use definitions. ***ACAA supports refinements to the beneficial use definitions.*** The May 2000 Regulatory Determination only defined very broad categories of beneficial uses of CCPs that correlate to the category of unencapsulated or geotechnical uses. Those uses are road bed, structural fill, soil stabilization, snow and ice control, and waste stabilization.

The uses presented in the May 2000 Regulatory Determination are not well-defined and can easily be misinterpreted. Furthermore in its current proposal, EPA defines beneficial use of CCPs to not include high-volume structural fill projects that restructure the landscape. If these applications and terminology are not further defined and justified through their widely-accepted uses in construction, they are in danger of no longer being allowed.

2. *Geotechnical Beneficial Use Definitions*

In response to EPA's request for comments that may refine its May 2000 Regulatory Determination, ACAA recommends that the following geotechnical or unencapsulated application classifications for CCPs be defined by EPA as beneficial uses:

1. **Subgrade fills** – A subgrade fill is an engineered project where CCPs are used in lieu of virgin materials to provide a sturdy, flat surface that serves as the support below roads and buildings. Subgrade fill can range in depth from 6 inches to 4 feet. This can further be defined as follows:
    a. Grade course, subbase or subgrade fill for the construction of commercial, industrial, agricultural and non-residential institutional buildings, paved parking or storage surfaces
    b. Grade course, subbase or subgrade fill for the construction of paved federal, state or municipal roadways
2. **Soil and base stabilization** – Soil and base stabilization is used by contractors to improve the engineering properties of soils and base materials through treatment with fly ash. CCPs used for these applications are either (i) Class C fly ash, which is self-cementing upon the addition of water, or (ii) Class F fly ash combined with an activator (calcium source) such as cement, lime, cement kiln dust or lime kiln dust. Both fly ash application types will cement, harden and gain significant strength upon addition of water. The stabilization process generally consists of thoroughly mixing 7%–20% fly ash with the soil or base material being treated, blending in the appropriate quantity of water to optimize compactability and the cementitious hydration reaction, and compacting the resultant mixture to the appropriate density. The cementitious nature of fly ash, either alone or in combination with an activator, can be used to impart a variety of benefits to soil and base materials, and is used for the following purposes:
    a. Soil drying to facilitate construction
    b. Reducing shrink-swell properties of clay soils
    c. Increase in strength properties and load-bearing capacity of native soils
    d. Aggregate base stabilization
    e. Bituminous pavement recycling
    f. Unencapsulated stabilization applications such as feedlot stabilization and gravel road solidification, which may or may not be covered with a pavement layer after hydration has taken place
3. **Surface applications** – Surface applications are defined as the use of CCPs for their standardized granular material properties that can be used in lieu of natural materials such as stone, gravel, and sand.

a. Bound and unbound applications – chip seal and surface material for low traffic areas

b. Winter weather abrasives – anti skid road applications

c. "Cinders" on running tracks, walking trails, equestrian trails, etc.

d. Decorative stone – primarily used for landscaping applications

4. **Feedlot, Dairy, and Livestock Pen Stabilization –** Earthen pens and laneways do not withstand concentrated livestock traffic, particularly when the surface remains wet for any length of time such as during wet winters or spring thaw. As the integrity of the pen or laneway surface breaks down, deep mud and poor drainage reduce animal performance and health (as indicated by poor weight gain and reduced milk production, and increased incidence of mastitis), increase odor emissions, and prevent regular maintenance operations such as manure removal. Stabilization of the soil using CCPs can provide feedlot and dairy operators with an environmentally safe, low-cost option to improve feedlot conditions, animal health, animal weight gain, and odor control. CCPs derived from Class C or high lime fly ashes also have a higher pH which helps reduce bacteria, flies and the use of antibiotics.

5. **Waste stabilization and solidification** – Self-cementing fly ash can be used as a stand-alone binder or it can be blended with other cementitious materials to treat contaminated materials or waste materials. Environmental consultants provide guidance and recommendations on how to best treat contaminated materials. These recommendations may include a mix design for the binding agent to stabilize/solidify the waste material(s). The mix design will be one in which the stabilized material meets or exceeds minimum standards set forth by the state or federal agency with oversight authority on the project. There are two primary forms of waste stabilization:

   a. Fly ash is mixed into contaminated media to immobilize heavy metals and contaminants of concern. The stabilized media is then permanently disposed of in place or transported to a landfill.

   b. Fly ash is used to solidify liquids and sludges to allow for permanent disposal in landfills.

Specific details on the generally-accepted industry construction techniques and environmental considerations that support these beneficial uses as functional benefits to society are provided for each category of uses in this document. ***ACAA recommends that the beneficial uses that are discussed in this response to EPA be specifically listed and included as acceptable uses for CCPs in any regulatory action proposed by EPA.***

3. <u>Environmental and Engineering Beneficial Use Guidelines</u>

Market-driven use of CCPs by contractors in competitive bidding situations ensures that CCPs are used appropriately, and not in excess, and that project performance requirements are met. If there is a price that is charged by the marketer for the fly ash, the contractor will not use

more than is needed to accomplish the purpose. The cost factor works to prevent irresponsible overuse and waste of the CCP. Most specifications require field testing to verify that performance goals such as proper compaction and compressive strengths are met. Failure to meet those targets may result in economic penalties, performance issues, and loss of contractor qualification for future projects.

It must be emphasized that the costs for the use of CCPs in geotechnical applications such as soil stabilization or bituminous pavement recycling assures that their use is always for a specific purpose. Contractors and specifiers choose to use CCPs in place of conventional materials of construction or conventional construction techniques because they can attain equal or better performance for a lower cost. In fact, there are diminishing returns from using excess quantities of reactive Class C fly ash in these applications. Even more important than the application rate of fly ash to soil or recycled asphalt pavement are the percent moisture in the mix and the delay time between mixing and compaction. ACAA encourages the use of laboratory testing procedures to determine proper mix design for specific materials.

EPA is soliciting comments on whether it should promulgate standards allowing beneficial uses on a site-specific basis taking into account the characterization and leaching potential of the material, including volume, location and proximity to water. ACAA agrees that certain types of beneficial use projects need to be assessed on a site-specific basis, but the majority of the beneficial uses identified above can be implemented using a basic protocol whereby i) the CCP is assessed for its chemical and physical characteristics, ii) locational criteria that take into account ground water and surface water proximity are applied, iii) nationally-accepted construction standards defined by ASTM International (ASTM) and/or the American Association of State Highway and Transportation Officials (AASHTO) or other organizations are applied when appropriate, and iv) post-construction activities are provided that, at a minimum, record the location of large projects.

Some states have designed programs whereby the size of the project or the leaching potential of the CCP defines the level of analysis required before a project can be implemented. In some cases, such as Wisconsin and Iowa, states allow projects to proceed without review. Even though these projects proceed without a review, users are required to characterize the material, abide by locational criteria, adhere to referenced engineering and construction standards in code, and in some cases submit reports.

Lastly, EPA has asked whether its proposed changes to the leaching methods in SW-846 and the Industrial Waste Evaluation Model should be used for site-specific assessments of beneficial use projects. Although EPA has indicated that use of the Toxicity Characteristic Leaching Procedure (TCLP) may not be appropriate to properly characterize leaching in geotechnical uses, it has not been demonstrated that the use of TCLP to characterize CCPs in properly designed projects, where appropriate environmental and engineering criteria have been applied, has resulted in damage to the environment or put the public health at risk. Simple screening tools such as TCLP should be used if mandated by the regulatory authority and with other available leach tests such as ASTM D3987 or the Synthetic Precipitation Leach Procedure (SPLP) to better understand the characteristics of CCPs. Some states use specific leaching models that may be

appropriate as well. Until it can be demonstrated that the new leach tests proposed by EPA (i.e. LEAF), or the use of groundwater models, are superior to existing procedures in predicting levels of contaminants in ground water—and verified by actual ground truth data—these procedures should only be used in concert with existing leach tests to assist in the engineering design of beneficial use projects.

In the event that the U.S. EPA requires the use of the proposed leach methods, EPA should provide guidance and training to the states in order to fully utilize these tools properly before any new leach tests and models are applied. Applicability of results and their interpretation are of paramount concern to ACAA.

4. Regulatory Approach

A wide variety of state regulatory programs are already in place that assure the environmentally sound beneficial use of CCPs in geotechnical applications. ACAA recommends that the Geotechnical Uses of CCPs described in this comment document continue to be exempted by the U.S. EPA from federal regulation and that the states are allowed and encouraged to continue their regulation of beneficial reuse of CCPs.

The spectrum of state beneficial use programs ranges from those that allow CCP utilization under a general exemption to those with strict and comprehensive provisions governing every aspect of the projects.

If the beneficial uses of CCPs are conducted according to the engineering and environmental guidelines recommended in this document, the protection of human health and the environment will be assured. ***ACAA recommends that these guidelines be used by states to develop a uniform approach to the utilization of CCPs***. These procedures may be in the form of rules, permits, or approvals but should recognize the fact that most beneficial uses, other than high-volume structural fills, should not require a case-by-case review to create a functionally efficient program that is protective of human health and the environment.

ACAA recognizes, through its review of state beneficial use procedures, that the majority of states may not have specific rules or procedures in place to evaluate beneficial use projects, and that the absence of these procedures is a concern to EPA. ***If EPA determines that beneficial use should be regulated more fully, ACAA recommends that it be regulated by the states. Further, if EPA decides that national standards for beneficial use are necessary, then all stakeholders, including ACAA, NGOs, state regulators and end users should be included in the process to create the environmental and engineering criteria for a national program.***

ACAA further recognizes that state solid waste programs may not have the staff to implement procedural changes in a timely manner before and after national standards are promulgated. ***Therefore, EPA should consider re-establishing its Coal Combustion Products Partnership (C^2P^2) program and expanding it to provide guidance to states through conferences or regionally organized training programs.*** ACAA would gladly offer to assist in this effort.

Lastly, ACAA recognizes that because staffing at state agencies may not be sufficient to properly implement beneficial use programs, consideration should be given by EPA to support permit

programs that are designed to provide revenue for beneficial use programs. Permit programs for other air, water and solid waste programs are common among the states and if properly designed provide necessary revenue commensurate with the scale of project use.

5. *Federal Procurement Guidelines*

In addition to the previous recommendations, ***ACAA recommends that EPA establish a new set of Federal Procurement Guidelines that mandate the use of CCPs in the geotechnical applications discussed in this report in any projects receiving federal funds in amounts greater than $10,000***. EPA established Federal Procurement guidelines for the use of fly ash in concrete in 1980, and the action was very helpful in increasing the beneficial utilization rate of fly ash in the cement replacement markets.

c. Technical and Public Policy Rationale for Recommendations

1. *Damage Cases*

In its proposal, EPA has offered two options to regulate the unencapsulated use of CCPs: either through Subtitle C or Subtitle D of RCRA. The rationale given to regulate beneficial use is based upon "…damage cases associated with disposal in sand and gravel quarries that occurred many years ago, as well as a few cases…" of what EPA refers to as "large-scale fill projects."

ACAA agrees with EPA that there is a need to further strengthen engineering and environmental considerations that are used in implementing beneficial use in certain limited applications, namely high-volume structural fill uses where the volume and site characteristics may require more engineering to protect public health and the environment. However, ACAA does not agree with EPA that past poorly planned and executed disposal practices at sand and gravel quarries are relevant as they relate to the impacts that the beneficial use of CCPs has on the environment or to the threat they pose to public health. ***These damage cases only point out the need for properly engineered projects, and bear no resemblance to the uses described in this comment document.***

2. *Existing State Beneficial Use Regulations and Reported Impacts*

It is undisputed that there are some states that do not have procedures in place that follow the recommended engineering and environmental criteria outlined in this document. The EPA has presented in its proposal a few damage cases of what it refers to as beneficial use, despite the fact that these cases represent only a very small number of projects that have used CCPs in the past four decades. ACAA is concerned that EPA will use these examples as justification to eliminate any future projects that they refer to as "unencapsulated" applications of CCPs.

Most geotechnical applications of CCPs use a limited amount of material, and do not fall in the category of "high-volume structural fill projects." Most of these applications use current industry standards and guidelines produced by consensus organizations such as ASTM or AASHTO that are referenced in state beneficial use rules, in state building and construction guidelines and standards, or are simply standard construction practice.

3. *Unencapsulated Uses as a Necessary Component of Ash Utilization*

The potential to use more coal ash for all applications is a function of the physical and chemical characteristics of the CCP; the economics of the market use; the overall market demand for the finished product; and the manner in which state and federal regulations either encourage or prohibit its use. In 2008, 45% of all CCP production, or 60.6 million tons, was used in all applications. The use of fly ash in concrete, concrete products and in cement comprised only 30.1% of the 60.6 million tons of CCPs used, or 18.2 million tons. In contrast, the unencapsulated uses, not including agriculture or mining applications, represented 31% of the total use (19.0 million tons), with the 11.5 million tons going into structural fills and embankments comprising 19% of the total use.

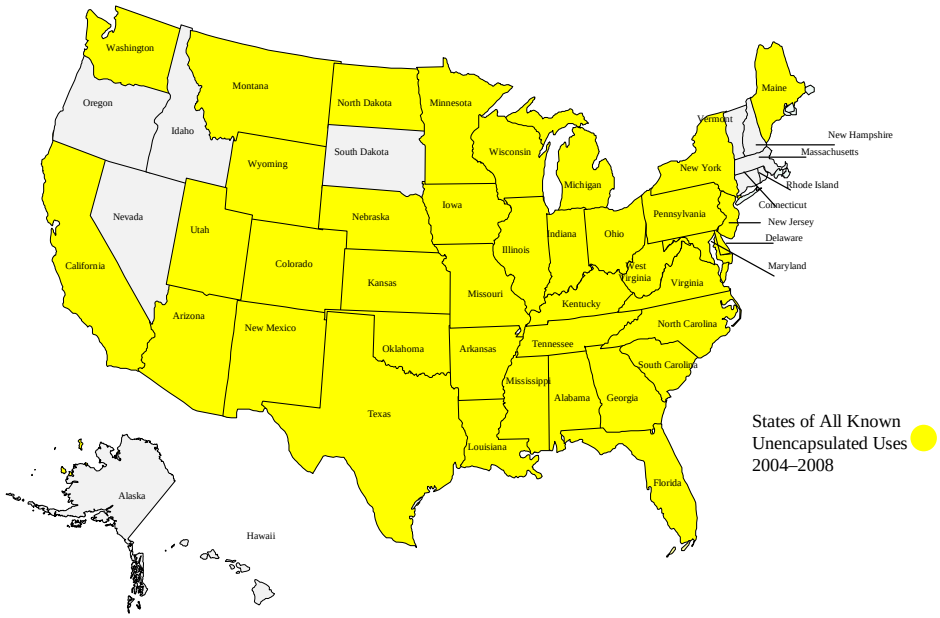
Figure 1-1 illustrates the geographic territory in which it was reported that CCPs were used in geotechnical applications, including high-volume structural fills and embankments, from 2004 to 2008. The table shows the tonnages of CCPs that were reported to ACAA as having been used in these geotechnical applications during these years. The use of CCPs in these applications has increased steadily as specifications have been developed and their positive economics have been recognized by contractors, specifiers, and project owners.

What alternatives are available to increase the amounts of CCPs currently used in all applications and approach the goal of 100% CCP utilization? While some believe it is possible that the use of fly ash in the production of concrete, concrete products and cement can be increased by a factor of 2 or 3, there are some practical limitations to the use of fly ash in these applications.

The fly ash that was sold for use in concrete, concrete products, and grout and as raw feed for cement clinker in 2008 represents only 22% of total U.S. fly ash production. While there is still some room for growth, it would require a 459% increase in fly ash currently used in these applications to reach 100% fly ash utilization.

It is apparent that if the United States expects to approach 100% utilization of CCPs, it is necessary to allow more uses for CCPs than just in concrete, concrete products, cement and other encapsulated uses. Paragraph i. below, entitled “Why Concrete and Concrete Products Cannot Use 100% of U.S. CCP Production,” expands on this argument in greater detail. To address additional specific questions posed by the EPA in the proposal, a table has been prepared containing ACAA answers and is located in Table IX-1.

It is ACAA’s position that a successful strategy to increase the use of CCPs in the United States and decrease the amount that currently is disposed of in land disposal must rely on all current uses of CCPs and not simply target one use over another. That having been said, any strategy to increase the use of CCPs must rely on the use of sound scientific data that supports and resolves issues with regard to its effects on human health and the environment.



2004	2005	2006	2007	2008	Totals 2004–2008
14,083,397	15,922,215	17,508,737	16,729,094	19,040,699	83,284,142

Figure 1-1
Map of all known unencapsulated uses of CCPs from 2004 to 2008.

4. *Encouragement vs. Stigma*

EPA states in its proposal that it believes that regulating CCPs under Subtitle C will not impose a significant barrier to beneficial use and that a hazardous waste label will not place a stigma on CCPs. In support of their position, EPA presents examples of waste streams that are regulated under Subtitle C or Superfund cleanups. EPA cites the examples of electric arc furnace dust, electroplating waste water sludge, chat, used oil, spent etchants, and spent solvents.

The waste stream examples that EPA presents have volumes that are extremely small in comparison to the 136 million tons of CCPs produced in the United States in 2008. In ACAA's opinion, these examples present no credible evidence that labeling a CCP as hazardous under Subtitle C will not have a negative effect on demand for these products, and would more likely be a detriment to increasing the levels of CCP use. In fact, the use of CCPs today is ubiquitous, and far greater than most common household products and industrial byproducts that are discarded.

On the other hand, states that have written and implemented regulations similar to those outlined in ACAA's recommendations have achieved high reuse rates utilizing all the beneficial use options presented here. Under the Wisconsin Department of Natural Resources Chapter NR

538 Beneficial Use of Industrial Byproducts (NR 538) rule, the state has achieved reuse rates of CCPs greater than 90%, one of the highest reuse rates in the United States. This is accomplished routinely through rules that incorporate many of the ACAA recommendations, including material assessment, locational criteria, national engineering standards for material use, and post-construction activities.

Wisconsin has achieved this level of CCP use by bringing all stakeholders to the table, those that use the material or are concerned with their use. In addition, they have promoted the reuse of this material by sponsoring and conducting conferences and other educational efforts, by working with the construction industry (both road builders and the Wisconsin Department of Transportation), and by providing an atmosphere whereby CCP generators and users are encouraged to use the material, not discouraged through demonization of the product with an inappropriate label. It should be noted that there have been few, if any, problems with high-volume beneficial use of CCPs in the state of Wisconsin since the NR 538 rule was established.

Lastly, ACAA would like to point out that municipal waste landfills caused significant negative impacts to the environment and threatened public health through the contamination of drinking water wells before EPA proposed regulations under Subtitle D of RCRA. The approach EPA used in this circumstance was successful and there is no reason to believe that it would not work in the situation of CCR disposal.

d. Discussion of Geotechnical and Unencapsulated Use Applications: Subgrade Fill

1. *Description of Beneficial Use*

Subgrade Fill: Subgrade fill is an engineered project where CCPs are used in lieu of virgin materials to provide a sturdy, flat surface that serves as the support system below roads and buildings. Subgrade fill can range in depth from 6 inches to 4 feet.

Applications:

- Grade course, subbase or subgrade fill for the construction of commercial, industrial, agricultural and non-residential institutional buildings, and paved roads, parking or storage surfaces.
- Grade course, subbase or subgrade fill for the construction of paved federal, state or municipal roadways.

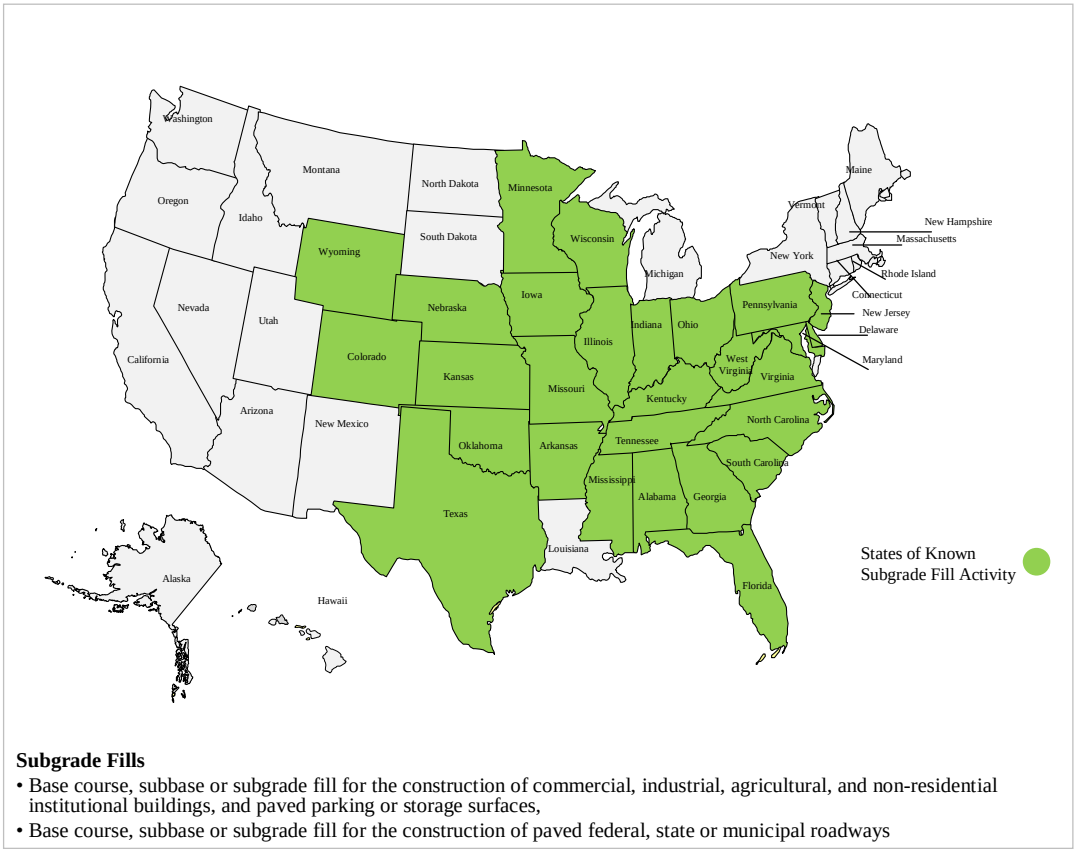
2. *Geographic Footprint and Use Statistics*

The use of coal ash for subgrade fill applications is widespread throughout the United States. Sectors utilizing coal ash for subgrade fill applications include state DOTs, county and city road districts, and private/commercial construction. The use of subgrade fill is similar to the use of structural fill with the distinction between the two being the depth of fill. Subgrade fill is typically considered to be no more than four feet in depth while structural fills can be far greater. As is the case in both uses, highly favorable engineering properties of the material can be easily achieved by adhering to standard construction specifications.

Figure 2-1 illustrates the geographic territory in which it was reported that CCPs were used in subgrade fill applications from 2004 to 2008. Figure 2-2 shows the tonnages of CCPs that were reported to ACAA as having been used in subgrade fill applications during these years.

3. *Examples of Use*

The use of coal ash as subgrade fill has been widely demonstrated to be a safe and beneficial use throughout the United States. The U.S. EPA, Federal Highway Administration, State DOTs, public and private universities, and ASTM have studied the use of coal ash and have concluded that the material has favorable geotechnical properties for subgrade fill[94].



Subgrade Fills

- Base course, subbase or subgrade fill for the construction of commercial, industrial, agricultural, and non-residential institutional buildings, and paved parking or storage surfaces,
- Base course, subbase or subgrade fill for the construction of paved federal, state or municipal roadways

Figure 2-1
Map of known subgrade fill activity of CCPs.

[94] Please see folder of reference documents titled "Section IX – Geotech. & Unencap." included with this comment submission, which provides a list of references and a number of additional documents specific to this discussion.

	2004	2005	2006	2007	2008
Annual Totals	1.587.290	3.049.282	1.648.202	1.179.509	1.802.025

Figure 2-2
Annual total CCP use in subgrade fills.

Proper material assessment, project location criteria, and construction procedures ensure safe and successful projects. Below is a summary of subgrade fill projects:

- Grade course, subbase or subgrade fill for the construction of commercial, industrial, agricultural and non-residential institutional buildings, and paved roads, parking or storage surfaces. Business owners are able to expand their businesses by constructing new buildings or new parking areas for equipment or vehicles. Coal ash can substitute for the aggregate material that is typically hauled to a project site to serve as the subgrade below buildings and parking areas.
- Grade course, subbase or subgrade fill for the construction of a paved federal, state or municipal roadway. New roads require enormous amounts of subgrade material that provides a sturdy subbase for the pavement above, but which still has some “give” to allow for movement and expansion/contraction.

Subgrade fill projects for municipal, county, state, and federal road projects utilize bottom ash as a base or subbase material following the standard specifications and construction procedures outlined by state DOTs or AASHTO as base aggregates. Bottom ash is typically compacted in accordance with ASTM Test Method D4254. Class C fly ash is also used for these applications as well as Class F fly ashes that are often mixed with lime products to improve the quality of material and provide hardening properties.

The use of coal ash for private sector projects to provide stable bases for buildings, and paved parking or storage surfaces is also growing. Engineering design and construction standards for these types of projects are based on standard engineering construction standards tailored to the applications involved.

Figure 2-3 illustrates typical construction practices a base for a commercial building, paved parking area, or storage lot. In this case, this project will have a standard concrete pad as part of the construction of a building. Standard construction practice in this case would be to:

- Strip topsoil and subsurface soil to a predetermined depth.

- Use subsurface soil as berms to contain ash prior to compaction and to ensure that ash remains on project footprint. Ash is delivered and spread.
- Compaction is completed in predetermined lifts using grading and roller compaction equipment, and water to condition ash. (Note: grading, roller compacting, ash delivery, and water trucks in background.
- As a final step gravel is placed on the compacted surface prior to construction of the concrete pad and the berms are tapered to the final level of the concrete surface, sloped away from the pad and vegetated.

Figure 2-3
Typical base construction practices.

4. *General Benefits to the Public and the Environment*

Benefits of utilizing coal ash for subgrade fill include conserving virgin materials that would otherwise need to be mined. The necessity of mining limestone, sand or other aggregate material for a fill project is not required when using coal ash as an alternative fill material. CO_2 emissions are reduced when heavy mining equipment and trucking of the material long distances are reduced or eliminated. In addition, the mining of our country's precious lands for

aggregates and fill material is reduced, and permitting for additional mining operations may be pushed further into the future or possibly even eliminated.

Coal ash reuse for subgrade fill further minimizes the amount of ash that would otherwise be sent to a landfill. In the years 2004 through 2008, approximately 9.2 million tons of coal ash was utilized in subgrade fill applications. Without this reuse, it would have all gone into a landfill.

Lastly, utilizing coal ash instead of native materials results in a cost savings to the project which is often passed on to the entity responsible for the project. In the case of a public roadway project, this savings would therefore be realized by the county or state and eventually the taxpayers.

5. *Environmental and Engineering Beneficial Use Guidelines*

Proper guidelines are critical in constructing successful subgrade fill projects with coal ash. ASTM has created a document, ASTM E2277-03 "Standard Guide for Design and Construction of Coal Ash Structural Fills" that addresses the important criteria that need to be followed. ASTM has revised this document several times to continue to improve its content and to ensure that engineers are following consistent guidelines on a nationwide basis. The ACAA recommended standards for subbase fill applications are provided in Table 2-1.

Table 2-1
Subbase Fill Recommended Standards

Criteria	Recommended Standards
Material Assessment	• Appropriate chemical and physical characterization – ASTM guidelines for characterization of CCP as structural fill material • Leachate testing – TCLP
Locational Criteria	• Proper separation from groundwater, surface water, water supply wells, wetlands, floodplains, and private residences • Materials shall be used in a manner that does not: – Adversely impact wetlands – Have detrimental effect on surface water – Have detrimental effect on groundwater quality
Design and Construction Standards	• ASTM guidelines for use of CCPs as subbase fill in nontransportation projects • AASHTO standards in public transportation facility projects • Proper engineering practices and guidelines dependent upon final

	use
Post-project Monitoring and Reporting	• Annual reporting to the state regulatory agency including: – Listing of projects completed with quantities of ash utilized – Results of material assessment • Additional monitoring requirement may be applicable depending on the material, location of project, and size of subbase fill project

6. *Regulatory Recommendations*

The approach by states to regulate coal ash for subgrade fill projects varies considerably. Below is a sampling of some states with a summary of the regulations involved in performing these projects.

- **Illinois**. The Illinois Environmental Protection Act 415 ILCS 5/3.135 allows for the use of coal ash as subgrade fill. Section a-7 allows "bottom ash for non-IDOT pavement subbase or base, pipe bedding, or foundation backfill". Section a-8 also defines structural fill as a beneficial use and includes material testing and assessment, project location criteria, cover requirements, and notification requirements.

- **Indiana.** The State of Indiana allows the use of coal ash for subgrade fill by including an exemption in legislative chapter IC-13-19-3. The Chapter is titled "Powers and Duties Concerning Solid Waste and Hazardous Waste Management" and subsection 13-19-3-3 includes the uses in which coal ash may be utilized in order to be "prohibited from regulation". Under 13-19-3-3(2)(F), a base in road construction is listed as an acceptable use.

- **Ohio.** Ohio Environmental Protection Agency (OEPA) has published draft beneficial reuse rules in the Administrative Code 3745-525-801 through 3745-525-811. OEPA is currently in the second phase of receiving public comments on the draft and their Web site currently states a new draft will be published in early 2010. The draft includes a process for byproduct leachate sampling and testing, project location criteria, acceptable uses based on leachate results, and acceptable coverage based on leachate results. Additional requirements include professional engineering design drawings, accepted engineering practices, certification statement, and no enforcement actions pending on the generator.

- **Pennsylvania.** Pennsylvania's Solid Waste Management Act excludes coal ash that is beneficially used in accordance with Pennsylvania Department of Environmental Protection (PADEP) standards and criteria from the definition of solid waste. Subchapter H of the PA Code Chapter 287, Section 665(b)(5) allows for the use of coal ash without a permit from the regulatory agency if the ash is used as a raw material, specifically construction aggregate.

- **Texas.** The Texas Commission of Environmental Quality (TCEQ) issued a guidance letter in 1995 that CCPs are recognized as a material and not considered a solid waste. This letter was instituted as an agency rule in 2001 and has been the key to the overwhelming success the State of Texas maintains in CCP utilization year after year. This is now referred to as the seven-waste criteria rule (30 Texas Administrative Code (TAC) Chapter 335). Since the new guidelines have been in place by TCEQ, Texas recycles more CCPs than any other state. Texas alone utilizes 60%-70% of in-state produced CCPs annually.

- **Virginia.** The Virginia Department of Environmental Quality (VDEQ) regulates the beneficial reuse of coal ash under the Virginia Administrative Code Chapter 85, "Coal Combustion Byproduct Regulations". This Code provides, "…standards for siting, design, construction, operation, and administrative procedures pertaining to their use, reuse, or reclamation." Violators of this Code are considered to be operating an unpermitted facility and would require a permit or risk additional action by the VDEQ including remediation, and/or civil charges and penalties.

- **Wisconsin.** The Wisconsin Department of Natural Resources (WDNR) regulates under Chapter NR 538 "Beneficial Use of Industrial Byproducts". This program may be one of the most progressive reuse programs in the country and includes specific performance criteria, a process for material characterization and categorization, project location criteria, defined acceptable uses based on material categorization, and reporting and monitoring specifications.

This summary of some of the beneficial reuse programs that exist in the United States illustrates the approval that many state regulators have given to the practice of using coal ash as a subgrade fill. Adhering to minimum standards and accepted practices allows regulators the assurance that projects are performed in a manner that will ensure protection of public health and the environment.

e. Discussion of Geotechnical and Unencapsulated Use Applications: Soil Stabilization and Asphalt Pavement Recycling

1. Description of Beneficial Use

Soil and base stabilization is the science of improving the engineering properties of soils and base materials through treatment with fly ash. CCPs used for these applications are either (i) Class C fly ash, which is self-cementing upon the addition of water, or (ii) Class F fly ash combined with an activator (calcium source) such as cement, lime, cement kiln dust or lime kiln dust. Class F fly ash is a pozzolan meaning that it requires an external calcium source for a cementitious reaction to occur. Class C fly ash (often referred to as self-cementing, cementitious or high calcium) will cement, harden and gain significant strength upon addition of water without the need to add an external calcium source activator. The stabilization process generally consists of thoroughly mixing 7%–20% fly ash with the soil or base material being treated, blending in the appropriate quantity of water to optimize compactability and the

cementitious hydration reaction, and compacting the resulting mixture to the appropriate density.

The cementitious nature of fly ash described above can be used to impart a variety of benefits to soil and base materials.

- **Soil Drying:** using the cementitious hydration reaction to consume excess moisture present in jobsite soils in order to facilitate mechanical compaction and overall progress of the project.
- **Reducing Shrink-Swell Properties of Clay Soils:** using the cementing action of the fly ash to reduce volumetric change in high-plasticity clay soils caused by variations in moisture content.
- **Soil Stabilization to Increase Strength Properties:** using the cementing action of the fly ash to increase subgrade support capacity for pavements and building slabs, to increase shear strength of soils in embankment sections and to decrease the compressibility of deep fills. In many cases the soil strength can be increased to a level where no overlying aggregate base is required.
- **Stabilized Aggregate Base:** using the cementing action of the fly ash to increase subgrade support capacity of crushed aggregates for pavements and building slabs thus reducing the quantity of aggregate required.
- **Pavement Recycling – Full Depth Reclamation (FDR):** pulverizing deteriorated pavements into an aggregate size gradation and then using the cementing action of the fly ash to increase subgrade support capacity of the pulverized material. The appropriate wearing surface may then be applied.

A detailed description and discussion of stabilization applications may be found in documents titled “Using Coal Ash in Highway Construction: A Guide to Benefits and Impacts” and “Soil Stabilization and Pavement Recycling with Self-Cementing Coal Fly Ash” and “Fly Ash Soil Stabilization for Non-Uniform Subgrade Soils: Volume 1 Engineering Properties and Construction Guidelines” as provided in the accompanying folder titled "Section IX – Geotech. & Unencap." A case study on pavement recycling was available on the C^2P^2 Web site until recently.

2. *Geographic Footprint and Use Statistics*

The use of fly ash for stabilization applications is longstanding and widespread throughout the United States. Sectors utilizing fly ash for stabilization applications include state DOTs, county road districts, city road and street departments and private/commercial construction. The vast historic usage of fly ash for stabilization applications coupled with the fact that there are no proven environmental damage cases of any kind associated with such use demonstrate the environmental, technical and economic viability of stabilization with fly ash.

Figure 3-1 illustrates the geographic territory in which it was reported that CCPs were used in soil stabilization applications from 2004 to 2008. Figure 3-2 shows the tonnages of CCPs that were reported to ACAA as having been used in soil stabilization applications during these years.

3. *Examples of Use*

It has been widely demonstrated through the successful utilization of millions of tons of fly ash over several decades that the cementing properties of the material can be utilized effectively in applications similar to those developed for lime and cement stabilization. These applications include drying soils to facilitate compaction, reduction of shrink-swell potential of high plasticity clays, to improve soil strength and to reduce compressibility of both cohesive soils and granular materials. The benefits derived through fly ash stabilization are comparable to those achieved through use of lime or cement, with fly ash stabilization generally providing a more economical solution.

The product delivery method, construction equipment requirements and construction techniques for fly ash stabilization are very similar to those used for lime or cement treatment of soils or base materials.

Several photographs which illustrate examples of stabilization projects utilizing fly ash are presented in Figure 3-3. Note the conventional construction equipment and delivery trucks. Numerous detailed case studies of past fly ash stabilization projects may be found in the folder titled "Section IX – Geotech. & Unencap." accompanying this report.

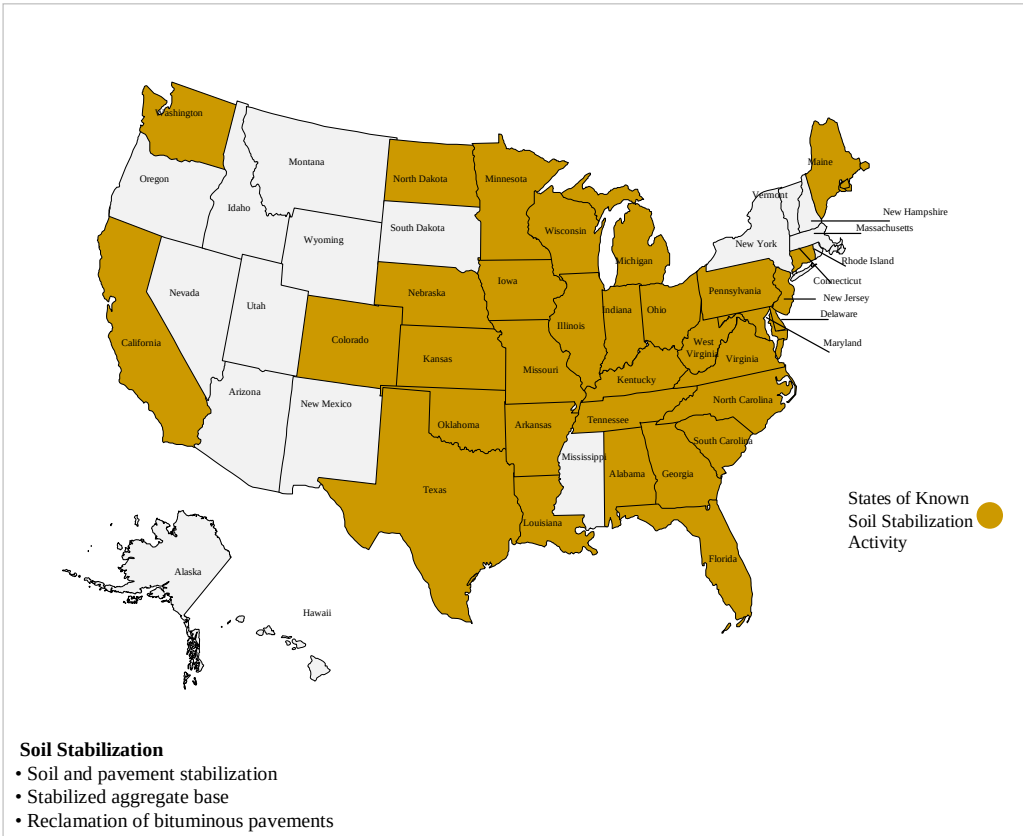


Figure 3-1
Map of known soil stabilization activity of CCPs.

	2004	2005	2006	2007	2008
Annual Totals	712.173	1.138.105	1.017.141	1.370.645	1.251.968

Figure 3-2
Annual total CCP use for soil and base stabilization.

Fly Ash is spread to grade in a controlled manner.

Fly ash is in incorporated into the soil utilizing a pulvamixer and direct water injection

Proper compaction helps performance characteristics

Wearing surface on fly ash treated base

Figure 3-3
Soil/base stabilization construction process.

4. *General Benefits to the Public and the Environment*

As previously discussed fly ash stabilization is used as an alternative to:

- stabilization with manufactured lime
- stabilization with cement
- removal of poor quality soil and replacement with select fill soil
- use of crushed natural aggregates
- in the case of pavement recycling, complete removal and reconstruction of the pavement section

Benefits of using fly ash for stabilization include significant reduction in CO_2 emissions related to reduction in production of manufactured lime and cement, conservation of natural

aggregates and conservation of select soil deposits. The traditional method of dealing with poor soils has been to remove and replace those soils with more competent soils. Stabilizing the in situ soils in place eliminates the need to excavate virgin soils from a borrow site and transport those soils to the site of use. Transportation of construction materials typically results in energy usage and the production of diesel exhaust emissions.

In the case of pavement recycling the additional benefit of reusing the deteriorated existing asphalt pavement materials is also realized. This eliminates the need to quarry aggregates, with attendant fugitive dust emissions and energy usage at the quarry; and the need to transport the aggregates to the jobsite, with the attendant energy usage and the production of diesel exhaust emissions.

Stabilizing in situ soils and recycled pavement in place also reduces truck traffic through neighborhoods and the fugitive dust and noise emanated by those trucks, as virgin materials do not need to be brought to the jobsite.

5. *Environmental and Engineering Beneficial Use Guidelines*

It is recommended that appropriate guidelines and specifications be employed whenever CCPs are used in soil stabilization and recycled bituminous pavement applications. There are numerous engineering specifications that are in common use by commercial contractors, state departments of transportation[95], and local units of government and which, when observed, assure the quality of the finished product. In general, these are the same specifications that are employed in the use of portland cement and lime in soil stabilization, and many of these specifications have been adapted for the use of fly ash.

Market-driven use of CCPs by contractors in competitive bidding situations ensures that they are used appropriately, and not in excess, and that project performance requirements are met. If there is a price that is charged by the marketer for the fly ash, the contractor will not use more than is needed to accomplish the purpose. The cost factor works to prevent irresponsible overuse and wastage of the CCP. Most specifications require field testing to verify that performance goals such as proper compaction and compressive strengths are met. Failure to meet those targets may result in economic penalties and loss of contractor qualification for future projects.

The ACAA manual entitled "Soil Stabilization and Pavement Recycling with Self-Cementing Fly Ash"[96] provides a comprehensive discussion of engineering design in Chapter 10 "Design Considerations," followed by a list of specifications and guidelines established by nine different state departments of transportation—as well as industry standards (ASTM, AASHTO, and American Concrete Institute (ACI))—for these uses on pages 64 and 65 of the manual.

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[95] A good example of a DOT specification for the use of fly ash in soil stabilization is ITEM MO-155 FLY ASH TREATED SUBGRADE, Missouri Department of Transportation, rev. 02/01/10. It is available on-line at: www.**modot**.**mo**.gov, under /Construction_Observation_Program-Required_Tests_and_Certifications.doc.

[96] Soil Stabilization and Pavement Recycling with Self-Cementing Fly Ash. American Coal Ash Association Educational Foundation, January 2008.

It must be emphasized that the costs for the use of CCPs in geotechnical applications such as soil stabilization or bituminous pavement recycling assures that their use is always for a specific purpose. Contractors and specifiers choose to use CCPs in place of conventional materials of construction or conventional construction techniques because they can attain equal or better performance for a lower cost. In fact, there are diminishing returns from using excess quantities of reactive Class C fly ash in these applications. Even more important than the application rate of fly ash to soil or recycled asphalt pavement are the percent moisture in the mix and the delay time between mixing and compaction. ACAA encourages the use of laboratory testing procedures to determine proper mix design for specific materials as detailed in Chapter 4: Laboratory Mix Design on pages 21–25 of the ACAA manual.

In addition to the technical requirements, it is recommended that the fly ash or other type of CCPs be qualified from an environmental standpoint. This consists of first characterizing the CCP using the appropriate leaching procedure to ensure that it is not a hazardous waste.

One of the most important environmental requirements is the establishment of locational criteria, which are essential to the proper use of CCPs in construction. These consist of guidelines to protect ground water and surface water, and setbacks from drinking water wells, wetlands and floodplains. Chapter 11 of the ACAA manual, "Environmental Considerations for Fly Ash Stabilization," discusses much of the scientific investigation that has been performed to verify the environmentally safe use of these products.

Impacts on surface water and ground water should not be an issue when specifications and guidelines are in place and followed. The third pathway is through the air. Fugitive dust may be an issue but can be controlled by using equipment for placement of fly ash that minimizes dusting, and by curtailing operations on windy days. Construction personnel are advised to wear dust masks whenever dust in the air is visible. Free crystalline silica can be a problem when dust from rock becomes airborne, but is not an issue with fly ash, as fly ash particles are smooth and rounded rather than sharp and angular.

Figure 3-4 contains a list of key criteria to consider in any state program established for the regulation of fly ash and other CCPs in soil stabilization and bituminous pavement recycling projects.

6. Regulatory Recommendations

There are a wide variety of state regulatory programs already in place that assure the environmentally sound beneficial use of CCPs in soil stabilization and bituminous pavement recycling projects. ACAA recommends that soil stabilization, bituminous pavement recycling, and other genuine geotechnical uses of CCPs continue to be exempted by the U.S. EPA from federal regulation, and that the states be allowed and encouraged to continue their regulation of beneficial reuse of CCPs. The ACAA recommended standards for soil and base stabilization applications are provided in Table 3-1.

Table 3-1
Soil and Base Stabilization Recommended Standards

Criteria	Recommended Standards
Material Assessment	• Appropriate chemical and physical characterization – ASTM C618 Class C or Class F determination • Strength testing – ASTM D5239 for very, moderate, or nonself-cementing property determination • Leachate testing – TCLP
Locational Criteria	• Site assessment – Distance from groundwater, surface water, wetlands, and floodplains
Design and Construction Standards	• Appropriate geotechnical engineering of proposed stabilization project to establish CCP treatment rate and validate technical performance • Appropriate construction procedures following DOT, county, city, or private sector construction standards/specifications • Adequate control of fugitive dust
Post-project Monitoring and Reporting	• Annual reporting to the state regulatory agency including: – Listing of projects completed with quantities of ash utilized – Results of material assessment

The spectrum of state beneficial use programs ranges from those that allow CCP utilization under a general exemption to those with strict and comprehensive provisions governing every aspect of the projects.

The Missouri Department of Natural Resources issues general source exemptions for the beneficial reuse of coal combustion products in specific construction applications under the Missouri Solid Waste Management Law and regulations, subject to conditions established by the Department. Those conditions include: material characterization and limits on concentrations of parameters of concern, locational restrictions, property owner notification, contractor notification of the permit exemption requirements, and submittal of a comprehensive annual report.

It should be noted that there are no known damage cases that have occurred as a result of beneficial reuse of CCPs when projects have been performed using specifications and under state regulations and/or guidelines. “Unencapsulated” applications generally use smaller

volumes of CCPs that are easily managed and placed. Locational restrictions and other technical guidelines for the use of CCPs work to prevent the placement of CCPs in the ground water table.

Wisconsin Chapter NR 538 is a good example of how a state environmental protection agency can establish effective rules for the protection of public health and the environment, while at the same time encouraging the beneficial reuse of industrial byproducts by not imposing onerous requirements. According to the Wisconsin Department of Natural Resources, the purpose of NR 538 is "to allow and encourage to the maximum extent possible, consistent with the protection of public health and the environment and good engineering practices, the beneficial use of industrial by-products in a nuisance-free manner."[97]

NR 538 establishes requirements for initial characterization of the industrial byproduct with re-characterization required every one to five years, depending on the uses to which the byproduct is put. It establishes categories for the universe of industrial byproducts that are based on concentrations of listed parameters in a set of tables, and sets out a list of allowable beneficial uses for each of the categories. NR 538 also specifies requirements for reporting, storage and transportation, and environmental monitoring.

NR 538 also contains provisions for public participation in large-volume projects and for property owner notification, raising concern for a hazardous waste "stigma" if CCP disposal is regulated under RCRA Subtitle C.

ACAA does not dispute that the Public has a right to participate in decisions that affect it, and that potential buyers of properties have a right to know what is on those properties. However, a Subtitle C classification of CCPs when disposed will provide a political argument to any opponent of a project that coal ash is inherently hazardous and that it should not be used in public works projects. This has the potential to end beneficial utilization of these valuable materials of construction when technical battles become political, and local elected officials begin to fear for their political futures.

In addition, potential buyers of commercial real estate, perhaps on the advice of legal counsel or perhaps on long-established precedent, will hesitate when considering whether to buy properties that contain so-called "hazardous wastes" because of future CERCLA liabilities and future resale potential—exemptions for beneficial reuse notwithstanding.

[97] Chapter NR 538: Beneficial Use of Industrial Byproducts. WDNR NR 538 can be found on the internet at: http://www.legis.state.wi.us/rsb/code/nr/nr538.pdf.

f. Discussion of Geotechnical and Unencapsulated Use Applications: Surface Applications

1. *Description of Beneficial Use*

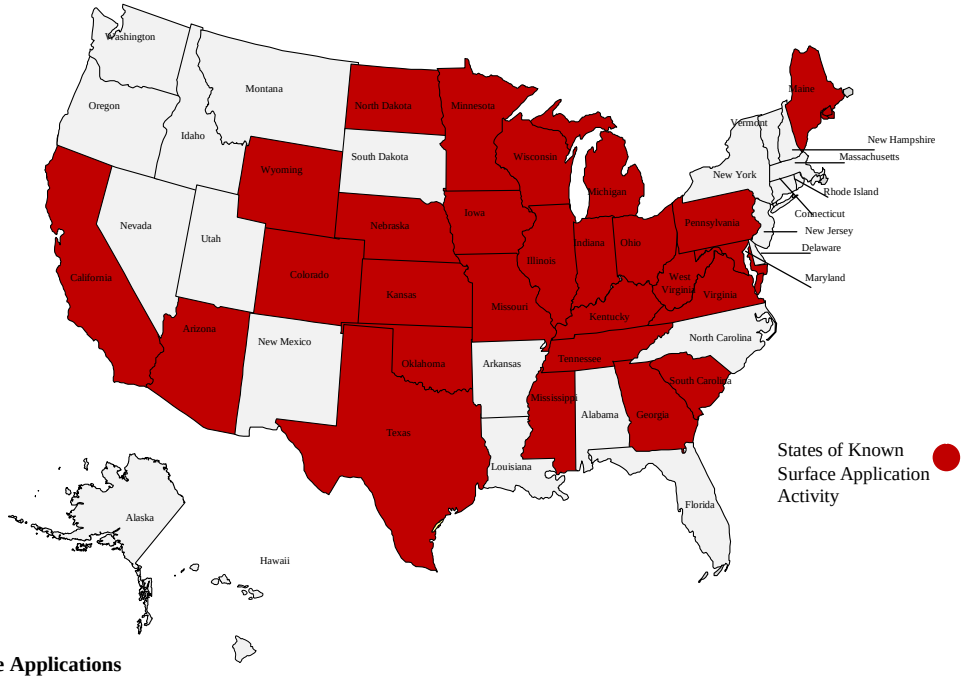
Surface Applications: Granular materials used in lieu of natural materials: stone, gravel, and sand.

- Winter Weather Abrasives – anti skid road applications
- Bound and Unbound Applications – chip seal and surface material for low traffic areas
- "Cinders" on running tracks, walking trails, equestrian trails, etc.
- Decorative Stone – for landscaping applications

2. *Geographic Footprint and Use Statistics*

The use of bottom ash and boiler slag in surface applications is longstanding and widespread throughout the United States. The vast historic usage of bottom ash and boiler slag for surface applications coupled with the fact that there are no known damage cases associated with surface applications indicates that existing state regulations in place are adequate to protect human health and the enviromnent and additional federal regulations would be unwarranted.

Figure 4-1 illustrates the geographic territory in which it was reported that CCPs were used in surface applications from 2004 to 2008. Figure 4-2 shows the tonnages of CCPs that were reported to ACAA as having been used in surface applications during these years.



Surface Applications
- Decorative stone
- Winter weather road abrasive for anti-skid
- Chip seal highway coating
- Unbonded surface course (i.e. "Cinders" on running tracks, walking & biking trails, parking areas, etc.)

Figure 4-1
Map of known surface application activity of CCPs.

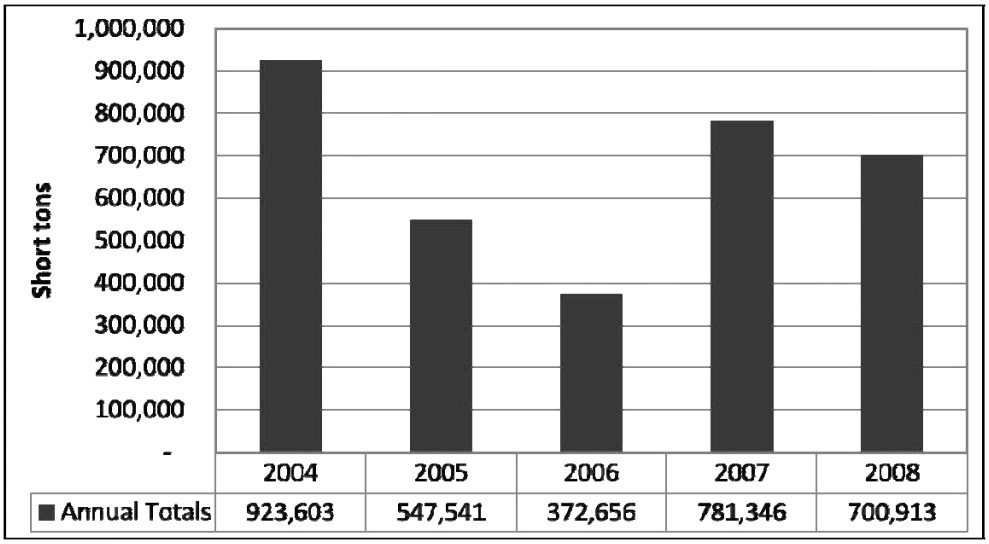


Figure 4-2
Annual total CCP use in surface applications.

3. *Examples of Use*

Bottom ash and boiler slag are used in a variety of surface applications. Photographs of these examples are provided in Figure 4-3. Details of the uses are summarized below:

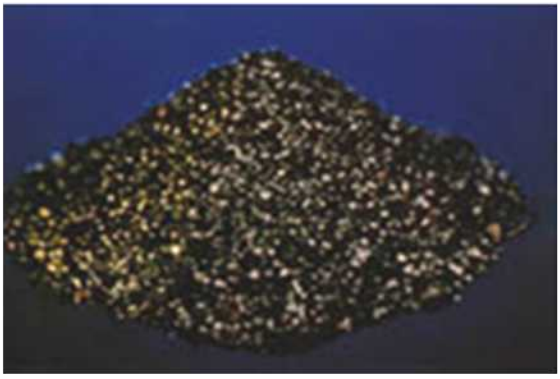
- Decorative stone
  - Screened and sized bottom ash or boiler slag is used in place of natural stone in landscaping applications
- Winter weather abrasives for anti-skid road applications
  - The spread rate varies by state and by storm size. In general, 100–300 pounds per single lane mile can be spread.
  - Abrasives (slag and bottom ash) are not good for de-icing. Mixing abrasives with salt can help, typically at a mixture of 50–100 lbs per cubic yard; above this amount may ionically negatively affect de-icing capability of the salt.
  - Abrasives are used only for traction control on road surfaces, particularly around corners.
  - The maximum particle size is 1/8” to 3/8,” depending on the state regulations. This serves to minimize windshield damage.
  - Material larger than a #50 sieve (0.297 mm) is most effective.
- Bound and Unbound Applications
  - Screened bottom ash and cyclone boiler slag are used in lieu of pea gravel or quarry fines by some states and municipalities in chip seal applications. The State of Wisconsin is a great example of a state that likes the performance and look of the screened bottom ash in chip seal applications.
  - The Federal Aviation Administration specifies the use of slag in any chip seal surfacing on secondary airport runways because its abrasiveness helps prevent skidding and its amorphous character helps withstand jet exhaust heat.
  - Bottom ash is used in lieu of natural aggregates as a surfacing material in low traffic roads, drives and parking areas.
  - Bottom ash and cyclone boiler slag (i.e. “cinders”) are commonly used as a surfacing material on low traffic volume parking areas and roads, high school running tracks, walking and biking trails, and equestrian trails. These materials are durable and safe, and provide good drainage.

Applicable state standards associated with surface applications can be found in the folder titled "Section IX – Geotech. & Unencap." that is accompanying this report. Additional information including case studies is also found in this folder.

Chip and Seal Application

Anti-Skid Material

Processing Bottom Ash



Decorative Stone

Figure 4-3
Examples of surface applications of CCPs.

4. *General Benefits to the Public and the Environment*

The beneficial reuse of Coal Combustion Products in surface applications reduces the dependence on virgin materials: stone, gravel, and sand. This beneficial reuse conserves natural resources while extending the life of solid waste landfills for other materials that cannot be recycled or reused. Surface applications also eliminate CO_2 production that would be associated with mining, crushing, and processing the natural material that would be used in these applications if CCPs were not available. There can be considerable cost benefits associated with utilizing bottom ash in surface applications depending on the project location.

5. *Environmental and Engineering Beneficial Use Guidelines*

The utilization of coal combustion products in lieu of virgin aggregate in surface applications reduces the demand on natural resources. This reduced demand on natural aggregates saves the energy required to mine, transport, and process these materials. The coal combustion

products used in these surface applications typically perform comparably to the natural materials they are replacing at a reduced cost. If these materials are beneficially reused they are not landfilled, which conserves landfill capacity. The ACAA recommended standards for surface applications are provided in Table 4-1.

6. *Regulatory Recommendations*

There are no known state specifications or guidelines that regulate decorative stone.

Gradation specifications determine if bottom ash can be utilized in bound/unbound applications and winter weather abrasives. The top end size is limited by the ability of the local equipment to spread the material. Another consideration that influences the gradation specification is driver's safety associated with the prevention of broken windshields.

Table 4-1
Surface Application Recommended Standards

Criteria	Decorative Stone	Winter Weather Abrasive	Bound/Unbound Surface Applications
Material Assessment	• Physical properties – Size • Must be granular material – Fly ash is not appropriate – Only boiler slag or bottom ash is to be used	• Physical properties – Size – Durability • Only boiler slag or bottom ash is to be used – Fly ash is not applicable	• Physical properties – Size – Durability • Only boiler slag or bottom ash is to be used – Fly ash is not applicable
Locational Criteria	• Local zoning • DOT restrictions • Distance to wetlands	• Local zoning • DOT restrictions • Distance to wetlands	• Local zoning • DOT restrictions • Distance to wetlands
Design and Constructio n Standards	• Appropriate construction procedures	• Gradation specifications • Spread rates • Angular vs. round particles	• Gradation specifications

g. Discussion of Geotechnical and Unencapsulated Use Applications: Feedlot, Dairy, or Livestock Pen Stabilization

1. *Description of Beneficial Use*

Soil stabilization with CCPs can also be applied to feedlot, dairy or livestock pen situations. Earthen pens and laneways do not withstand concentrated livestock traffic, particularly when the surface remains wet for any length of time such as during wet winters or spring thaw. As the integrity of the pen or laneway surface breaks down, deep mud and poor drainage reduce animal performance and health (as indicated by poor weight gain and reduced milk production, as well as increased incidence of mastitis in dairy cows), increase odor emissions, and prevent regular maintenance operations such as manure removal. Commonly, the soil–manure interface layer is damaged, resulting in deeper leaching of nutrients such as nitrates and phosphates and an increased risk of groundwater pollution. Stabilization of the soil using CCPs can provide feedlot and dairy operators with an environmentally safe, low-cost option to improve feedlot conditions, animal health, animal weight gain, and odor control. Benefits are derived from the cementitious properties of the CCP as described in Section 3. CCPs derived from Class C or high lime fly ashes also have a higher pH which helps reduce bacteria, flies and the use of antibiotics.

2. *Geographic Footprint and Use Statistics*

No geographic footprint and use statistics were determined for the feedlot stabilization category.

3. *Examples of Use*

As shown in Figure 5-1, conventional farm equipment can be used for the application of CCPs for soil stabilization in feedlot and livestock pen settings. A pad constructed of concrete or flowable fill is recommended in feeding and watering areas to provide skid resistance and extra durability in the high-traffic areas. An example of the placement of a CCP-based flowable fill is shown in Figure 5-2.

4. *General Benefits to the Public and the Environment*

Stabilization of feedlot or livestock pens with CCPs is an alternative to the conditions present with no treatment or to the cost of placing concrete in the pens. The benefits of using fly ash in combination with local soils in feedlot practices over soil alone can be described as follows:

- Reduced animal stress and incidence of mastitis due to wet soil conditions;
- Improved animal weight gains and/or milk production;
- Improved drainage and environmental stability of the feedlot surface;
- Reduced permeability of CCP-treated soils, thus less potential nutrient (nitrate and phosphate) infiltration to groundwater;

- Improved drying rate during spring thaw and rainfall events;
- Full-cycle utilization of mined materials; and
- Reduced handling and disposal of manure.

Figure 5-1
Conventional farm equipment can be used to spread the CCP, mix the CCP into the soil, and compact the mixture.

Figure 5-2
Placement of a fly ash, cement, and bottom ash flowable fill mix.

An example of the difference in drying rates between soil and fly ash-stabilized soil pens is shown in Figure 5-3.

Figure 5-3
Comparison of control (soil in the left) and soil stabilized (25% fly ash in the right) feedlot pens.

Runoff from fly ash-treated surfaces can contain less suspended solids than from soil alone (Pflughoeft-Hassett et al., 2004[98]; Hassett and Heebink, 2001[99]). In a study conducted at the North Dakota State University (NDSU) Carrington Research Extension Center (CREC) by the Energy & Environmental Research Center (EERC), the runoff from treated and control pens was of similar quality and met the most stringent North Dakota surface water standards for nearly all parameters evaluated. While concentrations of some parameters were higher than concentrations in local groundwater, these were consistently elevated in runoff from treated and control pens. Only boron concentrations were slightly elevated in runoff from treated pens compared to runoff from control pens.

5. *Environmental and Engineering Beneficial Use Guidelines*

Proper feedlot operation siting is essential to protecting the environment. National EPA regulations exist for large concentrated animal feeding and dairy operations. State, county, and local authorities may have additional rules that apply.

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[98] Pflughoeft-Hassett, D.F.; Dockter, B.A.; Hassett, D.J.; Heebink, L.V.; Solc, J.; Buckley, T.D.; Stewart, A.; Anderson, V. *Demonstration of Coal Ash for Feedlot Surfaces*; Final Report; EERC Publication 2004-EERC-02-10; Energy & Environmental Research Center: Grand Forks, ND, Feb 2004. Available at http://www.undeerc.org/carrc/html/Feedlot.html.

[99] Hassett, D.J.; Heebink, L.V. *Environmental Evaluation for Utilization of Ash in Soil Stabilization*; Final Report (August 11, 1999 – Nov 30, 2001) for U.S. Department of Energy Cooperative Agreement No. DE-FC26-09FT40321; EPRI No. 1005213; EERC Publication No. 2001-EERC-08-06; Energy & Environmental Research Center: Grand Forks, ND, August 2001. Available at http://www.undeerc.org/carrc/html/SoilStabilization.html and http://www.epri.com.

A manual for feedlot operators was developed by a research project team consisting of the NDSU CREC, the EERC, and Power Products Engineering, Inc., with guidance on the appropriate use of fly ash to stabilize soil in livestock facilities in the state of North Dakota (Anderson et al., 2003[100]). The instructions are set up for use by farmers and ranchers with equipment commonly found on any farm or ranch. They guide the user through the calculations necessary to determine the amount of CCP to use, CCP transport, placement at the site, and compaction and curing.

As is the case with beneficial use of any byproduct, laboratory characterization of the CCP materials must be performed to ensure their environmental suitability.

6. *Regulatory Recommendations*

Federal and state regulations are in place to protect the public and waterways from feedlot and dairy operations. States should be allowed and encouraged to continue their CCP beneficial reuse programs to include feedlot, dairy and livestock pen stabilization. The states are able to include steps to ensure that surface and ground water will not be adversely impacted through the use of CCPs. In reality, the use of CCPs in this application has been shown to be more beneficial for the animals' health and in maintaining the quality of groundwater and surface water runoff than no treatment to the feedlot surfaces.

h. Discussion of Geotechnical and Unencapsulated Use Applications: Waste Stabilization and Solidification Application

1. *Description of Beneficial Use*

The following provides the distinction between waste stabilization and waste solidification:

- Waste stabilization reduces the leaching potential of the waste by converting contaminants into less soluble forms.
- Waste solidification converts liquid, sludge and other physically non-stable wastes into stable solids for on- or off-site disposal.

The mixing processes associated with waste solidification at a treatment facility may be very basic in terms of how the coal combustion products or blend of cementitious materials are incorporated into the waste materials or contaminated soils. The CCPs or blends that include CCPs can and are often incorporated into the waste material with standard construction equipment like a backhoe or conventional mixers like a pug mill. This type of processing is typical when trying to improve the handling characteristics of the waste and incorporate the stabilization/solidification agent.

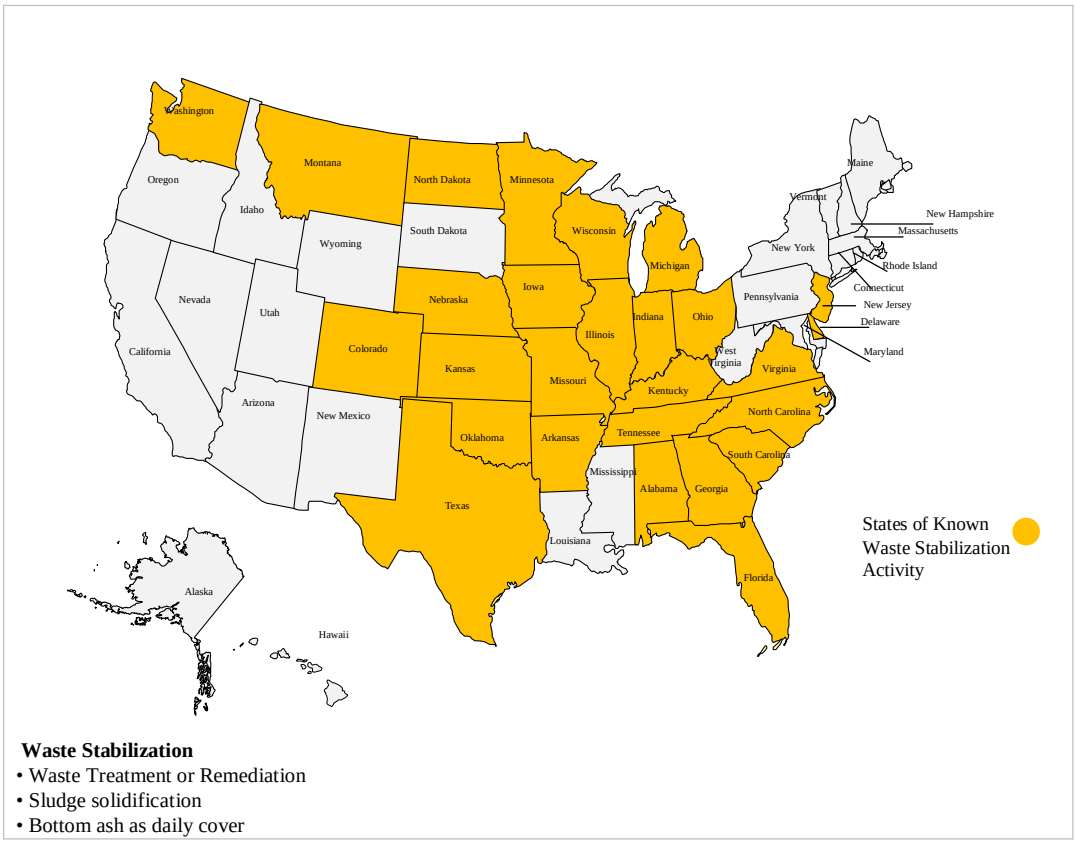
[100] Anderson, V.; Buckley, T.; Pflughoeft-Hassett, D.; Stewart, A. Instructions for Use of Fly Ash to Stabilize Soil in Livestock Facilities. AS-1258, North Dakota State University: Fargo, ND, Jan 2004. Available at http://www.undeerc.org/carrc/html/Feedlot.html and http://www.ag.ndsu.edu/pubs/ansci/livestoc/as1258w.htm.

The process for treating contaminated waste in-place is less crude. Cementitious slurry can be pumped into the hollow drill stem of a Caisson Rig or a Crane Mounted Turn Table and blended with the contaminated soil in situ resulting in a stabilized or solidified column of earth. The cementitious slurry can be produced at a batch plant at or near the remediation site and pumped down hole or through the auger. An entire area can be treated by interlocking these columns. Usually the acceptance criterion for the treated material includes meeting certain physical and chemical requirements. Examples of these properties may include the following: pH, compressive strength, permeability, leachability, durability, etc. Fly ash by itself or as part of a cementitious blend is a common coal combustion product used in this type of application.

2. *Geographic Footprint and Use Statistics*

The use of fly ash in waste stabilization is a common and proven technology throughout the United States. The usage of fly ash in a pure state or as a part of a blended product for waste stabilization/solidification applications, coupled with the fact that there are no known damage cases associated with the CCPs used in waste stabilization/solidification applications, supports that adequate state regulations are in place to protect human health and the environment and additional federal regulations are unwarranted.

Figure 6-1 illustrates the geographic territory in which it was reported that CCPs were used in waste stabilization applications from 2004 to 2008. Figure 6-2 shows the tonnages of CCPs that were reported to ACAA as having been used in waste stabilization and solidification applications during these years.



Waste Stabilization
- Waste Treatment or Remediation
- Sludge solidification
- Bottom ash as daily cover

Figure 6-1
Map of known waste stabilization activity of CCPs.

3. *Examples of Use*

Binders/reagents are mixed into contaminated media in order to immobilize hazardous constituents or transform liquid wastes, sludges, or high moisture content wastes to a solid drier form. These binders/reagents are often cementitious materials or cementitious blends. Cementing fly ash can be used as a stand-alone binder or can be blended with other cementitious materials to treat these contaminated materials or waste materials.

In addition to the more technical applications of CCPs in waste treatment, bottom ash is commonly used as daily cover in Subtitle D landfills.

	2004	2005	2006	2007	2008
Annual Totals	2.774.563	2.839.954	2.768.177	2.800.031	3.784.546

Figure 6-2
Annual total CCP use in waste stabilization and solidification applications.

4. *General Benefits to the Public and the Environment*

The beneficial reuse of CCPs in waste stabilization/solidification applications reduces the dependence on virgin materials and energy-intensive cementitious products (e.g., stone, gravel, sand, portland cement, lime, etc.). CCPs used in place of cement or lime in these binder blends reduce the demand for virgin raw materials used in the production of cement or lime. It also reduces CO_2 production derived from fossil fuels burned in the kilns used to manufacture lime/cement and also the CO_2 released in the associated calcining process.

5. *Environmental and Engineering Beneficial Use Guidelines*

Environmental consultants provide guidance and recommendations how on to best treat contaminated materials. These recommendations may include a mix design for the binding agent to stabilize/solidify the waste material(s). The mix design will be one in which the stabilized material meets or exceeds minimum standards set forth by the state or federal agency with oversight authority on the project. Additional information of waste stabilization/solidification is provided in the accompanying folder titled "Section IX – Geotech. & Unencap." The ACAA recommended standards for waste stabilization and solidification applications are provided in Table 6-1.

6. *Regulatory Recommendations*

These applications are typically unique and often a permitted activity and, therefore, regulatory recommendations are unnecessary except to be conditionally exempted. Treatability studies are conducted on the waste materials and the solidifying/stabilizing agents in order to identify the best solutions. Fly ash immobilizes many toxic heavy metals as relatively insoluble hydroxides

Table 6-1
Surface Application Recommended Standards

Criteria	Waste Stabilization	Waste Solidification
Material Assessment	• Chemical and physical properties	• Chemical and physical properties
Locational Criteria	• Contaminated materials are usually treated in place but could be performed remotely at a processing facility	• Waste materials are usually treated in place to improve the handling properties
Design and Construction Standards	• Per environmental engineering consultant recommendations and waste disposal criteria	• Depends largely on moisture content of waste material (liquid or solid) and how much stabilization is required to transport material
Performance	• Must meet standard by state environmental regulatory agency or federal performance criteria	• May be very little oversight by regulatory agencies • Often, this technique is used to facilitiate handling of material

or carbonates. Other proprietary additives may be used in conjunction with fly ash to treat wastes and decrease leachability.

i. Why Concrete and Concrete Products Cannot Use 100% of U.S. CCP Production

Over the past 40 years, the use of fly ash as a partial replacement for portland cement in concrete has attained full commercial status. There is a tremendous body of literature, case studies, and industry experience that proves that the use of fly ash in concrete is technically sound and commercially competitive. According to the American Coal Ash Association (ACAA), approximately 12,600,000 tons of fly ash was used in concrete, concrete products, and grout in 2008. This amount constitutes 42% of the fly ash that was beneficially used in 2008, but it was only 17% of the 72,454,000 tons of fly ash produced in the United States that year.

Fly ash in concrete is a spectacular recycling story, and one that our industry is very proud of. It would be ideal if 100% of U.S. fly ash production could be used in this manner. However, that is not possible, and there are two primary reasons for this.

1. **There is simply not enough concrete produced annually in the United States to utilize 100% of fly ash production.** According to cement industry statistics, the

United States consumed 93.6 million metric tonnes of portland cement in 2008[101], or 101.3 short tons. Approximately 75% of U.S. cement production is used to produce concrete, and fly ash can be used as a direct replacement for up to 30% of the portland cement in concrete[102]. Using these assumptions, the size of the potential market for fly ash in concrete was 23.2 million short tons in 2008, or 32% of fly ash production. The amount reported by ACAA that was actually used in this application (12.6 million short tons) would need to double in order to reach that target.

If we aim a little higher, and assume that 100% of cement production went into the production of concrete using a 30% direct replacement rate, then it would have been possible to use 30.9 million short tons, or 43% of total U.S. fly ash production.

2. **Not all fly ash meets the strict quality standards needed for it to be used in concrete.** The concrete industry takes the subject of raw material quality very seriously, and there is little deviation from strict standards. Quality is determined primarily through the use of ASTM International (ASTM)[103] standards and other industry standards and guidelines such as those established by American Association of State Highway and Transportation Officials (AASHTO)[104]. Fly ash quality is determined by a number of factors, primarily fuel source and power plant boiler combustion efficiency. Many utility power plants now combine coal with alternate fuels such as tire-derived fuel, biomass, pet coke, and other materials. Some coal sources produce fly ash that is too high in available alkalis and other deleterious substances for use in concrete. High loss on ignition, or unburned carbon, can be a problem with fly ash produced by less efficient generating units. It is estimated that only about 1/3 of utility fly ash production, or 24.2 million short tons in 2008, meets ASTM requirements for use in concrete.[105]

In addition to the issues of potential market size and quality, there are other factors that work against 100% fly ash utilization:

1. **Seasonal variations between concrete production and fly ash production.** Concrete production is dependent on the time of year and prevalent weather conditions. Nearly two-thirds of cement consumption occurs in the six months between May and October which are the heavier construction months[106]. Fly ash production is more dependent on electricity demand and tends to be a steady, year-round activity (subject of course to power plant outage schedules). Capturing fly ash

[101] Portland Cement Association, http://www.cement.org/econ/industry.asp

[102] A 30% replacement rate is considered above-average but technically sound. Usage rates range from as low as 10% to as high as 50%, but technical difficulties may be experienced at higher rates, especially with less-competent concrete producers. It should also be noted that there are many concrete users who still refuse to use fly ash either because they do not trust it or because of the capital investment required for a second silo.

[103] ASTM International, Conshohocken, PA, formerly known as the American Society for Testing and Materials.

[104] American Association of State Highway Transportation Officials, Washington, D.C.

[105] Personal communication - Mike Mings, Utility Services Manager, Lafarge Corporation, 2010.

[106] Portland Cement Association, id.

production during the slower months requires large investments of capital dollars by ash marketers and utilities in large storage facilities. To illustrate, if a generating station that produces 100,000 tons of fly ash annually sells 100% of production during six months of the year and 50% of production during the other six months, it would require fly ash storage on the order of 25,000 tons in order to sell 100% of its annual production. While this is technically possible, fly ash market prices must be relatively high in order to provide economic justification for the capital investment and the O&M costs of shipping into storage.

2. **Location of fly ash production facilities.** For a variety of reasons, there are many power plants that are located far away from centers of population. The cost of transportation by truck over distances of 100 miles or more can make the use of fly ash economically prohibitive. There are several large ash marketers that ship fly ash by rail to distant markets but this requires a large capital investment in terminals, trucks, railcars, and loading facilities, as well as higher O&M expenses. Again, the economics require relatively high fly ash selling prices to justify the expenses.

ACAA members constantly strive to increase the size of the cement replacement market, and have seen a great deal of success over the past 40 years, but it is the customers—users, specifiers, and owners—who ultimately decide whether to use the product.

ACAA questions whether a Subtitle C designation for fly ash will cause market prices for fly ash to decrease, increase, or remain stable. If there is an exodus of customers from fly ash to other raw materials, will market prices remain high enough to justify the additional capital expenditures, thereby increasing the quantities of concrete-quality fly ash into the marketplace? Basic economics dictates that prices go down when demand goes down and supply goes up. In order for ash marketers to stay in business, the additional costs would need to be subsidized by the utilities. The utilities' higher costs would then need to be passed along to consumers of electricity.

From the preceding discussion, it may be concluded that there is minimal growth potential in the markets for the use of fly ash in concrete and concrete products. At this point, the logical question is: How can higher rates of use for coal combustion products be attained?

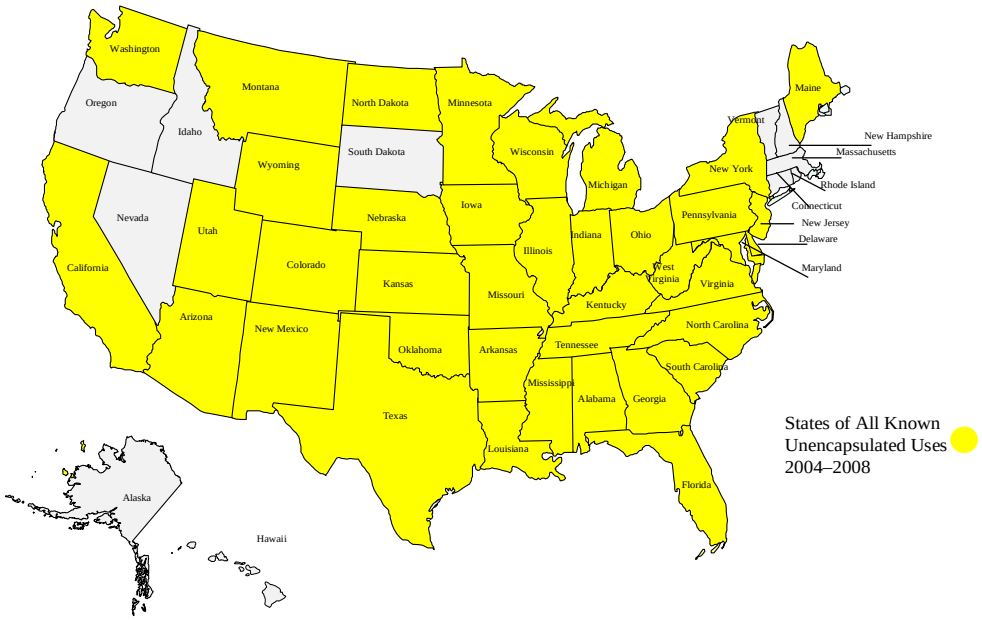
According to ACAA in its 2008 Coal Combustion Product (CCP) Production and Use Survey Report, a total of 60.6 million tons of all CCPs was used in all applications. Subtracting the 14.0 million tons of CCPs used in Concrete, Concrete Products and Grout, the 4.2 million tons of all CCPs used in Blended Cement and Raw Feed for Cement Clinker, and the 93,000 tons used in Flowable Fill (which is also an Encapsulated Use), it can be seen that 42.3 million tons of all CCPs were used in other beneficial use applications.

Of that 42.3 million tons, 8.5 million tons of FGD Gypsum went for use in Gypsum Panel Products, which the Environmental Protection Agency (EPA) has identified as a sanctioned use, and 10.5 million tons of all CCPs went for use in a variety of Mining Applications, which EPA has stated will be considered at a later date.

The remaining 23.3 million tons, or 17.1% of total CCP production, were used in other applications. It is apparent that if the United States expects to approach 100% utilization of CCPs, it is necessary to develop more uses for CCPs than just in concrete and concrete products.

There is tremendous market potential remaining for the use of CCPs in Geotechnical Applications (or "Unencapsulated Uses" as they are referred to by EPA). These uses are also commonly known in the coal ash industry as "Non-Traditional Uses," as they focus on different segments of the construction markets than the "Traditional Uses," which market fly ash into its traditional long-standing use as a partial replacement for portland cement in concrete.

The United States map below (Figure A-1) illustrates the geographic territory in which CCPs were used in geotechnical applications from 2004–2008. The table shows tonnages of CCPs reported to ACAA as having gone into these geotechnical applications during these years. These applications have increased steadily as specifications have been developed and their positive economics recognized by contractors, specifiers, and project owners.



2004	2005	2006	2007	2008	Totals 2004–2008
14,083,397	15,922,215	17,508,737	16,729,094	19,040,699	83,284,142

Figure A-3
Map of all known unencapsulated uses of CCPs from 2004 to 2008.

RESPONSES TO SPECIFIC QUESTIONS POSED BY THE EPA

Table IX-1 - Responses to Specific Questions Posed by the EPA

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
1	1	35128	1	EPA is not proposing to change the May 2000 Regulatory Determination for beneficially used CCRs, which are currently exempt from the hazardous waste regulations under Section 3001(b)(3)(A) of RCRA. However, EPA is clarifying this determination and seeking comment on potential refinements for certain beneficial uses. EPA is also not proposing to address the placement of CCRs in mines, or nonminefill uses of CCRs at coal mine sites in this action.	EPA should change the May 2000 Regulatory Determination to expand and explicitly identify specific beneficial uses. The May 2000 Federal Register identifies only road bed, structural fill, snow and ice control and waste stabilization as acceptable unencapsulated geotechnical uses. This list should be expanded for those recommended uses listed by ACAA in its submittal.
8	37	35146	1	EPA solicits comments on the effectiveness of additives such as organosilanes, which could take the hydraulic conductivity to zero, including any analysis that would reflect long-term performance, as well as the appropriateness of a performance standard that would allow such control measures in lieu of composite liners.	We are unaware of the use of this additive for use in beneficial use projects, in particular, for structural fill projects.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
14	41	35148	1	EPA solicits comments on EPRI's report and welcomes additional data regarding the proven damage cases identified by EPA, especially the degree to which there was off-site contamination.	The so-called damage cases reported by EPA are not representative of beneficial use projects that are designed and constructed using the guidelines provided in ACAA's comments.
15	41	35148	1	We encourage commenters on the proposal to consider this material (footnote), which EPA has placed in the rulemaking docket, as they prepare comments. Footnote: On February 24, the Environmental Integrity Project and EarthJustice issued a report on 31 'new' alleged CCRs damage cases...[as well as the EPRI report]	Same comment as Question 14.
17	42	35148	2	EPA makes it clear that CCRs in sand and gravel pits, quarries, and other large fill operations is not beneficial use, but disposal. As such, it would be regulated under whichever option is finalized. EPA solicits comments, however, on whether unencapsulated uses of CCRs warrant tighter federal control.	The presumption that the use of CCPs to reclaim sand and gravel quarries is not a beneficial use is flawed. While sand and gravel quarries have been used to dispose of CCPs it is not correct to assume that with proper engineering and environmental standards that CCPs cannot be used beneficially to reclaim quarries for uses such as recreational areas, commercial or industrial use, or to aesthetically improve the characteristics of the land.
28	57	35156	1	In the interest of reaching a more complete understanding of the nature and number of damage cases….EPA encourages commenters to consider all of these analyses in developing their comments.	Same comment as Question 14.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
41	37	35160	3	EPA solicits information and data on these developments [Increased use, GHG benefits, leaching studies, performance and risks of CCR uses including unencapsulated, state programs] and how the beneficial use of CCRs will be affected (e.g., increased use of fly ash in cement and concrete).	No comment.
42	67	35160	3	This section provides EPA's basis for leaving the Bevill exemption in place for these beneficial uses, although as discussed throughout this section, EPA is also soliciting comment on unencapsulated uses of CCRs and whether they should continue to be exempted as a beneficial use under the Bevill exemption.	Same comment as Question 1.
43	67	35161	1	The Agency solicits information and data on these and other approaches [defining beneficial use or developing detailed guidance on beneficial use] that EPA could take in identifying when uses of CCRs constitute a "beneficial use," and consequently will remain exempt.	The recommendations provided in ACAA's comments on beneficial use and in the regulations of states such as Wisconsin under NR 538 provide relevant guidance to be used in developing standards for the use of ash in geotechnical projects.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
44	68	35161	1	Today's proposed rule explicitly removes these types of uses [sand & gravel pits, landscape regarding] from the category of beneficial use, such that they would be subject to the management standards that EPA finally promulgates. EPA also seeks information and data on whether it should take a similar approach in today's proposal to unencapsulated uses of CCRs, such as the placement of unencapsulated CCRs on the land, e.g., agricultural uses.	Same comment as Question 17.
45	68	35161	1	EPA is also soliciting comment on whether the Agency should promulgate standards allowing such uses, on a site-specific basis, based on a site-specific risk assessment, taking into consideration, inter alia, the CCRs character and composition, their leaching potential under the range of conditions under which CCRs will be managed, and the context in which the CCRs will be applied, such as location, volume, rate of application, and proximity to water.	For some structural fill projects, site-detailed specific assessments may be necessary depending upon geological and other environment considerations and the volume of fill. The recommendations provided by ACAA provide guidelines to determine whether these types of assessments are necessary.
46	68	35161	3	EPA solicits comment on whether an alternative approach is appropriate, particularly for unencapsulated uses of CCRs on the land.	Same response as Question 43.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
47	70	35162	1	EPA is requesting information and data on the appropriate means of characterizing beneficial uses that are both protective of human health and the environment and provide benefits.	The use of CCPs for unencapsulated projects constitute beneficial use if they are constructed or applied in a manner consistent with the protection of public health and the environment, good engineering practice, and are consistent with the goal of preserving natural resources, conserving energy and reducing or eliminating the need to dispose of CCPs in landfills.
48	70	35162	1	EPA is also requesting information and data demonstrating where the federal and state programs are or have been inadequate in being environmentally protective and, conversely, where states have, or are developing, increasingly effective beneficial use programs.	Beneficial use regulations in state programs vary considerably. Some states have specific rules governing the beneficial use and others implement it on a case-by-case basis or under general permit provisions. Some states just provide general exemptions for beneficial use. It would be useful for EPA in concert with others to provide more guidance to some states to develop more comprehensive procedures on the use of CCPs for beneficial use projects.
49	72	35163	1	EPA is proposing that these criteria be included in the regulations as part of the definition of beneficial use. EPA requests comment on these criteria, as well as suggestions for other criteria that may need to be included to ensure that legitimate beneficial uses can be identified and enforcement action can be taken against inappropriate uses.	It is entirely appropriate for industry standards such as ASTM to be used to determine the technical or engineering criteria for beneficial use projects. However, it is entirely inappropriate for EPA to specify in rule when a project constitutes a beneficial use simply by volume or amount of structural fill a project requires to construct a stable base for a building, or to determine the size of a fill for a parking lot or a storage pad, or to determine whether a particular use constitutes a beneficial use. Such determinations should be subject to local building ordinances or zoning requirements in coordination with state agencies implementing their beneficial use programs.
50	72	35163	2	The EPA solicits comments on the need to provide a formal listing of all beneficial uses. To this end, EPA solicits comment on whether additional uses of CCRs have been established since the May 2000 Regulatory Determination that have not been discussed elsewhere in today's preamble should be regarded as beneficial.	Same answer as Question 1.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
51	72	35163	2	Of particular concern in this regard are reports that CCRs are being used in producing counter tops, bowling balls, and in the production of makeup. The Agency solicits comment on whether use of CCRs in consumer products of this kind can be safely undertaken.	Encapsulated question. No comment.
52	72	35163	2	The Agency further solicits comment any new uses of CCR, as well as the information and data that supports that it is beneficially used in an environmentally sound manner. The concern with such an alternative [of a formal listing]is that new and innovative uses that are not on the list would be subject to disposal regulations, until EPA revised its rule.	Same answer as Question 1. However, provisions should be made to allow the testing and evaluation of new and innovative uses where it can be demonstrated that they can used in an environmentally sound manner.
53	73	35163	3	EPA solicits comments on appropriate criteria to distinguish between legitimate beneficial uses and inappropriate operations, such as, for example, a comparison to features associated with relatively small landfills used by the utility industry, and whether characteristics of the materials would allow their safe use for a particular application in a particular setting (i.e., characterize both the materials for the presence of leachable metals and the area where the materials will be placed).	ACAA recognizes that a “large-scale” fill that is simply used to fill “a void” cannot be considered as a legitimate beneficial use. Because sand and gravel quarries were used in some circumstances to simply fill a void does not mean all use of CCPs to reclaim a quarry is considered not to be beneficial use. Reclamation of quarries is a legitimate beneficial use for recreational parks or for their use in commercial or industrial development. With proper engineering, quarries can be reclaimed for productive use rather than being abandoned and creating and aesthetic eyesore or safety issue.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
54	73	35163	3	Accordingly, in this section, the Agency presents information on the issues on which it is specifically soliciting comment. First, we identify the array of environmental issues associated with unencapsulated uses. CCRs can leach toxic metals at levels of concern, so depending on the characteristics of the CCR, the amount of material placed, how it is placed, and the site conditions, there is a potential for environmental concern.	ACAA has provided specific environmental and engineering standards for each beneficial use. Using these standards will ensure that the beneficial uses recommended will not negatively impact the environment and will provide protection for public health.
55	76	35164	3	While EPA does not want to negatively impact the legitimate beneficial use of CCRs unnecessarily, we are also aware of the need to fully consider the risks, management practices, state controls, research, and any other pertinent information. Thus, to help EPA determine whether to revise its approach and regulate, for example, unencapsulated uses of CCRs on the land, we solicit comments on whether to regulate, and if so, the most appropriate regulatory approach to be taken.	In its proposal, EPA has suggested that it may regulate the unencapsulated uses of CCPs either through Subtitle C or Subtitle D of RCRA. The rationale given to regulate beneficial use as presented in its proposal is based upon so-called damage cases associated with simple disposal in sand and gravel quarries that occurred many years ago, and infers that these practices that occurred years ago reflect the current state of the beneficial use of coal ash in the United States. ACAA recognizes the fact that some states may not have those procedures in place that follow the recommended practices outlined here to ensure proper engineering procedures and safeguards to the environment from beneficial use. Even though procedures for the beneficial use of coal ash across the states are not uniform, no states to our knowledge have reported damage to the environment or negatively impacted public health that warrants the regulation of the beneficial use of coal ash by Subtitle C of RCRA. If EPA finds it necessary to regulate the beneficial use of CCPs, the preferable approach would be through Subtitle D of RCRA. Most states that have successful programs, for example Wisconsin under NR 538, regulate the beneficial use of ash through regulations similar to those procedures recommended here rather than demonizing its use by inferring the material is hazardous.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
56	76	35165	1	We would like comment on whether persons should be required to use a leaching assessment tool in combination with the Draft SW-846 leaching test methods described in Section I. F. 2 and other tools (e.g. USEPA's Industrial Waste Management Evaluation Model (IWEM)) to aid prospective beneficial users in calculating potential release rates over a specified period of time for a range of management scenarios, including use in engineering and commercial applications using problematic assessment modeling.	Although EPA has indicated that TCLP may not be appropriate to properly characterize leaching in unencapsulated uses, it has not demonstrated that the use of TCLP to characterize CCPs in properly designed projects where appropriate environmental and engineering considerations have resulted in damage to the environment or impacted public health. Simple screening tools such as TCLP can and still should be used with other available leach tests such as ASTM D3987 and SPLP to better understand the characteristics of coal ash uses in unencapsulated projects. Until it can be demonstrated that new leach tests proposed by EPA or the use of groundwater models are superior to existing procedures, based on actual ground truth data, or groundwater monitoring on actual projects, existing leach procedures should be used in concert with properly designed projects.
58	76	35165	2	If EPA determines that regulations are needed, should EPA consider removing the Bevill exemption for such unencapsulated uses and regulate these under RCRA subtitle C or should EPA develop regulations under RCRA subtitle D?	The Bevill exemption should be preserved with the addition of those beneficial uses recommended by ACAA. CCPs should not be regulated under Subtitle C of RCRA unless the specific CCP has been tested to be hazardous under the existing TCLP procedures. The disposal of CCPs, however, should be regulated under Subtitle D of RCRA. In addition, the EPA should provide guidance to states and encourage them to develop beneficial programs consistent with recommendations by ACAA.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
59	76	35165	2	If materials characterization is required, what type of characterization is most appropriate? If the CCRs exceed the toxicity characteristic at pH levels different from the TCLP, should they be excluded from beneficial use? When are total levels relevant? EPA solicits information and data on the extent to which states request and evaluate CCR characterization data prior to the use of unencapsulated CCRs (keeping in mind that EPA ORD studies generally show that measurement of total concentrations for metals do not correlate well with metal leachate concentrations).	Same answer as Question 56.
60	76	35165	2	If regulations are developed, should they cover specific practices, for example, restricting fill operations to those that moisten and compact fly ash in layers to attain 95% of the standard Proctor maximum dry density value and provide a drainage layer? Are such construction practices largely followed now?	Engineering practices to implement beneficial use projects should be commensurate with the spatial and volume size of the use, structural considerations, and geologic site conditions. Some small and less complicated projects may not require that optimum moisture and in-field density be achieved to 95% of standard Proctor. Those projects and beneficial uses that may require such standards should be based on good engineering practice. ACAA has proposed proper engineering procedures to implement beneficial use projects.
62	76	35165	2	Should the EPA exclude unencapsulated uses in direct contact with water bodies (including the seasonal high groundwater table) from beneficial use?	Yes. Regulations should prohibit unencapsulated uses from being placed in direct contact with either surface water bodies or groundwater.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
84	120	35186	2	As a result, EPA is explicitly not proposing to change their Bevill status (although we do take comment on whether ''unconsolidated uses'' of CCRs need to be subject to federal regulation).	We do not understand the term "unconsolidated use."
139	192	35222	1	The screening analysis conducted to estimate risks from fugitive CCR dust; data from any ambient air monitoring for particulate matter that has been conducted; where air monitoring stations are located near CCR landfills or surface impoundments; and information on any techniques, such as wetting, compaction, or daily cover that are or can be employed to reduce such exposures.	This question relates to disposal sites not beneficial use projects. For beneficial use projects using CCPs, appropriate dust control measures are required either by providing on-site water availability or CCPs delivered with the proper moisture content. In addition, for projects that require longer construction times, temporary covers are appropriate. Appropriate dust control measures are included in ACAA's recommended beneficial use procedures.
144	192	35222	1	The effectiveness of such additives as organosilanes, including any analyses that would reflect long-term performance of the additives, as well as the appropriateness of a performance standard that would allow the use of these additives in lieu of composite liners.	Same answer as Question 8.
146	192	35222	2	Information and data on the extent to which states request and evaluate CCR characterization data prior to the beneficial use of unencapsulated CCRs.	The TCLP test is the most common test used by states to initially determine whether a CCP can be used for a beneficial use project. Some states require further leach testing that they consider appropriate to the use of CCPs, for example, the SPLP or ASTM D3987 leach tests. The results of these tests in many cases are compared to groundwater, drinking water, or surface water standards to determine the appropriate engineering or environmental performance standards for projects.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
147	193	35222	2	The appropriate means of characterizing beneficial uses that are both protective of human health and the environment and provide benefits. EPA is also requesting information and data demonstrating where the federal and state programs could improve on being environmentally protective and, where states have, or are developing, increasingly effective beneficial use programs.	A number of states have developed or recently developed rules or approval procedures that are protective of human health and the environment with regard to the beneficial use of CCPs. The procedures in these state programs together with the recommendations outlined by ACAA can be used as a template for other states to follow.
148	193	35222	2	Whether certain uses of CCRs (e.g., uses involving unencapsulated uses of CCRs) warrant tighter control and why such tighter control is necessary.	For most beneficial uses of CCPs, further regulations are not necessary based upon their type of use, the limited amount of material that is placed in the land environment, and the current use of industry guidelines such as ASTM or AASHTO. In some cases, however, where the volume of the material is large, for example, in some structural fills, individual assessments are necessary to evaluate proper engineering construction practices that may require liners in situations where geologic or other environmental conditions dictate their use.
149	193	35222	2	If EPA determines that regulations are needed for the beneficial use of CCRs, should EPA consider removing the Bevill exemption for such uses and regulate these uses under RCRA subtitle C, develop regulations under RCRA subtitle D or some other statutory authority, such as under the Toxic Substances Control Act?	If EPA determines it must regulate the beneficial use of CCPs, it should do so under RCRA Subtitle D without removing the Bevill exemption for such uses. The use of Subtitle D for the regulation of municipal landfills has proven to be successful.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
150	193	35222	2	Whether it is necessary to define beneficial use better or develop detailed guidance on the beneficial use of CCRs to ensure protection of human health and the environment, including whether certain unencapsulated beneficial uses should be prohibited.	The unencapsulated beneficial uses that are recommended by ACAA for CCPs are those listed in our comments. Guidance should be developed to assist states in the development of their programs. Those beneficial uses that should be prohibited are those that are used in direct contact with surface or ground water and those that simply fill a void and constitute disposal. The restoration of quarries to a productive use should not be prohibited, and that determination should be based upon local or state government decisions based upon the proposed use.
151	193	35222	2	Whether the Agency should promulgate standards allowing uses on the land, on a site-specific basis, based on site-specific risk assessments, taking into consideration the composition of CCRs, their leaching potential under the range of conditions under which CCRs would be managed, and the context in which CCRs would be applied, such as location, volume, rate of application, and proximity to water.	Most unencapsulated beneficial uses of CCPs do not require site-specific assessments because they pose little if any risk to the environment or to public health. For those beneficial use projects that may require site specific assessments, tools are currently available to assist states in determining the necessary engineering features and environmental performance requirements.
152	193	35222	2	If materials characterization is required, what type of characterization is most appropriate? If the CCRs exceed the toxicity characteristic at pH levels different from the TCLP, should they be excluded from beneficial use? When are totals levels relevant?	Same answer as Question 56.

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
155	193	35222	3	Historically, EPA has proposed or imposed conditions on other types of hazardous wasted used in a manner constituting disposal (e.g. maximum application rates and risk-based concentration limits for cement kiln dust used as a liming agent in agricultural application (see 64 FR 45639; August 20, 1999); maximum allowable total concentrations for nonnutriative and toxic metals in zinc fertilizers produced from recycling hazardous secondary materials (see FR 48393; July 24, 2002). Should EPA establish standards, such as maximum/minimum thresholds, or rely on implementing states to impose CCR site specific limits based on front-end characterization that ensures individual beneficial uses remain protective?	It is entirely appropriate to conduct front-end characterization. In fact, some states have developed a matrix based upon these tests. In that matrix, for example, NR 538 provides for increasingly more stringent engineering and environmental standards for the type of beneficial uses allowed as the concentrations from leach test result increase.
156	193	35222	3	Whether additional beneficial uses of CCRs have been established, since the May 2000 Regulatory Determination, that have not been discussed elsewhere in today's preamble. The Agency solicits comment on any new uses of CCR, as well as the information and data which support that CCRs are beneficially used in an environmentally sound manner.	Same answer as Question 1.
188	197	35224	1	EPRI's report and additional data regarding the proven damage cases identified by EPA, especially the degree to which there was off-site contamination.	

263-page Prepublication Version		163-page Federal Register Version			
Question No.	**Page No.**	**Page No.**	**Column No.**	**EPA Question**	**ACAA Answer**
189	197	35224	1	The report of additional damage cases submitted to EPA on February 24, 2010 by the Environmental Integrity Project and EarthJustice.	

Section X – Beneficial Use: Agricultural Applications (FGD Gypsum)

a. Introduction

A team including representatives of utilities, marketers, researchers, academics and users of FGD gypsum in agriculture collaborated in analyzing the EPA Proposed Rule- Hazardous and Solid Waste Management System; Identification and Listing of Solid Wastes; Disposal of Coal Combustion Residuals from Electric Utilities (40 CFR Parts 257, 261, 264 et al.) as it relates to and could impact the emerging use of FGD gypsum in agricultural applications. Specific issues raised by EPA in the Proposed Rule relative to this beneficial use were catalogued and categorized into the eight topic headings addressed in this document. Collectively, those involved in this collaboration were able to bring to this subject an unequalled, comprehensive understanding of this relatively new emerging beneficial use for material generated form the forced oxidation sulfur dioxide scrubbing process at a growing number of power plants across the US.

As the result of years of positive research results, growing market awareness and increased availability of economically accessible FGD gypsum to agricultural communities, momentum has been growing for beneficial use of FGD gypsum in agriculture as a soil amendment and nutrient source. Production of this material is expected to grow substantially in the coming years, and agriculture represents the largest untapped potential market for beneficial use of this valuable resource. EPA has historically been a meaningful contributor to developing such market opportunities and, we hope, through this review process, will recognize the role expanded agricultural use of FGD gypsum can play in addressing broader environmental challenges including clean water, restored waterways and improved soil quality.

b. Use of FGD Gypsum in Agriculture is a Legitimate Beneficial Use

EPA has requested comments on the proposed criteria for defining legitimate beneficial uses to ensure that these uses can be identified and that enforcement action can be taken against inappropriate uses. With respect to the agricultural use of FGD gypsum, the definition EPA proposes clearly supports the classification of FGD gypsum for this application as a legitimate beneficial use that is protective of human health and the environment and provides clear benefits.

Following are the criteria EPA has proposed, and how FGD gypsum for agricultural use conforms to those criteria:

- **The Material Must Provide a Functional Benefit.** The functional benefits of agricultural use of FGD gypsum reported in the literature by USDA-ARS and other government and private sources include, among other benefits: reduces aluminum toxicity (i.e. provides drought tolerance and extensive root systems); provides macronutrients (Ca, S); reduces sodium and magnesium; improves soil structure and

moisture (more water infiltration, less soil erosion from runoff); and reduces soluble phosphorus in runoff where animal wastes are used as fertilizer[107].

Providing some more specific examples, non-point source pollution caused by nutrient run-off from farms is one of the leading contributors to water quality problems in much of the US today. Initial research on use of FGD gypsum in sensitive watersheds to mitigate runoff has shown promising results which could lead to adoption of gypsum application as an agricultural Best Management Practice to improve water quality. Also, IFDC, a public International organization dedicated to issues such as food security, has identified sulfur deficiency in agricultural soils as a priority issue that will need to be addressed if we are to maintain soil productivity. Application of FGD gypsum is the lowest cost, most practical approach to addressing this issue in much of the world today.

- **The Material Substitutes for the Use of a Virgin Material.** Pulverized naturally occurring gypsum rock is a high quality agricultural product which is mined in Canada and in 55 mines in 18 States in the United States[108]. Most of the mined material, however, is not near agricultural users and accordingly is economically unavailable for agricultural use. Basic characterizations from several sources show that FGD gypsum is almost identical to naturally occurring gypsum except that FGD gypsum is often better in purity (as $CaSO_4 \bullet 2H_2O$), guaranteed agricultural analysis (calcium, sulfur - dry basis), and trace metal contents[109]. Further, as Dr. Malcolm Sumner's research, research at Ohio State, and work by the USDA-ARS have found, the list of functional benefits shown above are equivalent to those of natural gypsum[110, 111].

- **The Material Must be Applied at Appropriate Agronomic Rates.** Extensive demonstrations over a period of several years have developed agronomically typical application rates for crops such as peanuts (0.5 tons/acre annually), cotton (4.5 tons/acre at five-year intervals), tomatoes, corn, soybeans and other vegetables (1-2 tons/acre annually) and forage/turfgrass (4.5 tons/acre at five-year intervals)[112, 113].

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[107] 2010 Unpublished Data Files by Malcolm Sumner, Agricultural and Environmental Consultant: "Other Benefits"; Root Responses – Alfalfa"; "Root Responses – Other Crops."
[108] USGS Mineral Commodity Summary – Gypsum, January 2010.
[109] 2010 Unpublished Data File by Malcolm Sumner, Agricultural and Environmental Consultant: "Gypsum Composition."
[110] Research by Warren A. Dick of the Ohio State University, which was previously submitted as part of the 46 technical papers concerning agricultural research in this area that ACAA submitted to EPA on November 9, 2010.
[111] United States Department of Agricultural, Agricultural Research Service research and analysis which was also previously submitted as part of the documents submitted to EPA on November 9, 2010.
[112] 2010 Unpublished Data Files by Malcolm Sumner: "Yield Increases"; Agricultural and Industrial Uses of FGD Gypsum Workshop, National Network for Use of FGD Gypsum in Agriculture, Atlanta, Georgia, October 23-24, 2007, EPRI.
[113] Research by Warren A. Dick of the Ohio State University, which was previously submitted as part of the 46 technical papers concerning agricultural research in this area that ACAA submitted to EPA on November 9, 2010.

There is no justification for use in excess of these rates, since that would increase the grower's operating costs and make the material less attractive, while offering no incremental benefit to the crops.

- **Use of the Material Meets Applicable Standards.** In the absence of more appropriate standards, EPA has proposed that Part 503B standards for land application of exceptional quality treated biosolids should be met or exceeded for agricultural applications of CCPs with respect to constituent levels, prescribed total loads and application rates[114]. Sumner's data compares allowable 503B concentrations to FGD gypsum and other materials (soil, mined gypsum, poultry litter), with results showing that FGD gypsum is at least an order of magnitude lower than the 503B limits. Loadings would also be easily acceptable when using the modest application rates discussed above.

  A comparison of FGD gypsum to the Part 503 standards is below:

(mg/kg)	Part 503 Exceptional Quality BioSolid Limits	FGD Gypsum Typical Range per USEPA	Active Ag-gypsum program- Plant A	Active Ag-gypsum Program-Plant B
Metal				
Arsenic	41	0.6-4.0	<0.43	2.4
Cadmium	39	0.2-1.2	0.042	n.d.
Copper	1500	1.1-4.7	n.d.	4.6
Lead	300	0.8-12.0	1.5	n.d.
Mercury	17	0.01-1.4	0.97	0.08
Molybdenum	75	0.5-12.0	0.31	2.89
Nickel	420	0.73-20.1	2.6	2.6
Selenium	100	2.0-30.0	12	4.12
Zinc	2800	3.4-47.5	5.5	10

As indicated, the levels of RCRA metals allowed for unpermitted land spreading of Biosolids are at levels at least 10 times and in many cases more than 100 times the levels of metals present in FGD gypsum.

In addition to these specific proposed criteria, the legitimacy of the beneficial use of FGD gypsum in agriculture is confirmed by the reality that FGD gypsum material is produced as a "product" rather than a waste material, which is evidenced by the typical handling steps in production and processing. Although in reference to the production of FGD gypsum for use in the production of wallboard, EPA even acknowledges this in the Proposed Rule.
The entire FGD scrubber system is designed, at significantly greater initial capital cost, to facilitate "product" sales. With power plant SO_2 scrubbers, gypsum is produced by adding excess oxidation air (forced oxidation) to the scrubber in order to intentionally form gypsum rather than the less desirable calcium sulfite, which is difficult to handle or spread agriculturally and as a result has no agricultural market value. The material also undergoes dewatering (by gravity means or vacuum filtration) in order to offer a drier material, which is required for

[114] 2010 Unpublished Data File by Malcolm Sumner, Agricultural and Environmental Consultant: "Gypsum Composition."

transportation, handling, and spreading in agricultural or other uses. Interferences such as chlorides are also reduced by washing the material before or during the dewatering step. Finally, a stockpile of marketable material is maintained at power plants and distributor locations.

c. FGD Gypsum used in Agriculture Produces Measurable Economic Value

In addition to technical benefits discussed, several measures of economic value exist that provide additional confirmation that agronomic uses for FGD gypsum are legitimate beneficial uses and not disposal disguised as beneficial use.

- **Purchase Price.** An informal ACAA survey revealed that those companies represented do not subsidize the purchase of FGD gypsum for agriculture or other gypsum uses[115]. Utilities generally charge customers in the range of $1-$10 FOB for sales to suppliers, and up to $50 per ton for material delivered to growers. The Department of Energy's EIA-923 power plant database for 2008 shows that 46 utility power plants reported FGD gypsum revenues in 2008, including use in wallboard, cement and agriculture.

- **Quantities.** The ACAA CCP annual survey for 2008 revealed an estimate of 17.75 million tons of FGD gypsum produced, with 10.65 million tons used, including 279,000 tons in agriculture. This figure demonstrates an increase of 143% from the level of agricultural use of FGD gypsum in 2007[116]. USGS data shows that synthetic gypsum now represents 57% of the U.S. gypsum supply. USGS also placed an $8.50 per ton average value on gypsum for all uses in 2009[117]. With more publicity about gypsum benefits in agriculture, plus successful demonstration projects, the agricultural tonnage can be expected to increase significantly in coming years.

- **Crop Yield Increase.** Dr. Malcolm Sumner's extensive database of more than 75 FGD gypsum demonstration projects covers a variety of soil and crop types over a four-state area in the Southeast for the 2003-2010 period. Across the board, there has been a positive yield response with FGD gypsum compared to the controls at each site where no gypsum was applied. This is accomplished without negative environmental consequences to soil or plant tissues[118] and is a direct result of technical benefits such as reduced soil acidity, more extensive root systems, improved soil structure, increased water infiltration and soil moisture, improved germination rate, and reduced tillage requirements. The yield increases are further enhanced in some cases by improved shelf life for crops such as tomatoes,

[115] June 2010 ACAA Meeting, Baltimore, Maryland.
[116] ACAA 2008 Coal Combustion Production (CCP) Production and Use Survey Report; ACAA 2007 Coal Combustion Production (CCP) Production and Use Survey Report.
[117] USGS Mineral Commodity Survey for 2009.
[118] Data from Study of Metals in Plant Tissue.

cantaloupes and potatoes due to higher calcium levels in the skin. Average crop yield increases at multiple sites over the period of observation in Sumner's work includes: peanuts 13%; alfalfa 36%; cotton 10%; cucumber 32%; squash 36%, tomatoes 28% and watermelon 40%.

d. Current Testing Protocols are Adequate for FGD Gypsum used in Agriculture

The Proposed Rule requests input on what testing would be appropriate for evaluating the potential beneficial use and safety of these materials. In the case of FGD gypsum, expert opinion is that **basic testing for total elemental content is sufficient to evaluate the safety of the material,** and that additional leach testing is unnecessary. Total elemental analysis, with a standard test such as EPA 3051, of the source material will identify if any RCRA metals are present outside of acceptable ranges. These measurements will, in every case involving material from contemporary forced oxidation scrubbing systems, confirm that RCRA metals are only present at very low levels. Further, considering that FGD gypsum applied for agricultural use involves applying a very thin layer of the material over the surface of the soil, any concentrations of metals present in application will be well below the levels measured at the source.

FGD gypsum in agricultural application works by dissolving its constituent elements, including Calcium and Sulfur, into the soil. Accordingly this use requires that materials "leach" into the soil and that, so long as the constituent metals of concern are below threshold limits, leach testing is irrelevant. EPA's proposed "LEAF" test suggests that leachate be tested at pH levels between 2 and 12 to evaluate performance across a range of possible field conditions. Agronomic experts tell us that soil with pH below 4 or above 8 cannot support economically productive plant life, so there would be no instance where testing at those levels would be at all relevant to practical agricultural use of FGD gypsum. In the opinion of ACAA, the USDA is the most informed and relevant agency to develop testing protocols and guidance for agricultural products and should be consulted as to relevant and appropriate testing standards for FGD gypsum to be used in agricultural applications.

e. Site Specific Standards are NOT Necessary for FGD Gypsum used in Agriculture

EPA has asked for comments on whether EPA should establish standards such as maximum/minimum thresholds, or rely on implementing States to impose CCP site-specific limits based on front-end characterization that ensures that individual beneficial uses remain protective. EPA expresses concern that application of CCPs for agricultural uses at constituent levels or loading rates greater than EPA's Biosolids regulations allow would not be a legitimate beneficial use. In addition, EPA has requested comments on whether tighter controls such as site-specific standards and risk assessments are appropriate for unencapsulated uses such as land application.

We do not believe that tighter controls are necessary. We do not think it is necessary for EPA to establish specific application rates for FGD gypsum in agriculture, either site-specific or otherwise, and we believe their concern about over application is unfounded.

It is highly unlikely that FGD gypsum will ever be applied at rates above those justified by agronomic benefit as a means for utilities to dispose of more of the material (and if this is the concern, regulations can be tailored to address this concern, and in most cases such regulations already exist). Application rates are strictly governed by the economics of farming. Farmers operate in an economic environment where they must carefully balance input costs with achievable revenues from their crops. No farmer will incur the costs to apply more gypsum than justified by the potential benefit in increased yield or reduced costs of other inputs. Accordingly, no farmer will apply gypsum at a rate in excess of that at which it generates maximum benefit to the crops. Since the cost of transport is a meaningful portion (frequently the majority) of the cost of the material to the farmer, this will remain the case even if the utility provides the material at low or no cost.

Moreover, as detailed elsewhere in these comments, materials applied to agricultural lands, including fertilizers, herbicides, fungicides and soil amendments are closely regulated by State programs which oversee the content and application practice of all these materials. Regulations in all of the 29 States surveyed by ACAA address application rates for materials such as FGD gypsum. Regulations range from very specific (tons/acre by specific crop) to more general (rates as per proven agronomic practice).

As detailed elsewhere, there are already in place substantial levels of oversight of by-product materials in agriculture by state agriculture and environmental agencies. Moreover, management practices at utilities and at farms are also strict since FGD gypsum is now clearly recognized as a valuable agricultural product. There have been no proven damage cases involving FGD gypsum applied in agriculture (or any other use). All of this together has spurred robust research programs at universities, USDA and EPA. Consequently, there is no justification for tighter controls or federal regulation for agricultural applications of this safe and valuable commodity.

In addition to these factors, it would be impractical to develop and implement customized standards for each agronomic site for a number of reasons: (a) time delays could be crippling for growers who often have a very short window to apply soil amendments and fertilizers as they plant and work their crops; (b) growers will be inclined to avoid materials that require additional paperwork to demonstrate compliance; (c) additional time and compliance paperwork will translate into extra cost, which most growers cannot afford, as they already have very tight budgets; and (d) most sites have soil variations and grow multiple crops in rotation on the same land, so site-specific standards would be confusing and could require more than one set of standards for the same land.

Moreover, USDA-ARS is currently performing research which will result in creation of Best Management Practices (BMPs) for FGD gypsum in agronomic applications. These BMPs will define recommended crop specific application rates and may sometimes offer financial incentives for growers who implement these practices. Development of BMPs also includes investigation of environmental considerations before the practices are completed and published. We believe that EPA should defer to these agricultural experts with regard to application and site specific standards for agricultural use of FGD gypsum.

f. Regulation under RCRA Subtitle D or C

EPA has requested comments on whether EPA should remove the Bevill exemption for unencapsulated uses and regulate these under RCRA Subtitle C or whether EPA should develop regulations under RCRA Subtitle D. With regard to FGD gypsum material in general and agricultural applications specifically, ACAA believes EPA should not impose specific regulation, but, if they do, such regulation should be under Subtitle D of RCRA, not Subtitle C.

In order for EPA to regulate a material under RCRA, the material must be a solid waste, which the statute defines as materials that have been discarded (see Section 1004(27)). As is discussed above, EPA, in the Proposed Rule, points out that utilities design and operate their air pollution control devices to produce an optimal product in the form of FGD gypsum intended as a product, and not as a waste to be discarded.

Moreover, EPA confirms that FGD gypsum used for wallboard manufacture is a product rather than a waste or discarded material. We see no reason why this distinction should be use-dependent. This same material in agricultural application is also a product, manufactured to match the performance characteristics and attributes of naturally mined gypsum used for agricultural land application. Accordingly, FGD gypsum produced for agricultural land application should be exempt from regulation under RCRA, irrespective of whether CCPs are regulated under Subtitle C or Subtitle D.

If it is determined that FGD gypsum produced for agricultural application requires regulation under RCRA, it can be adequately regulated under Subtitle D, and there is no need to regulate it as a Subtitle C hazardous waste. There are no measurements of chemical constituents or performance characteristics of the material that meet the criteria for classification of the material as hazardous waste under Subtitle C. There have been no known damage cases associated with these materials or this application. It is a byproduct of the emissions scrubbing process and not the process of burning coal, and there is no justification for lumping it together with other byproducts of the coal combustion process for regulatory purposes.

Under Subtitle D, state-level regulations, already in place in all states for agricultural materials such as FGD gypsum, can continue to operate as they do today, providing a seamless transition to a regulated environment for these materials in this application. Under Subtitle D, expansion of agricultural use of the material can continue, with the attendant benefits to agriculture, the environment and the economy. Under a Subtitle D regulatory structure, Utilities would be

encouraged to devote the necessary resources to further developing the agricultural market as an alternative to wasteful and unproductive disposal of these valuable resources. Under the Subtitle D approach, implementation will occur years earlier than if Subtitle C regulations are adopted, enabling the currently expanding market for FGD in agriculture to maintain its growth momentum without interruption, building on the research and investment in this market that has occurred over the past five years.

If FGD gypsum for agricultural application becomes regulated under Subtitle C, the further development of this market will be severely impacted. In addition to the issues associated with stigma (addressed below and throughout this submission) the practical implications of beneficial use of the material under a Subtitle C regulatory structure will make continued marketing of the material for agriculture virtually impossible. Most, if not all, state programs prohibit the land application of RCRA Subtitle C hazardous materials on agricultural land, thus one could not even seek a permit to continue using FSD gypsum in agricultural applications.

Practically, distribution practices would also be severely disrupted. The agricultural market for FGD gypsum is highly seasonal, requiring stockpiling of material in anticipation of those windows in the growing year when land application is practical. Since such stockpiling would be prohibited under Subtitle C regulation, available material would be limited to only that that is actually produced on those days when growers can spread material on their land.

If CCPs as a category are classified as RCRA Subtitle C materials, it would be appropriate for utilities to apply for delisting of gypsum for agricultural purposes from RCRA Subtitle C and a strong case can be made that such a delisting would be appropriate. However, between the stigma that would linger from the period when the hazardous regulations applied, and the market development momentum that would be lost, it is highly unlikely that the agricultural market for FGD gypsum would recover for a very long time. Moreover, it makes little sense to force businesses through this process when the correct decision can be made now.

g. The Stigma Impact of a Hazardous Designation will be Severe

EPA has requested comment on what is a clear reality – that “stigma” will drive people away from the use of valuable products, if EPA regulates any aspect of CCP management under Subtitle C. With regard to use of FGD Gypsum for agricultural purposes, the potential stigma of hazardous designation will be severe and will have a very negative impact on the future of this beneficial use. This will be the combined result of utilities that will not be willing to undertake beneficial use programs, end users who will be unwilling to use the material on their farms, and intermediaries who will not be able to continue their businesses.

Our survey of utilities confirms that virtually all utilities now implementing or planning to implement FGD gypsum agricultural marketing programs will end those programs if the material is declared hazardous under Subtitle C of RCRA. Utilities will not be willing to take the legal risk of allowing the material out of their full control in a disposal situation due to the potential liabilities and penalties under Subtitle C of RCRA. They have no incentive to

undertake such programs since the potentially large legal risk accrues to their shareholders while the increased costs of disposal they will incur can be passed through to their rate payers.

As a result, marketers, most of which are small businesses, will not be able to obtain supplies from utilities. Where they could, since virtually all state programs prohibit the application of materials classified as hazardous wastes to agricultural land, they will not be able to obtain approvals, licenses and permits necessary to market FGD gypsum for agricultural use.
If material were available, and State prohibitions were not an obstacle, farmers would not be willing to apply it to their crops if it were in any way identified as a hazardous waste. Farmers are conscientious stewards of the land, usually living where they farm, and will not take the risk of damaging their livelihood by applying material to the land that has been designated as somehow "hazardous." Much agricultural land is passed down through generations within families, and the prospect that a currently active farmer would damage the productive capacity or value of the land for future generations by applying a hazardous material to the fields would be a major deterrent. Growers also rely on the advice and expertise of University researchers who will no longer support the use of FGD gypsum for land application if it is identified as a hazardous material. Professional crop consultants, also relied upon by farmers for advice, will no longer recommend application of FGD gypsum. Our survey of farmers currently using the material confirms that they will no longer be willing to use the material if it is designated as a hazardous or special waste by the Federal government.

Moreover, there are readily available alternatives to use of FGD gypsum, such as chemical based fertilizers and additives, that farmers can turn to instead of using FGD gypsum if it is categorized as somehow "hazardous." In some cases, farmers can gain access to naturally mined gypsum near their farms although such mining only takes place in a few areas of the country. Most growers, however, will regain the advantages they will lose by no longer using gypsum by increasing their application of chemical based fertilizers and other additives, almost all of which are more threatening to the environment and human health than FGD gypsum.

h. State Regulation of FGD Gypsum used in Agriculture is Universal and Comprehensive

EPA has requested information and data on state programs regulating beneficial use of CCPs including the extent to which states request and evaluate CCP characterization data prior to the beneficial use of unencapsulated CCP, information demonstrating where federal and State programs are or have been inadequate in being environmentally protective and, conversely, where States have, or are developing, increasingly effective beneficial use programs. With regard to agricultural use of FGD gypsum, ACAA has conducted a comprehensive survey of state programs including interviews with key state level regulators in 29 States which together represent most areas where FGD gypsum is now or will be produced and agricultural areas where it will be used as a soil amendment. A summary of the information collected in that survey is included in Table X-1.

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
South Carolina	Hugh Weathers, Commissioner - SC Dept. of Ag.; Chris Ray, Kyle Stephens- Clemson University Plant Industry	BUD referred to SC Dept. of Ag & Clemson University Plant Industry	SC Fertilizer Law of 1954 as Amended; 1976 Code Section 46-25-20 et. Sq.	TCLP for 8 RCRA metals, must meet Federal CFR 503 requirements for A-EQ Biosolids	Waste material description, detailed industrial process description	Recommended 1/2-1 ton/acre. Determination based on soil analysis	Process changes, updated analysis, distribution records	no limitations	Annual report on Distribution (methods, tons, locations) Quarterly report on tonnage sold	Fertilizer permit from SC Dept. of AG & Clemson- submit guaranteed agricultural analysis	$1.50/ton Inspection fee plus annual registration fee of $100-$400	Label must show guaranteed agricultural analysis (CA, S, purity). $1.50/ton penalty if fail to meet guarantee	Permits issued for FGD gypsum since 2005
Oklahoma	Kenny Naylor, Dept. of Agriculture	Oklahoma DEQ & Department of Agriculture	No specific regulations currently	TCLP for 8 RCRA metals, must meet Federal CFR 503 requirements for A-EQ Biosolids		Rates to be established by certified agronomist based on plant needs	not site specific	Only under cover with paved loading/ unloading areas	Summary of tons sold each six months	Obtain after letter approval from DEQ. Marketer licensed as registrant and must guarantee chemical content, nutrient value, etc.	$1/ton sold	Required both bulk and bagged- Bulk utilize AAPCO Statement	No current use in State. Will use 503 regulations when approvals are sought
Mississippi	Mark Williams- MS DEQ; Harry Ballard- MS DAC	Beneficial Use Determination	Section III.B- MS Regs for Beneficial Use of Nonhazardous Solid Waste (see www.deq.state.ms.us)	Chemical characterization including total RCRA metals	Industrial process description, expected benefits from use, Letters, permits from other States	Specific by plant type- .5-1.0 tons/acre/ year. Consideration of buffer distances from adjacent landowners, wetlands and State waters	Process changes, updated analysis, distribution records	no limitations	Annual Report describing process changes, updated analysis and distribution (methods, tons, locations)	Fertilizer permit required- must submit guaranteed agricultural analysis and approved label. MS Code of 1972, Section 75-47-27, Regulation 10	$.25/ton sold quarterly plus $10 registration fee	Product label must show guaranteed agricultural analysis (CA, S, purity)	

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Kentucky	Bob Bickner-KY Dept. of Waste Management	Department of Environmental Protection-Division of Waste Management-Registered Permit by Rule Program	Sewerage Sludge Program-KY 401KAR45:100	TCLP testing for total metals	Specific designation of plants to be treated to be included in Permit by Rule application process	Based on agronomic recommendations	not site specific	Stock piles must be controlled and monitored for runoff	Quarterly reporting of tons used	None if considered beneficial product unless seeking to classify as a fertilizer then requires registration with KY Dept. of Ag and University of KY	If classified as fertilizer then $.50/ton fee	Required if classified as fertilizer, otherwise MSDS form	Only one permit issued to date
South Dakota	Jim Wendte, Dept. of Environment & Natural Resources; Brad Berven, Dept. of Agriculture	No program at DENR since there are no power plants in SD producing material	n.a.	Testing required as part of "Proof of Value and Claims" for licensing. No additional metals testing	Case by case approvals for specific power plant source-materials analysis, volumes, other properties considered	Rates as per proven agronomic standards.	not site specific	no limitations	Tonnage report annually	Required. Issued once applicant shows "Proof of Value and Claims". Modeled on AAPCO standards	$.25/ton sold paid annually. $25 registration fee.	Must show guaranteed analysis	Familiar with material but no specific approvals issued yet. No plants in SD scrub emissions yet.

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Wisconsin	Phil Fauble, WI Department of Natural Resources; Charlene Khazae, WI Dep. Agriculture, Trade and Consumer Protection	Beneficial Use Program, Bureau of Waste and Materials Management	ss 289.43(8) WI Statutes- Conditional Grant of Exemption; NR 538 WI Admin. Code- Beneficial Use of Industrial Byproducts. (see www.legis.state.wi.us/rsb/)	Total bulk chemical and leachate characterization per NR 538 Table 1A & 1B, purity, TCLP	Research results supporting beneficial claims made	Rates based on agronomic practices suitable for soil type and crop. Use of best management practices to protect surface water; buffer strips; no application to standing or ponded water	Annual reporting of application sites	<1 year if exposed to elements; longer if in building; BMPs for run-on and run-off protection	Annual Report describing process changes, updated analysis and distribution (methods, tons, locations)	After WDNR approval, then apply for fertilizer or soil amendment license- provide labels, guaranteed agricultural analysis and product claims. Under DATCP 40 WI Admin. Code- Fertilizer and Related Products	$.45/ton sold annually; $25 registration fee	Product label must show purity, beneficial claims, production locations, recommended application rates	Separate exemptions required for each FGD gypsum source. Beneficial use limited to "non-hazardous" materials
Illinois	Darin LeCrone, IL Environmental Protection Agency; Tom Waller, IL Dept. of Agriculture	Division of Water Pollution Control	35 IL Admin. Code, Part 391 (Design Criteria for Sludge Application on Land) (see www.ipcb.state.il.us/SLR/IPCB)	Quarterly total bulk chemical and leachate characterization of gypsum, purity	Research results supporting beneficial claims made	Rates based on agronomic practices suitable for soil type and crop. Specific separation from potable wells, surface water, seasonal high water table	Monthly reporting of application sites including submittal of signed User Information Sheets	2 months or less at application site. Bulk storage locations require operating permit as solid waste facility	Monthly application site information. Semi-annual reporting of quarterly analytical sampling results	Following approval by IEPA, application for fertilizer or soil amendment license from Dept. of Agriculture. Can register as either Fertilizer (505 ILCS 80); or as Soil Amendment (505 ILCS 120)	$.25/ton sold; $25 annual registration fee	Label showing guaranteed analysis	Land application permit held by generator; Dept. of Ag. License can be held by marketer. Beneficial use restricted to "non-hazardous" materials

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Nebraska	Michael Behrens- Dept. of Environmental Quality-Solid Waste; Ken Jackson- Dept. of Agriculture	DEQ- Office of Solid Waste	No specific regulations currently- will follow Bio-solids Part 503 standards	Metals, pH, Nitrogen, Phosphorous, Calcium		Based on agronomic rates as established by testing and field trials	not site specific	Limit to no more than 75% of annual production at source	Semi-annual reports on tonnage	Commercial fertilizer and soil conditioner permit required	$.10/ton annually; $15 annual license fee	Must list active and inactive ingredients. All above 2% must be listed individually	Only one permit issued to date to marketer of gypsum from lactic acid plant
Alabama	Donnie Walker, Manager, AL Dept. of Agriculture and Industries	Department of Agriculture and Industries	Code of Alabama 1975, S2228 Chapter 80-1-6	no specific environmental testing	Proof of all claims made verified by Auburn University or other source acceptable to Commissioner of Agriculture	Specific by plant type- .5-1.0 tons/acre/year.	Monthly reports of tons sold and counties where distributed	no limitations	Monthly reports of tons sold and counties where distributed. Complete annual report at year end.	Fertilizer permit required for soil conditioners and amendments . Must submit product guaranteed analysis label for review and approval	$.70/ton annually	Label showing guaranteed analysis (Ca,S, purity)	Auburn University performs all analysis to confirm product label guarantees
Georgia	Julie Hester- GA Dep. Of Agriculture; Jim McNamara, GA EPD	GA Department of Agriculture	Georgia Fertilizer Act of 1997	Heavy metal assay for byproduct material		Specific by plant type- .5-1.0 tons/acre/year.	Process changes, updated analysis, distribution records	no limitations	Quarterly reports of tonnage	Required under GA Fertilizer Act of 1997	$.60/ton sold to non-licensees; $100 license fee	Label showing guaranteed analysis (Ca,S, purity)	
Florida	William Cox, Kelly Friend- FL Dept. of Agriculture and Consumer Services; Susan Pelz, Richard Tedder, FL Dept. Environment Protection	Department of Agriculture and Consumer Services, FL Dept. of Environmental Protection	Chapter 576 Section 576.041,576.045 FS and 5E-1.012, & Chapter 62-701 F.A.C. (see www.doacs.state.fl.us)	no specific environmental testing		Specific by plant type- .5-1.0 tons/acre/year. No application on wetlands	Tracking of counties where sold and type of use (farm, turf, nursery, golf course)	Subject to Florida Green Industries BMPs for protection of water resources	Monthly reports- tons sold, where, etc.	Fertilizer License required under FL Fertilizer Law, Rules and Regs	$.30/ton sold paid monthly	Label showing guaranteed analysis (Ca,S, purity)	Annual Audit to confirm tonnage, counties and use. Beneficial use is restricted to "non-hazardous" materials.

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Kansas	Arthur Fink, Joe Cronin- KS Dept. of Health and Environment	Coordinated between KS Dept. of Health and Environment, KS Dept. of Environmental Quality & KS Dept. of Agriculture	No specific regulations currently- no power plants producing FGD gypsum and no marketer or user has applied	TCLP, N,P,K, CA, CCE, pH		Application rates to be determined by marketer, supported by data	Will require tracking and reporting of material to application sites	Limit to no more than 75% of annual production at source	Annual reporting to Dept. of Agriculture	License issued by Dept. of Ag.	Yes	Required for bagged product. Bulk product must guarantee certain constituents	
North Dakota	Steve Toleson-ND Dept. of Health, Solid Waste Div.	Beneficial Determination Program, Solid Waste Division	No specific regulations currently- no power plants producing FGD gypsum and no marketer or user has applied. Intend to be guided by Biosolids Part 503 standards.	TCLP, leachable metals analysis		Based on agronomic practices supported by good soil science	not site specific	No outside storage allowed	not yet addressed	No agricultural license required.	none	Will consult with Fertilizer Division of Dept. of Agriculture regarding need for guarantee of constituents and MSDS form for each source	No beneficial use of FGD gypsum currently done in State
Colorado	David Snapp- CO Dept. of Public Health and Environment	Waste Management Division, CO Dept. of Public Health and Environment	C.R.S. 1973, 30-20-109 and 25-1-107 (as amended).	TCLP, leachable metals analysis, agronomic analysis	Proof of beneficial properties of material, process description	Rates based on sound agronomic science	Annual reporting of application sites	Storage limits- 3 year rolling average with 75% of accumulation used within the 3rd year	Annual report of tonnage by user- site specific to each customer and field	No agricultural license required.	Permitting and review fees charged for initial approval	no specific requirements	No formal program in place yet; no permit letters have been issued
Maryland	Ed Dexter, Administrator, Solid Waste Program; Steve Pattison, Assistant Secretary of MDE,	Maryland Department of the Environment, Solid Waste Program; MD Department of Agriculture	Regulations .09 and .10 under COMAR 26.04.10 Management of Coal Combustion Byproducts	TCLP, leachable metals analysis		Rates based on sound agronomic science	under development	no impacts on ground water or surface water and no nuisance dusting	under development	No agricultural license required.	none	no specific requirements	Program under development by MD Dept. of Agriculture. No materials have been considered for Agricultural use yet

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Arkansas	Bryan Leamons, AR Department of Environmental Quality	Solid Waste Management Division; AR DEQ	AR Code Annotated 8-6-204 et seq., AR Solid Waste Management Regulation 22	Total metals, nutrients	Documentation from qualified soil scientist or agronomist of beneficial use	Loading rates recommended by certified agronomist and allowable quantities per acre based on existing soil conditions and analysis of the material	not site specific	Must submit plan for storage prior to use including runoff controls, buffer zones.	not yet addressed	License under AR Soil Amendment Act of 1977	$.375/ton of material sold. Registration fee of $25	Label must show net weight, name, guaranteed analysis, purpose, directions and name and address of registrant	Plant Board may require proof of claims made for any soil amendment. No AR Coal Power Plants are currently producing FGD gypsum. No permits have been issued for FGD in State yet
Missouri	Tony Dohmen, Water Pollution Control, Permits, Soil Scientist, MDNR; Refaat Mefrakis, Water Protection Program MDNR; Charlene Fitch, Solid Waste Management Program; Rich Nussbaum, Hazardous Waste Management Program	Missouri Department of Natural Resources, Division 20, Clean Water Commission	10 CSR 20-6.015	TBD in conference with Missouri Experimental Station Staff	TBD	TBD	TBD	75% annual production	TBD	License under Missouri Fertilizer Law, Sections 266.291-266.351	$.50/ton inspection fee; $100 annual permit fee	Guaranteed analysis of nutrients listed in 6CSR 250-11.030(10)(C) and metals content above specified minimum level	No current permits have been issued; program specifics are under development in consultation with University of Missouri Department of Agriculture and Missouri Agricultural Experimental Station

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Tennessee	Jeff Norman, Paul Evans Davis, TN Division of Solid Waste Management; Dan Danielson, TN Dept. of Agriculture	Division of Solid Waste: Permit by Rule Program	TN Division of Solid Waste Management: Land Application of Solid Wastes Guidance Document; Tennessee Rule 1200-1-7-.13 section ,02, subparagraph (1) (c)	TCLP, agronomic data	Case Specific approval requires range of additional information as determined by DSWM	Application rates based on analytical data submitted and approved	Case by case application with indemnification form signed by farmer	Maximum of 1000 cubic yards on any one property	Annual report showing tons used, application rates and any relevant ground water information	Beneficial Use products do not require registration with Dept. of Agriculture	$100 annual maintenance fee	Accepted guaranteed analysis must be maintained	Beneficial use approved on a case by case basis. Once material has been proven to work, Dept. of Agriculture will issue a blanket approval for use anywhere in the State
Indiana	Jeff Harmon, Senior Environmental Manager Senior Environmental Manager Indiana Department of Environmental Management	Solid Waste Permit Section, Indiana Department of Environmental Management	Indiana Administrative Code, (329 IAC 10-7.2) Title 329, article 10, rule 7.2	TCLP, leachable metals analysis (monthly)	Process description	Rates based on sound agronomic science	Tracking of tonnage used by customer	Storage sites separated from wells, water.	Monthly report of tons used, analytical data	Required if claim nutrient value	If claimed nutrient value, fee of $.45/ton	no specific requirements- must provide user information sheets	State Chemists Office (Purdue University) monitors use of fertilizer materials. Not involved unless claims nutrient value
Ohio	Jacob Howdyshell, Division of Surface Water, Ohio Environmental Protection Agency	Division of Surface Water, Land Application Program	Chapter 3745-40 of the Ohio Administrative Code	TCLP analysis of 6 random samples; must meet Part 503 Biosolids Regs	Management Plan including industrial process description, spill contingency plan, justification of agronomic benefit	Rates based on sound agronomic science, separation from wells, water, buildings, etc.	not site specific	Storage sites separated from wells, water.	Analytical results annually to OEPA, Tonnage summary to ODOA for taxes	Once OEPA permit obtained, fertilizer License required under Section 905.32, of the Ohio Revised Code	$200 application fee, $.25/ton sold	User Information sheet	

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
Michigan	Dwayne Roskofkey, Environmental Engineer, Solid Waste Program, Michigan Department of Natural Resources and the Environment	Solid Waste Program, MI DNRE	Part 115, Solid Waste Management, of the Natural Resource and Environmental Protection Act, 1994 PA 451, as amended	**TCLP** and SPLP analysis of 20 metals: compare to other byproducts that are landspread		Rates based on sound agronomic science; generally follow 1 ton/acre	Annual reporting of application sites	Storage must be inside building or conform to long term storage requirements in Part 115	Annual reporting of tonnages sold and identification of user sales	Required as soil amendment	$100 registration fee; $.10/ton sold	Guaranteed analysis, name of registrant	Permit or approval given to the generator of the material
Iowa	Matt McDonald, Environmental Specialist, Land Quality Bureau, Iowa Dept. of Natural Resources; Terry Jensen, Bureau Chief, Commercial Feed and Fertilizer Bureau, Iowa Dept. of Agriculture	Land Quality Bureau, Iowa Dept. of Natural Resources	Chapter 121, Land Application of Waste, Section 567-121.1 (4555B)	TCLP leaching procedure and total metals testing, pH	Management Plan including procedures for testing, storage, run-off control,	Rates based on sound agronomic science, not to exceed 2 tons/acre/year; separation from wells, water, buildings, etc.	Must track all usage by specific land owner	No storage at application site unless inside permitted building	Annual report on tonnage sold	Required as soil amendment	$.17/ton sold	Label showing guaranteed analysis (Ca,S, purity)	Material meeting specific regulatory standards can be applied without site specific permit. Otherwise each application must be individually permitted
Minnesota	Geoff Strack, MN Pollution Control Agency	Solid Waste Utilization Program, MN PCA	Minn rule Ch 7035	TCLP leachate testing, nutrients, pH, Sodium		limited to no more than quantity at which specific limits for 9 RCRA metals would be achieved	Site specific approval, tracking and notification of local community before program initiated	Temporary storage not to exceed 30 days at application site	Annual report including material sampling, site specific reports including soil tests	Required as soil amendment	$.30 per ton inspection fee; $200 registration fee	Guaranteed Analysis, name of registrant	No reuse permitted for any material classified as a hazardous waste

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
North Carolina	Michael Scott, Division of Waste Management, NC Department of Environment and Natural Resources	Solid Waste Program, Division of Waste Management; NC Dept. of Agriculture	15A_NCAC_13B.1708; North Carolina Agricultural Liming Materials and Landplaster Act. (1979, c. 590.)	Chemical Analysis as approved by State Chemist		Rates as per proven agronomic standards.	not site specific	no limitations	Annual reports on tonnage sold	Required under Agricultural Liming Materials and Landplaster Act	$.10/ton annually; $25 annual license fee	Guaranteed analysis Calcium and Sulfate %, registrants name and address	No permits have been issued for FGD gypsum in NC yet
Virginia	Don Brunson, Senior Environmental Engineer, Leslie Beckwith, VA DEQ	Solid Waste Program, VA Dept. of Environmental Quality	9 VAC 20-80-150 or 9 VAC 20-80-160 of the Virginia Solid Waste Management Regulations		Under 9VAC 20-80-160 if gypsum meets definition of soil amendment or conditioner the material is exempt from regulation					Need to contact VA. Dept. of Agriculture to determine if 9 VAC 20 80 160 exemption is met Required as soil amendment	$100 registration fee plus $.25/ton inspection fee on all tonnage sold	Guaranteed Analysis, name of registrant	
Pennsyl-vania	C.B. Vu, PA Dept. of Environmental Protection	Solid Waste Management, Municipal Waste Beneficial Use Permits	WMGM038	Metals testing, SW-846, EPA 600/4-79-020	Demonstrate material presents no threat of harm to health, safety or welfare	Based on soil analysis completed within last 12 months	not site specific	Specifics regarding distance to waterways, dwellings, flood plains and wetlands if not in enclosed structure	Record keeping per Sections F & G WMGM038 including collection of samples, photos, measurements, surveys and inspections	Required using Form 20-Municipal or Residual Waste General Permit	Determination of applicability $500, Registration $250, Renewal $300	Guaranteed analysis as presented in application process	Transportation of gypsum per Requirements of 25 PA Code, Chapter 285. Beneficial use limited to "non-hazardous" materials.

State Level Regulation of FGD Gypsum in Agriculture													
State	Contacts	Program	Reg Reference	Env. Testing	Other Info Required	Application	Tracking	Storage	Reporting	Ag License	Taxes/fees	Labeling	Other
New York	Kathleen Prather, Dept. of Environmental Conservation	Department of Environmental Conservation	Part 360 Regulations, 6 NYCRR Part 360-1.15(b) (Beneficial Use Determination-BUD)	Heavy metals analysis, TCLP. CCE required if used as other than soil amendment	Demonstrate proper containment	Based on sound agronomic science and supportive documentation	Annual reporting of application sites	90 days-18 months storage classified as disposal. Can get additional months if demonstrated to be needed for inventory	Annual report of tons used, recovered from disposal and final destinations of materials	No agricultural license required.	none	no specific requirements	BUD determination made by DEC. Once issued, material ceases to be considered a solid waste

As a summary of the information contained in Table X-1, ACAA's survey reveals that most states have programs in place to regulate agricultural use of materials such as FGD gypsum both within their environmental agencies and within their agricultural agencies. Those few state programs that do not include environmental agency participation are all states which do not currently have power plants producing FGD gypsum or any growers that are currently utilizing synthetic gypsum material. Environmental agency programs typically include materials testing (TCLP, SPLP or equivalent), application standards, storage limitations and annual reporting. More than half of the states surveyed require specific tracking of material application either to specific sites or to specific counties. In all but three states surveyed, FGD gypsum used in agriculture is also regulated under the state's agricultural agency. These states require licensing, proof of claims, specific labeling and user instruction and payment of taxes, usually per ton of material used. Licenses typically need annual renewal and requalification.

In the opinion of the ACAA, these state level programs provide adequate levels of oversight of use of FGD gypsum in agriculture and are protective of human health and the environment. We believe that incremental federal levels of testing and approvals for agricultural application of FGD gypsum would be redundant and wasteful and would achieve no additional degree of protection for human health and the environment.

i. Extensive Research has been Conducted by USDA and Others

EPA has requested descriptions of the research and field work being done within USDA and elsewhere evaluating the agronomic performance and environmental concerns relative to FGD gypsum used in Agriculture. Such research has been extensive and ongoing and indicates the degree to which USDA is committed to demonstrating how expanded use of FGD gypsum in agriculture will be beneficial and safe.

USDA Agricultural Research Service is actively engaged in several technical R&D projects involving FGD gypsum. These efforts have been primarily initiated by USDA, but also involve participation by industry groups. All parties see the advantage of a "win-win" situation in which utilities prefer not to store high quality soil amendment material on site when it can be used to help solve several problems in another industry (agriculture). FGD gypsum is and will be available in large quantities as utilities implement sulfur dioxide controls; therefore, the time and cost of USDA R&D will be worthwhile. *Note that all work is consistent with the USDA-ARS mission to improve agronomic performance while protecting the environment.*

Several active efforts are listed below. It is expected that ARS will provide other details and results through its own comments.

- **Use of FGD Gypsum to Improve Crop and Forage Production on Erodible Soils of the South.** This project is in the second year of a three-year effort to investigate any environmental effects and determine agronomic performance for forage crops when FGD gypsum is applied to various soil types in the Southeast. Forage crops and

cotton have been planted at five sites in five states (not all at each site) to document crop yield improvement, as well as the effectiveness in remediating soil erosion and phosphorus runoff issues from animal waste applied as fertilizer. These problems are very common throughout the Southeast. ARS laboratories in Oxford MS, Auburn AL, and Watkinsville GA are leading this work, with participation by EPA and three major utilities.

- **EPRI FGD Gypsum Network.** The Electric Power Research Institute, along with Ohio State University, has sponsored a network of gypsum agronomic demonstrations involving different soil types and gypsum sources. Goals are to document agronomic performance and trace metals in soil, shallow ground water and plant tissues and grains. Currently there are 13 separate sites in seven states, each involving EPRI and Ohio State staff, as well as USDA-ARS at West Lafayette, IN. All investigations are in progress.

- **Historical USDA Research with FGD Gypsum.** ARS labs have investigated agricultural value of FGD gypsum over 20+ years, including West Lafayette IN, Oxford MS, Beltsville MD, Auburn, AL, and Watkinsville GA in addition to those mentioned above for current projects.

These research efforts are in addition to the USDA/EPA risk assessment project currently underway as noted in the Proposed Rule. ACAA believes the preliminary results of that work have been supportive of the safely of using FGD gypsum in agriculture and encourage EPA to complete the current work with all due haste. It is our understanding that, while field work and data collection is near complete, final review and documentation of the USDA/EPA Risk Assessment will not be finished until 2012. ACAA believes that a deferral of determination of regulatory status of FGD gypsum pending the final documentation of this report would be unwarranted and very harmful to the market momentum FGD gypsum has gained in the agricultural community, and that a substantial volume of valuable material would be lost to unnecessary disposal. A substantial body of research work already exists that confirms the efficacy and safety of utilizing FGD in agriculture which, taken in combination with the near complete USDA/EPA analysis, should support uninterrupted continuation of this beneficial use, and thus the appropriate decision should be made now. Furthermore, alternative interim standards are available for measuring the suitability of specific materials (e.g. Part 503B Biosolids Standards), should EPA determine that such measurements are needed.

Section XI – Beneficial Use: Minefills and Mine Land Reclamation

a. Background and Introduction – There is a Long History of Successful Mine Land Reclamation Using CCBs in Many Mining States

Coal Combustion Products (CCPS) have been successfully utilized in mine land reclamation projects, and the use of CCPs in mine land reclamation has been occurring over the past 40+

years. The Office of Surface Mining Reclamation and Enforcement (OSM) has been a leader is working with the utility industry and states to identify issues, conduct workshops and symposia and to facilitate information exchange throughout the nation on mining issues related to the use of CCPs. OSM's Mid-Continent Office in Alton, Illinois has been the agency's primary point of contact for these activities. This office's website (http://www.mcrcc.osmre.gov/MCR/Resources/ccb/ccb-1.shtm) contains a great deal of information on the use of CCPs in mining applications, including case studies, reports, and technical resources. OSM has partnered with a number of universities to conduct research and field studies of various CCP applications.

Today, there is in excess 130 million tons of CCPs generated annually. Of this volume, more than 60 million tons per year are being beneficially used[119], and over 10.6 million tons are being used successfully in minefill and mine-land reclamation. Historically, EPA has recognized this use of CCBs in mine land reclamation as a beneficial use and allowed this use to be reported as such.

Specific to mine land reclamation CCPs have been used in the reclamation, utilization, and mine drainage abatement of:

- Abandoned surface mines or pits
- Active surface mines including remining operations
- Coal Refuse Disposal Operations
- Underground mining operations

The states are very familiar with the use of CCPs in minefill and reclamation activities because until now the states have been the ones analyzing and then regulating this issue (and for the most part doing an exception job of it). The states recognize that CCPs, based on their chemical, physical and leaching characteristics, produces benefits when properly managed in the reclamation of active and abandoned coal mine lands, subsidence control, mine-fire control, and the amelioration of mine drainage problems. The states understand that CCPs are not hazardous wastes. Further, the state regulatory programs also understand that CCPs vary in chemical, physical, and leaching characteristics. By realizing that the chemical, physical, and leaching properties of CCPs vary, the states are able to develop and implement programs that allow the CCPs to be properly managed. (All of this was developed based on a Subtitle D RCRA program with minimal guidance from EPA, which EPA had promised to provide in its reports to Congress under the Bevill Amendment regarding the management of coal combustion byproducts.)

The states designed their CCP management programs to take advantage of the benefits associated with CCPs being utilized in minefills and mine land reclamation. This resulted in the integration of the solid waste programs and the mine-land reclamation programs determining

[119] ACAA Website: http://acaa.affiniscape.com/associations/8003/files/2008_ACAA_CCP_Survey_Report_FINAL_100509.pdf

which CCPs were acceptable and how the CCPs would be integrated into the reclamation and abatement programs (thus, limiting the amount of CCPs that would be utilized in the reclamation). As a result, the use of CCPs in coal mine land reclamation are an integral part of OSM's approval of the states' programs regarding primary jurisdiction over coal mining activities in the states.

A significant amount of CCPs being beneficially utilized in minefills and reclamation has occurred in Pennsylvania as part of integrated mine land reclamation projects. Pennsylvania alone has utilized in excess of 150 million tons of CCPs in its various mine land reclamation programs resulting in greater than 4,500 acres of mine-land reclaimed[120]. This 4,500 acres of surface land reclaimed, has also provided improvements in water quality. The Pennsylvania waste coal power plants alone produce greater than 7 million tons of CCPs annually that are used in mine land reclamation.

In the case of Pennsylvania (as is the case in West Virginia, and Kentucky as well as other states), their Abandon Mine Land (AML) program does not have adequate moneys to begin the reclamation process of all of the mining lands. While some of these lands may be eligible for Federal funding, the priority of many of these sites is low. Many of these lower priority sites, however, could be reclaimed by using CCPs.

Similarly, the National Academy of Science concluded that CCPs utilized in coal mine land reclamation could produce benefits if properly managed[121]. Further, the NAS Study encouraged EPA and OSM to develop a regulatory approach to properly manage CCPs in mine reclamation applications. (A key aspect is this approach is the recognition that the CCPs are not hazardous wastes.)

Industry, the states and OSM, however, do recognize that not all CCPs can be used in mine land reclamation. The states have taken the lead in developing criteria under their regulatory programs that allow selective use of CCPs in mine land reclamation. OSM incorporated this point into their comments to OMB regarding EPA proposal to regulate CCPs under Subtitle C of RCRA. OSM made the following statement in their comments to OMB (regarding the initial proposal EPA submitted to OMB and for which OMB solicited comments from Federal Agencies) that supports how the states and OSM have addressed the use of CCPs in mine land reclamation projects[122]:

> *"It is important to note that not all CCRs are created equal. There are various types of CCRs and the chemical and physical properties of the specific types of CCRs vary. The chemical and physical properties are affected by the source of the coal, the type of combustion process, the types of other fuels burned with the*

[120] ARIPPA Website: http://arripa.org.

[121] National Academy of Science, Managing Coal Combustion Residues in Mines. The National Research Council (NRC) Committee on Mine Placement of Coal Combustion Wastes. The National Academies Press. Washington, DC. 2006.

[122] OMB COMMENTS from following EPA files: EPA-HQ-RCRA-2009-0640-0263 and EPA-HQ-RCRA-2009- 0640-0349.

coal, and the pollution controls on the power plant. CCRs should be characterized based on their chemical and physical properties. Those CCRs that exhibit hazardous waste characteristics should be managed in a manner that is protective of the environment and the public.

Just as all CCRs are not the same, not all mine sites are suitable for the placement of CCRs. It is OSM's view that CCRs that are suitable for placement or beneficial use on a mine based on appropriate testing be able to be placed in the appropriate mine with no pollution from the CCRs as the ultimate standard. Similarly, CCRs that do not exhibit hazardous waste characteristics that are not placed in a mine should be managed in a manner that does not cause pollution or threaten the public. Science should be the basis for how CCRs are managed."

b. Examples of Beneficial Use/Mine Land Reclamation at Mines

1. Filling Mine Voids in Underground Mines to Prevent Surface Subsidence

One of the primary uses of CCPs is to fill mining voids in underground mines to prevent surface subsidence. Specifically, through the history of mining operations, numerous documented cases of collapses of underground workings of mines exist for coal, metal and non metal mines. These collapses can be prevented by filling the void with a structural material. As CCP is the product of what was removed, at least from coal mines, this use makes practical sense, without even delving into the specifics.

To effectively fill mine voids, it is important to use a material that has very good flowability to ensure that the entire void is filled rather than mounding material only where a placement hole was drilled, which would leave unsupported sections of mine roof (this would occur using sand injected from the surface). This can be accomplished very well with CCPs or a grout made with CCPs. The CCPs or CCP-grout mix must be cementitious to provide the required structural support; otherwise, it will not accomplish the objective of structural support.

The definitions set forth in the Proposed Rule appear to be putting structural stabilization of underground mines, a very valuable use, in a category of a "sham beneficial use" by excluding fill in sand and gravel pits or large scale fill projects as beneficial uses. The sand and gravel pits, and or quarry definition appears to include any type of aggregate mine and doesn't distinguish between surface or underground mines. The definition also says these are disposal applications. However, an underground mine is excluded as a CCR landfill therefore appearing to take away any future potential use of CCP's as structural fill materials in underground workings of mines.

The use of CCPs as structural fill in underground mines, however, clearly fits the three beneficial use criteria set forth in the Proposed Rule definition.

- **Provides a Functional Benefit.** The use supports the mine so the surface can be developed into valuable real estate that couldn't otherwise be done.

- **Replaces a Virgin Material.** The use of CCPs replace the use of clay, sand, cement or other aggregates to fill the voids, and the fly ash actually improves the results due to its superior flowability over other materials.

- **Meets Relevant Product Specifications OR Regulatory Standards.** Engineers overseeing the filling require certain strength requirements for structural stabilization depending on the conditions of the site. The uses are also carefully analyzed by the state authorities to ensure protection of human health and the environment by characterizing the CCP constitutes and characterizing the site they will be placed. Most states have developed some regulatory guidelines for approving the use of CCP's for particular uses such as structural fill in underground mines. They all in some fashion or another characterize the material constituents and characterize the setting they are proposed to be placed in.

To better understand how CCPs are used in filling voids and the natural protections associated with this type of use, let us look at a specific mining operation in Kansas City. Although for a limestone mine, the same principals are applicable to filling any underground mine void. The process is well known for subsidence prevention and remediation in most underground coal regions throughout the country.

At this mine, a particular limestone is mined in an underground setting due to its superior properties over other available limestone near the surface. These types of mines can deteriorate over time resulting in a collapse to the surface if not stabilized. The particular limestone and surrounding rock strata of the mine, both above and below, is very impermeable at ten to the minus seven or less. By using a self cementing fly ash to gain the structural support needed, a first line of defense is provided from metals leaching by locking them in the cemented material. The surrounding rock provides a further barrier from migration due to the high impermeability of the natural strata. The application is monitored with monitoring wells to confirm the hydrogeologic conditions are working as anticipated, which, in this example, after 14 years of placement and regulation under the Water Quality branch of the Missouri Department of Natural Resources, they are. The surface has also seen nearly $200 million of development due to the support provide to the mine.

In instances such as the one described above, the underground mines are technically under the natural water table, but the mines themselves see very little if any water infiltration to the void as the ground water flows above through less impermeable strata. Any water would instead come from surface water running in through the entrance, which is easily captured and pumped back out. Therefore, blankly stating that placement under the water table is not allowed will eliminate valuable beneficial uses used in unique natural settings below the water table such as this, which, as can be seen in this example, can be very protective of human health and the environment. ACAA recognizes that CCP characterization and site

characterization should be an essential requirement when considering such uses, but a blanket prohibition is shortsighted. Placement below the water table should not automatically be disqualified as a beneficial use.

Importantly, mine fill projects for stabilization provide a significant outlet for CCPs as they do require significant quantities of fill to completely fill the void and provide the required structural support. To stabilize an acre of ground may require 16,000 tons of material possibly more depending on the void that was mined out. Blanketly excluding large scale fill projects as beneficial uses again can unintentionally carve out very valuable uses such as underground mine stabilization. Excess material is not being used, but a large quantity is required to complete the project. But again, CCP characterization and site characterization should be an essential requirement when considering large quantities of fill.

2. *Surface Mine Land Reclamation*

The use of CCPs in surface mines also clearly satisfies the three beneficial use criteria in the proposed rule definition: 1) provides a functional benefit; 2) replaces a virgin material; and 3) meets relevant product specifications **OR** regulatory standards. As with minefill, CCP characterization and site characterization should be an essential requirement for the use of CCPs in surface mining such as sand and gravel pits. This analysis may or may not lead to more extensive protections such as the need for a composite liner. For example, sand and gravel operations in glacial till can be very impermeable at ten to the minus 6 and could be protective on their own after reviewing the local hydro geologic conditions. Filling of these voids may provide a very functional benefit by making the area safe and reclaiming the mined out land to return it to a natural state or make it useful for development. Again, prohibiting uses under the natural water table (when alternate protections exist and differing site characteristics can exist) and prohibiting large fill operations as beneficial uses will discourage this beneficial use if operators are required to meet the more onerous disposal requirements for hazardous wastes under RCRA.

c. EPA's Proposed Rule Excludes Mines? – EPA Needs to Clarify

EPA has issued draft regulations regarding the disposal of CCPs produced by the electric utility industry and independent power producers[123]. The proposed rule is to apply to all CCPs generated by electric utilities and independent power producers (not from industrial, commercial, or institutional boilers). EPA, however, states that the proposed rule does not address the placement of CCPs in minefills. According to EPA, the U. S. Department of Interior (DOI) and EPA will address the management of CCRs in minefills in a separate regulatory action(s), consistent with the approach recommended by the National Academy of Sciences and under the expertise of DOI's Office of Surface Mining Reclamation and Enforcement. To this end, EPA states that the Proposed Rule at issue now will not be addressing EPA's "regulatory

[123] Hazardous and Solid Waste Management System: Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities, 75 *Federal Register* 35128, June 21, 2010.

determination on minefilling," and instead EPA will work with OSM "to develop effective regulations to ensure that the placement of coal combustion residuals in minefill operations is adequately controlled."

EPA is currently soliciting comments on the Proposed Rule (a rule with several hybrid approaches but in essence either a Subtitle C or a Subtitle D RCRA format). Irrespective of EPA's decision to address mining uses at a later date, the ACAA still has two concerns about how the current efforts will still impact such uses. Specifically, the Proposed Rule still needs clarification on the above point because clear questions still exist as the extent to which minefill and reclamation are truly excluded at this time. This is discussed in greater detail later. The other issue is the chilling effect that characterizing CCPs as somehow "hazardous" will have on continued use of such materials in the mining industry.

The Subtitle C format would declare coal combustion residuals as a hazardous waste. As with most uses of CCPs, this classification will give almost certainly give rise to continuous legal challenges in this arena as well as others and will likely deter the continued use of such materials in mine land reclamation efforts.

Furthermore, from a stigma/perspective standpoint, how does an agency utilize one set of standards for "what has been determined to be a hazardous waste" and a different set of standards for other uses. State programs would then have to establish two different siting and design standards for hazardous waste that are CCPs versus other types of hazardous wastes.

d. Definitional Issues - Need Clarification Mines Are Excluded

As is referenced above, EPA states that it is "not proposing to address mine placement of CCRs in mines, or non-minefill uses of CCRs at coal mine sites in this action." Instead, EPA maintains that it will be working with OSM to address this aspect of CCP management. While the language in the preamble includes these statements, ACAA has significant concerns with certain definitions and the rule language, at it simply is not this clear. Specifically, the language is clouded as to the terms minefills, beneficial use of coal combustion products, and CCR landfills and therefore provides for unclear and different interpretations (which are then dependent on how the term minefill is used in other documents, including the NAS Study).

EPA clearly appears to intend to exclude mines and minefilling from the rule, and ACAA interprets the preamble definitions and the definitions in the Subtitle D and Subtitle C rule not to be applicable to any mine land reclamation. ACAA's understanding is that the regulation for utilization of CCPs at mines will be developed by OSM. Since EPA refers to the NAS Study regarding the use of CCPs in minefills, it would appear that EPA is planning on OSM taking the lead in developing a regulatory program that covers the use of CCPs in coal mine land reclamation. If this is not the case, EPA should clarify in the preamble its intent.

Specific to the use of CCPs in mining applications, ACAA provides the following points of concern:

- **Absence of a Definition for Minefill.** First, there is no definition of minefill in either the draft language of the rule for either Subtitle D or Subtitle C proposed rules. The only definition is in the preamble.

- **The Definition Provided in the Preamble is NOT clear.** The preamble definition of minefill reads as follows:

  > "*Minefill* means a project involving the placement of CCRs in coal mine voids for use as fill, grouting, subsidence control, capping, mine sealing, and treating acid mine drainage, whether for purposes of disposal or for beneficial use, such as mine reclamation."

  This definition appears to limit the applicability to "the placement of CCRs in coal mine voids". ACAA interprets coal mine voids to include underground mine voids as well as surface mine voids and therefore this definition does not exclude surface mine land reclamation If EPA intends otherwise it should be clarified.

- **Impacts on Current State Regulations.** Multiple states regulate the use of CCPs in minefills or mine land reclamation as a beneficial use. It is not clear, however, whether EPA considers this to be a beneficial use, or is simply choosing to enact different regulations. If the EPA's statements and regulations can be interpreted to suggest that such applications do not constitute a "beneficial use," this could have impacts on how states currently regulate such uses, even if EPA is currently excluding such uses from the Proposed Rule. Since EPA has eliminated the reporting the use of CCPs in minefills or mine-land reclamation as a beneficial use, does this imply that the use of CCPs in such applications is not considered by EPA to be a beneficial use? Or because Section 261.4(b)(4)(i) excludes CCPs that are "beneficially used or placed in minefilling operations," does EPA consider at least some minefilling operations a beneficial use?

- **Express Exclusion of Large Scale Fill Projects in Definition of "Beneficial Use" Calls into Question Mining Applications.** The definition of "Beneficial Use of Coal Combustion Products (CCPs)"in the preamble and the actual regulation set forth in the Subtitle C draft rule reads as follows:

  > "*Beneficial Use of Coal Combustion Products (CCPs)* means the use of CCPs that provides a functional benefit; replaces the use of an alternative material, conserving natural resources that would otherwise need to be obtained through practices such as extraction; and meets relevant product specifications and regulatory standards (where these are available). CCPs that are used in excess quantities (e.g., the field-applications of FGD gypsum in amounts that exceed scientifically-supported quantities required for enhancing soil properties and/or crop

yields), placed as fill in sand and gravel pits, <u>or used in large scale fill projects, such as for restructuring the landscape, are excluded from this definition.”</u>

This raises a question as to how minefill and mine-land reclamation will ultimately be treated as both of these easily constitute "large scale fill project, such as for restructuring the landscape." Specifically, the use of CCPs in surface coal mine reclamation is for restructuring the landscape by either returning the land to approximate original contour or to an approved alternative contour as well as addressing water, land and air pollution concerns. (Yet, EPA states that it is not proposing to affect the status of the beneficial use of coal combustion byproducts, but the language does.) Moreover, even if EPA no longer classifies the use of CCPs in mining applications as a beneficial use and is choosing to regulate through another set of regulations, again, multiple states still regulate such uses as a "beneficial use." But, now under EPA's definition, such uses are arguably excluded from being treated as a "beneficial use." In ACAA’s discussion of geotechnical uses above, many of the applications described are used in mining settings, such as road construction, which ACAA would consider beneficial use. However, since the activity takes place on a mine site, how does the EPA look at this use? Are they all exempt from EPA concern by virtue of them being at a mine site or does EPA consider them part of the larger category of “unencapsulated Uses” requiring some EPA review?

- **The Definition of CCR Landfill (as proposed in both Subtitle C and Subtitle D Calls into Question Certain Minefill or Reclamation Applications.** The definition of CCR landfill (as proposed in both Subtitle C and Subtitle D) reads as follows:

  “CCR Landfill means a disposal facility or part of a facility where CCRs are placed in or on land and which is not a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit. For purposes of this proposed rule, landfills also include piles, **sand and gravel pits, quarries, and/or large scale fill operations**. Sites that are excavated so that more coal ash can be used as fill are also considered CCR landfills.” (emphasis added)

  Although ACAA agrees that some sand and gravel pits, quarries, and/or large scale fill operations may require landfill-like regulation, ACAA is concerned that this definition could be interpreted to subsume minefill and mine-land applications. Furthermore, ACAA maintains that there are instances, even within the parameters of this definition, where CCPs can be safely used in these situations and should not be outright rejected.

- **Regulations Create Concern that Minefill and Mine-Land Applications would be Considered an "Open Dump."** With regulation under either Subtitle C or Subtitle D,

significant requirements arise concerning disposal and open dumping and issues arise concerning what is and what is not disposal. Section 257.1 establishes the criteria for determining if a site and operation should be considered "open dumping," a prohibited activity. ACAA is concerned that, without clarification, there is a risk that certain applications could be treated as an "open dump," as it does involve land application of materials that EPA is now saying are a Subtitle C or Subtitle D waste.

Reuse of CCPs to reclaim any current or past man made land void, (including but not limited to mines, quarries, sand and gravel pits) is beneficial to the environment and society.

If EPA retains the current proposed narrow definition of "beneficial use" **and/or** selects the proposed option to list coal ash as a hazardous waste, the following affects will be experienced by the current management practice of beneficially using coal ash for mine/quarry reclamation including sand and gravel pits purposes/industry. (See definition of beneficial use above).

In spite of EPA's preamble statement that the proposed regulations do not propose "*to address the placement of CCRs in mines or non-minefill uses" …the proposed regulations may significantly affect (both DIRECTLY and INDIRECTLY) current mine reclamation benefits and practices*

e. Impacts

1. *INDIRECT Affects (most of the following benefits will be lost)*

- Functional benefits:

  - Safety Benefit: avoidance of deaths from people falling from high walls or drowning in pooled water or burned from Abandoned Mine Land fires are eliminated. The area is "secured" during the filling operation.
  - Land/Use Benefit: land returned to its natural terrain can be utilized for business, industrial, or community uses; eliminates surrounding lands from collapsing into existing void, eliminates or improves the chance for structural collapse, due to deep mine underground tunneling, sinkholes, etc
  - Environmental Benefits: Surface water runoff/pooling improvements/prevention including but not limited to PH levels, erosion and Acid Mine Drainage
  - CCP as a soil amendment adjusts the pH of soil to promote plant growth.
  - Grouting, subsidence control, capping, mine sealing, and treating acid mine drainage
  - Air flows during operations may be controlled by selective use of fill
  - Overfill may also be an environmental benefit

- Replaces use of alternative material

  - Massive amounts (nearly 8% of all CCPs (10.5 million tons) were utilized for land reclamation in 2008) of costly and potentially unavailable alternative natural materials would need to be found mined, transported, and placed in order to reclaim current or past man made land voids.
  - Soil improvements.

- Conserving natural resources

  - Taxes and government labor benefit: Industry utilizes its own labor and funds for land/stream reclamation
  - CCPs can be substituted for many virgin materials that would otherwise have to be mined and processed for reclamation use. These virgin materials include limestone, aggregate, such as stone and gravel, and clay/top soil. Using virgin materials for these applications requires mining and processing them, which can impair wildlife habitats and disturb otherwise undeveloped land
  - The beneficial use of CCPs offers significant environmental benefits, including greenhouse gas (GHG) reduction, energy conservation, reduction in land disposal (i.e., avoidance of potential CCR disposal impacts), and reduction in the need to mine and process virgin materials and the associated environmental impacts.

- Meets relevant product specs/regulatory standards

  - EPA cites the National Academy of Sciences Managing Coal Combustion Residues in Mines; The National Academies Press, Washington, D.C., 2006 report which outlines the following current regulatory framework that governs the use of CCPs for land reclamation: Most states, SMCRA-OSM (including performance standards) NPDES, Clean Water Act, Pollution Prevention Act, Safe Drinking Water Act, RCRA, and the Emergency Planning Act.
  - Ash placement in land voids including but not limited to mines, quarries, sand and gravel pits is managed in conformance with many engineering considerations

2. *DIRECT Affects: (the official hazardous waste "generation point" being the "collection/storage" point…direct affects are based on:*

- proposed "beneficial use definition" adopted (i.e. only encapsulated products) **and/or**
- coal ash is hazardous waste RCRA C

3. *3 Stages in the production of electricity/ash management*

- Ash managed at the plant site:
  Internal risk assessment, legal, and liability findings will force existing energy generating plants to managing coal ash as a hazardous material. This will involve time and expense including but not limited to employee education, training, clothing and other appropriate apparatus, special equipment/separation, and or insurance availability/costs. MSDS information and appropriate handling practices will be changed.

- Transporting ash off site:
  Shared MSDS information and appropriate handling practices will be altered
  Transport Manifests and handling costs will likely be altered

- Disposal (CCR) ----------**OR**---------- Beneficial Use (CCP)

Current:
Each plant currently utilizing ash for mine reclamation will need to determine the final placement (disposal) or beneficial usage of its generated ash based on the following criteria:

1. Availability -limited Hazardous waste disposal sites in USA, distance /costs to transport/handle (While this discusses existing sites; there is a problem with siting new hazardous waste sites. As it relates to siting hazardous waste sites, the permitting of a new site would most likely occur under a state's already existing permitting requirements for hazardous waste as well as the need for the states to amend their Hazardous Waste Plans.
2. Qualifications/Specifications- Most if not all CFB ash does not qualify to be used in current encapsulated uses Liability-Risk Assessment- Hazardous waste at a licensed-regulated and generally confined remote disposal site includes cradle to grave liability…where as liability risk-assessment in encapsulated products includes widespread uses in potentially densely populated areas. Capacity- encapsulated ash products cannot absorb the total current volume of ash produced…likely handling costs will be affected if demand exceeds capacity.
3. Costs-the costs of each option (if indeed options exist) will be calculated on a per MGW basis

If EPA develops regulations under the Federal Solid Waste Disposal Act (aka RCRA) and the state programs implement similar regulations for managing CCPs, these rules have the potential to impact OSMs ability to regulate the use of CCPs in mine land reclamation. Thus, EPA needs to clearly state that their rules are not applicable to the use of CCPs in minefills and coal mine land reclamation. Further, EPA needs to recognize that the placement of CCPs in coal mine land reclamation and minefills is not a disposal activity, but a reclamation activity (whether or not classified as a beneficial use) and EPA needs to clearly state this. Also, EPA needs to modify the definition of “CCR Landfill” to expressly exclude surface mine-land reclamation from the CCR Landfill definition.

f. Mines, Quarries, Pits: *The Reuse Of CCP Ash To Properly Reclaim Any Current Or Past Man Made Land Void, (Including But Not Limited To Mines, Quarries, Sand And Gravel Pits) Is Beneficial to the Environment And Society.*

Science should be the basis for how CCRs are defined, managed and beneficially used. Joe Pizarchik, Director of OSM on November 19th 2009 submitted the following comments in writing to OMB recognizing this basic logical position:

> *"It is important to note that not all CCRs are created equal. There are various types of CCRs and the chemical and physical properties of specific types of CCRs vary."*
>
> *"CCRs should be characterized based on their chemical and physical properties."*
>
> *"Just as all CCRs are not the same, not all mine sites are suitable for the placement of CCRs. It is OSM's view that CCRs that are suitable for placement or beneficial use on a mine based on appropriate testing be able to be placed in the appropriate mine with no pollution from the CCRs as the ultimate standard. Science should be the basis for how CCRs are managed."*

"Benefit" is "something that has a good effect or promotes well-being" and "Reuse" "to use something again, often for a different purpose and usually as an alternative to throwing it out. (See definition of beneficial use in beneficial use section) Disposal on the other hand offers no environmental benefit "the process of throwing away or getting rid of something…discard…dumping."

Proper placement of ash in metal and non metal mines should be recognized in the rule as a potential beneficial use or as a part of the definition of a minefill (to be addressed in later regulations in cooperation between OSM and EPA). There are documented cases of structural collapse of underground workings of limestone and metal mines. These collapses can be prevented by filling the void with a structural material. Coal ash or an ash grout that has very good flow ability is ideal for such purposes…assuring that the entire void is filled rather than leaving unsupported sections of the mine roof.

The proposed rule excludes structural stabilization of underground mines, (to date a highly beneficial use), and instead unfairly places it in a category of a "Sham beneficial use". By excluding as beneficial use of any ash placement in any/all sand and gravel pits or large scale fill projects including any type of aggregate mine, (while not distinguishing between surface or underground) EPA effectively determined such uses as "disposal". This action arbitrarily and capriciously removes any future potential use of CCP's as structural fill materials in underground workings of metal or non metal mines.

This is in spite of the fact that the placement of CCPs as structural fill in mines fits many of the beneficial use criteria in the extremely narrow definition proposed in the rule: provides a functional benefit- use supports the mine so the surface can be developed into valuable real estate, replaces a virgin material- use replaces the use of say sand, cement or other aggregates; meets relevant industry or regulatory standards-Engineers require specific requirements for structural stabilization depending on the conditions of the site. The ash and uses are carefully analyzed by state authorities to ensure protection of human health and the environment

Using self-cementing fly ash to achieve structural support, in effect, encapsulates the cemented material. The rock provides a further barrier from migration due to the high impermeability of the natural strata. The application is monitored with monitoring wells to confirm the hydro geologic conditions are properly working as anticipated.

While it may make sense, in some or most cases, not to place CCPs in ground or surface water, an absolute prohibition or ban is not based on science. This is especially true when you broaden groundwater to include water in non-saturated zones including soil water and limited perched groundwater. There needs to be a mechanism to allow placement of CCPs in these areas when it can be demonstrated to the regulatory authority that a water quality problem will not develop. Likewise there should not be an absolute prohibition of placement of CCPs in floodplains, wetlands, fault areas, seismic impact zones, unstable areas and other specific terrain…especially when the applicant can demonstrate that the proposed CCP management design will not result in a negative, and potentially a positive environmental affect.

Since the definition of minefill is not included within the language of the proposed regulations, EPA would likely use the definition of minefill set forth in the preamble (as EPA stated in the preamble that the definitions in the preamble are carried forward into the regulation if not otherwise defined in the regulation). The limitation imposed by the definition of minefill to mine voids, implies that it is not applicable to surface mine land reclamation. This needs to be modified to insure that is applicable to surface mine land reclamation. The proposed definition of "Beneficial Use" causes the confusion. The definition in the preamble and within the actual regulation reads as follows:

> *"CCPs that are…placed as fill in sand and gravel pits, or used in large scale fill projects, such as for restructuring the landscape, are excluded from this definition."*

Accordingly the language in the beneficial use definition states that large scale fill projects, such as for restructuring the landscape are excluded. However the use of CCPs in surface coal mine reclamation is for restructuring the landscape by either returning the land to approximate original contour or to an approved alternative contour as well as addressing water, land and air pollution concerns.

In addition, the definition of CCR landfill (as proposed in both Subtitle C and D) reads as follows:

> "CCR Landfill means a disposal facility or part of a facility where CCRs are placed in or on land and which is not a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit. For purposes of this proposed rule, landfills also include piles, sand and gravel pits, quarries, and/or large scale fill operations. Sites that are excavated so that more coal ash can be used as fill are also considered CCR landfills."

This language covers the utilization of CCRs in coal surface mining reclamation activities and makes these activities subject to the disposal regulations (either Subtitle C or Subtitle D).

Even though mine placement meets most of the proposed narrow EPA definition of beneficial use eliminating mine placement as a beneficial use will decrease the overall annual beneficial use of ash by over 10 million tons/year. If EPA's goal is to increase beneficial use how is discounting a legitimate beneficial use accomplishing that goal? We recognize mine placement of ash may require careful assessment prior to placement, and follow-up management reviews compared to ash use in concrete, but placement of ash has affectively, safely and beneficially filled voids and mines which provide a true benefit just like use in concrete.

Joe Pizarchik, Director of OSM (also cited above) on November 19th 2009 also submitted the following comments in writing to OMB concerning EPA's proposed rules:

> *"Concerning mine filling, EPA states that "EPA is not addressing its regulatory determination on mine filling, and instead will work with the OSM to develop effective federal regulations to ensure that the placement of coal combustion residuals in mine fill operations is adequately controlled." As we note above, SMCRA has no provision for permitting the disposal or placement of listed hazardous wastes. Some states (e.g. Illinois and Indiana); however, have specific rules that prohibit the disposal or placement of listed hazardous wastes at coal mines or in beneficial uses. Pennsylvania law prohibits the disposal of waste (including hazardous waste) in mines".*

The NRC, a research arm of the National Academy of Sciences, in March 2006 concluded in a study titled *Managing Coal Combustion Residues in Mines* (THE NATIONAL ACADEMIES PRESS Washington, D.C. www.nap.edu :

> *"Ohio and Pennsylvania have monitoring requirements for CCRs that are substantially greater than SMCRA requirements"…and "Some states, such as Indiana and Pennsylvania, specifically require monitoring for particular CCR parameters.p138"*
>
> *"Placement of ash in mines may be appropriate based on an integrated process of*

- *ash characterization,*
- *site characterization,*
- *management and engineering design of placement activities,*
- *and design and implementation of monitoring"*

In developing these points, it is recognized that there is great variability in CCRs. There is also variability in sites where CCPs are placed and that the states are in the best position to be familiar with the topographic, geologic, and hydrologic differences in addressing these concerns. (Note-Congress may a similar determination with regard to Coal Mining in PL95-87 Title 1 Section 101 (f) which reads "The Congress finds and declares that – (f) because of the diversity in terrain, climate, biologic, chemical, and other physical conditions in areas subject to mining operations, the primary governmental responsibility for developing, authorizing, issuing, and enforcing regulations for surface mining and reclamation operations subject to this Act should rest with the States;")

Most states have developed some regulatory guidelines for approving the use of CCPs for particular uses such as structural fill in underground mines. They all, in some fashion or another, characterize the material constituents and characterize the setting where they are proposed to be placed. The beneficial use of CCPs in non-coal mine land reclamation is minimal. Accordingly ACAA suggests that EPA allow states to determine whether placement of CCPs at sites is beneficial (provided certain pre placement requirements are met) or disposal. The use of CCPs in non-coal underground mines has proven to safely minimize the impacts of subsidence which provides a benefit to the surface owner, the community and the environment in that area. Science should determine applications.

Accordingly ACAA suggests that EPA/OSM adopt a definition of mine-placement/reclamation that is more in line with the concepts discussed in the National Academy of Science Study regarding the use of CCR in mine land reclamation. A definition that allows for the beneficial use of CCPs in the placement or reclamation of mine lands (a benefit) provided that the CCPs meet certain state regulatory review criteria and that the permit clearly states how the CCPs will be placed and managed at the mine site to insure hazards are eliminated, voids are sealed, subsidence is eliminated or minimized, reclamation is achieved, water quality problems ameliorated, and the land return to a productive use.

g. EPA Should Defer CCP Regulation at Mines to OSM – EPA Should Listen to OSM Concerns with Subtitle C

The Federal Office of Surface Mining Reclamation and Enforcement commented to OMB regarding the October 14, 2009 draft of EPA's proposal to regulate CCR. OSM makes it clear that if EPA classifies CCRs and regulates the management of CCRs under Subtitle C of RCRA, that the Agency believes it will be difficult to develop a regulatory program that will effectively address the utilization of CCR in mine land reclamation.[4] The "stigma of such a classification"

will most likely result in any regulatory program being subject to legal challenge as being an arbitrary and capricious action and as a result OSM believes any regulations it attempt to develop and implement would most likely not withstand judicial scrutiny.

The following is a brief excerpt of OSM's memo to OMB commenting on EPA draft of the proposed rule:

> "The RIA only minimally considers the hazardous waste stigma" based on what would happen in the future. The RIA does not consider the impact of "hazardous waste stigma" on past or existing sites and situations where CCRs have been placed or used (e.g., mines, roads, and other forms of construction material). The RIA appears to dismiss the impact of this stigma on continued beneficial use without any real basis to do so.

The issues raised above will likely result in increased use of CCRs at some coal mining sites to avoid hazardous waste disposal requirements, making the need for SMCRA regulation even greater. During the review by OSM, the question arose as to whether EPA's proposed rule, as submitted to OMB, would prohibit OSM from allowing the use at CCRs at minesites?

EPA's proposed action would not directly affect OSM's legal authorities; however, if EPA lists CCRs as a hazardous waste under Subtitle C of RCRA, it will become more difficult to for OSM to allow the placement of CCRs on minesites because doing so could be construed as an arbitrary and capricious action subject to legal action.

EPA's proposed rule, even though it exempts CCR placement in minesites from regulation under Subtitle C at this time, casts doubts on whether OSM could allow CCR placement in coal minesite. Primarily, what level of proof would OSM need to demonstrate to withstand a challenge that such regulations are arbitrary and capricious if OSM allows an otherwise hazardous waste to be placed on minesites? Thus, the listing of CCRs as a Subtitle C hazardous wastes makes it unlikely that OSM regulations permitting CCR placement in minesites would withstand judicial scrutiny."

> *"The NRC Committee on Mine Placement of Coal Combustion Wastes also stated that OSM and its SMCRA state partners should take the lead in developing new national standards for CCR use in mines because the framework is in place to deal with mine-related issues. Consistent with the recommendations of the National Academy of Sciences, EPA anticipates that the U. S. Department of the Interior (DOI) will take the lead in developing these regulations. EPA will work closely with DOI throughout that process. Therefore, the Agency is not addressing minefilling operations in this proposed rule".*

Again citing Joe Pizarchik, Director of OSM, on November 19th 2009 he submitted the following comments in writing to OMB:

"…if EPA lists all CCRs as hazardous waste the current placement of CCRs at some SMCRA permitted coal mines will have to cease. The proposal for a separate regulatory action concerning development of specific CCR regulations for SMCRA mine fills will be moot for some states. Based on our experience, the SMCRA Title IV abandoned mine reclamation program costs would significantly increase if they could no longer use CCRs in AML reclamation

OSM comments identified the following points or concerns:

1. Any EPA regulations dealing with CCRs or CCPs should be under Subtitle D not Subtitle C of RCRA.
2. The Subtitle D regulations need to clearly state that the regulations are not applicable to the use of CCPs in minefilling and mine land reclamation.
3. The use of CCPs in minefilling and mine land reclamation projects is not considered disposal but is consider as reclamation or a beneficial use.
4. The term "minefill" must be broadened to include the reclamation of surface mines and surface effects of underground mining.
5. The preamble should clearly state that EPA will work with OSM to develop a program for the management.
6. OSM, working with EPA and the states (through IMCC) should develop a regulatory program that allows the use of CCPs in minefills and mine-land reclamation. Further, the use is not considered disposal, but reclamation.

h. Various Federal Agency Findings: *Including the EPA, OSM, and the National Academy of Sciences Indicate That a RCRA D Classification of Ash Is Justified and That Government Should Promote CCR Use or Remove Impediments to Its Use*

In the current EPA preamble EPA states: *"This proposed rule does not address the placement of CCRs in minefills. The U. S. Department of the Interior (DOI) and EPA will address the management of CCRs in minefills in a separate regulatory action(s), consistent with the approach recommended by the National Academy of Sciences, recognizing the expertise of DOI's Office of Surface Mining Reclamation and Enforcement in this area. In addition under either alternative proposal, EPA is not proposing to affect the current status of coal combustion".*

In the 1970s coal ash use in structural fills was documented in the United States and the Resource Conservation and Recovery Act (RCRA) was enacted…becoming the dominant statute governing the disposal of waste derived from the combustion of coal.

In the 1980s Congress enacted the Solid Waste Disposal Act Amendments to RCRA, also known as the Bevill Amendment, which excludes coal ash from Subtitle C regulation:

- EPA implements federal procurement guidelines that favor the purchase of cement and concrete containing fly ash
- EPA issues a report to Congress concluding that coal ash does not exhibit hazardous characteristics and that regulation of coal ash should be under Subtitle D

Between 1988 and 2005 the EPA issued repeated assessments (1988, 1993, 1999, 2000, and 2005) that CCR disposal does not warrant regulation as hazardous waste under RCRA Subtitle C; EPA issued final regulatory determinations, based on two separate reports to Congress that concluded fully protective federal rules for CCRs can be developed under RCRA's Subtitle D non-hazardous waste program.

In March 2006 at the direction of EPA the NRC, a research arm of the National Academy of Sciences, concluded a multi-year study of the beneficial use of coal ash for mine placement or reclamation and the current regulatory framework that governs the use of CCRs-CCPs (EPA cites the National Academy of Sciences report in its preamble)…some of the conclusions of the report are:

- Pg 87 "EPA has not identified any cases in which exceedances in water quality standards could be attributed directly to CCR mine placement"

- Pg 89 "EPA concluded that regulation was warranted under either RCRA or SMCRA or some combination".

- Pg 101 "In 2000, EPA published a regulatory determination on wastes from the combustion of fossil fuels (65 FR 32214) and concluded that CCRs do not warrant regulation under subtitle C (hazardous waste) of RCRA."

- Pg 102 "EPA further justified its choice of subtitle D regulation by noting that it did not want to place any unnecessary barriers on the beneficial reuse of CCRs and the consequent environmental benefits associated with such reuse".

- Pg 138 "Ohio and Pennsylvania have monitoring requirements for CCRs that are substantially greater than SMCRA requirements"…and "Some states, such as Indiana and Pennsylvania, specifically require monitoring for particular CCR parameters"

- Pg 147 "The U.S. Environmental Protection Agency (EPA) has not specifically attributed significant environmental problems to CCR use in minefills."

- Pg 148 "Therefore, the committee recommends that secondary uses of CCRs that pose minimal risks to human health and the environment be strongly encouraged….'Government agencies should examine ways in which they can promote CCR use or remove impediments to its use"

- Pg 153-154 "The committee recommends that enforceable federal standards be established for the disposal of CCRs (coal combustion residue's) in minefills to ensure that states have specific authority and implement adequate safeguards"

While EPA sites the NRC National Academy of Sciences Ash Study in its preamble, it ignores its ash management suggestions based on scientific and factual findings

In the current EPA preamble EPA states: *"The NRC Committee on Mine Placement of Coal Combustion Wastes also stated that OSM and its SMCRA state partners should take the lead in developing new national standards for CCR use in mines because the framework is in place to deal with mine-related issues. Consistent with the recommendations of the National Academy of Sciences, EPA anticipates that the U. S. Department of the Interior (DOI) will take the lead in developing these regulations. EPA will work closely with DOI throughout that process. Therefore, the Agency is not addressing minefilling operations in this proposed rule".*

The NRC, a research arm of the National Academy of Sciences, in March 2006 concluded in a study titled *Managing Coal Combustion Residues in Mines* (THE NATIONAL ACADEMIES PRESS Washington, D.C. www.nap.edu :

1. Enforceable federal standards should be established to ensure that **states have specific authority** and implement adequate safeguards.

2. Primary regulatory mechanisms that should be used to develop enforceable standards are:
   SMCRA, Joint OSM-EPA rules; or **RCRA-D** rules

3. Beneficial use of ash should be strongly encouraged: Government agencies should examine ways in which they can **promote ash use or remove impediments to its use**.

The NAS study concluded that CCPs utilized in coal mine land reclamation produce benefits if properly managed further, the NAS Study encouraged EPA and the OSM to develop a regulatory approach allowing states to properly manage CCPs in mine reclamation applications. (A key aspect of this approach is the recognition that the CCPs are not hazardous wastes and may be beneficially used.)

The NAS Study clearly outlines why the committee felt strongly that government agencies should examine ways in which they can promote CCR use or remove impediments to its use. The report noted that Pennsylvania's current "model" regulated approach has provided environmental benefits as well as employment, alternative energy and environmental benefits at a vast savings to the Commonwealth and its citizens.

NRC-NAS Report also recognized that the placement or use of coal ash on mine sites is regulated under both federal and state regulatory programs. Current federal regulations include:

- OSM since 70's has had federally enforceable regulations (SMCRA…CCPs mine reclamation)
- RCRA…as D vs. C
- Safe Drinking Water Act
- Clean Water Act
- Emergency Planning Community Right to Know Act
- Pollution Prevention Act
- Energy Policy Act of 2005
- PURPA
- Various State Laws/Regulations approved by a Federal Agency

NRC and OSM

Notably, the NRC concluded: "Under SMCRA, the OSM and related state agencies that implement SMCRA currently have the regulatory framework in place to deal with ash used in mine reclamation and have considerable expertise in review, permitting, and management of mine lands." *Id.* at 154. NRC also concluded that "OSM and its SMCRA state partners should take the lead in developing new national standards for ash use in mines because the framework is in place to deal with mine-related issues." *Id*.

In response to the NRC report, OSM issued an advance notice of proposed rulemaking (ANPR) under SMCRA on the placement of coal combustion products in active and abandoned coal mines. 72 Fed. Reg. 12,025 (March 14, 2007). OSM recognized in the ANPR that "[t]he use of properly managed ash on both active and abandoned mines can contribute to successful reclamation," 72 Fed. Reg. at 12,029. OSM also recognized the benefits of coal ash in the construction of haul and access roads and in the restoration of mine lands to their approximate original contour. *Id*.

According to OSM, "SMCRA provide[s] adequate authority for the adoption of regulations governing the placement of CCPs with respect to both permitted mines and abandoned mine reclamation projects conducted under an [abandoned mine lands] reclamation plan approved under section 405 of SMCRA ." 72 Fed. Reg. at 12,028. Through the ANPR, OSM put forward a regulatory approach to "minimize the possibility that the placement of CCB[s] could cause adverse impacts on public health and the environment." 72 Fed. Reg. at 12,030.

Joe Pizarchik, Director of OSM has stated:

"The Office of Surface Mining Reclamation and Enforcement (OSM) has been involved in issues related to the regulation of CCRs for over a decade. Generally, CCR disposal operations are regulated under state solid waste management programs under Subtitle D of RCRA. If the disposal site is a mine with a SMCRA permit, the requirements of the applicable SMCRA regulatory program also apply. Some states do not allow disposal of CCRs on mine sites but do provide for placement at mines if the CCR can be beneficially used in reclamation of abandoned and active sites".

"On March 14, 2007, in response to the National Academy of Sciences (NAS) report and discussions between OSM and EPA, OSM published an advance notice of proposed rulemaking (ANPR) to solicit comments on the development of proposed CCR regulations under SMCRA. We received approximately 1,900 comments. In general, industry and the states supported regulation under SMCRA"

The EPA through NRC-NAS, OSM, and industry, recognize that not all CCRs can be used in mine placement or reclamation. The states have taken the lead in developing criteria under their regulatory programs that allow selective use of CCPs in mine land reclamation. As the statements from Joe Pizarchik quoted on page 180 above demonstrate, he incorporated this point into his comments to OMB regarding EPA proposal to regulate CCPs under Subtitle C of RCRA. Specifically, OSM, in its comments to OMB (regarding the initial proposal EPA submitted to OMB and for which OMB solicited comments from Federal Agencies), he noted that CCPs should be characterized based on their chemical and physical properties and that such placement should be site specific[4.]

i. State Agencies Findings And Reports*: States Currently Have Regulations In Place That Have Been Developed Over Time (After Conducting Unbiased Scientific Studies And Sampling) And Include Scientific Based Procedures To Properly Address Ash Management Issues. In Fact, Pennsylvania's Ash Regulations have been cited As "Model Regulations" By EPA.*

In 2007 Tera D. Buckley Marketing Research Specialist University of North Dakota Energy & Environmental Research Center for EPA concluded**:**

"*PADEP residual waste coal ash beneficial use regulations and program implementation policies are perhaps the most comprehensive and dependable in the country, particularly for abandoned mine reclamation. These regulations coupled with the state's 14 CFB power plants successfully using CCRs in mine applications make Pennsylvania a model state for the use of CCRs in mine applications."*

The EPA Fails To Consider the effectiveness of current State Programs (Developed under RCRA Subtitle D) To Regulate The Beneficial Use Of CCRs/CCPs That Minimize or Eliminate Any Risk Associated With Such Use.

States through direct correspondence with EPA (based on over 20 years of testing) have communicated that CCRs are not hazardous. Further, state regulatory programs acknowledged that CCRs vary in chemical, physical, and leaching characteristics. By realizing that the chemical, physical, and leaching properties of CCRs vary, the states were able to develop and implement programs that allowed CCRs-CCPs to be properly managed including the reclamation of active and abandoned mine lands, subsidence control, mine-fire control, and the amelioration of mine drainage problems.

As an example in 1985 Pennsylvania's General Assembly recognized the selective beneficial use of CCRs to reclaim active and abandoned mines. As a result of this, a regulatory program was established that consists of three initial basic regulatory steps. First ash composition and leach characteristics are assessed using over twenty different parameters. Once assessed the second stage is a determination of the potential beneficial uses of the ash. Site placement or utilization characteristics are then also assessed. If an ash-use-site fails these assessments it cannot be used for beneficial purposes and must be disposed of in a landfill

This initial regulatory process incorporates elements of the state's comprehensive residual waste management program and its federally-approved surface mining program. The regulatory parameters for beneficial use of CCRs are designed to avoid any environmental risk associated with the beneficial use of CCPs.

This result is the perfect integration of solid waste programs and mine-land reclamation programs scientifically determining which CCRs-CCPs are acceptable for beneficial use and limiting the amount of CCRs placed in landfills. As a result, the use of CCPs in mine land placement and/or reclamation is an integral part of OSM's approval of the states primary jurisdiction programs. Based on historic data compiled by PADEP, there is minimal environmental risk associated with the beneficial use of CCRs for mine placement or reclamation, especially CFB ash (CCRs-CCPs) from coal refuse power plants utilizing CFB technology.

On November 9, 2007 PADEP performed a scientific\c technical review and published the following comments concerning a Clean Air Task Force (CATF- a special interest group opposed to the use of fossil fuels) report that alleged that coal ash causes pollution:

- *"Most of the allegations made by the CATF in its report are a rehash of issues raised by CATF associates in the past. This response to the CATF report demonstrates, once again, that the CATF allegations of pollution from ash are seriously flawed."*

- *"To date we have not observed water quality degradation as a result of ash placement, and in some instances we have seen significant improvements in water quality."*

PA DEP Response to Clean Air Task Force Report: "Impact on Water Quality From Placement of Coal Combustion Waste in Pennsylvania Coal Mines"

In March of 2009 Keith Brady, Bureau of Mining and Reclamation, Division of Permits PADEP wrote:

- *"Despite claims to the contrary, we have not seen pollution from beneficially used ash. Last year PA used over 11 million tons of ash in the mining program. With the amount that's been used for mine reclamation in PA, if it were going to pollute we should be seeing pollution…We aren't."* (*http://www.uswag.org/pdf/2009/PADEPOMB.pdf will take you to the report he presented to OMB)*

On April 10, 2009 Thomas Fidler, PADEP Secretary Waste, Air and Radiation Management wrote to EPA reconfirming these factors:

- *"Since 1985 DEP has provided oversight on the use of the beneficial use of coal ash for mine reclamation and other uses. Pennsylvania implemented regulations governing the management of coal combustion wastes covering storage, disposal and beneficial use. Under those regulations and oversight coal has been successfully used for mine reclamation throughout the Commonwealth. Through our groundwater monitoring program and data collected at reclamation sites, we have found no indication of ground water degradation attributable to the placement of coal ash. "*

THE ENVIRONMENTAL COUNCIL OF THE STATES also recently wrote to EPA stating the following:

> *"ECOS Agrees with U.S. EPA's finding in the 2005 study previously cited that "the regulatory infrastructure is generally in place at the state level to ensure adequate management of these wastes" and believes that states should continue to be the principal regulatory authority for regulating CCW as they are best suited to develop and implement CCW regulatory programs tailored to specific climate and geological conditions designed to protect human health and the environment;*
>
> *Believes that the adoption and implementation of a federal CCW regulatory program would create an additional level of oversight that is not warranted, duplicate existing state regulatory programs, and require additional resources to revise or amend existing state programs to conform to new federal regulatory programs and to seek U.S. EPA program approval;*

Therefore ECOS calls upon U.S. EPA to conclude that additional federal CCW regulations would be duplicative of most state programs, are unnecessary, and should not be adopted, <u>but if adopted must be developed under RCRA Subtitle D rather than RCRA Subtitle C</u>, and calls upon U.S. EPA to begin a collaborative dialogue with the states to develop and promote a national framework for beneficial use of CCW including use principles and guidelines, and to accelerate the development of markets for this material."

Under the current regulatory format industry has demonstrated for over two decades a performance record resulting in zero indication of ground water degradation due to the placement of coal ash in mines. Accordingly ACAA suggests that federal/state regulation of ash be based on unbiased, scientifically based historic data, and findings. Completely re-writing the current regulatory scheme potentially revamping effective and successful management plans concerning ash beneficial use, placement, and monitoring requirements is counter productive.

If EPA proceeds with its proposed rule to reclassify coal ash as hazardous, there will be significant impacts on, and substantial interference with, various states' existing solid-waste management programs, as well as alternative energy policies in Pennsylvania and other jurisdictions, among other consequences.

EPA claims that under either the Subtitle C or Subtitle D proposal that it is not proposing to affect the current status of coal combustion residuals that are beneficially used. Since many states (following evaluation and determination) consider mine-land reclamation and/or the placement of CCPs in mines as a beneficial use, EPA should agree and work with states to beneficially reuse ash in a coordinated regulated manner.
CCRs have a wide range of physical, chemical, and leaching characteristics that dictate how they are managed at the state level. EPA appears to fail to recognize that the states have established ash management requirements in terms of testing, placement, notification, groundwater monitoring and bonding for sites where CCPs are being managed. Most state regulatory programs include groundwater monitoring, corrective action and closure/post closure procedures.

Accordingly EPA should carefully assess all existing state and federal regulatory programs concerning the beneficial use/management of CCPs before it concludes that the risk associated with such use is such that a RCRA Subtitle C designation or severely limiting beneficial uses (Bevel exemption) are necessary.

EPA has made an estimate that if RCRA D proposal is adopted only 52% of the states would comply whereas adoption of RCRA C would assure 100% state participation. ACAA respectfully suggests that there is no evidence to support such a theory and applauds the majority of states that have to date taken the lead in CCR-CCP management regulations. Accordingly States appear knowledgeable and prepared to take the lead concerning ash management and mine

placement beneficial use. ACAA suggests that EPA/OSM work in conjunction with states to develop a regulatory approach that insures the proper management of CCRs nationwide.

j. Stakeholders: *EPA Has Received Correspondence From Various Congressional Leaders And Industry-Government Stakeholders Representing Hundreds Of Millions Of Citizens And Jobs Stating That A "Hazardous" Determination For Coal Ash Is Illogical, Unnecessary, And Will Have A Negative Impact On Jobs And Beneficial Recycling -Reuse.*

Following the TVA Kingston TN CCR wet ash impoundment accident, House Natural Resources Committee Chairman Nick Rahall (DWV) introduced legislation requiring federal standards to regulate the engineering and safety of CCR impoundments. It directs the Department of Interior to impose uniform federal design, engineering, and performance standards on CCR impoundments to avoid a repeat of the TVA accident.

Since that time ACAA is aware of approximately 30 US Senators, approximately 130 US Congressmen-women that have written to EPA encouraging it to not regulate coal ash as a hazardous waste.

Likewise the National Governors Association, the Environmental Council of States, the Interstate Mining Compact Commission, the American Assoc of State Highway and Transportation Officials, approximately 30 separate state governors/governments, and various municipal and tribal local governments have agreed with our congressional leaders that EPA should not regulate ash as hazardous.

Organizations representing employment and commerce including Unions for Jobs and Environment, various separate industries/companies, the US Chamber of Commerce, the National Association of Manufacturers, and Industry associations groups including, ACAA, USWAG, ASTM have all asked the EPA to consider the significant negative outcome of declaring ash hazardous.

k. Hazardous Stigma: *The Stigma of Declaring Ash a Hazardous Waste Is Not Hypothetical. It is both Incorrect and Naive To Believe That EPA's Actions and Proposed Ash Rule "Does Not Address" Ash Placement in Mines… If EPA Further <u>Declares Ash</u> a Subtitle C RCRA <u>Hazardous</u> Substance It Will Have A <u>Direct Grave Negative Impact</u> on Past, Current, and Future <u>Beneficial Use Of Ash For Mine Placement And/Or Reclamation</u>*

Summary: If EPA regulates CCR's as Subtitle C RCRA hazardous substance, it will have a negative impact on past and future beneficial use of ash at mines. Despite EPA's setting mine

applications aside for now in its current proposed options, it is clear that any CCR Subtitle C classification for CCR's at any stage in their lifecycle will detrimentally impact CCR use at mines. OSM has made numerous statements to establish their concerns. The economic impact of CCR's Subtitle C classification is cited here and is substantial. It will likely shut down a budding industry that was created to deal with legacy mining issues and to reduce our dependency on foreign energy sources in most cases using taxpayer dollars. It will also limit OSM's ability to address Acid Mine Drainage (AMD) a critical issue that impacts environmental and human health issues in area's where abandoned mines are numerous and unable to be addressed in a timely manner.

Another excerpt from Joe Pizarchik's , Director of Federal Office of Surface Mining (OSM), written comments to Office of Management and Budget (OMB) November 19th 2009 reads as follows:

> *"…if EPA lists all CCRs as hazardous waste the current placement of CCRs at some SMCRA permitted coal mines will have to cease. The proposal for a separate regulatory action concerning development of specific CCR regulations for SMCRA mine fills will be moot for some states. Based on our experience, the SMCRA Title IV abandoned mine reclamation program costs would significantly increase if they could no longer use CCRs in AML reclamation"*

Other OSM written comments to OMB:

> *"The RIA fails to explain how it would be possible to disassociate the beneficial use, including mine placement, from the hazardous waste stigma that would be attached to the CCRs under this proposal. The proposal and RIA just exclude CCR beneficial uses without any explanation and, more importantly, without any scientific basis. There are several references that should have been cited to provide an adequate scientific basis for differentiating beneficial use from disposal. In particular, OSM has worked closely with EPA, other agencies and academia to provide scientific data that would assist in providing background information to help assuage the hazardous waste stigma."*
>
> *"The RIA only minimally considers the hazardous waste stigma based on what would happen in the future. The RIA does not consider the impact of "hazardous waste stigma" on past or existing sites and situations where CCR's have been placed or used (e.g., mines, roads, and other forms of construction material). The RIA appears to dismiss the impact of this stigma on continued beneficial use without any real basis to do so."*
>
> *"While it is not an OSM issue, operators need to be aware that EPA's proposed rule may render it practically impossible for a surface coal mine operator that wishes to use CCR's in reclamation to secure the required reclamation bond. Section 509 of SMCRA requires that surface coal mining operations have a bond*

in an amount "sufficient to assure the completion of the reclamation plan if the work had to be performed by the {RA} in the event of forfeiture."

A hazardous classification will render any approach to mine placement or reclamation as not being viable and subject to continuous legal challenge. Alternate energy Plants, Industrial Facilities, Institutions and other coal burning facilities may need to cease operations until a new facility could be developed and approved. This is more than likely a multi-year or decade process.

Dedicated electric generation facilities with capital expenditures in the hundreds of millions of dollars (Note: A Wharton Business School study published in the 80's estimated $1.5 billion in capital expenditures for coal refuse plants in Northeast PA, alone) were constructed to remove coal refuse convert it into alternative energy and reclaim abandoned mine lands with the ash by-product. Reclamation efforts by our industry, valued at over 1 billion dollars have had a positive effect not only on the directly improved community, but also on many other affected counties that are nearby.

Today, there are CFB alternative energy plants converting coal refuse in Pennsylvania, West Virginia, New York, and Utah collectively supplying 10% of the total electricity generated in Pennsylvania/West Virginia region alone. CFB plants are supplying hundreds of thousands of homes and industry with much needed alternative energy, while at the same time directly and indirectly employing approximately 10,000 citizen workers and pumping millions of dollars into the regional economy.

Since 1988 CFB plants have collectively removed over 162 million tons of coal refuse and converted it into much needed alternative electricity. The removal efforts combined with industry totals of reclaiming and restoring over 4,700 acres of unsafe mine-scarred lands and hundreds of miles of formerly dead streams with regulated and beneficially utilized CFB coal ash serves as further proof of the industry's commitment to beneficially improve the environment and landscape of our nation. The coal refuse power plants based in Pennsylvania alone produce greater than 7 million tons of CFB ash annually that are reused in mine land reclamation. Nationwide over 10.6 million tons of coal combustion by-products (CCPs) are being successfully used in a regulated beneficial manner for mine placement and reclamation purposes. Ash from CFB technology beneficial utilization rate is over 90% and has been used for mine reclamation without a single incident or damage case.

The vast majority of CFB ash has not and likely will not meet relevant product specifications ("encapsulation recycling/reuse standards") as outlined in EPA's proposed beneficial use definition criteria. Accordingly our industry ash management costs will increase by more than 31 times to an amount that exceeds PJM energy market rates by approximately $40 to $50 per MWhr. Our industry would operate at a loss…accordingly it would cease to exist.

- THOUSANDS OF **WORKERS WILL BECOME UNEMPLOYED,**
- 10% of our region's **ELECTRIC ENERGY WILL BE GONE,**

- Tax Free **RECLAMATION BENEFITS,** that to date includes 1000's of acres of mine damaged land and hundreds of polluted stream miles, **WILL VANISH.**

Further, in regard to "STIGMA" and EPA, the following points are offered:

EPA has dismissed that a "Subtitle C – Hazardous Waste Classification" will result in a stigma on beneficial use of CCRs. EPA believes that a "Subtitle C classification" will increase beneficial use of CCRs .
To justify their position, EPA points to the following as a demonstration that a "Subtitle C" approach will not create a stigma:

- K061 Dust
- Electroplating wastewater sludge
- Hardrock Mine Superfund where the source of the contamination was used in highway construction

K061 Dust
EPA claims: "Slag from the smelting of K061 is in high demand for use in road construction." This is based on one instance. EPA states that according to the most recently available data, in 2008 *Horsehead* produced about 300,000 tons per year of an Iron-Rich Material (IRM) as a byproduct of its dust recycling process, and in 2009 *Inmetco* produced close to 20,000 tons per year. PADEP asserts that these plants cannot meet the demands for use of the slag by PaDOT.

Response: This is comparing apples to oranges. The K061 is a source of raw material processed by Horsehead to reclaim specific metals (Zinc). The K061 material is a source of Zinc and in higher concentrations than other sources of Zinc being processed. The **slag** resulting from the smelting operations has potential use as a construction material and has a different chemical and physical characteristics than K061 Dust. The quality of the slag produced meets PaDOT specifications for use in highway construction projects. (The K061 would not meet the physical requirements let alone the chemical requirements for use as **slag** in highway construction.

Electroplating wastewater sludge
EPA: "Electroplating wastewater sludge is a listed hazardous waste (F006) that is recycled for its copper, zinc, and nickel content for use in the commercial market."

Response: The electroplating wastewater sludge is being recycled as a valuable source of copper, zinc, and nickel that can readily be extracted for the metal market. In this case, the extraction of the copper, zinc, and nickel metal produces both a chemical and physical change in the residual wastes. The key is marketable product (copper, zinc, and nickel) that is extracted and sold. The recovery of these metals is profitable. If not for a metal market for these constituents and cost effective methods for recovering these metals, the material would not be recycled.

Hardrock Mine Superfund where the source of the contamination was used in highway construction

EPA: "A Superfund mining cleanup waste with lead, cadmium and zinc contamination, is used in road construction in Oklahoma and the surrounding states. EPA states that in this case, the very waste that has triggered an expensive Superfund cleanup is successfully offered in the marketplace as a raw material in road building. The alternative costs of disposal in this case are a significant driver in the beneficial use of this material, and the Superfund origin of the material has not served as a barrier to its use."

Response: This is extremely misleading statement. EPA attempts to imply that mine tailings (which are a source of pollution) can easily be utilized in highway construction without a problem and does not clearly address that in this case the mine tailings were processed (screened) to allow the resulting two products to be managed accordingly.

The problem was a superfund site comprised of mine tailings with high concentrations of lead and zinc associated with the Galena left in the tailings. To address the clean up of the site, it was determined that by processing the tailings that galena could be recovered and used as a source of lead and zinc.

The process was comprised of a jig that separated the material based on size fractions. The galena was removed and the remaining material was primarily "chert". This product was called "Chat". In this case, the mine tailings are processed to recover the lead and zinc (using a jig). (The galena is recovered and is generally in the size range of 5/8 to 200 mesh material.) The resulting byproduct is an angular material (most likely) greater than 5/8 inch size and it was used as an aggregate in asphalt for highway construction containing minimal to no galena.

This "by product" is a chert material (a type of quartz, very hard and durable), which is called "chat" and is used in asphalt highway construction. The driver is the metal recovery and a construction material which had value in the market. This would reduce the cost of the superfund clean-up.

Waste Oil

EPA points to used oil as another example. Interestingly, EPA did not go all over the country and campaign in print labeling used oil as a hazardous toxic waste. At that time, EPA understood the issues and new that if not managed correctly waste oil could cause pollution problems.

EPA: "Used oil is regulated under RCRA subtitle C standards. While used oil that is recycled is subject to a separate set of standards under subtitle C (and is not identified as a hazardous waste), ''stigma'' does not prevent home do-it yourselfers from collecting used oil, or automotive shops from accepting it and sending it on for recovery.

Collected used oil may be re-refined, reused, or used as fuel in boilers, often at the site where it is collected."

Response: First, the home owner does not fully recognize their potential liability. Second, the quantities are small. For the automotive shops, if you are doing oil changes, you need to recover and properly dispose of the waste. (DOES EPA REALLY THINK THAT THE AUTOMOTIVE SHOPS ARE ACCEPTING THE WASTE OIL OUT OF THE GOODNESS OF THEIR HEART?) The Automotive Shops want to remain in business of doing car repairs and servicing. Oil changes are a critical aspect of that industry. The Industry has insurance obligations as well as contracting with reputable companies to manage the waste oil collected from oil changes (i.e., Safety Kleen). Once again EPA has not fully clarified the difference in the issues involved.

May 2000 Regulatory Determination, EPA makes the following statements:

- We also see a potential downside to pursuing a subtitle C approach. ***Section 8002(n)(8)*** directs us to consider, among other factors, ''the current and potential utilization of such materials.''
- We do not wish to place any unnecessary barriers on the beneficial uses of these wastes, because they conserve natural resources, reduce disposal costs and reduce the total amount of waste destined for disposal. States and industry have also expressed concern that regulation under subtitle C could cause a halt in the use of coal combustion wastes to reclaim abandoned and active mine sites. We recognize that when done properly, minefilling can lead to substantial environmental benefits.
- EPA believes the contingent management scheme we discussed should diminish any stigma that might be associated with the subtitle C link. Nonetheless, we acknowledge the possibility that the approach could have unintended consequences. We would be particularly concerned about any adverse effect on the beneficial re-use market for these wastes because more than 23 percent (approximately 28 million tons) of the total coal combustion waste generated each year is beneficially reused and an additional eight percent (nine million tons) is used for minefilling.
- However, given our conclusion that the subtitle D approach here should be fully effective in protecting human health and the environment, and given the large and salutary role that beneficial reuse plays for this waste, concern over stigma is a factor supporting our decision today that subtitle C regulation is unwarranted in light of our decision to pursue a subtitle D approach.

In the May 2000 determination, EPA stated, "We have further decided to establish national regulations under subtitle D of RCRA (RCRA Sections 1008(a) and 4004(a)) for coal combustion wastes that are disposed in landfills or surface impoundments or used to fill surface or underground mines." However, in the proposed rulemaking this approach is completely

ignored. The failure of EPA to follow through with their original determination has created a conflicted and impractical approach for the industry to address at this time.

I. Damage Cases*: Health Officials And EPA Have Repeatedly Reported "No Adverse Impact To Human Health"; Due To Accidental Exposure To Ash Accordingly It Appears That The Alleged CCR "Proven Damage" Cases Cited By EPA Do Not Provide A Sufficient Or Scientific Basis To Propose Ash As Hazardous*.

EPA's supposed motivation to propose federal ash management rules appears to be based on what EPA has termed "proven damage cases". EPA specifically cites two wet ash impoundment breach/accidents at Kingston, TN (TVA) and Martins Creek, PA and an ash placement project at a golf course, Battlefield, Chesapeake, VA as a few of the largest proven damage cases. However:

- In March of 2009 PADEP published comments that "a thorough study of the Martins Creek accident found no adverse impacts to the river, wildlife or human health"
- In December 2009 the Tennessee Dept of Health found that at no time did the surrounding water contain metals above primary drinking water standards and there were no significant human health impacts due to the Kingston accident…Oak Ridge Associated Universities also recently confirmed "no adverse health effects" (NOTE: EPA approved clean-up disposal of the ash spilled at the Kingston accident site to a Subtitle D landfill)
- April 22, 2010 EPA reported that "Residential wells near the Battlefield Golf Club in Chesapeake, Va. have not been impacted by the fly ash used to contour the golf course" and…"no adverse health effects are expected from exposure to surface water or sediments on the site".

These findings combined with the fact that hundreds of millions of tons of CCP have been beneficially and safely managed at thousands of sites clearly indicate that EPA's true motivation to propose ash as a hazardous waste is based on political and media appeasement versus scientific fact.

The two most recent cases identified--the Martins Creek and TVA Kingston dam failures--involved sluicing and/or slurring CCRs into a holding facility. The failures and the resultant environmental impacts were likely due to inadequate construction, inspection, or maintenance of the facilities, including performance of ongoing structural analyses and making needed repairs to meet recommended dam safety requirements

EPA has also identified other sites as being potential or proven damage cases. The damage cases cited by EPA including those above are not indicative of CCP beneficial management practices. A careful scrutiny of these damage cases, based on the information provided, indicates that these sites had more than just CCRs placed in them. One case included less than

ACAA American Coal Ash Association

Advancing the management and use of coal combustion products.

November 18, 2010

Administrator Lisa P. Jackson
US Environmental Protection Agency
EPA West, Room 3334
1301 Constitution Avenue N.W.
Washington, DC 20460

Re: Hazardous Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities Docket, Attention Docket IDNo.,EPA-HQ-RCRA-2009-0640.

Dear Administrator Jackson:

Enclosed please find the comments of the membership of the American Coal Ash Association (ACAA) on the referenced document. Included in this submittal are numerous references and attachments including discs with relevant materials in support of these comments.

This package represents the work product of volunteers who dedicated over 14,000 hours since the proposal was published on June 21, 2010 to inform the EPA as to the impacts of the proposed rule on the beneficial use. In addition our members have invested thousands of hours responding as individual entities. The beneficial use industry is providing detailed, factual information vital to the rulemaking process.

The ACAA supports regulation of coal ash disposal under Subtitle D of the Resource Conservation and Recovery Act of 1976. We also support an amendment to RCRA to provide enforcement authority of Subtitle D regulation of coal ash disposal if Congress and the President would consider such an amendment. *We oppose any form of Subtitle C regulation of coal ash disposal as such a regulation will devastate the beneficial use industry.* This submittal details the devastation resulting from any form of Subtitle C regulation.

The ACAA stands ready to resume collaborative efforts with the EPA to encourage the safe beneficial use of coal combustion products.

Sincerely,

Thomas H. Adams

Thomas H. Adams
Executive Director

Enclosures

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1% CCPs. It simply cannot be assumed that the mere presence of CCRs was the primary environmental risk associated with these sites. Rather, it appears that these sites were like many other sites at which municipal, industrial and hazardous wastes were co-placed causing environmental problems. Consequently, it is disingenuous to cite them as CCR damage cases.

Joe Pizarchik, Director of OSM, recently commented on the proposed rule as follows:

> *"The risk assessment references a significant number of "mine" sites as data-collection sites, but fails to clarify if they are coal mines under the jurisdiction of SMCRA. We are concerned that this lack of information could add confusion to the promulgation of a regulatory program under SMCRA and hamper the beneficial use of CCRs at coal mining sites as envisioned in EPA's proposal".*

None of these examples are even remotely analogous to the CCR-CCP management practices adhered to by ACAA member facilities. There have been approximately 4.5 billion tons of CCRs properly managed over the past few decades. The extremely small number of sites with environmental/structural problems is not indicative of any risk associated with the beneficial use of CCPs.

Beneficial placement of coal ash at mines in non-impoundment settings is subject to state and/or federal regulation. Leach tests are required as part of the SMCRA permit application and groundwater monitoring is also necessary to comply with existing state and federal water quality laws. Groundwater monitoring is specifically required by OSM regulation and must be submitted to the state at least once every three months (see 30 C.F.R. § 816.41(c)). SMCRA regulations require all surface mining activity, including placement of CCPs, to be conducted so as to minimize disturbance of the hydrologic balance in the permit and adjacent area and to prevent material damage to the hydrologic balance outside the permit area (see 30 C.F.R. § 816.41(a)). The Clean Water Act provides additional protection of surface waters through federal and state water quality laws and requires mine operators to meet strict water quality standards. State water quality programs, along with the Federal Safe Drinking Water Act, offer further groundwater protection (see 30 C.F.R. 816.42; 40 C.F.R. Part 434).

The unfortunate TVA ash impoundment accident was due to a breach or failure of a retention dam/pond wall which caused significant damage to 40 homes, the Emory River, a nearby recreational lake, community roadways, a gas pipeline, and a railroad. However even an accident of this magnitude which may serve as a true field test of the toxicity of coal ash found "no adverse health effects".

Just as it would be illogical to declare water or soil to be hazardous based on the destruction and loss of life caused by dam/reservoir breaches or mudslides…it is unscientific and illogical to declare ash something that it is not…hazardous…based on structural accidents.

True proven damage cases involving citizens shattering bones, becoming paralyzed or sick or even dying can be attributed to mine lands containing dangerous voids, high walls and abandoned mine streams

polluted with acid mine drainage, yet EPA fails to recognize that the beneficial reuse of ash placed in mines, quarries and pits in a regulated manner can and has eliminated hundreds of these historical true "proven damage cases".

It is unreasonable to make any comparison between the unfortunate TVA ash storage accident to dry CFB ash residue managed in a highly regulated, time tested (safely utilized for over 20 years) environmentally beneficial manner. A regulated effort backed by a vast amount of unbiased scientific data and reports/cases indicating that CCPs are indeed safe and can be a beneficially used by-product to reclaim previously mine voids and damaged lands and streams.

m. Summary

Assuming EPA intends to exclude mines from the proposed rule and intends to work with OSM to jointly develop a regulatory approach regarding the management of CCRs/CCPs in minefills and mine-land reclamation, then EPA and OSM should look to the states on how they approached the issues (where both the Solid Waste Programs worked with the Coal Mining Programs) in developing a program to obtain the benefits of the use of CCPs in minefills and mine-land reclamation and at the same time meeting the requirements of both regulatory programs insuring environmental requirements of these programs were met.

Further, the issues that will most likely be included in a regulatory approach to be developed jointly by EPA and OSM will most likely need inputs on the following:

The integrated regulatory process that sets forth the criteria related to the use of CCBs in minefills and mine-land reclamation, which would include but not limited to:

i. Characterization of CCR/CCP to determine acceptability for use in minefills and mine land reclamation projects.
ii. Water Quality Monitoring
iii. Design criteria for how the CCR/CCP is incorporated into the minefill and /or mine-land reclamation
iv. Treatment Requirements for controlling water from the site
v. Financial Assurances, if necessary, above that already established under the State Coal Mining Regulatory Program.

The use of CCRs/CCPs in minefills and mine-land reclamation provide benefits that result in protection of the land, improving the environment and returning unreclaimed mine-lands to a productive use. Examples of these benefits are:

i. Mine Subsidence Control
ii. Mine Drainage Amelioration
iii. Part of an integrated abatement program to achieve water quality improvements

iv. Land Reclamation (elimination of water quality problems associated with runoff) and restoring the land to a productive use; eliminating safety hazards (highwalls and water impoundments)
v. Economic Benefits
    1. Reclamation Benefits associated with abandoned and active mine land reclamation. (Also, a critical component related to reclamation of large scale open pit mine operations (anthracite) and possible (Area mines (i.e. Illinois and Indiana) by eliminating last pit that had been returned to surface water impoundments in the past and thus eliminating long term responsibility for maintained these impoundments on the property.)

Section XII – Testing Methodology

The EPA proposal challenges the use of the Toxicity Characteristic Leaching Procedure (TCLP, SW-846 Method 1311) and Synthetic Precipitation Leaching Procedure (SPLP, SW-846 Method 1312) for determining the constituents of coal combustion products (CCP). The proposal states "*…results might understate CCR leaching potential if actual field conditions extend beyond the pH range of 5.4 and 12.4.*"[124] Since the TCLP and SPLP are single point tests providing one concentration per constituent per sample, these tests may or may not present a true characterization for the tested material. The EPA has suggested a test method developed at Vanderbilt University as providing more accurate characterization since it includes data points over a range of pH levels and liquid/solid ratios.

The Leaching Environmental Assessment Framework (LEAF) protocol is a suite of four different laboratory tests. The suite of procedures included in LEAF represents a comprehensive protocol for evaluating leaching under a variety of conditions. Much of the work for this protocol was done at Vanderbilt University. While we agree that testing for accurate characterization of CCP is vital to protecting human health and the environment, we must note several concerns with the LEAF test protocol that should preclude its use at this time, especially when evaluating performance in beneficial uses.

A major deficiency with the LEAF protocol method is that it has not been correlated with field data. While the EPA is working to fill this void, this important aspect of the research is vital to the future of beneficial use. Many beneficial uses contain only small volumes of CCP in the finished product. For example, a cubic yard of concrete containing 100 lb. of fly ash amounts to 0.70 cubic feet of ash in a batch of concrete weighing 4000 lb. A cubic yard of stabilized gravel for road base will contain approximately 150 lb. of CCP. The amount of CCP and, therefore the quantity of constituents of concern are a very small portion of the mass of the finished product. Even if 100% of the available leachate could be extracted from the finished product, the quantity would be insignificant. In the case of concrete products, it would also be questionable

[124] Hazardous and Solid Waste Management System: Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities, 75 *Federal Register* 35128, 35140, June 21, 2010.

as to the source of the constituent since portland cement contains the same constituents of concern as found in fly ash. To use raw data on CCP for inclusion in these beneficial uses distorts the actual concentration available to leach in the finished product. The solubility of these constituents is also a major factor in characterizing their safety in beneficial uses.

In the case of unencapsulated beneficial use, in-situ correlation testing is vital to establish the relationship between the CCP prior to placement and the effects of handling, compaction, and any possible treatment in-place. For example, self-cementing fly ashes placed in large structural fills are often treated with water initiating a hydration of calcium oxide creating a finished product that resembles a low-strength concrete. The constituents undergo a chemical reaction in hydration which further binds these constituents. Therefore the level of leaching is impacted by the binding action of the hydration process. There is also evidence that carbonation of ash will occur over a period of days with exposure to the atmosphere resulting in a more neutral pH[125]. Field correlation with beneficial uses must be established before the LEAF protocol is used to decide future regulation of beneficial uses. Because of the variety of environmental influences on field conditions, LEAF and other protocols may only be indicators of actual field results. The effect of carbonation cannot be ignored.

A second major concern with the LEAF protocol is that is exaggerates some constituent concentrations under certain pH levels. While this exaggeration may be understood by scientists, it creates the opportunity for misuse. The range of concentrations can be extreme in some cases and the data manipulated for any number of reasons. Without sufficient expertise in geochemistry, geology, and environmental effects the data presented can be easily misinterpreted.

The lack of commercial laboratories trained and equipped to execute the LEAF protocol is also problematic. We realize this problem can be overcome in time, but it is a concern at present. In addition, LEAF is a much costlier and time-consuming analysis due to its complexity.

The investment of time and money for using the LEAF protocol may be warranted under very special conditions. However it cannot be justified for the vast majority of beneficial uses. It certainly has no material value for encapsulated uses where CCP is bound and, in some cases, chemically transformed. Where relatively modest volumes of CCP are being used, the LEAF protocol is also not justifiable. While we believe the single-point tests are limited in the amount and depth of data provided, they do offer a characterization sufficient for the intended purpose. More intensive characterization should be conducted only when special conditions exist. We urge the EPA to continue to pursue improved protocols for characterization that will provide accurate data calibrated to field conditions.

[125] Schramke, J. A., 1992. *Neutralization of Alkaline Coal Fly Ash Leachate by CO2(g)*. Applied Geochemistry, 7, 481-492.

Section XIII – Conclusion

The comments contained in this document are the result of an unprecedented volunteer effort by members of the American Coal Ash Association. Approximately 150 people expended more than 14,000 volunteer hours over a six-month period to analyze EPA's proposed rules and provide meaningful input.

The volunteers responsible for formulating these comments have combined centuries of experience in coal ash beneficial use issues. They include ash marketing experts, academicians, engineers, technology developers, and former environmental regulators. Most of the volunteers are employed by small businesses. As a group, they have more experience in the practical considerations of recycling coal ash than any other organization participating in the EPA's public comment process. They are also the group who are feeling the early impacts of stigma and are most at risk of further harm if EPA regulatory actions are finalized under Subtitle C, thereby further stigmatizing coal ash and causing a more drastic reduction in beneficial use activities.

ACAA volunteers struggled to formulate responses to the proposed EPA rule because they found it to be poorly conceived, inconsistent, and incomplete. For instance:

- EPA professes to be promulgating a rule covering coal ash disposal while continuing to exempt beneficial uses from regulation. However, the inclusion of numerous information requests regarding beneficial uses in the same rulemaking document creates a cloud of uncertainty and confusion over the process and EPA's intentions.

- In addressing beneficial use, the EPA document presents an incomplete list of potential beneficial uses for consideration and arbitrarily attempts to classify uses as either "encapsulated" or "unencapsulated." The terms encapsulated and unencapsulated are not adequately defined and EPA's attempts to categorize beneficial uses as one or the other contain several obvious errors under any potential definition.

- Similarly, EPA invents the new term "Coal Combustion Residuals" without adequately differentiating between waste materials and beneficial use products, further contributing to stigma issues to be discussed below.

- EPA also frequently presents general statements that are difficult to address because the concepts are vague. For example, EPA indicates an aversion to large structural fills without revealing what it considers to be "large" or even why the size of a properly engineered project should have anything to do with its environmental impact.

The Regulatory Impact Assessment at the heart of EPA's proposed rule provided the most jaw dropping reactions from ACAA's volunteers, however. EPA's assertion that coal ash recycling rates will ultimately <u>increase</u> under a hazardous waste designation was received with shock and

incredulity by the people who actually recycle coal ash. EPA's simplistic and faulty assumption that higher disposal costs automatically lead to increased recycling shows not only a lack of understanding of beneficial use markets, but a lack of concern for analyzing real world impacts of the proposed regulation.

An exemption from disposal regulation will not leave coal ash recyclers exempt from market forces. Stigma from a "hazardous when disposed" regulatory designation is a powerful market force that will affect every level of the coal ash beneficial use distribution chain. Producers of coal ash have testified they will be reluctant to allow a material considered "hazardous waste" on their own property to be distributed to literally thousands of locations around the community. Architects and engineers have testified they will be reluctant to specify use of a material considered hazardous in another setting. Product manufacturers have testified they will be reluctant to assume the additional potential liabilities and operational constraints associated with handling a material considered hazardous in another setting. Consumers of products that could contain coal ash have testified that they would be frightened at the prospect of having coal ash in their homes or neighborhoods.

EPA's proposed rule attempts to refute the existence of stigma by providing examples of other materials that get recycled even though they are considered hazardous waste for when disposed. None of EPA's examples are analogous to coal ash, however, which is not reprocessed during recycling and which is incorporated in products that come into direct contact with tens of millions of consumers every day.

ACAA's volunteers are experts in beneficial use and left comments about EPA's proposed disposal standards up to other individuals and organizations. However, the most casual reader of EPA's proposed rule cannot help but notice that the actual landfill engineering standards being proposed are essentially the same under both the Subtitle C and Subtitle D proposals. It is clear that EPA considers single liner systems with groundwater monitoring to be a disposal strategy that is protective of human health and the environment. ACAA's volunteers questioned why EPA would not want to enact those standards years sooner under a Subtitle D framework and avoid stigmatizing beneficial use activities that create significant, demonstrable environmental benefits.

As people who have spent whole careers trying to do something good for the environment by encouraging beneficial use of materials that would otherwise be disposed, the ACAA volunteers were troubled by EPA's apparent lack of consideration for the environmental benefits of coal ash utilization. EPA posed numerous questions apparently seeking environmental damages related to beneficial use (although none were actually presented by the agency.) But EPA completely failed to consider the environmental damages associated with <u>not</u> beneficially using these materials (namely increased landfill utilization, increased natural resources and energy consumption, reduced durability of construction materials, increased greenhouse gas emissions, etc.)

ACAA's volunteers – through these comments, other testimony and a formal resolution of the Association – have consistently supported EPA's efforts to enact improved coal ash disposal standards nationwide and have endorsed the concept of federal enforcement authority for those regulations. However, ACAA's volunteers cannot support EPA gaining the federal enforcement authority it seeks by designating coal ash a "special" hazardous waste under Subtitle C. Subtitle C would unnecessarily stigmatize the coal ash resource and damage our environment by unraveling one of the greatest recycling success stories in history.

The negative impact of EPA's proposal on coal ash beneficial use is real and is already being felt well in advance of the adoption of any regulation. The drumbeat of the misleading and inaccurate term "toxic coal ash" by anti-coal environmental groups combined with EPA's near total disregard for beneficial use activities has already affected the recycling market. Some utilities have already halted beneficial use programs. Some specifiers have banned the use of coal ash. Some manufacturers of products that compete with products containing coal ash have begun advertising regarding the purported "toxic" and "hazardous" nature of the material.

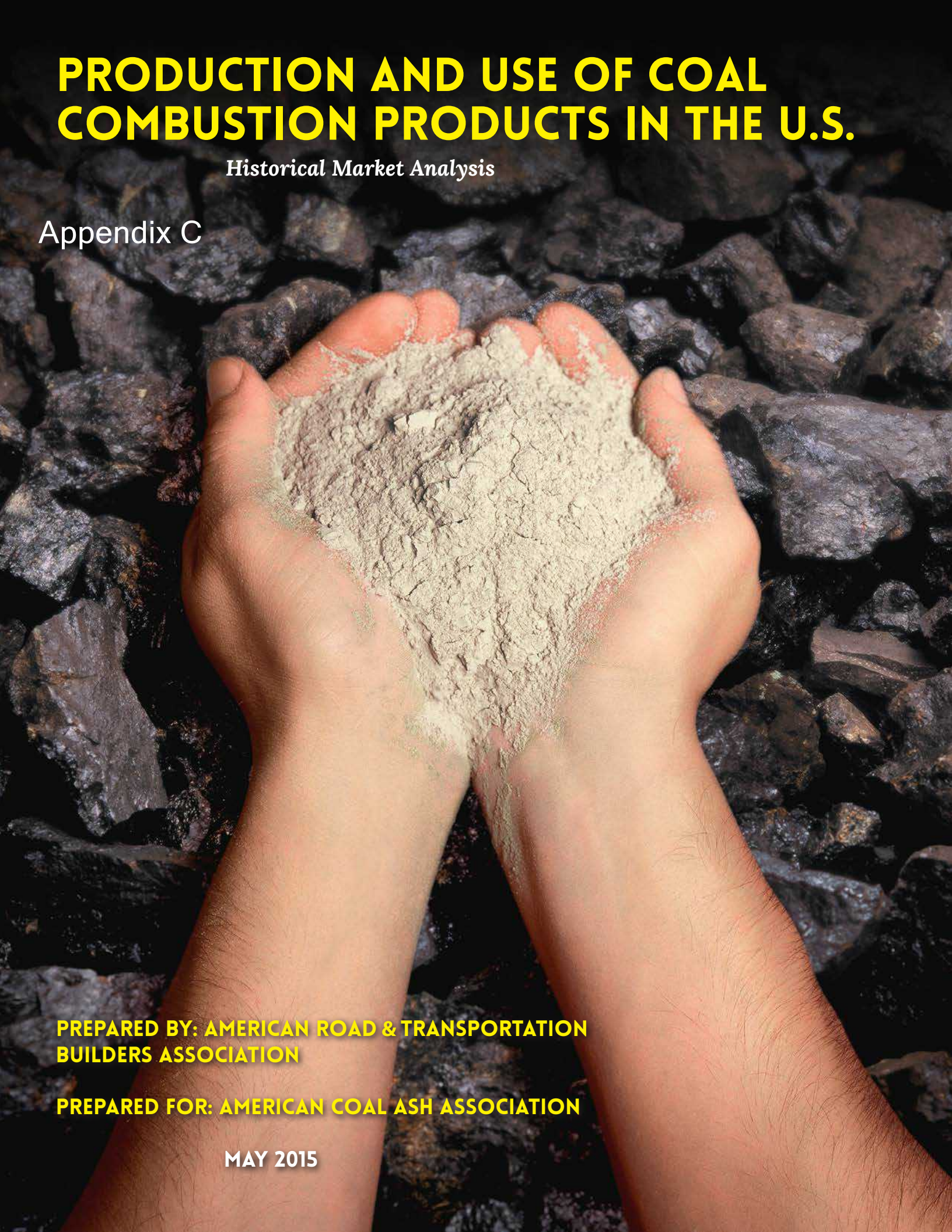
Coal ash does not qualify as a hazardous waste based on its toxicity. Its toxicity is comparable to the toxicity of materials it replaces in beneficial use applications. Properly engineered beneficial use applications – encapsulated and unencapsulated, small and large – safely create significant performance, environmental and economic benefits worth encouraging.

EPA should enact new standards for coal ash disposal that are protective of human health and the environment. EPA should not jeopardize beneficial use of coal ash with any form of Subtitle C designation.

PRODUCTION AND USE OF COAL COMBUSTION PRODUCTS IN THE U.S.

Historical Market Analysis

Appendix C



PREPARED BY: AMERICAN ROAD & TRANSPORTATION BUILDERS ASSOCIATION

PREPARED FOR: AMERICAN COAL ASH ASSOCIATION

MAY 2015

ABOUT ARTBA

Established in 1902, the American Road & Transportation Builders Association's (ARTBA) membership includes over 6,000 private and public sector representatives that are involved in the planning, designing, construction and maintenance of the nation's roadways, waterways, bridges, ports, airports, rail and transit systems.

ABOUT THE AUTHOR

This research was conducted by Dr. Alison Premo Black, senior vice president and chief economist for the American Road & Transportation Builders Association in Washington, D.C.

Dr. Black, who earned her PhD in Economics at The George Washington University in the Nation's Capital, also holds an M.A. in International Economics and Latin American Studies from the Johns Hopkins School of Advanced International Studies. She graduated magna cum laude from Syracuse University, where she was a member of Phi Beta Kappa and the Golden Key Honors Society, with majors in International Relations, Latin American Studies and Spanish. Since joining ARTBA in 2000, Dr. Black has led teams and authored over 75 studies examining state transportation funding and investment patterns and was responsible for the 2011 report "The Economic Impacts of Prohibiting Coal Fly Ash Use in Transportation Infrastructure Construction."

ACKNOWLEDGMENTS

This study relied on historical data on coal combustion products (CCPs) compiled by the American Coal Ash Association (ACAA), considered the authoritative source for CCP production and use statistics in the U.S. ACAA conducts a voluntary annual survey of the coal-fueled electric utility industry to track quantities of CCPs produced and beneficially used. The annual CCP Production & Use Survey Report has been used by industry and government agencies including the Environmental Protection Agency and the Department of Energy.

This study relied on energy data related to electric generation, projected coal unit retirements, fuel costs, and CCP disposition from the U.S. Energy Information Administration (EIA). The EIA collects, analyzes and disseminates independent and impartial energy information for policymakers and public understanding. The EIA publishes the Annual Energy Outlook and data collected directly from generators on numerous annual survey forms.

TABLE OF CONTENTS

Executive Summary 5
The Generation of Coal-Fueled Electricity 9
Increased Competition 10
Demand for Electricity 12
Plant Closures & Environmental Regulations 15
Changes in Type of Coal 18
Total CCP Production 19
Fly Ash Production 21
FGD Material Production 22
Bottom Ash Production 24
Boiler Slag Production 26
FBC Ash Production 28
Total CCP Utilization 30
Fly Ash Utilization 32
FGD Material Utilization 39
Bottom Ash Utilization 45
Boiler Slag Utilization 48
FBC Ash Utilization 50
Regulatory Uncertainty and CCP Utilization 52
Major Markets for the Beneficial Use of CCPs 57
Cement and Concrete Products 57
Gypsum Panel Products 59
Mining Applications 63
Structural Fills and Embankments 65
Additional Beneficial Use Markets 67
Appendix: Historical Data Tables from the ACAA Production & Use Survey 68
Methodology and Sources 72

EXECUTIVE SUMMARY

Coal combustion products (CCPs) are valuable materials that have numerous applications, including the construction of dams, bridges and highways; building products; manufacturing; mining and agricultural uses. Products containing CCPs can be found in nearly every U.S. home, including gypsum wallboard, foundations, roofing shingles and concrete driveways. CCPs are the solid byproducts from burning coal to produce electricity. Although collectively known as "coal ash," CCPs are a class of materials that have varied chemical and physical characteristics and include fly ash, bottom ash, flue gas desulfurization (FGD) material, boiler slag and fluidized bed combustor (FBC) ash.

The use of coal ash in concrete (specifically fly ash) dates back to the construction of the Hoover Dam. By the 1970s, the use of fly ash was encouraged for roadway and interstate highway construction by the Federal Highway Administration (FHWA). The utilization of CCPs as replacement for mined or manufactured materials has been increasing over the last four decades. Since 1974, the American Coal Ash Association (ACAA) has collected data on the production and utilization of CCPs in the U.S. This study is the first to examine historical trends in annual production and utilization from 1974 to 2013.

This study was undertaken to examine the impacts of economic and regulatory factors on past CCP production and utilization. Relationships between the CCP data and other economic factors, including electricity demand and generation, U.S. recessions and changes in markets for CCPs, were analyzed using a variety of data sources and economic models. Details on this econometric analysis, which is the basis of a 20-year forecast for CCP production and use, can be found in a companion document.

Regulatory and policy factors include major environmental regulations affecting coal-fueled electricity generation, technologies for emissions reductions, regulatory uncertainty and standards and specifications pertaining to CCPs.

CCP PRODUCTION 1974 – 2013

Once accounting for over 50 percent of total electric generation, coal-fueled power generation has fallen to just over 40 percent in 2013 due to a number of factors. Environmental regulations, competition from natural gas power and relatively flat electricity demand has resulted in the retirement of coal-fueled capacity, reducing coal-fueled electricity generation, and thus, CCP production.

The overall production of CCPs grew at an average annual rate of 1.7 percent, from 59.5 million short tons in 1974 to 114.7 million short tons in 2013, as shown in Figure E-1. Production of fly ash and FGD material, which combined represent 77 percent of total CCP production by weight, have been positively impacted by capital investments from coal-fueled generating utilities to meet the requirements of the 1970 Clean Air Act and its amendments in 1977 and 1990. Production of fly ash has grown at an average annual rate of just under one percent, while production of FGD material has grown at an average annual rate of 3.5 percent, driven in large part by the development of technologies for reducing sulfur dioxide emissions in response to federal regulation.

CCP UTILIZATION 1974 – 2013

The growth in CCP utilization has been enabled by the development of standards for CCP use in construction and new techniques for using higher quantities of ash. CCP utilization has grown during three of the last five U.S. recessions since 1974, as shown in Figure E-2, as concrete producers and other end users have utilized CCPs as less expensive material substitutes to save on overall material costs. This includes the most recent recession that began in December 2007.

During periods following two regulatory determinations (1993 and 2000) by the U.S Environmental Protection Agency (EPA) that CCPs did not warrant regulation as a hazardous waste, CCP utilization increased significantly, as can be seen in Figure E-2. Fly ash utilization doubled from 10.5 million short tons in 1993 to 20.1 million short tons in 2000, growing at an average annual rate of 10 percent. Between 2000 and 2007, fly ash utilization increased 6.6 percent annually. Similarly, FGD material utilization grew by 23 percent annually from 1993 through 2000, and by 12 percent annually between 2000 and 2008.

EPA's decision to reconsider the classification of CCPs as a hazardous waste after the December 2008 coal ash spill in Kingston, Tennessee resulted in regulatory uncertainty for CCP markets. CCP utilization had been at its highest in 2008 at 60.6 million short tons following the 2007 recession. After EPA's reconsideration, CCP utilization declined by 15 percent from 2008 to 2013. Despite increased CCP utilization during previous recessions, regulatory uncertainty affected markets for CCPs, reducing overall utilization after 2008.

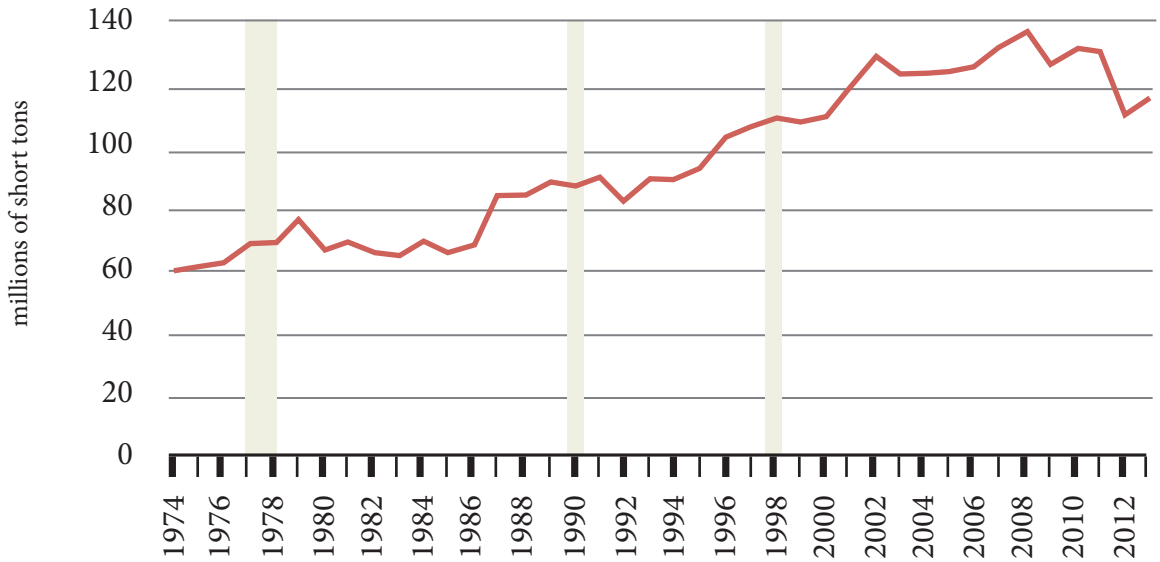
NEW MARKETS AND STANDARDS

Since 1974, markets and applications for CCPs have increased dramatically. Total CCP utilization has increased from 8.7 million short tons in 1974 to 51.6 million short tons in 2013, as shown in Figure E-3. This represents an increase of nearly 500 percent over that period, or an average increase of 5.1 percent annually, as shown in Figure E-4.

The development of industry standards and specifications for CCP utilization in various engineering applications has encouraged wider use of these materials. More than a dozen federal agencies have published articles, guidelines and standards on the beneficial use of CCPs. EPA has released a study supporting the use of fly ash in concrete and FGD gypsum in wallboard. Further, EPA's final rule for CCP disposal specifically exempts beneficial uses, which will impart regulatory certainty for markets in the years to come.[1]

[1] The final rule, Disposal of Coal Combustion Residuals from Electric Utilities was published in the Federal Register on April 17, 2015 and uses the terminology coal combustion residuals (CCRs) rather than coal combustion products. The rule does not regulate practices that meet the definition of a beneficial use of CCR. 80 Fed. Reg. 21301.

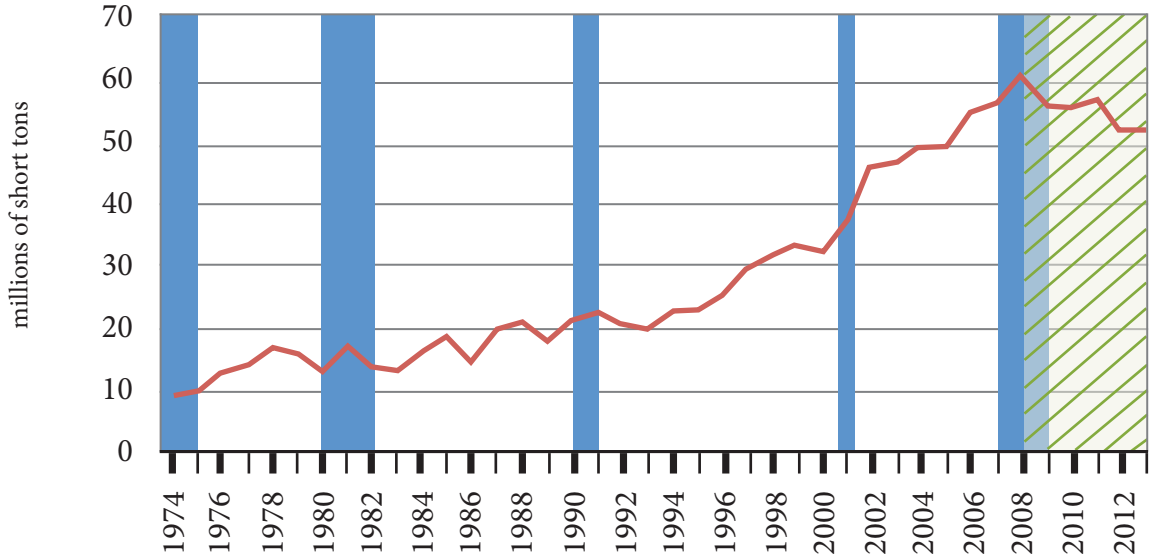
FIGURE E-1: PRODUCTION OF CCPs HAS GROWN AT AN AVERAGE ANNUAL RATE OF 1.7 PERCENT



Dates of Major Air Emissions Regulatory Activity
1977: Clean Air Act (CAA) Amendment
1978: EPA New Rules on Industrial Growth in Clean Air Areas
1990: CAA Amendment
1998: EPA NOx Transport Rule

Total CCP Production

FIGURE E-2: UTILIZATION OF CCPs HAS INCREASED DURING RECESSIONS, BUT DROPPED DURING A PERIOD OF REGULATORY UNCERTAINTY



U.S. Recession

CCP Regulatory Uncertainty

Total CCP Utilization

Major U.S. Recessions
November 1973 to March 1975
January to July 1980
July 1981 to November 1982
July 1990 to March 1991
March to November 2001
December 2007 to June 2009

CCP Regulatory Uncertainty:
December 2008 to April 2015
EPA decision to reconsider the classification of CCPs as a hazardous waste

FIGURE E-3: PRODUCTION OF CCPs HAS INCREASED WITH INSTALLATION OF POLLUTION CONTROL EQUIPMENT, AND USE OF CCPs HAS INCREASED AS NEW MARKETS EMERGE

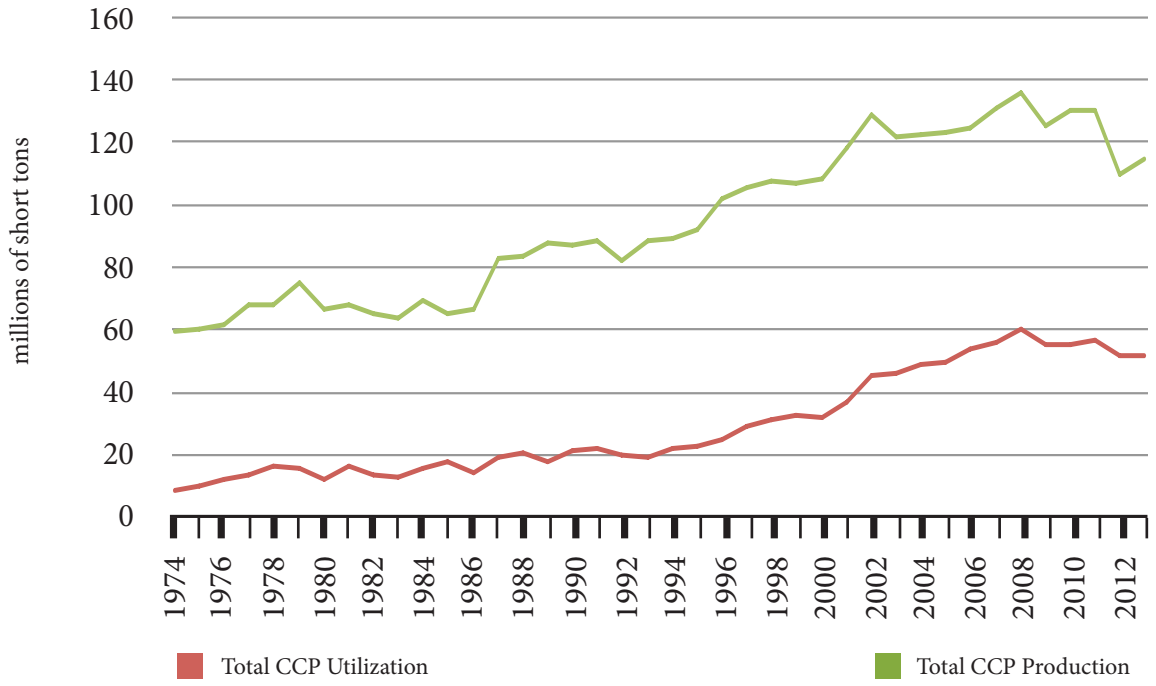
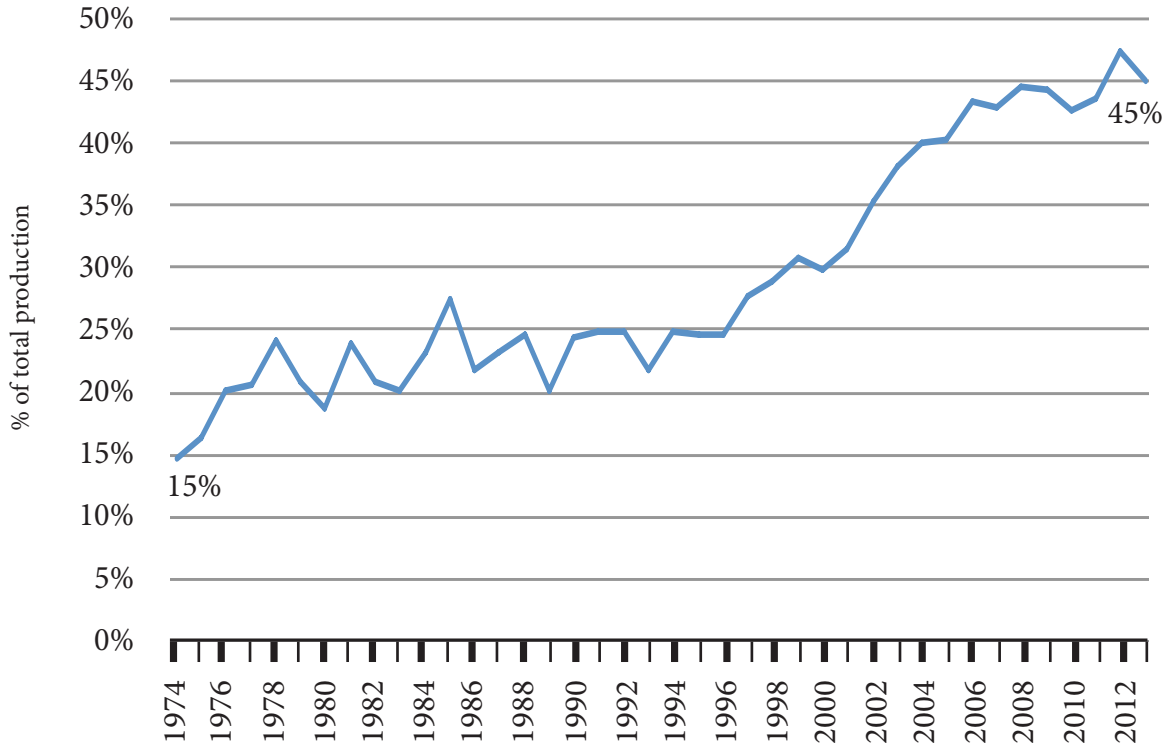


FIGURE E-4: THE PERCENTAGE OF CCPs UTILIZED HAS INCREASED SIGNIFICANTLY SINCE 1993



THE GENERATION OF COAL-FUELED ELECTRICITY

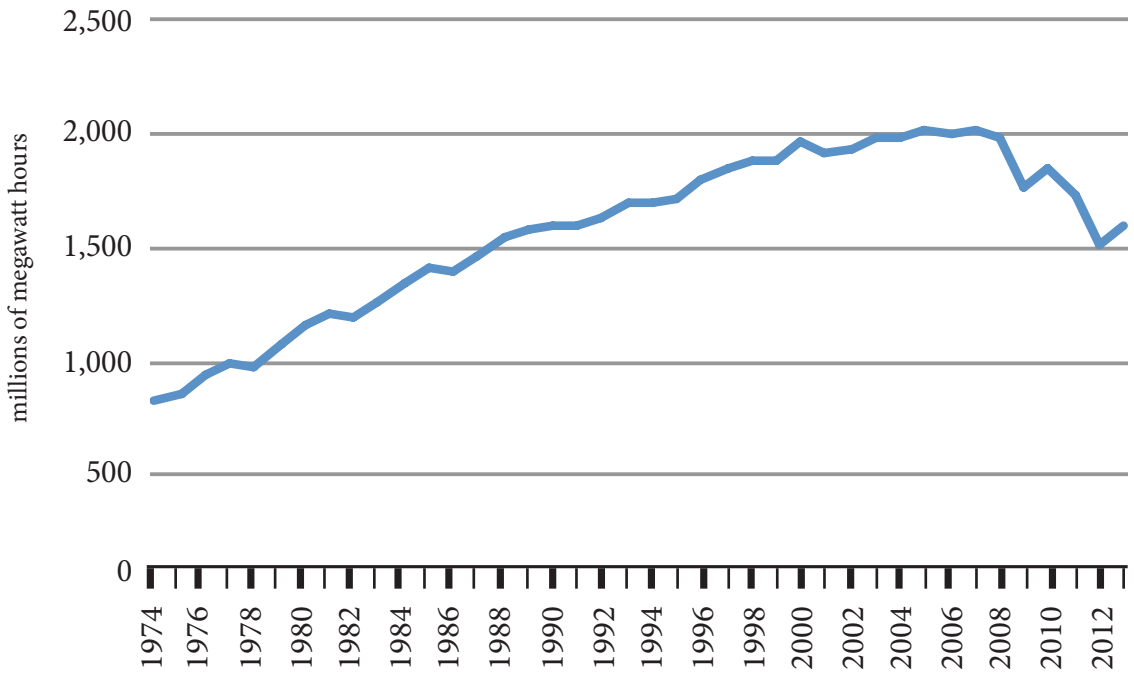
Coal is the largest energy source for generation of electricity in the United States, accounting for over 40 percent of electricity generation in 2013.[2] The share of coal generated electricity was 44 percent of total electricity in 1974, increasing to as high as 57 percent in 1988.

Although the share of coal generated electricity has declined since 1988, the overall consumption of coal by the power sector and the megawatt hours of coal generated electricity have remained high, resulting in the continued production of large volumes of CCPs.

The total consumption of coal for electricity grew from 391.8 million short tons in 1974 to a peak of just over 1 billion short tons in 2008. Since that time, consumption has declined to 858.4 million short tons.

There are a number of factors that have contributed to the recent decline in coal consumption for electricity. Environmental regulations have led to the closure of some coal-fueled generating capacity. Other contributing factors include competition from lower priced natural gas and a slower growth in electricity demand.[3]

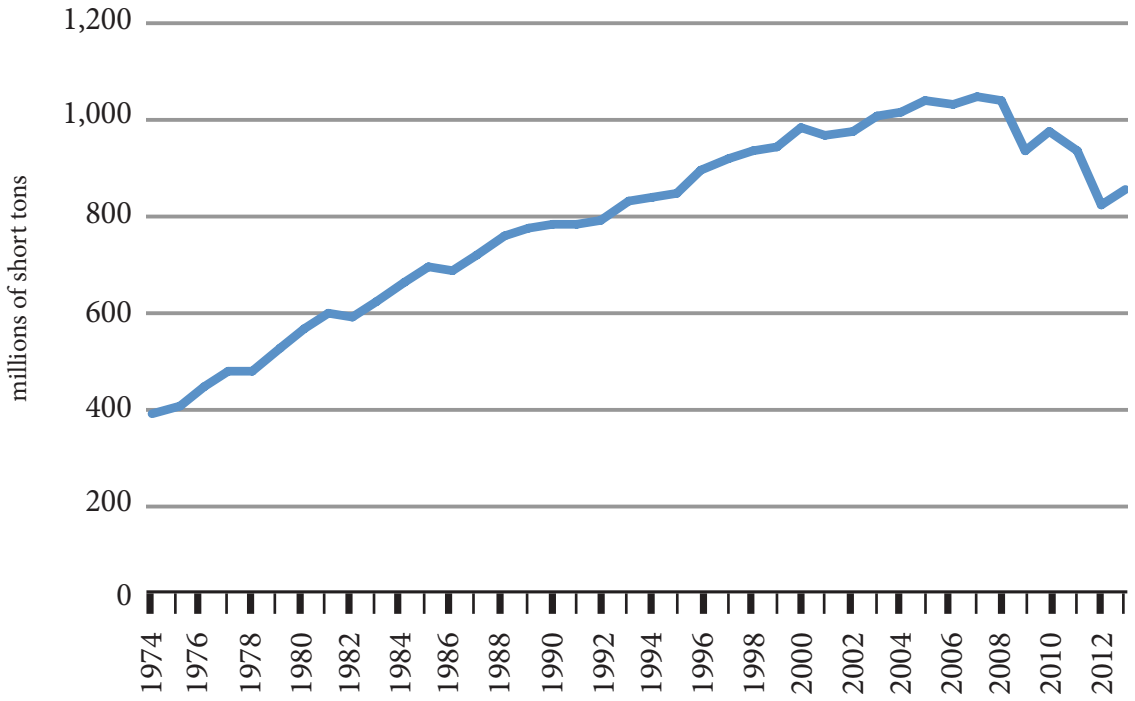
FIGURE 1-1: ELECTRICITY GENERATED FROM COAL IN THE U.S.



[2]Outlook, Annual Energy. "Annual Energy Outlook, 2014." US Energy Information Administration, Early Release Overview (2014). (http://www.eia.gov/forecasts/aeo/er/early_elecgen.cfm

[3]U.S. EIA. "AEO2014 projects more coal-fired power plant retirements by 2016 than have been scheduled." February 14, 2014. (http://www.eia.gov/todayinenergy/detail.cfm?id=15031)

FIGURE 1-2: COAL CONSUMPTION FOR ELECTRICITY IN THE U.S.



INCREASED COMPETITION

Economic drivers have impacted coal consumption by electric utilities since 2008, including increased competition from natural gas.

The more widespread use of high-volume, horizontal hydraulic fracturing techniques, commonly known as "fracking," have provided greater access to U.S. shale and natural gas reserves since the early 2000s and lowered the costs of withdrawing and producing natural gas. Shale gas reserves are located in a number of states, including Texas (49 billion cubic feet in 2013), Pennsylvania (44.3 billion cubic feet), West Virginia (18.1 billion cubic feet) and Arkansas (12.2 billion cubic feet).[4]

Fracking has led to a "revolution" in natural gas drilling.[5] As the price of natural gas has fallen relative to coal, utilities have used this energy source to generate a greater share of total electricity. In 1974, natural gas accounted for 17 percent of total U.S. net electricity generation. That grew to 27 percent in 2013.

The price of natural gas fell from $9.26 per thousand cubic feet in 2008 to $4.93 in 2009, according to data from the U.S. Energy Information Administration (EIA), a one-year decline of nearly 47 percent. The price continued to drop, reaching $3.54 in 2012.

[4]U.S. EIA data on Shale Gas Proved Reserves as of December 31, 2013 (http://www.eia.gov/dnav/ng/ng_enr_shale-gas_dcu_nus_a.htm)
[5]Kris Maher & Tom McGinty. "Coal's Decline Hits Hardest in the Mines of Kentucky." Wall Street Journal November 26, 2013. (http://www.wsj.com/articles/SB10001424052702304337404579212262280342336)

FIGURE 1-3: PRICE OF NATURAL GAS

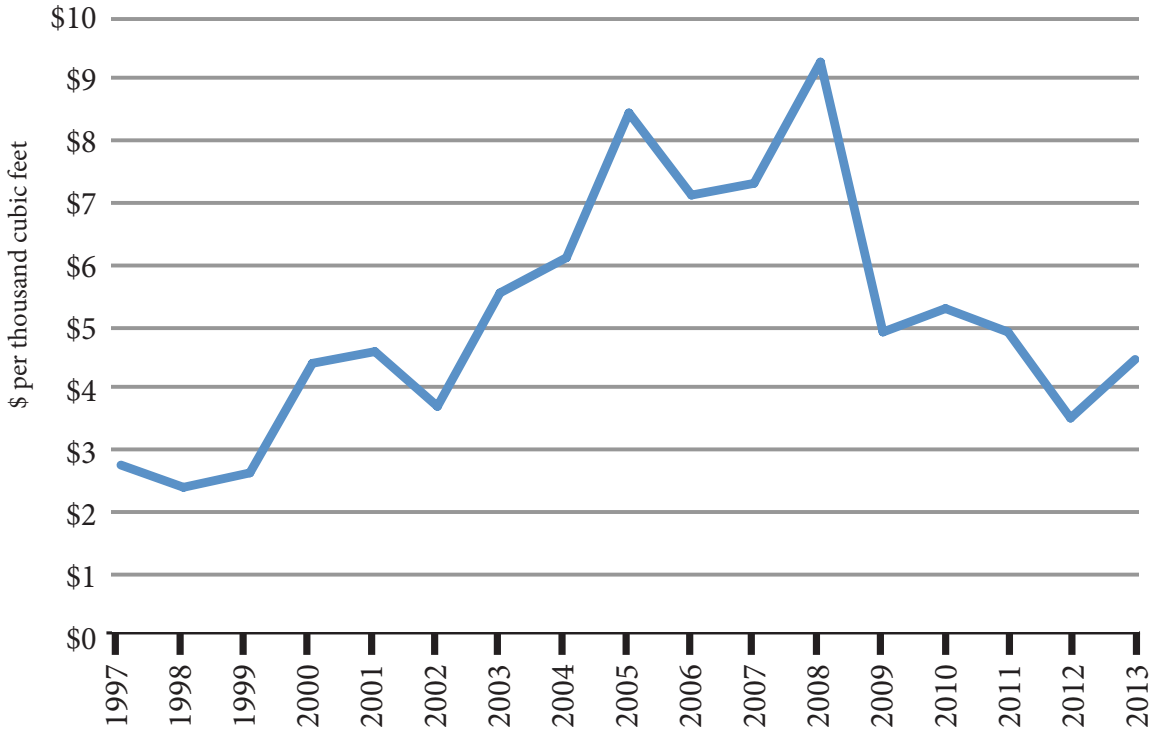
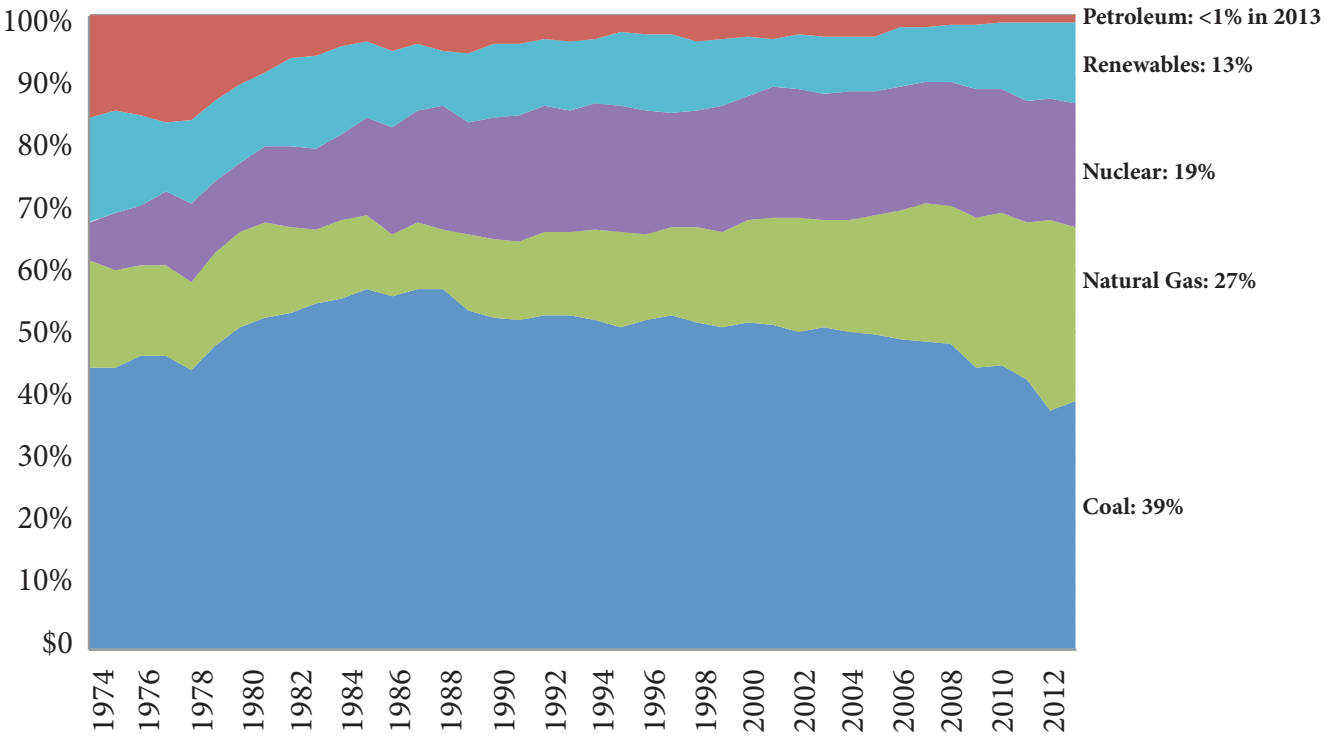


FIGURE 1-4: U.S. ELECTRICITY NET GENERATION BY SOURCE, 1974 TO 2013



DEMAND FOR ELECTRICITY

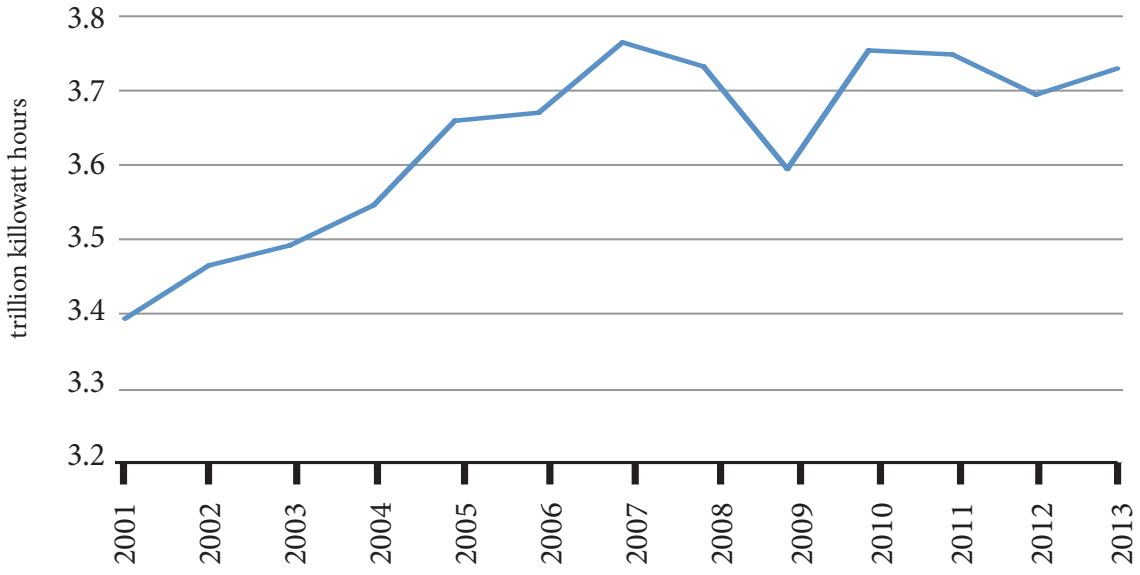
The overall demand for electricity has also impacted total coal consumption by utilities. Such factors as economic growth, income, tax changes, energy prices and weather drive residential and commercial demand.[6]

Americans consumed 3.73 trillion kilowatt hours of electricity in 2008, according to data from EIA. That fell 3.7 percent in 2009, during the recession, to 3.6 trillion kilowatt hours. A nine percent decline in industrial electricity consumption accounted for over two-thirds of the overall downturn.

Weather has the most significant impact on residential electricity demand, especially cold weather.[7]

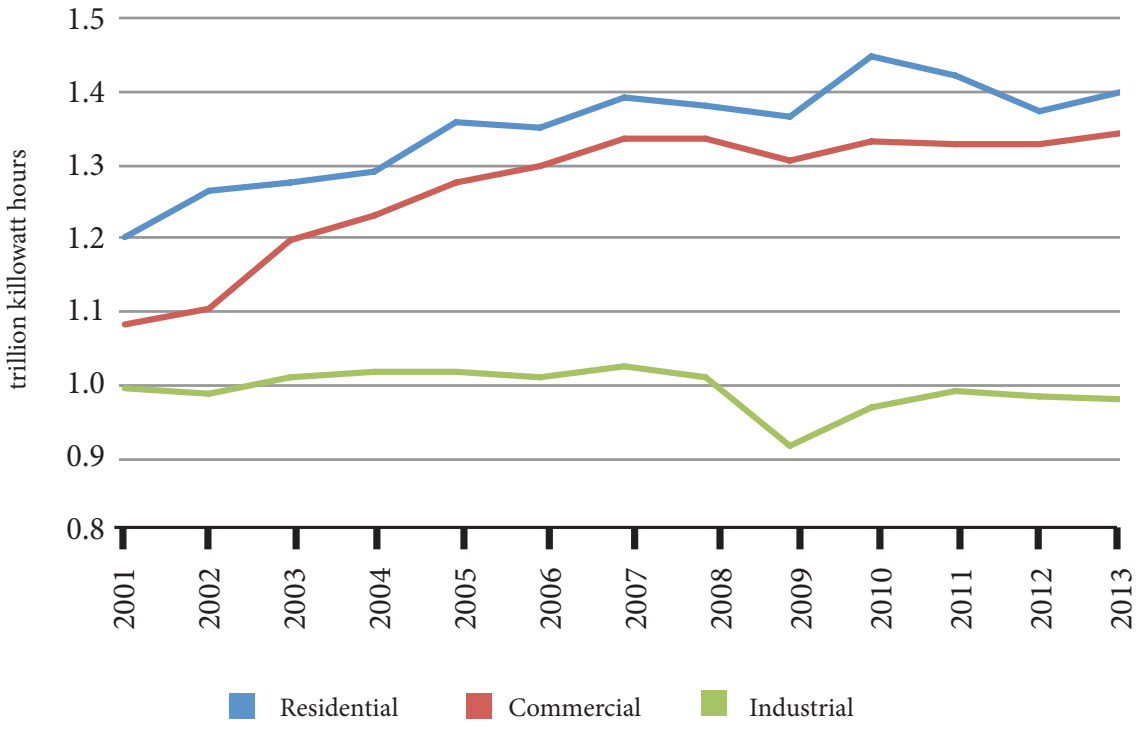
If the average temperature is higher, people don't use as much electricity to heat their homes. The average temperature for 2012 was the warmest on record since 1974, according to data from U.S. the National Climatic Data Center, followed by 2006, 1998 and 1999. In 2012, residential electricity demand was down 3.4 percent from 2011 levels, compared to a decline of less than one percent for the commercial and industrial sectors combined.

FIGURE 1-5: TOTAL U.S. RETAIL SALES OF ELECTRICITY



[6]Jay Zarnikau, "Functional form in energy demand modeling." Energy Economics, Volume 25 (2003). (http://www.sciencedirect.com/science/article/pii/S0140988303000434)
[7]David Kamerschen & David V. Porter. "The demand for residential, industrial and total electricity, 1973-1998." Energy Economics, Volume 26, Issue 1, (2004). (http://www.sciencedirect.com/science/article/pii/S0140988303000331)

FIGURE 1-6: TOTAL U.S. RETAIL SALES OF ELECTRICITY BY MAJOR SECTOR



PLANT CLOSURES AND ENVIRONMENTAL REGULATIONS

Electric utilities shut down coal-fueled units representing 8.1 gigawatts of generating capacity in 2013 and 2014, according to data from EIA.[8]

Although more closures are expected in the next few years, this is not expected to have a significant impact on CCP production. This is because most of the units that are being closed are older, smaller, and not as frequently utilized, and are therefore not producing a significant share of the total production of CCPs. EIA describes the units closed between 2010 and 2012 as "small, with an average size of 97 megawatts (MW), and inefficient, with an average tested heat rate of about 10,695 British thermal units per kilowatt-hour (Btu/kWh)."[9]

Historically, federal and state regulations have had a role in overall CCP production by requiring utilities to install equipment that capture the ash produced during the generation of electricity from coal. The major piece of legislation affecting the industry was the Clean Air Act, first introduced in 1963, with amendments in 1970, 1977 and 1990. The 1963 Clean Air Act was the first federal legislation involving air pollution, and provided funds for federal research, ambient monitoring studies and stationary source inspections.[10]

According to the U.S. Environmental Protection Agency (EPA), the 1970 amendment to the Clean Air Act "resulted in a major shift in the federal government's role in air pollution control." The legislation gave both federal and state governments the ability to limit emissions from stationary and mobile sources. The 1970 act required the following:[11]

- EPA was directed to establish national ambient air quality standards for the major criteria air pollutants.
- States were required to develop implementation plans on how they would establish limits for individual sources to meet and maintain the national standards.
- The legislation contained deadlines and strengthened enforcement of emission limitations.
- New sources were forced to meet standards based on the best available technology.

National Ambient Air Quality Standards (NAAQS) were established under the 1970 amendment to the Clean Air Act for the priority pollutants ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide and lead. The emission standards most affecting the utility industry were for particulate matter, nitrogen oxides and sulfur dioxide.

The implementation of technologies to meet the new emissions standards for particulate matter meant that power plants began to capture fly ash in emissions control equipment.

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[8]Outlook, Annual Energy. "Annual Energy Outlook, 2014." US Energy Information Administration, Early Release Overview (2014), (http://www.eia.gov/forecasts/aeo/er/early_elecgen.cfm), Table A9.
[9]U.S. EIA. "AEO2014 projects more coal-fired power plant retirements by 2016 than have been scheduled." February 14, 2014 (http://www.eia.gov/todayinenergy/detail.cfm?id=15031)
[10]U.S. EPA. "History of the Clean Air Act." (http://www.epa.gov/air/caa/amendments.html)
[11]U.S. EPA. "The Benefits and Costs of the Clean Air Act, 1970 to 1990." prepared for the U.S. Congress October 1997 (http://www.epa.gov/cleanairactbenefits/retro.html)

Emissions standards for new power plants were established by the EPA and required the latest technology that corresponded to a roughly 75 percent reduction from the average emissions rates at the time. Power plants could meet this standard by installing a Flue Gas Desulphurization ("FGD") system or burning low-sulfur coal.

U.S. manufacturing companies, privately and cooperatively owned electric utilities, publicly owned electric utilities and other non-manufacturing companies spent $2.24 billion on plants and equipment for air pollution abatement in 1972.[12]

EPA estimates that as a result of Clean Air Act compliance, particulate matter emissions from coal-fueled electricity generating plants decreased from 1.68 million short tons in 1970 to 941,000 short tons in 1979, and to 188,000 short tons in 2005.[13]

The 1977 amendment to the Clean Air Act established the New Source Review permitting program, requiring legal documents for facility owners and operators that want to construct new or modify existing factories, industrial boilers and power plants.[14]

In 1978, EPA followed up with new rules on industrial growth in clean air areas, requiring "large new pollution sources such as factories and power plants which build in these areas to install the best available pollution control technology."[15]

The Clean Air Act amendments of 1990 "substantially increased the authority and responsibility of the federal government" and implemented new regulatory programs and standards.[16] Prior to the amendment, EPA regulated air toxics "one chemical at a time." The new approach identified major industrial sources for 187 listed toxic air pollutants and steps to "reduce pollution by requiring sources to install controls or change production processes."

As part of the update, EPA issued a two-phase strategy to reduce nitrogen oxide emission from utilities that used coal boilers. Phase I took effect in January 1996 and required emissions levels from a group of dry-bottom wall-fired boilers and tangentially-fired boilers to reduce their emission by over 400,000 tons per year between 1996 and 1999.[17] The goal of the second phase, which began in 2000, was to reduce nitrogen oxide emissions by an additional 2 million tons per year.

EPA issued the NOx Transport Rule in 1998 that required 21 states and Washington, D.C. to use new and cleaner control strategies to further reduce nitrogen oxide emissions by one million tons by 2007. The rule allowed each state to determine how it planned to reduce its emissions.[18]

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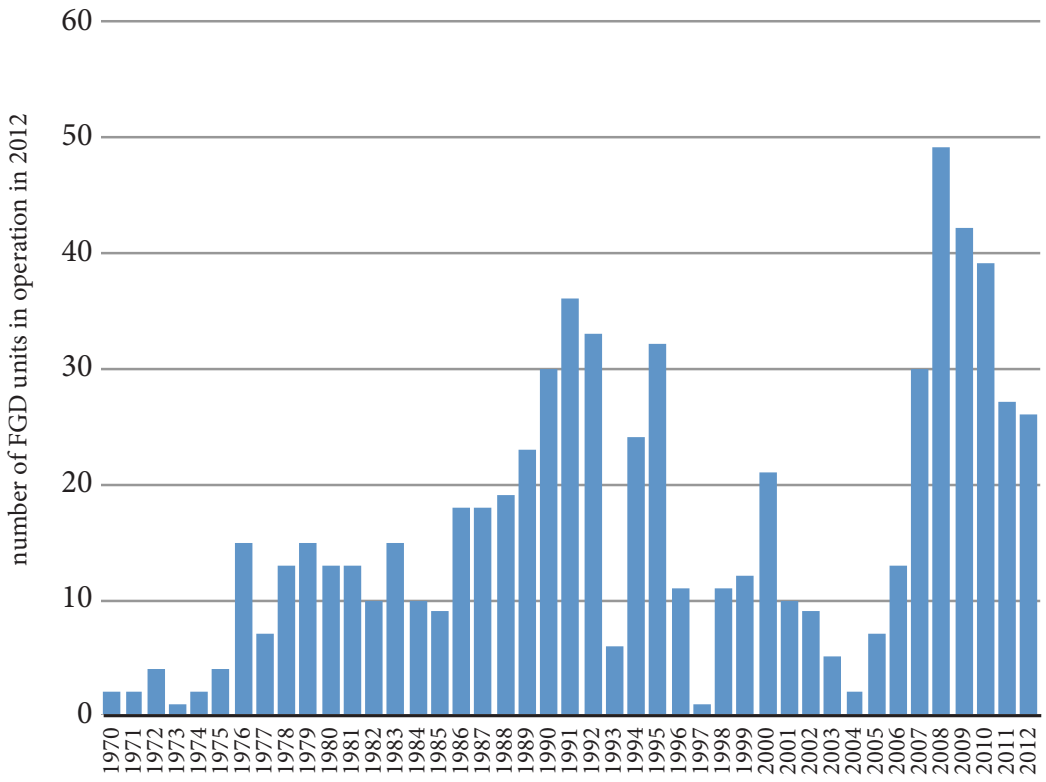
[12]Cogan, Christine, "Pollution Abatement and Control Expenditures, 1972-94," Survey of Current Business (http://www.bea.gov/scb/pdf/national/niparel/1996/0996eed.pdf)
[13]EPA, "National Emissions Inventory, Trends for Electric Generating Utilities for 1970 to 2005", (2008).
[14]U.S. EPA, New Source Review (http://www.epa.gov/ttnchie1/trends/)
[15]EPA Press Release, June 13, 1978. (http://www2.epa.gov/aboutepa/epa-announces-new-rules-industrial-growth-clean-air-areas)
[16]EPA, History of the Clean Air Act, August 15, 2013. (http://www.epa.gov/air/caa/amendments.html)
[17]Maroto-Valer, M. Mercedes, D. N. Taulbee, and J. C. Hower. "Characterization of Fly Ash Carbons Derived Due to the Implementation of NOx Clean Air Act Amendments." Prepr. Pap. Am. Chem. Soc., Div. Fuel Chem 45 (2000): 401-405. (https://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/45_3_WASHINGTON%20DC_08-00_0401.pdf)
[18]EPA, "The Regional Transport of Ozone: New EPA Rulemaking on Nitrogen Oxide Emissions" (http://www.epa.gov/air/noxfacts.pdf)

The 1990 amendment to the Clean Air Act introduced a permanent cap on sulfur dioxide emissions from electric power plants across the country and implemented a cap and trade system. In order to comply with the new standards, utilities could either switch to low sulfur coal, add FGD scrubbers or other equipment to remove emissions, purchase permits from other utilities, or use some combination of those strategies.[19]

Of the operational FGD units in 2012, 219 began service between 1956 and 1990, 217 units began service between 1990 and 2000, and 259 units after 2001. A total of 183 operation units just began service in the last five years, between 2008 and 2012.

FIGURE 1-7: CURRENT OPERATIONAL FGD UNITS BY YEAR SERVICE BEGAN



[19]Institute for Energy Research. "The Facts About Air Quality and Coal-Fired Power Plants." (http://instituteforenergyresearch.org/studies/the-facts-about-air-quality-and-coal-fired-power-plants/)

CHANGES IN TYPE OF COAL

In addition to the volume of coal burned by electric utilities, changes in the types of coal consumed have had an impact on the historical production of CCPs.

There are four main classifications for coal, known as coal rank: anthracite, bituminous, subbituminous and lignite. Each type varies based on heating value, moisture, fixed carbon content, ash content, sulfur and chlorine.[20]

Utilities may burn one or more types of coal at a power plant to generate electricity, and may even blend different types of coal. Most coal-fueled electricity generating plants burn bituminous or subbituminous coals. The use of lignite coal is generally limited to utilities that are located near those coal supplies.[21] Anthracite coal is rarely used for electricity generation.

In 1974, over 84 percent of the coal deliveries to utilities was bituminous coal, with an average ash content of 14.6 percent. Subbituminous coal, with an average ash content of 8.3 percent, accounted for just over 12 percent of all deliveries.[22]

With the implementation of the Clean Air Act provisions, utilities began using more of the subbituminous coal, which has both a lower sulfur and ash content.

By 1990, subbituminous coal accounted for nearly 30 percent of deliveries. The average ash content of the coal that year was 6.2 percent. Bituminous coal, with an average ash content of 10.5 percent, accounted for 61 percent of deliveries, with lignite coal at just below 10 percent, with an ash content of 12.4 percent.

In 2005, subbituminous coal was 49 percent of deliveries and bituminous coal was 47 percent. That trend continued, with subbituminous coal accounting for 53.2 percent of deliveries in 2012, while bituminous coal was 38 percent.[23]

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[20]Purdue University, Indiana Center for Coal Technology Research. "CCTR Basic Facts File #8." (http://www.purdue.edu/discoverypark/energy/assets/pdfs/cctr/outreach/Basics8-CoalCharacteristics-Oct08.pdf)
[21]EPA. "Available and Emerging Technologies For Reducing Greenhouse Gas Emissions From Coal-Fired Electric Generating Units." October 2010. (http://www.epa.gov/nsr/ghgdocs/electricgeneration.pdf)
[22]ARTBA analysis of historic EIA form 423 and FERC-423 data. (http://www.eia.gov/electricity/data/eia423/)
[23]ARTBA analysis of EIA form 923 data.(http://www.eia.gov/electricity/data/eia923/)

TOTAL CCP PRODUCTION

The total production of CCPs has grown from 59.5 million short tons in 1974 to 114.7 million short tons in 2013, an increase of 93 percent. There were 413 plants that reported collecting CCPs in 2012.[24]

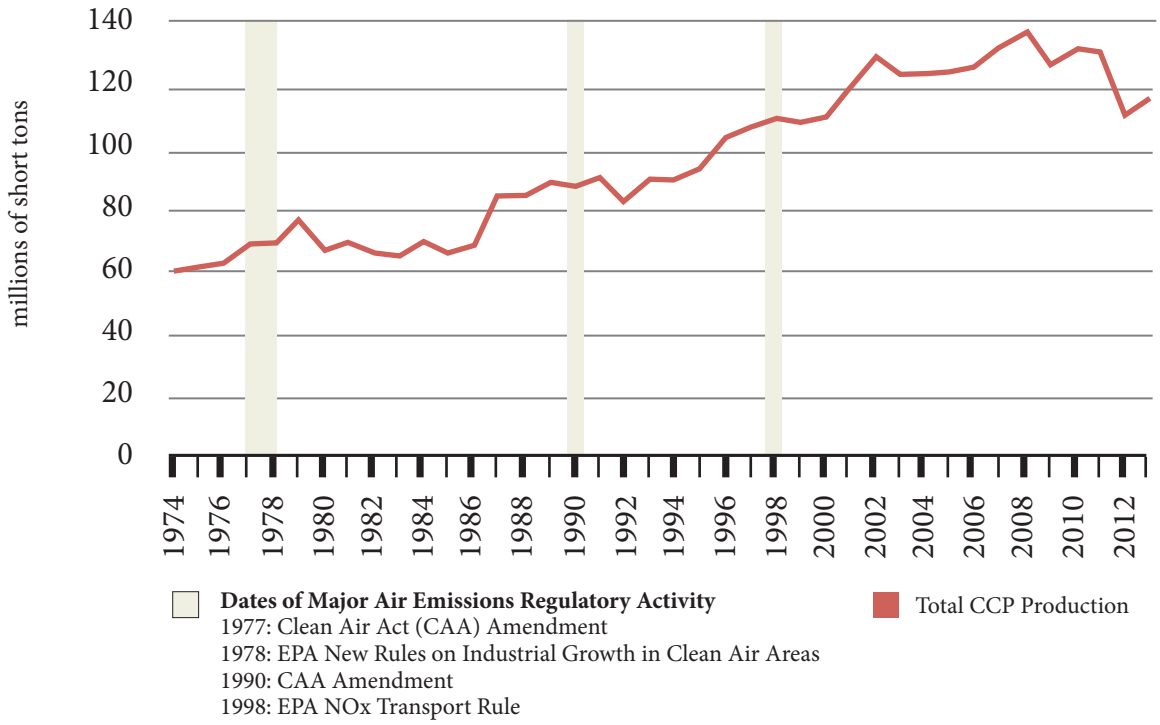
As a byproduct of the coal combustion process, CCP production is primarily driven by the consumption of coal for electricity generation. Although the overall impact can vary from year to year, this link is particularly evident during the sharp swings in the coal generated electricity market over the last few years. The most recent example of this was in 2012. CCP production fell in all the major product types when the total volume of coal generated electricity declined in response to lower natural gas prices and a very mild winter.[25]

Additional growth over the last 40 years, especially for fly ash and FGD material, is attributable to environmental regulations that required electric utilities to begin collecting CCPs.

In particular, the 1968 Clean Air Act, with amendments in 1970, 1977 and 1990 set regulations for nitrogen oxides, particulate matter and sulfur dioxide that required utility owners to install equipment and processes to capture CCPs. The legislation also allowed states to set additional emissions standards and required reduced output levels for key emissions with the construction of new utility generators and plants.

New developments in technology to meet these standards, such as the evolution of scrubber and boiler technology and the use of low sulfur coal, have had implications for individual CCP markets.

FIGURE 2-1: PRODUCTION OF CCPs HAS GROWN AT AN AVERAGE ANNUAL RATE OF 1.7 PERCENT



[24]ARTBA analysis of EIA form 923 data. (http://www.eia.gov/electricity/data/eia923/)
[25]U.S. EIA. "Monthly coal and natural gas-fired generation equal for first time in April 2012." July 6, 2012. (http://www.eia.gov/todayinenergy/detail.cfm?id=6990)

FLY ASH PRODUCTION

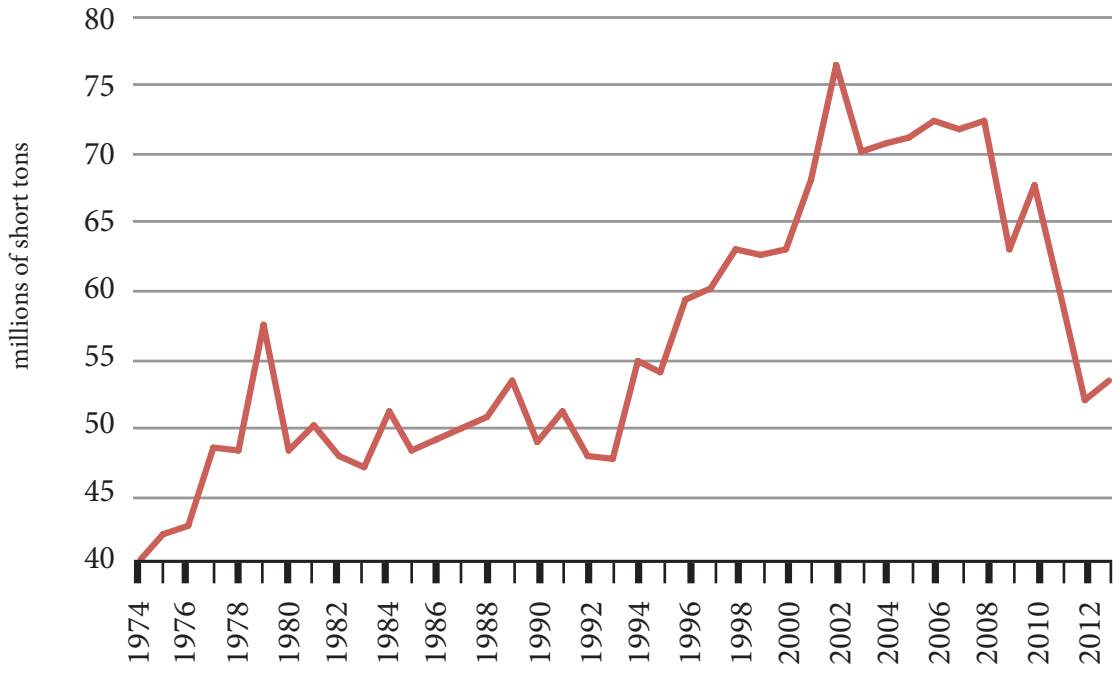
Since 1974, the production of fly ash has increased 29 percent from 40.4 million short tons to 53.4 million short tons in 2013, growing at an average annual rate of just under one percent.

As the non-combustible mineral portion of coal, the production of fly ash is wholly related to the volume of coal generated electricity. The capture of fly ash has also been impacted by the implementation of emission control regulations by coal-fueled electricity producing utility plants.

During the early years of the Clean Air Act, fly ash production grew from 40.4 million short tons in 1974 to 57.5 million short tons in 1979. Total fly ash production averaged 50 million short tons over the next decade, between 1980 and 1990.

Fly ash production grew at an average annual rate of 2.2 percent between 1990 and 2008, increasing from 48.9 to 72.5 million short tons. This rate of growth was higher than the average annual increase in coal consumption for electricity, which was 1.6 percent, and megawatt hours of coal generated electricity, which grew at a rate of 1.2 percent.

FIGURE 2-2: FLY ASH PRODUCTION



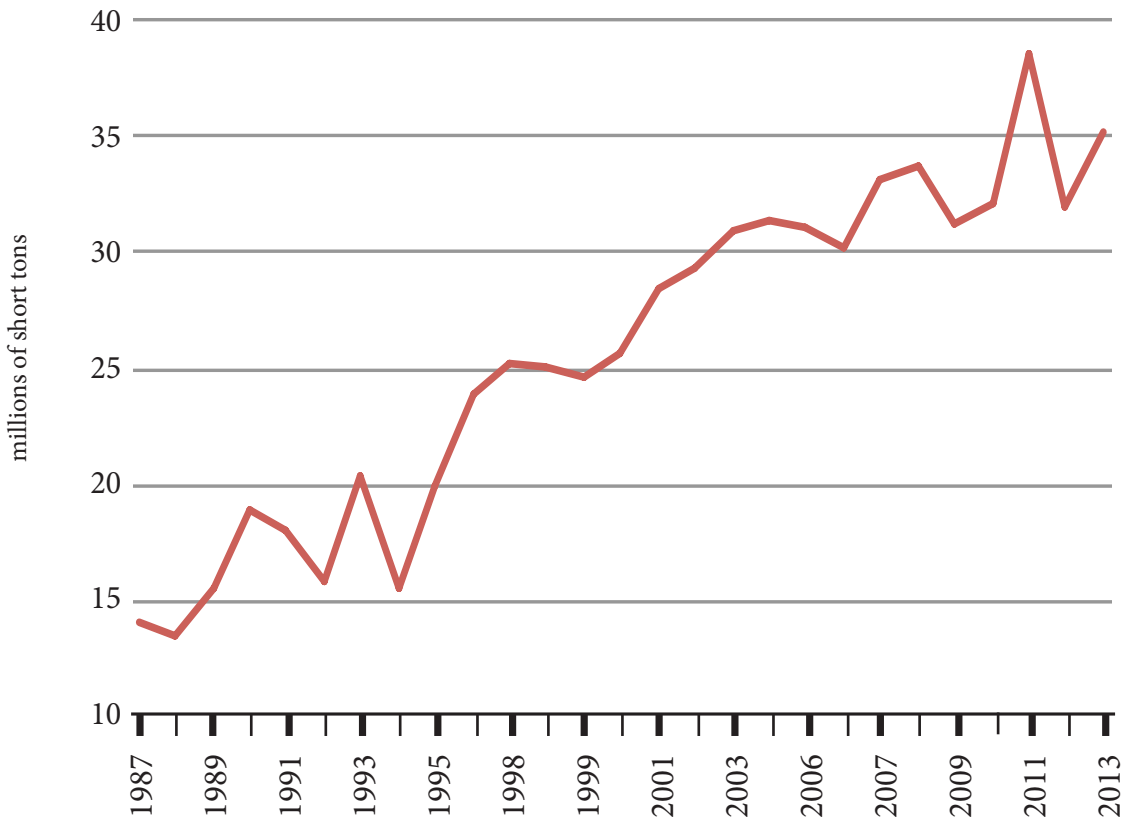
FGD MATERIAL PRODUCTION

The production of FGD material, including FGD gypsum, wet scrubber and dry scrubber material, has grown from 14.2 million short tons in 1987 to 35.2 million short tons in 2013, an increase of 148 percent. The average annual growth rate for FGD production was 3.5 percent over that time period, greater than the average annual growth rate in megawatt hours of coal generated electricity (0.3 percent), the consumption of coal for electricity generation (0.7 percent) and U.S. real GDP (2.6 percent).

A growing number of coal-fueled electricity generators use a FGD process to remove gaseous sulfur dioxide from the boiler exhaust gas. The primary types of FGD processes used are wet scrubbers, dry scrubbers and sorbent injections with lime, limestone, sodium-based compounds or high-calcium coal fly ash. Depending on the process used, the resulting FGD material can be a wet sludge or a dry powder.[26]

Historically, the production of FGD material has been dependent on changes in the technology and processes for capturing FGD material, environmental regulations for sulfur dioxide emissions and the overall volume of coal used by coal-fueled electricity generating plants.

FIGURE 2-3: FGD MATERIAL PRODUCTION



[26]American Coal Ash Association. "Glossary of terms concerning the management and use of coal combustion products (CCPs)." American Coal Ash Association, Inc., Aurora, CO (2003).

CHANGES IN FGD TECHNOLOGY & SCRUBBERS

There were 808 FGD units with 1,326 unit scrubber trains or modules installed at U.S. steam-electric power plants that had a capacity of 10 megawatt hours or more in 2012.[27] A total of 695 of these units are operational, 35 are under construction and 16 are expected to go into service within the next ten years. There are 30 units that have been retired and 15 that are out of service.

Over 69 percent of these units are classified as a spray type wet scrubber, a spray dryer type FGD or semi-dry FGD scrubber. In all, utilities have either spent or plan to invest approximately $57.4 billion for the purchase, installation, and planned upgrades on these units.

There has been a clear shift in the type of scrubbers being put into service by power plants over the last two decades that has coincided with increases in FGD production.

Dry scrubber technology for commercial utilities began appearing in the U.S. in the late 1970s and early 1980s. This type of scrubber has been primarily used to retrofit applications on units that burn low-sulfur coals.[28]

The growing popularity of wet scrubbers over the last forty years is in part due to the equipment's high removal efficiencies and the simplicity of the overall system. Wet scrubbers have become "state of the art methods for achieving removal efficiencies in the 90% to 98% range."[29]

Of the operational scrubbers that began service between 1990 and 2000, 122 were classified as spray dryer type, dry FGD or semi-dry FGD equipment. A total of 54 were classified as spray type wet scrubbers. In the last five years of available data, between 2008 and 2012, there were 29 dry scrubbers that were put into service and 84 wet scrubbers.

During this time, there has also been an increase in the number of utilities that have reported the recovery of a "salable byproduct" from their FGD equipment.[30] Of all the FGD units in operation today, utilities report that 194 units produce a byproduct material that is sold. Of that total, 130 units are wet scrubbers, of which 84 began service between 2008 and 2012.

These equipment changes have occurred as total FGD production, as measured in the ACAA survey has shown significant growth. Total annual FGD production averaged 21.2 million short tons between 1990 and 2000, and rose to an average of 33.5 million short tons between 2008 and 2012. In 2013, FGD production reached 35.2 million short tons.

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[27]ARTBA analysis of EIA-860 form data, Schedule 6 Part F.
[28]Paul S. Nolan. "Flue gas desulfurization technologies for coal-fired power plants." Coal Tech 2000 International Conference, Jakarta, Indonesia. 2000. (http://www.babcock.com/library/Documents/br-1709.pdf)
[29]Ibid.
[30]Ibid.

BOTTOM ASH PRODUCTION

The production of bottom ash grew one percent between 1974 and 2013, increasing from 14.3 to 14.5 million short tons. Production has increased and contracted over the years, reaching a high of 19.8 million short tons in 2002. The production of bottom ash is driven by the volume of coal generated electricity, total coal consumption by electric utilities and the type of coal being burned.

Bottom ash is comprised of the "ash particles formed in pulverized coal furnaces that are too large to be carried in the flue gases and impinge on the furnace walls or fall through open grates to an ash hopper at the bottom of the furnace."[31] Whereas fly ash is light enough to fly up the stack, bottom ash falls to the bottom of the furnace. If the boiler is a dry bottom boiler, the material is dry bottom ash. If the utility is using a wet-bottom boiler, the material is boiler slag.

When pulverized coal is burned in a dry bottom boiler, about 80 percent of the ash flies up the flue gas and is recovered as fly ash, and the remaining 20 percent of the unburned material is bottom ash. Since 1974, bottom ash has averaged 21.5 percent of the total amount of fly and bottom ash produced.

Of the 413 plants that reported collecting ash in 2012, 84 percent collected both fly ash and bottom ash. Just 34 utilities reported collecting fly ash with no bottom ash, and nine said they produced bottom ash without any fly ash.[32]

As is the case with fly ash, the production of bottom ash is related to coal consumption by electric utilities for the generation of electricity. Although changes in the production of bottom ash have mirrored the ups and downs of fly ash production, the bottom ash market has not seen the same level of overall growth since 1974. Further research in this area is needed to explore the reasons for the difference between fly ash and bottom ash production, given the traditional relationship between their production levels.

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[31]American Coal Ash Association. "Glossary of terms concerning the management and use of coal combustion products (CCPs)." American Coal Ash Association, Inc., Aurora, CO (2003). (http://www.acaa-usa.org/Portals/9/Files/PDFs/ACAA_Glossary_of_Terms-Apri_2003.pdf)

[32]ARTBA analysis of EIA form 923 data.

FIGURE 2-4: BOTTOM ASH PRODUCTION

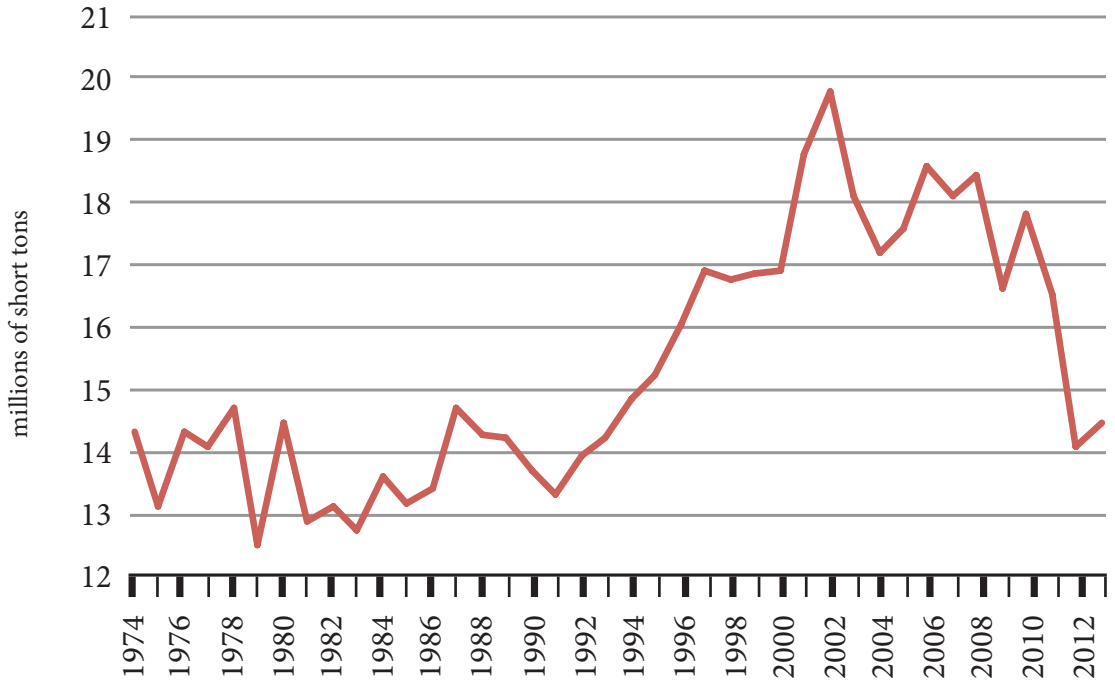
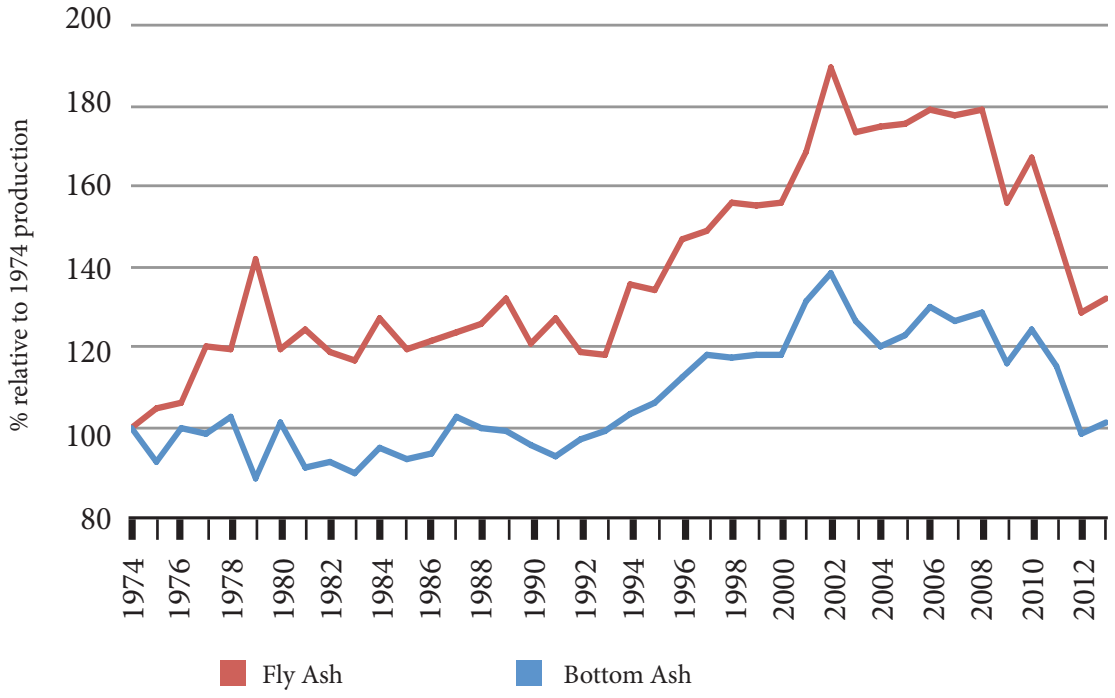


FIGURE 2-5: INDEX OF FLY ASH AND BOTTOM ASH PRODUCTION, 1974 TO 2013



BOILER SLAG PRODUCTION

Boiler slag production has dropped 72 percent from 4.8 million short tons in 1974 to 1.4 million short tons in 2013. The decrease in supply is largely due to the retirement of the wet-bottom boilers that produce this type of CCP.[33]

The slag tap boiler and the cyclone boiler are the two types of wet-bottom boilers used in the U.S. When pulverized coal is burned, the ash that falls to the bottom is kept in a liquid state. Both of the types of wet-bottom boilers contain quenching liquid that mixes with the molten ash to form a hard, black, angular, glassy material sometimes referred to as "Black Beauty."[34]

In a slag-tap furnace, as much as 50 percent of the ash becomes boiler slag. In a cyclone furnace, that total can be as high as 70 to 80 percent. The remaining ash in both cases leaves the furnace in the form of fly ash.[35]

Wet-bottom boilers are more compact than pulverized coal boilers that are found at the larger utility generating plants. Thus they are used more often by industrial manufacturing plants and smaller utilities.[36]

Most of the existing cyclone boilers in the U.S. were constructed before 1981. These boilers have high nitrogen oxide emission rates, and "no new cyclone boilers are expected to be built."[37] With fewer wet-bottom boilers being used, this has impacted the production of boiler slag.

Utilities are turning more to the fluidized-bed combustion boiler, which includes many of the benefits of wet bottom boilers, such as burning lower rank coals with higher moisture and ash contents. This alternative technology has less nitrogen oxide emissions.[38]

There were 147 wet-bottom boilers in operation in 1985 where coal was the primary fuel for the boiler, representing over 14 percent of the boilers mainly burning coal. By 1996, there were 128 such operational boilers. This downturn coincided with a sharp decline in boiler slag production, which fell from a high of 6.2 million short tons in 1993 to 2.7 million short tons in 1997.[39]

Since that time, the average annual production of boiler slag has been 2.2 million short tons, and the total for 2013 was a new low of 1.4 million short tons. Of the primarily coal burning boilers in operation in 2012, there were 137 wet-bottom boilers, the same number as in 2005. Utilities plan to retire 13 of the wet-bottom boilers between 2013 and 2020.[40]

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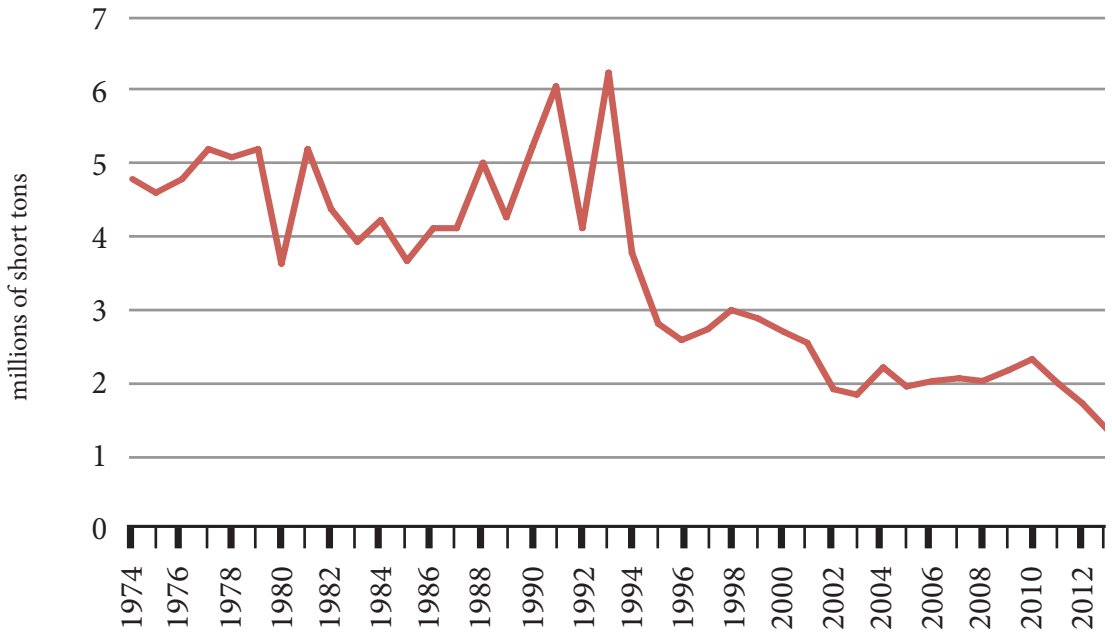
[33]Rusta S. Kayoncu and Donald W. Olson. Coal combustion products. US Department of the Interior, US Geological Survey, 2001. (http://pubs.usgs.gov/fs/fs076-01/fs076-01.pdf)
[34]Warren Chesner, Robert J. Collins, and M. H. MacKay. User guidelines for waste and by-product materials in pavement construction. No. FHWA-RD-97-148. 1998. (http://www.fhwa.dot.gov/publications/research/infrastructure/structures/97148/intro.cfm)
[35]Ibid.
[36]University of Kentucky, Center of Applied Energy Research. (http://www.caer.uky.edu/kyasheducation/boilerslag.shtml)
[37]U.S. EPA. "Available and Emerging Technologies for Reducing Greenhouse Gas Emissions From Coal-Fired Electric Generating Units." October 2010. (http://www.epa.gov/nsr/ghgdocs/electricgeneration.pdf)
[38]Ibid.
[39]ARTBA analysis of EIA report 767 data for operational boilers where the primary source of fuel is coal.
[40]ARTBA analysis of EIA Reports 923 and 860 data for operational boilers where the primary source of fuel is coal.

FIGURE 2-6: BOILER SLAG PRODUCTION



FBC ASH PRODUCTION

Total production of ash from fluidized bed combustion (FBC) has increased from 1.2 million short tons in 2002 to 10.3 million short tons in 2013. Part of this increase was the expansion of the ACAA production and use survey in 2007 to include data from the Anthracite Region Independent Power Producers Association (ARIPPA), comprised of non-utility alternative energy electric power generation stations that burn waste coal using FBC technology.

Since that time, the total production has grown from 6.1 million short tons in 2007, increasing at an average annual rate of nine percent.

The production of FBC ash is highly dependent on the volume of coal generated electricity, total coal consumption by electric utilities and the burning of waste coal. In addition, this market is impacted by technology and equipment upgrades to comply with environmental regulations.

FBC ash is the fly ash and the bed ash produced by an FBC boiler. The FBC fly ash is collected in the flue of the boiler with a baghouse filter or electrostatic precipitator. The bed ash is the residue that is removed from the bottom of the boiler.[41]

In an effort to meet emissions requirements, more utilities are building FBC boilers, which allows operators to burn lower rank coals with a higher moisture and ash content while reducing nitrogen oxide emissions.[42] FBC boilers operate at a lower temperature than conventional boilers, and this reduced temperature results in the reduction in nitrogen oxide emissions.

FBC technology is also used to convert coal refuse from current and past mining activities into energy. Many of these plants, captured in the ARIPPA data, are located in Pennsylvania. ARIPPA members have removed more than 212 million tons of coal refuse and restored more than 8,200 acres of damaged mine lands since 1988.[43]

There were 46 plants that produced FBC ash in 2012, with the largest volumes in Texas, Pennsylvania and Kentucky.[44]

FBC ash production fell sharply in 2012 from 13.2 to 9.8 million short tons, a decline of 26 percent. This was the same year that coal consumption for electricity fell 12 percent and the total megawatt hours of coal generated electricity was down 13 percent, once again highlighting how such dramatic shifts in these markets will impact CCP production.

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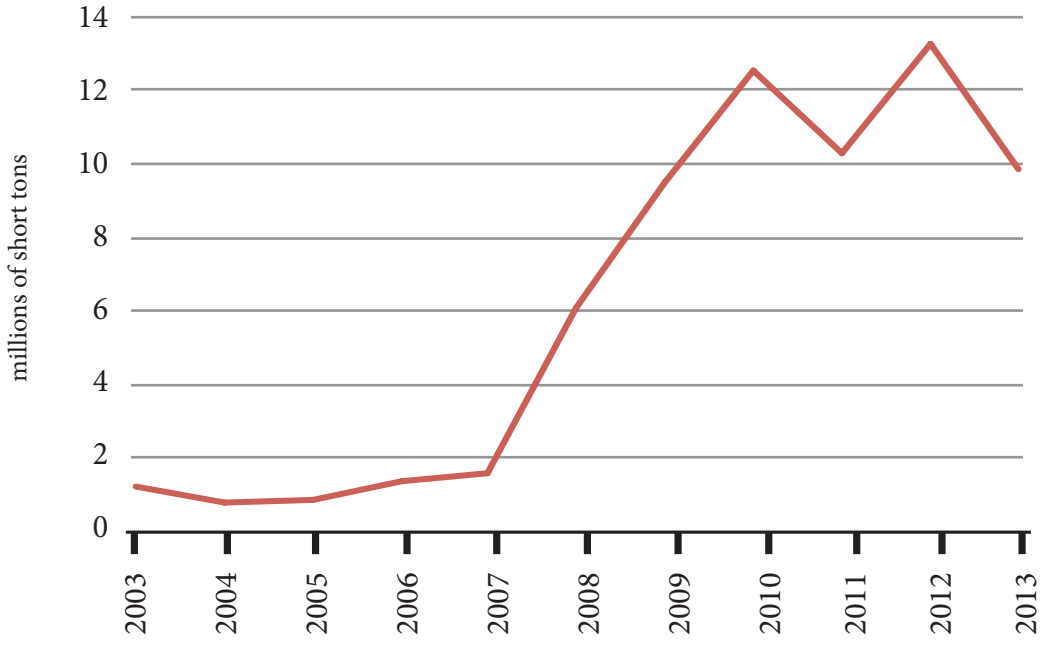
[41]American Coal Ash Association. "Glossary of terms concerning the management and use of coal combustion products (CCPs)." American Coal Ash Association, Inc., Aurora, CO (2003). (http://www.acaa-usa.org/Portals/9/Files/PDFs/ACAA_Glossary_of_Terms-Apri_2003.pdf)
[42]Ibid.
[43]"Environmental Win-Win, ARIPPA's Role: Cleaning Up Historic Coal Waste Sites, Restoring the Land Using Ash." Ash at Work 1 (2014). (http://arippa.org/documents/ACAA%20ARIPPA%20Environmental%20Win-Win%20Article.pdf)
[44]ARTBA analysis of EIA 923 form data.

FIGURE 2-7: FBC ASH PRODUCTION



TOTAL CCP UTILIZATION

Total CCP utilization increased from 8.7 million short tons in 1974 to 51.6 million short tons in 2013, an increase of nearly 500 percent. Utilization was as high as 60.6 million short tons in 2008.

Two of the largest beneficial uses of CCPs in the U.S. are fly ash as a replacement for portland cement in concrete and FGD gypsum as a replacement for mined gypsum in wallboard.[45]

Research and analysis has shown that the beneficial use of CCPs can "contribute significant environmental and economic benefits."[46] This can include reduced greenhouse gas emissions, reduced need for disposing of CCPs in landfills and the reduced use of virgin resources. The economic benefits include job creation in the end industries, reduced costs associated with CCP disposal, increased revenue from the sale of CCPs, and savings from using CCPs in place of other costly materials.

A number of factors have impacted CCP utilization over the last 39 years:[47]

- Regulatory certainty or uncertainty
- Demand from end markets, including production changes to incorporate a growing supply of CCPs
- Role of specifications and standards
- Logistics and infrastructure to support beneficial use as an alternative to disposal
- Role of technologies to improve ash quality
- Emerging utilization technologies
- Wider use and recognition that CCP material makes a superior product

As CCPs have become more widely used in construction materials, mining applications and agriculture, among other markets, and standards have been established, the focus has shifted to techniques for using increasingly higher quantities of ash. New industries have also emerged to help CCP producers improve, maintain and manage their supply.[48]

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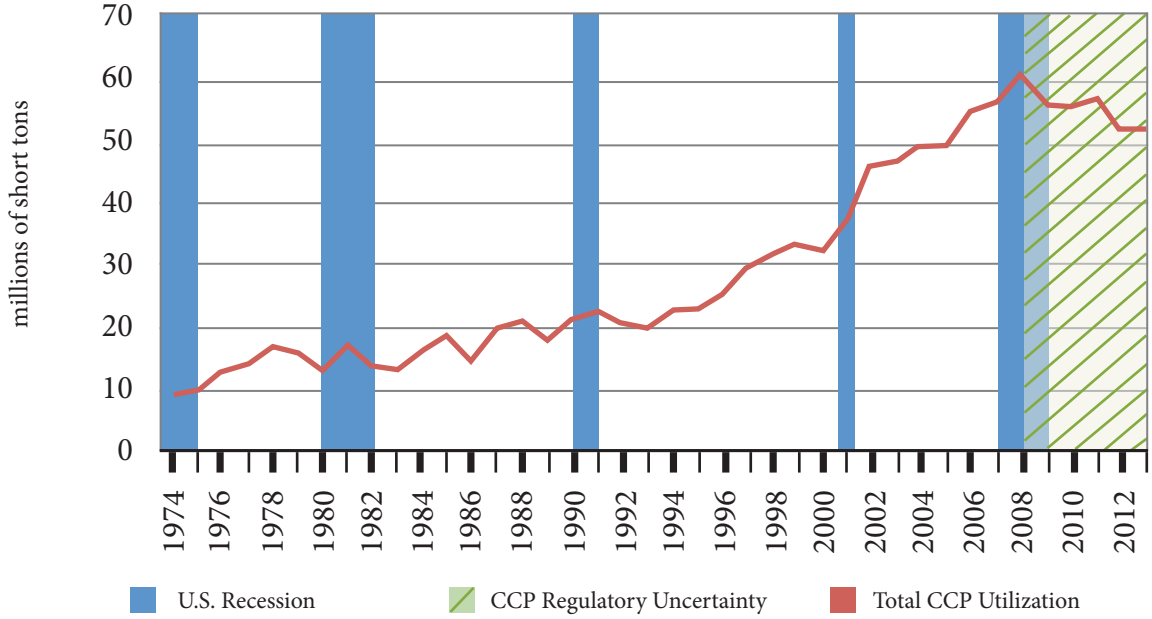
[45]U.S. EPA Office of Solid Waste and Emergency Response, Office of Resource Conservation and Recovery. "Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard." (February 2014) (http://www.epa.gov/waste/conserve/imr/ccps/pdfs/ccr_bu_eval.pdf)
[46]Ibid.
[47]John Ward & A. Steward. The value of coal combustion products: an economic assessment of CCP unitization for the US economy. American Coal Council, Phoenix, AZ (United States), (2010). (https://c.ymcdn.com/sites/www.americancoalcouncil.org/resource/resmgr/Docs/ACC_2010_CCP_ECON_ASSESSMENT.pdf)
[48]Ibid.

FIGURE 3-1: UTILIZATION OF CCPs HAS INCREASED DURING RECESSIONS, BUT DROPPED DURING A PERIOD OF REGULATORY UNCERTAINTY



Major U.S. Recessions
November 1973 to March 1975
January to July 1980
July 1981 to November 1982
July 1990 to March 1991
March to November 2001
December 2007 to June 2009

CCP Regulatory Uncertainty:
December 2008 to April 2015
EPA decision to reconsider the classification of CCPs as a hazardous waste

FLY ASH UTILIZATION

Fly ash utilization has grown from 3.4 million short tons in 1974 to 23.3 million short tons in 2013, an increase of 586 percent. The utilization rate of fly ash has grown from 8.4 percent of production in 1974 to 43.7 percent in 2013.

Although the overall demand for construction materials and ready-mixed concrete are main drivers of fly ash utilization, there are a number of regulatory incentives and disincentives that have historically impacted the market.

Between 1975 and 2013, fly ash utilization grew at an average annual rate of 4.4 percent, well above the average annual growth rate for ready-mixed concrete production at 1.5 percent and U.S. GDP, which increased at an annual rate of three percent.

The majority of fly ash is used as an additive to enhance the durability and strength of construction materials, including concrete. The physical and chemical properties of fly ash improve both the plastic and hardened properties of concrete. "Adding fly ash to concrete reduces the water required, improves pumpability, reduces segregation, yields higher ultimate strength, and is very effective at mitigating durability problems like alkali-silica reactivity and reinforcing steel corrosion."[49]

Fly ash has been used in many U.S. large-scale construction projects, beginning with the Hungry Horse Dam in Montana in 1948. Engineers with the U.S. Bureau of Reclamation were looking for a way to mitigate the heat of hydrating cement during the placement of concrete on the structure. That project alone used 120,000 metric tons (132,277 short tons of fly ash.[50] Between 1950 and 1970, concrete with fly ash content as high as 50 percent was used on over 100 major dam construction projects across the country.[51]

Other key uses of fly ash include structural fills and embankments, mining applications and waste stabilization and solidification.

Over time, the focus on fly ash utilization has shifted from education, demonstrating the usefulness of the material and establishing standards, to emerging technologies helping fly ash producers improve and maintain the quality of the product being utilized.[52]

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[49]Hank Keiper, P.E., "Addressing Coal's Negative Impact – Beneficial Use of Fly Ash," The Virginia Engineer, (April 2011). (http://vaeng.com/guestarticle/addressing-coal-s-negative-impact-beneficial-use-of-fly-ash)
[50]Ruta S. Kalyoncu and Donald W. Olson, "Coal Combustion Products," U.S. Geological Survey Fact Sheet 076-01. (http://pubs.usgs.gov/fs/fs076-01/fs076-01.html)
[51]Ibid.
[52]John Ward & A. Steward. The value of coal combustion products: an economic assessment of CCP unitization for the US economy. American Coal Council, Phoenix, AZ (United States), (2010). (https://c.ymcdn.com/sites/www.americancoalcouncil.org/resource/resmgr/Docs/ACC_2010_CCP_ECON_ASSESSMENT.pdf)

FIGURE 3-2: FLY ASH UTILIZATION

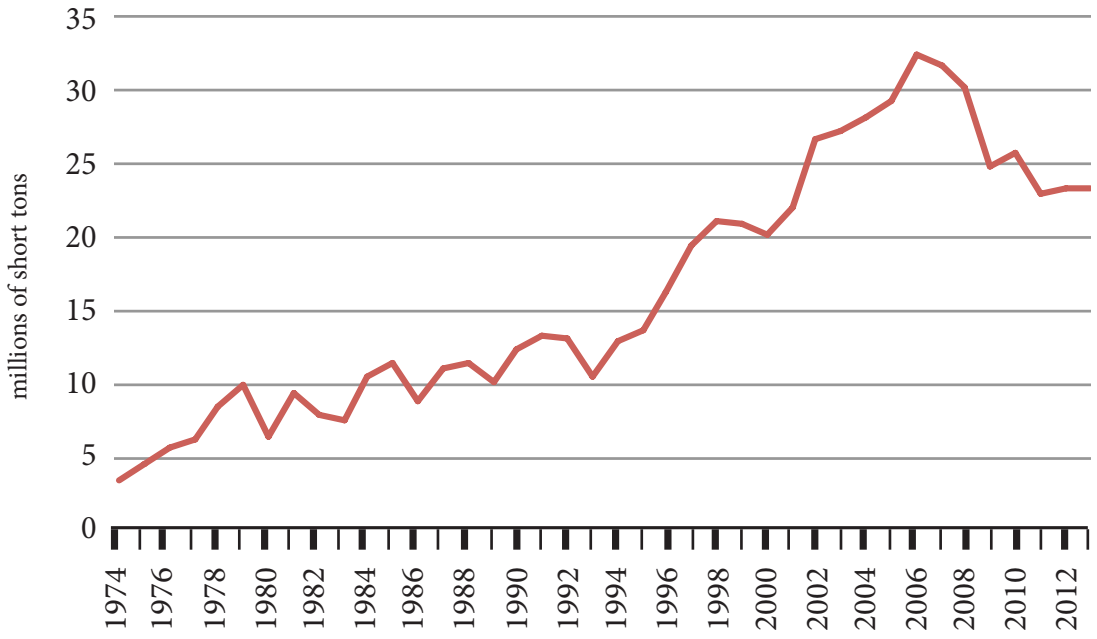
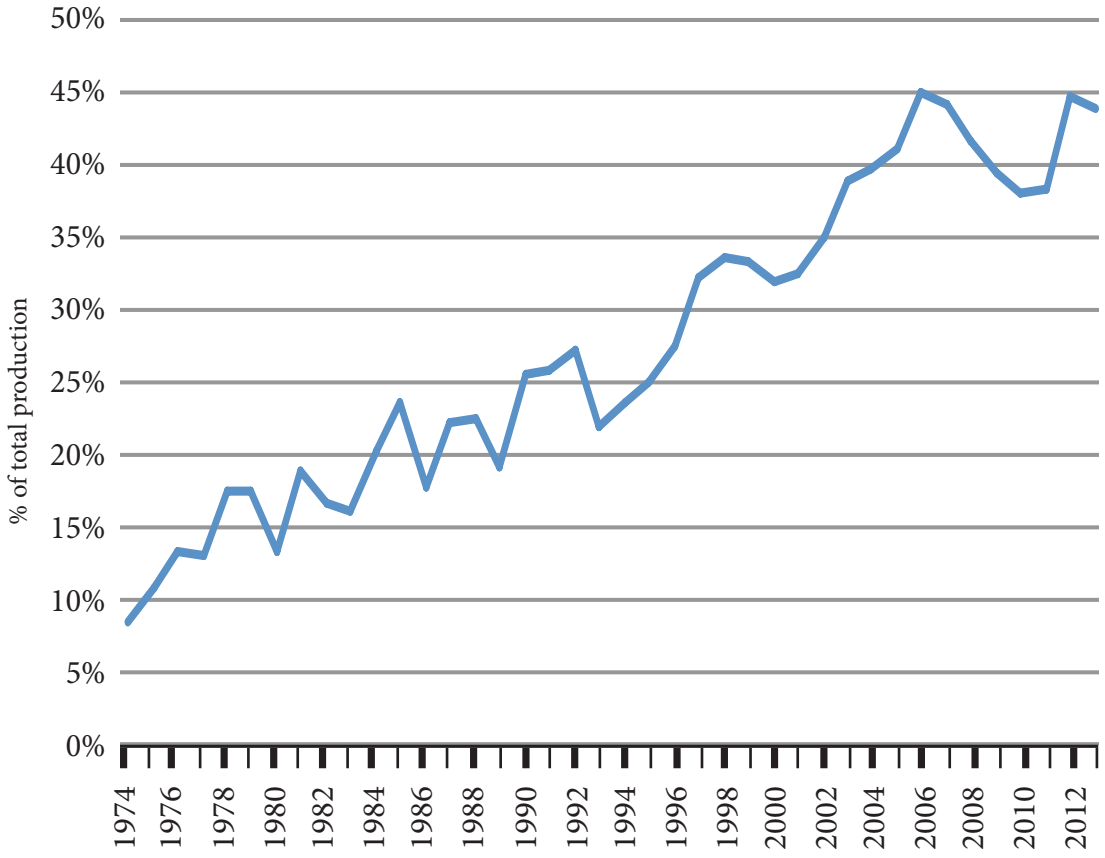


FIGURE 3-3: FLY ASH UTILIZATION RATE



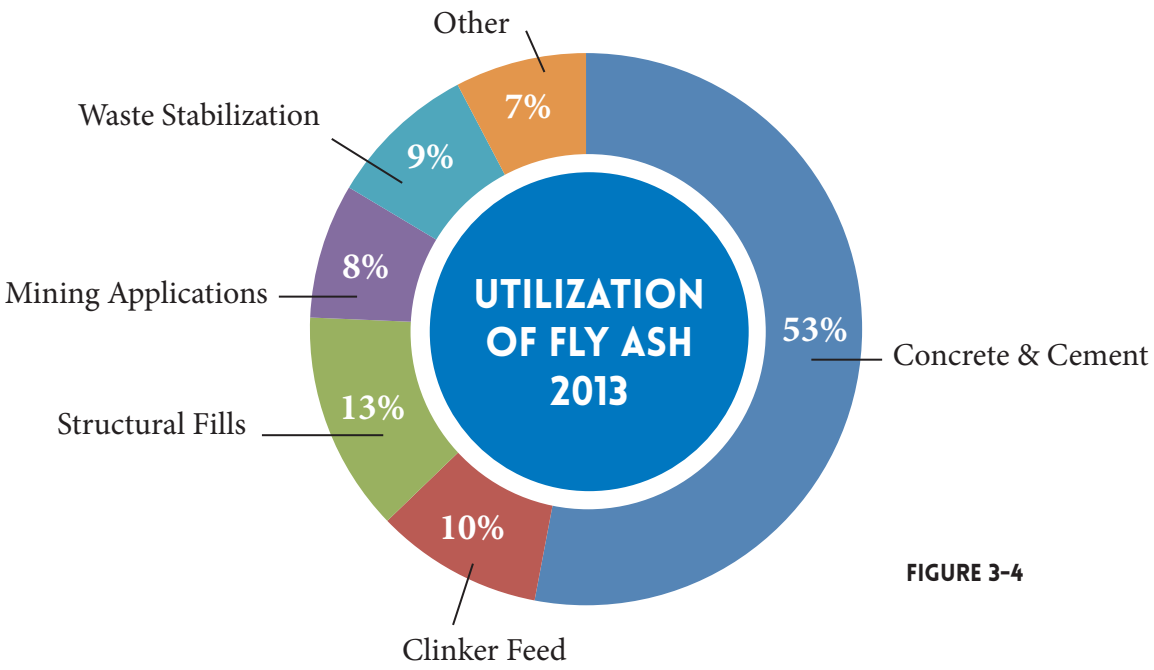
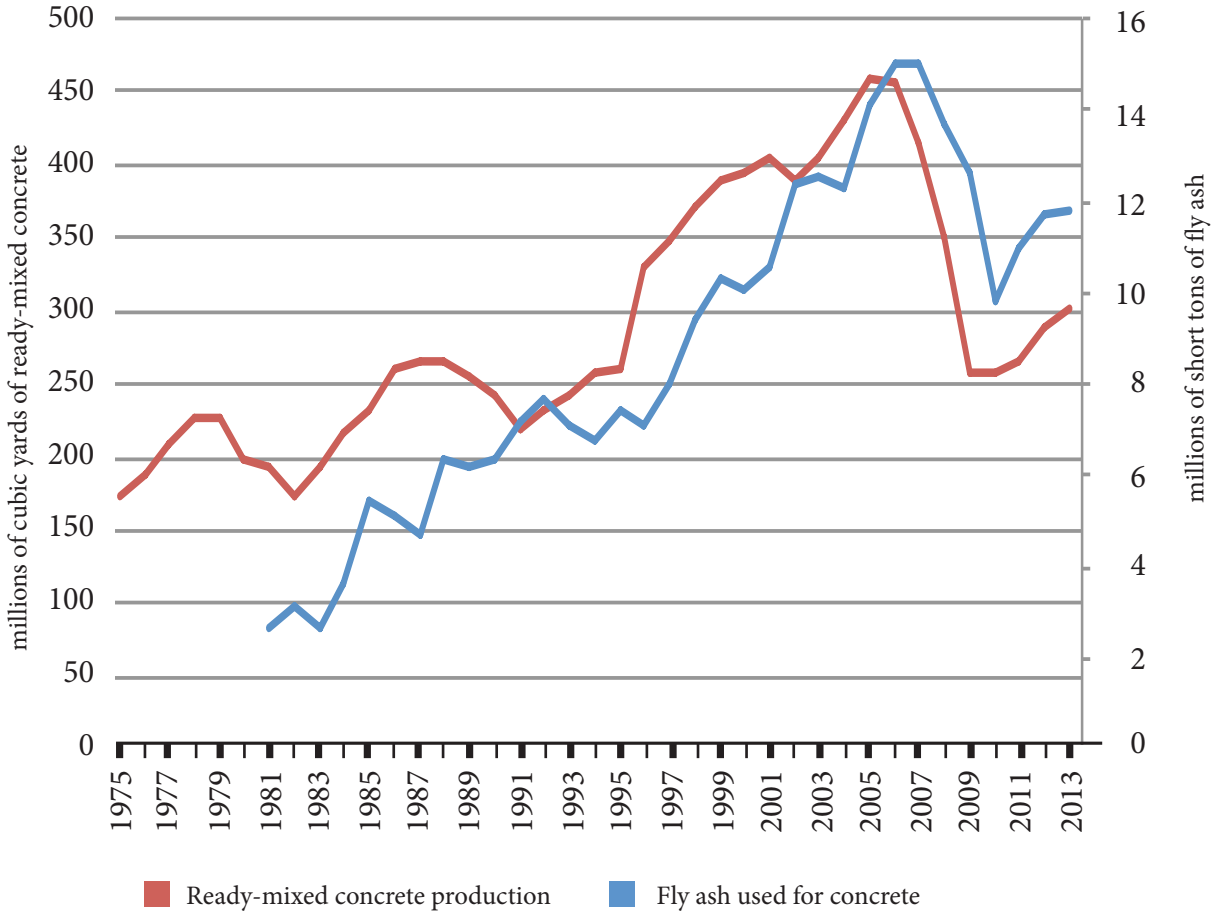


FIGURE 3-4

FIGURE 3-5: READY-MIXED CONCRETE PRODUCTION & FLY ASH USED FOR CONCRETE



REGULATORY CERTAINTY & GROWTH OF FLY ASH UTILIZATION

Historically, regulations regarding the classification of fly ash as either a solid waste or a hazardous material have had an impact on utilization.

The Resource Conservation and Recovery Act (RCRA), which amended the Solid Waste Disposal Act of 1965, is the primary law that governs the disposal of hazardous and solid waste in the United States.

RCRA Subtitle C establishes a "cradle to grave" system for controlling materials classified as hazardous waste. If a material is a solid waste but not considered hazardous, it is regulated under RCRA Subtitle D, which requires states to develop a comprehensive plan for managing nonhazardous solid waste.[53] In the original legislation, it was not clear if fly ash was considered a hazardous waste under Subtitle C or a solid waste under Subtitle D.

On October 12, 1980, Congress passed a law which amended RCRA. Fly ash and other CCPs were temporarily excluded from regulation under Subtitle C as a hazardous waste until further study and assessment. This regulatory exemption, known as the Bevill exemption, meant that CCPs were temporarily considered a solid waste under Subtitle D, thus subject to state regulations, until a formal report was conducted by EPA.

On August 9, 1993, EPA issued a regulatory determination that concluded that CCPs should continue to be exempt from Subtitle C of the RCRA because of the "limited risks posed by them and the existence of generally adequate State and Federal regulatory programs."[54]

Under this environment of regulatory certainty, fly ash utilization doubled from 10.5 million short tons in 1993 to 20.1 million short tons in 2000, growing at an average annual rate of 10 percent. During the same time period the production of ready-mixed concrete grew at an average annual rate of seven percent.

The EPA issued a Final Regulatory Determination on May 22, 2000 that retained the Bevill exemption for fly ash and other "fossil fuel combustion wastes," reaffirming the 1993 notice. EPA also determined that there would be no additional regulation for fly ash and the agency did "not wish to place any unnecessary barriers on beneficial use." EPA announced it would develop national standards for the disposal of fly ash and other CCPs in landfills, surface impoundments and mines.

This utilization of fly ash grew at an average annual rate of 6.6 percent between 2000 and 2007, compared to an average annual rate of growth of 0.7 percent for ready-mixed concrete production. Fly ash utilization grew from 20.1 million short tons in 2000 to 31.6 million short tons in 2007.

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[53]U.S. EPA, "History of RCRA" (http://www.epa.gov/osw/laws-regs/rcrahistory.htm)

[54]U.S. Federal Register Vol. 58, No. 151, 40 CFR Part 261, "Final Regulatory Determination on Four Large-Volume Wastes From the Combustion of Coal by Electric Utility Power Plants." (http://www.epa.gov/epawaste/nonhaz/industrial/special/mineral/pdfs/080993.pdf)

In the most recent recession, which began in December 2007 and ended June 2009, fly ash utilization declined slightly in 2007 and 2008, falling from 32.4 million short tons in 2006 to 31.6 million short tons in 2007 (a decline of 2.5 percent) and 30.1 million short tons in 2008 (a further decline of 4.7 percent).

GROWTH IN FLY ASH UTILIZATION AND READY-MIXED CONCRETE

	AVERAGE ANNUAL GROWTH RATE	
TIME PERIOD	FLY ASH UTILIZATION	READY-MIXED CONCRETE PRODUCTION
1974 to 1980	11.2%	3.5%
1981 to 1990	3.1%	2.5%
1991 to 2000	4.8%	6.8%
2000 to 2008	5.2%	-1.5%
2009 to 2013	-5.0%	-3.1%
Total for 1974 to 2013	**5.1%**	**1.6%**

Meanwhile, the U.S. production of ready-mixed concrete had started to fall even before the official start of the recession, declining from 458.3 million cubic yards in 2005 to 456.8 million cubic yards in 2006 and 414.6 million cubic yards in 2007.

It was not until 2009 that fly ash utilization fell to 24.7 million short tons, a decline of 18 percent from 2008 levels—one full year after the recession began in December 2007. Although total volumes of ready-mixed concrete in 2013 are still below their pre-recession levels, the market bottomed out in 2010 and production has increased annually since that time. Meanwhile, fly ash utilization continues to remain depressed.

INDUSTRY SPECIFICATIONS AND MATERIALS STANDARDS

Over the years, the development of guidelines, specifications and industry standards have encouraged wider use of fly ash in U.S. construction markets.

Guidelines for the use of fly as a concrete additive are part of standards ASTM C 618 and AASHTO M 295, ensuring that the final product conform to consistent, high quality physical and chemical properties.[55]

Additional standards address the particle size of fly ash (ASTM D 422 and AASHTO T88), the specific gravity (ASTM D 554 and AASHTO T 100) and the compaction (ASTM D 698 and AASHTO T 999 and T 180).

Other specifications for the use of CCPs for various manufacturing and engineering purposes have been developed separately. This includes standards for using fly ash with lime (ASTM C 593), blended hydraulic cements (ASTM C 595 and ASTM C 1157), for soil stabilization (ASTM D 5239), structural fills (ASTM E 2277-14), surface mine reclamation (ASTM E 2278 and ASTM E 2243-02) and other uses (ASTM D 5759).

More than a dozen federal agencies have published articles, guidelines and standards on the beneficial use of fly ash for construction and agricultural purposes. Many of these publications have been instrumental in educating a larger audience about the benefits of fly ash to improve material performance and reduce costs.

Some examples of U.S. federal support of fly ash utilization include:[56]

- **ENVIRONMENTAL PROTECTION AGENCY:** Over the years EPA has published a number of case studies and procurement guidelines that include information on using fly ash.[57]

  In 1993, President Clinton established a federal environmental executive at EPA to develop a federal plan "to encourage the acquisition of recycled and environmentally preferable products by the Federal Government." This included issuing guidance for federal agencies, which should consider the "elimination of virgin material requirements," life cycle costs, recyclability, waste prevention and the use of environmentally preferable products in the acquisition planning for all procurements and contract awards.[58]

  In 1997, EPA adopted the "Comprehensive Guideline for the Procurement of Products Containing Recovered Waste" and the "Recovered Materials Advisory Notice." The guidelines recommended that all federal agencies, state and local government agencies and contractors using federal funds revise their cement and concrete procurement to allow the use of fly ash and ensure that guide specifications "do not inappropriately or unfairly discriminate against

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[55]John Ward & A. Steward. The value of coal combustion products: an economic assessment of CCP unitization for the US economy. American Coal Council, Phoenix, AZ (United States), (2010). (https://c.ymcdn.com/sites/www.americancoalcouncil.org/resource/resmgr/Docs/ACC_2010_CCP_ECON_ASSESSMENT.pdf)

[56]Ibid.

[57]A full list of detailed historical documents is available from ACAA in the Compilation of Regulations, Standards, Guidelines, Websites and other References Pertinent to Coal Combustion Products, revised February 12, 2007. (http://www.epa.gov/epawaste/conserve/imr/pdfs/acaadoc.pdf)

[58]Executive Order 12873—Federal Acquisition, Recycling and Waste Prevention, October 20, 1993. (http://www.epa.gov/oppt/epp/pubs/eo12873.pdf)

the use of coal fly ash …"[59] Similar recommendations were made for the use of fly ash in flowable fills.

EPA recently conducted an evaluation of the beneficial use of fly ash as a direct substitute for portland cement in concrete. In the 2014 report Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard, the Agency concludes "the beneficial use of CCRs, when conducted in an environmentally sound manner, can contribute significant environmental and economic benefits" and "the agency supports the beneficial use of coal fly ash in concrete and FGD gypsum in wallboard."[60] The evaluation was based on the methodology developed by the Agency and published in 2013.[61]

- **FEDERAL HIGHWAY ADMINISTRATION (FHWA) GUIDELINES:** FHWA has published several documents and guidelines for using CCPs and fly ash in highway construction: Fly Ash Facts for Highway Engineers, Using Coal Ash in Highway Construction: A Guide to Benefits and Impacts and User Guidelines for Waste and Byproduct Materials in Pavement Construction.[62]

  FHWA has also published research information on high-volume fly ash mixtures and the associated benefits of this technology.[63]

- **ARMY CORPS OF ENGINEERS:** There are a number of Army Corps specifications and reports that discuss the use of fly ash in concrete for transportation and construction projects.[64] The Army Corps also allows fly ash to be used for sub-grade stabilization, embankments, flowable fill, soil amendment and asphalt filler.

- **ADDITIONAL FEDERAL AGENCIES:** Additional material has been published by the Federal Aviation Administration, the U.S. Department of Agriculture, the U.S. Geological Survey and the U.S. Department of Energy.[65]

State Departments of Transportation (DOTs) also maintain specifications for fly ash used in concrete. Although specifics may vary regionally, nearly all of the standards are based on ASTM C618 or AASHTO M295.[66] An average of 75 percent of all the concrete poured on U.S. highways,

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[59]U.S. EPA. "Consolidated Recovered Materials Advisory Notice (RMAN) For the Comprehensive Procurement Guideline (CPG)," Compiled December 1997, revised as recently as September 2007. (http://www.epa.gov/epawaste/conserve/tools/cpg/pdf/consolrman.pdf)

[60]U.S. EPA Office of Solid Waste and Emergency Response, Office of Resource Conservation and Recovery. "Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard." (February 2014) (http://www.epa.gov/waste/conserve/imr/ccps/pdfs/ccr_bu_eval.pdf)

[61]U.S. EPA Office of Solid Waste and Emergency Response, Office of Resource Conservation and Recovery. "Methodology for Evaluating Encapsulated beneficial Uses of Coal Combustion Residuals." (September 2013) http://www2.epa.gov/sites/production/files/2014-12/documents/ccr_bu_method.pdf

[62]FHWA Reports # FHWA-IF-03-019, # EPA-530-K-05-002 and # FHWA-RD-97-148. (http://www.fhwa.dot.gov/pavement/recycling/fafacts.pdf)

[63]FHWA-HRT-12-062. "Benefits of High Volume Fly Ash: New Concrete Mixtures Provide Financial, Environmental and Performance Gains." FHWA-HRT-10-051 (http://www.fhwa.dot.gov/advancedresearch/pubs/10051/)

[64]Toy S. Poole. Use of Large Quantities of Fly Ash in Concrete. No. WES/TR/SL-95-9. ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS STRUCTURES LAB, 1995. (http://acwc.sdp.sirsi.net/client/en_US/default/search/detailnonmodal/ent:$002f$002fSD_ILS$002f0$002fSD_ILS:282653/ada/?rt=CKEY%7C%7C%7CCKEY%7C%7C%7Cfalse)

[65]ACAA, "Compilation of Regulations, Standards, Guidelines, Websites and other References Pertinent to Coal Combustion Products," (2007). (http://www.epa.gov/epawaste/conserve/imr/pdfs/acaadoc.pdf)

[66]Bruce A. Dockter and Diana M. Jagiella. "Engineering and Environmental Specifications of State Agencies for Utilization and Disposal of Coal Combustion Products." World of Coal Ash Conference, Lexington Kentucky. 2005. (http://www.worldofcoalash.org/2005/ashpdf/136doc.pdf)

valued at nearly $10 billion, utilizes fly ash as a partial cement replacement blend.[67]

A recent report by the Transportation Research Board, which included a survey of state DOTs and a literature review, suggested a need for "refining the existing classification method to include properties known to affect performance."[68] As one example the authors noted that the classification of fly ash does not include reporting calcium content, which is important for alkali-silica reaction mitigation practices.

FGD MATERIAL UTILIZATION

The utilization of FGD material has grown from 1.02 million short tons in 1987 to 12.9 million short tons in 2013, increasing at an average annual rate of 10.3 percent.

Most of the FGD material, 7.4 million short tons, was used in gypsum panel products in 2013. Known as FGD gypsum or synthetic gypsum, this material can be used as a full substitute for mined gypsum in wallboard and drywall because the primary chemical constituent is identical.[69] FGD gypsum may even have higher gypsum purity than mined gypsum because of the "greater control over the chemical composition of the final product."[70]

FGD material is also used as an input for blended cement and feed for clinker and in both mining and agricultural applications.

The total utilization of FGD material has grown from 7.2 percent of total material produced in 1987 to 37 percent in 2013.

As a substitute for natural gypsum, demand for FGD material has historically been related to demand for gypsum wallboard and total U.S. construction activity. But as wallboard manufacturers have recognized the superior properties of FGD material—they have shifted their production process to further reduce the costs of using the synthetic material.

As overall demand for gypsum has increased with U.S. construction activity, the use of FGD synthetic gypsum has coincided with a decline in gypsum imports.

The growth in the utilization of FGD over the last 27 years is supported by increased production, the commercialization of the product and the ease of substitution with the virgin material. FGD material has become the "preferred feedstock" for wallboard manufactures because its "uniform properties simplify manufacturing operations for existing users."[71] In addition, many wallboard manufacturers have located new facilities near coal-fueled power plants to have access to FGD gypsum.

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[67]Alison Premo Black, et al. "The Economic Impacts of Prohibiting Coal Fly Ash Use in Transportation Infrastructure Construction." (2011). (http://trid.trb.org/view.aspx?id=1123544)
[68]Lawrence L. Sutter, R. Douglas Hooton, and Scott Schlorholtz. Methods for Evaluating Fly Ash for Use in Highway Concrete. Vol. 749. Transportation Research Board, 2013. (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_749.pdf)
[69]EPA. "Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard." (February 2014). (http://www.epa.gov/waste/conserve/imr/ccps/pdfs/ccr_bu_eval.pdf)
[70]Ibid.
[71]U.S. Department of Energy National Energy Technology Laboratory, DOE/NETL-2001/1158. "Advanced Flue Gas Desulfurization Demonstration Project, A DOE Assessment." (August 2001). (http://www.netl.doe.gov/research/coal/major-demonstrations/clean-coal-technology-demonstration-program/bectso-adflug)

FIGURE 3-6: FGD MATERIAL UTILIZATION

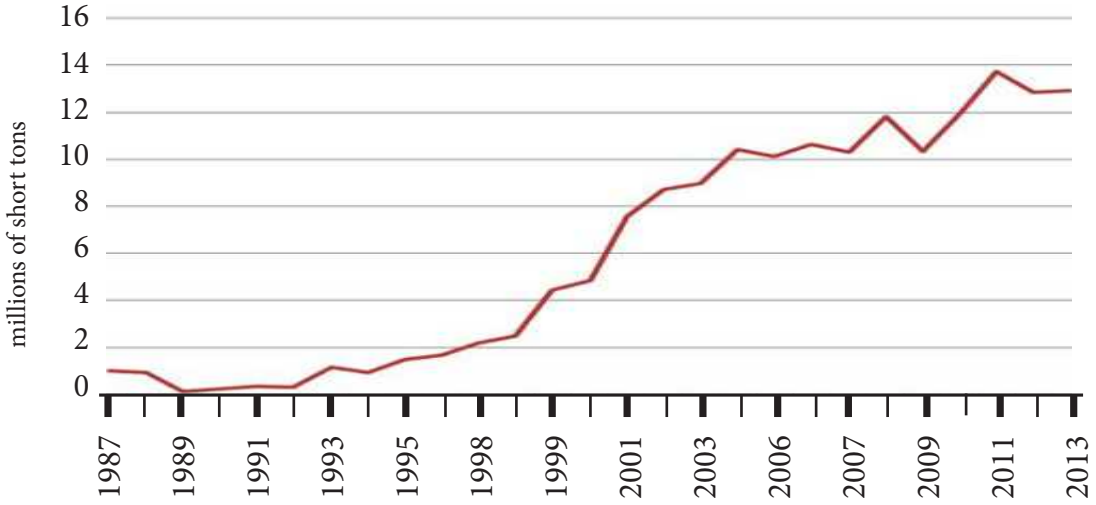
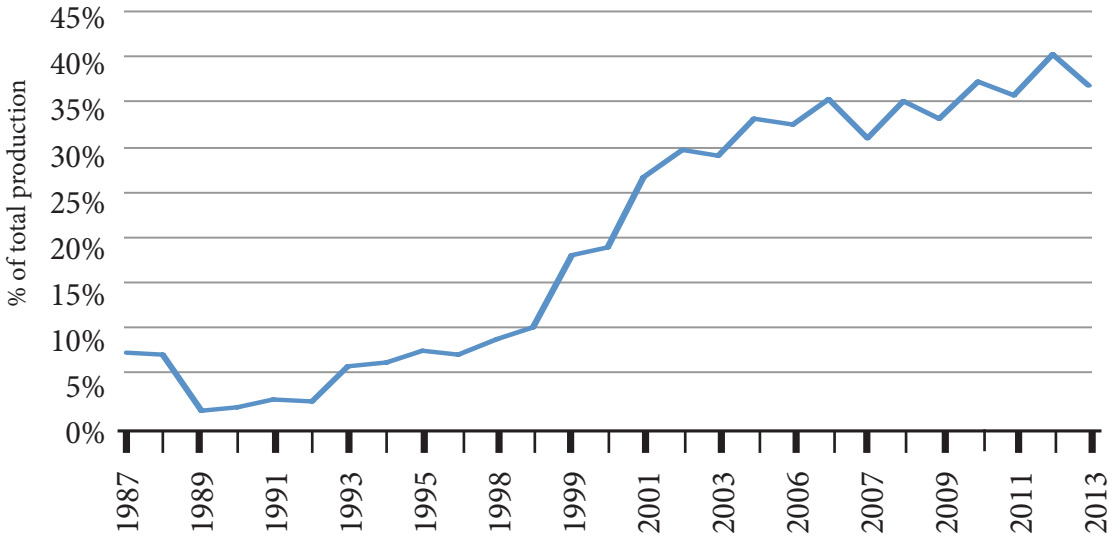


FIGURE 3-7: FGD MATERIAL UTILIZATION RATE



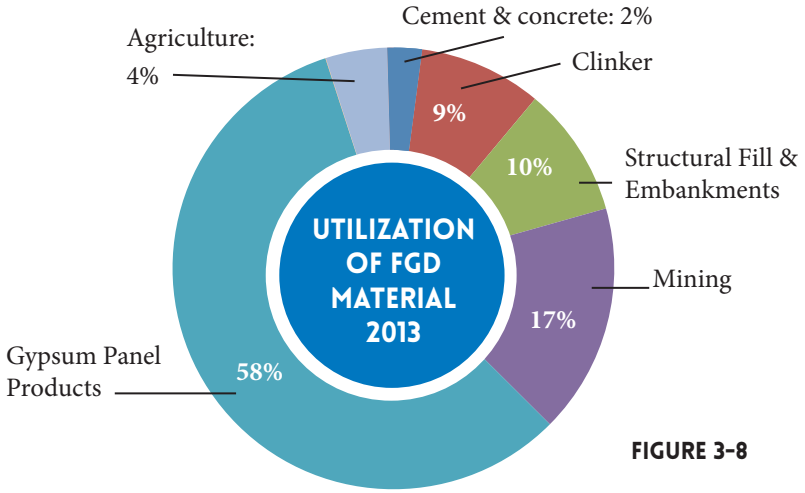


FIGURE 3-8

GROWTH IN FGD MATERIAL UTILIZATION—1987 TO 2008

Between 1987 and 1992 the utilization of FGD material averaged 486,500 short tons per year. In the U.S. gypsum market, "byproduct gypsum" accounted for 4.2 percent of total domestic production in 1987 and 2.6 percent of U.S. consumption. The U.S. Geological Survey noted that there were seven companies that sold byproduct gypsum "principally for agricultural use, but some for gypsum wallboard manufacturing."[72]

The utilization of FGD material began increasing significantly after 1993, growth that coincided with the regulatory certainty provided by the EPA. FGD material was one of the CCPs being reviewed by EPA for regulation under RCRA Subtitle C or Subtitle D and was included in the Bevill exemption in 1980.

The EPA final regulatory determination that concluded CCPs and FGD gypsum should continue to be exempt from Subtitle C of the RCRA and regulated as a solid waste, issued on August 9, 1993, provided regulatory certainty for utilization.

Between 1993 and 2000, utilization grew at an average annual rate of 23 percent, increasing from 1.2 million short tons in 1993 to 4.8 million short tons in 2000.

During this same time, total domestic gypsum production grew at an average annual rate of 5.7 percent, crude gypsum mining grew at a rate of 3.1 percent and total U.S. domestic gypsum consumption grew at a rate of 5.0 percent. The total million square feet of wallboard products sold increased at an average annual rate of 1.7 percent.

Synthetic gypsum grew from 4.8 percent of total domestic gypsum production to 20.2 percent. As a percentage of total consumption, synthetic gypsum increased from 2.9 percent of the market to 14.7 percent.

Although the U.S continued to import more gypsum to meet growing demand, as a percentage of total production, imports declined from 31 percent of the market in 1993 to 27 percent in 2000. The use of imports continued to decline over the next decade, both in terms of volume and market share, with additional regulatory certainty and the increased use of FGD material.

The EPA issued another Final Regulatory Determination on May 22, 2000 that retained the Bevill exemption for FGD material, reaffirming the 1993 notice and determined that there would be no additional regulation. At this point, FGD material was "becoming very important as a substitute for mined gypsum in wall board manufacturing, cement production and agricultural applications."[73]

Between 2000 and 2008, FGD material utilization grew at an average annual rate of 12 percent, more than doubling from 4.8 million short tons to 11.8 million short tons as the overall U.S. gypsum market was in decline.

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[72]U.S. Geological Survey. "Gypsum." Minerals Yearbook (1987) (http://minerals.usgs.gov/minerals/pubs/commodity/gypsum/)

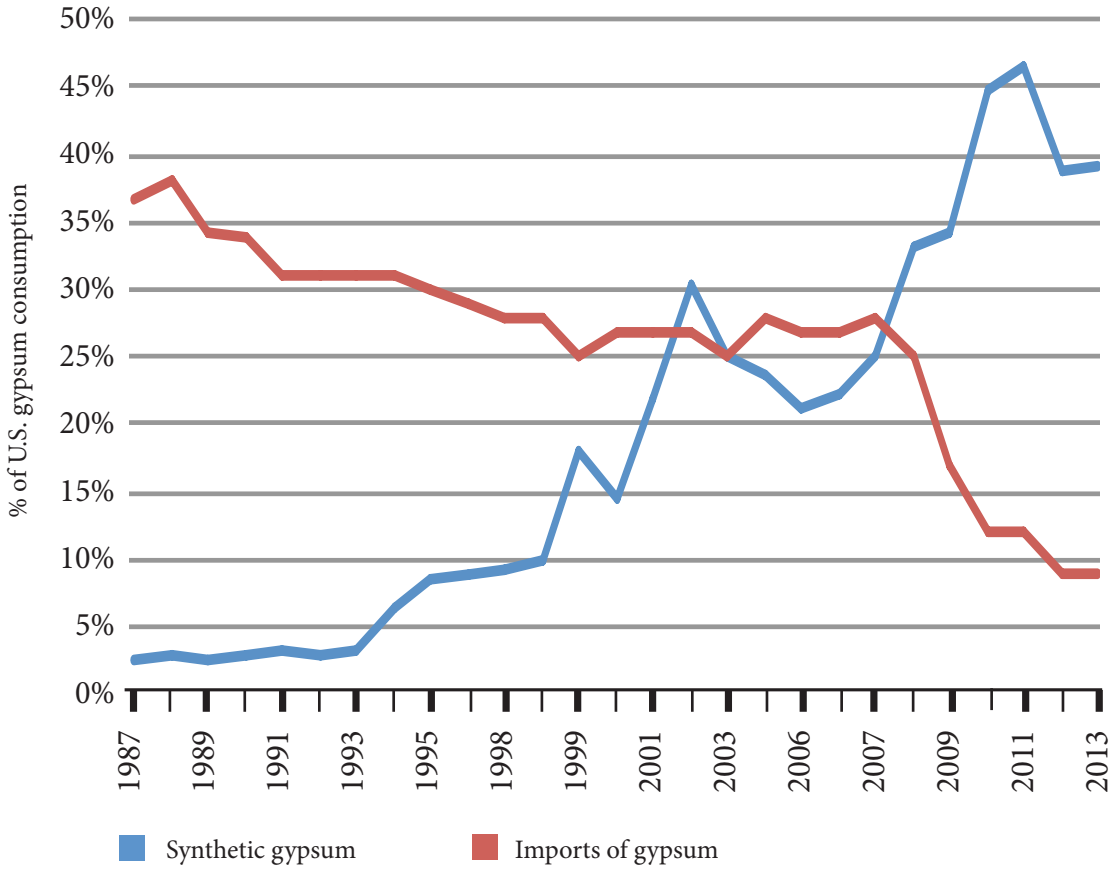
[73]U.S. Geological Survey. "Mineral Commodity Summaries." (2002) (http://minerals.usgs.gov/minerals/pubs/mcs/2002/mcs2002.pdf)

FGD material was increasingly used as a substitute for U.S. mined crude gypsum and gypsum imports. U.S. production of crude gypsum declined at an average annual rate of 5.2 percent between 2000 and 2008, falling from 19.5 million metric tons to 12.7 million metric tons. Total domestic gypsum production declined at a rate of 1.1 percent and total gypsum consumption fell at a rate of 1.8 percent. This decline was driven by lower demand for gypsum products: total volume of wallboard products sold in the United States declined at an average annual rate of 2.9 percent.

Synthetic gypsum from FGD plants grew at an average annual rate of 8.7 percent between 2000 and 2008 as imports of gypsum declined at a rate of 2.8 percent.

The availability of FGD material as a substitute for mined gypsum continued to change the fundamentals of the domestic industry. To take advantage of the FGD material, "much of the production at new and expanded facilities will consume synthetic gypsum produced by scrubbing emission from coal-fired electric power plants."[74]

FIGURE 3-9: SYNTHETIC (FGD) GYPSUM HAS BEEN REPLACING GYPSUM IMPORTS



74U.S. Geological Survey. "Gypsum." Minerals Yearbook (2007)

FIGURE 3-10: TOTAL U.S. GYPSUM PRODUCTION & UTILIZATION

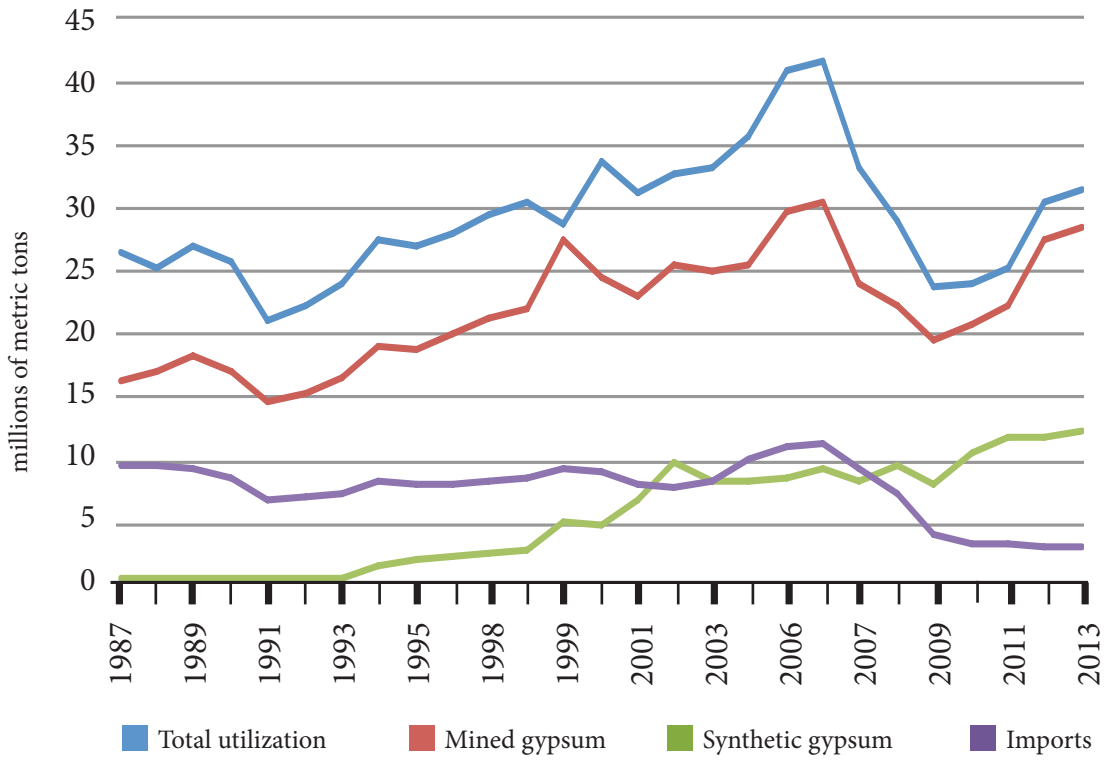
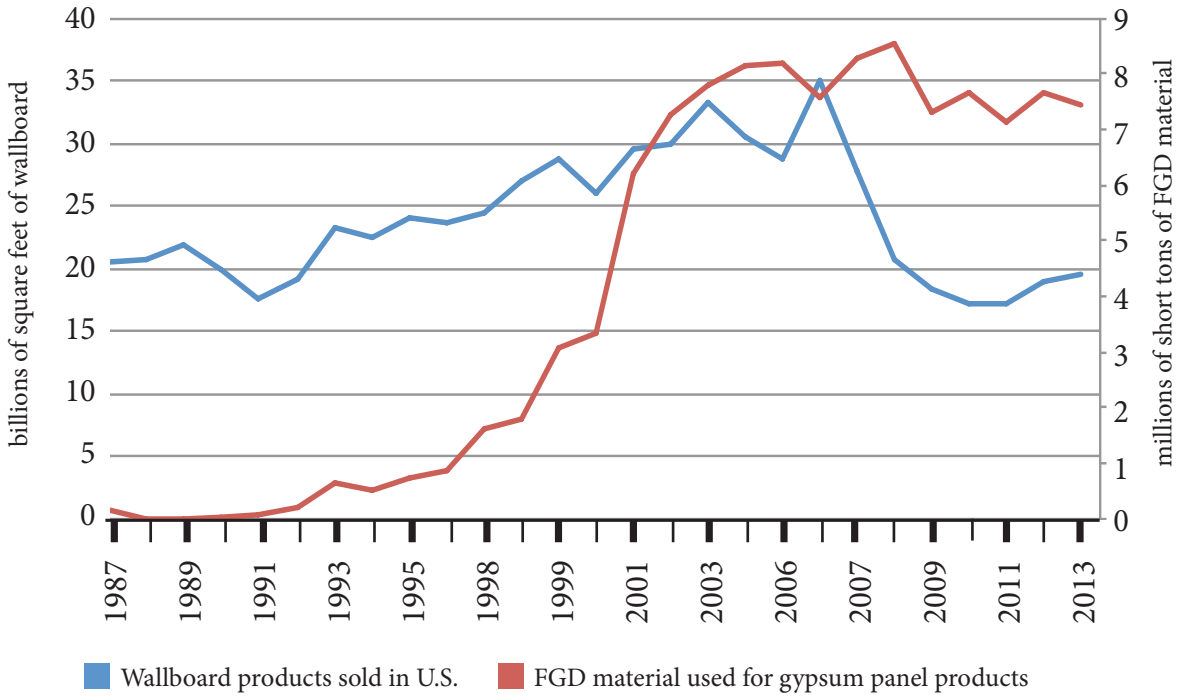


FIGURE 3-11: SALES OF WALLBOARD PRODUCTS & FGD MATERIAL UTILIZATION



RECENT DEVELOPMENTS IN FGD MATERIAL UTILIZATION—2008 TO 2013

Recent development in the utilization of FGD material have been largely driven by overall demand for gypsum wallboard and the supply of FGD material.

FGD material utilization continued to grow between 2008 and 2013, increasing from 11.8 million short tons to 12.9 million short tons. But the rate of average annual growth has slowed to two percent.

Total U.S. gypsum production and consumption declined in 2008 and 2009 as "the housing and construction markets continued to falter."[75] The utilization of FGD material also declined from 11.8 million short tons in 2008 to 10.3 million short tons in 2009, following the U.S. recession.

FGD material utilization began to grow in 2010, even as sales of wallboard products and total U.S. gypsum production declined further. The increase in FGD material helped to meet a slight increase in overall domestic gypsum consumption in 2010.

The utilization of FGD material for agriculture and mining applications has grown significantly since 2008. Total utilization for mining nearly doubled from 794,745 short tons in 2008 to 1.5 million short tons in 2013.

The use of FGD material for agriculture applications was 281,752 short tons in 2008. That has grown to 655.6 thousand short tons in 2013. Although gypsum was used for agriculture purposes as early as the 18th century, high extraction and transportation costs meant it was used only for a few crops.[76] Much like the wallboard industry, agriculture producers are finding that the availability of FGD gypsum, as well as the smaller and uniform particle size mean that the synthetic material is providing "greater soil improvements" than commercially mined gypsum.[77]

INDUSTRY SPECIFICATIONS AND MATERIALS STANDARDS

There are several standards and specifications that have helped support the growing utilization of FGD materials.

FGD gypsum used for wallboard and related materials are produced in compliance with ASTM C1396, ASTM C 1395, ASTM C 1278 and ASTM C1179, among others.[78]

FHWA published guidelines for using FGD material in pavement construction as a subbase material in 1997.[79]

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[75]U.S. Geological Survey., "Gypsum." Minerals Yearbook (2008)
[76]Dexter B. Watts and Warren A. Dick. "Sustainable uses of FGD gypsum in agricultural systems: Introduction." Journal of environmental quality 43.1 (2014): 246-252.
[77]Ibid.
[78]Gypsum Association. "Gypsum Panel Products Types, Uses, Sizes and Standards (GA-223-04)." (https://www.gypsum.org/wp/wp-content/uploads/2011/11/223-04.pdf)
[79]Warren H. Chesner, Robert J. Collins, and M. H. MacKay. User guidelines for waste and by-product materials in pavement construction. No. FHWA-RD-97-148. 1998. (http://www.fhwa.dot.gov/publications/research/infrastructure/structures/97148/intro.cfm)

BOTTOM ASH UTILIZATION

Bottom ash utilization has grown from 2.9 million short tons in 1974 to 5.6 million short tons in 2013, an increase of 95 percent. The utilization rate of bottom ash has grown from 20.3 percent of production in 1974 to 39 percent in 2013.

Bottom ash is mainly used as an input for blended cement, clinker and concrete products, structural fills and embankments, soil modification and snow and ice control.

Although bottom ash has a chemical composition that is similar to fly ash, the size of the material can range from "fine sand to large gravel," and thus it does not have any cementitous properties.[80] Since bottom ash is not pozzolanic it has more limited applications in the cement and concrete industry than fly ash.[81] Bottom ash is typically used as a lightweight aggregate in precast concrete products, including concrete blocks and masonry units.[82] The final product is much lighter than when using conventional aggregates, such as sand and gravel, and is just as strong.[83]

Two-thirds of the bottom ash utilized in 2013 was for concrete, blended cement/feed for clinker and structural fills and embankments.

In terms of highway embankments, subgrades and sub-bases, bottom ash has properties that "compare favorably with conventional highway materials" and meet the same specification requirements in testing.[84] Research also shows that there is "no difference in performance" when bottom ash is incorporated into asphalt mixtures.[85] Some mixes with bottom ash are improved by showing "high-temperature rutting and low-temperature cracking characteristics" and require less compactive effort to achieve "desired optimum densities."[86]

The same regulatory incentives and disincentives that have impacted fly ash utilization have also had an effect on the utilization of bottom ash.

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[80]Texas Coal Ash Utilization Group, FAQ. "What are coal combustion products?" (http://www.tcaug.org/faq/)
[81]R.C. Joshi and R. P. Lohita. Fly ash in concrete: production, properties and uses. No. 2. CRC Press, 1997. (https://books.google.com/books/about/Fly_Ash_in_Concrete.html?id=8ITxm7zHul4C)
[82]G.J. Dienhart, B. R. Stewart, and S. S. Tyson. "Coal ash: innovative applications of coal combustion products." American Coal Ash Association, Alexandria, VA (1998).
[83]University of Kentucky, Center for Applied Energy Research (http://www.caer.uky.edu/kyasheducation/bottomash.shtml)
[84]Wsei-Hsing Huang, "The use of bottom ash in highway embankments, subgrades, and subbases." (1990). (http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1782&context=jtrp)
[85]Khaled Ksaibati and Jason Stephen. Utilization of bottom ash in asphalt mixes. No. MCP Report No. 99-104A. Department of Civil and Architectural Engineering, University of Wyoming, 1999. (http://trid.trb.org/view.aspx?id=502631)
[86]Ibid.

FIGURE 3-12: BOTTOM ASH UTILIZATION

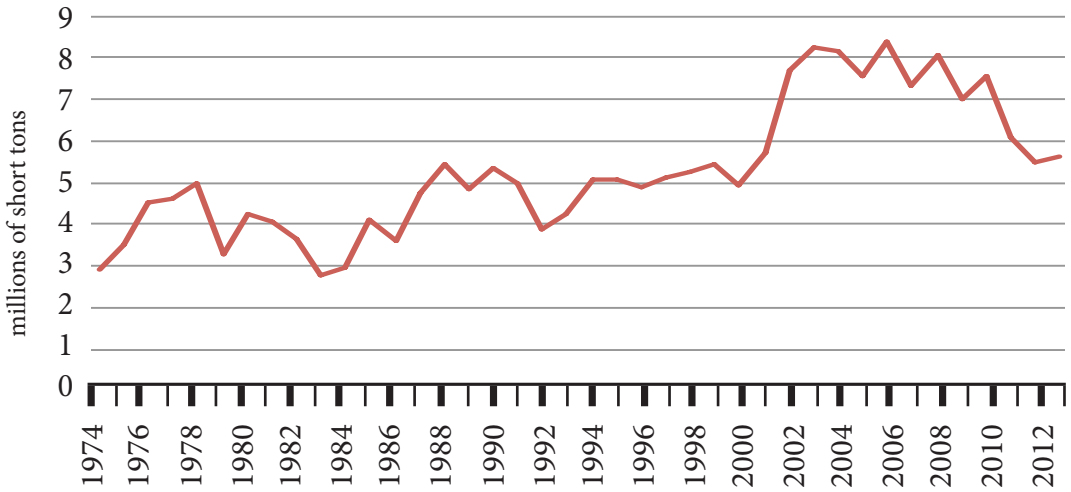
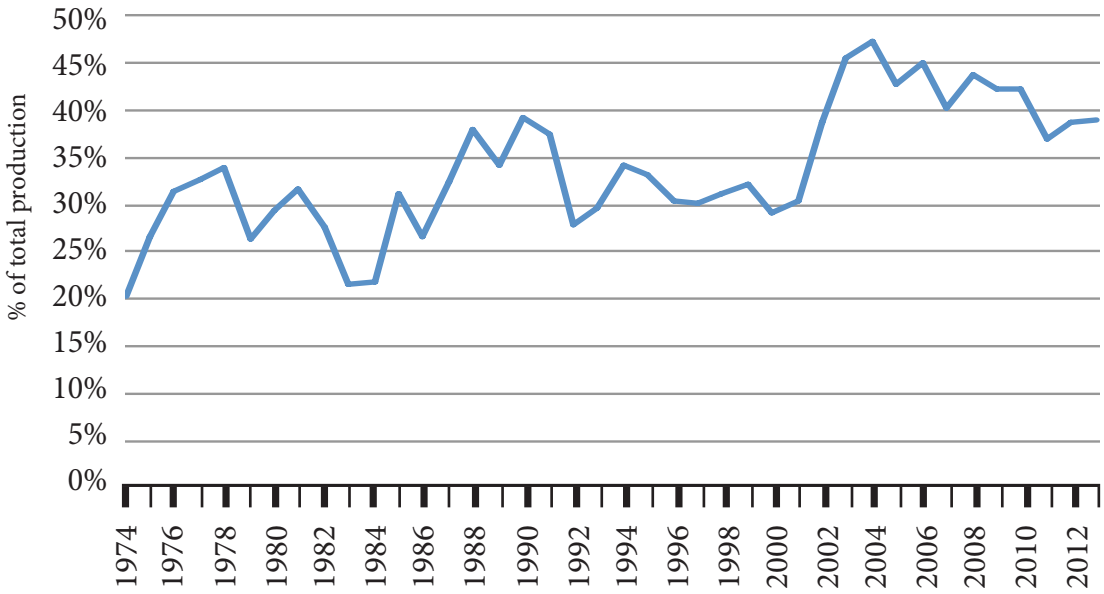


FIGURE 3-13: BOTTOM ASH UTILIZATION RATE



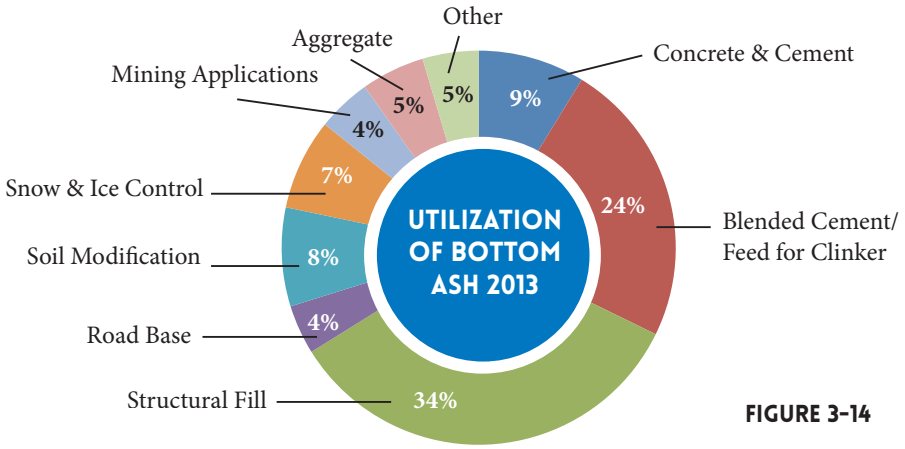


FIGURE 3-14

REGULATORY CERTAINTY & BOTTOM ASH UTILIZATION—1974 TO 2007

Bottom ash was one of the "four Bevill CCR wastes" along with fly ash, boiler slag and FGD materials, that was being considered a coal combustion residual under the RCRA and the Bevill Amendment exemption.[87]

The utilization of bottom ash grew at an average annual rate of two percent between 1974 and 1993, outpacing bottom ash production, which was fairly flat over the same time period, declining slightly from 14.3 million short tons in 1974 to 14.2 million short tons in 1993.

The utilization of bottom ash continued to grow at an average annual rate of two percent between 1993 and 2000, after the August 9, 1993 EPA Regulatory Determination that concluded bottom ash and CCPs should continue to be exempt from Subtitle C of the RCRA and not be classified as a hazardous waste.

Total bottom ash utilization grew from 4.2 million short tons in 1993 to 4.9 million short tons in 2000.

The Final Regulatory Determination issued by EPA on May 22, 2000 that retained the Bevill exemption for bottom ash ushered in a new era of regulatory certainty.

Between 2000 and 2008, the utilization of bottom ash grew at an average annual rate of six percent, growing from 4.9 million short tons to 8.0 million short tons. This increase in volume reflects higher demand for bottom ash as an input for blended cement and concrete and structural fills/embankments.

This growth occurred at a time when the real value of pavement work, which is a major end market for bottom ash in structural fills, actually declined slightly from $57.2 billion in work to $56.9 billion. U.S. production of ready-mixed concrete fell at an average annual rate of one percent between 2000 and 2008, and housing starts declined at an average annual rate of four percent. This points to the increased value of bottom ash as a less expensive substitute for traditional building materials, especially during a time when the construction markets are beginning to weaken.

Bottom ash utilization has declined at an average annual rate of seven percent between 2008 and 2013, falling from 8 million short tons to 5.6 million short tons in the environment of regulatory uncertainty.

GROWTH IN BOTTOM ASH UTILIZATION	
TIME PERIOD	AVERAGE ANNUAL GROWTH RATE
1974 to 1980	6.6%
1981 to 1990	3.1%
1991 to 2000	-0.1%
2000 to 2008	6.3%
2009 to 2013	-6.9%
Total for 1974 to 2013	**1.7%**

[87]EPA, June 21, 2010, Proposed Rule, "Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities." (http://www.epa.gov/epawaste/non-haz/industrial/special/fossil/ccr-rule/ccr_propsd_rul.htm)

BOILER SLAG UTILIZATION

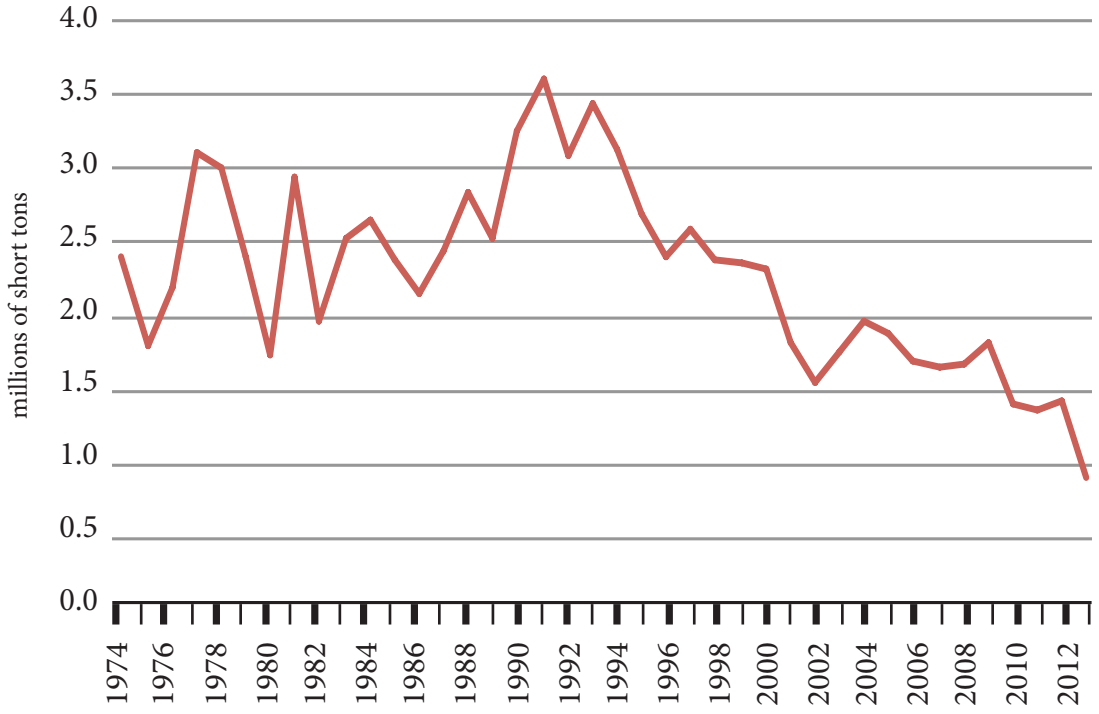
The utilization of boiler slag has declined at an average annual rate of 2.5 percent, falling from 2.4 million short tons in 1974 to 909,066 short tons in 2013. Despite this decline, the utilization rate of boiler slag remained high compared to other CCPs, averaging 70 percent over the same time period.

In 2013, 98 percent of the boiler slag utilized was for roofing granules or blasting grit. The use of boiler slag in the cement and concrete industry, as well as embankments, road base or subbase, is limited.[88]

The decline in boiler slag utilization is due in large part to a decline in production and availability. Boiler slag production peaked at 6.2 million short tons in 1993 and fell sharply to 3.8 million short tons in 1994 as more wet-bottom boilers began to be retired.

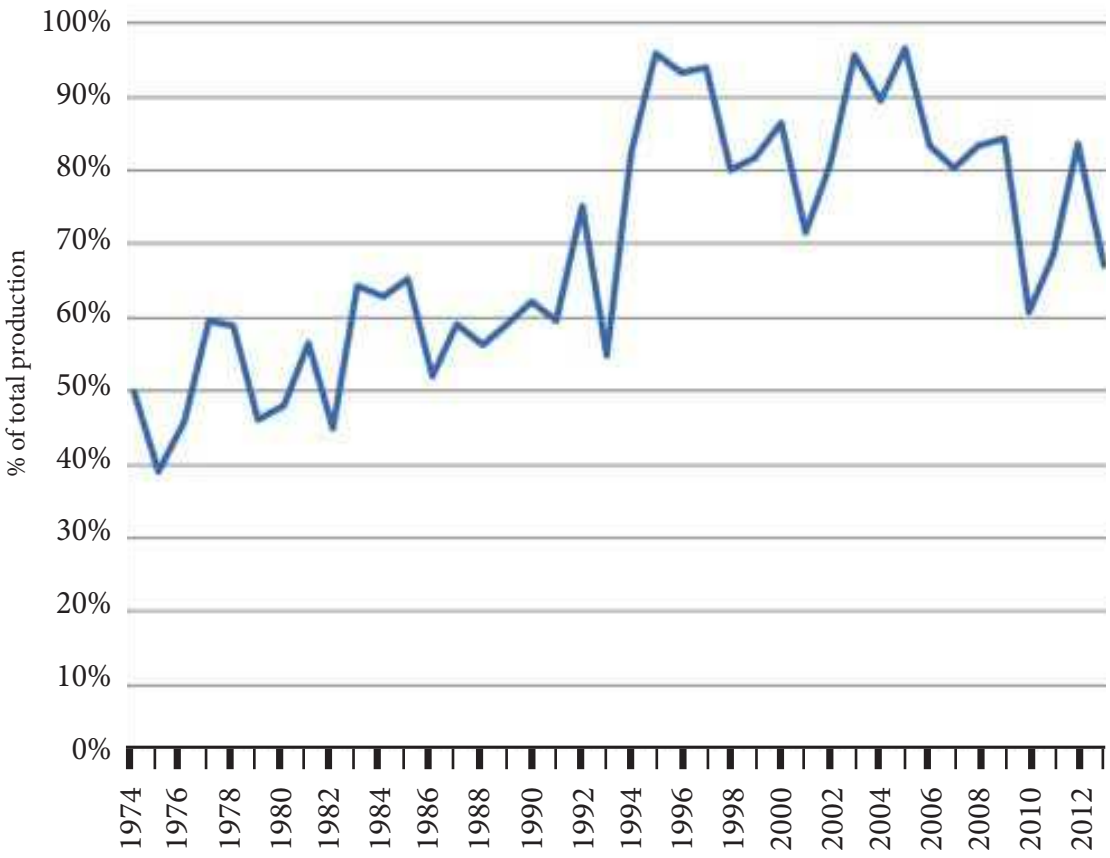
So although boiler slag continues to be utilized at a high rate after that time, the overall utilization has fallen in line with production. Overall, boiler slag is a unique product that is used in a niche market. The future availability and utilization of boiler slag is questionable given the continued replacement of older, wet bottom boilers that produce the material.

FIGURE 3-15: BOILER SLAG UTILIZATION



[88]R.C. Joshi and R. P. Lohita. Fly ash in concrete: production, properties and uses. No. 2. CRC Press, 1997. (https://books.google.com/books/about/Fly_Ash_in_Concrete.html?id=8ITxm7zHul4C)

FIGURE 3-16: BOILER SLAG UTILIZATION RATE



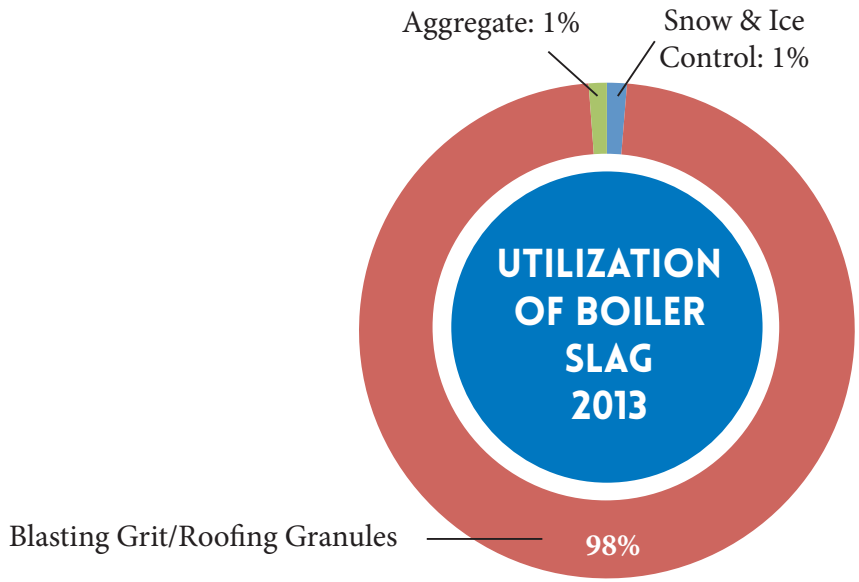


FIGURE 3-17

FBC ASH UTILIZATION

The utilization of FBC ash has increased from 953,410 short tons in 2002 to 8.8 million short tons in 2013. In 2013, over 95 percent of the FBC ash utilized was for mining applications. The remaining FBC ash was used in soil modification and stabilization, waste stabilization and aggregates.

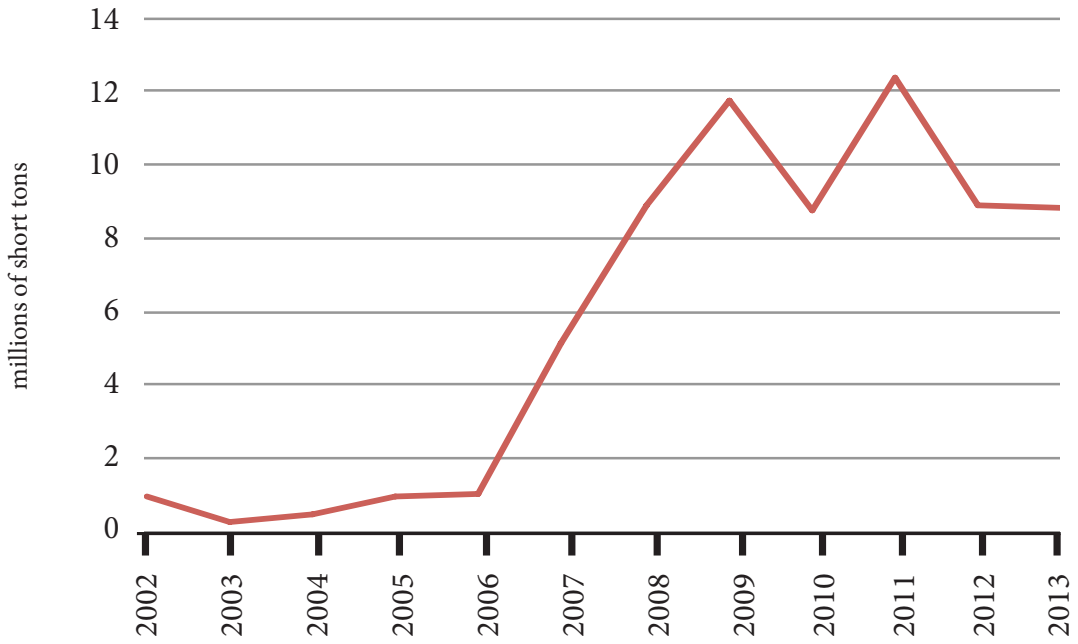
In 2007, ACAA expanded the production and use survey to include data from the ARIPPA, a group of non-utility alternative energy electric power generation stations that burn waste coal using FBC technology.

FBC ash provides a number of environmental and economic benefits when used in mines, and has been placed in at least 20 sites across the country.[89]

Most FBC ash has been used in surface mines to help restore the land to beneficial use. In several states FBC ash has also been used to fill underground mines, providing structural support.[90]

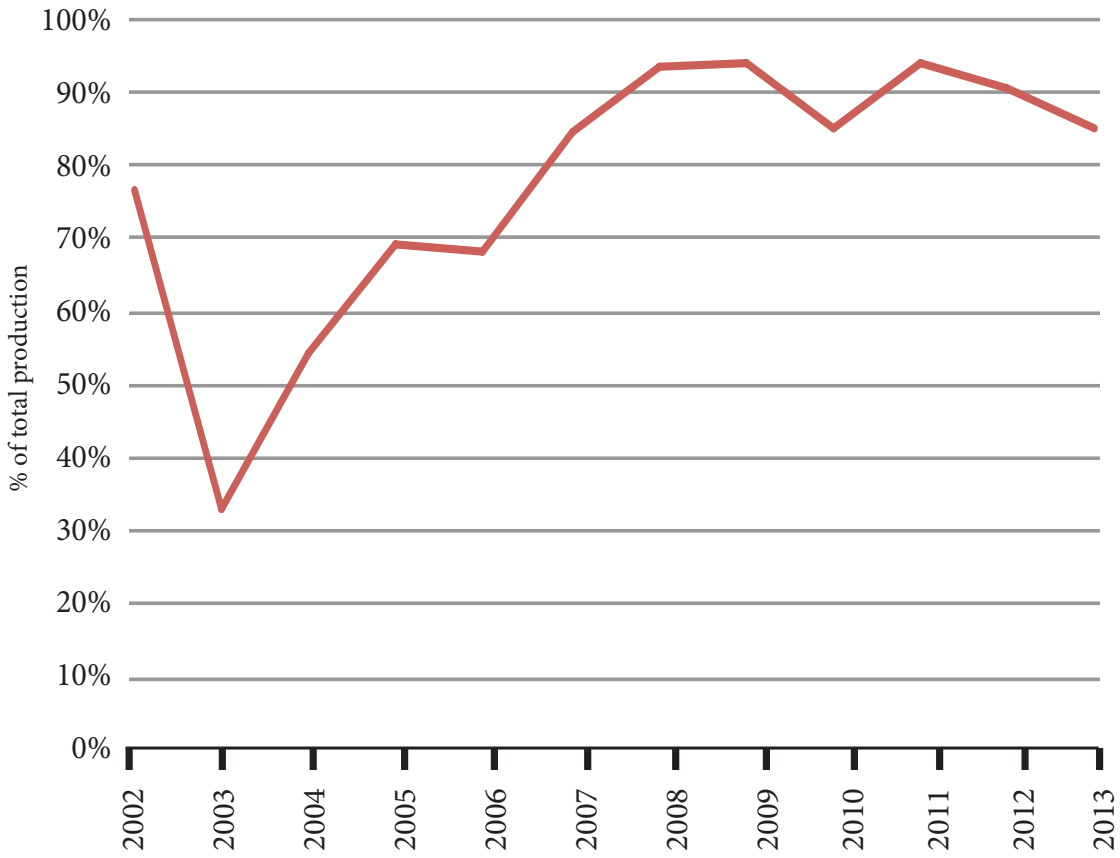
In the case of Clinton County, Pennsylvania, the use of FBC ash had a positive impact on the water quality. The alkaline FBC ash neutralized the acidic waters, resulting in "precipitous decreases in arsenic, cadmium, and aluminum concentrations..."[91]

FIGURE 3-18: FBC ASH UTILIZATION



[89]Ishwar P. Murarka and Jim Erickson. "Use of coal combustion products in mine-filling applications: a review of available literature and case studies." (2006). (http://wvwri.org/wp-content/uploads/2012/05/99-EC-W05.pdf)
[90]Ibid.
[91]Ibid.

FIGURE 3-19: FBC ASH UTILIZATION RATE



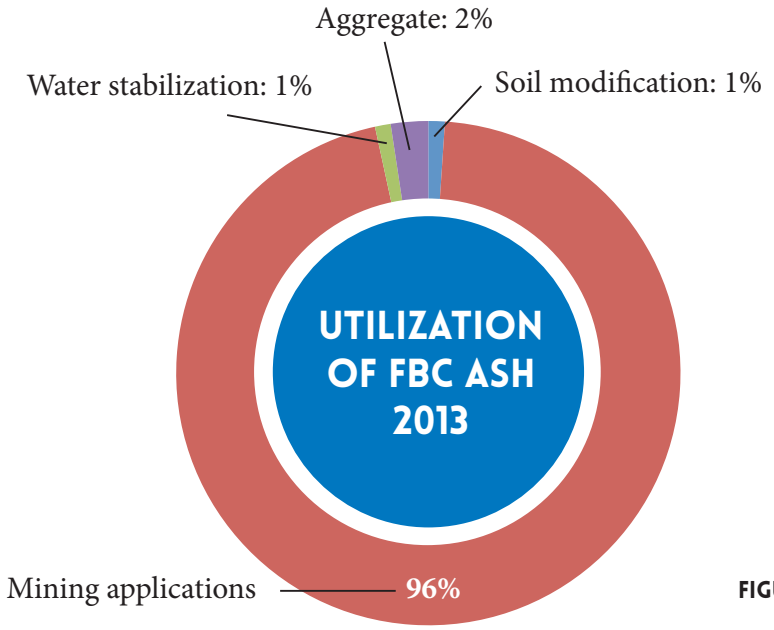


FIGURE 3-20

REGULATORY UNCERTAINTY AND CCP UTILIZATION

On December 22, 2008, a containment dike at a Kingston, Tennessee power plant's coal ash disposal facility failed, flooding more than a billion gallons of ash slurry into an area of 300 acres. Following the incident, coal ash disposal received renewed interest from Congress, which held several hearings on the issue.

The EPA looked for ways to obtain federal RCRA jurisdiction over coal ash disposal and discussed reversing the 2000 Final Regulatory Determination, possibly classifying coal ash as a hazardous waste under Subtitle C. On June 21, 2010, EPA published a proposed rule to regulate fly ash and other CCPs for the first time under either Subtitle C or Subtitle D of RCRA. The rule would not be finalized until December 19, 2014, resulting in six years of uncertainty about the status of fly ash, bottom ash, FGD material and other CCPs as a nonhazardous waste under RCRA Subtitle D, as clarified in the exemptions of the Bevill Amendment.

In October 2010, the EPA Office of Inspector General published a review of the agency's Coal Combustion Products Partnership (C2P2) website, concluding that it conflicted with agency policies and positions as proposed in the proposed rule. The C2P2 program was created in 2001 by the EPA's Resource Conservation Challenge voluntary program to actively promote the beneficial use of CCPs. The removal of the website was another indicator over the questionable status of coal ash's classification as a hazardous material, further contributing to market uncertainty.

EPA noted that the website "presented an incomplete picture regarding actual damage and potential risks that can result for large-scale placement" and the site "gave the appearance that EPA endorses commercial products."[92] The report also noted the December 2008 incident in Kingston, Tennessee as part of the background on the issue.

Revisiting the classification of fly ash under RCRA Subtitle C or Subtitle D created a new level of uncertainty, putting a damper on the utilization of fly ash and other CCPs.

The downturn in CCP utilization during this uncertainty coincided with the U.S. recession from December 2007 to June 2009. The contraction in U.S. construction market activity impacted overall demand for construction materials, including ready-mixed concrete, but this was not solely responsible for the sharp decline in CCP utilization.

Historically, the use of CCPs has grown during economic downturns as concrete and other construction material producers turn to less expensive products to save on overall costs. Typically, CCPs are less expensive than the materials they replace.

Bottom ash utilization increased following the beginning of every U.S. recession since 1973, including the most recent economic downturn.

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[92]EPA Office of Inspector General. "Early Warning Report: Website for Coal Combustion Products Partnership Conflicts with Agency Policies." Report No. 11-P-0002, October 13, 2010 (http://www.epa.gov/oig/reports/2011/20101013-11-P-0002.pdf)

Fly ash utilization increased in three of the last five U.S. recessions:

- **NOVEMBER 1973–MARCH 1975**. Total tons of utilized fly ash increased steadily from 3.4 million tons in 1974, during the height of the recession, to 4.5 million short tons in 1975 and 5.7 million short tons in 1976.

- **JULY 1990–MARCH 1991.** Fly ash utilization, which was 10.2 million short tons in 1989, increased in both 1990 and 1991, even as the total U.S. production of ready-mix concrete declined. Total volumes of ready-mixed concrete production would not return to the 1989 pre-recession levels until 1994.

- **MARCH 2001–NOVEMBER 2001.** Fly ash utilization grew from 20 million short tons in 2000 to 22 million short tons in 2001, and continued to grow steadily over the next seven years. U.S. production of ready-mixed concrete grew in 2001, but dropped in 2002 and 2003, gradually returning to pre-recession levels in 2004.

Fly ash utilization declined during the double-dip recession that occurred from January to July of 1980 and July 1981 to November 1982 (counted as one recession for this analysis), but began to recover before the U.S. ready-mixed concrete market. Total fly ash utilized dropped from 10 million short tons in 1979 to 6.4 million short tons in 1980. The market began to recover, increasing to 9.4 million short tons in 1981 before falling back to 8 million short tons in 1982. In 1984, the total volumes of fly ash utilized recovered to pre-recession 1979 levels, after nearly five years. During the recession total cubic meters of U.S. ready-mixed concrete produced declined, climbing back to pre-recession levels in 1985, one year after the fly ash market.

In the most recent recession, which began in December 2007 and ended June 2009, fly ash utilization declined slightly in 2007 and 2008, falling from 32.4 million short tons in 2006 to 31.6 million short tons in 2007 (a decline of 2.5 percent) and 30.1 million short tons in 2008 (a further decline of 4.7 percent).

Meanwhile, the U.S. production of ready-mixed concrete had started to fall even before the official start of the recession, declining from 458.36 million cubic yards in 2005 to 456.8 million cubic yards in 2006 and 414.6 million cubic yards in 2007.

It was not until 2009 that fly ash utilization fell to 24.7 million short tons, a decline of 18 percent from 2008 levels—one full year after the recession began in December 2007. Although total volumes of ready-mixed concrete in 2013 are still below their pre-recession levels, the market bottomed out in 2010 and production has increased annually since that time. Meanwhile, fly ash utilization continues to remain depressed.

Given historical patterns, we would expect fly ash utilization to show signs of recovery before the turn-around in the ready-mixed concrete market. The sharp drop in fly ash utilization in 2009 and the continued low levels of activity despite the uptick in ready-mixed concrete production point to another factor impacting the market—the uncertainty over the regulatory environment.

Bottom ash utilization in the most recent recession, which began in December 2007 and ended June 2009, actually grew in 2008 to eight million short tons from 7.3 million short tons in 2007.

Total utilization dropped sharply to seven million short tons in 2009, after the Kingston, Tennessee accident and declined further to 5.6 million short tons in 2013.

Given the historical relationship between bottom ash utilization and the overall U.S. economy, we would have expected the utilization in 2013 to be higher than pre-recession levels.

Regulatory uncertainty has not had a significant impact on the utilization of FGD material because of the close distribution ties between suppliers and wallboard manufacturers.

There are currently a few large, vertically integrated companies that mine gypsum and manufacture wallboard and related products, with seven companies producing 62 percent of U.S. crude gypsum.[93]

FIGURE 4-1: ANNUAL PERCENT CHANGE IN U.S. FLY ASH UTILIZATION VERSUS PRE-RECESSION LEVELS

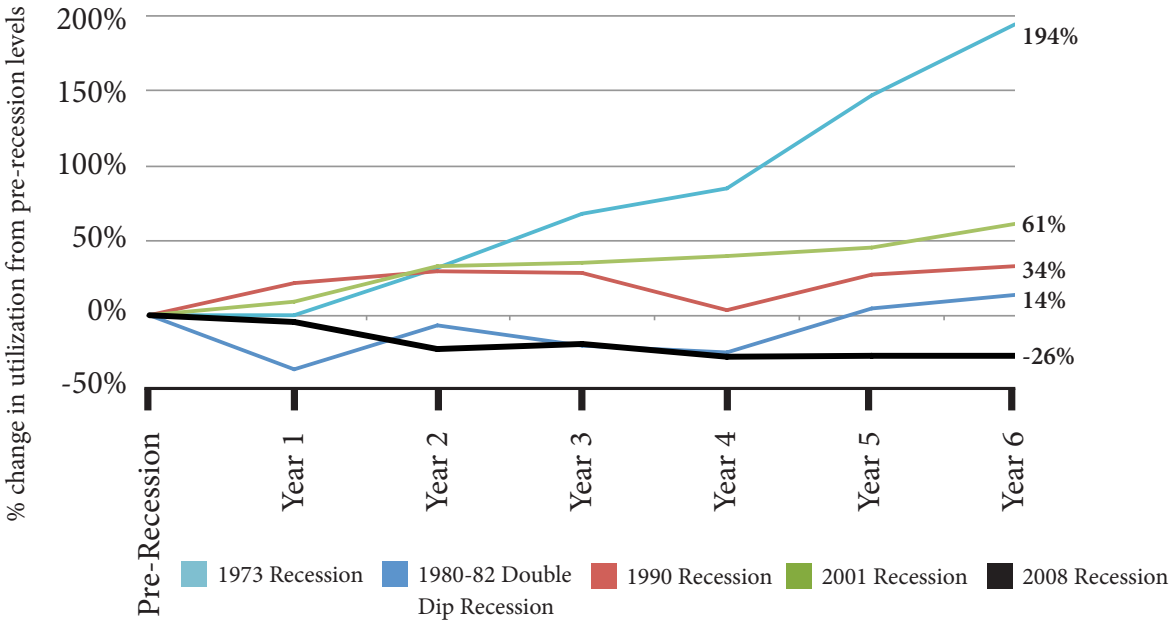
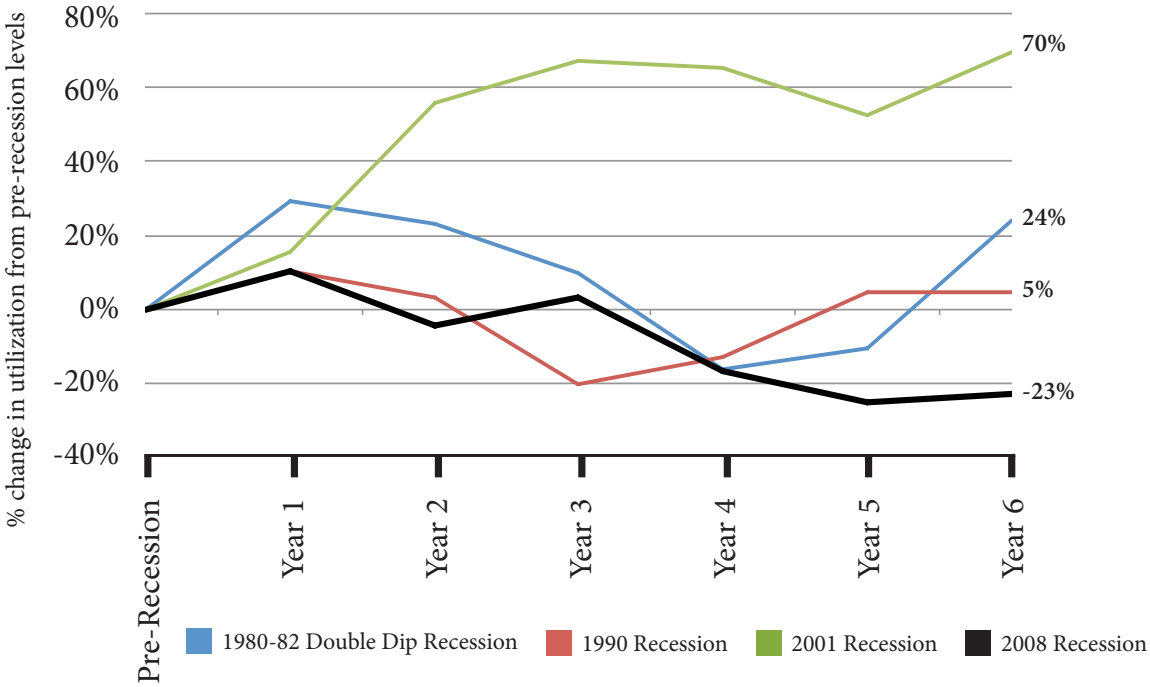


FIGURE 4-2: ANNUAL PERCENT CHANGE IN U.S. BOTTOM ASH UTILIZATION VERSUS PRE-RECESSION LEVELS



[93]U.S. Geological Survey. "Gypsum." Minerals Yearbook (2012) (http://minerals.usgs.gov/minerals/pubs/commodity/gypsum/)

With close commercial ties and manufacturing facilities located near plants that supply FGD material, these firms are less impacted by the regulatory uncertainty surrounding the CCP market compared to fly ash.

This means that the utilization of FGD material has been impacted by larger market supply and demand and new areas for beneficial use.

FIGURE 4-3: ANNUAL PERCENT CHANGE IN U.S. FGD MATERIAL UTILIZATION VERSUS PRE-RECESSION LEVELS

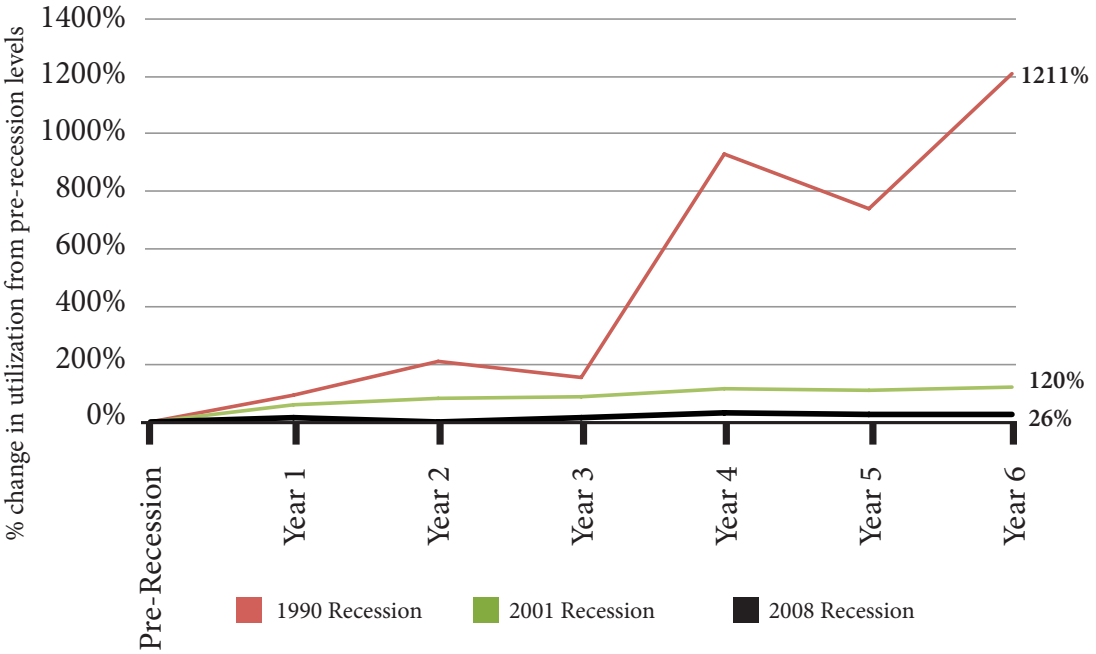
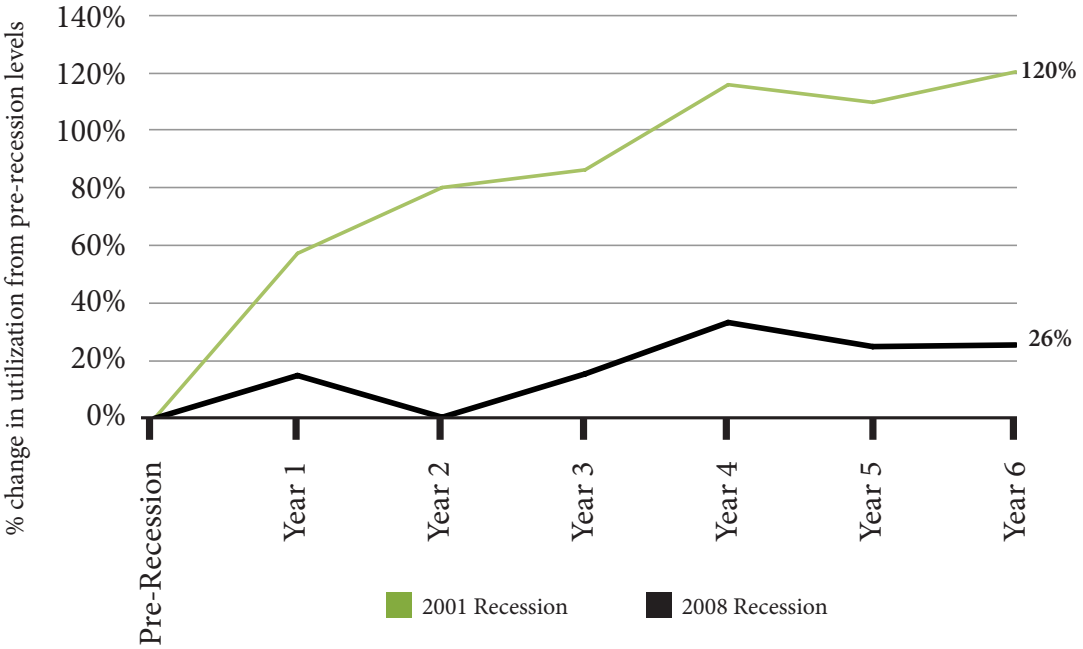


FIGURE 4-4: ANNUAL PERCENT CHANGE IN U.S. FGD MATERIAL UTILIZATION VERSUS PRE-RECESSION LEVELS FOR 2001 AND 2008



MAJOR MARKETS FOR THE BENEFICIAL USE OF CCPs

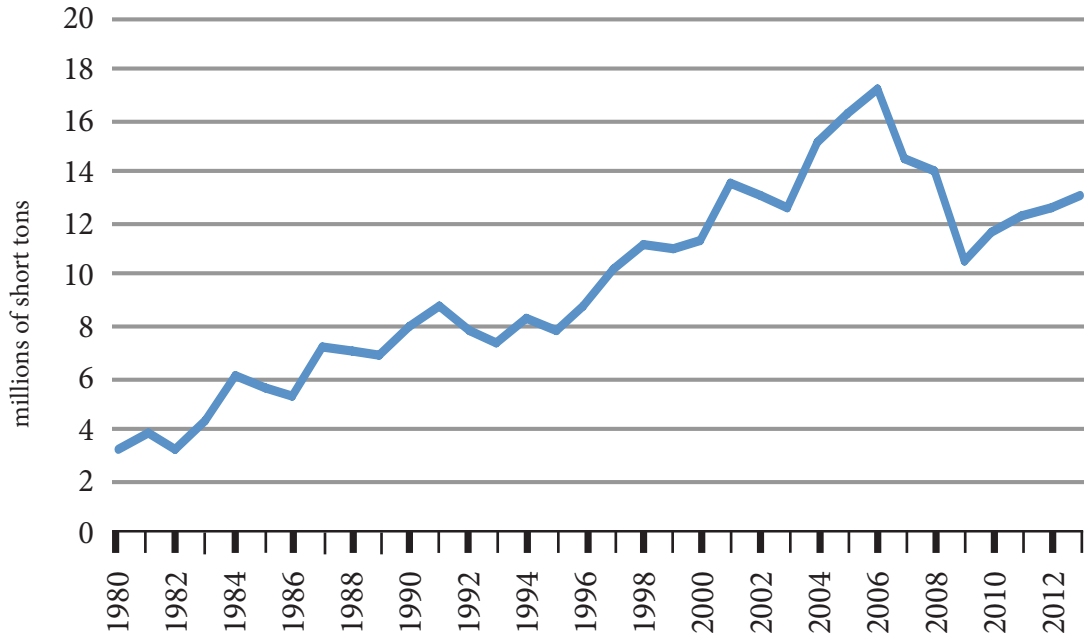
CEMENT AND CONCRETE PRODUCTS

The beneficial use of CCPs as an input for cement and concrete products has historically been one of the primary uses of CCPs. Fly ash, the largest volume CCP, is a "pozzolan" that when mixed with calcium hydroxide produced during cement hydration, takes on many of the same properties as cement. Thus utilizing fly ash with cement in concrete mixtures produces concrete that is stronger, more durable, easier to work with, and is more economical.

Some of the key insights into this end use market:

- A total of 3.2 million short tons CCPs were utilized for cement and concrete products in 1980. This grew to 13.1 million short tons in 2013, an increase of 306 percent.
- The use of CCPs in this industry grew at an average annual rate of 4.3 percent between 1980 and 2013.
- Fly ash is the main type of CCP used, accounting for 94 percent of the total amount of CCPs utilized for concrete and cement products in 2013.
- The overall use of CCPs in the cement and concrete market is closely correlated with total U.S. ready-mixed concrete production and consumption, which is tied to the U.S. economy and construction markets.

FIGURE 5-1: CCPs UTILIZED FOR CONCRETE AND CEMENT PRODUCTS



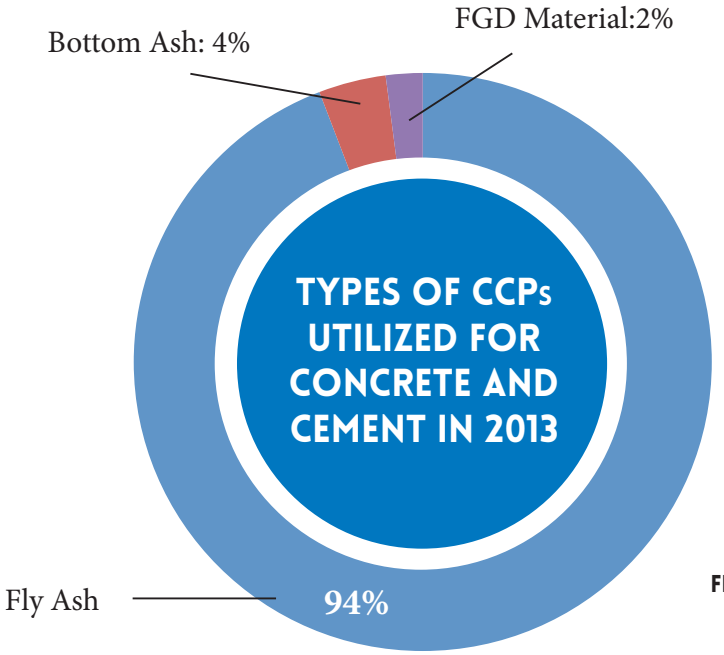
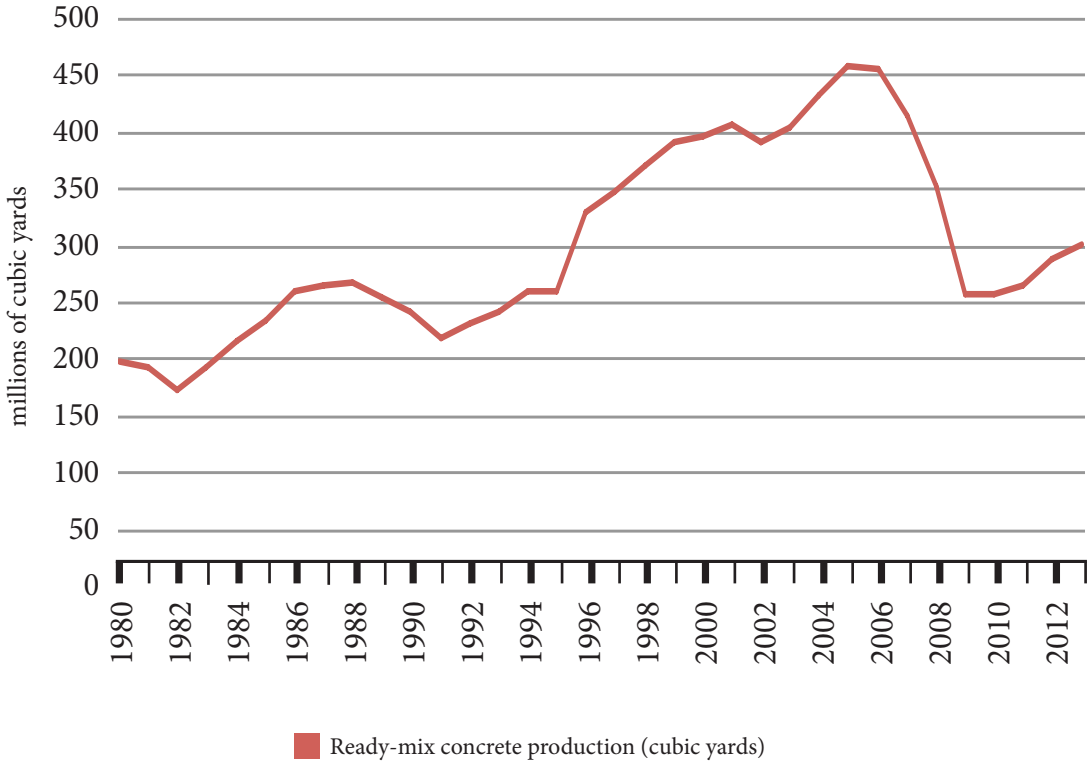


FIGURE 5-2

FIGURE 5-3: OVERALL DEMAND FOR READY-MIX CONCRETE IS A MAJOR DRIVER OF CCPs UTILIZED FOR CONCRETE/CEMENT



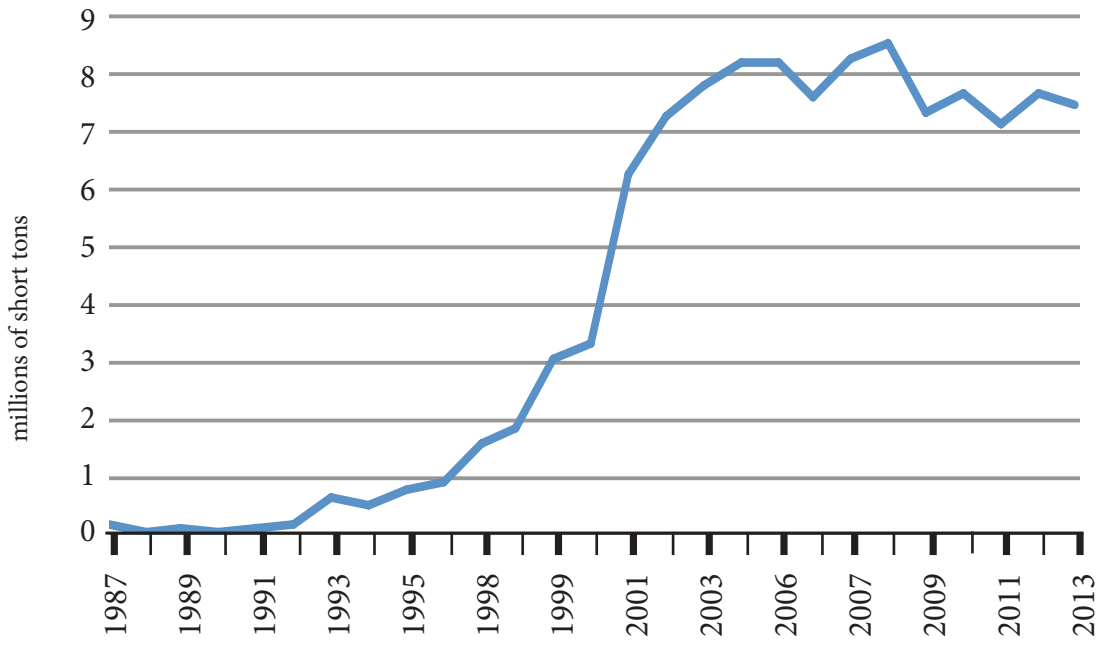
GYPSUM PANEL PRODUCTS

Over forty percent of the gypsum panel products manufactured in the United States, including wallboard, ceiling board and backing board, contain CCPs.[94] The primary type of coal ash used for this market is dry FGD material, either in the form of dry scrubber material or FGD gypsum, a fine particulate matter. Wet FGD material can also be used in making wallboard after it has dried out.

ACAA began collecting data on the beneficial use of CCPs for gypsum panel products in 1987. Some of the key insights into this end use market:

- Just over 157,000 tons of CCPs were used for gypsum panel products in 1987. This grew to 7.4 million short tons in 2013.
- The use of CCPs in this industry grew at an average annual rate of 16 percent between 1987 and 2013.
- FGD gypsum material and FGD material from wet and dry scrubbers were the only CCPs utilized for gypsum panel products in 2013. Historically, small amounts of fly ash, bottom ash and even boiler slag have been recorded in the ACAA data.
- An estimated 90 percent of domestic gypsum consumption is accounted for by manufacturers of wallboard and plaster products, according to the U.S. Geological Service. The demand for gypsum is correlated with the strength of the construction industry.

FIGURE 5-4: CCPs UTILIZED FOR GYPSUM WALLBOARD AND OTHER MATERIALS



[94]"Beneficial Use of Coal Combustion products An American Recycling Success Story." Ash at Work 1 (2013). (http://www.acaa-usa.org/Portals/9/Files/PDFs/ASH01-2013.pdf)

FIGURE 5-5: SYNTHETIC GYPSUM AS PERCENT OF TOTAL GYPSUM PRODUCTION

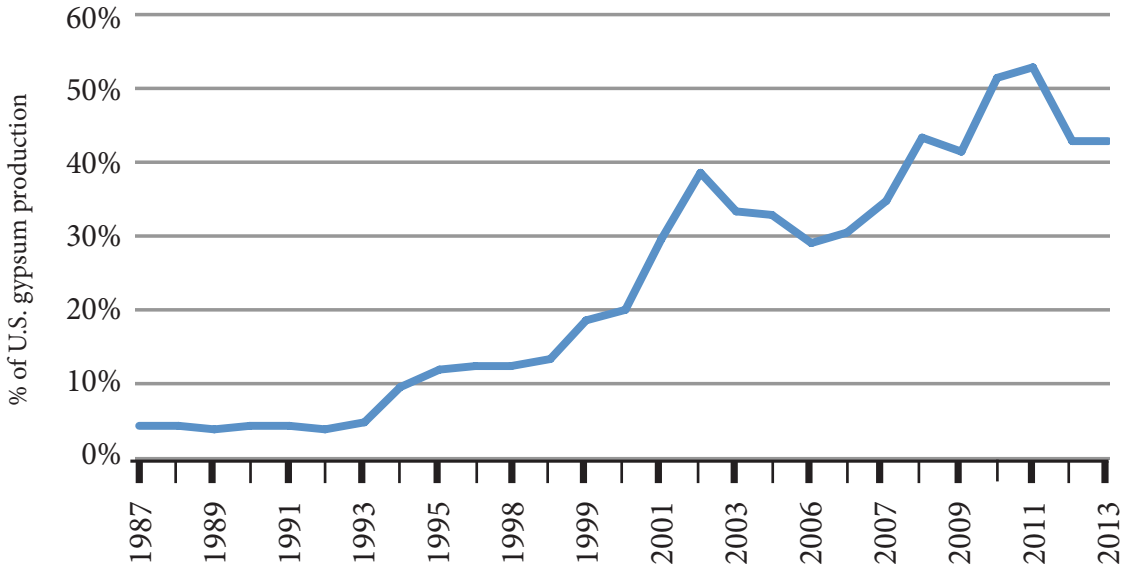
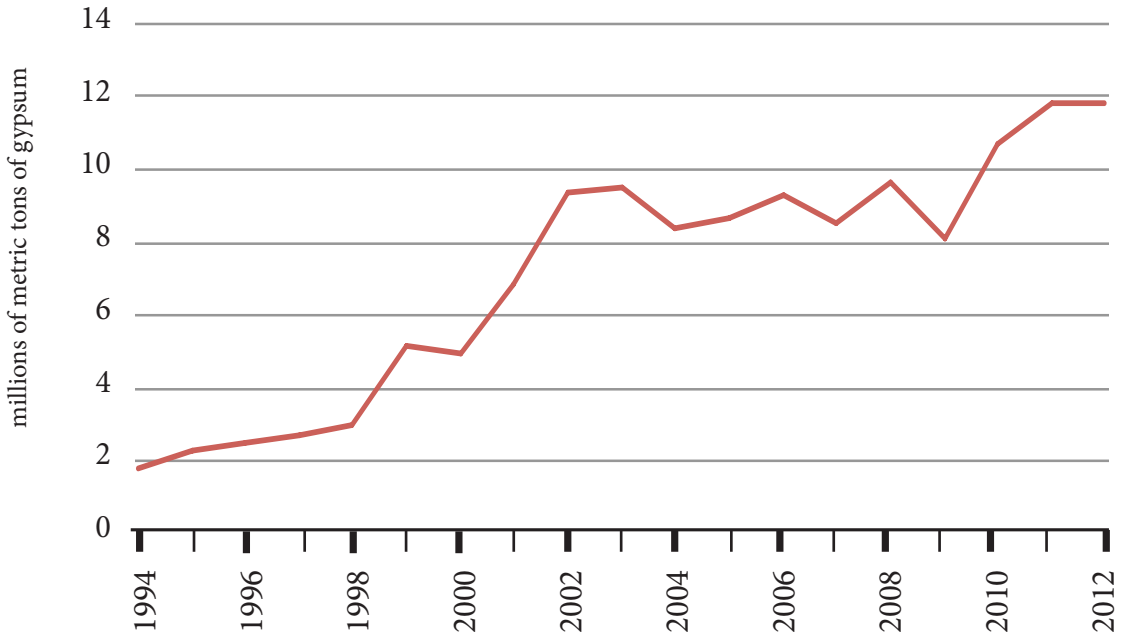


FIGURE 5-6: OVERALL U.S. SALES OF SYNTHETIC GYPSUM



MINING APPLICATIONS

The mining industry uses CCPs in a variety of ways, including as a fill material for mine sites to restore original land contours. In Pennsylvania, CCPs are used as a low permeability material to pave pit floors, cap materials, encapsulate rejected material and even cap entire sites.[95] A study by the National Academy of Sciences recommended that placing CCPs in mines as part of the reclamation process was a "viable option" for utilizing coal ash material.[96]

Some highlights of the use of CCPs in mining applications:

- A total of 160,000 short tons of CCPs were utilized for mining applications in 1980. This increased to over 1.1 million short tons in 2006. The average annual growth in the utilization of CCPs by the mining industry was 9.3 percent over that 26 year period.
- In 2007, ACAA began including data on the beneficial use of FBC ash for mining purposes collected by ARIPPA, a Pennsylvania association of 14 power plants that utilize waste coal for fuel.
- With the new data, the total beneficial use of CCPs for mining applications was 6.7 million short tons in 2007.
- Average annual growth in the use of CCPs in this area grew at an average annual rate of 11.2 percent since 2007, reaching 12.7 million short tons in 2013.
- Historically, fly ash was the main type of CCP utilized for mining applications, accounting for 75 percent of the market in 1980.
- With the inclusion of the ARIPPA data, FBC Ash now accounts for over 66 percent of the CCPs utilized for mining applications.
- Regardless of the change in methodology, the beneficial use of CCPs for mining applications has been growing since 1980.

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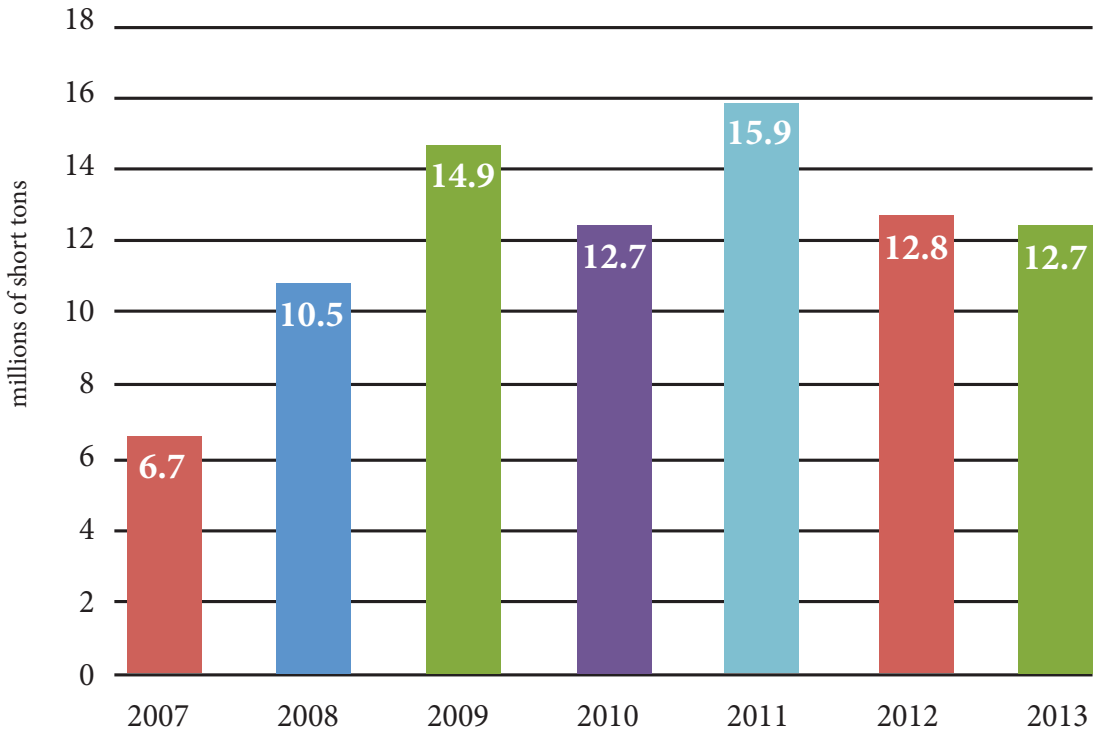
[95]Dalberto, et al. "Overview: Coal Ash Beneficial Use and Mine Land Reclamation." Pennsylvania Department of Environmental Protection (http://www.depweb.state.pa.us/portal/server.pt/document/1239456/chapter_1_final_pdf.)
[96]National Research Council. Managing Coal Combustion Residues in Mines. The National Academies Press. Washington, DC. 228 p. (2006). (http://www.nap.edu/catalog/11592/managing-coal-combustion-residues-in-mines)

FIGURE 5-7: CCPs RECYCLED FOR MINING APPLICATIONS



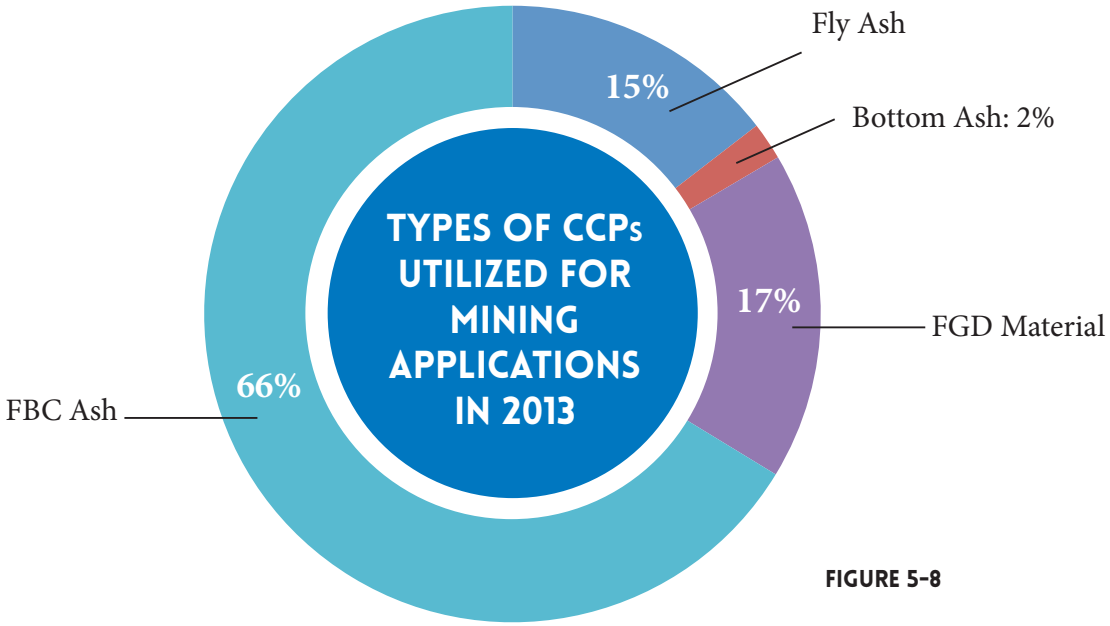


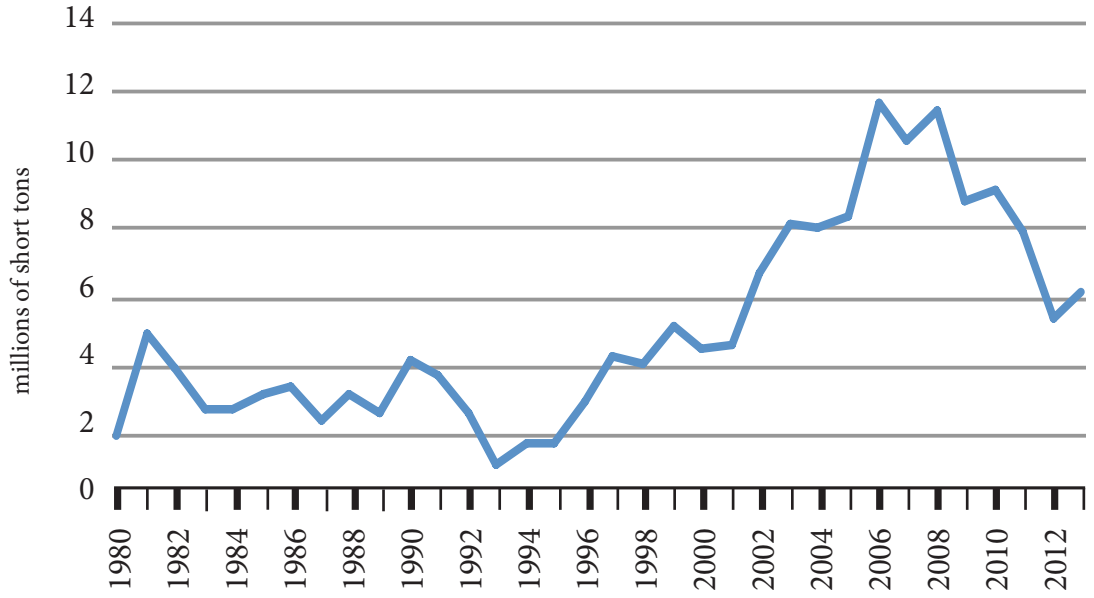
FIGURE 5-8

STRUCTURAL FILLS AND EMBANKMENTS

CCPs improve the strength and durability of structural fills and embankments, creating a stable base for construction projects, trench filling and other excavations, especially for road construction. Some of the beneficial engineering properties include its moisture-density relationships, the particle size distribution, sheer strength, bearing strength, permeability and consolidation characteristics.[97]

- Just under 2.0 million short tons of CCPs were utilized for structural fills and embankments in 1980. This grew to 6.2 million short tons in 2013, an increase of 209 percent.
- The use of CCPs in this industry grew at an average annual rate of 3.5 percent between 1980 and 2013.
- Fly ash is the main type of CCP used, accounting for 49 percent of the total amount of CCPs utilized for structural fills and embankments in 2013. This is compared to 50 percent in 1980. Bottom ash accounted for 31 percent of the utilized material in 2013, down from 41 percent in 1980.
- The highway and bridge construction industry is one of the main sectors using CCPs for structural fills and embankments. The downturn in this beneficial use since 2008 mirrors the decline in the real value of U.S. pavement work over the same time period.

FIGURE 5-9: CCPs UTILIZED FOR STRUCTURAL FILLS AND EMBANKMENTS



[97]Warren H. Chesner, Robert J. Collins, and M. H. MacKay. User guidelines for waste and by-product materials in pavement construction. No. FHWA-RD-97-148. 1998. (http://www.fhwa.dot.gov/publications/research/infrastructure/structures/97148/intro.cfm)

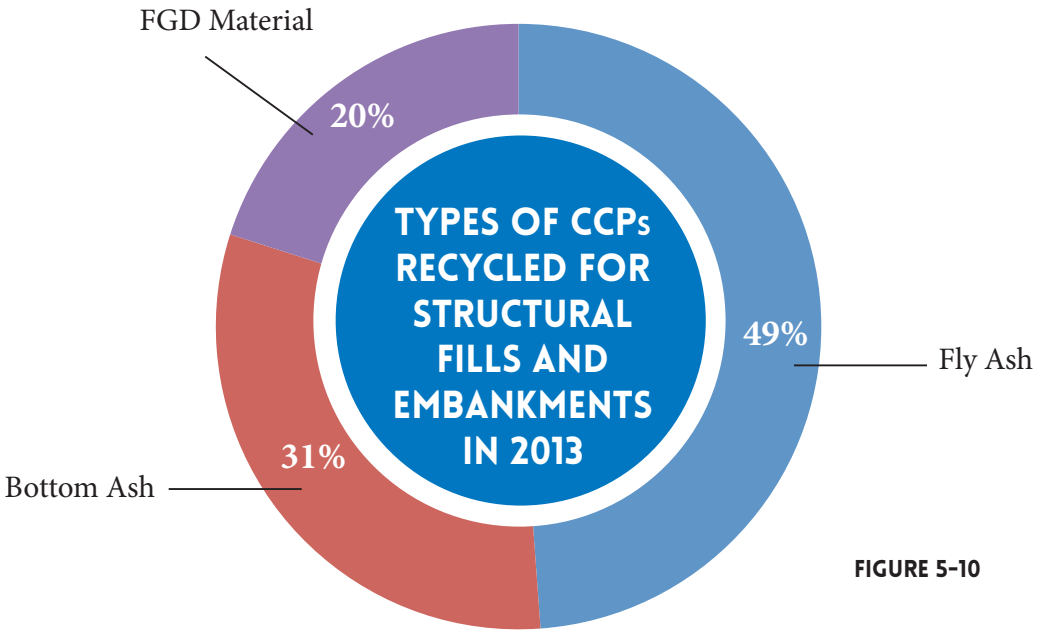
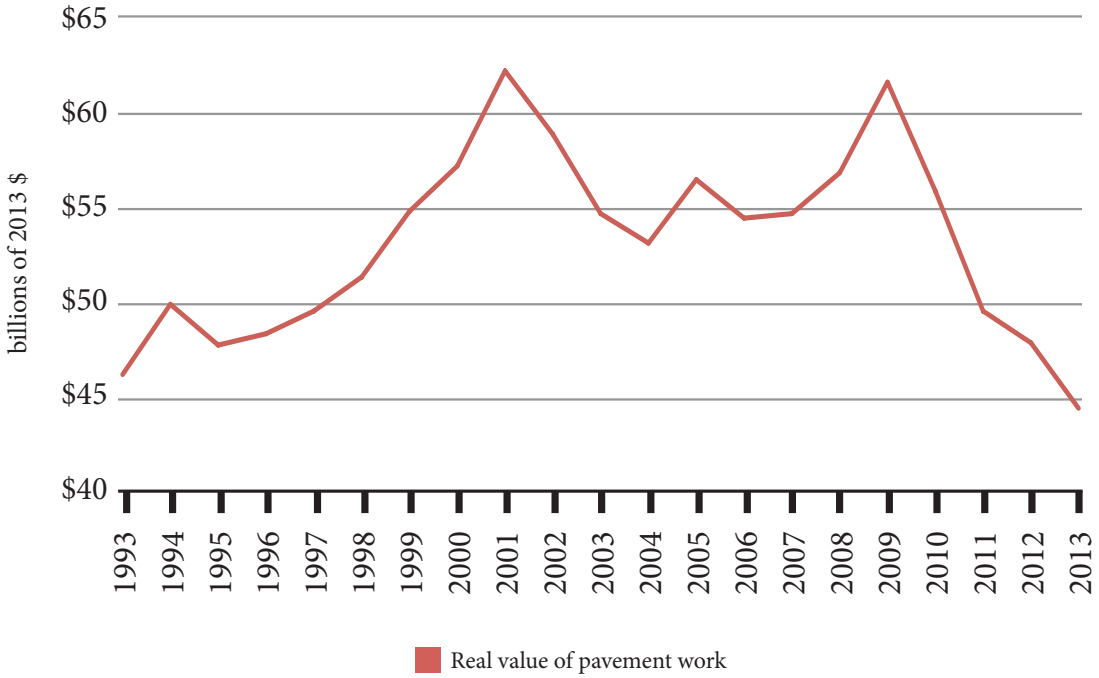


FIGURE 5-10

FIGURE 5-11: HIGHWAY CONSTRUCTION IS A MAJOR END MARKET FOR THE BENEFICIAL USE OF CCPs IN STRUCTURAL FILLS AND EMBANKMENTS



ADDITIONAL BENEFICIAL USE MARKETS

Other beneficial use markets, including agriculture, aggregates, oil field services, blended cement/clinker feed and waste stabilization, utilize significant volumes of CCPs.

AGRICULTURE: ACAA began collecting data on the beneficial use of CCPs for agriculture in 1995. This market had grown from 14,681 short tons in 1995 to 598,105 short tons in 2013. Although it is just one percent of the total utilization of CCPs, the increase in use has been significant. The major CCP types utilized for agriculture are FGD, fly ash and bottom ash.

BLENDED CEMENT/FEED FOR CLINKER: Since 1999, the use of CCPs for this industry has grown from 1.4 million short tons to 4.8 million short tons, an increase of 235 percent. The amount of CCPs utilized for blended cement and feed for clinker were nine percent of total utilization reported by ACAA in 2013.

WASTE STABILIZATION/SOLIDIFICATION: This end use market has grown from utilizing 400,000 short tons of CCPs in 1991 to over 2.2 million short tons in 2013, an increase of 447 percent. This beneficial use represented four percent of total CCP utilization in 2013.

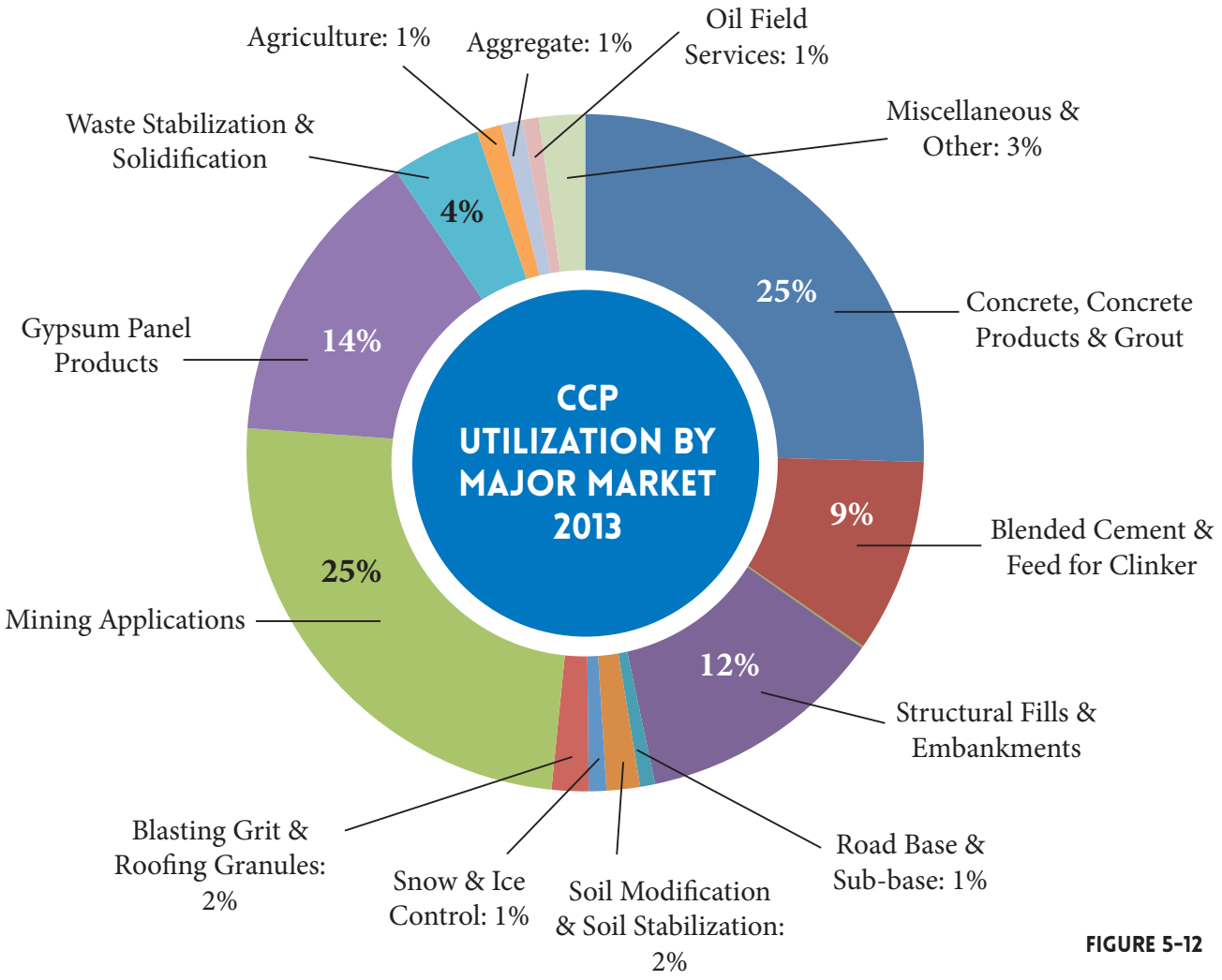


FIGURE 5-12

APPENDIX: HISTORICAL DATA TABLES

CCP TOTAL PRODUCTION (IN SHORT TONS)

YEAR	FLY ASH	BOTTOM ASH	BOILER SLAG	ALL FGD MATERIALS	FBC ASH	TOTAL CCPs
1974	40,400,000	14,300,000	4,800,000			59,500,000
1975	42,300,000	13,100,000	4,600,000			60,000,000
1976	42,800,000	14,300,000	4,800,000			61,900,000
1977	48,500,000	14,100,000	5,200,000			67,800,000
1978	48,300,000	14,700,000	5,100,000			68,100,000
1979	57,500,000	12,500,000	5,200,000			75,200,000
1980	48,310,000	14,450,000	3,640,000			66,400,000
1981	50,260,000	12,870,000	5,180,000			68,310,000
1982	47,910,000	13,130,000	4,370,000			65,410,000
1983	47,150,000	12,730,000	3,940,000			63,820,000
1984	51,320,000	13,620,000	4,210,000			69,150,000
1985	48,310,000	13,150,000	3,650,000			65,110,000
1986	49,260,000	13,410,000	4,130,000			66,800,000
1987	50,113,178	14,715,570	4,115,899	14,204,638		83,149,285
1988	50,905,161	14,272,459	5,025,540	13,526,701		83,729,861
1989	53,383,591	14,205,221	4,267,563	15,603,436		87,459,811
1990	48,931,722	13,705,653	5,234,316	18,932,688		86,804,379
1991	51,300,000	13,300,000	6,050,000	18,100,000		88,750,000
1992	48,061,898	13,917,623	4,112,796	15,883,538		81,975,855
1993	47,756,492	14,215,711	6,228,523	20,340,130		88,540,856
1994	54,835,570	14,827,165	3,785,852	15,545,068		88,993,655
1995	54,166,769	15,224,269	2,806,557	19,974,829		92,172,424
1996	59,355,009	16,060,762	2,568,349	23,854,328		101,838,448
1997	60,264,791	16,904,663	2,741,614	25,163,394		105,074,462
1998	62,995,872	16,760,091	2,980,627	25,002,877		107,739,467
1999	62,699,947	16,875,991	2,890,843	24,608,099		107,074,880
2000	62,943,732	16,915,826	2,684,889	25,652,994		108,197,441
2001	68,123,551	18,788,004	2,536,195	28,482,792		117,930,542
2002	76,500,000	19,800,000	1,919,579	29,235,394	1,248,599	128,703,572
2003	70,150,000	18,100,000	1,836,235	30,861,618	796,718	121,744,571
2004	70,800,000	17,200,000	2,202,296	31,395,426	867,397	122,465,119
2005	71,100,000	17,600,000	1,957,392	31,102,263	1,366,438	123,126,093
2006	72,400,000	18,600,000	2,026,066	30,188,146	1,580,912	124,795,124
2007	71,700,000	18,100,000	2,072,695	33,162,242	6,092,756	131,127,693
2008	72,454,230	18,431,297	2,028,455	33,672,068	9,487,057	136,073,107
2009	63,000,000	16,600,000	2,176,054	31,181,736	12,524,796	125,482,586
2010	67,700,000	17,800,000	2,332,944	32,080,506	10,267,914	130,181,364
2011	59,900,000	16,500,000	2,002,764	38,428,388	13,246,123	130,077,275
2012	52,100,000	14,100,000	1,720,945	31,985,517	9,843,922	109,750,384
2013	53,400,000	14,450,000	1,355,939	35,159,926	10,326,745	114,692,610

APPENDIX: HISTORICAL DATA TABLES

CCP TOTAL UTILIZATION (IN SHORT TONS)

YEAR	FLY ASH	BOTTOM ASH	BOILER SLAG	ALL FGD MATERIALS	FBC ASH	TOTAL CCPs	UTILIZATION RATE - TOTAL CCPs
1974	3,400,000	2,900,000	2,400,000			8,700,000	14.6%
1975	4,500,000	3,500,000	1,800,000			9,800,000	16.3%
1976	5,700,000	4,500,000	2,200,000			12,400,000	20.0%
1977	6,300,000	4,600,000	3,100,000			14,000,000	20.6%
1978	8,400,000	5,000,000	3,000,000			16,400,000	24.1%
1979	10,000,000	3,300,000	2,400,000			15,700,000	20.9%
1980	6,420,000	4,260,000	1,750,000			12,430,000	18.7%
1981	9,410,000	4,070,000	2,930,000			16,410,000	24.0%
1982	7,950,000	3,630,000	1,970,000			13,550,000	20.7%
1983	7,520,000	2,760,000	2,530,000			12,810,000	20.1%
1984	10,430,000	2,960,000	2,650,000			16,040,000	23.2%
1985	11,390,000	4,100,000	2,380,000			17,870,000	27.4%
1986	8,776,000	3,585,000	2,145,000			14,506,000	21.7%
1987	11,049,576	4,769,054	2,436,178	1,021,032		19,275,840	23.2%
1988	11,364,244	5,433,161	2,833,348	930,210		20,560,963	24.6%
1989	10,153,399	4,848,288	2,518,306	112,635		17,632,628	20.2%
1990	12,420,163	5,360,104	3,252,220	215,852		21,248,339	24.5%
1991	13,200,000	5,000,000	3,600,000	350,000		22,150,000	25.0%
1992	13,071,114	3,870,241	3,089,714	289,774		20,320,843	24.8%
1993	10,507,824	4,231,249	3,424,017	1,163,076		19,326,166	21.8%
1994	12,930,690	5,082,966	3,117,838	944,182		22,075,676	24.8%
1995	13,562,813	5,068,493	2,689,309	1,476,662		22,797,277	24.7%
1996	16,234,488	4,868,253	2,396,070	1,656,132		25,154,943	24.7%
1997	19,317,362	5,096,905	2,578,851	2,183,363		29,176,481	27.8%
1998	21,105,468	5,239,184	2,387,737	2,494,262		31,226,651	29.0%
1999	20,793,473	5,420,676	2,363,464	4,452,405		33,030,018	30.8%
2000	20,076,909	4,937,908	2,321,568	4,824,727		32,161,112	29.7%
2001	22,004,955	5,712,398	1,818,473	7,583,495		37,119,321	31.5%
2002	26,628,881	7,689,589	1,549,972	8,701,404	953,410	45,523,256	35.4%
2003	27,136,524	8,247,273	1,756,004	8,980,981	263,623	46,384,405	38.1%
2004	28,068,970	8,152,469	1,973,385	10,421,603	473,391	49,089,818	40.1%
2005	29,118,454	7,541,972	1,890,809	10,116,747	944,559	49,612,541	40.3%
2006	32,423,569	8,378,494	1,690,999	10,631,817	1,078,291	54,203,170	43.4%
2007	31,626,037	7,303,538	1,663,980	10,302,014	5,143,436	56,039,005	42.7%
2008	30,142,274	8,076,255	1,689,892	11,820,549	8,864,690	60,593,660	44.5%
2009	24,716,665	7,000,665	1,834,257	10,342,050	11,748,374	55,642,011	44.3%
2010	25,723,217	7,541,732	1,418,996	11,921,473	8,732,008	55,337,426	42.5%
2011	22,975,450	6,082,407	1,374,716	13,733,186	12,406,559	56,572,318	43.5%
2012	23,205,204	5,474,167	1,437,556	12,855,313	8,914,774	51,887,014	47.3%
2013	23,321,230	5,640,693	909,066	12,934,146	8,794,240	51,599,375	45.0%

Includes both internal and external utilization, which was captured separately through 1994.

APPENDIX: HISTORICAL DATA TABLES

UTILIZATION OF CCPs BY MAJOR MARKET (IN SHORT TONS)

YEAR	CONCRETE, CONCRETE PRODUCTS & GROUT	BLENDED CEMENT, FEED FOR CLINKER	FLOWABLE FILL	STRUCTURAL FILLS & EMBANKMENTS	ROAD BASE & SUB-BASE	SOIL MODIFICATION & STABILIZATION	SNOW AND ICE CONTROL	BLASTING GRIT & ROOFING GRANULES
1980	3,230,000			1,990,000	860,000			1,810,000
1981	3,920,000			4,950,000	930,000		1,110,000	1,180,000
1982	3,190,000			3,930,000	1,075,000		1,350,000	750,000
1983	4,372,000			2,780,000	932,000		651,000	1,560,000
1984	6,130,000			2,740,000	847,090		1,114,000	1,240,000
1985	5,665,000			3,230,000	1,228,000		984,000	1,412,000
1986	5,340,000			3,411,000	1,099,000		734,000	1,591,000
1987	7,255,559			2,377,390	772,385		883,915	1,604,985
1988	7,101,759			3,190,085	663,268		1,151,338	1,934,023
1989	6,884,289			2,651,372	1,391,804		719,769	1,807,418
1990	7,987,651			4,176,336	2,064,815		1,717,304	1,836,845
1991	8,725,000			3,700,000	1,875,000		1,900,000	1,966,666
1992	7,896,343			2,688,955	2,385,363		793,823	2,062,656
1993	7,431,940		383,003	1,142,350	2,756,085		1,203,600	2,720,718
1994	8,334,138		741,860	1,776,549	1,710,108		1,019,875	2,719,558
1995	7,813,821		357,263	1,760,889	1,204,122		719,875	2,185,990
1996	8,860,150		367,579	2,940,755	1,590,527		780,245	2,342,450
1997	10,239,786		401,418	4,346,622	2,722,774		779,672	2,448,330
1998	11,215,311		399,031	4,042,372	3,134,635		767,320	2,359,872
1999	11,086,908	1,425,027	860,456	5,219,512	2,342,026	110,634	1,162,262	2,289,131
2000	11,357,204	1,307,724	759,085	4,545,144	2,137,850	139,803	892,990	2,245,560
2001	13,628,275	1,226,678	811,142	4,574,749	1,675,785	850,548	871,707	1,530,028
2002	13,090,433	2,806,977	455,018	6,686,630	2,247,131	1,003,254	778,712	1,640,125
2003	12,679,134	3,954,504	156,945	8,187,469	1,661,388	773,076	788,184	1,497,744
2004	15,239,721	3,482,892	179,735	8,085,768	1,587,290	712,173	923,603	1,817,550
2005	16,353,334	4,215,234	250,234	8,349,999	1,461,992	1,139,640	547,541	1,633,407
2006	17,194,884	5,358,457	109,357	11,702,561	1,648,451	1,018,943	372,656	1,759,940
2007	14,515,690	4,989,988	114,979	10,598,118	1,179,509	1,371,228	781,346	1,449,561
2008	14,015,616	4,198,198	74,794	11,501,247	1,802,025	1,251,968	700,913	1,637,867
2009	10,610,410	3,577,726	398,198	8,856,396	968,291	957,116	302,827	1,743,621
2010	11,669,321	4,133,191	201,733	9,116,218	964,455	966,806	590,714	1,363,969
2011	12,282,718	4,209,009	210,288	7,883,521	1,153,675	1,112,438	464,444	1,390,457
2012	12,580,260	5,324,445	150,544	5,403,116	547,511	510,254	256,128	1,183,854
2013	13,120,252	4,774,924	44,142	6,152,569	366,861	823,017	432,884	906,683

Note: Data for 1980 does not include 2.67 million short tons for "other uses" that is included in the total utilization number. This was the only year that included this additional category.

APPENDIX: HISTORICAL DATA TABLES

UTILIZATION OF CCPs BY MAJOR MARKET (IN SHORT TONS)

YEAR	MINING APPLICATIONS	GYPSUM PANEL PRODUCTS	WASTE STABILIZATION & SOLIDIFICATION	AGRICULTURE	AGGREGATE	OIL FIELD SERVICES	MISC.	GROUT	ASPHALT	TOTAL UTILIZATION
1980	160,000						1,190,000	360,000	160,000	12,430,000
1981	70,000						3,730,000	390,000	130,000	16,410,000
1982	110,000						2,700,000	290,000	160,000	13,555,000
1983	170,000						2,070,000	170,000	104,000	12,809,000
1984	120,000						3,050,000	670,000	134,000	16,045,090
1985	1,020,000						3,980,000	290,000	80,000	17,889,000
1986	27,000						1,905,000	190,000	209,000	14,506,000
1987	444,579	157,147					5,509,420	129,124	141,339	19,275,844
1988	613,025	16,951					5,327,323	175,813	387,397	20,560,982
1989	22,190	72,277					3,632,956	242,341	208,211	17,632,628
1990	61,798	43,947					2,871,062	338,864	149,705	21,248,328
1991	216,663	100,000	400,000				2,850,000	200,000	216,666	22,149,996
1992	83,395	202,858	545,362				3,168,148	35,718	458,222	20,320,844
1993	29,692	633,526	736,938				1,984,847	146,299	157,168	19,326,166
1994	257,724	533,941	254,359				4,476,325	17,044	234,195	22,075,676
1995	726,753	741,616	980,683	14,681			6,155,832		135,752	22,797,276
1996	843,506	887,064	2,241,686	27,089			4,026,240		247,651	25,154,942
1997	1,680,895	1,603,762	3,339,743	98,412			989,800		525,264	29,176,478
1998	2,163,365	1,814,944	3,641,421	102,812			1,158,302		427,266	31,226,652
1999	1,923,216	3,053,268	2,013,749	137,052			1,172,852		233,925	33,030,018
2000	1,700,949	3,328,651	2,043,095	94,649			1,373,926		234,482	32,161,112
2001	1,078,264	6,224,872	1,555,595	157,199			2,806,031		128,448	37,119,320
2002	3,841,080	7,247,856	3,467,327	86,021	687,525		1,240,415		240,739	45,519,244
2003	2,330,032	7,780,906	3,999,623	50,487	687,839		1,741,411		84,010	46,372,752
2004	1,692,313	8,148,078	2,774,563	216,012	458,856		3,630,015		129,975	49,078,544
2005	1,132,945	8,178,079	2,839,954	415,741	872,776		2,071,154		140,838	49,602,868
2006	1,338,391	7,579,187	2,796,015	251,775	918,788		2,052,953		90,970	54,193,328
2007	6,701,910	8,254,849	2,800,031	180,100	1,013,373		1,973,173		102,723	56,039,005
2008	10,466,272	8,533,732	3,784,546	320,863	901,462		1,120,232		265,587	60,575,320
2009	14,897,415	7,288,755	3,738,799	388,990	574,083		1,323,172			55,625,800
2010	12,723,659	7,661,636	3,410,941	508,721	588,912		1,437,150			55,337,424
2011	15,897,089	7,110,921	2,751,974	612,365	624,806		868,613			56,572,320
2012	12,812,131	7,641,625	3,053,301	683,610	393,692	602,339	744,204			51,887,016
2013	12,676,264	7,446,839	2,186,926	598,105	524,088	413,210	1,132,611			51,599,375

Note: Data for 1980 does not include 2.67 million short tons for "other uses" that is included in the total utilization number. This was the only year that included this additional category.

METHODOLOGY AND SOURCES

The primary source of data on CCP production and utilization is the American Coal Ash Association (ACAA), which began collecting data in 1966. ARTBA used the published reports from 1977 through 2013 to analyze the overall market. Relationships between the CCP data and other economic factors, including electricity demand and generation, U.S. recessions and changes in markets for CCPs, were analyzed using economic models. Although this study does not include the results of this econometric analysis, they were used as the basis for a 20-year forecast for CCP production and use in a companion document.

In the original 1977 report, data was reported on fly ash, bottom ash and boiler slag. Through the 1994 report, utilization was reported for internal and external (or commercial) use. In this analysis we have combined these two categories, since the goal is to capture the total beneficial use.

In the 1980 report, ACAA captured two additional utilization categories, entitled "Ash Removed From Plant Sites At No Cost to Utility" and "Ash Utilized After Disposal Costs." Both of these totals are included with the commercial and internal utilization for the grand total of CCPs utilized in that year. This was the only year those two additional categories were included. Thus the total utilization categories in the appendix in 1980 do not add up to the final utilization number that year.

Although ACAA captures the beneficial use of CCPs by detailed end markets prior to 1980, the categories differ from future reports. Thus most of the end market analysis in the report, for the beneficial use, is for 1980 to 2013.

In the 1984 report ACAA listed comparative results at the bottom of the report and included total CCPs produced and utilized in previous years. On this report, the 1983 totals are different form the published 1983 report. There is no note of a revision, so we have included data from the original 1983 report for this analysis.

In 1987 ACAA began capturing data on FGD sludge. This category was renamed FGD by-product in 1988, FGD sludge in 1989 and FGD material in 1990. In 2002, ACAA classified FGD materials as FGD Gyspum, FGD Material Wet Scrubbers, FGD Material Dry Scrubbers and FGD Other. For the purposes of this report, we have combined all FGD related categories into one total.

There are a few minor discrepancies in the 1988 published ACAA report, where individual totals for fly ash, bottom ash, boiler slag and FGD gypsum utilization in the external markets are slightly different from the published subtotals. In most cases, the subtotals are off by less than ten tons of material. We have used the sum of the utilization reported, so the total we include in the year 1988 for utilization is slightly different (20,560,982 short tons versus the original 20,560,963 short tons) that was in the original report.

Several external and internal utilization totals were estimated by ARTBA for the 1991 analysis. For several end use markets, the ACAA published report includes "<50,000" or "<100,000" instead of specific totals. We estimated these numbers based on the total utilization reported, so all final totals add up to the total production and utilization reported for the year.

The 1994 ACAA report (as well as the 1999 and 2001 report) split CCPs into dry and ponded categories. The data reported for that year in this analysis is for the combined total in the ACAA published report.

In 2007, ACAA included data on FBC ash collected by a Pennsylvania association of 14 power producers, ARIPPA. The published report included total utilization and production both with and without the additional FBC Ash totals. We included the ARIPPA data in the 2007 numbers. From 2008 onward, the ARIPPA totals were not reported separately, and folded into the total ACAA report.

In 2013, the total utilization numbers used in this report for boiler slag, FGD material and FBC ash are slightly different from the published totals in the ACAA annual survey. The total utilization numbers reported by ACAA are different from the individual sum of utilization by major category. This report uses the sum of all the individual utilizations listed on the ACAA report as the total utilization for boiler slag, FGD material and FBC ash. For example, the boiler slag total utilization reported by ACAA in 2013 is 897,185 short tons, but adding up the individual ACAA published numbers for boiler slag utilization in the soil stabilization (1,000), snow and ice (11,797), blasting grit (884,861), waste (727) and aggregate (10,681) categories, the total utilization would be 909,066 short tons.

Additional market data is from the U.S. Energy Information Association, the U.S. Geological Survey and the U.S. Census Bureau.

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Appendix D

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April 1, 2015

Via E-Mail and Hand Delivery

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Re: Computational Error Requiring Correction of Coal Combustion Residuals Rule

Dear Messrs. Stanislaus and Johnson,

I am writing on behalf of Headwaters Resources, Inc. to let you know that we have identified a computational error that we believe will require an important change in the rule language in the new coal ash combustion residuals (CCR) rule. Specifically, subparagraph 4 of the definition of "beneficial use of CCR" in new 40 CFR §257.53 provides:

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

Under this rule, if a project involves the beneficial use of less than 12,400 tons of unencapsulated CCR, a risk demonstration is not required. As explained at pages 176 to 182 of the pre-publication version of the CCR final rule, the 12,400 ton threshold is intended to represent the capacity of the smallest CCR landfill in the United States as reflected in the two databases that EPA relied upon in its Notice of Data Availability (NODA) at 78 Fed. Reg. 46,940 (August 2, 2013) when EPA considered adopting a size criterion.[1] There is a critical mistake in the data entry EPA relied upon to identify the smallest landfill. The entry should have been in cubic feet but instead it almost certainly was entered in cubic yards, thus causing this landfill to appear to be 27 times smaller than it actually is since 1 cubic yard equals 27 cubic feet. We will explain this mistake below in more detail.

Based on discussions we have had with EPA staff, the 12,400 ton threshold in the rule was taken from the attached "Landfill_Dim" spreadsheet dated August 8, 2013, which was developed by the Office of Water. EPA staff confirmed that 12,400 tons represents the capacity of the landfill at plant 8752, which was referred to as the "Bangor" landfill. On page 6 of this spreadsheet, the "As Built" landfill size is shown as 2.3 acres with a depth/height of 91.5 ft. An acre is 43,560 sq. ft. Thus, this landfill covers an area of 100,188 sq. ft. (2.3 acres x 43,560 sq. ft./acre). If the landfill were a perfect cube, i.e., 91.5 feet deep/high all around, the total volume would be 9,167,202 cu. ft. (100,188 sq. ft. x 91.5 ft.). Instructions to this database Questionnaire state that the landfill volume was to be entered as cubic feet. (See attached page from Questionnaire.) The volume of this Bangor landfill under the column "Ldfl__Vol" in the attached Office of Water spreadsheet, however, is shown as 280,830, not the 9,167,202 cu. ft. or any number close to it. We suspect the landfill owner who filled out the Questionnaire mistakenly stated the volume of the landfill in cubic yards instead of cubic feet. In fact, if the landfill were a perfect cube it would be 339,526 cu. yd. (9,167,202 divided by 27 cu. ft., since I cu. yd. = 27 cu.ft.) The database shows the volume to be 280,830, which almost surely is intended to be a cu. yd. measurement reduced somewhat because a landfill will have sloped sides and is not a perfect cube. In fact, since the area of this landfill is 100,830 sq. ft. (2.3 acres x 43,560 sq. ft./acre), if the 280,830 were a good number, it would mean that the landfill was built to receive only about 2.8 feet of CCR, since 2.8 feet multiplied by 100,188 sq. ft. would equal about 280,830 cu. ft. Obviously, this landfill and all landfills are built to receive more than 2.8 feet of waste.

Apparently believing that this Bangor landfill only had 280,830 cubic <u>feet</u> capacity, EPA multiplied that amount by 88 lbs./cu. ft., which is the weight we have been told EPA considers a square foot of CCR to be, then converted that to tons (2000 lbs. = 1 ton).[2] and got a result of 12,356 tons, which it rounded to 12,400 tons. This is the threshold value EPA uses in its Rule. But because the entry of 280,830 is 27 times smaller than it should have been, the true capacity of this Bangor landfill is closer to 333,612 tons (27 cu. ft./1 cu. yd. x 12,356 tons).

Since this Bangor landfill is clearly not the smallest landfill, we have reviewed both of the NODA databases to try to determine what is the smallest landfill based on correctly entered data.

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[1] EPA acknowledges at page 181 of the pre-publication version that *"...based on the current rulemaking record, EPA lacks the information necessary to demonstrate that unencapsulated uses in smaller amounts [than the smallest CCR landfill] are likely to present a risk. In other words, the evidence relating to these uses is not sufficient to shift the burden to the potential user to affirmatively demonstrate the safety of the proposed use."*

[2] Using 88 lbs/cu. ft. as the weight of CCR, the weight of a cubic yard of CCR would be 2,376 (88 lbs. x 27 cu. ft./1 cu. yd.). Dividing that by 2,000 lbs./ton results in a cubic yard of CCR weighing about 1.2 tons.

Starting with the Office of Water's 2013 database, we expanded and color-coded that database in a new "Corrected Office of Water Database," which is attached. First, we understand that negative entries in this Office of Water database represent no response or uncertain responses that EPA received. These are shaded in pink in the attached Corrected Database, and are not further considered in this analysis. We then checked whether the amounts in the "Ldfl_Vol" column F reflect cubic feet or mistakenly reflect cubic yards. To do that, we multiplied the value in column E "Ldfl_SA," which represents the acreage, by 43,560 sq. ft., which is the number of square feet in an acre. The results are shown in new column H "Landfill Sq. Ft.." We then multiplied that amount by the depth/height of the landfill as shown in the column G "Ldfl_Ht," which results in a cubic foot volume. Those values are shown in new column I "Landfill Sq. Ft. x Ht./Depth." If the new value in column I for a specific landfill is clearly much greater (i.e., ≥ 200%) than the amount shown in the "Ldfl_Vol" column F for that landfill, we show in column K that the computation diverges by more than 200%. Based on that, we conclude that there was a computational error for that landfill wherein the value was entered in cubic yards instead of cubic feet. To correct this, we have multiplied the amount that appears in the "Ldfl_Vol" column F by 27 (1 cu. yd. = 27 cu. ft.), and entered that result in column M "Corrected Cu. Ft. Vol." Each landfill row that has been corrected is also highlighted in yellow. For landfills that appear to have had correct volume entries (i.e. < 200% difference), we have imported their values from column F "Ldfl_Vol" into new column M. This enables us to order this spreadsheet showing the smallest to largest positive cubic foot volume number in column M for all landfills, i.e., those that have corrected entries and those that did not need correction. As you will see, the smallest positive landfill in this Corrected Office of Water Database is the landfill at Plant 6602 with a current (as opposed to "as-built") capacity of 1,700,000 cubic feet. When multiplied by 88 pounds per cubic foot and divided by 2,000 lbs./ton, this now smallest landfill based on current capacity in this Office of Water database has a capacity of 74,800 cubic tons.[3]

The second database that was used in the NODA is also attached. It was introduced with the 2010 proposed rule, and it shows that the landfill with the smallest capacity is the Big Stone landfill at facility ID number 15. That landfill has a capacity of 80,000 cubic yards. This is equivalent to 95,040 tons (80,000 cu. yds. x 27 cu. ft./cu. yd. x 88 lbs./cu. ft. ÷ 2000 lbs./ton).

In summary, the 12,400 ton threshold is clearly a mistake and appears to have resulted from the data being entered in cubic yards instead of cubic feet. Instead, it appears that the smallest landfill based on current capacity in the two databases would be the landfill at Plant 6602 with a capacity of 74,800 tons. EPA should make this correction to the Rule before it is published in the Federal Register, or shortly afterwards as part of a technical correction notice, and in all cases, the Rule should be corrected before the 90 day period expires in which a petition for review challenging the Rule would have to be filed.[4]

---

[3] When EPA mistakenly identified the smallest landfill as the Bangor landfill at Plant 8752, it chose to use the "As Built" volume of 280,830 instead of the smaller "Current" or "At Closure" volumes of 215,900. (See page 6 of attached "Landfill_Dim" Office of Water spreadsheet.) The corrected smallest landfill at Plant 6602 only has a reported "Current" volume of 1,700,000 cu. ft. Rather than using this "Current" volume, EPA may want to find out what is the "As Built" volume at this landfill and use that value, or use the lowest "As Built" volume it has in this database, which would be 3,500,000 cu. ft. for the landfill at Plant 3157.

[4] In footnote #1 of its August 30, 2013 comments on the August 2, 2013 NODA, Headwaters Resources, Inc. noted that the Office of Water database appeared to contain numerous incorrect unit measurement entries.

Please let me know if you have any questions regarding anything in this letter or need additional information.

Respectfully submitted,

Kenneth M. Kastner
Counsel to Headwaters Resources, Inc.

Attachments

cc: Steve Souders (via email only at Souders.Steve@epa.gov)

1.5. A Comprehensive Survey of Coal Ash Law and Commercialization: Its Environmental Risks, Disposal Regulation, and Beneficial Use Markets, National Association of Regulatory Utility Commissioners (NARUC, 2020)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

A COMPREHENSIVE SURVEY OF COAL ASH LAW AND COMMERCIALIZATION:

Its Environmental Risks, Disposal Regulation, and Beneficial Use Markets

National Association of Regulatory Utility Commissioners | January 2020

Maria Seidler

Ken Malloy

Acknowledgments and Disclaimers

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Table of Contents

Section 1: Executive Summary 1

Section 2: Introduction 5

Section 3: Coal Ash Spills and Setting the Regulatory Stage 7

Section 4: Coal Ash and Its Legacy 10

A. Facts about Coal Ash 10

B. Surface Impoundments: Compromised Structures 12

C. CCR Units: Groundwater Exposure 14

D. Coal Ash Toxicology 16

Section 5: Federal Framework for Regulating Coal Ash Disposal 18

A. Pre-Kingston Spill 18

1. Legislative Origins of EPA's Regulatory Authority 18
2. EPA's Follow-through of Its Legislative Directive 20

B. Post-Kingston Spill 22

C. EPA's Final Rule: National Minimum Criteria for Coal Ash Disposal 23

1. Who Must Comply 24
2. Key Technical Criteria Required for CCR Units' Continued Operations 26
3. Closure of Non-Compliant CCR Units and Post-Closure Care 29
4. inal Rule Compliance Deadlines and Timelines for Closure 34

D. Coal Ash Regulation under the Clean Water Act (CWA) 35

1. CWA's Effluents Limits Guidelines and NPDES Permit Program 35
2. CWA and Coal Ash Leachate Risk to Groundwater 38

Section 6: State Environmental Regulatory Role in Coal Ash Management 40

A. RCRA's Self-Implementing Enforcement before WIIN 40

B. WIIN: A New Federal and State Cooperative Enforcement 41

C. Individual State Actions on Coal Ash Permitting 42

1. WIIN State Permit Programs 42
2. Recent State Coal Ash Legislation Post-Final Rule 43
3. Standard State Permitting Process 46

Section 7: Coal Ash Products and Beneficial Uses **48**
A. CCPs and Their End Uses 48
B. Commercialization of Coal Combustion Byproducts 52
1. CCP Market History and Present Sales 52
2. Future Commercial CCP Uses 54
3. Rare Earth Elements 56
C. Beneficial Use Exemption from RCRA Disposal Criteria 62
1. RCRA Conservation Objective 62
2. Encapsulated Beneficial Use versus Unencapsulated Beneficial Use 63
3. EPA's Final Rule Definition of Beneficial Use 64
D. Temporary Storage for Beneficial Use 68
E. Disposal versus Storage and Warehousing for Future Beneficial Use 69

Section 8: PUC Challenges with Utility Cost Recovery Applications **73**
A. Ratemaking Implications for Utility Recovery of CCR Compliance Costs 73
B. North Carolina Rate Case: Leading the Way on CCR Costs Recovery 79
1. Known and Measurable 80
2. Just and Reasonable and Prudency 80
3. Used and Useful 81
4. Cost Causation 83
5. Operating versus Capital Expenses 83
C. Addressing Future Coal Ash Costs in the Present 85
D. Afterthoughts for Regulatory Consideration 86

Section 9: Conclusion **87**

Table of Figures

Figure 1: Illustration of Coal Generation Process 10
Figure 2: Top 10 States with Heaviest Concentration of Coal Ash Impoundments 11
Figure 3: EPA Classifications of Reviewed Coal Ash Impoundments 12
Figure 4: EPA Ranking of Utility-Owned Impoundments by State 13
Figure 5: Regulated Coal Dumps Producing Groundwater Monitoring Data 14
Figure 6: Health Effects of Common Coal Ash Constituents 16
Figure 7: Constituents Targeted in EPA Final Rule 17
Figure 8: CCR Landfill Restricted Locations 26
Figure 9: Fugitive Dust Control Plan Example 27
Figure 10: CCR Groundwater Monitoring Phases 28
Figure 11: Engineered Capping System Example 30
Figure 12: Overview of Closure by Removal 32
Figure 13: Coal Ash Pond Types by Region 34
Figure 14: Typical CCR Wastewater Management 35
Figure 15: Typical Future CCR Wastewater Management 32
Figure 16: Transportation Requirements Associated with CCRs 44
Figure 17: 2017 Coal Combustion Product Production & Use Survey Report 51
Figure 18: CCP Market Growth, 1991 – 2017 53
Figure 19: CCP Eco-Industrial Park Concept 56
Figure 20: Rare Earth Elements 57
Figure 21: Major End Uses of Light Rare Earths 58
Figure 22: Major End Uses of Heavy Rare Earths 58
Figure 23: Prices of Selected Rare Earth Element Ores 59
Figure 24: Summary Flowchart of the Beneficial Use Methodology 67
Figure 25: Byproduct Lifecycle and Impacts 70

SECTION 1:
Executive Summary

This white paper, ***A Comprehensive Survey of Coal Ash Law and Commercialization:*** *Its Environmental Risks, Disposal Regulation, and Beneficial Use Markets* (Comprehensive Survey) was commissioned by the National Association of Regulatory Utility Commissioners (NARUC) under a grant from the U.S. Department of Energy (DOE), in response to a major rule, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule* (Final Rule) issued by the U.S. Environmental Protection Agency (EPA) on April 17, 2015,[1] on coal ash disposal and remediation of disposal sites, which has significant implications to states. It subjects state environmental agencies and public utility commissions to regulatory responsibilities to implement federal regulations under the Final Rule and oversee the cost implications on electric customers. Members of the NARUC Subcommittee on Clean Coal and Carbon Management, along with DOE and NARUC staff and other state public utility commissioners, helped to conceptualize and guide this resource as a tool to assist state public utility commissions in understanding markets, regulations, and policy relevant to coal ash, including recent EPA rulemakings.

The EPA issued its Final Rule, using its authority over the management of hazardous and nonhazardous waste under the Resource Conservation and Recovery Act (RCRA[2]) to establish national minimum criteria for the disposal of coal combustion residuals (CCR) or coal ash as a nonhazardous waste. The Final Rule promulgates complex and technical criteria for the management of active coal ash disposal facilities and for closing facilities that cannot comply with the criteria, in addition to providing a regulatory exception for recycling and reuse activities that qualify as a beneficial use of CCR.

To better evaluate the regulatory issues underlying the choices facing utilities and independent power producers (IPPs) regarding coal ash management options under the Final Rule, an overview of coal ash production and disposal practices is helpful. This comprehensive survey provides background information on the following topics: (a) coal ash production by a coal combustion generation plant, (b) the historical practices of utility waste management practices, (c) coal ash toxicity and related constituents, (d) further understanding of potential impacts to groundwater, and (e) the aging structures and outdated designs of coal ash surface impoundments and landfills.

Together with the background provided in the overview, the history of regulatory oversight of coal ash waste establishes a foundation for understanding the regulatory drive to address the environmental risks of coal ash that resulted in the 2015 Final Rule. The question of regulating coal ash waste was first raised in relation to RCRA that was enacted in 1976 to address increasing concern that open dumping practices being used for municipal and industrial waste streams that qualified as hazardous waste risked public exposure to chemical and toxic substances. It was amended in 1984 by the Hazardous and Solid Waste Amendments (HSWA[3]) to add subtitle D, which prohibits "open dumps" and established a second regulatory framework applicable to the disposal of nonhazardous waste.

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1 Final Rule, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, 80 *Federal Register* 21,302 (2015), [hereinafter *Final Rule*]. The Final Rule was signed by the EPA Administrator on Dec. 19, 2014, published in the Federal Register on Apr. 17, 2015; and became effective on Oct. 14, 2015. https://www.federalregister.gov/documents/2015/04/17/2015-00257/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric.

2 Resource Conservation and Recovery Act of 1976, 94 P.L. 580, 90 Stat. 2795 (codified as amended at 42 U.S.C. §§ 6901-6992k); amended by Solid Waste Disposal Act Amendments of 1980, 96 P.L. 482, 94 Stat. 2334 (codified at 42 U.S.C. §§ 6991-6991m); and Hazardous and Solid Waste Amendments of 1984, 98 P.L. 616, 98 Stat. 3221 (codified at 42 U.S.C. § 6924). https://www.law.cornell.edu/uscode/text/42/chapter-82.

3 Hazardous and Solid Waste Amendments of 1984, 98 P.L. 616, 98 Stat. 3221 (codified at 42 U.S.C. § 6924). https://www.law.cornell.edu/uscode/text/42/chapter-82.

The enactment of RCRA triggered a series of investigative proceedings by EPA to determine the need for regulation of coal ash as hazardous waste. The Bevill Amendment to RCRA in 1980 formalized investigations being conducted by EPA as to whether coal ash should be regulated as hazardous waste, requiring EPA to report back to Congress. Based on its investigations, EPA issued determinations in 1988,4 1993,5 and 20006 that coal ash should not be regulated as hazardous waste under RCRA subtitle C. Its 2000 Determination further announced EPA's intention to regulate coal ash waste as nonhazardous under subtitle D.

Before EPA could follow-through with its intention, the largest coal ash spill in U.S. history occurred in 2008.[7] The spill was caused by the failure of a dike at the surface impoundment sited at Tennessee Valley Authority's (TVA) Kingston generation station, highlighting the structural risks of these surface impoundments. The dike failure caused 5.4 million cubic yards of coal ash to spill into Tennessee's Emory River and across the neighboring community.[8] The environmental spillage was 100 times larger than the Exxon Valdez spill in Alaska and the BP oil spill in the Gulf Coast.

Two regulatory actions occurred following the Kingston spill. In 2010, EPA proposed its rules for regulating coal ash as nonhazardous waste[9]. EPA also commenced its *Coal Ash Surface Impoundment Integrity Assessment Program (Surface Impoundment Assessment Program)*, working with utilities and IPPs to collect data and perform on-site inspections of 676 coal ash surface impoundments at 240 generation stations.[10] However, the efficacy of EPA's assessments and on-site inspections only went so far. In the same year, 2014, that EPA published its assessments' results, the third largest spill[11] in the country occurred at Duke Energy's Dan River generation station in North Carolina, almost five years after the Kingston spill. A break in a pipe underneath the station's surface impoundment allowed 39,000 tons of coal ash slurry to escape and flow into the Dan River.[12]

Finally, in 2015, shortly after the Dan River spill, EPA issued its Final Rule, using its authority over the management of hazardous and nonhazardous waste under RCRA to designate coal ash as nonhazardous waste and to establish national minimum criteria for the disposal of coal ash, more formally referred to as coal combustion residuals (CCR). The national minimum criteria promulgated in the Final Rule and succeeding amendments are highly technical and complex and are designed to address environmental risks from groundwater contamination, structural failures of CCR surface impoundments and fugitive dust emissions and

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4 Availability of Report to Congress on Wastes from the Combustion of Coal by Electric Utility Power Plants; Public Hearings, 53 *Federal Register* 9976 (Mar. 28, 1988).

5 Final Regulatory Determination, Final Regulatory Determination on Four Large-Volume Wastes from the Combustion of Coal by Electric Utility Power Plants, 58 *Federal Register* 42,466, 42,476 (Aug. 9, 1993).

6 Regulatory Determination, Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels, 65 *Federal Register* 32,214, (2000).

7 EPA Response to Kingston TVA Coal Ash Spill, EPA (Dec. 23, 2016). https://www.epa.gov/tn/epa-response-kingston-tva-coal-ash-spill.

8 Jamie Satterfield, *Knoxville News Sentinel* (April 17, 2019), (revealing that TVA's own tests revealed radium, heavy metals in coal ash before 2008 spill). https://www.knoxnews.com/story/news/local/tennessee/tvacoalash/2019/04/17/tva-internal-records-reveal-radium-heavy-metals-found-in-coal-ash/3275139002/.

9 Proposed Rule, *Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities,* Proposed Rule, 75 *Federal Register* 35,128 (June 21, 2010).

10 *Frequent Questions about the 2015 Coal Ash Disposal Rule,* EPA (Nov. 2, 2018), https://www.epa.gov/coalash/frequent-questions-about-2015-coal-ash-disposal-rule; *also see Effort to Assess Coal Combustion Residuals (CCR) Disposal Units*, EPA (Aug. 29, 2016). https://www.epa.gov/coalash/effort-assess-coal-combustion-residuals-ccr-disposal-units.

11 The second largest coal ash spill was in Wisconsin on October 31, 2011. A cliff collapsed and tons of coal ash fell into Lake Michigan. Associated Press, "A Look at 3 of the Largest Coal Ash spills in the US" (December 19, 2014), http://www.startribune.com/a-look-at-large-coal-ash-spills-in-the-us/286393991/. This coal ash spill receives little attention in the literature of coal ash spills. Apparently, this coal ash spill was significant in order of magnitude of coal ash volume but not in environmental impact relative to cleanup, duration, and property damage.

12 Taft Wireback, "EPA Knew of Faulty Pipes at Dan River Ash Basin in 2009," *Greensboro's News & Record* (Mar. 19, 2014). https://www.greensboro.com/news/article_a21bd962-afd0-11e3-80a2-001a4bcf6878.html.

to bring transparency to coal ash disposal operations in the electric generation sector. The national minimum criteria require any non-compliant CCR landfill or CCR surface impoundment to be closed consistent with the closure minimum criteria. However, compliance has become a moving target as certain provisions of the minimum criteria were challenged in various Court of Appeals cases and EPA considers revisions as a result of these legal challenges and court decisions.

Although EPA sets national minimum criteria for the management of coal ash disposal, the major responsibility for implementing and enforcing the regulatory criteria resides with the states under RCRA. Pursuant to the *Water Infrastructure Improvements for the Nation Act of 2016 (WIIN),*[13] state environmental authorities are responsible for creating and obtaining EPA approval of a permitting program that incorporates and enforces disposal requirements that are at least as restrictive as the national minimum criteria. Once a state permit program is approved, it operates in lieu of EPA's CCR regulations. If a state does not adopt a permit program or its permit program is not approved by EPA, then EPA can implement a federal permit program and enforce permit requirements,[14] but only so long as Congress has appropriated funds for its administration. Congress appropriated the required funds for its implementation in 2018.[15] Two states, Oklahoma and Georgia, have applied for approval from EPA for their CCR permit programs pursuant to WIIN. Oklahoma's program was approved in 2018, but its approval has been challenged by environmentalists in the D.C. Federal District Court.[16] Georgia's program was approved in January 2020.[17]

Several other state legislatures have enacted their own legislative solutions to their coal ash problems that now will need to be integrated into their states' WIIN permit program. Virginia, Illinois, and Michigan enacted legislation in 2019. North Carolina enacted the Coal Ash Management Act (CAMA) in September 2014[18] following the Dan River spill. It subsequently amended CAMA in July 2016 to incorporate the national minimum criteria and performance standards of the Final Rule. CAMA provided an aggressive schedule for closing surface impoundments in North Carolina by 2029, prioritized depending on their CAMA hazardous classification.[19]

Serving as a contrast to regulation of coal ash as waste is the marketing of coal ash products as valuable resources. (See Section 7A for a detailed discussion of coal combustion products). In 2017, 64 percent of the byproducts generated by coal combustion for electricity in the United States were recycled and used in a beneficial end use. Future demand will only increase as research of new uses transition to commercial deployment, including the extraction of rare earth elements (REE) from coal ash, over which China currently has market power.

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13 42 U.S.C. § 6945(d). https://www.congress.gov/114/plaws/publ322/PLAW-114publ322.pdf.

14 EPA has submitted a proposed rule to the Office of Management and Budget on Federal permitting under the WIIN Act. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities: Federal CCR Permit Program, https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201910&RIN=2050-AH07. In March 2018 (Pub. L. 115-141) and March 2019 (Pub.L. 116-6), Congress appropriated funding for federal CCR permitting. The proposal would establish a new federal permitting program for disposal of CCR." *Id.*

15 Steven A. Burns & David W. Mitchell, *EPA's Coal Ash Rule Relies on Unique Enforcement Framework*, ABA (Mar. 1, 2015). https://www.americanbar.org/groups/environment_energy_resources/publications/trends/2014-2015/march-april-2015/epas_coal_ash_rule_relies_unique_enforcement_framework/.

16 *See e.g.* Motions for Intervention, Waterkeeper Alliance, Inc. v. Wheeler, United States District Court for the District of Columbia, Jan 29, 2019, Civil Action No. 18-2230 (JDB) (D.D.C. Jan. 29, 2019). https://casetext.com/case/waterkeeper-alliance-inc-v-wheeler.

17 Georgia: Approval of State Coal Combustion Residuals Permit Program, January 10, 2020. https://www.federalregister.gov/documents/2020/01/10/2019-27665/georgia-approval-of-state-coal-combustion-residuals-permit-program.

18 S.B. 729, 2013 Sess. (NC 2013), (including text of CAMA as ratified). https://www.ncleg.net/Sessions/2013/Bills/Senate/PDF/S729v6.pdf.

19 *See* §130A-309.214, https://www.ncleg.gov/EnactedLegislation/Statutes/PDF/BySection/Chapter_130A/GS_130A-309.214.pdf. CAMA also provides a procedure for extending these deadlines. *See* §130A-309.215, Variance authority. https://www.ncleg.gov/EnactedLegislation/Statutes/PDF/BySection/Chapter_130A/GS_130A-309.215.pdf.

Beneficial uses of coal ash, however, are not subject to regulation by EPA under RCRA. Although RCRA was designed to "conserve valuable material and energy resources by [promoting] . . . new and improved methods of collection, separation, and recovery, and recycling of solid wastes,"[20] conservation activities are exempt from direct regulation. Consequently, in promulgating national minimum criteria for coal ash disposal, EPA promulgated a definition of beneficial use[21] to differentiate those use activities that would not be classified as disposal from regulated disposal activities. EPA's beneficial use definition distinguishes between two different forms of coal ash uses, encapsulated and unencapsulated. Both forms can qualify as beneficial uses so long as the use meets the definition's conditions applicable to the respective form.

End-use customers are concerned about maintaining access to byproduct supplies with the annual production rate of coal ash declining as existing coal-fired power plants are modified, repowered or decommissioned. Utilities and IPPs are under a time deadline to comply with environmental regulations that will certainly result in even more constrained supplies while the market demand for "homegrown fly ash" increases, particularly by the cement industry.[22] The commercial beneficial use markets thus are adversely affected by the regulatory pressure to close coal ash facilities. Consequently, public and private partnerships interested in the commercial value of coal ash are working to develop methodologies for harvesting needed coal ash products from the mixed contents of older CCR units. This may require, in turn, flexibility in utility regulatory models to allow utilities to position themselves to take advantage of additional revenue streams associated with these markets, which could partially offset clean-up and compliance costs under EPA's Final Rule.

Activities taken to comply with EPA/state requirements by utilities or IPPs subject to the Final Rule will be costly. Utilities' recovery of compliance costs will usually fall within the purview of state public utility commissions. Estimates of costs range from into the millions for individual coal ash ponds to billions for some utilities, and up to possibly hundreds of billions of dollars across the country, but true cost projections will be dependent on the closure and clean-up methods that are approved by state legislatures and/or environmental regulators. Compliance costs may effectively be established at the permitting stage well before costs are reviewed by public utility commissioners, rendering after-the-fact prudency hearings a controversial issue. Although there are supporters of utility responsibility, the magnitude of costs could impact utility credit ratings and shareholders. The burden of compliance and clean-up costs constitute a difficult question for state utility regulators in allocating liability to shareholders or ratepayers.

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20 Pub. L. 89–272, § 1002(a)(4), 42 U.S. Code § 6901. https://www.law.cornell.edu/uscode/text/42/6901.

21 80 *Federal Register* at 21,329.

22 Homegrown fly ash indicates demand looking to domestic cementitious products instead of imported. "During periods of strong economic performance, the U.S. cementitious market historically has seen approximately 80% of cement produced domestically, with the remaining 20% imported. 'Homegrown fly ash' has always filled a strategic need within the cementitious market, replacing roughly 15-20% of cementitious materials, which in times of healthy economic conditions reduces the amount of cement imported." Danny Gray, Alternative Supplementary Cementitious Materials Availability – The Next 50 Years, Ash at Work, Issue 1 at 6 (2019).

SECTION 2:
Introduction

This white paper, ***A Comprehensive Survey of Coal Ash Law and Commercialization****: Its Environmental Risks, Disposal Regulation, and Beneficial Use Markets* (Comprehensive Survey) was commissioned by the National Association of Regulatory Utility Commissioners under a grant by the United States Department of Energy, in response to a major rule, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule* (Final Rule) issued by the U.S. Environmental Protection Agency (EPA) on April 17, 2015,[23] on coal ash disposal and remediation of inactive disposal sites, and its complicated antecedents and progeny.

The EPA issued its Final Rule, using its authority over the management of hazardous and nonhazardous waste under the Resource Conservation and Recovery Act (RCRA[24]) to establish national minimum criteria for the disposal of coal combustion residuals (CCR) or coal ash as a nonhazardous waste. The Final Rule promulgates complex and technical criteria for the management of active coal ash disposal facilities and for closing facilities that cannot comply with the standards, in addition to providing a regulatory exception for recycling and reuse activities that qualify as a beneficial use of CCR.

EPA, and not states, has led the regulatory assessment of CCR as hazardous or nonhazardous waste since enactment of RCRA. It issued multiple determinations finding that CCR was not hazardous and thus should not be regulated under subtitle C of RCRA. Not until its 2000 Determination did it announce its intention to pursue regulation of coal ash as nonhazardous waste. It issued a proposed rulemaking in 2010, followed by its Final Rule promulgating the national minimum criteria for management of coal ash waste disposal.

However, prior to the Final Rule, states had the major responsibility for implementing and enforcing the regulatory criteria for nonhazardous waste under RCRA. RCRA did not provide EPA authority to directly enforce its standards nor did it give EPA the authority to mandate that states enforce EPA's anti-dumping, solid waste criteria.[25] Consequently, implementation of EPA's national minimum criteria was generally reliant on a waste facility owner or operator's voluntary compliance. Its enforcement mechanism are citizen suits brought under RCRA for non-compliance with federal regulations adopted under subtitle D unless the state acted to adopt enforceable regulation and permit requirements.

In 2016, Congress addressed the Final Rule's enforcement gap by including provisions in the *Water Infrastructure Improvements for the Nation Act of 2016 (WIIN)* that would amend subtitle D's self-implementation provisions as they would otherwise apply to coal ash. WIIN allows a state to establish its own permit program which then must be submitted to EPA for approval. It can adopt EPA's national minimum criteria or adopt its own criteria for its permit program, so long as its permit program is at least as protective as EPA's federal regulations. Once a state permit program is approved, it operates in lieu of EPA's CCR regulations. However, if a state does not adopt a permit program or its permit program is not approved by EPA, then EPA can implement its own federal permit program but only so long as Congress has appropriated funds for its administration. In

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23 Final Rule, *supra* note 1.

24 Resource Conservation and Recovery Act of 1976, 94 P.L. 580, 90 Stat. 2795 (codified as amended at 42 U.S.C. §§ 6901-6992k); amended by Solid Waste Disposal Act Amendments of 1980, 96 P.L. 482, 94 Stat. 2334 (codified at 42 U.S.C. §§ 6991-6991m); and Hazardous and Solid Waste Amendments of 1984, 98 P.L. 616, 98 Stat. 3221 (codified at 42 U.S.C. § 6924). https://www.law.cornell.edu/uscode/text/42/6901.

25 Steven A. Burns & David W. Mitchell, *EPA's Coal Ash Rule Relies on Unique Enforcement Framework*, ABA (Mar. 1, 2015). https://www.americanbar.org/groups/environment_energy_resources/publications/trends/2014-2015/march-april-2015/epas_coal_ash_rule_relies_unique_enforcement_framework/.

2018, EPA received the required funding.[26] Coal ash units located in states that do not have an EPA-approved permit program would be required to obtain permits under the federal program.

Whether the minimum criteria are implemented through either a state or federal permit program, activities taken in order to comply with EPA/state requirements by utilities or IPPs subject to the Final Rule will be costly. Utilities' recovery of compliance costs will usually fall within the purview of state public utility commissions. Estimates of costs range into the millions for individual coal ash ponds, billions for some utilities, and into possibly hundreds of billions across the country, but true cost projections will be dependent on the closure and clean-up methods that are approved by state legislatures and/or environmental regulators. Compliance costs may effectively be established at the permitting stage well before costs are reviewed by public utility commissioners, rendering after-the-fact prudency hearings a controversial issue.

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Utilities are facing myriad regulatory compliance challenges that will affect (i) energy costs for ratepayers and electric customers and (ii) escalating costs for the fossil fuel aging fleet, already facing pressure to retire. In short, the challenge for state officials, including energy regulators and environmental regulators, will involve a significant balancing of environmental protection with the allocation of increasingly scarce resources, and yet, it is unclear as to where the responsibility for balancing resides. The implementation of the EPA rule will raise new and challenging issues for state officials that could have significant consequences for the environment and the price of electricity.

This Comprehensive Survey presents a broad survey of coal ash literature for the purpose of providing a context inclusive of the diverse issues and diverse perspectives on those issues associated with coal ash management for regulators and stakeholders challenged with formulating next steps in coal ash management and regulation. In Sections 3 and 4, it explores the legacy of coal ash, including environmentally catastrophic spills, and then provides a factual context of what coal ash is, including its environmental and public health risks. In Section 5, it lays out the legal framework for federal regulation under RCRA, EPA's promulgation of the Final Rule, and core provisions of EPA's national minimum criteria for coal ash disposal. Section 6 describes the shared responsibility for disposal regulation between federal and state officials under WIIN and what actions some states have taken to address coal ash issues in their state. Section 7 is, substantively, a major piece of the Comprehensive Survey. It explores the commercialization of coal ash as an alternative to coal ash disposal as a waste. It highlights the commercial and economic value of coal ash as a beneficially useful resource with a diverse and growing market demand. The environmental question of regulating coal ash as waste, which is explored in the first half of this Comprehensive Survey, is slowly converging into the broader economic question of recovering coal ash as a resource, as compared to the regulatory costs for complying with the Final Rule and states permit programs, which becomes a rate recovery issue to be decided by public utility commissions, as discussed in Section 8. Section 8 includes a detailed summary of North Carolina's approach to cost recovery as a valuable case study for other commissions that may need to respond to coal ash costs in the near future. Section 9 provides some conclusions.

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26 EPA has submitted a proposed rule to the Office of Management and Budget on Federal permitting under the WIIN Act. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities: Federal CCR Permit Program, https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201910&RIN=2050-AH07. "In March 2018 (Pub. L. 115-141) and March 2019 (Pub. L. 116-6), Congress appropriated funding for federal CCR permitting. The proposal would establish a new federal permitting program for disposal of CCR." *Id.*

SECTION 3:
Coal Ash Spills and Setting the Regulatory Stage

Coal-fired electric generation results in the second largest industrial waste stream in the country after mine wastes. EPA estimates that an average of 110 million tons of coal ash, formally referred to as coal combustion residuals (CCR), are produced annually by coal-fired electric generation.[27] Coal and the mineral content within coal deposits may contain trace toxic metals at concentration levels similar to naturally occurring soil deposits, including mercury, cadmium, and arsenic. When burning coal for electricity generation, trace elements can concentrate within the coal combustion byproducts. Over the last century, coal ash containing varied concentrations of these metals was either placed in landfills or, more frequently, was sluiced by mixing the waste stream with water and pumped into surface impoundments built near generating plants. There, the solid particle ash settles and the clarified waters are discharged under water discharge permits. The remaining coal ash slurry has been accumulating in these surface impoundment facilities for decades during the time in which cheap electricity from coal-burning plants fueled a growing economy.

Although society has benefited from the prosperity and quality of life conveniences enabled by low-cost energy, it has also struggled with the environmental impact of coal-burning plants across the country. Since the 1970s, tremendous strides have been made to control air emissions under the Clean Air Act,[28] but the growing accumulation of coal ash slurry contained in surface impoundments on coal plant sites across the country did not capture national attention until one dike holding coal ash collapsed on December 22, 2008, spilling 5.4 million cubic yards (CYs) of coal ash into Tennessee's Emory River and over 300 acres, the equivalent of filling a football field ½ mile high.[29]

The failed impoundment was located at the coal-fired Kingston Steam Plant owned and operated by the Tennessee Valley Authority (TVA). TVA claimed that the immediate cause of the dike's failure was a combination of rain totaling six inches in ten days and 12°F temperatures, but later TVA executives and its own inspector general admitted that TVA was aware of, and missed, opportunities to fix the dike's stability issues, which could have avoided the collapse.[30] TVA's lack of attention to the environmental risk posed by Kingston's impoundment resulted in $11.5 million in fines, over a billion dollars in cleanup costs, and $43 million in lieu of tax payments being paid to affected local governments from lost property and sales tax revenue.[31]

From New York

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27 Final Rule, *supra* note 1, at 21,327; for 2017 recent data, *see infra* note 46.

28 Clean Air Act, 42 U.S.C. §§7401-7642; *Overview of the Clean Air Act and Air Pollution*, EPA (Sept. 16, 2019), https://www.epa.gov/clean-air-act-overview.

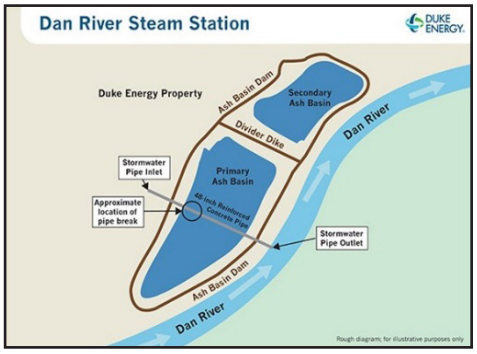
29 EPA Response to Kingston TVA Coal Ash Spill, EPA (Dec. 23, 2016), https://www.epa.gov/tn/epa-response-kingston-tva-coal-ash-spill; Photograph of Coal Ash Spill by J. Miles Carey, *Knoxville News Sentinel*, reprinted in "Coal Ash Spill Revives Issue of Its Hazards", *New York Times* (Dec. 24, 2008), https://www.nytimes.com/2008/12/25/us/25sludge.html.

30 "TVA President: 'Missed Opportunities' to Avoid Coal Ash Spill," *Huntsville Times* (Sept. 21, 2011), https://www.al.com/huntsville-times-business/2011/09/tva_president_missed_opportuni.html.

31 S.B. 729, *supra* note 18 (including text of CAMA as ratified).

After the TVA spill, EPA assiduously began field work in 2009 to implement its multi-year *Coal Ash Surface Impoundment Integrity Assessment Program* (Surface Impoundment Assessment Program). It sent multiple rounds of data requests to utilities to gather information and arranged for on-site inspections of the structural integrity of 676 surface impoundments at 240 generation stations across the country.[32] In 2014, it published the data, including the extensive correspondence between EPA and the companies on an impoundment-by-impoundment basis. Some of the early poor ratings reflected the absence of required engineering documentation, but were raised once the documentation was supplied. Other utilities began to correct instability issues in response to EPA's on-going field work and inspections of coal ash sites. However, the efficacy of inspections only went so far. At the top of the EPA's final list for poor assessments was Duke Energy[33] which owned fifteen impoundments classified as "Poor" over four states, with six in North Carolina.[34] Rated by EPA as "Fair," however, was the impoundment at Duke's Dan River generation station in North Carolina, and yet, that same year, it resulted in the third largest coal ash spill in U.S. history.[35]

The spill occurred on February 2, 2014, after the rupture of a corrugated metal stormwater pipe that ran under the primary ash pond.[36] The break in the pipe allowed 39,000 tons of ash slurry to escape and flow into the Dan River. EPA's inspectors raised concerns regarding the integrity of the pipe in a report to the EPA in 2009, but their concerns were not included into the EPA's inspection letter to Duke. Duke made improvements to the impoundment consistent with the inspection letter, but because of the lack of notice, those improvements did not include the pipe that caused the catastrophe.[37] Although the public could point to the pipe's exclusion in the EPA inspection letter to Duke, other evidence showed that Duke was aware of the pipe's vulnerability and did nothing. For example, plant staff had requested $20,000 to install a camera to monitor pipes including the one that ruptured, but management refused to approve the expenditure. As a result of this kind of evidence being presented in a federal case to hold Duke criminally liable for the spill, Duke agreed to plead guilty to nine violations of the Clean Water Act (CWA) and pay $102 million in fines and restitution.[38] However, the real lesson from both TVA and Duke's stories isn't just for utilities, but also for federal and state regulators, as well.



WFMY News

32 *See Frequent Questions about the 2015 Coal Ash Disposal Rule*, EPA (Nov. 2, 2018), https://www.epa.gov/coalash/frequent-questions-about-2015-coal-ash-disposal-rule; and *see Effort to Assess Coal Combustion Residuals (CCR) Disposal Units*, EPA (Aug. 29, 2016), https://www.epa.gov/coalash/effort-assess-coal-combustion-residuals-ccr-disposal-units.

33 Duke Energy and Progress Energy were separate companies at the time of EPA's Assessment. Duke and Progress merged into a single company in 2012. Matthew L. Wald, "Duke and Progress Energy Become Largest U.S. Utility," *New York Times* (July 3, 2012), https://www.nytimes.com/2012/07/04/business/energy-environment/duke-energy-merger-creates-largest-us-utility.html.

34 *Coal Combustion Residuals Impoundment Assessment Reports*, EPA (Apr. 19, 2016), https://archive.epa.gov/epawaste/nonhaz/industrial/special/fossil/web/html/index-4.html [hereinafter, *Assessment Reports*].

35 The second largest coal ash spill was in Wisconsin on October 31, 2011. A cliff collapsed and tons of coal ash fell into Lake Michigan. Associated Press, "A look at 3 of the largest coal ash spills in the US" (December 19, 2014) http://www.startribune.com/a-look-at-large-coal-ash-spills-in-the-us/286393991/. This coal ash spill receives little attention in the literature of coal ash spills. Apparently, this coal ash spill was significant in order of magnitude of coal ash volume but not in terms of damage caused by the spill.

36 Diagram of Dan River Steam Station, *50,000 Tons of Coal Ash Spill Into Dan River*, WFMY (Feb. 5, 2014), https://www.wfmynews2.com/article/news/local/50000-tons-of-coal-ash-spill-into-dan-river/83-298080513.

37 Taft Wireback, "EPA Knew of Faulty Pipes at Dan River Ash Basin in 2009," *Greensboro's News & Record*, (Mar. 19, 2014), https://www.greensboro.com/news/article_a21bd962-afd0-11e3-80a2-001a4bcf6878.html.

38 *Duke Energy Fined $102 Million in Coal Ash Spill*, CBS News (May 14, 2015), https://www.cbsnews.com/news/duke-energy-fined-102-million-in-coal-ash-spill/; *see also Summary of Criminal Prosecutions*, EPA (Sept. 23, 2019), https://cfpub.epa.gov/compliance/criminal_prosecution/index.cfm?action=3&prosecution_summary_id=2746.

Although the Kingston spill occurred over a decade ago, remediation continues at tremendous costs. Newspaper headlines today continue to remind the public of not only the financial and environmental costs, but also the health costs as litigation continues, claiming inadequate protection of clean-up workers' safety and health.[39] The cleanup of the Dan River spill also continues at a cost of millions. Ratepayer recovery was denied to Duke for the costs of the spill[40] and North Carolina's attorney general has contested recovery of coal ash remediation of unrelated coal ash ponds.[41] Events that traumatized local communities such as those at Kingston and Dan River have expanded public awareness of coal ash risks beyond a local concern to a national priority.

Although studied and evaluated for years, a final determination on the question of whether and how to regulate coal ash, if not as a hazardous waste, then as a solid waste, had been postponed since the enactment of RCRA. In light of the environmental risks made evident by the Kingston and Dan River spills, EPA finally acted to fulfill its obligation under the 1980 Bevill Amendment to RCRA and issued its Final Rule regulating disposal of CCR under subtitle D of RCRA in 2015. EPA determined that for purposes of regulation, coal ash was a nonhazardous waste, and so established national minimum criteria for coal ash disposal by utilities and independent power producers. Yet, the application of coal ash's new regulatory framework continues to be challenged in court, debated at the state level, and implemented at a slow pace. Stakeholders have yet to agree on the level of regulation regarding what coal ash management practices are good enough, and at what costs.

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39 "A federal jury ruled a global contractor tasked with keeping disaster clean-up workers safe instead endangered them – some fatally." Jamie Satterfield, "Jury: Jacobs Engineering endangered Kingston disaster clean-up workers," *Knoxville News Sentinel* (Nov. 8, 2018), https://www.knoxnews.com/story/news/crime/2018/11/07/verdict-reached-favor-sickened-workers-coal-ash-cleanup-lawsuit/1917514002/.

40 S.B. 729, *supra* note 18 (including text of CAMA as ratified).

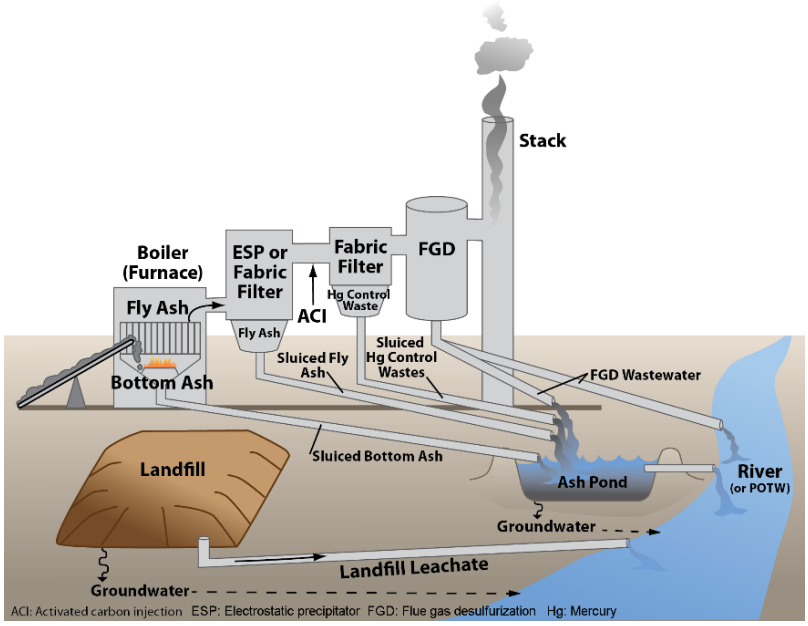
41 Deon Roberts, "NC attorney general gives reasons why Duke customers shouldn't pay for coal ash cleanup,"s *Charlotte Observer* (Apr. 26, 2019), https://www.charlotteobserver.com/news/business/banking/article229720699.html.

SECTION 4:
Coal Ash and Its Legacy

A. Facts about Coal Ash

Coal ash generally refers to what is left after coal is burned, usually for the generation of electricity. In the regulatory context, it is referred to as coal combustion residuals or CCR. Commercial markets use various CCR in manufacturing or construction because of their specific chemical or physical properties and refer to it as coal combustion products or CCPs. CCR or CCPs are individually identified at the stage at which they are produced during the generation process, as illustrated in **Figure 1.**[42] They include fly ash, bottom ash, boiler slag, and flue-gas desulfurization materials.

Figure 1: Illustration of Coal Generation Process



Individual CCPs are valued for their properties by a multitude of industries and are collected for subsequent beneficial use, a form of recycling, as they are generated. In 2017, 111.3 million tons of coal ash were generated, with 64 percent or 71.8 million tons being recycled.[43] The remainder was disposed of. Notwithstanding that the share of coal ash being recycled and reused continues to increase, coal ash is still primarily conceptualized as a solid waste requiring disposal by utilities and regulatory programs.

Coal ash may be disposed of wet or dry. Dry coal ash is disposed of in a landfill, which is simply a designated area of land for long-term disposal. EPA considers sand and gravel pits, and quarries that had occasionally been used for CCR disposal, as landfills. The Final Rule defines a landfill more through exclusion and by what it is not.[44]

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42 Diagram of Key Wastestreams, *Steam Electric Power Generating Effluent Guidelines - 2015 Final Rule*, EPA (July 5, 2019), https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines-2015-final-rule.

43 *Coal Ash Recycling Reaches Record 64 Percent Amid Shifting Production and Use Patterns*, Am. Coal Ash Ass'n https://www.acaa-usa.org/Portals/9/Files/PDFs/Coal-Ash-Production-and-Use-2017.pdf.

44 "CCR landfill means an area of land or an excavation that receives CCR and which is not a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground or surface coal mine, or a cave. For purposes of this subpart, a CCR landfill also includes sand and gravel pits and quarries that receive CCR, CCR piles, and any practice that does not meet the definition of a beneficial use of CCR." 40 C.F.R. § 257.2; *see also* Final Rule, *supra* note 1, at 21,355.

Surface impoundments are natural topographic depressions, or depressions constructed by excavation, or diked areas formed primarily of earthen materials used in the waste industry for water treatment and solid waste management, including management of coal ash. This includes wet scrubber discharge from flue gas desulfurization (FGD), as well as the wet coal ash that occurs by adding water or sluicing the CCR at a collection point in the power plant to facilitate its movement to the disposal site.

Attempting to assess the degree of risks from coal ash disposal based on the number and location of coal ash ponds and landfills on any given site can be difficult and at times confusing. Many coal plant sites included previously closed landfills and surface impoundments. Larger coal power stations may have multiple disposal units that could include both impoundments and landfills on the station's site, as reflected in the numbers cited in the bullets that follow. There are also 111 inactive units that have been reported as remaining open and thus exposed. There is no reliable source on the number of inactive units that have been closed, many of which are located at retired generation plants. Still, though dated, EPA's 2008 data published in the Final Rule provides a reference point for understanding the size of the coal ash problem.[45]

Of the 478 plants generating coal ash, 307 plants disposed of coal ash on-site using one or more form(s) of the following CCR disposal: 201 plants used on-site landfills and 169 used on-site surface impoundments, with 197 transporting coal ash to off-site landfills.[46]

- Among those 478 plant sites, there were 310 active landfills and 735 active surface impoundments;
- The average size of landfills was over 120 acres, or 90 football fields, with a depth of 40 feet; and
- The average size of surface impoundments was 50 acres, with a depth of 20 feet.

Coal ash disposal sites are not uniformly distributed across the United States. According to EPA data on utility-owned CCR units, 18 states have no surface impoundments, whereas a heavy concentration of surface impoundments can be found in a few states. The table in **Figure 2** lists the top 10 states with the heaviest concentration in the EPA dataset:[47]

Figure 2: Top 10 States with Heaviest Concentration of Coal Ash Impoundments

RANK	STATE	TOTAL IMPOUNDMENTS
1	INDIANA	74
2	ILLINOIS	51
3	MISSOURI	42
4	PENNSYLVANIA	42
5	TEXAS	38
6	KENTUCKY	36
7	NORTH CAROLINA	33
8	GEORGIA	31
9	OHIO	30
10	IOWA	29

45 Final Rule, *supra* note 1, at 21,303 & 21,309.

46 Because of definitional differences, estimates of the number of coal ash ponds differs. EPA in its 2009 to 2014 data collection focused only on electric utilities and other electric generators, and even then, it was a subset of the total number of ponds that may have existed. There are, however, industrial coal ash units that are not included in EPA data. Environmentalists often produce numbers of coal ash ponds that may differ from EPA's list of ponds covered by the Final Rule. This may be because they are counting ponds not covered by the EPA or because their analysis focuses on a subset of ponds included in the EPA Rule. Earthjustice, for example, publishes an interactive map that provides access to information on individual CCR units, *see Mapping the Coal Ash Contamination*, Earthjustice (Aug. 20, 2019), https://earthjustice.org/features/map-coal-ash-contaminated-sites [hereinafter, *Interactive Map*]. Many of the generating plants have multiple CCR units on their generation sites, and some have both landfills and surface impoundments.

47 EPA published spreadsheets that included a synthesis of information on each coal ash unit for which utilities provided information. EPA published data on over 600 coal ash units and listed the states in which the coal ash units are located. These spreadsheets were used by the authors to characterize coal ash units to derive insights about coal ash units at the state level and to re-characterize the information on coal ash units in a more global manner. The main EPA spreadsheet can be found at https://archive.epa.gov/epawaste/nonhaz/industrial/special/fossil/web/xls/summarytable_073114.xls.

B. Surface Impoundments: Compromised Structures

The size and structural stability of many of these CCR units are proportional to their long tenure of operation. Many, particularly surface impoundments, have been receiving coal ash for decades. Surface impoundments were designed to last for the operating life of coal-fired boilers, which typically was 40 years, but many were expanded in size when the coal plant continued to operate beyond their initially anticipated useful lives. This creates implications for the internal structural stability of many of these facilities. A majority are over 40 years old, with the oldest impoundment recorded by EPA, having been constructed in 1925, and now being almost 95 years old.[48] Many of the older impoundments were also not designed by professional engineers.[49] The question of their structural integrity is critical because surface impoundments are generally located adjacent to surface water. Coal plants are typically constructed near a water body that can be used as a source of cooling water and conveyance of waste. EPA's Surface Impoundments Assessment, conducted after the Kingston spill, rated 318 surface impoundments as a high or significant hazard potential for many of these reasons.[50] The several impoundments at TVA's Kingston Generating Station were between 40 and 50 years old at the time when one of the dikes failed, spilling 130 million tons of coal ash slurry into the river and neighboring community.

As part of its regular Surface Impoundment Assessment, EPA began its field survey in 2009 by sending multiple rounds of data requests to utilities to gather information. EPA further arranged for on-site inspections of the structural integrity of 676 surface impoundments at 240 generation stations across the country.[51] In 2014, it published the data submitted, including the extensive correspondence between EPA and the companies on an impoundment-by-impoundment basis. Based on the data, EPA classified the impoundments as "Satisfactory," "Fair," "Poor," "Unsatisfactory," or "Not Assessed." Utilities were given the opportunity to respond to the classifications to dispute or correct the basis for the classification, which resulted in 12 different rounds of data exchanges. The table in **Figure 3** shows the aggregate results per classification across the 559 impoundments reviewed, excluding those not assessed.

Figure 3: EPA Classifications of Reviewed Coal Ash Impoundments

EPA Rounds	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
Satisfactory	22	31	15	23	15	3	34	9	29	20	13	27	**241**
Fair	15	9	12	17	14	27	10	16	18	9	11	8	**166**
Poor	6	0	10	30	9	14	12	21	4	38	0	8	**152**
Unsatisfactory	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total # of Units Assessed	**43**	**40**	**37**	**70**	**38**	**44**	**56**	**46**	**51**	**67**	**24**	**43**	**559**

48 Based on the EPA's data, a subset of units for which age data were available showed approximately 195 active surface impoundments exceed 40 years of age; 56 units are older than 50 years, and 340 are between 26 and 40 years old. The authors derived these calculations from EPA's spreadsheet that collated the information from utilities on 676 individual coal ash units. *Information Request Responses from Electric Utilities*, EPA (Apr. 19, 2016), https://archive.epa.gov/epawaste/nonhaz/industrial/special/fossil/web/html/index-3.html#note.

49 Final Rule, *supra* note 1, at 21,327.

50 *d.*

51 Assessment Reports *supra* note 34.

Figure 4 ranks states based on EPA's data by the number of total utility-owned impoundments within their respective border:

Figure 4: EPA Ranking of Utility-Owned Impoundments by State

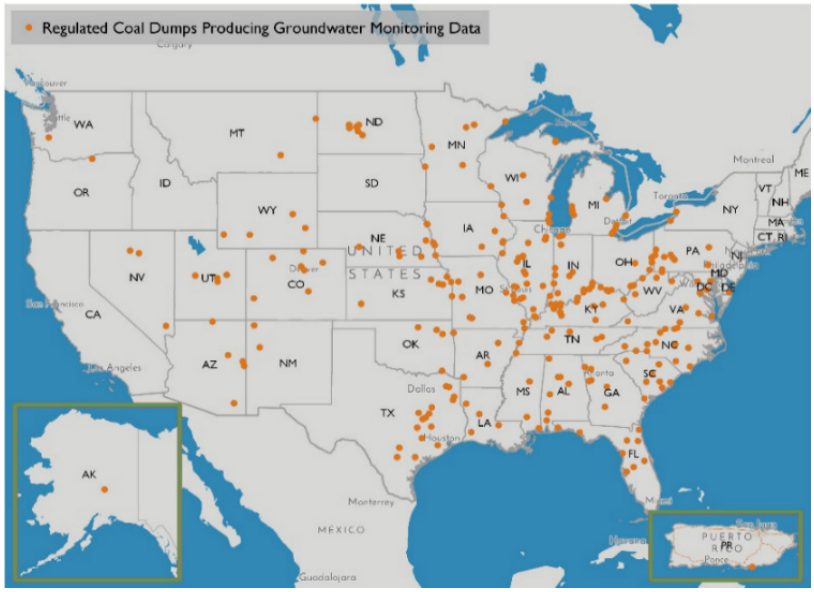
STATE	POOR	FAIR	SATISFACTORY	NOT ASSESSED	TOTAL
IN	33	17	11	13	74
IL	18	16	4	13	51
MO	10	13	13	6	42
PA	8	5	12	17	42
TX	4	4	22	8	38
KY	3	15	11	7	36
NC	6	9	16	2	33
GA	2	2	23	4	31
OH	15	9	6	0	30
IA	6	5	15	3	29
WI	4	1	16	2	23
SC	2	10	9	1	22
WY	10	2	5	3	20
TN	0	7	10	3	20
AL	3	3	12	1	19
ND	4	3	7	3	17
FL	2	6	4	5	17
MI	2	3	5	4	14
LA	7	5	1	0	13
KS	2	3	7	1	13
MN	2	2	8	1	13
WV	0	3	7	2	12
VA	2	7	2	0	11
AZ	0	0	10	0	10

C. CCR Units: Groundwater Exposure

In addition to the physical risks surface impoundments present to nearby surface waters, they also present the potential for groundwater impact and risks to groundwater quality, as do unlined CCR landfills. Many of the older CCR disposal units were built without any liner separating the coal ash from the ground; others used inadequate clay liners which were not designed to address hydraulic conductivity minimums.[52] EPA found that of the impoundments constructed pre-1994, 63 percent had no liners and 24 percent had clay liners.[53] Notwithstanding these numbers, EPA's Assessment Program conducted between 2009 and 2014 focused on the structural integrity of surface impoundments, but did not review leachate risks to groundwater from lack of liners or from insufficient liner design.[54]

It was the Final Rule that ultimately advanced a national effort to evaluate and make public groundwater's environmental exposure associated with CCR units, both from landfills and surface impoundments. Current groundwater data is now available due to EPA's ground water monitoring requirements and the requirement that groundwater data, among a myriad of other required information associated with the operation of CCR units, be posted on a publicly accessible website per the Final Rule. The Environmental Integrity Project[55] (EIP) partnered with other environmental organizations to review current groundwater data from 4,600 groundwater monitoring wells across 348 surface impoundments and 210 landfills, which represents ownership of 75 percent of coal power plants across the U.S., and are represented on EIP's map included in **Figure 5** here.[56]

Figure 5: Regulated Coal Dumps Producing Groundwater Monitoring Data



52 Hydraulic conductivity is a measurement that reflects the ease with which water moves through the subsurface and is used to calculate rates of groundwater movement. It is defined as the ability of a porous medium, such as soil, to transmit water under saturated or nearly saturated conditions. *"How to measure soil hydraulic conductivity—Which method is right for you?,"* Meter Group (last visited Sept. 23, 2019), https://www.metergroup.com/environment/articles/how-to-measure-soil-hydraulic-conductivity-which-method-is-right-for-you/.

53 Final Rule, *supra* note 1, at 21,324.

54 Final Rule, *supra* note 1, at 21,313 n.5.

55 *Coal's Poisonous Legacy: Groundwater Contaminated by Coal Ash Across the U.S.*, Envtl Integrity Project (Mar. 4, 2019; revised, July 11, 2019), http://www.environmentalintegrity.org/wp-content/uploads/2019/03/National-Coal-Ash-Report-Revised-7.11.19.pdf [hereinafter, *EIP Groundwater Report*]. Figure 5 depicts the interactive map hosted by EIP. Environmental Integrity Project (EIP) consists of Earthjustice, Sierra Club, Prairie Rivers Network, and other organizations, as participants.

56 *See* Interactive Map, *supra* note 46.

Data were not available for the remaining plants because they were closed prior to the Final Rule's effective date, they qualified for an extension to comply, or they were exempt. EIP clarified in the report that it could only identify the quality of groundwater found at each coal plant location, but it was not possible to conclude how much each onsite CCR unit contributed to the contamination reported in the samplings. The presence of certain potentially harmful constituents in the water assumed leachate impact from the CCR unit. The report concluded that "242 coal plants, or 91 percent, have unsafe levels of one or more coal ash constituents in downgradient wells that appear to be affected by onsite, regulated coal ash dumps."[57]

EIP's report has been criticized for its analytical methods that rely simply on one set of raw data that results in overestimating groundwater impact.[58] The groundwater data reported and posted per the Final Rule is only one factor to be considered within EPA's risk assessment framework that assesses a variety of factors, including toxicity, concentration, and exposure pathway, in determining downstream contamination risks for purposes of the Final Rule.[59] EPA's national minimum criteria identify the acceptable statistical methods used to evaluate individual sets of data that are required to be posted. EIP's report is notable in coal ash literature for its wide press coverage, particularly in local publications in areas where coal ash facilities were highlighted in the report. However, even without a context of detailed knowledge of statistical methods, the report, on its face, provides little, if any, conclusive information that could be used to infer downstream risks to drinking water and public health generally.

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57 *EIP Groundwater Report, supra* note 55, at 13.

58 Sonal Patel, Power Magazine, *Construction Power Companies Refute Findings of Widespread Coal Plant Groundwater Contamination* (Mar. 7, 2019), https://www.powermag.com/power-companies-refute-findings-of-widespread-coal-plant-groundwater-contamination/?pagenum=3.

59 Final Rule, *supra* note 1, at 21,444-446.

D. Coal Ash Toxicology

Although coal is mostly carbon, it also contains concentrations of trace elements and amounts of heavy metals that become mobilized during the combustion process and are captured in the waste streams. These elements are found in soils and throughout the environment, but they naturally occur in higher concentrations in coal ash as a result of coal formation from pressurization of decaying plant matter over millions of years. Coal ash is primarily made up of silicon, aluminum, calcium, and iron oxides, with lesser amounts of other metal oxides and sulfur. The presence of mercury, cadmium, chromium, lead, arsenic, and other metals, as well as boron, nitrates, and fluoride are also a concern. **Figure 6** lists many of the constituents found in coal ash, with their potential health impacts.[60]

Figure 6: Health Effects of Common Coal Ash Constituents

POLLUTANTS	HEALTH EFFECTS
Aluminum	Lung disease, developmental problems
Antimony	Eye irritation, heart damage, lung problems
Arsenic	Multiple types of cancer, darkening of skin, hand warts
Barium	Gastrointestinal problems, muscle weakness, heart problems
Beryllium	Lung cancer, pneumonia, respiratory problems
Boron	Reproductive problems, gastrointestinal illness
Cadmium	Lung disease, kidney disease, cancer
Chromium	Cancer, ulcers, and other stomach problems
Chlorine	Respiratory distress
Cobalt	Lung/heart/liver/kidney problems, dermatitis
Lead	Decreases in IQ, nervous system, developmental and behavioral problems
Manganese	Nervous system, muscle problems, mental problems
Mercury	Cognitive deficits, developmental delays, behavioral problems
Molybdenum	Mineral imbalance, anemia, developmental problems
Nickel	Cancer, lung problems, allergic reactions
Selenium	Birth defects, nervous system/reproductive problems
Vanadium	Birth defects, lung/throat/eye problems
Zinc	Gastrointestinal effects, reproductive problems

60 *Public Health Impacts,* Southeast Coal Ash.org (last visited Sept. 23, 2019), http://www.southeastcoalash.org/about-coal-ash/public-health-impacts/.

In the Final Rule, EPA found that there is significant potential for CCR landfills and CCR surface impoundments to leach hazardous constituents into groundwater, impair drinking water supplies, and cause adverse impacts on human health and the environment. Indeed, groundwater contamination is one of the key environmental and human health risks EPA has identified with CCR landfills and CCR surface impoundments.[61]

Accordingly, EPA established detection and assessment requirements for water monitoring in the Final Rule, targeting the constituents listed in **Figure 7** from EPA's Part 257 regulations.[62]

Figure 7: Constituents Targeted in EPA Final Rule

Appendix III to Part 257—Constituents for Detection Monitoring

Common name [1]
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

[1] Common names are those widely used in government regulations, scientific publications, and commerce; synonyms exist for many chemicals.

Appendix IV to Part 257—Constituents for Assessment Monitoring

Common name [1]
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 combined

[1] Common names are those widely used in government regulations, scientific publications, and commerce; synonyms exist for many chemicals.

61 Final Rule, *supra* note 1, at 21,396.

62 *See infra*. at p. 28.

SECTION 5:
Federal Framework for Regulating Coal Ash Disposal

A. Pre-Kingston Spill

1. Legislative Origins of EPA's Regulatory Authority

Over the decades, the question of regulating the waste streams from the coal burning process in electricity generation has been embedded within the larger environmental conversation on the need to regulate industrial waste produced across all types of industries, as well as the regulation of municipal waste. Waste has been and continues to be viewed as a local matter, even during the rise of the modern environmental movement during the 1960s that saw the beginning of the shift from state and local responsibility to more federal oversight of environmental impacts.[63]

The first federal attempt to address solid waste, which had been exponentially growing since the Industrial Revolution, was the enactment of the Solid Waste Disposal Act of 1965 (SWDA).[64] Still, SWDA defined solid waste as a local responsibility and so limited federal involvement to providing federal assistance to states to promote better municipal waste disposal technology while encouraging states to consider waste management planning that focused on waste reduction and recycling.

In the 1970s, Congress stepped up federal involvement in environmental issues[65] with the enactment of the National Environmental Policy Act (NEPA),[66] the Clean Air Act[67] in 1970, and the Clean Water Act[68] in 1972. Congress then moved to address growing concern about public exposure to toxic substances contained in industrial and chemical waste streams as a result of open dumping practices that had become conventional with the next set of environmental statutes,[69] including RCRA. Enacted in 1976, it amended and effectively superseded SWDA in how waste streams that posed significant risks to public health were to be regulated.

RCRA authorizes EPA to establish controls that would ensure the safe management of hazardous waste from "cradle to grave."[70] Subtitle C of RCRA defines the factors that EPA is to use to identify wastes that are hazardous to public health; establishes a cradle-to-grave tracking system for hazardous wastes; sets standards for its treatment, storage, and disposal; and provides for state implementation of permitting systems to enforce the federal standards.

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63 Robert V. Percival et al., Environmental Regulation: Law, Science, and Policy 222 (4th ed. 2003).

64 Eugene H. Robinson, Jr., *Solid Waste Disposal Act (1965), Major Acts of Congress,* Encyclopedia.com (Sept. 19, 2019), https://www.encyclopedia.com/history/encyclopedias-almanacs-transcripts-and-maps/solid-waste-disposal-act-1965.

65 Dr. Neil S. Shifrin, *Environmental Management and Its History,* Envtl Science.org (last visited Sept. 23, 2019), https://www.environmentalscience.org/environmental-management-history.

66 42 U.S.C. §§4321-4370a.

67 Clean Air Act, 42 U.S.C. §§7401-7642.

68 33 U.S.C. §§1251-1376, enacted first as the Federal Water Pollution Control Act, and then renamed the Clean Water Act.

69 The other two toxic regulatory acts are the Safe Drinking Water Act in 1974 and the Toxic Substances Control Act in 1976 (15 U.S.C. §§2601-2629).

70 *Summary of the Resource Conservation and Recovery Act: 42 U.S.C. §6901 et seq. (1976),* EPA (Aug. 15, 2019), https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act.

In 1978, EPA proposed *Hazardous Waste Guidelines and Regulations*[71] to implement its new subtitle C responsibilities, including a proposed list of hazardous wastes. However, it deferred any proposed hazardous classification for certain high-volume, low-risk waste streams, including utility waste made up of fly ash, bottom ash, and scrubber sludge, until more information could be gathered to assess how they can best be managed should it be determined they were hazardous. EPA noted that it had limited information about these "special wastes" other than that (i) they occur in very large volumes; (ii) it appeared the potential hazards posed by the waste was relatively low; and (iii) the control techniques that had been developed for other toxic and hazardous wastes did not appear applicable to them.[72]

By the time EPA was ready, in May 1980, to issue its final order on hazardous classifications, Congress had also taken up the regulatory question on this group of special wastes in considering legislation to reauthorize RCRA. Consequently, EPA deferred taking any action on special wastes, pending further congressional action.[73] Meanwhile, Congress focused on similar questions raised in EPA's 1978 rulemaking regarding special wastes, including the potential cost to the associated industries if these wastes were to be regulated as hazardous waste, and the uncertainties of risks associated with their storage and disposal.

Congress' final bill, the Solid Waste Disposal Act Amendments of 1980,[74] included what is commonly referred to as the Bevill Amendment, which kicked the utility waste issue back to the EPA. The Bevill Amendment added a new subsection 3001(b)(3) to RCRA that required EPA to study and report back to Congress on these large-volume special wastes and to make a regulatory determination as to whether or not their regulation under subtitle C was warranted.[75] Covered under the Bevill Amendment were fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste generated from the combustion of coal or other fossil fuels.[76]

EPA began its study, but before it submitted its first report to Congress, Congress amended RCRA once again, passing the Hazardous and Solid Waste Amendments (HSWA) in 1984.[77] HSWA was a significant amendment in that it added a new subtitle D to RCRA, which provided a regulatory framework for nonhazardous solid waste. Subtitle D prohibits "open dumps," which are sites where nonhazardous solid waste is disposed and which do not qualify as sanitary landfills that require a finding of "no reasonable probability of adverse effects on health or the environment from disposal of solid waste at such [facilities]."[78] Under subtitle D, EPA sets minimum guidelines for sanitary landfills to be incorporated into a state's solid waste management plan for how nonhazardous solid waste should be managed.

In addressing the high-volume special wastes, including coal ash, HSWA reaffirmed their exemption from subtitle C, pending further study by EPA. Congress effectively left it to the states to decide whether to regulate these special wastes under their subtitle D programs unless and until EPA should classify coal combustion wastes as hazardous.

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71 Proposed Rule, Hazardous Waste Guidelines and Regulations, 43 Fed. Reg. 58,946 (Dec. 18, 1978).

72 *Id.* at 58,991-92.

73 Final Rule and Interim Final Rule, Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 45 *Federal Register* 33,154, 33,175 (May 19, 1980).

74 96 P.L. 483, 94 Stat. 2360.

75 In RCRA § 8002(n), Congress directed EPA to conduct a detailed and comprehensive study based on eight study factors and to submit a Report to Congress on "the adverse effects on human health and the environment, if any, of the disposal and utilization of fly ash waste, bottom ash waste, slag waste, flue gas emission control waste, and other byproduct materials generated primarily from the combustion of coal or other fossil fuels." *See* discussion, *infra* at p. 31.

76 Linda Luther, Background on and Implementation of the Bevill and Bentsen Exclusions in the Resource Conservation and Recovery Act: EPA Authorities to Regulate "Special Wastes," *Cong. Research Serv.* (August 6, 2013).

77 Eugene H. Robinson, Jr., Hazardous and Solid Waste Amendments of 1984, Major Acts of Congress, Encyclopedia.com (Sept. 19, 2019), https://www.encyclopedia.com/history/encyclopedias-almanacs-transcripts-and-maps/hazardous-and-solid-waste-amendments-1984.

78 42 U.S.C. §§ 6944(a), 6903(14), (26).

2. EPA's Follow-through of Its Legislative Directive

In March 1988, EPA published its Report to Congress on coal combustion wastes from electric utility power plants. The Report recommended preliminarily that high-volume coal combustion wastes not be regulated under subtitle C. In August 1993, EPA issued its final determination (1993 Determination) under the Bevill Amendment, addressing fly ash, bottom ash, boiler slag, and flue gas emission control waste, and found that these large-volume coal combustion wastes generated at a utility's or an IPP's power plant did not exhibit hazardous waste characteristics warranting a classification as hazardous wastes and therefore should not be subject to regulation under subtitle C of RCRA.[79] It reaffirmed its decision in 2000,[80] which left the management of coal ash to be regulated as nonhazardous in accordance with requirements established by individual states. Had EPA classified coal ash as a hazardous waste under part C, it would have strengthened the federal role in how coal ash should be managed.

In making its finding in the 1993 Determination not to classify coal combustion wastes as hazardous, EPA considered the eight study factors required under Section 8002(n) of the amended RCRA:

1. Sources and volumes of such material generated per year;
2. Present disposal and utilization practices;
3. Potential danger, if any, to human health and the environment from the disposal and reuse of such materials;
4. Documented cases in which danger to human health or the environment from surface runoff or leachate has been proved;
5. Alternatives to current disposal methods;
6. Costs of such alternatives;
7. Impact of those alternatives on the use of coal and other natural resources; and
8. Current and potential utilization of such materials as an alternative to disposal.[81]

EPA found that 95 percent of the materials found in coal ash were not of major concern, e.g., oxides of silicon, aluminum, iron, and calcium. Only trace constituents in the waste were toxic presenting risks to human health and the environment and were not found in leachate at levels above hazardous waste toxicity. EPA also found that current waste management practices appeared adequate to protect human health and the environment. Although there were documented impacts associated with coal ash management practices, the damage cases were at a very limited number of sites. It noted only 10 damage cases from among all the generation sites it examined. It also noted that there was minimal documentation of impacts on drinking water sources in the vicinity of coal-fired utilities. The known releases were from unlined units at older sites in states that had since implemented more stringent design and operating criteria.

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79 Final Regulatory Determination, *supra* note 5, at 42,466. EPA issued a second part to its Final Determination in April 1999 to address other fossil fuel combustion wastes, for which it reached a similar conclusion, except for oil combustion wastes that it determined required some form of disposal controls. See Notice of Availability, *Availability of Report to Congress on Fossil Fuel Combustion; Request for Comments and Announcement of Public Hearing,* 64 *Federal Register* 22,820 (April 28, 1999).

80 Regulatory Determination, Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels, 65 *Federal Register* 32,214 (2000).

81 Final Regulatory Determination, *supra* note 5. at 42,467.

Using specified assessment tools and criteria described in the 1993 Determination, EPA also found that contamination of groundwater and surface water through groundwater recharge was possible but only under certain plausible conditions, such as unlined units. However, the risk would mostly result in ecological and natural resource damages as the risk of human exposure was limited. Two considerations in EPA assessing the potential for human exposure were the population in the surrounding region and the remoteness of drinking water systems from the site. As for minimizing the risk of surface water waste discharge, EPA looked to the Clean Water Act controls under utilities' National Pollutant Discharge Elimination System (NPDES) permits, and found that, even should constituents reach surface waters, the volume of surface water and high flow rates would dilute the degree of constituents' concentration. The factors identified above, as well as others discussed in the 1993 Determination, demonstrate the changing character of these factors, particularly in the context of increasing volumes as these units continued to operate over the years and accept more and more coal ash.

However, at the same time EPA affirmed its early decision not to regulate under subtitle C in its 2000 Determination, EPA also announced its intention to regulate under subtitle D and to establish national minimum criteria for the disposal of coal combustion wastes in landfills or surface impoundments.[82] In support of its decision not to regulate coal ash waste under subtitle C, EPA took note of the significant improvement in coal ash waste management practices due to states adopting more stringent requirements and voluntary improvements by generation owners. However, it voiced concerns that there still existed significant gaps across the electric generation industry in implementing these better practices. Between 40 percent and 70 percent of sites lacked environmental controls, such as liners and/or groundwater monitoring as of 1995. EPA specifically noted that controls were much less common at surface impoundments than at landfills.[83] EPA believed that the regulatory process under subtitle D would be sufficient to cause the remaining states to close the regulatory gaps in environmental protection, notwithstanding EPA's limited enforcement authority.

EPA's determination to issue national minimum standards under subtitle D was based on information it had gathered and reviewed prior to 1995, and thus, EPA decided there was a need to update the factual record. It initiated a joint study with DOE in 2005 to collect more recent information on coal combustion waste management practices by the electric power industry. EPA also updated and completed a risk assessment on the conditions of surface impoundments owned by utilities and IPPs that it had begun for the 2000 Determination, evaluating types of coal ash waste, toxic constituents, liner types, receptors, and exposure pathways, with potential risks of leachate and spills. Finally, it reviewed cases of environmental damage associated with coal ash landfills and surface impoundments reported since its 2000 Determination. In 2007, EPA issued a Notice of Data Availability (NODA)[84] presenting the information it gathered and its assessment of public comments as its first step in preparing to propose minimum national standards for coal combustion waste disposal in landfills and impoundments. The next year saw the dike at TVA's Kingston impoundment fail, causing the largest coal ash spill in history.

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82 65 *Federal Register* at 32,214.

83 Final Rule, *supra* note 1, at 32,229.

84 Notice of Data Availability on the Disposal of Coal Combustion Wastes in Landfills and Surface Impoundments; Extension of Comment Period, 72 *Federal Register* 57,572 (Oct. 10, 2007).

B. Post-Kingston Spill

EPA followed the TVA Kingston coal ash spill by issuing a proposed rule in 2010[85] to regulate coal ash for the first time under subtitle D of RCRA. It provided the public a second opportunity to submit to EPA comments on how coal ash should be regulated, whether under subtitle C as a hazardous waste, or subtitle D as nonhazardous solid waste, and proposed a set of minimum criteria under each of the subtitles. While reviewing comments and completing the rulemaking process, EPA also conducted data requests, inspections, and other field work for its next Surface Impoundments Assessment. It completed the assessment five years later, publishing the findings discussed in Section 4[86] shortly before it finalized its proposed rule and issued the Final Rule in 2015. EPA issued its final decision to regulate coal ash as a nonhazardous waste under subtitle D over subtitle C. It also used its subtitle D authorization to establish national minimum criteria in the Final Rule for existing and new CCR landfills and surface impoundments that addressed location restrictions, design and operating criteria, groundwater monitoring and corrective action, closure requirements, post-closure requirements and care, recordkeeping, notification, and Internet posting requirements, all outlined in Section 5c.

Not surprisingly, the Final Rule was appealed on a multitude of grounds by a multitude of parties with diverse stakes in the Final Rule in *Utilities Solid Waste Activities Group, et al. v. EPA*.[87] Although the D.C. Circuit Court of Appeals agreed to a voluntary remand of many of the issues raised by appellants, giving EPA the opportunity to reconsider and revise the relevant sections of its minimum criteria,[88] the Court ultimately decided the following key issues, overturning certain of EPA's exemptions from compliance and expanding the number of CCR units that must now comply with the minimum criteria. EPA recently amended its regulations[89] to incorporate the Court's findings as follows:

1. The Court overturned the Final Rule's requirement that contamination must be detected at a unlined surface impoundment before it is subject to the closure criteria of the Final Rule.[90] As amended, EPA national minimum criteria now requires all unlined surface impoundments to cease accepting CCR for disposal by a specified date and to be closed or retrofitted in compliance with the minimum criteria.

2. All CCR units using a clay liner of any design would be considered unlined and thus must be closed or retrofitted consistent with the minimum criteria. Although EPA had concluded in the Final Rule that most of the clay liners installed were insufficient to protect against environmental contamination, it adopted minimum criteria providing that a clay liner meeting both the depth and hydraulic conductivity performance standards complies with the liner criteria and thus, would not trigger any closure requirements. The Court overturned this provision in the minimum criteria as conflicting with EPA's own factual record.[91]

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85 Proposed Rule, *Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities,* Proposed Rule, 75 *Federal Register* 35,128 (June 21, 2010).

86 *See* discussion, *infra* at Section 4.

87 Util. Solid Waste Activities Group v. EPA, 901 F.3d 414, 433 (D.C. Cir. 2018) [hereinafter *USWAG v. EPA*].

88 *Id.* at 437; ". . . we granted the EPA's unopposed motion to remand to itself several provisions of the Final Rule not at issue here that the EPA had decided to vacate . . . " *Id.* at 425 (citing Per Curium Order, *Utility Solid Waste Activities Grp. v. EPA,* No. 15-1219, 2016 U.S. App. LEXIS 24320 (D.C. Cir. June 14, 2016)).

89 Proposed Rule, *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,* 84 *Federal Register* 65,941 (Dec. 2, 2019).

90 901 F.3d at 430, 432.

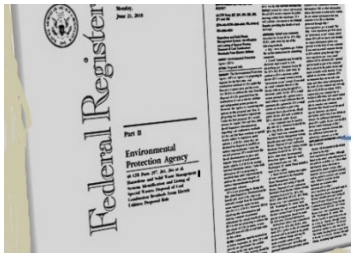
91 *Id.* at 431-32.

3. The Court overturned the EPA's finding that the minimum criteria would not apply to inactive surface impoundments located on retired or inactive electric generating stations.[92]

EPA noticed its intent to issue a future proposed rule in response to the Court's decision addressing inactive surface impoundments at retired stations.[93] EPA also issued a Direct Final Rule[94] in compliance with its voluntary vacatur of the Final Rule provisions that would have exempted surface impoundments that would have completed closure within three years from the issuance date of the Final Rule. It deleted these "early closure" provisions (as they are termed by EPA), and added a new section that clearly states that all inactive surface impoundments must comply with the same rules that apply to other surface impoundments. EPA then extended the compliance deadlines originally established in the Final Rule to compensate for these units' late notice of the need to comply.

EPA has additionally issued other subsequent rules, that at best, could be described as insubstantial as they relate to the overall impact of the Final Rule and the behavioral change in coal ash management intended by EPA in implementing subtitle D requirements. They address nuances in performance standards and other technical requirements and thus are not discussed in detail in this white paper.[95]

C. EPA's Final Rule: National Minimum Criteria for Coal Ash Disposal



EPA's national minimum criteria are designed to address environmental risks from groundwater contamination, structural failures of CCR surface impoundments, and fugitive dust emissions, and to bring transparency to coal ash disposal operations in the electric generation sector. EPA used its years of investigations and data gathering from its Surface Impoundments Assessments, NODAs, and surveys conducted on hundreds of utilities' and IPPs' landfills and surface impoundments, making the following broader-based findings:

- EPA declared, for the third time, that CCR should be considered a nonhazardous waste under RCRA subtitle D and not be subject to regulation under subtitle C as hazardous waste.
- The basic components of CCRs to be regulated include fly ash, bottom ash, boiler slag, and flue gas desulfurization (FGD) materials.

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92 *Id.* at 438-39.

93 84 *Federal Register* 65,941 at n.1.

94 Direct Final Rule, *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur,* 81 *Federal Register* 51,802 (Aug. 5, 2016).

95 *See e.g.* Final Rule, *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One),* 83 Fed. Reg. 36,435 (July 30, 2018), revising alternative performance standards that a State could adopt in place of the standards adopted by the minimum criteria where there is evidence that hazardous constituents could not migrate to the uppermost aquifer. In addition, the initial criteria required for compliance by a CCR unit with certain performance standards must be certified by a professional engineer. The amended criteria would now allow a technical certification in lieu of certification by a professional engineer. Finally, EPA established groundwater protection standards for particular contaminants for which no Maximum Contaminant Levels (MCL) had previously been established. Similar types of revisions are proposed in EPA's Proposed Rule, *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One),* 83 *Federal Register* 11,584 (Mar. 15, 2018). Many of these amendments could be perceived as a relaxation of environmental standards and attributable to the current political persuasion of the President and the Administration, including the EPA Administrator, but in evaluating these changes, it might well be remembered that the Court's decision which strengthened the application of the Final Rule resulted from eliminating exceptions that had been approved in the initial Final Order before the change in the Administration.

- Existing CCR units should be allowed to continue to operate unless and until the unit poses an unacceptable risk, in which case they should then be required to be closed or retrofitted. Unacceptable risks include:
    - CCR surface impoundments failing to achieve "factors of safety";
    - Improper siting of CCR landfills or surface impoundments; and
    - Leaking unlined surface impoundments.

However, the D.C. Court of Appeals disagreed with EPA as to the last risk listed above.[96] The Court found that EPA's own factual records on the high degree of risk of leachate from unlined surface impoundments did not support waiting until actual leaking from an unlined surface impoundment was detected before the impoundment could be required to cease operation and either close or be retrofitted. The fact that an impoundment is unlined should be sufficient to determine that it poses an unacceptable risk.

Although individual specific criteria are designed to protect against the types of risks listed previously how those criteria are implemented is dependent on the activity being regulated. Consequently, the Final Rule organizes the criteria as they pertain to two types of activities:

1. Criteria for how new and existing landfills and surface impoundments can continue to operate and receive CCR after the Final Rule's effective date, and

2. Criteria for how landfills and impoundments that cannot comply with the criteria to continue operations, or are presently inactive, should be cleaned up, decontaminated, and closed.

Criteria for both continued operations and closure also include informational requirements that will result in greater self-awareness by utilities and IPPs owning and operating CCR units and in public awareness regarding the environmental status of all CCR units subject to the Final Rule. This set of criteria includes groundwater monitoring, recordkeeping, and public access of operating records.

1. Who Must Comply

Although coal ash is produced from other industrial and manufacturing sectors, the Final Rule applies only to the coal ash produced by the burning of coal to produce electricity at power stations owned by electric utilities and IPPs.[97] It also does not apply to municipal solid waste landfills that are subject to other RCRA regulations.[98] Initially, the Final Rule held that the national minimum criteria would apply to:

(i) New and existing landfills[99] currently accepting CCR, both on site and off site, not including municipal solid waste landfills;

(ii) New and existing active surface impoundments located on site at an active generation station, regardless of the fuel currently being used for generation;

(iii) Active surface impoundments, even if located on site at a retired generation station;

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96 901 F.3d 414.

97 40 C.F.R. § 257.50 (2019); *see also* 80 *Federal Register* 21,302 at 21,468 for exceptions, including coal ash produced by manufacturing facilities, universities, and hospitals, or generated by other combustion of fuels other than coal for electricity, or co-generation unless coal makes up more than 50 percent of the fuels burned.

98 Municipal solid waste landfill facilities (MSWLFs) accepting CCR are not covered by the Final Rule. EPA concluded that 40 C.F.R. § 258 establishing national minimum criteria for MSWLFs is as protective as the Final Rule criteria for CCR units, and therefore MSWLFs could be exempt. *See* 80 *Federal Register* at 21,341.

99 40 CFR § 257.54 (listing definitions of active, existing, and new CCR landfills and CCR surface impoundments).

(iv) Inactive surface impoundments located on site at any active generation station currently producing electricity, regardless of the fuel currently being used; and

(v) The lateral expansion of a CCR unit, which EPA concluded effectively meets the definition of a new unit and is treated as such.[100]

As this list indicates, inactive ponds located on site at a retired power station were not initially included under the Final Rule. However, the D.C. Circuit found in *USWAG v. EPA* that the basis for different regulatory treatment of inactive impoundments located at a closed site, versus an active generation site, was arbitrary and capricious and so remanded this discriminatory treatment back to EPA.[101] EPA subsequently amended its rule to apply to all inactive impoundments. EPA had clarified in the Final Rule that it was not proposing to require that previously closed units be re-closed in compliance with the minimum criteria.[102] There is nothing to indicate that the Court's decision would change EPA's position that CRR units closed before the Final Rule would not be required to re-close, consistent with the Final Rule.

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100 80 *Federal Register* at 21,361.

101 *See* 901 F.3d 414.

102 80 *Federal Register* at 21,343 (noting "EPA proposed to regulate only "inactive" surface impoundments that had not completed closure of the surface impoundment before the effective date. "Inactive" surface impoundments are those that contain both CCR and water, but no longer receive additional wastes. By contrast, a "closed" surface impoundment would no longer contain water, although it may continue to contain CCR (or other wastes) and would be capped or otherwise maintained.").

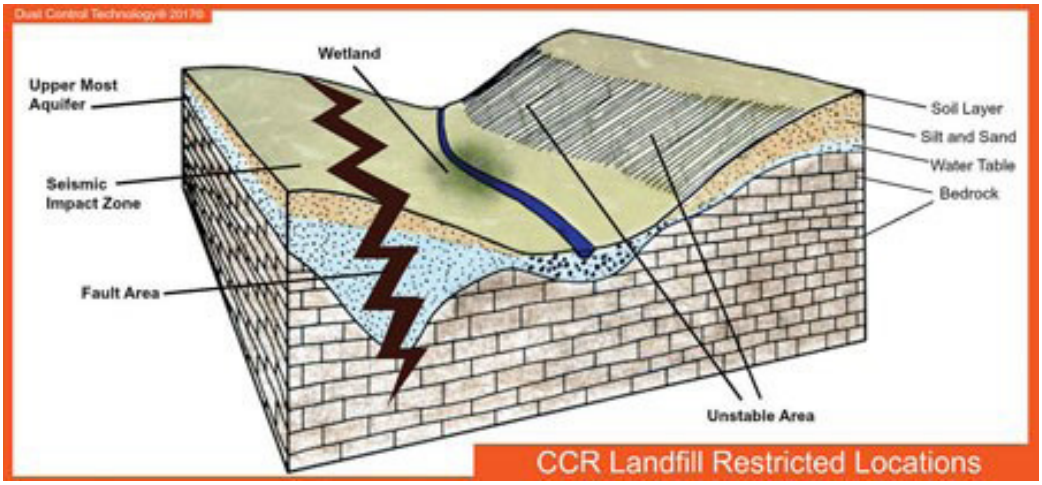
2. Key Technical Criteria Required for CCR Units' Continued Operations

The first set of key technical minimum criteria address day-by-day operating conditions that a CCR unit must meet, which can be broken down into the following four substantive areas:

a. Location Restrictions

The location criteria, as depicted in **Figure 8**,[103] restrict the placement of CCR where it could expose environmentally sensitive areas to possible contamination due to exceptional weather, earthquakes, structural failure of the CCR unit, or other circumstances. Environmentally sensitive areas include minimum separation from the uppermost groundwater aquifer, wetlands, fault areas, seismic impact zones, and any other unstable areas and/or conditions.

Figure 8: CCR Landfill Restricted Locations



b. Design Standards

The design criteria address risks of leachate impact on adjacent water systems and structural failures, as follows:

(i) Liner & Leachate Collection Systems: A critical design element for groundwater protection is installation of a composite liner system comprised of an EPA-compliant geomembrane upper liner in direct contact with a constructed clay liner (or engineered alternative equivalent) is required to minimize leaching of constituents from the CCR unit into the surrounding environment, and ultimately into groundwater or nearby surface waters. New landfills are also required to operate with a leachate collection and removal system (LCRS) that will remove excess leachate accumulating on the upper liner of the composite system.

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103 Derek Schussele, *CCR Impound Regulations Spur Questions Over Dust Emissions and Wastewater Control*, PowerEng.com (Mar. 9, 2017), https://www.power-eng.com/2017/03/09/ccr-impound-regulations-spur-questions-over-dust-emissions-and-wastewater-control/#gref.

(ii) Structural Integrity: EPA recognized that the kind and degree of risks of possible failure of a CCR surface impoundment were very much linked to the structural design of an individual impoundment and the evolving conditions at the site. Consequently, rather than prescriptive engineering specifications, criteria to ensure structural integrity mostly rely on a mixture of various periodic assessments of certain structural elements that are listed in EPA's regulations. Minimum criteria specify certain minimum Factors of Safety standards to assess the safety of slope and set certain height limitations for damns, dikes, or other containment structure. These criteria only apply to surface impoundments.

c. Operating Standards

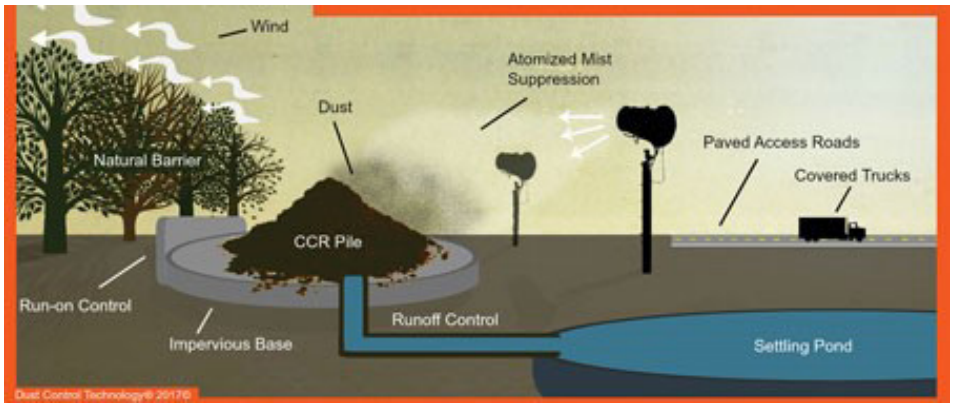
These minimum criteria apply to the day-to-day operations of CCR units to address the potential health and environmental impacts associated with their operations.

(i) *Fugitive Dust Control* – These air criteria serve to mitigate CCR from becoming air-borne. Each active CCR unit must implement a fugitive dust control plan, as depicted in **Figure 9**,[104] that minimizes CCR from becoming airborne and include the plan in its operating records. A report on compliance must be prepared each year as part of a unit's operating records. It should also record any complaints received and the corrective action taken in response.

(ii) *Run-on/Run-off for Landfills* – Each landfill must implement: (1) run-on controls that minimize the amount of surface water that can enter for the prevention of erosion, surface discharges of CCR, and generation of landfill leachate; and (2) run-off controls that also prevent erosion, protect downstream surface water from CCR releases from the unit, and minimize storm water run-off both in volume and velocity.

(iii) *Hydrologic and Hydraulic Capacity Requirements for Surface Impoundments* – CCR surface impoundments must meet hydrologic and hydraulic capacity specifications to ensure they can safely manage flood flows. A design meeting these specifications helps prevent uncontrolled overtopping of the impoundment and the erosion of the materials used in its construction. To ensure compliance, the criteria also requires periodic inspections to detect any indications of structural weakness with findings made a part of the operating records.

Figure 9: Fugitive Dust Control Plan Example



104 *See, infra* at p. 28.

d. Monitoring, Inspections, and Public Information

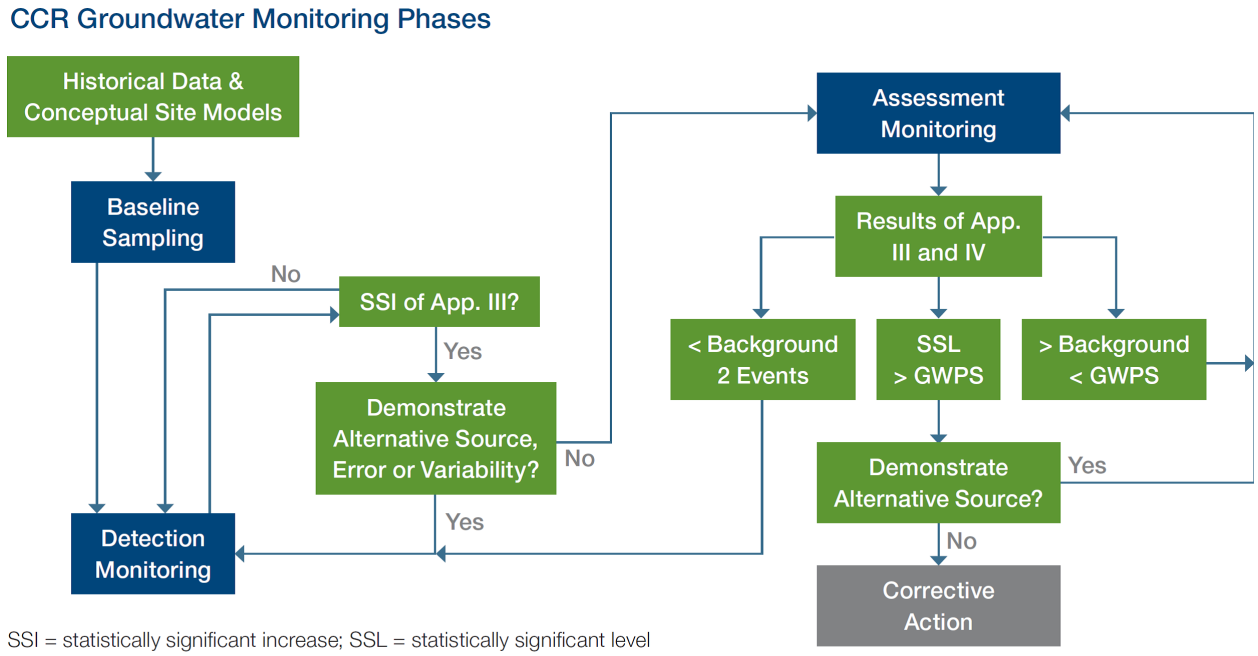
The following three criteria areas address the knowledge gap that has existed since before the Final Rule, both on the part of the owner/operator of CCR units and on the part of the public due to the lack of transparency and reporting failures.

(i) *Groundwater monitoring:* A groundwater monitoring program should consist of:

- Detection monitoring, which includes installation of a system of monitoring wells, and regularly conducting water sampling consistent with specified procedures and data analysis to detect a potential release of hazardous constituents from the CCR unit;
- Assessment monitoring to be implemented upon a determination of a statistically significant exceedance(s) of detection monitoring parameters in the monitoring well system; and
- Corrective action whenever the groundwater monitoring assessment confirms an exceedance of a groundwater protection standard(s) established for the listed constituents.[105]

The flowchart in **Figure 10**[106] illustrates the process in which the three criteria work together to protect groundwater standards and to result in a more timely reaction to events in which constituent concentrations (see Section 5C2) are approaching statistically significant levels (SSL) before violating groundwater protection standards (GWPS).

Figure 10: CCR Groundwater Monitoring Phases



SSI = statistically significant increase; SSL = statistically significant level
GWPS = groundwater protection standard
App. III and IV = lists of CCR constituents to be analyzed

105 *See Figure 7, supra* at p. 17.

106 *Assessment of Corrective Measures: CCR Rule Groundwater Monitoring Requirements*, TVA (Aug. 12, 2019), https://www.tva.gov/file_source/TVA/Site%20Content/Environment/Environmental%20Stewardship/Coal%20Combustion%20Residuals/Groundwater%20Fact%20Sheets/groundwater_executive_summary.pdf.

(ii) *Inspections for Surface Impoundments:* As a result of EPA's previous periodic Surface Impoundment Assessments discussed in Section 5B, EPA determined the need for structural stability criteria in the Final Rule,[107] including the requirement that all surface impoundments be inspected weekly for any evidence of structural weakness or other conditions that could disrupt the operation and safety of the impoundment. Instrumentation is required to be inspected at least every 30 days. Surface impoundments that exceed certain height parameters, must be inspected every year, as well as assessed for structural stability based on factors of safety every five years. Annual inspections are intended to be broader in scope than weekly inspections and are required to be conducted to ensure that the design, construction, operation, and maintenance of a CCR unit is consistent with recognized and generally accepted good engineering standards.[108] Inspections are to include review of past operating records, as well as visual inspections, and must be conducted by a qualified professional engineer.

e. Record Keeping and Internet Posting

Operating records must be maintained for each CCR unit, which is to include all data collected and inspection reports required under the different criteria codified in EPA's regulations. Whenever information is placed in the operating record, notice is to be provided to the appropriate state agency. Current operating records must be posted on an Internet site accessible to the public.[109]

3. Closure of Non-Compliant CCR Units and Post-Closure Care

The national minimum criteria require that any CCR landfill or CCR surface impoundment that is located within an area restricted by the minimum criteria, or that cannot meet the applicable factor of safety criteria for structural integrity, must be closed consistent with the closure requirements.[110] The Final Rule also provided that any existing unlined CCR surface impoundment *that is contaminating groundwater* above the groundwater protection standard set for the particular toxic constituent must cease accepting CCR and either be retrofitted or closed, with some limited exceptions. Units that used clay liners that meet certain depth and hydraulic conductivity performance standard were deemed lined and thus excluded from closure. As discussed previously, the Court overturned the clay-liner exception and the contamination condition, which expands the number of CCR units that are required to close. Consistent with the Court's decision, EPA has proposed to amend its regulations to require a surface impoundment to cease receipt of CCR and initiate closure by August 31, 2020, where the CCR unit either (1) is unlined or formerly "clay-lined"; or (2) failed the aquifer location requirement, unless the generation facilities require additional time to develop alternate capacity to manage their waste streams.[111]

The minimum criteria for closure and post-closure care were designed to ensure the long-term safety of closed CCR units. The specific applicable criteria are dependent on the method used to close a CCR unit. In designing the Final Rule, EPA considered the two conventional closure methods (1) by leaving the CCR in place and installing a final cover system, which has been the conventional approach to closure referred to as "cap-in-place," or (2) through removal of the CCR and decontamination of the CCR unit, generally referred to as "excavate and haul" or "closure by removal."

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107 80 *Federal Register* at 21,315.

108 *Id.*

109 EPA has a website that has links to all the companies' postings of their compliance with the EPA rule in alphabetical order by state. EPA, *List of Publicly Accessible Internet Sites Hosting Compliance Data and Information Required by the Disposal of Coal Combustion Residuals Rule*, https://www.epa.gov/coalash/list-publicly-accessible-internet-sites-hosting-compliance-data-and-information-required.

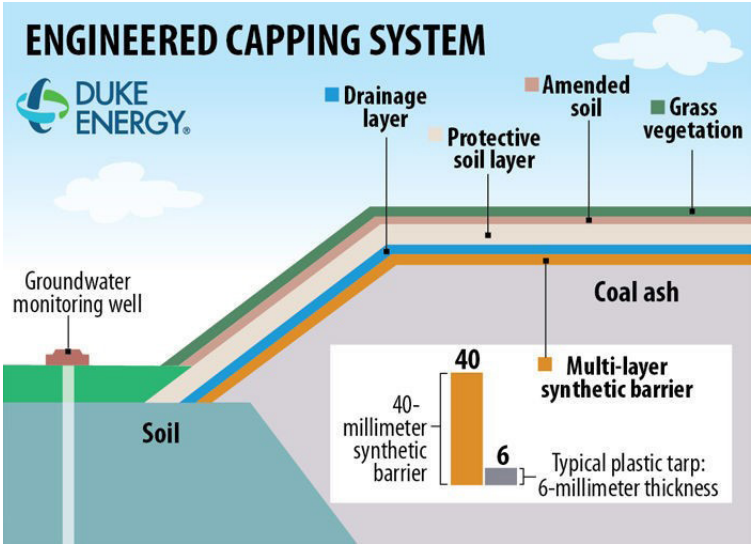
110 For fault areas, seismic impact zones, and unstable areas (using karst areas as a proxy) the EPA's Regulatory Impact Analysis (RIA) projected that 51 of the 1045 waste management units would be subject to the location restrictions resulting in an estimated 26 waste management units closing and safely relocating offsite.

111 84 *Federal Register* at 65,942.

a. Closure with CCR in Place

A cap-in-place approach to closure has historically been utilities' preferred approach to closure. It was a much simpler process involving placement of a cover over the coal ash after the coal ash has been dewatered and the coal ash stabilized. Costs were, correspondingly, significantly less.[112] The minimum criteria impose more performance standards for closure designs and continue to appear less costly, even if more environmentally risky, illustrated in **Figure 11**.[113]

Figure 11: Engineered Capping System Example



Minimum criteria for closure with CCR in place are designed to:

- Control, minimize, or eliminate, to the maximum extent feasible, future infiltration of liquids into the waste and releases of CCR, leachate, or contaminated runoff to the ground or surface waters or to the atmosphere;
- Preclude the probability of future impoundment of water, sediment, or slurry;
- Prevent the sloughing or movement of the final cover system during the closure and post-closure care period; and
- Minimize need for future maintenance.

Accordingly, closure will require: (1) dewatering or drainage to eliminate all free liquids by removing liquid wastes or solidifying the remaining wastes and waste residues; and (2) stabilization of the contained CCR by reinforcing the dike or other sloping feature of the impoundment to protect against sloughing or movement of the final cover system. Dewatering activities and discharge of decant water may require new or revised NPDES as part of the closure permit.

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112 80 *Federal Register* at 21,305.

113 Taft Wireback, 'What science demanded': Duke Energy ordered to excavate all coal ash in North Carolina," *Journal Now* (figure of Engineered Capping System) (Apr. 1, 2019), https://www.journalnow.com/news/local/what-science-demanded-duke-energy-ordered-to-excavate-all-coal/article_5b090c4a-ee70-54a5-b296-6aa3b1efbbe2.html (second picture).

Finally, the final cover system:

- Must restrict permeability based on the minimum criteria's performance standards,
- Include an infiltration layer minimizing the infiltration of liquids through the closed CCR unit, and
- Include an erosion layer of at least six inches of earthen material that minimizes the erosion of the final cover.

What the minimum criteria do not require for closure with CCR in place is a bottom liner to separate the CCR from its surrounding soil environment. Instead of guarding against leachate using a liner system, EPA relies on water monitoring requirements and other post-closure care requirements that are to be in effect for 30 years after closure is complete. Post-closure criteria include the obligation to:

- Maintain the integrity and effectiveness of the final cover system,
- Maintain the integrity and effectiveness of the leachate collection and removal system, and
- Maintain the groundwater monitoring system and continue monitoring groundwater consistent with the groundwater monitoring requirements of the minimum criteria.

If at the expiration of the 30-year post-closure period, the CCR unit is subject to assessment monitoring due to a previous failure of a water quality performance standard, the 30-year period can be extended.

Thus, a tradeoff for utilities in pursuing the less expensive cap-in-place is the assumption of a 30-year obligation with its associated liability. Future corrective action and the associated financial liabilities could off-set the present cost savings. Additionally, the long-term legal liability associated with the post-care obligation is evidenced by the further requirement that "the owner or operator must record a notation on the deed to the property, or some other instrument that is normally examined during title search," and that the notation "must in perpetuity notify any potential purchaser of the property that: (i) the land has been used as a CCR unit; and (ii) its use is restricted under the post-closure care requirements as provided by [EPA's regulations]."[114] This may be disconcerting for a utility or IPP who might consider selling its generating station within the 30-year timeframe.

On the other hand, the potential exposure of groundwater to leachate from a closed impoundment with CCR in place has resulted in environmentalists, nearby communities, and state environmental regulators — as well as some legislators — abandoning support for the cap-in-place closure,[115] notwithstanding that EPA held that cap-in-place could be as protective as removal and decontamination.[116] Cap-in-place could also mean the installation of other corrective action features such as slurry walls, etc., if there is either evidence of groundwater interaction with the CCR unit or if groundwater quality impacts are already detected. Groundwater reports posted to utility CCR compliance webpages indicate a large number of impoundments are in assessment monitoring, or have exceeded groundwater protection standards, which underscores the vulnerability of this closure approach.[117]

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114 40 C.F.R. § 257.102(i).

115 See, for example, Chelsea King, Residents oppose Duke Energy's preference to cap coal ash ponds (January 26, 2019), http://www.personcountylife.com/stories/residents-oppose-duke-energys-preference-to-cap-coal-ash-ponds,21595; Emily Sides, Dominion Energy open to coal ash cap; legislators say Possum Point pond has to go. (Dec 12, 2018), https://www.insidenova.com/news/politics/prince_william/dominion-energy-open-to-coal-ash-cap-legislators-say-possum/article_03b0060a-fe53-11e8-8bc0-0f5804636223.html.

116 80 *Federal Register* at 21,412.

117 *Coal's Poisonous Legacy: Groundwater Contaminated by Coal Ash Across the U.S.*, Envtl Integrity Project (Mar.4, 2019, revised July 11, 2019), http://www.environmentalintegrity.org/wp-content/uploads/2019/03/National-Coal-Ash-Report-Revised-7.11.19.pdf.

b. Closure through Removal and Decontamination

EPA also refers to this approach as "clean closure." The requirements in the minimum criteria pertaining to this closure approach are straightforward and hardly technical **(Figure 12)**, particularly as compared to the closure requirements, where CCR remains in place with the detailed specifications for the cover that is to be installed. The minimum criteria for closing a CCR unit by removing the CCR and decontaminating the unit's footprint appear to have the least long-term risks for utilities and IPPs. Although the minimum criteria for clean closure do not expressly specify dewatering in the requirements, excavation of the CCR would, by necessity, require impoundments to be dewatered before excavation begins. Disposal of the liquids from dewatering raises environmental concerns and could trigger revised or new NPDES requirements. There is no obligation for post-closure care of the CCR site once closure is complete. The closure of the unit is deemed complete when constituent concentrations throughout the unit and any areas affected by releases have been removed, and monitored concentrations do not exceed groundwater protection standards.

Figure 12: Overview of Closure by Removal

The conventional term for this approach, excavate and haul, underscores the more controversial transportation activities associated with EPA's remove and decontaminate closure approach. Transportation significantly contributes to the overall costs of closure by removal that may result in it being more costly than closure with CCR in place. However, from EPA's perspective, its regulatory responsibility ceases once the coal ash is placed on a truck or rail car for transportation. There is no post-monitoring or other post-care requirements: "Once a facility has removed the waste and any liner, the presumption is that the source of contamination has been removed as well."[118] It also provides for the title to be cleared. Unless prohibited by state law, the deed notation that would otherwise be required regarding the post-care obligation under cap-in-place would be removed upon certification that clean closure has been completed, effectively evidencing a regulatory cut-off of liability under the excavate and haul scenario.[119]

118 *Id.*

119 40 C.F.R. § 257.102(g)(4).

Two activities that are required for both closure methods but are not addressed in the Final Rule are dewatering and pre-construction stabilization. Ensuring site stability pre-closure for construction activities should also be a significant part of closure plans as the character of coal ash can change in response to construction activities, such as to the vibration of heavy truck activities that can exacerbate instability of a site. Safety of construction workers during closure activities is the central concern in assessing risks of stability failure during the construction process that could subject workers to exposure for longer duration and higher concentration with health risks.[120]

Although the EPA national minimum criteria do not address any specific requirements for dewatering, it is a significant activity in impoundment closures. Technical issues relating to dewatering and its role in structural stabilization are often challenging and very dependent on local conditions.[121] Treatment of the extracted water for ultimate safe discharge should also be addressed in closure plans. Site stabilization and dewatering are large contributing factors in the overall costs of closures, regardless of whether closure is achieved by leaving CCR in place or removal.

Some circumstances may promote a third option: on-site disposal via the development and construction of an on-site compliant landfill or innovative in-place closure, where CCR is excavated, lined, and capped. This option can be applied with a variety of hybrid ash basin closure methods using time tested remediation technologies. These technologies include innovative temporary closure covers with barrier walls and dewatering so the CCR materials can be excavated and used for beneficial use at a future date. This third option would require specialized stabilization methods that would use macroencapsulated CCRs and provide separation and protection of the groundwater.[122]

c. Closure Plans

A closure plan is required for all existing CCR units. It must identify how the CCR unit will be closed and the steps necessary to accomplish closure at any point during its active life. For closure with CCR in place, the plan must describe the final cover system and how it will meet the minimum criteria's performance standards, and the methods and procedures of how it will be installed and the estimated time schedule. The plan should estimate the largest size the CCR could achieve in acreage and volume. The closure plans were to be included in the CCR unit's operating records with a notice provided to the appropriate state agency by October 17, 2016.[123]

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120 Mark Johnson, PG and Kent Nilsson, PE "Construction Concerns Are Key in Closure Planning for Coal Ash Ponds," *Power Magazine*, (Dec. 1, 2014), https://www.powermag.com/construction-considerations-are-key-in-closure-planning-for-coal-ash-ponds/?pagenum=4; also Kathryn Nash , Marcella Funderburg, P.E., Ryan Kamp, "Best Practices During Closure," *World of Coal Ash Conference*, (May 2019), http://www.flyash.info/2019/095-paper.pdf.

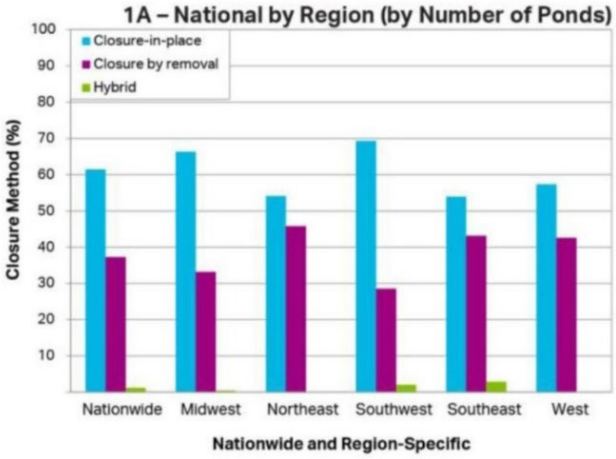
121 Jeffrey B. Heyman, G. Richard Bird, Stephen Couture, "CCR Pond Dewatering – Critical Planning and Characterization Tasks," *World of Coal Ash Conference* (May 2017), http://www.flyash.info/2017/214-Heyman-14-woca2017p.pdf.

122 Jeffrey T. Crate, John P. Swenson, Scott Sheridan, "Using geosynthetics for macroencapsulation for CCR on-site clean closure," *Geosynthetics Magazine* (August 1, 2017), https://geosyntheticsmagazine.com/2017/08/01/macroencapsulation-obtaining-on-site-clean-closure/.

123 40 C.F.R. § 257.101(b).

AECOM compiled data comparing CCR impoundments' closure plans for a report it prepared for Dominion Energy to submit to the Virginia General Assembly under Virginia SB1398. As seen in AECOM's chart in **Figure 13**,[124] nationwide more than 93 percent of ponds with CCR volumes greater than 5 million CY and 75 percent of surface impoundments with between 1 and 5 million CY are being closed in place.

Figure 13: Coal Ash Pond Types by Region



Closure-in-place and closure-by-removal are being used almost equally for surface impoundments with CCR volumes of less than 1 million CY. Although closure-by-removal is used more than closure-in-place for impoundments with areas of less than 20 acres, closure-in-place is the predominant option for surface impoundments larger than 20 acres (75 percent to 95 percent).[125] However, environmental pressure, local coal ash publicity, and the real fear of lawsuits felt by CCR unit owners and operators is shifting away from closure-in-place to excavate and haul, particularly as public policy looks to a "one size fits all" solution.

4. Final Rule Compliance Deadlines and Timelines for Closure

Deadlines for meeting the different criteria under the Final Rule all commence based on the publication of the Final Rule on April 17, 2015. Several of the deadlines for compliance by existing CCR units have already occurred between October 2015 and October 2018. Deadlines for compliance for a new CCR unit are triggered by its initial receipt of CCR. However, the minimum criteria were not applicable to inactive and early closure surface impoundments when the Final Rule issued. Subsequently, the Court vacated its conditional exemption, causing the EPA to amend its rule so that it would now apply to all active impoundments,[126] with the notation that it would issue a further order to establish compliance timeframes for surface impoundments newly affected by the Court's decision. EPA has yet to adopt dates for the applicable impoundments.

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124 Kula Kulasingam, Ph.D., P.E. & John Bove, P.E., *Closure in Place: Regulatory Design Issues and Impacts* (Mar. 20, 2018), http://carbon2019.org/wp-content/uploads/2018/04/4-r-kula-kulasingam.pdf (noting AECOM cautions that "[d]ata compiled from publicly available sources and can not [sic] be independently verified."), as cited in AECOM for Dominion Energy, *SB1398 Response: Coal Combustion Residuals Ash Pond Closure Assessment* (Nov.2017), p.3.1.

125 *Id.*

126 901 F.3d 414.

The Final Rule also establishes closure timeframes by the end of which closure must be completed and certified pursuant to EPA's regulations. Landfills must complete closure within six months of commencing closure and surface impoundments must complete compliance closure within five years of commencing closure. With appropriate documentation and justification beyond the control of the CCR unit's owner or operator, the deadline for a particular CCR unit may be extended. CCR landfills may extend the timeframe to complete closure but for no more than two one-year increments. CCR surface impoundments of 40 acres or smaller is limited to one extension for no more than two years. CCR surface impoundments larger than 40 acres may qualify for up to five two-year extensions, potentially resulting in a total timeframe of 15 years to complete closure.[127]

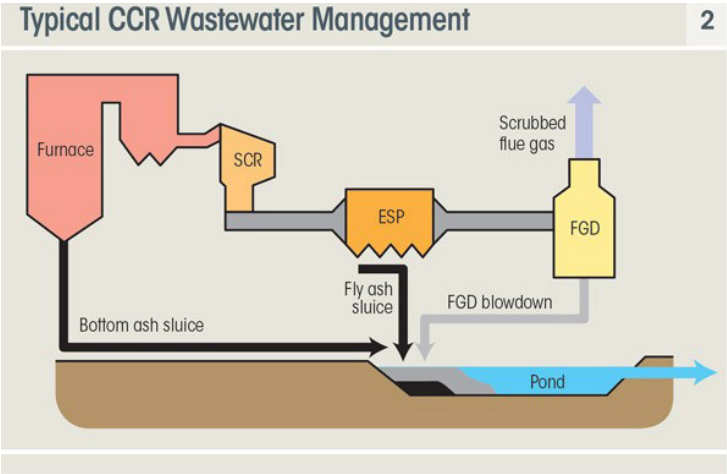
D. Coal Ash Regulation under the Clean Water Act (CWA)

1. CWA's Effluents Limits Guidelines and NPDES Permit Program

Several different liquid waste streams are discharged by coal-fired steam electric plants, as illustrated in **Figure 14**,[128] which include fly ash and bottom ash transport water, once through cooling water, cooling tower blowdown, coal pile runoff, and a broad class of low-volume waste, such as boiler feedwater treatment wastewater and flue gas desulfurization (FGD) wastewater.

These waste streams or effluents are generally managed in on-site wastewater treatment facilities or in CCR surface impoundments prior to being discharged into surface waters under defined terms in facility NPDES permits.

Figure 14: Typical CCR Wastewater Management



127 40 C.F.R. § 257.02(f); *see also* 80 Fed. Reg 21493.

128 Thomas E Higgins, Dennis Fink, Kristen Jenkins and Julianne Schucker, "Planning for the Wastewater Impacts of the CCR Rule and Effluent Limitation Guidelines," *Power Engineering*, Issue 5 and Vol. 119 (May 21, 2015), https://www.power-eng.com/2015/05/21/planning-for-the-wastewater-impacts-of-the-ccr-rule-and-effluent-limitation-guidelines/#gref.

Seepage is another form of discharge. Seepage is collected and managed through a seepage interception system that are built into surface impoundments to help prevent internal erosion of the impoundment's structure. Wastewater from these systems is either pumped back into the impoundment or discharged via a discrete conveyance. Whatever the conveyance that empties the effluent into a particular body of water, it is a regulated point source under the CWA.[129] Consequently, electricity generation facilities must obtain a permit under CWA that will attempt to control the pollutants being discharged through their wastewater systems. Closure of surface impoundments will require removal of decant water and dewatering as a preliminary step to excavation. These activities will require permits depending on how the closure plan proposes to dispose of them.

The CWA establishes a regulatory framework for regulating the direct discharge of designated pollutants from a point source into navigable waters through a permit program administered by the state or the regional office of the EPA as part of CWA's national pollutant discharge elimination system. The CWA is not intended to apply to any and all discharge(s), but only those from a specific point source.[130] CWA § 301 prohibits industrial discharge of pollutants into jurisdictional waters without a permit such as would be issued under CWA § 402 that creates the National Pollutant Discharge Elimination System (NPDES). An individual NPDES permit translates the general requirements of the CWA into specific provisions tailored to the industry, individual operations, and activities by the applicant and the specific effluents to be controlled.

Conditions and restrictions placed on a NPDES permit are based on national wastewater discharge standards consistent with EPA's Effluent Guidelines developed by EPA on an industry-by-industry basis. They are technology-based regulations designed to achieve maximum pollutant reductions economically achievable for an industry. EPA identifies the best available technology that is economically achievable for that industry and sets regulatory requirements based on the performance of that technology. The Effluent Guidelines do not require facilities to install the particular technology identified by EPA but do require facilities to achieve the regulatory standards that were developed based on a particular model technology.[131]

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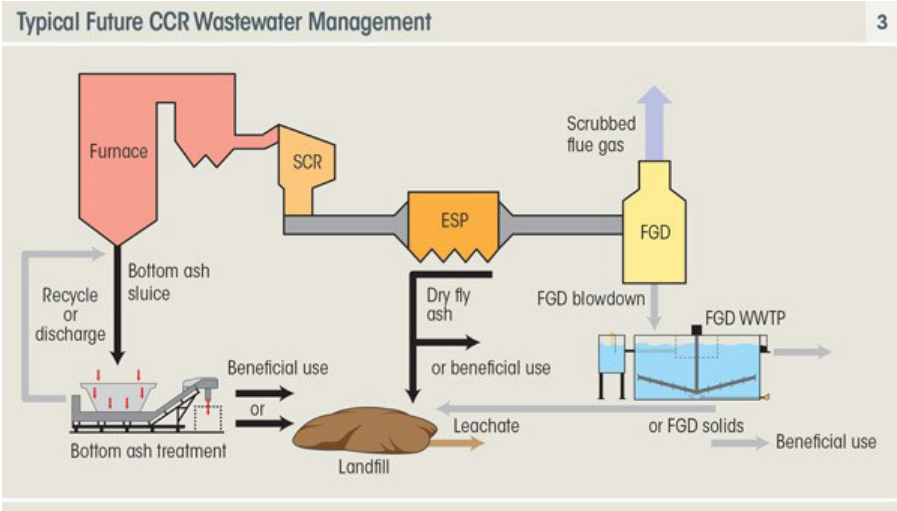
129 EPA, Water Quality-Based Effluent Limits Coal Combustion Waste Impoundments, https://www3.epa.gov/npdes/pubs/wqp-coalcombustionwasteimpoundments.pdf.

130 CWA §502(12), see also Robert V. Percival, et al., *Environmental Regulation: Law, Science, and Policy 222* (4th ed. 2003).

131 See EPA's discussion of Effluent Guidelines at https://www.epa.gov/eg and subsequent web pages.

Figure 15: Typical Future CCR Wastewater Management



The same year that EPA issued its Final Rule on CCR regulations, EPA also issued a final rule that adopted effluent guidelines that would apply to coal-fired steam electric generation plants. As indicated in **Figure 15**,[132] it will affect the wastewater streams from the same processes and similar byproducts as affected under EPA's CCR Final Rule: FGD residuals, fly ash and bottom ash, with the addition of flue gas mercury control and gasification of fuels, such as coal and petroleum coke.[133] The Effluent Limitation Guidelines (ELG) require substantial investment in technology to achieve compliance, in addition to CCR compliance costs. Ultimate disposal of wastewater as part of CCR unit closures will also be affected by NPDES new conditions resulting from ELG compliance. EPA is very aware of the combined economic and time constraints from utilities and IPPs having to comply with both within the same timeframe:

> EPA also takes very seriously the concern that facilities are not prematurely compelled to make potentially irreversible operational changes or otherwise be forced to invest in compliance measures that may subsequently need to be modified. This was part of the reason that EPA originally chose to align key implementation and operational decisions under the CCR rule with EPA's schedule for issuing the effluent limitations guidelines and pretreatment standards (ELG) for the Steam Electric Power Generating Point Source Category.[134]

Meanwhile, in May 2019, EPA postponed issuance of an order revising ELG, projecting a proposed rulemaking by June 2019, and a final rule by August 2020.[135]

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132 https://www.power-eng.com/2015/05/21/planning-for-the-wastewater-impacts-of-the-ccr-rule-and-effluent-limitation-guidelines/#gref.

133 EPA issued the Final 2016 Effluent Guidelines Program Plan, 83 *Federal Register* 19,281 (May 2, 2018), https://www.federalregister.gov/documents/2015/11/03/2015-25663/effluent-limitations-guidelines-and-standards-for-the-steam-electric-power-generating-point-source.

134 83 *Federal Register* at 36,411.

135 See https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201904&RIN=2040-AF77.

2. CWA and Coal Ash Leachate Risk to Groundwater

The Clean Water Act (CWA) unambiguously regulates the discharge of pollutants into the navigable waters of the United States.[136] However, recent environmental litigation has raised the question of whether CWA provides for the regulation of pollutants being discharged into jurisdictional water indirectly via the contamination of groundwater. This question has been asked in the context of coal ash leachate that contaminates groundwater, which ultimately discharges the pollutants into nearby lakes, streams, and rivers. The Circuit Courts of Appeal who have heard cases on this question have split in their answer. Because of the split in the Circuits, the Supreme Court has agreed to hear the issue in its next term. In anticipation of the Supreme Court case, EPA recently issued an interpretative rule[137] addressing whether the CWA NPDES permit program applies to pollutants like coal ash from a point source to groundwater.

In *Sierra Club v. Dominion*, the Sierra Club sued Dominion for violation of CWA and violation of its Virginia Pollutant Discharge Elimination System Permit (VPDES),[138] the Virginia version of the NPDES. The Sierra Club alleged Dominion was discharging arsenic into navigable surface waters, via hydrologically connected groundwater, without permitting authority under the CWA and VPDES. The Eastern Federal District Court of Virginia broke its decision into two parts. First, it ruled that the CWA does cover groundwater discharge where it hydrologically connects with surface water, and therefore, since Dominion did not have a discharge permit for its CEC (Cation Exchange Capacity) coal ash pond, it violated the CWA. Second, however, the court gave deference to the DEQ's interpretation that VDPES regulations are not applicable to groundwater and so found that Dominion had *not* violated its VDPES permit. The District Court's decision was appealed, and in 2018 the Fourth Circuit Court of Appeals reversed the District Court's interpretation of the CWA, finding that leaching through groundwater into navigable waters did NOT constitute a "point source" that would trigger the CWA.[139] This is in conflict with an earlier Fourth Circuit opinion by another panel that adopted a more generous interpretation of the CWA.[140]

During this same timeframe, two Sixth Circuit cases[141] adopted a view similar to the Fourth Circuit's *Dominion Decision*, finding that the "conduit theory" was insufficient to implicate the CWA. The Ninth Circuit case decided this issue in agreement with the earlier Fourth Circuit's more expansive view of the CWA.[142] Given this split in the Circuits, the Supreme Court granted a petition for *certiorari* in February 2019.[143] Pending the hearing at the Supreme Court, EPA issued an interpretative ruling in April 2019, largely agreeing with the Sixth Circuit that the hydrological connection of groundwater to navigable waters does not implicate the CWA.[144]

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136 *See* Summary of the Clean Water Act, 33 U.S.C. § 1251 *et seq.* (1972), https://www.epa.gov/laws-regulations/summary-clean-water-act.

137 Interpretive Statement on Application of the Clean Water Act National Pollutant Discharge Elimination System Program to Releases of Pollutants From a Point Source to Groundwater, 84 *Federal Register* 16810 (April 23, 2019), https://www.govinfo.gov/content/pkg/FR-2019-04-23/pdf/2019-08063.pdf.

138 *See Virginia Pollutant Discharge Elimination System Permit Program,* Va. DEQ (last visited Oct. 3, 2019), https://www.deq.virginia.gov/Programs/Water/PermittingCompliance/PollutionDischargeElimination.aspx.

139 *Sierra Club v. Va. Elec. & Power Co.,* 903 F.3d 403 (4th Cir. 2018), hereinafter *Dominion Decision*.

140 *Upstate Forever v. Kinder Morgan Energy Partners, L.P.*, 887 F.3d 637 (4th Cir. 2018).

141 *Ky. Waterways All. v. Ky. Utils. Co.,* 905 F.3d 925 (6th Cir. 2018); *Tenn. Clean Water Network v. TVA*, 905 F.3d 436 (6th Cir. 2018), *reh'g denied,* 913 F.3d 592 (6th Cir. 2019).

142 *Hawai'i Wildlife Fund v. Cty. of Maui,* 886 F.3d 737 (9th Cir. 2018) *cert granted*, 139 S.Ct. 1164 (2019), https://www.scotusblog.com/case-files/cases/county-of-maui-hawaii-v-hawaii-wildlife-fund/.

143 The Writ of Certiorari was granted on February 19, 2019, and oral argument was held on November 6, 2019. No decision has been reached as of the publication of this report, https://www.scotusblog.com/case-files/cases/county-of-maui-hawaii-v-hawaii-wildlife-fund/.

144 EPA, Interpretive Statement on Application of the Clean Water Act National Pollutant Discharge Elimination System Program to Releases of Pollutants From a Point Source to Groundwater, https://www.federalregister.gov/documents/2019/04/23/2019-08063/interpretive-statement-on-application-of-the-clean-water-act-national-pollutant-discharge.

However, the Supreme Court might find on the facts of the case before it relative to the conduit theory under the CWA, the application of its decision in the coal ash context is mostly moot. The Final Rule addresses groundwater protection through monitoring and corrective action criteria under RCRA's solid waste regulation and so further regulation under CWA would be mostly duplicative. Many of these cases were most likely brought because of the frustration of environmentalists with the lack of action in implementing the Final Rule that was issued in 2015 with little actually happening. Should the Supreme Court find that the CWA does apply as challenged, then the environmentalists will have another means of pressuring for action by the EPA and CCR unit owners.

SECTION 6:
State Environmental Regulatory Role in Coal Ash Management

A. RCRA's Self-Implementing Enforcement before WIIN

Section 7002 of RCRA generally provides for limited federal enforcement of EPA regulation of solid waste disposal under subtitle D.[145] Subtitle D regulations have been described as self-implementing, meaning that while EPA can adopt national minimum criteria, it can neither enforce compliance nor mandate a state to enforce compliance.[146] Consequently, implementation of national minimum criteria promulgated by EPA in regards to solid waste disposal are generally reliant on a waste facility owner or operator to voluntarily comply. Otherwise, the only enforcement mechanism is a citizen suit under RCRA that would open the door for courts to enforce compliance. EPA's only recourse would be to use its imminent and substantial endangerment authority where there has been demonstrable environmental and public health harm.[147]

EPA discussed this self-implementing character of subtitle D in the Final Rule, recognizing that its authority over CCR waste disposal was limited to adopting national minimum CCR criteria[148] and that it needed the states to adopt its minimum criteria if it were to be effective in changing coal ash waste management practices. Consequently, it turned to the provisions outlining a process for state solid waste management plans (SWMP) under §4002 of RCRA, which EPA must approve. EPA "strongly recommended" that states take advantage of this process to amend their existing SWMP to include coal ash requirements consistent with the Final Rule and to submit their amended plans to EPA for approval.[149] However, subsequent action by Congress addressed EPA's enforcement limitation and provided EPA a stronger stick to incentivize states to adopt EPA's minimum criteria for CCR disposal.

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145 42 U.S.C. § 6972.

146 Steven A. Burns & David W. Mitchell, *EPA's coal ash rule relies on unique enforcement framework,* Am. Bar. Ass'n (Mar. 1, 2015), https://www.americanbar.org/groups/environment_energy_resources/publications/trends/2014-2015/march-april-2015/epas_coal_ash_rule_relies_unique_enforcement_framework/.

147 *Id.*

148 Final Rule, *supra* note 1, at 21,303; *see also* discussion on the voluntary character of the Final Rule, *id.*, at 21,311: "The federal standards apply directly to the facility (are self-implementing) and facilities are directly responsible for ensuring that their operations comply with these requirements. States are not required to incorporate or implement these requirements under any state permitting program or other state law requirement, and EPA is not authorized to impose such requirements, directly or indirectly on the states. States and citizens may enforce this prohibition (and therefore, the federal criteria) using the authority under RCRA section 7002."

149 Final Rule, *supra* note 1, at 21,430.

B. WIIN: A New Federal and State Cooperative Enforcement

However, as noted earlier, in 2016, after the issuance of the Final Rule, Congress enacted the *Water Infrastructure Improvements for the Nation* (*WIIN*)[150] establishing a different federal and state cooperative framework for enforcement of federal coal ash regulations only. As an alternative to amending its SWMP, a state can establish its own permit program (or other system that would require prior approval and conditions under state law), which then must be submitted to EPA for approval. EPA must approve the program if it determines that it complies with the national minimum criteria as set forth in EPA's regulations or with other state criteria that is "at least as protective" as EPA's criteria. It also allows the permit program to include flexibility in issuing individual permits. Conditions placed on a permit can deviate from any national minimum criteria when needed to address unique on-site circumstances, so long as they are as environmentally protective. Once a state permit program is approved, it operates in lieu of EPA's regulations for CCR disposal. Until a CCR unit has obtained a permit, however, it continues to be subject to EPA's CCR disposal criteria.

WIIN goes beyond the SWMP process used for other nonhazardous waste. In the event that a state does not file a permit program for CCR disposal activities, or that EPA does not approve a permit program submitted by a state (both identified as a "nonparticipating state"), EPA can implement its own permit program for the nonparticipating state, but only where Congress provides funding for EPA's permit program. WIIN also provided EPA with the authority to directly enforce the federal CCR Rule in nonparticipating states. Otherwise, the Final Rule would continue to be self-implementing under RCRA and enforceable through citizen lawsuits.

Because WIIN was enacted after the CCR Final Rule was issued, two petitions for reconsideration were filed with EPA on May 12, 2017, and May 31, 2017, requesting EPA to reconsider those provisions of the rule that could be affected by WIIN. EPA granted the petitions.[151] Meanwhile, however, some states have filed their permit programs.

In August 2017, EPA issued its *Coal Combustion Residuals State Permit Program Guidance Document* (Guidance) intended as a "technical resource to States that may be useful in developing and submitting a State Coal Combustion Residuals (CCR) Permit Program to EPA for approval."[152] The Guidance includes four chapters:

1. An overview of the provisions of WIIN;
2. The process and procedures EPA will use to review and make determinations on state CCR permit programs and the documentation that should also be submitted for approval;
3. A checklist of all the requirements of the Final Rule as codified at 40 CFR Part 257 subpart D; and
4. A checklist of those items to be submitted by a state when seeking approval of its permit program.

Although EPA noted its anticipation that the Guidance would be updated as the rules are revised and as it considers comments it invited the public to submit, EPA has not yet provided any revised or updated version.

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150 42 U.S.C. § 6945(d). Text of WIIN Act at https://www.congress.gov/114/plaws/publ322/PLAW-114publ322.pdf.

151 EPA to Reconsider Certain Coal Ash Rule Provisions, EPA, (September, 14, 2017), https://www.epa.gov/newsreleases/epa-reconsider-certain-coal-ash-rule-provisions.

152 *Coal Combustion Residuals State Permit Program Guidance Document*, EPA, at iv (Aug. 2017), https://www.epa.gov/sites/production/files/2017-08/documents/eo12866_ccr_state_permit_prog_guide_2050-za10_significant_guidance_20170809_final_omb_clean_copy_002508.pdf.

C. Individual State Actions on Coal Ash Permitting

As discussed, federal structure for waste environmental regulation often relies on cooperative relationships with states through a permit program. Since the Final Rule was issued, there have been several state actions regarding the state permitting function. Oklahoma and Georgia submitted their permit program to EPA for approval under WIIN, and Oklahoma has received approval.[153] Four states have passed coal ash legislation that will need to be integrated into their permit program under WIIN or into a coal ash amendment to their SWMP: Illinois, Michigan, North Carolina, and Virginia. Additionally, many state environmental offices have amended their solid waste regulations to include EPA's minimum criteria.[154] Compliance with the Final Rule will be implemented more or less through the standard permitting process generally implemented by states.

1. WIIN State Permit Programs

a. Oklahoma

Oklahoma was the first state to submit its own permit program for EPA approval under WIIN. It was approved by EPA on June 18, 2018, thereby allowing it to operate in lieu of EPA's Federal CCR program.[155] However, EPA's approval is being challenged in the D.C. Federal District Court on two grounds:[156]

1. EPA failed to develop and publish minimum guidelines for public participation in the design, implementation, and approval of state CCR programs.

2. EPA approval of Oklahoma's permit program included the same federal CCR regulations that had been vacated in USWAG v. EPA.

b. Georgia

Georgia submitted its permit program and associated regulations for partial approval by the EPA. On June 28, 2019, EPA published its proposed approval for public comment and held a public hearing on August 6, 2019.[157] Georgia asked for partial approval, excluding from EPA review two definitions, ''CCR Landfills'' and ''CCR Surface Impoundments,'' which expand the types of landfills and surface impoundments that would be subject to Georgia's CCR regulations that are not now covered by federal CCR regulations. Georgia's definitions include dewatered surface impoundments, inactive (but not dewatered) surface impoundments at inactive facilities, and inactive CCR landfills. Although the definitions were to be excluded from EPA's review, EPA commented that the definition, by requiring that inactive units located at inactive generation facilities, aligns with the decision in USWAG v. EPA.[158] However, because EPA had not yet promulgated final regulations

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153 See Permit Programs for Coal Combustion Residual Disposal Units, https://www.epa.gov/coalash/permit-programs-coal-combustion-residual-disposal-units#guidance, for a discussion of state permitting generally and the Oklahoma and Georgia applications specifically.

154 *See e.g.* Utah Admin. Code r. 63G-3-102(5), -701 (Sept. 1, 2019), https://rules.utah.gov/publicat/code/r315/r315-319.htm; Ind. Code § 13-19-3-3 (2017), https://www.in.gov/idem/landquality/2503.htm; Sonal Patel, "EPA Urges States to Submit CCR Programs Even as Coal Ash Regulatory Overhaul Continues," PowerMag.com (June 26, 2019), https://www.powermag.com/epa-urges-states-to-submit-ccr-programs-even-as-coal-ash-regulatory-overhaul-continues/; *but see* "Coal Combustion Residuals," Ky.com (2019), https://eec.ky.gov/Environmental-Protection/Waste/solid-waste/i-need-information/Pages/coal-combustion-residuals.aspx.

155 https://www.epa.gov/coalash/us-state-oklahoma-coal-combustion-residuals-permit-program.

156 *See e.g.*, Motions for Intervention, Waterkeeper Alliance, Inc. v. Wheeler, United States District Court for the District of Columbia, Jan 29, 2019, Civil Action No. 18-2230 (JDB) (D.D.C. Jan. 29, 2019) https://casetext.com/case/waterkeeper-alliance-inc-v-wheeler.

157 *U.S. State of Oklahoma Coal Combustion Residuals Permit Program*, EPA (July 10, 2019), https://www.epa.gov/coalash/us-state-georgia-coal-combustion-residuals-ccr-permit-program.

158 *Georgia: Approval of State Coal Combustion Residuals Permit Program,* 84 *Federal Register* 30,977, 30,980 (June 28, 2019), https://www.federalregister.gov/documents/2019/06/28/2019-13907/georgia-approval-of-state-coal-combustion-residuals-permit-program.

consistent with the USWAG v. EPA decision, it had no comparative basis on which to make a determination that Georgia's permit rules were at least as strict as EPA's.[159] Georgia otherwise adopted by reference nearly all the technical criteria contained in federal CCR regulations. Georgia's CCR regulations can be found in 391-3-4-.10 of the Georgia Compilation of Rules and Regulations.

Environmentalists have challenged the Oklahoma program and have indicated that they oppose aspects of the Georgia program.[160] "[E]nvironmentalists are concerned that a state-operated permit program encroaches on the ability to file citizen suits in federal court. 'Citizens would potentially be able to challenge state permits ... in state court. But that process is a lot more complicated than being able to bring a citizen suit in federal court.'"[161]

2. Recent State Coal Ash Legislation Post-Final Rule

a. Virginia

Virginia's General Assembly enacted coal ash legislation, SB 1355,[162] in 2019 that effectively prohibits closure by leaving CCR in place (cap-in-place). It mandates that all inactive CCR units located at specified generating stations owned by Virginia's primary utility, Dominion Energy, be closed by removing all CCR from the CCR unit in accordance with Virginia DEQ standards and that the excavated CCR must be either beneficially reused or disposed in a permitted landfill, either on-site or off-site. Permitted landfills accepting CCR must have a composite liner and leachate collection system that meets or exceeds EPA's national minimum criteria set out in its regulations.

Beneficial reuse under the Bill must be in a recycling process for encapsulated beneficial use, which SB 1355 defines as a beneficial use of CCR that "binds the CCR into a solid matrix and minimizes its mobilization into the surrounding environment." An example of an encapsulated use is the use of fly ash in cement products. Unencapsulated uses, such as for structural fill, are not allowed, even if the unencapsulated use would be consistent with industry specifications and environmental standards.[163] In addition, Virginia's largest utility, Dominion Energy, is required to beneficially reuse a total of 6.8 million CY from no fewer than two of the sites specified in the Bill. Closure projects must be completed within 15 years of commencement.

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159 Under WIIN, EPA has 180 days to review a state's petition. Accordingly, a decision by EPA is expected in mid-December 2019.

160 Catherine Morehouse, "EPA recommends Georgia become 2nd state to run its own coal ash permit program," *Utility Dive* (June 26, 2019), https://www.utilitydive.com/news/epa-recommends-georgia-become-2nd-state-to-run-its-own-coal-ash-permit-prog/557623/.

161 *Id.* (quoting Southern Environmental Law Center attorney, April Lipscomb).

162 Va. Code Ann. § 10.1-1402.03 (July 1, 2019), https://lis.virginia.gov/cgi-bin/legp604.exe?191+sum+SB 1355.

163 *See* discussion, *infra* at Section 7, for detailed explanation of unencapsulated and encapsulated.

The exclusion of closure with CCR in place will likely cause tons of CCR to be transported to remote landfills, with only a limited amount to be disposed of in on-site landfills located at the generation plants. During the legislative process on SB 1355, Dominion Energy prepared a report for the General Assembly summarizing responses to its Request for Proposals asking for bids on a combined recycling and closure project for each of its coal generation stations. The report's summary included the chart shown in **Figure 16**,[164] which represented the transportation requirements associated with those projects removing and transporting CCR to either a disposal or beneficiation plant.

Figure 16: Transportation Requirements Associated with CCRs

Power Station	Transportation Options	Vehicle Volume	Project Duration (Years)
Bremo Power Station		124 to 161 Trucks/day	10 to 11
		270 Railcars/year	14
Chesapeake Energy Center		65 to 143 Trucks/day	5 to 11
		20 Trucks/day + 67 Railcars/year	11
		Up to 5 Barges/year	10
Chesterfield Power Station		278 to 300 Trucks/day	15
		34 Trucks/day + 260 Railcars/year	13
		2,500 to 3,750 Railcars/year	15
Possum Point Power Station		105 to 114 Trucks/day	7 to 11
		232 Railcars/year	10

In response to the potential local and regional impacts from the number of trucks projected to move through communities every day, SB 1355 requires the utility to prepare a transportation plan in consultation with each county, city, or town within two miles of the CCR site that (1) minimizes traffic impact on adjacent property and surrounding communities, and (2) uses a mix of transportation options, including rail and barge when possible, as needed to meet the closure timeframe. Finally, the plan must include details of truck transportation, including the frequency of truck travel, travel route, noise mitigation, traffic impact, safety, and fugitive dust caused by truck travel.

SB 1355 also provides instructions for the utility's recovery of costs associated with closing the applicable CCR units. Closure costs are recoverable through a rate adjustment clause authorized by the State Corporation Commission. Costs associated with closure by leaving the CCR in place will be disallowed. Finally, it caps the utility costs for closure at $225 million, which it will be allowed to recover annually through the rate adjustment clause, with some deferral ability for any under-recovery amount and for carrying cost. The utility may begin accruing costs on July 1, 2019, but no approved rate adjustment clause charges shall be included in customer bills until July 1, 2021. Recoverable costs shall be allocated to all Virginia customers served by the utility as a non-bypassable charge.

164 AECOM *CCR Recycling/Beneficial Use Assessment Business Plan*, prepared for Dominion Energy, https://www.dominionenergy.com/library/domcom/media/about-us/electric-projects/coal-ash/ccr-recycling-beneficial-use-assessment-business-plan.pdf?la=en.

b. Illinois

Illinois enacted the Coal Ash Pollution Prevention Act[165] on July 30, 2019. It requires that all closure plans submitted for approval must include a closure alternative analysis across all considered closure methods, including removal of CCRs from the CCR unit. It further sets a timeline for the Illinois EPA to propose, and the Illinois Pollution Control Board to adopt, rules to implement the new Act, including:

- Deadlines;
- Prioritizing of impoundments posing the highest risks to public health and environment and considering environmental justice concerns;
- Defining when complete removal of CCR is achieved; and
- Setting standards for responsible removal of CCR from CCR surface impoundments.

Because Illinois utilities divested their generation facilities when Illinois adopted retail choice, many of the CCR units are owned by IPPs. Consequently, the Act requires for-profit generators to post a performance bond or other financial security to ensure that companies have the funds to close and maintain CCR surface impoundments or remediate releases from the impoundments. It also sets fees of $50,000 for each closed CCR surface impoundment and $75,000 for each CCR surface impoundment that hasn't yet closed, as well as annual fees ranging from $15,000 to $25,000 per impoundment. The fees will be deposited into the state's "Environmental Protection Permit and Inspection Fund," which will be used to pay for regulatory purposes.

c. Michigan

Michigan's legislature enacted HB 6269 in December 2018,[166] revised its existing solid waste statutory framework to include provisions applying to coal ash consistent with EPA's CCR regulations. It also requires Michigan DEQ to adopt regulations mirroring EPA's CCR regulations and national minimum criteria. It established licensing fees specific to coal ash and payments into a perpetual coal ash care fund based on a per ton or per yard levy for coal ash disposed in the CCR unit since 1990 up to a cap of $1,156,000.[167] The fund should continue until 30 years after the final closure of the CCR unit.

d. North Carolina

North Carolina did not wait for the federal government to address coal ash after the Dan River spill in its state. It adopted the Coal Ash Management Act in September 2014,[168] which it subsequently amended in July 14, 2016, after the issuance of EPA's Final Rule. The 2016 amendments generally incorporated the national minimum criteria into CAMA. Overall, however, CAMA's coal ash requirements are considered stricter than those adopted in EPA's Final Rule.

Before CAMA, wet storage of coal ash was not considered solid waste for purposes of North Carolina's solid waste management regulations. Under CAMA, only dry storage of coal ash is allowed, and all surface impoundments must be closed. The deadline for closure depends on the impoundment's risk classification among the Act's three levels of risk. High-risk impoundments are to be closed by December 31, 2019. The coal ash is required to be excavated and moved to an onsite or offsite synthetically lined landfill, or a municipal solid waste facility, or structural fill, or it can be beneficially reused. The definition of beneficial use allows flexibility of potential uses that include (i) as an ingredient in an industrial process to make a product or in a function, or (ii) in an application as a substitute for a commercial product or natural resource.

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165 415 Ill. Comp. Stat. 5/3.140 (July 30, 2019), http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=101-0171.

166 H.B. 6269, 99th Leg., Reg. Sess. (Mi. 2018), https://www.legislature.mi.gov/documents/2017-2018/publicact/pdf/2018-PA-0640.pdf.

167 Emily S. Smith & Austin Scott, *Compliance with Fed. and State Admin. Rules for Coal Ash, H.B. 6269 as Introduced,* House Fiscal Agency (Sept. 26, 2018), http://www.legislature.mi.gov/documents/2017-2018/billanalysis/House/htm/2017-HLA-6269-533A01FE.htm.

168 S.B. 729, *supra* note 18 (including text of CAMA as ratified).

CAMA also required Duke Energy to develop three "beneficiation" plants capable of annually producing 300,000 tons of ash "to specifications appropriate for cementitious products" from wet waste impoundments. The sites are to be operational within two years of permit issuance, and if the carbon content is too high, further processing should be used. Finally, the impoundments at those sites must be emptied of ash by December 31, 2029. Duke is proceeding on three beneficiation projects at the requisite three sites.[169]

3. Standard State Permitting Process

As a general matter, for each CCR unit that is required to be closed under EPA's Final Rule or other state coal ash legislation, the owner or operator will typically need to obtain approval and acquire the necessary permits from the state's environmental agency that oversees RCRA solid waste authority for the state, although some states may not yet have established permitting rules specifically applicable to CCR disposal. The permitting procedure under which a closure plan will be approved by a state's environmental agency will vary from state to state, although their permitting requirements will likely align with the environmental framework established under RCRA and the CWA. A typical process presumes the existence of state permitting rules applicable to CCR units and a federal CCR permit program for non-participating states as laid out in WIIN. EPA issued a proposed rule for Federal Permitting under WIIN in December 2019. Congress appropriated the designated funds required under WIIN.[170] Accordingly, the process will generally include the following steps:

- File for an NPDES under the CWA, or alternatively, an amendment to any existing NPDES held by the relevant CCR unit if the closure activity will result in discharges related to the dewatering of the disposal facility and removal of decant water. The application should be filed with either the applicable EPA region or a state environmental agency that is approved by EPA to oversee the NPDES permit program.
- Submit the closure plans and application for a solid waste permit that will set out the closure design particular to the relevant CCR unit. The environmental agency that is authorized by EPA to manage the state's SWMP under RCRA or has been authorized to administer the CCR permit program as approved by EPA will oversee the issuance of permits. If the state has not adopted a permit program or adopt CCR rules in its SWMP that has been approved by EPA, and is thus a non-participant under WIIN, EPA will review the permit application consistent with its own permit program once finalized and the national minimum criteria. The state or EPA will issue the applicable permits that will include requirements that are tailored to specific site conditions consistent with either the state's CCR permit program that has been approved by EPA or EPA's CCR permit program.
- Apply for any necessary permits or an amendment to an existing permit applicable to the construction and operation of impoundments under dam safety regulations administered by the appropriate state agency.

Permits will note the applicable water discharge limits that are calculated to ensure that discharges comply with water quality standards and maximum contaminant levels (MCL) regulations. EPA established MCL for those pollutants identified in its national minimum criteria but for which no water quality standards have been set.[171] The permit will also be conditioned on compliance with monitoring requirements that are at least as strict as EPA's national minimum criteria or consistent with state law.

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169 *Coal Ash Beneficiation Projects*, NC DEQ (Sept. 4, 2018), https://files.nc.gov/ncdeq/Coal+Ash/CoalAshDAQ-Handout-090418.pdf (listing the three sites as the Buck Steam Station, the H.F. Lee, and the Cape Fear plants).

170 EPA issued a prepublication version of a proposed rule on Federal Permitting on December 19, 2019. https://www.epa.gov/coalash/proposed-rule-disposal-coal-combustion-residuals-electric-utilities-federal-ccr-permit.

171 83 *Federal Register* at 36,444.

EPA intends permit rules to provide for extensive public involvement. The Final Rule required that each CCR unit, active or inactive, have a closure plan included in the unit's operating record and that current information on any proposed or final permits for each CCR unit at coal generating stations are available on a website hosted by the owner or operator of the CCR unit. EPA discussed in the Final Rule the importance of these notice criteria for an informed public on whom enforcement relied under the self-implementing provisions of RCRA pre-WIIN.[172] After enactment of WIIN, EPA issued a guidance document on what a state CCR permit program should contain for EPA approval, including public participation procedures that create an "inclusive dialogue."[173] However, notwithstanding EPA's guidance document, environmentalists challenged EPA's approval of Oklahoma's permit program partially based on EPA failure to develop and publish minimum guidelines for public participation in the design, implementation, and approval of state CCR programs.[174]

Whereas these state procedures may vary, public input could occur either after the closure application is filed or after regulatory review has been completed and a draft permit has been prepared. For instance, in Virginia a formalized public review process is initiated via an announcement that the draft permit is available for public review.[175] Based on the volume and nature of the comments received during the public comment period, a public hearing may be held. The director of the regulatory body will consider the nature of public comments, including whether there is new information that had not been considered previously during draft permit development. Upon termination of the public participation process, the director of the regulatory body may deny the permit, proceed with the permit as drafted, or modify the draft permit.

Generally, adjudicated hearings are not required to meet the public participation criteria prior to the issuance of an environmental permit, unless the permit will have a direct impact on a landowner. Typically, legislative-type hearings are held if any hearings at all are necessary.[176]

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172 Final Rule, *supra* note 1, at 21,399.

173 Coal Combustion Residuals State Permit Program Guidance Document, Interim Final, August 2017, at 12, https://www.epa.gov/sites/production/files/2017-08/documents/eo12866_ccr_state_permit_prog_guide_2050-za10_significant_guidance_20170809_final_omb_clean_copy_002508.pdf.

174 Ibid.

175 See, e.g., *Coal ash management in Virginia,* https://www.deq.virginia.gov/ConnectWithDEQ/EnvironmentalInformation/CoalAshPermits.aspx.

176 *See e.g. Getting Heard: When Are Hearings Before the NJDEP or Courts Available?* https://www.csenviroblog.com/2009/04/articles/environmental-litigation/getting-heard-when-are-hearings-before-the-njdep-or-courts-available/.

SECTION 7:
Coal Ash Products and Beneficial Uses

A. CCPs and Their End Uses

Coal-burning processes will naturally result in the generation of secondary solid materials that the Final Rule defines as CCR. CCPs differ from CCR primarily as a matter of perception. The American Coal Ash Association (ACAA), which is the leading trade association representing cross sections of stakeholders having an interest in CCP markets, chronicles the history of coal ash terminology and how those terms track the growth of commercial interests in coal ash. First, coal combustion wastes (CCW) were seen as a disposal problem. Next, CCW became coal combustion byproducts (CCBP), as coal ash's image changed from waste to being a secondary resource looking for a market where it could be sold as an alternative to disposal; and finally, CCBP dropped the byproduct from its acronym to become coal combustion products (CCP) that are in demand at a market price similar to other commodities.[177] Even EPA's use of the term CCR in the regulatory context relative to disposal rules is applauded by ACAA for at least not sliding back into a characterization as "waste."[178]

ACAA, in its role as the leading trade association for coal ash markets, tracks each year the production and use of those CCPs that are generated in the highest volumes and make up the largest markets. These CCPs coincidentally are the same constituents identified in EPA's definition of CCR:

1. **Fly ash** is a powdery material that is captured by emissions control equipment before it can escape through the stack. It is a pozzolan, a substance containing aluminous and siliceous material and having mechanical and chemical properties that make it a valuable ingredient in a wide range of concrete products. Fly ash's major use is in concrete, substituting for manufactured cement.[179] It makes the concrete measurably stronger and more durable than concrete made with cement alone, and so can commonly be found in roads, bridges, and buildings. Because cement requires extreme heat for production, substituting fly ash for cement in concrete reduces carbon emissions from the offset in cement production. ACAA projects that every ton of fly ash used as a substitute for traditional cement roughly results in one ton of CO_2 emission reduction, which approximates two months' average emissions from an automobile. Consequently, based on the average annual use of fly ash in concrete, carbon emissions could be reduced by an estimated 13 million tons of carbon each year.[180] Fly ash is also used in the construction of structural fills and embankments, waste

177 John Ward, "What Lies Ahead for Beneficial Use of Coal Combustion Products," *Ash at Work*, Issue 2 at 27 (2018), https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH02-2018.pdf.

178 *Id.*

179 *Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard*, EPA, at 3 (Feb. 2014), https://www.epa.gov/coalash/coal-combustion-residual-beneficial-use-evaluation-fly-ash-concrete-and-fgd-gypsum-wallboard.

180 *About Coal Ash*, ACAA (last visited Sept. 30, 2019), https://www.acaa-usa.org/aboutcoalash/ccpfaqs.aspx#Q3.

stabilization and solidification, mine reclamation, and as raw feed in cement manufacturing. ACAA cites the American Road & Transportation Builders Association, which estimated that using fly ash in roads and bridges saved $5.2 billion per year in U.S. construction costs.[181] It is also a source of cenospheres, which are microscopic hollow spheres. Cenospheres are strong and lightweight, making them useful as fillers in a wide variety of materials, including concrete, paint, plastics, and metal composites.[182] They are being researched for a number of new applications as discussed later in this section.

2. **Bottom ash** is a heavier, granular material collected from the "bottom" of coal-fueled boilers. Its agglomerated particles are too large to be carried in the flue gases and collect on furnace walls or fall through open grates to an ash hopper at the bottom of the furnace. Bottom ash is often used as an aggregate substitution for sand and gravel and as a lightweight aggregate ingredient in manufacturing concrete masonry or cinder blocks. Like fly ash, it can also be used in constructing structural fills and embankments, mine reclamation, and as raw feed in cement manufacturing.[183]

3. **Boiler slag** is a molten ash collected at the base of older generation wet-bottom boilers. Bottom ash is kept in a molten state in the boilers until it is actively removed. It flows into water that cools it rapidly causing it to crystallize immediately into a black, dense, glassy mass that fractures into sharp, angular particles. These particles are known as boiler slag, and can be crushed into different sizes for a variety of uses.[184] Boiler slag is in high demand for use as: (i) blasting grit and roofing granules; (ii) a mineral filler in asphalt; (iii) fill material for structural applications and embankments; and (iv) as snow and ice traction control material, as well as feed stock in cement production and aggregate in lightweight concrete products. Almost 90 percent of boiler slag is recycled or reused. However, although demand continues to grow, supplies are decreasing as a result of the retirement of older coal plants.[185]

181 Beneficial Use of Coal Combustion Products: An American Recycling Success Story, ACAA, at 4 (last visited Sept. 30, 2019), https://www.acaa-usa.org/Portals/9/Files/PDFs/ACAA-Brochure-Web.pdf.

182 *Id.*

183 *Id.* at 6.

184 Bethel Afework, Jordan Hanania, Kailyn Stenhouse, Jason Donev, *Boiler Slag*, Univ. of Calgary, Energy Educ. (Jan. 4, 2019), https://energyeducation.ca/encyclopedia/Boiler_slag.

185 *American Recycling*, *supra* note 181, at 6.

4. **Flue gas desulfurization (FGD)** is a chemical process using a sorbent that binds with the sulfur and oxides pollutants that are released from the combustion of coal. FGD sorbents are typically lime, limestone and ammonia, although far less commonly used in the U.S. The sulfur dioxide (SO_2) reacts with the sorbent to form calcium sulfite. At some plants, added process equipment can convert the calcium sulfite to calcium sulfate, a synthetic gypsum. Although FGD gypsum is not technically "ash" because it is not present in the coal and refined by its combustion, it is still included as a CCP.[186] Depending on the scrubber configuration, the byproducts vary in consistency from wet sludge to dry powdered material. Synthetic gypsum can be substituted for natural gypsum, which must be mined. It is used extensively in the manufacturing of wallboard. In fact, wallboard manufacturers will often be located adjacent to power plants to allow the FGD material to be delivered directly to the wallboard facilities. This synergistic relationship not only is economically attractive, with less need to mine natural gypsum, but also it produces a positive environmental impact. Another rapidly growing use of synthetic or FGD gypsum is by the agricultural industry to improve soil conditions and prevent runoff of fertilizers and pesticides. It can also be used for waste stabilization and mine reclamation, and in cement manufacturing.[187]

The size of the 2017 markets for each of these CCP compared to the amount produced is shown in ACAA's chart in **Figure 17**:

186 *About Coal Ash*, *supra* note 180, at Q5.

187 *Id.*

Figure 17: 2017 Coal Combustion Product Production & Use Survey Report

American Coal Ash Association Phone: 720-870-7897
38800 Country Club Drive Fax: 720-870-7889
Farmington Hills, MI 48331 Internet: www.ACAA-USA.org
Email: info@acaa-usa.org

2017 Coal Combustion Product (CCP) Production & Use Survey Report

Beneficial Utilization versus Production Totals (Short Tons)

2017 CCP Categories	Fly Ash	Bottom Ash	Boiler Slag	FGD Gypsum	FGD Material Wet Scrubbers	FGD Material Dry Scrubbers	FGD Other	FBC Ash	CCP Production / Utilization Totals
Total CCPs Produced by Category	38,189,790	9,655,931	2,574,673	32,707,136	11,311,344	2,454,818	6,293	14,469,553	111,369,538
Total CCPs Used by Category	24,095,590	4,839,420	1,570,375	22,839,385	3,905,009	382,048	2,407	14,134,477	71,768,712
1. Concrete/Concrete Products /Grout	14,065,791	785,527	0	67,009	0	0	0	0	14,918,326
2. Blended Cement/ Feed for Clinker	4,579,724	1,622,612	132,183	2,317,445	0	51	0	0	8,652,015
3. Flowable Fill	86,379	0	0	0	0	0	0	0	86,379
4. Structural Fills/Embankments	465,653	871,875	0	0	0	0	0	0	1,337,529
5. Road Base/Sub-base	674,155	159,084	0	2,460	0	11,931	0	0	847,630
6. Soil Modification/Stabilization	360,796	48,876	0	0	0	0	0	0	409,673
7. Mineral Filler in Asphalt	59,317	0	0	0	0	7,019	0	0	66,336
8. Snow and Ice Control	69,192	276,989	4,220	0	0	0	0	0	350,402
9. Blasting Grit/Roofing Granules	0	17,705	1,412,685	44,981	0	0	0	0	1,475,371
10. Mining Applications	901,181	232,110	0	927,949	3,905,009	202,092	0	14,037,913	20,206,254
11. Gypsum Panel Products (formerly Wallboard)	0	0	0	15,859,606	0	0	0	0	15,859,606
12. Waste Stabilization/Solidification	1,065,993	48,964	0	3,026	0	114,646	0	96,564	1,329,193
13. Agriculture	0	0	0	1,157,877	0	35,121	0	0	1,192,998
14. Aggregate	0	10,237	21,287	0	0	0	0	0	31,524
15. Oil/Gas Field Services	78,716	0	0	0	0	11,188	0	0	89,905
16. CCR Pond Closure Activities	1,468,203	730,600	0	2,270,326	0	0	0	0	4,469,130
17. Miscellaneous/Other	220,489	34,840	0	188,705	0	0	2,407	0	446,442

Summary Utilization to Production Rate

CCP Categories	Fly Ash	Bottom Ash	Boiler Slag	FGD Gypsum	FGD Material Wet Scrubbers	FGD Material Dry Scrubbers	FGD Other	FBC Ash	CCP Utilization Total
Totals by CCP Type/Application	24,095,590	4,839,420	1,570,375	22,839,385	3,905,009	382,048	2,407	14,134,477	71,768,712
Category Use to Production Rate (%)	63.09%	50.12%	60.99%	69.83%	34.52%	15.56%	38.25%	97.68%	64.44%
2017 Cenospheres Sold (Pounds)	147,958	Data in this survey represents 145.20701 GWs of Name Plate rating of the total industry wide approximate 263.0478 GW capacity based on EIA's July 2017 Electric Power Monthly.							
CCPs Imported in 2016 (Short Tons)	0								
CCPs Exported in 2016 (Short Tons)	0								

B. Commercialization of Coal Combustion Byproducts

1. CCP Market History and Present Sales

The recycling and reuse of coal ash products have been consistently growing over the decades of coal generation primacy. Use of fly ash in cement was discussed in the first published university research study on the subject in 1937. Its first large-scale use was in the construction of the Hungry Horse Dam in Montana in 1949. The first commercial company to market fly ash as a construction material was the Chicago Fly Ash Company, formed in 1949, which sold fly ash as a cement replacement to enhance the qualities of concrete.[188]

Subsequent commercial success of CCPs as valued resources for end uses beyond cement is demonstrated by the expanding influence of the ACAA, formed in 1968 as a nonprofit trade association. ACAA's stated mission is the support of the recycling of CCPs as *valuable* materials that "support environmental sustainability, minimize the need for disposal, generate revenues, and reduce liability."[189] The history of ACAA tells the story of the growing demand for coal ash and its maturation into a resource industry distinct from waste management.[190]

Utility leaders were early participants in the ACAA, seeing the potential commercial and environmental value in recycling their wastes' output. ACAA and utilities continue to work closely together through utilities' direct participation as members, which has resulted with the close partnership between ACAA and EEI's Utilities Solid Waste Activities Group (USWAG). ACAA has also worked with EPRI and DOE for decades, researching to improve the use of fly ash in cement and to develop other CCP commercial uses. As a consequence, coal ash has significantly overcome its stigmatization. Markets also have expanded as a result of ACAA working with standard setting organizations, such as ASTM, to develop standards and specifications for using CCPs in various end products.[191] Standards in CCP processes ensures the quality and environmental safety of end-use products made with coal ash and its toxic constituents.

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188 D.F. Pflughoeft-Hassett, E.A. Sondreal, E.N. Steadman, K.E. Eylands, & B.A. Dockter, *Barriers to the Increased Utilization of Coal Combustion/Desulfurization By-Products by Government and Commercial Sectors Update 1998*, U.S. DOE Office of Scientific & Technical Info, at 35 (July 1, 1999), https://www.osti.gov/servlets/purl/777109.

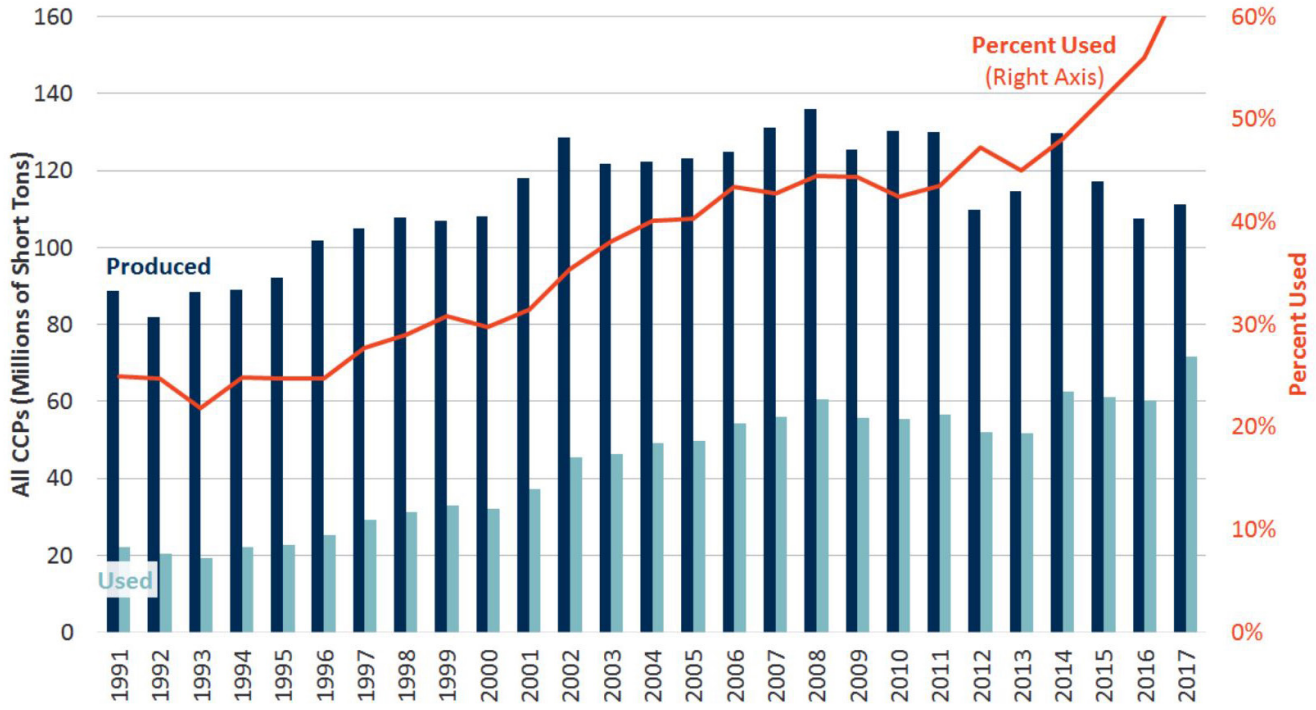
189 See *About ACAA*, ACAA (last visited Sept. 30, 2019), https://www.acaa-usa.org/aboutacaa/joinacaa.aspx.

190 Goss, David, "Fifty Years of Ash Management and Reuse," *Ash at Work*, Issue 2 at 6 (2018), https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2019.pdf.

191 Because CCPs have many uses in engineering activities, a number of organizations issue technical standards or guidelines for the use of CCPs, including the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), the Federal Highway Administration (FHWA), the Federal Aviation Administration (FAA), the Army Corps of Engineers, the American Association of State Highway and Transportation Officials (AASHTO), the American Concrete Paving Association (ACPA), the National Ready Mixed Concrete Association (NRMCA), the American Society for Civil Engineers (ASCE) and many state departments of transportation (DOT). *See About Coal Ash, supra* note 180.

The growth of CCP markets over the last 27 years compared to coal ash production is shown on ACAA's chart in **Figure 18**. There was an increase in CCP demand in 2017, during which 71.8 million tons of coal combustion products were recycled and used out of 111.3 million tons produced, which equals a record 64 percent of coal ash production being recycled rather than disposed.[192] This is an increase from 56 percent in coal ash utilization in 2016, whereas coal ash production only increased 4 percent over the same period. In reporting the 2017 results, ACAA further states that "concrete producers would have used more fly ash if they could get it; numerous key markets can be characterized as 'under-supplied.'"[193] However, to increase the percentage of CCP used versus disposal, the fly ash and other CPPs need to be more consistent and available to meet customers' schedules, which will require investments in technology and logistics.

Figure 18: CCP Market Growth, 1991 – 2017



192 Ward, *supra* note 177, at 51.

193 Goss, *supra* note 190, at 28.

2. Future Commercial CCP Uses

The Department of Energy (DOE) has shown the government's interest in advancing the reuse of coal ash. It issued a Request for Information (2019 RFI)[194] in March 2019 that included a request for information about new advancements in fossil fuel byproduct utilization and the development of pathways to produce value-added products from CCR. The National Energy Technology Lab (NETL), whose mission is to maximize the value of coal as a feedstock and develop new high-value products derived from coal, initiated the Coal Beneficiation Program. Research includes the testing of laboratory- and pilot-scale technologies, which extends to coal ash and the development of additional revenue-producing products.

Possible future uses will be the result of research into the chemical and physical makeup of fly ash into its elemental parts. For example, fly ash could be a source for carbon nanomaterials, which are being studied for a wide range of uses from electronics to medicine.[195] These nanomaterials have the ability to form covalent bonds with many other types of atoms, which will then adapt their chemical properties while adding strength to the new composition. Consequently, they are highly valuable for their use in a multitude of applications. For example, bonding carbon nanotubes with carbon fiber results in a stronger material.

Fly ash also contains cenospheres, which are fine microscopic structures that are strong but hollow bubbles. Because of their high value, they are measured by the pound, compared to other CCPs that are valued by the ton. They are easily separated from the rest of the fly ash material using water, because they float, whereas the rest sink. Coating the spheres with nickel, copper, or other composite metal or ceramic material can create an ultra-strong yet lightweight material that can be mixed in with a variety of metals. Dr. Nikhil Gupta, associate professor of mechanical and aerospace engineering at the Polytechnic Institute of New York University, has researched the use of cenospheres to produce lightweight materials for car manufacturing, although this application has value for other industries, as well.[196]

The use of cenosphere-based material in construction of cars would dramatically cut the use of steel or aluminum in cars, making the cars lighter without compromising the strength of the metal. He projects that the weight of a car could be reduced by at least 10 percent, which translates to reduced fuel consumption and emissions. Weight is extremely significant in the design of electric cars. Weight affects travel range, which is a key manufacturing challenge. Bigger and heavier batteries are needed to power an electric car for longer distances, but a heavier battery, in turn, increases the energy needed to power the car, which thus, decreases the travel range of the car. Dr. Gupta is also working on the use of cenospheres in the construction of battery casings. He projects he can reduce a battery's weight by 20 percent to 30 percent.[197] Dr. Gupta is working with the University of Wisconsin and industry partners to manufacture battery prototypes.[198]

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194 *Request for Information: Strategies for Improving or Creating Emission Reduction Technology and Byproduct Utilization for Hazardous Substances Resulting from Coal Combustion*, NETL.DOE.gov (Mar. 25, 2019), https://www.netl.doe.gov/node/8548.

195 *See* Mohammed Alrashed, *The Use of Coal Fly Ash as a Catalyst Support in the Fabrication of Carbon Nanotubes*, Emporia State Univ. (Dec. 6, 2016), https://esirc.emporia.edu/handle/123456789/3550.

196 Nathaniel Gronewald, "Will the Car of the Future Be Made from Coal Ash?" *Scientific Am.* (Mar. 28, 2011), https://www.scientificamerican.com/article/will-car-of-future-made-from-coal-ash/.

197 *Id.*

198 *Id.*

Dr. Gupta has also led in the development of syntactic foams using cenospheres, which are mixed with matrix materials to create a resulting composite of higher specific strength (strength divided by density). Because of the light weight and high strength characteristics of the cenosphere, and the flexibility of foam to be tailored to a specified end use, syntactic foams can be used in designs involving multifunctional requirements such as in aerospace structures, subsea applications, microwave electronics, and EMI shielding.[199]

The hurdle with broad commercializing of emerging CCP technologies, however, is the inconsistency of fly ash quality due to differences in coal types burned and the differences in the waste produced which is dependent on the pollution control equipment installed at the thousands of coal generation plants[200] across the country.

States are also pursuing new CCP markets in finding new coal ash uses that can help reduce the amount of CCRs disposed. For example, as part of North Carolina's CAMA program, utilities owning coal generation plants were required to perform a study of coal combustion product (CCP) uses and markets and submit results to the legislature. The state required that utilities, in the third phase of the study, identify promising alternative and innovative technologies and to understand their technical readiness. In May 2016, Duke Energy submitted its study, discussing 18 technologies and more than 50 products.[201] However, in conclusion, Duke cautioned regarding investment by power companies in these technologies:

> Because sustainable markets for these technologies are not fully developed, they will require greater time and financial commitment by the power company. Most of the technologies will require a commitment to working with the vendors to develop the products, obtain regulatory approvals, and communicate with end users to stimulate the nascent markets.[202] Should and when these technologies prove ready for commercialization, they could provide additional revenues for utilities and IPPs, which will, in turn, enhance the economics of coal as a higher-value fuel for existing and advanced coal plants.[203] To take advantage of the investment into research and development of an expanding array of CCP products requires a shift in the perspective of utilities from seeing coal as a problem to be rid of, and environmentalists who would prefer coal plants close. DOE's research into the life cycle of CCPs from the point of their production through their end use could help the development of a policy that envisions coal combustion plants as an integrated part of an industrial closed loop eco-system.[204]

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199 What is Syntactic Foam? *Synfoam* (2016), https://synfoam.com/What-Is-Syntactic-Foam.

200 For the number of generation plants in the U.S., *see How many power plants are there in the United States?* U.S. Energy Info. Admin. (Oct. 26, 2018), https://www.eia.gov/tools/faqs/faq.php?id=65&t=2.

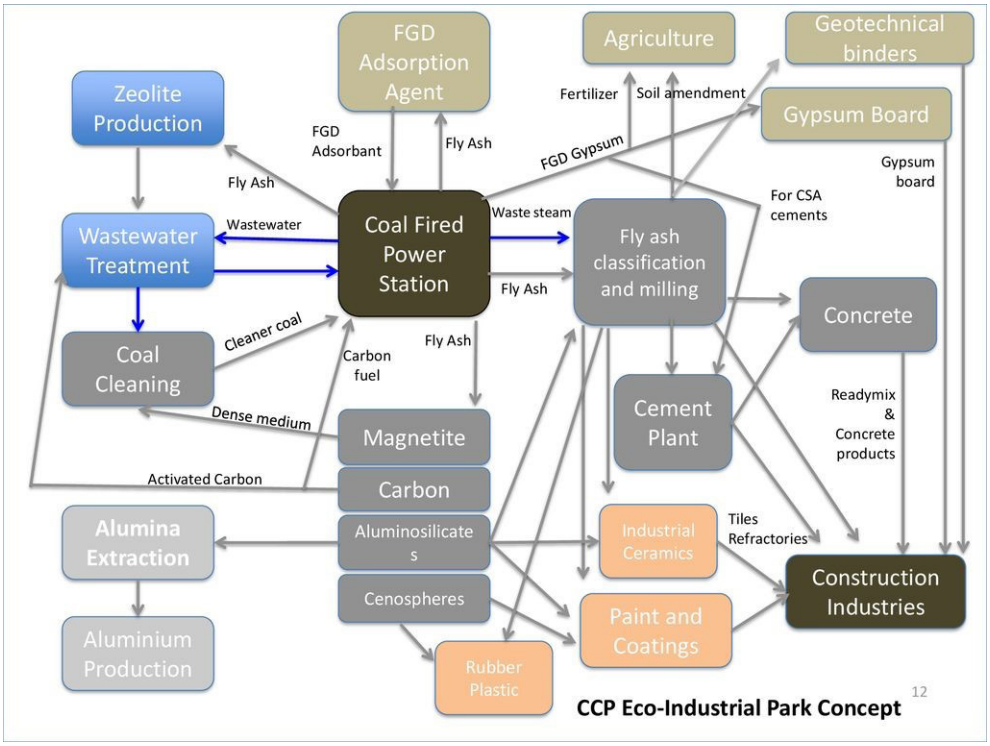
201 *Duke Energy Coal Combustion Product Management Study Phase 3 - Alternative and Innovative Technologies Final Report,* Elec. Power Research Inst., at ES-2 (May 2016), http://southeastenergynews.com/wp-content/uploads/sites/58/2016/09/Phase-3-Innovative-Technologies-Final-Report.pdf.

202 *Id.*

203 *Coal Beneficiation Program Factsheet*, NETL.DOE.gov (Aug. 2019), https://www.netl.doe.gov/sites/default/files/2019-09/Program-151.pdf.

204 Robert A. Frosch & Nicholas E. Gallopoulos, (1989). "Strategies for Manufacturing," *Scientific Am.* (Reprinted with permission.), http://isfie.onefireplace.com/resources/Documents/Strategies_For_Manufacturing_Sci_American_1989.pdf.

Figure 19: CCP Eco-Industrial Park Concept



Asian countries, including China, are seeking ways to better manage their growing coal power plants by advancing the CCP markets for their coal ash waste. Working with Optimus, an extension of the University of Kentucky, the Asian Coal Ash Association is developing a plan for a CCP Eco-Industrial Park. A schematic of its closed loop eco-system is shown in **Figure 19**.[205] However, valuating coal combustion plants as a critical component in a greater ecological loop will require a significant shift away from the traditional utility business model.

3. Rare Earth Elements

Coal ash has come to national attention recently as a potential source of rare earth elements (REE) in the context of the trade tensions between the U.S. and China, who last year, in 2018, controlled 70 percent of supply in the global REE market.[206] The vulnerability of U.S. defense industries and major economic sectors including cell phones, computers and other electronics, engines, and even clean energy technologies, has demonstrated the need to cultivate a domestic supply that includes not just a domestic source of the elements themselves but also domestic processing and refinery facilities to purify the elements so they can be used. Technology is the pathway to stabilizing supply/demand volatility from geopolitics and ensuring REE processing does not add to already heightened environmental concerns. Technology applied to coal ash resources could be a solution. Research shows the promise of processing technology that could extract REEs from coal ash, while reducing the waste impact of coal combustion and creating another value stream for coal combustion generation, a win-win for the environment and the economy.

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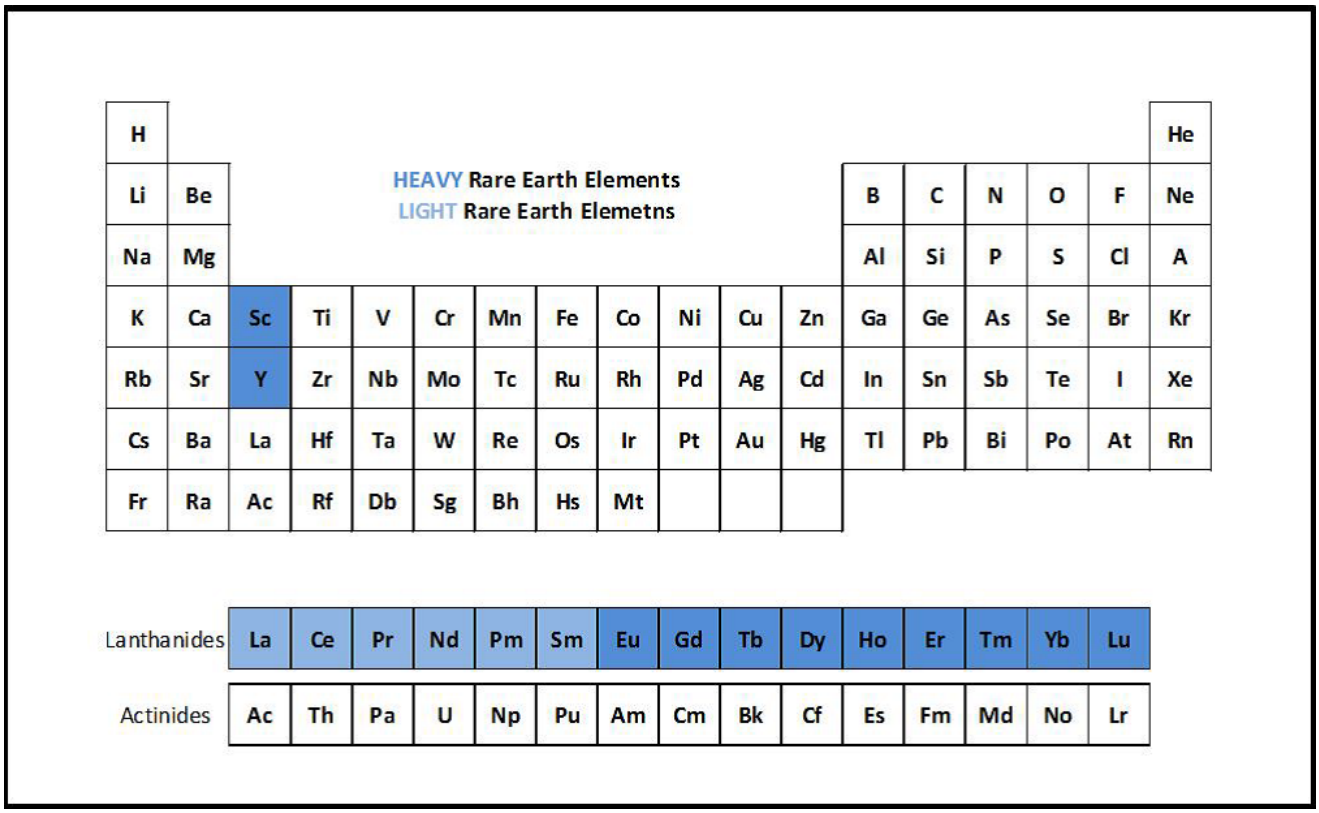
205 David Harris, *Coal Combustion Products & the Circular Economy*, Asian Coal Ash Assoc. Optimus Mgmt. Ltd., at slide 12 (2017), http://unia-ups.pl/wp-content/uploads/2016/03/Harris.pdf.

206 *See* Russ Read, *Pentagon turns to coal ash to escape Chinese dominance of rare earth elements*, Washington Examiner (June 3, 2019), https://www.washingtonexaminer.com/policy/defense-national-security/pentagon-turns-to-coal-ash-to-escape-chinese-dominance-of-rare-earth-elements. More significant is that China produces 90 percent of the world's permanent magnet alloys that is a necessary component in products throughout major economic sectors. *See The Geopolitics of Rare Earth Elements,* Strafor WorldView (April 8, 2019), https://worldview.stratfor.com/article/geopolitics-rare-earth-elements.

Figure 20: Rare Earth Elements



Rare earth elements are 17 metals, specifically fifteen lanthanides plus scandium and yttrium, as highlighted in the periodic table in **Figure 20**. Although they are abundant within the earth's crust, they are not found in isolated form and they exist generally in low concentrations, a few thousand parts per million, which are too scarce for economical extraction.[207] They also require a lot of energy to extract and process according to specifications for their ultimate use. Processing requires grinding, extraction, and purification (99.9 percent) to transform the ores to the high purity needed for commercial applications. However, due to their unique magnetic, phosphorescent, and catalytic properties, they are in high demand for high-tech applications. Neodymium, for example, is used to manufacture the most commonly used permanent magnet that is a critical component in personal computers, engines, rechargeable batteries, cameras, and all forms of electronics including cell phones. **Figures 21** and **22** identify high valued end-uses for each of the different elements. Technology industries rely on them so much so that DOE refers to them as technology metals.[208]

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207 John Simpson, "Mining Coal Ash for Rare Earth Elements," *Ash At Work*, Issue 1 at 16 (2019), https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2019.pdf.

208 The REEs highlighted in the periodic table in Figure 15 include lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu). The rare earths are also often considered to include the metals scandium (Sc) and yttrium (Y). See *Report on Rare Earth Elements from Coal and Coal Byproducts*, NETL.DOE.gov, 2-3 (Jan. 2017), https://www.energy.gov/sites/prod/files/2018/01/f47/EXEC-2014-000442%20-%20for%20Conrad%20Regis%202.2.17.pdf.

Figure 21: Major End Uses of Light Rare Earths

Light Rare Earths	Major End-Use
Scandium	TVs, fluorescent and energy-saving lamps
Lanthanum	hybrid engines, metal alloys
Cerium	catalysts, metal alloys
Praseodymium	Magnets
Neodymium	catalysts, hard drives in laptops, headphones, hybrid engines
Promethium	watches, pacemakers
Samarium	Magnets
Europium	red color for television, computer screens

Figure 22: Major End Uses of Heavy Rare Earths

Heavy Rare Earths	Major End-Use
Terbium	phosphors, permanent magnets
Dysprosium	permanent magnets, hybrid engines
Erbium	phosphors
Yttrium	red color, fluorescent lamps, ceramics, metal alloy agent
Holmium	glass coloring, lasers
Thulium	medical x-ray units
Lutetium	petroleum catalysts
Ytterbium	lasers, steel alloys
Gadolinium	magnets

The importance of REEs to the U.S economy is illustrated by stock trading in one of the highest traded U.S. companies, Apple. Apple's iPhone uses nine of the 17 REEs in its manufacturing. Barron's attributed a 40 percent decline in Apple's stock during the last quarter of 2018 due to trade tensions between the U.S. and China, cautioning that it "may drop even further if rare earths become the latest casualty in the trade war."[209] Barron's also referenced a similar cautionary statement by Goldman Sachs' analysts, assessing Apple's preparation to ramp up production of its new iPhone, that "even a short-term action affecting production could have longer term consequences for the company."[210]

209 Sophia Cai, *Companies Like Apple That Depend on Rare-Earth Metals Have Nowhere to Turn*, Barron's (May 30, 2019), https://www.barrons.com/articles/stocks-exposed-rare-earths-metals-51559164960.

210 *Id.*

Figure 23: Prices of Selected Rare Earth Element Ores

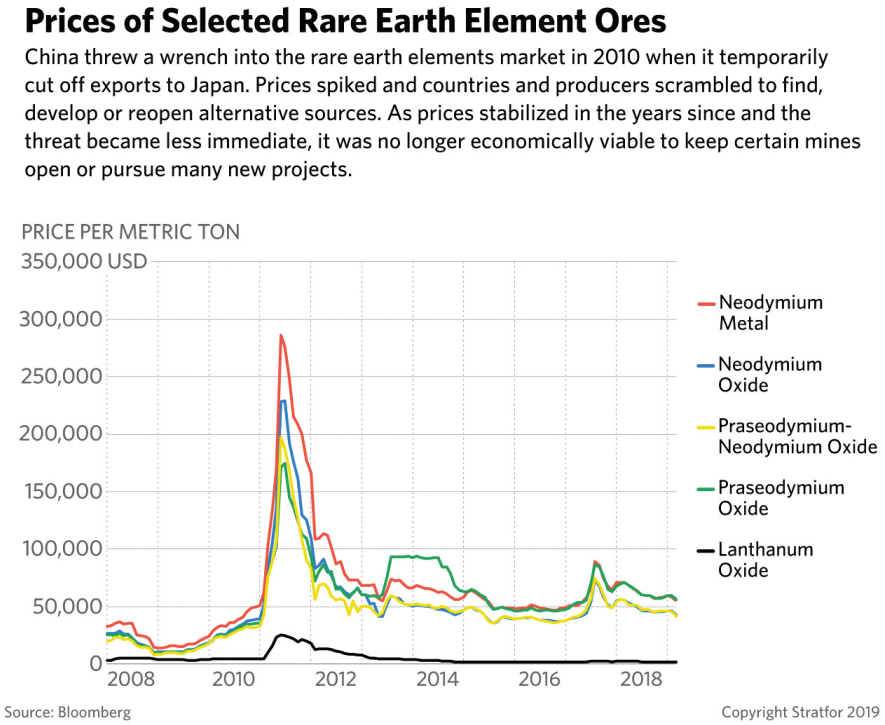

Figure 23 demonstrates the global price sensitivity of REEs, showing the spike in prices in 2010 when China imposed strict quotas on REE exports to Japan. Prices show a slight increase from 2006 to 2010 as China began to limit its REE exports as a protectionist step to build up its own domestic reserves to meet growing demand in its own electronics industry. Then, in 2010, China and Japan's territorial dispute in the East China Sea resulted in China banning REE shipments to Japan, which DOE projected would result in market shortages in five of the more valued REEs. REE prices quadrupled in 2010 and then doubled again in the first quarter of 2011. In 2012, China announced new export REE quotas for 2013, but they set quotas higher than the actual amount of REEs exported, so the quotas had no market impact and market prices began to stabilize. Stable prices were also helped by new supplies from Australia and growing black market supplies from within China. Then in 2014, the U.S. won a World Trade Organization's complaint against China on REEs, which resulted in China eliminating quotas for 2015.[211]

The history of the U.S.'s only domestic REE supplier demonstrates the supply dynamics of a complex resource like REEs. Large deposits of bastnasite ore were discovered at Mountain Pass, California, in 1949. Bastnasite ore contains an 8 percent to 12 percent concentration of REE, specifically europium, which is used in color television screens.[212] In 1952, Molycorp, Inc. commenced operating the mine and a refinery to meet europium demand and subsequently other REEs. Mountain Pass became the world's largest supply of REEs between 1965 and 1995.[213] In fact, its owner, Molycorp, Inc., was the only global vertically integrated producer of REEs, owning both the mine and downstream refinery and processing facilities. To extract REEs from bastnasite ore, the ore must be dissolved in solutions of acids, over and over again, then filtered, and dissolved once more. Old technologies required 1,800 different extraction stages in series and in parallel for purification.[214]

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211 WTO Dispute Settlement, *China - Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum*, WT/DS431/AB/R (Aug. 7, 2014), https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm.

212 Lisa Margonelli, "Clean Energy's Dirty Little Secret," *The Atlantic* (May 2009), https://www.theatlantic.com/magazine/archive/2009/05/clean-energys-dirty-little-secret/307377/.

213 *Id.*

214 Simpson, *supra* note 207, at 16.

One of the environmental challenges in processing REEs is the content of radioactive thorium that is naturally found with rare earth deposits. While the higher concentrations of REEs contributed to Mountain Pass's commercial viability, the costs of environmental impacts from its operations, on the other hand, eventually resulted in Mountain Pass's unprofitability.[215] In the 1980s, Molycorp began piping its wastewater 14 miles to evaporation ponds. Mineral deposits, called scale, accumulated in the pipelines, and were radioactive. During routine cleaning of the pipelines, multiple breaks occurred, causing the radioactive waste to leak and contaminate surface soil. In addition, two larger radioactive wastewater spills occurred in 1989 and 1990, subjecting the company to escalating environmental penalties and cleanup costs.[216] Meanwhile, Molycorp could not compete with China's cheap labor costs and less restrictive environmental regulations that enabled China to gain market power over global supply. The U.S. ceded its position to China as the leading supplier in 1988. Although Mountain Pass has continued to mine bastnasite ore, it ceased separating and processing REEs.

Seeing the global price spike in 2010 caused by China's Japanese quotas and the government's growing concern regarding reliance on China for REE supplies as opportunities, Molycorp decided to re-open Mountain Pass and re-enter the REE market. It raised capital through a public offering in July 2010, and by May 2011, it had a market capitalization of more than $5 billion.[217] It then purchased Canada's Neo Material Technologies and constructed a $1.25 billion state-of-the-art processing facility. However, it had not prepared for prices to drop as China lifted its quotas. Ultimately, Molycorp had to shut down operations and file for restructuring under bankruptcy law in 2015. Its Mountain Pass operation was sold in June 2017 to MP Materials, with a minority interest to a Chinese REE company.

Once again, however, China's REE market power is under scrutiny. The current trade conflict between the U.S. and China has highlighted the vulnerability of both national security and the U.S. economy to China's control of REE products. The use of REEs is ubiquitous through core economic sectors that define today's quality of life. Current U.S. policymaking has begun to evaluate China as an economic aggressor unfairly competing as an economic superpower in global markets, rather than as a fair and mutually advantageous trading partner. China's monopoly control over downstream processing facilities presents high risk to the U.S. economy and national defense. While the U.S. and other countries mine and excavate ores containing REEs, the ore is shipped to China for processing. In June 2019, China set a 25 percent tariff on rare earth ores imports into China for processing. President Trump proposed to retaliate by imposing a 10 percent tariff on China's REEs, but it was eventually dropped, which served to highlight U.S. reliance on Chinese REE supply.[218] Meanwhile, MP Materials is producing REEs from Mountain Pass but is having to ship its production, like other REE producers, to China for processing and pay the Chinese tariff. This is another incentive for MP Materials to complete work to operate its own separation and processing facilities, which it announced should be completed by the end of 2020.[219]

The Department of Defense has tracked China's dominance in REE global production closely since China's geopolitical play in 2010. It has voiced particular concern regarding China's control over production of heavy REEs that are the most scarce of the 17 elements, and, therefore, the most expensive. These heavy REEs are critical to national defense systems. U.S. defense end uses equal 1 percent of the total U.S. demand.

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215 Molycorp was acquired by Union Oil in 1977, which later became a part of Chevron in 2005.

216 Kemakta Konsult, *Health and safety issues in REE mining and processing,* EURare, at 10 (Sept. 2014) http://www.eurare.eu/docs/internalGuidanceReport.pdf; *see also* Eugene Gholz, *Rare Earth Elements and National Security,* Council of Foreign Relations, at 2 (Oct. 2014), https://cdn.cfr.org/sites/default/files/pdf/2014/10/Energy%20Report_Gholz.pdf.

217 Simon Casey, "A Cautionary Rare Earths Tale Can Be Found in Molycorp's Rise and Fall," *Bloomberg* (May 20, 2019), https://www.bloomberg.com/news/articles/2019-05-29/cautionary-rare-earths-tale-found-in-molycorp-s-rise-and-fall.

218 Eric Ng, "Caught between Trump and its biggest market, America's sole rare earths mine is an unusual victim in the US-China trade war," *South China Morning Post* (May 26, 2019), https://www.scmp.com/business/commodities/article/3011687/caught-between-trump-and-its-biggest-market-americas-sole-rare.

219 *Id.*

For example, a F-35 jet uses 920 pounds of material made from rare earths.[220] The CIA's 2013 World Threat Assessment warned about China's control over REE supplies, years before China's recent reminder of the U.S.' vulnerability when its trade negotiators raised the possibility of a ban on REEs exports during current trade negotiations.[221] China had previously leveraged its supply dominance in international negotiations, as it did against Japan.[222] In response, U.S. policy is supporting research and development of a domestic resource, including researching fly ash, which has shown strong promise as a domestic resource from which these rare earth elements could be extracted.

Since then, the federal government has been active in studies and research initiatives to assess coal and coal byproducts for their REEs potential. In the 2014 appropriation bill,[223] Congress allocated $15 million to NETL to perform an assessment and analysis of the feasibility of economically recovering REEs from coal and coal byproduct streams, such as fly ash, coal refuse, and aqueous effluents. DOE was instructed to report the findings and, if determined feasible, to outline a multi-year research and development program for recovering REEs. DOE subsequently issued a report on REEs in January 2017, affirming that "opportunities to recover REEs from coal and coal byproducts appear possible," but it will require improved economics and technology developments, particularly in better separation technologies.[224] Coal byproducts' advantage is that REEs are present in materials already being produced and certain byproducts have elevated concentrations of heavy REEs. Economic projections and national security assessments place heavy REEs at higher risks as they are in lower supply; they serve critical needs in significant sectors of the economy and national defense; their demand is projected to increase significantly; and their market price reflects their constrained supply.[225]

ACAA supported research by Duke University and University of Kentucky to characterize the content of a broad selection of U.S. coal ashes to rank their potential for REE recovery.[226] It collected coal ash from coal plants that burned coal from the 3 largest sources, the Appalachian Mountains, southern and western Illinois, and the Powder River Basin in Wyoming and Montana. The value of REEs extractable from fly ash is based on the REE content of the fly ash and the concentration of REEs present. Research shows that these two factors are dependent on the geological origin of the feed coal. Appalachian coals indicate higher REE contents. Its ash was found to contain REEs at 591 parts per million (ppm), compared to Illinois at 403 ppm, and Powder River Based at 337 ppm. This suggests that Appalachian sources should be prioritized in any REE recovery operation. The REE contents in the subject coal ash were found to be superior to the bastnasite ores from the largest Chinese REE deposit. Research findings overall showed that "coal fly ashes currently being produced in the U.S. would provide more than three times the critical REE mass per kg of total REE extracted than conventional ores."[227]

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220 Alexandra Ma, "From iPhones to fighter jets: Here's a list of American products that could be affected if China banned rare-earth metal exports to the US as a trade-war weapon," *Business Insider* (May 31, 2019), https://www.businessinsider.com/china-rare-earth-list-of-us-products-could-affected-2019-5.

221 *Worldwide Threat Assessment Statement for the Record,* U.S. Intelligence Cmty, at 11 (March 12, 2013), https://nsarchive2.gwu.edu/NSAEBB/NSAEBB424/docs/Cyber-090.pdf.

222 Keith Johnson, Elias Groll, *China Raises Threat of Rare-Earths Cutoff to U.S.*, ForeignPolicy.com (May 21, 2019), https://foreignpolicy.com/2019/05/21/china-raises-threat-of-rare-earth-mineral-cutoff-to-us/); *see also Report on Rare Earth Elements, supra* note 208, at 26 (citing NETL-issued RFI for *Funding Opportunity Announcement* (FOA) DE-FOA0001202).

223 *Report on Rare Earth Elements, supra* note 210, (citing Consolidated Appropriations Act, Pub. L. 113-76 (2014)).

224 *Id.* at 8.

225 *Id.*

226 Simpson, *supra* note 207, at 17.

227 Ross K. Taggart, James C Hower, Gary S. Dwyer, & Heileen Shu-Kim, *Trends in the Rare Earth Element Content of U.S.-Based Coal Combustion Fly Ashes,* Am. Chemical Soc'y Pubs., 5919, 5922 (2016), https://pubs.acs.org/doi/pdfplus/10.1021/acs.est.6b00085.

Fly ash has several advantages over the lengthier processing of REE ores, beginning with its broad availability as a waste product with its environmental incentives for alternative uses. Avoided disposal costs can offset the costs of processing the fly ash. REE avoids costly excavation of coal or other ores containing REEs, benefiting from excavation of coal for electric generation that bears the costs. In addition, fly ash is a fine powder that is ideal for chemical processing, which eliminates several costly ore process steps. In addition, fly ash is already used for recovery of other metal, including gallium, germanium, and aluminum. These recovery activities could be combined with REE recovery for maximizing fly ash value as a resource. The ability to process multiple products in addition to REEs is a key factor to the economic recovery of REEs from fly ash or other coal byproducts. The second key is reduction in operating expenses. According to DOE, "operating costs far exceeded an annualized capital cost, on a per-ton-of-product-produced basis."[228] Moving beyond these studies, innovators are planning demonstration projects that could bring added value to coal generation to offset environmental costs associated with what was once perceived as waste.

C. Beneficial Use Exemption from RCRA Disposal Criteria

1. RCRA Conservation Objective

RCRA's conservation and recovery objective is based on the congressional observation that "millions of tons of recoverable material which could be used are needlessly buried each year."[229] Consequently, RCRA was designed to "conserve valuable material and energy resources by [promoting] . . . new and improved methods of collection, separation, and recovery, and recycling of solid wastes and environmentally safe disposal of nonrecoverable residues."[230] Many of RCRA definitions reflect the priority of the conservation and resource recovery objective:

- "Resource conservation" means the "reduction of the amounts of solid waste that are generated, reduction of overall resource consumption, and utilization of recovered resources";[231]
- "Resource recovery" means "the recovery of material or energy from solid waste";[232] and
- "Solid waste management" and "comprehensive planning" includes "planning or management respecting resource recovery and resource conservation."[233]

These definitions reflect RCRA's underlying purpose to support the public interest in recovery of valued materials, metals, or other resources captured in waste streams, and in their reuse, which can achieve conservation and other benefits. However, RCRA limits EPA's authority over these resource recovery and recycling activities to providing federal technical assistance to state and local governments regarding these activities, while granting EPA broader regulatory authority over disposal practices. RCRA directs EPA to develop national minimum criteria under subtitles C and D for those "solid waste management practices" that might otherwise constitute "open dumping of solid waste or hazardous waste," now prohibited under RCRA.[234] Thus, only those activities that are deemed disposal are regulated and those waste management activities that relate to recycling and resource use are not regulated.[235] Consequently, in developing disposal criteria under its RCRA obligations, EPA also had to develop criteria to distinguish exempt beneficial uses from disposal.

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228 Simpson, *supra* note 207, at 19.

229 Pub. L. 89–272, § 1002(c), 42 U.S. Code § 6901, https://www.law.cornell.edu/uscode/text/42/6901.

230 *Id.* at § 1002(a)(4).

231 *Id.* at §1004(21).

232 *Id.* at §1004(22).

233 *Id.* at §1004(30).

234 *Id.* at §1008(a)(3).

235 While EPA had postponed answering the question of whether CCR should be regulated under subtitle C or D in its 2000 Regulatory Determination, it did determine that CCR used for beneficial purposes would be exempt from regulation as hazardous waste under §3001(b)(3)(A) of RCRA. In electing subtitle D in the Final Rule, EPA affirmed its decision to exempt CCR uses that meets the Final Rule's definition of beneficial use from any disposal requirements.

2. Encapsulated Beneficial Use versus Unencapsulated Beneficial Use

The Final Rule, in developing beneficial use criteria, discusses the regulatory implications of the form in which CCR is used. Whether CCR is encapsulated or unencapsulated triggers the level of environmental scrutiny required to qualify as a beneficial use. Encapsulation is illustrated in the use of fly ash in concrete products while unencapsulation can be generally understood to mean the use of coal ash in a loose, unbound state, such as fill for structural support. The Final Rule defines an encapsulated beneficial use as a use that "binds CCR into a solid matrix that minimizes its mobilization into the surrounding environment,"[236] but does not define unencapsulated beneficial use. Consequently, unencapsulated use is any use that does not meet the regulatory definition of encapsulated beneficial use, and because of the environmental risk associated with loose, unbound ash, the unencapsulated form of CCR becomes a significant factor in evaluating a CCR beneficial use and its exemption from the Final Rule's national minimum criteria regulating coal ash disposal.

It is easy to envision how the use of loose, unbound coal ash in large quantities could be disposal disguised as a resource use to avoid regulation. EPA acknowledged in the Final Rule that allowing a beneficial use exemption for particular uses of large quantities of unencapsulated CCR can be problematic when unencapsulated CCR poses greater environmental risks of leachate, as compared to encapsulated uses. The need for regulatory treatment of unencapsulated applications depends on the chemical characteristics of the CCR, the amount of material placed, how it is placed, and the site conditions.[237] To demonstrate unencapsulated uses that would not be considered a beneficial use, the Final Rule used examples such as fill for old quarries or gravel pits and certain landscape applications, which uses EPA noted are more akin to disposal.[238] A more controversial use of unencapsulated CCR is as structural fill. EPA found that the use of 1.1 million yards of fly ash for contouring a golf course in Chesapeake, Virginia, was not a beneficial use. This is the same project that garnered national attention as part of a CBS 60 Minutes report on coal ash in August, 2010.[239] EPA reviewed this use as a potential damage case rather than a proven damage case due to groundwater contamination above MCLs at the edges and corners of the golf course, but not in residential wells.[240]

Yet, EPA refused to disqualify for beneficial use all CCR uses as structural fill on a blanket basis, but rather conditioned their qualification on whether the CCR use provides a conservation benefit and meets environmental performance objectives.[241] EPA noted that many unencapsulated CCR uses like structural fill are subject to other environmental regulations and oversight by other agencies. The American Society for Testing and Materials (ASTM) and the Utility Solid Waste Activities Group (USWAG) provide standard guidance and methodologies for using CCR in a structural fill project, including consideration of engineering properties and behaviors, testing procedures, and design considerations.[242] Unencapsulated uses that comply with industry-established engineering specifications and material requirements, many of which address environmental risks, do not resemble "disposal." As an example, EPA points to industry specifications for agricultural uses of CCR that limit the amount of CCR that can be placed on the land.[243] Another example is the unencapsulated use of fly ash in highway construction that is subject to regulation by the Department of Transportation and the Federal Highway Administration.[244]

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236 40 C.F.R. §257.53; *see also "Methodology for Evaluating Beneficial Uses of Industrial Nonhazardous Secondary Materials,* EPA, 530-R-16-011 n.1 (April 2016).

237 80 *Federal Register* at 21,328.

238 *Id.* at 21,330.

239 *See Coal Ash: 130 Million Tons of Waste*, CBS NEWS 60 MINUTES (Aug. 15, 2010), https://www.youtube.com/watch?v=1PYexB76KIQ.

240 Final Rule, *supra* note 1, at 21,328.

241 *Id.* at 21,351-52.

242 *Id.* at 21,350 (citing *Engineering and Environmental Guidance on the Beneficial Use of Coal Combustion Products in Engineered Structural Fill Projects,* USWAG; and ASTM Standard E2277-03, since updated in ASTM Standard E2277-14).

243 *Id.* at 21,330.

244 *Id.* at 21,328.

3. EPA's Final Rule Definition of Beneficial Use

The Final Rule adopts a definition of beneficial use that consists of a four-pronged qualifying test that incorporates RCRA's conservation objective while imposing checks on unencapsulated uses to protect against disguised disposal. It maximizes opportunities for CCR uses as an alternative to disposal by allowing unencapsulated uses with some environmental protections.

> The beneficial use of CCR [both encapsulated and unencapsulated] when performed correctly, can offer significant environmental benefits, including greenhouse gas (GHG) reduction, energy conservation, reduction in land disposal (along with the corresponding avoidance of potential CCR disposal impacts), and reduction in the need to mine and process virgin materials and the associated environmental impacts.[245]

To qualify as a beneficial use and thus be exempt from subtitle D regulation, unencapsulated CCR uses must meet all of definition's four conditions, whereas encapsulated uses must meet only the first three:[246]

> (1) The CCR must provide a functional benefit;
>
> (2) The CCR must substitute for the use of a virgin material, conserving natural resources that would otherwise need to be obtained through practices, such as extraction;
>
> (3) The use of the CCR must meet relevant product specifications, regulatory standards or design standards when available, and when such standards are not available, the CCR is not used in excess quantities; and
>
> (4) When unencapsulated use of CCR involving placement on the land of 12,400 tons or more in non-roadway applications, the user must demonstrate and keep records, and provide such documentation upon request, that environmental releases to groundwater, surface water, soil and air are comparable to or lower than those from analogous products made without CCR, or that environmental releases to groundwater, surface water, soil, and air will be at or below relevant regulatory and health-based benchmarks for human and ecological receptors during use.[247]

In August 2019, however, the EPA issued proposed rules in its Reconsideration of Beneficial Use and Piles[248] that would revise this fourth prong of CCR beneficial use definition by replacing the mass-based numerical threshold of 12,400 tons that triggers the environmental demonstration that an unencapsulated use is required to conduct, with specific location-based criteria based on the location restrictions EPA imposed on CCR landfills and impoundments in its Final Rule.[249] A location-based criteria would include placement within: (i) a specified distance from the uppermost aquifer, (ii) a wetland, (iii) an unstable area, (iv) a flood plain, (v) a specified distance from a fault area, and (vi) a seismic zone. EPA also invited comments on a trigger that would be a combination of land-based and mass-based numerical criteria.[250]

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245 80 *Federal Register* at 21,329.

246 *Id.* at 21,349.

247 40 C.F.R. §257.53.

248 Proposed Rule, *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles,* 84 *Federal Register* 40,353 (Aug.14, 2019).

249 *See* 40 C.F.R. §257.60.

250 84 *Federal Register* at 40,358.

EPA provided further explanation of each prong in the Final Rule:

> *(1) Functional benefit:* This criterion requires that the CCR must serve a legitimate function in the product or use that demonstrates a value to the end use product that rebuts that the use is merely a substitute for disposal. For example, CCR provides a functional benefit when used in concrete, not only as a replacement for cement, but also in increasing its durability and strength against degradation from saltwater. FGD gypsum serves the same function as mined gypsum in wallboard, and CCR as a soil amendment adjusts the pH of soil to promote plant growth.[251] The use of CCR as structural fill or in other construction applications reduces land use needs for CCR that would have otherwise been headed to landfills.
>
> *(2) Substitution of a virgin material:* The substitution requirement ensures that the use is "beneficial" from an environmental perspective and RCRA's conservation goals.[252] EPA discusses how virgin materials require mining and excavation which can impair wildlife habitats and disturb otherwise undeveloped land.[253] Reducing the need for mining virgin materials likewise reduces waste and environmental footprints, as well as reduce impacts associated with transportation of the materials, such as energy usage. Finally, this substitution criterion advances land conservation principles, as EPA indicates, by reducing the need for additional landfill space coupled with associated environmental impacts. Examples in the Final Rule include:
>
> - FGD gypsum used in manufacturing wallboard or drywall, which decreases the need to mine and thus conserve, natural gypsum as a natural resource;[254]
> - CCR as a substitute in structural fill for sand, gravel and other traditional earthen materials requiring excavation;[255]
> - Fly ash as a substitute for Portland cement that conserves (i) the raw materials used in high quantities, principally clay, shale and limestone; (ii) land use as the raw materials are mined in open pits; and (iii) the large amount of energy needed for heat in the manufacturing process; and
> - CCR as a substitute for traditional earthen materials.

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251 80 *Federal Register* at 21,347.

252 *Id.* at 21,349.

253 *Id.* at 21,239.

254 *Id.* at 21,347.

255 In fact, EPA acknowledges the value of substituting CCR for earthen materials in construction of final cover systems consistent with the Final Rule's closure design criteria, stating. "the process for procuring at-specification earthen material in the volumes necessary for the final cover system construction can complicate completion of closure requirements within the required time frames." Proposed Rule, *Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One),* 83 *Federal Register* 11,584, 11,605 (Mar. 15, 2018).

(3) Relevant product specifications, regulatory standards or design standards: This third criterion serves to verify the conservation purpose of the CCR use versus disposal by demonstrating that CCR is not used in more quantity than justified by the specific use. EPA noted in the Final Rule that where "excessive volumes of CCR are used—*i.e.*, greater than necessary for a specific project—that calls into question whether the purpose of the application was in fact a sham to avoid compliance with the disposal regulations."[256] Compliance with industry standards is particularly informative when evaluating an unencapsulated CCR use, which because of its loose form could more closely resemble disposal, and should not be a difficult condition to meet to qualify as a beneficial use. Specifications and standards exist for most of the popular uses of CCR. One example in the Final Rule is the use of fly ash as a stabilized base course in highway construction based on ASTM C 593 test for compaction and the ASTM D 560 freezing.[257] It also references two sources for standards and engineering designs for structural fill using CCR: ASTM Standard E2277-03,[258] *The Standard Guide for Design and Construction of Coal Ash Structural Fills*, and USWAG's "*Engineering and Environmental Guidance on the Beneficial Use of Coal Combustion Products in Engineered Structural Fill Projects.*"[259]

(4) An environmental demonstration for unencapsulated uses of CCR when triggered by mass-based numerical threshold or location restrictions: The Final Rule acknowledged the environmental concern associated with unencapsulated uses of large quantities, ranging from hundreds of thousands of tons to millions of tons per year and identified many of these large quantity applications, such as flowable fill, soil modification/stabilization, waste stabilization/solidification, agricultural use as a soil amendment, and aggregate, as well as CCR use, as structural fill.[260] However, EPA did not conclude that such large scale fill operations would not qualify "per se" as a beneficial use. It acknowledged that, if constructed properly, fill operations could meet all of the criteria for a beneficial use, subject to mitigating the environmental risks that these projects could present.[261] The fourth criterion conditions the qualification of these uses as a beneficial use on an environmental demonstration that projects using unencapsulated CCR do not violate environmental standards and include protections against these potential risks.

EPA provided guidance for applying the four prongs of its beneficial use definition in its *Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals.*[262] As the title indicates, the guidance is limited to encapsulated uses of CCR only. EPA later expanded its guidance to include unencapsulated uses and broadened its application to beneficial uses of all nonhazardous secondary materials, as indicated in its title: *Methodology for Evaluating Beneficial Uses of Industrial Nonhazardous Secondary Materials.*[263] EPA uses the flow chart in **Figure 24** to depict the methodology for applying the four conditions in the beneficial use definition to a particular CCR use or application.

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256 80 *Federal Register*. at 21,349-350.

257 *Id.* at 21,350.

258 Since the issuance of the issuance of the Final Rule, ASTM Standards E2277-03 has been replace with version E2277-14.

259 As cited in EPA's Final CCR Rule, 80 *Federal Register* at 21,351.

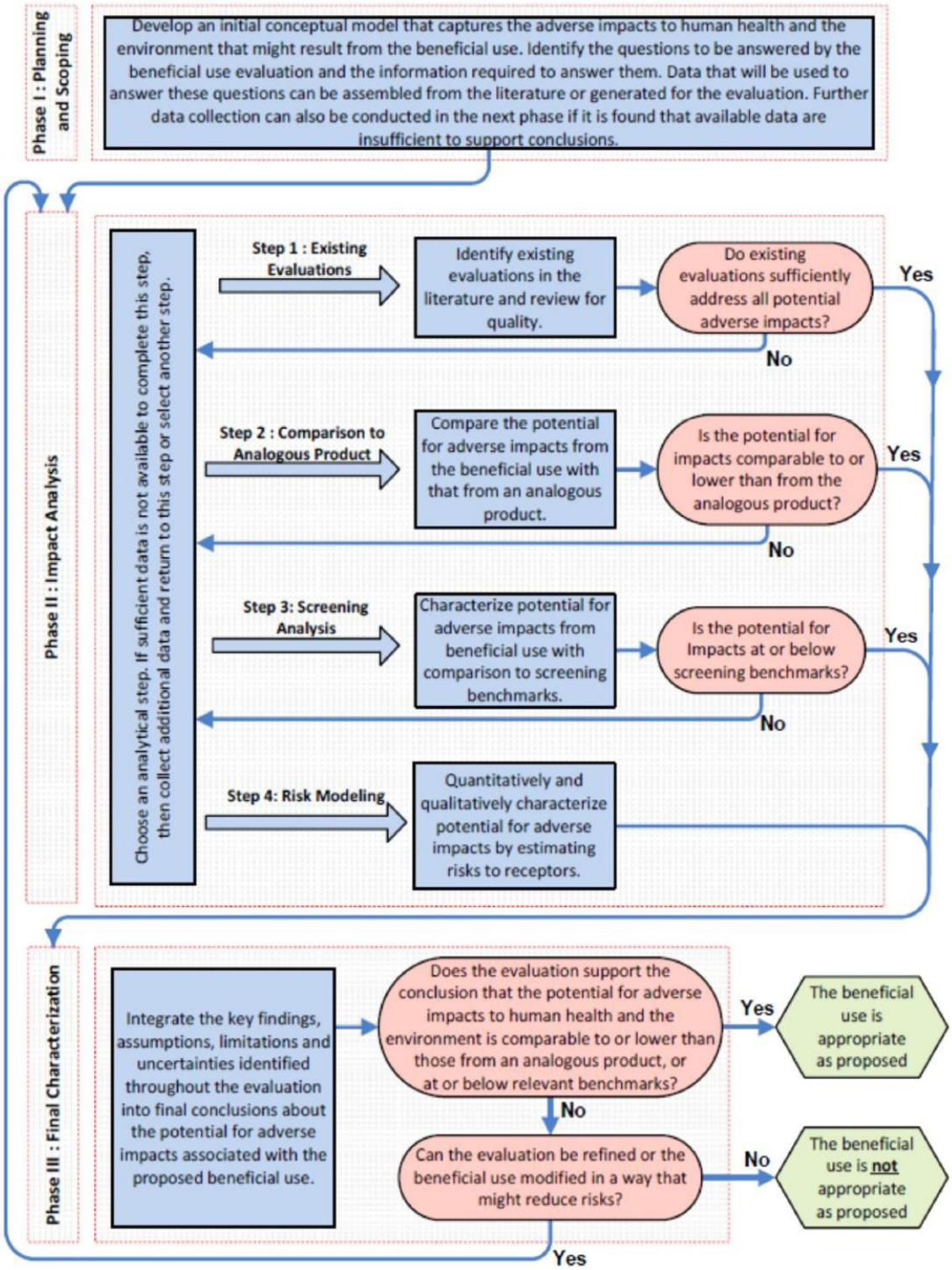
260 80 *Federal Register* at 21,353.

261 80 *Federal Register* at 21,351.

262 *Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals*, EPA (Dec. 19, 2014), https://www.epa.gov/coalash/methodology-evaluating-encapsulated-beneficial-uses-coal-combustion-residuals.

263 *Methodology for Evaluating Beneficial Uses of Industrial Nonhazardous Secondary Materials*, EPA, at 2 n.1 (Apr. 2016), https://www.epa.gov/sites/production/files/2016-07/documents/methodology_for_evaluating_beneficial_use_of_secondary_materials_4-14-16.pdf (explaining "Encapsulated beneficial uses are those where the secondary material is bound in a solid matrix that minimizes mobilization into the surrounding environment.").

Figure 24: Summary Flowchart of the Beneficial Use Methodology



Summary Flowchart of the Beneficial Use Methodology

D. Temporary Storage for Beneficial Use

EPA has attempted to address where the beneficial use characterization attaches to determine what is regulatory versus non-regulatory. It recognized the need of either the CCR unit operator or the beneficial end-user to sometime hold CCP as a potentially necessary intermediate point on the CCP's commercial pathway from its point of origin at the coal plant to its ultimate end use. EPA saw the need to distinguish between a CCR pile that is non-compliant disposal and a pile being held pending its beneficial use per the Final Rule, and EPA has drawn that distinction in the Final Rule's definition of CCR pile. It adopted a definition of CCR pile to ensure that this intermediary activity was properly classified, and not be disguised disposal.

> *CCR pile or pile* means any non-containerized accumulation of solid, non-flowing CCR that is placed on the land. CCR that is beneficially used off-site is not a CCR pile.[264]

EPA interprets "place on the land" to mean piles on-site, at the generation station, and thus on-site piles constitute disposal and therefore can be subject to containment criteria. CCR that is beneficially used off-site is interpreted to "mean temporary piles of CCR off-site (a beneficial use site), based on whether CCR from the pile could fairly be considered to be in the process of being beneficially used."[265] Consequently, a temporary pile located at a beneficial use site is, on one hand, excluded from the definition of a CCR pile, but on the other hand, it must meet the four prong conditions of the beneficial use definition to qualify as a beneficial use, including the last condition for an environmental demonstration applicable to unencapsulated CCR.

Using location, however, as the determining factor for whether a temporary holding of CCR is regulated or not is an arbitrary criterion that could improperly deny exemption of CCR that factually is an extension of a beneficial use. Consequently, in September 2019, EPA proposed to delete the term *CCR pile or pile* and replace it with the term *CCR **storage** pile* defined as "any temporary accumulation of solid, non-flowing CCR placed on the land that is designed and managed to control releases of CCR to the environment." Temporary accumulation is one that is neither permanent nor indefinite and to help identify an accumulation's temporary status, EPA proposes to require some record that evidences a contract, purchase order, facility operation and maintenance plan, or fugitive dust control plan, documenting that all of the CCR in the pile will be completely removed according to a specific timeline. EPA proposed to recognize the temporary holding status pending delivery of the CCR to a specific beneficial use market, regardless of whether it is located on-site or off-site. Creating a role for storage accommodates a need of the beneficial use markets to be able to temporarily store CCR pending transportation or its ultimate use.

EPA recognized in its Final Rule that many states had existing beneficial use programs that incorporated similar criteria as adopted in EPA's definition. Consequently, a state determination that a particular CCR use constitutes a beneficial use could be deemed to satisfy the first two conditions: (i) provides a functional benefit, and (ii) substitutes for the use of a virgin material and conserves natural resources. Also, where a state has established environmental standards for a particular use as part of its beneficial use programs, compliance with those standards could be used to meet the third and fourth prong. EPA referenced how Wisconsin and Virginia allow evaluation of their sites' suitability *prior to* construction that proposes to use CCR as structural fill.[266]

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264 80 *Federal Register* at 21,470.

265 84 *Federal Register* at 40,326.

266 80 *Federal Register* at 21,350.

However, after the Final Rule had issued, Virginia effectively outlawed unencapsulated uses of CCR generated within the state. In March 2019, its General Assembly enacted SB 1355,[267] which mandated removal of all CCR from CCR units within the Chesapeake Bay watershed. The excavated CCR must be either beneficially reused in a recycling process for an *encapsulated beneficial use* or disposed in a permitted landfill with a composite liner and leachate collection system. It sets a minimum of 6.8 million CY of CCR from at least two CCR units that must be recycled in an encapsulated form, which equals 25 percent of the total 27.3 million CY of CCR that must be removed under the statute. It defines "encapsulated beneficial use" consistent with the Final Rule's definition where CCR is bound "into a solid matrix and minimizes its mobilization into the surrounding environment." Consequently, CCR excavated from a CCR unit in Virginia can no longer be used as unencapsulated structural fill.

Hopefully, states will remain open to retaining the flexibility of the Final Rule in developing their own permitting requirements and SWMP coal ash program. Limiting beneficial uses of CCR to encapsulated uses frustrates RCRA's conservation objectives and pushes more CCR to landfills at a time when landfill capacity is becoming constrained.

E. Disposal versus Storage and Warehousing for Future Beneficial Use

RCRA envisions two alternative pathways for CCR destination: disposal or beneficial use markets. As discussed earlier, EPA's authority to regulate waste management activities under RCRA only extends to those activities that are deemed disposal. EPA does not have regulatory authority over activities that relate to beneficial use. However, its definition of beneficial use within the CCR context achieves backdoor regulation by requiring unencapsulated uses to demonstrate conformance with applicable environmental standards to meet the definition. If an unencapsulated use cannot provide evidence of environmental qualification, the use is deemed disposal and subject to EPA's national minimum criteria.

As discussed previously,[268] EPA attempts to answer the question of where to draw the line in differentiating beneficial use activities and disposal. It recognizes the reality of the need to engage in certain preliminary activities, such as temporarily holding coal ash in piles, before the CCR is processed at a beneficiation facility. However, it proposes to restrict extending the beneficial use exemption to CCR piles unless there are records and other documentation, such as a contract, demonstrating that the piles are temporary and are committed to a beneficiation facility or specific end use.

Restricting coal ash management to a choice between only two options: (i) immediate, real-time reuse/beneficiation, and (ii) disposal, ignores the current state of beneficial use markets. Earlier, this Section quoted information compiled by the American Coal Ash Association that reported 64 percent utilization of the 111 million tons of CCP produced in the United States for the year 2017, and the increasing rate of beneficiation of CCR versus the declining volume of production. As promising as these statistics are, the overall picture is less impressive. Earthjustice estimates that 1,971,614,293 million CY of CCR also reside within open and closed CCR units. Thus, it is apparent that although current successful methods of beneficiation offer a long-term solution to the CCR management dilemma, the availability of real-time beneficiation falls far short of satisfying the total demand necessitated by short-term closures, as well as current production. However, over time current methods of beneficiation could play a large role in managing the volume of ash produced and stored in this country, subject to the status of the economy, proximity of ash to market, and the quality of stored CCR.

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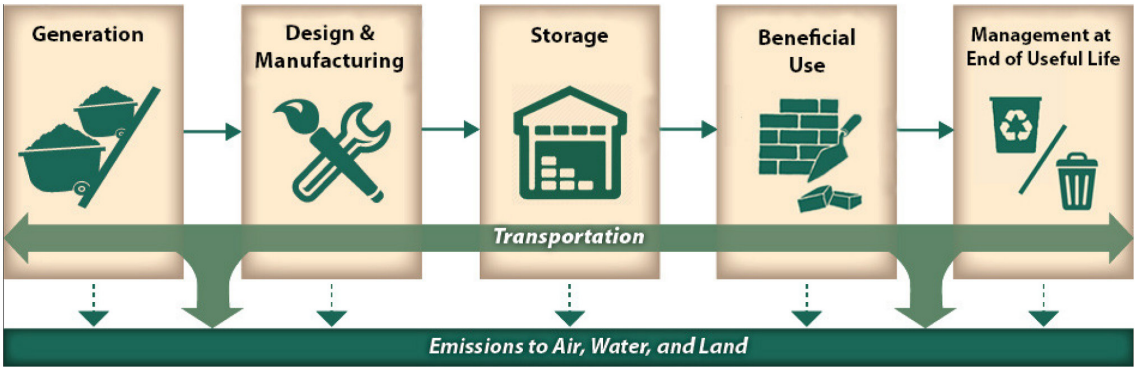
267 S.B. 1355, ch 651, 2019 Sess. (Va. 2019), (passing the same version as H.B. 2786, ch 650, 2019 Sess. (Va. 2019), http://lis.virginia.gov/cgi-bin/legp604.exe?191+ful+CHAP0650+pdf.

268 *See, infra* at p 85.

This section also described promising breakthroughs for new uses of CCR, which will expand the value of CCPs in other economic sectors, such as auto manufacturing, health care, and national defense. The sense of urgency to close coal ash ponds conflicts with the hopeful anticipation and enthusiasm to bring these potentially significant CCP applications to market. Disposal as the dominating policy option could undermine this new emerging independent CCP industry.

EPA published a methodology for evaluating whether a particular reuse qualifies as a beneficial use under EPA's definition.[269] To qualify, the evaluation must consider the aggregate of adverse impacts to human health and the environment resulting at each stage of the life cycle of the beneficially used byproduct. As illustrated in **Figure 25**, EPA identifies storage as an intermediate stage between production of the byproduct and its ultimate end use.[270]

Figure 25: Byproduct Lifecycle and Impacts



ACAA has articulated its CCP customers' supply concerns in response the decline in CCR generation due to the shift to renewable energy and gas power generation, partially in response to environmental regulations, while the market demand for "homegrown fly ash" increases, particularly by the cement industry. The commercial beneficial use markets thus will be adversely affected by the possible premature drive to close coal ash facilities by methods that could foreclose future CCR excavation:

> EPA stated that its CCR rule was directed at disposal and exempted beneficial use. However, the exemption is not as clear and the impact tentacles are both direct and indirect as we move forward . . . "The direct result is that impoundments are closing. Additionally, in many cases the cost to install wet-to-dry collection equipment and/or composite-lined management systems are prohibitive, and utilities are making the decision to prematurely close plants or generation units. The indirect impact on the CCP industry is that fly ash material sources are disappearing . . ."[271]

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269 The detailed methodology referenced here addresses the definition of beneficial use criteria, specifically the requirement that the potential adverse impacts to human health and the environment resulting from the proposed reuse of an industrial byproduct, such as CCR, that must be comparable to or less than the impacts from an analogous product, discussed *supra* at pp. 83-85. *See Methodology for Evaluating Beneficial Uses of Industrial Nonhazardous Secondary Materials*, EPA (Apr. 2016), https://www.epa.gov/sites/production/files/2016-10/documents/methodology_for_evaluating_beneficial_use_of_secondary_materials_4-14-16.pdf.

270 *Beneficial Use Compendium: A Collection of Resources & Tools to Support Beneficial Use Evaluations*, EPA at 2-1 – 2.2 (June 2016), https://www.epa.gov/sites/production/files/2016-06/documents/ben_use_compendium_062216.pdf.

271 Danny Gray, "Alternative Supplementary Cementitious Materials Availability – The Next 50 Years," *Ash at Work*, Issue 1 at 7 (2019). https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2019.pdf.

What EPA and states do in response to the environmental threat of these aging coal ash units will impact the fly ash market, which "will be felt for decades to come."[272] Policy outcomes prioritizing closure and disposal could slow investments in beneficiation facilities and detrimentally hamper the growth of fly ash use, as an example of one unintended outcome.

A response to EPA's closure policies has been the development of capabilities to harvest from utilities' legacy coal ash ponds desirable CCR content that can be further processed for purposes of beneficiation to meet future beneficial use markets. ACAA calculated that there are over 1.5 billion tons of previously disposed coal ash in both landfills and surface impoundments, based on production and use surveys it conducted. Harvesting and beneficiation of these ash deposits "provides a potential avenue for recouping some of the expenses associated with such closures."[273] However, to meet EPA's deadlines for required closure of CCR units under its rule, utilities and IPPs need a clear regulatory pathway to transfer the excavated CCR to alternative *storage* facilities offering the capability to harvest CCPs for eventual beneficiation. EPA's concept of temporary storage piles needs to be extended to long-term storage facilities offering services above and beyond landfill disposal.

In support of the movement to develop harvesting capabilities, ASTM recently published the *Standard Guide for Harvesting Coal Combustion Products Stored in Active and Inactive Storage Areas for Beneficial Use.*[274] Its guidance on harvesting CCPs also includes evaluation of storage areas for harvesting, detailed characterization of CCP storage areas; planning and scoping of harvesting projects; and detailed design and approval of CCP storage areas for harvesting. These standards could be used to distinguish storage facilities serving beneficial use markets consistent with the EPA's beneficial use definition from disposal with its minimum criteria under EPA regulations.

Waste management companies are preparing for an increase in demand for landfill capacity to meet disposal needs for CCR at a time when landfill capacity may be facing critical regional shortages.[275] In addition, many landfill owners-operators are making additional investments to craft design and structural changes to their facilities in order to comply with the minimum criteria to qualify as a CCR landfill. Higher demand and increased regulatory costs mean higher tipping fees for disposal in the overall closure cost calculations. To encourage an alternative and competing response by CCR management firms to enter the "storage" market, a clarification of EPA's Final Rule to exempt or reclassify these storage facilities under CCR regulation under RCRA is needed quickly. Second, utilities/IPPs should be encouraged to determine and catalog the constituent elements in their coal ash that will help match supply with market demand specifications. Just as there was an information gap regarding the pollutants contained in their coal ash waste streams, there is also a gap regarding the potentially useful components in the coal ash. DOE's research role could support creating an index and catalogue system for registering CCR information for these nascent markets and evaluating closure alternatives could also include an evaluation of the beneficial use value of the components in the CCRs.

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272 *Id.*

273 Rafic Minkara, Ph.D. P.E., "Digging through the Past: Harvesting Legacy Ash Deposits to Meet Future Demand," *Ash at Work*, Issue 1 at 22-23 (2019). https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2019.pdf.

274 For an overview of ASTM Guide, *see* Ivan Diaz Loya, *ASTM Guide for Harvesting CCPs from Active & Inactive Storage Areas for Beneficial Use – Task Group Overview*, BORAL (Mar. 29, 2018), http://worldofcoalash.org/wp-content/uploads/2018/11/12_ivan-diaz_panel-discussion_first-speaker.pdf. For other discussion of Harvesting Coal Ash, *see ACAA, Ash at Work,* Issue 1 at 22, 28, 36, 43 (2019), https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2019.pdf.

275 *See* James Thompson & Rob Watson, *Time is Running Out: The U.S. Landfill Capacity Crisis*, Solid Waste Envt'l Excellence Protocol (SWEEP) (May 4, 2018), https://nrra.net/sweep/time-is-running-out-the-u-s-landfill-capacity-crisis/.

Third, public policy consideration of regulatory and financial incentives under Subchapter VIII of RCRA[276] would advantage the development of environmentally secure storage and incentivize utilities' decision-making, away from disposal, to either transfer excavated CCR to storage or convert on-site CCR units into qualifying storage facilities, qualifying as used and useful facilities under regulated rate-making principles. Utilities/IPPs themselves using available macroencapsulation technologies and/or working with a qualified strategic landfill partner would help utilities make decisions on coal ash management that would maximize beneficial use value and potentially reduce costs for closure and post-closure care, while complying with EPA's Final Rule. Storage using available environmentally isolating technology (macroencapsulation, not disposal) on or off site would allow utilities to offset conversion costs with potential earnings from CCPs markets. Policies supporting public/private partnership's investment in beneficiation storage and harvesting align with the conservation mission of RCRA.

276 42 U.S. Code § 6981 to 6987. Subchapter VIII—Research, Development, Demonstration, and Information, https://uscode.house.gov/view.xhtml?path=/prelim@title42/chapter82&edition=prelim.

SECTION 8:
PUC Challenges with Utility Cost Recovery Applications

A. Ratemaking Implications for Utility Recovery of CCR Compliance Costs

As discussed in Section 5, the Final Rule provides for two primary methods to close CCR surface impoundments: (i) close with CCR in place in the existing impoundment and cover with an EPA-compliant cap; or (ii) remove the CCR and re-dispose of it in a landfill, if not beneficially used. Between these two options, the cost differential is substantial. For example, TVA noted in its EIS that estimated costs for closure with CCR in place could range from $3.5 million to $200 million, whereas the range of costs for closure by removal and re-disposal is between $20 million to $2.3 billion.[277] Because each CCR unit is unique, its site-specific conditions affect the costs, including the need to shore up structural stability to better handle onsite construction and transportation activities. However, if choosing between spending $200 million versus $2.3 billion, utilities must first consider which could more significantly affect and benefit their electricity customers.

The impact of compliance costs incurred under EPA's Final Rule will affect customers' electricity rates, and will manifest differently depending primarily on whether the CCR unit is owned by a utility or IPP. Utilities may attempt to recover their costs through their regulated rates charged to customers. IPPs, however, will attempt to recover their costs through the competitive wholesale market. The higher costs incurred by IPPs could potentially change the independent system operator's (ISO) generation stacking order for economic dispatch and ultimately impact market clearing prices. In the end, the IPP's shareholders bear the risk, as the law firm Wilkinson Barker Knauer and the Power Research Group state in a June 2017 report: "The key weakness of the merchant generation business model is that generators' revenues generally do not cover the all-in cost of supply, which includes the cost of capital recovery as well as the variable cost of operation."[278] This risk to a corporate bottom line was born out recently in Vistra Energy Corp.'s (formerly Dynegy) 2018 annual report in which it reported $605 million in "coal ash and other" noncurrent liabilities as of December 31, 2018. Its power generation subsidiary operates merchant coal-fired plants in the ERCOT, MISO, and PJM wholesale power markets and has no end-use ratepayers from whom it can directly recover costs. "Independent power producers face a much different set of economics, [Morningstar Research Services analyst Travis] Miller said."[279]

Although it is clear that IPP shareholders bear the market risks associated with the CCR compliance costs for each of their merchant power plants, it is not clear, at the present time, whether regulated utilities will be allowed by their public utility commissions to recover all their CCR compliance costs. Coal ash cleanup presents somewhat unique circumstances that do not fit easily into the conventional public utility business model, which rests on the regulatory principle that, in exchange for accepting the obligation to serve, a utility is provided an opportunity to recover its costs of service plus a fair rate of return on its investment. However, the utilities' opportunity for recovery is also subject to other ratemaking principles of least-cost, prudency, and just and reasonable rates, and there are few lessons in the historical analogues of commissions'

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277 Ashley R. Farless, *Final Ash Impoundment Closure Envt'l Impact Statement*, TVA (June 2016), https://www.tva.gov/file_source/TVA/Site%20Content/Environment/Environmental%20Stewardship/Environmental%20Reviews/Closure%20of%20Coal%20Combustion%20Residual%20Impoundments/Final%20EIS%20Part%20I.pdf.

278 Kennedy Maize, "What Is the Future of Independent Power?," *PowerMag.com* (Jan. 3, 2018), https://www.powermag.com/what-is-the-future-of-independent-power/?pagenum=2. See, Vistra Energy, *2018 Annual Report*, page 169, https://s21.q4cdn.com/410616722/files/doc_financials/annual/2018/Vistra-Energy_2018-Annual-Report.pdf.

279 Darren Sweeney, Ashleigh Cotting, & Zack Hale, *Cost questions loom as utilities prepare to close hundreds of coal ash sites*, S&P Global Market Intelligence (June 17 2019), https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/52117110.

application of these ratemaking principles to help public utility commissions in upcoming rate determinations regarding coal ash compliance costs. North Carolina adopted coal ash legislation both before and after EPA issued its Final Rule and is thus ahead of most states in dealing with questions associated with regulatory treatment of coal ash compliance costs.

The magnitude of the costs based on the closure option chosen by any given utility was summed up by *Townhall*, a publication that does not generally write on energy topics, but which realized the national significance of these costs. To provide a better comparison of the cost of regulation, it compared the following utilities' costs on a per impoundment basis:[280]

- Duke Energy, with its low-end $4 billion project cost, can expect to pay an average of $125 million to cleanup each ash basin. Duke Energy's costs, however, could soar if the state's environmental agency maintains intermediate- and high-risk ratings for its 32 basins. Intermediate and high-risk rated impoundments require the most expensive option for managing coal ash waste: excavate-and-remove. Under an all-excavate program, Duke Energy's project cost could reach $10 billion, or about $312 million per pond.
- Georgia Power's $2 billion estimated total cleanup expense averages to about $68 million per pond.
- Dominion Virginia Power's $500 million of total cleanup costs is equivalent to approximately $45 million per pond.

Townhall included a caveat regarding the use of an average cost per impoundment that costs could widely vary for any specific individual impoundment. "Waste removal experts say excavation versus cap-in-place aren't the only decisions that affect estimates. Basin size, amount of material, wet-versus-dry storage methods, union labor requirements, hauling costs, and distance to alternate landfills all factor into ash pond closing costs."[281]

One potentially useful historical analogy involved costs expended by utilities to comply with air pollution control regulations. EPA commissioned a study in 2011 to better understand how PUCs would treat costs that were both unexpected and extraordinary.[282] Typically, an electric utility would apply to a state's environmental permitting agency for approval of its proposed plan to comply with EPA's air quality mandates.[283] The utility would then file with the PUC to have the costs of the approved plan included in its rates. The study notes:

> Filing a rate case is the traditional method for curing a revenue deficiency. Historically, the capital investment aspects of the rate case are reviewed after-the-fact, i.e., the investment has been made and the project entered into service before the case is filed. The PUC

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280 Bruce Parker, *Regulations create wide-ranging costs for coal-ash cleanups, Townhall* (June 29, 2016), https://townhall.com/watchdog/virginia/2016/06/29/coal-ash-regulations-create-wide-ranging-costs-for-power-companies-n9586. It should be noted that this article was written in 2016, and this source is referenced here to demonstrate the range of potential costs. At that time, utilities were estimating coal ash unit closure costs, but had not yet provided specific closure plans on which to provide a more accurate assessment of costs. Since then there have been legal developments affecting these costs for both Dominion and Duke.

281 *Id.*

282 *Public Utility Commission Study,* SRA International (Mar. 31, 2011), https://www3.epa.gov/airtoxics/utility/puc_study_march2011.pdf.

283 *Permitting Under the Clean Air Act*, EPA, (July 2, 2019), https://www.epa.gov/caa-permitting; *see e.g. Oklahoma Air Quality Division*, OK DEQ (last visited Oct. 6, 2019), https://www.deq.ok.gov/divisions/aqd/.

determines whether the investment was prudent. The prudence review is based on the conditions prevailing when the decisions were made and often includes questions such as:

- Are the costs incurred to meet the needs of customers?
- Are the costs necessary to provide adequate service?
- Are the costs reasonable?
- Was the technology selection prudent?
- Is the plant investment used and useful?
- Will ratepayers derive a benefit?
- Is the capital investment consistent with any commission mandated integrated resource plan?

All prudent aspects of the investment will be added to the rate base, whereas costs deemed imprudent will be disallowed and borne by shareholders.[284]

The study continued, however, to note that, despite the incurrence of costs to comply with laws requiring pollution control technologies, the costs were not always approved for recovery by PUCs.

> As a general rule, capital investment in pollution controls that are required for compliance will be deemed a prudent investment. For example, as stated by the Alabama Public Service Commission in a case establishing an environmental compliance cost recovery mechanism:
>
> > [Environmental compliance costs] by definition are the product of governmental mandates establishing environmental requirements with which Alabama Power, by law, must comply. These are not costs that Alabama Power can simply choose not to incur, which in turn strongly supports a presumption that they are prudent expenditures.[285]
>
> However, there are often nuances to this general rule that make approval less certain. For example, multiple options could be available to reach compliance, each with different costs and benefits. In addition, regulatory burdens may be uncertain or undefined, potentially making early compliance strategies more of a risk. In another possible scenario, aspects of a nominally prudent investment could be deemed imprudent and disallowed (e.g., because of inadequate cost controls). For example, a case in Indiana rejected activated carbon injection (ACI) technology to reduce mercury emissions, based on the assertion that there were numerous mercury emission control technologies under development at the time that could prove to be more economical and efficient.[286]

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284 *Public Utility Commission Study, supra* note 282, at 16.

285 Re Ala. Power Co., Nos. 18117 & 18416, 237 P.U.R.4th 337 (Oct. 29, 2004).

286 *Public Utility Commission Study, supra* note 282, at 16.

Many such nuances arise in the context of coal ash remediation and recovery of its associated costs. Consequently, electric utilities have several fundamental considerations in developing a closure plan in compliance with EPA's rule that could have impact on its ability to recover its compliance costs:

- How much of the CCR is capable of being sold as a beneficial use, exempting the CCR from EPA's disposal regulation and potentially lowering the cost of remediation?
- Should the unit be closed with the CCR in place (on-site closure), which will trigger the 30-year monitoring requirement, including the obligation to engage in corrective action to address any groundwater contamination or structural instability that occurs during or following closure of the CCR unit?
- Should the unit be excavated and the CCR hauled to a remote location (off-site disposal) with attendant high costs and potential for additional environmental impacts associated with transporting millions of tons of ash to remote locations? After excavation and removal of the CCR, the excavated basin will require decontamination to ensure that groundwater protection standards are met.
- Is there a middle ground solution, such as retrofitting the impoundment and converting it to a landfill that complies with EPA's national minimum criteria?
- What time frame should be adopted for the remediation of existing coal ash ponds and how will this impact ratepayers as well as costs given possible advances in beneficiation technology and remediation technology?
- Should it matter in choosing closure alternatives whether the CCR unit is inactive and no longer accepting coal ash or it is inactive and part of the facilities at a generation site that has been retired and no longer generating electricity, so that the unit is potentially considered no longer used and useful?

Each of the above decisions will involve a significant amount of subjective judgment, like many regulatory decisions. While it may not be surprising that utilities and environmentalists may differ significantly as to what is the proper decision, a utility's choice of closure option may not be rationally decided based on economics alone:

> The decision to close [a surface impoundment (SI)] in place or excavate and re-dispose of the stored CCR is a critical question, but one that is often not based on pragmatic evaluations that fully consider the full set of issues and downstream consequences associated with each closure option. Based on media reports and actions taken by non-governmental organization (NGO) public interest groups, the prevailing public sentiment seems to be that closing an SI via CCR excavation and re-disposal is the preferred option; this seems to be driven by the notion that removing CCR from the existing SI is the only way to ensure that the groundwater and surface water surrounding the SI are completely protected. This position is at odds with the Rule, which explicitly states, " . . . both methods of closure (i.e., clean closure and closure with waste in place) can be equally protective, provided they are conducted properly." Despite this, public pressure rooted in these assumptions and the threat of litigation has caused some utilities to pursue plans to excavate and re-dispose of the CCR in their SIs.[287]

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287 Ari Lewis & Andrew Bittner, Methods of Closing CCR Surface Impoundments: Holistic Assessment Key to Developing Effective Plans, *Ash at Work*, Issue 2 at 6-7 (2016), https://www.acaa-usa.org/Portals/9/Files/PDFs/AshAtWork/ASH01-2016.pdf. (citing Final Rule, 80 Fed. Reg. 21,302 (2015)).

This raises the potential for conflict between the policy objectives of the state environmental agency in establishing permitting conditions for a utility's CCR closure plan to comply with the EPA's minimum criteria and the commission's mission in reviewing compliance costs for ratemaking purposes. For example, the NCDEQ has ordered closure requirements using an excavate and haul approach for Duke's surface impoundments to achieve its clean closure objectives. Duke estimates costs to comply with NCDEQ's requirements could be as much as an additional $5 billion, which costs are at risk of recovery through rates, notwithstanding that Duke managed coal ash no differently than other utilities across the country.

Kentucky's regulatory process to address coal ash remediation offers a model that may minimize this potential for conflict. While a typical process, such as the process used in North Carolina, begins with the environmental agency granting the required permits for closure of coal ash units and the utility then expending funds to comply with the permit followed by regulatory review of the utility's costs, this sequence subjects the utility to financial risks and uncertainty as to the size of the utility's liabilities which can ultimately affect its credit rating. In Kentucky, the process begins with the Kentucky Energy and Environment Cabinet, Division of Waste Management issuing a permit for the remediation of a coal ash unit.[288] The utility next applies to the PUC for a Certificate of Public Convenience and Necessity[289] to build or close a coal ash unit under a unique statutory provision specifically covering recovery of coal ash costs. The utility's plan for a CCR unit's construction or closure and the costs are reviewed by the PUC. If the plan is approved, the costs are recovered using a statutory recovery mechanism for coal ash costs.[290]

This procedural approach is illustrated in a Kentucky Utilities Company Order[291] by the Kentucky Public Utility Commission. The utility company had to make several changes to its previously filed plan with Kentucky's DEQ to build new ash units and to close several ash units. As a result, the dual track procedure before closure activities commenced, provided the utility assurance of cost recovery; the Commission has the ability to evaluate the overall costs of closure before costs are incurred; and the DEQ can consider changes to closure permits informed by the impact on customers' rates.

Indiana follows a similar procedural approach. Indiana specifically requires utilities to file for a certificate of public convenience and necessity for "federally mandated" environmental costs.[292] The Indiana Code provides that: "The commission shall issue a certificate of public convenience and necessity under section 7(b) of this chapter if the commission finds that the proposed compliance project will allow the energy utility to comply directly or indirectly with one (1) or more federally mandated requirements."[293] The statute specifically covers environmental costs required by RCRA.[294]

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288 https://eec.ky.gov/Environmental-Protection/Waste/solid-waste/Pages/default.aspx.

289 Kentucky Revised Statutes Title XXIV. Public Utilities § 278.020. Certificate of convenience and necessity required for construction provision of utility service or of utility; exceptions; approval required for acquisition or transfer of ownership; public hearing on proposed transmission line; limitations upon approval of application to transfer control of utility or to abandon or cease provision of services; hearing; severability of provisions, https://codes.findlaw.com/ky/title-xxiv-public-utilities/ky-rev-st-sect-278-020.html.

290 Kentucky Revised Statutes Title XXIV. Public Utilities § 278.183. Surcharge to recover costs of compliance with environmental requirements for coal combustion wastes and by-products; environmental compliance plan, review and adjustment, https://codes.findlaw.com/ky/title-xxiv-public-utilities/ky-rev-st-sect-278-183.html.

291 Electronic Application of Kentucky Utilities Company for a Certificate of Public Convenience and Necessity and Approval of Amendment to its 2016 Compliance Plan for Recovery by Environmental Surcharge, Case NO. 2017-00483, https://psc.ky.gov/pscscf/2017%20Cases/2017-00483//20180709_PSC_ORDER.pdf.

292 https://codes.findlaw.com/in/title-8-utilities-and-transportation/in-code-sect-8-1-8-4-6.html.

293 *Id.*

294 TITLE 8. Utilities and Transportation Article 1. Utilities Generally Chapter 8.4. Federally Mandated Requirements for Energy Utilities 8-1-8.4-5. "Federally mandated requirements" IC 8-1-8.4-5 "Federally mandated requirements, https://law.justia.com/codes/indiana/2017/title-8/article-1/chapter-8.4/section-8-1-8.4-5/.

This all raises several upfront key questions in evaluating a utility's request for cost recovery:

1. What closure options did the utility have and what impact did these options have on costs?
2. What additional safety requirements and structural changes are necessary for safe excavation and to protect workers' health, as well as to protect the environment during the closure process?
3. How much will it cost to remediate coal ash units?
4. Was the utility imprudent in how it handled the coal ash units in the past?
5. Are coal ash expenses used and useful?
6. Should all costs of closure and remediation be passed on to ratepayers?
7. Should utility shareholders bear some of the expenses?
8. Over what period of time should the costs be recovered?
9. Should the utility be allowed to earn a rate of return on the costs of remediation?

These questions and the application of rate principles to their answers will form the arguments made in support of and in opposition to a utility's request for recovery of its compliance costs. The recent court filings in the appeal of Duke Energy's rate case in North Carolina[295] provides a near perfect case study for evaluating how these various arguments could potentially play out in other jurisdictions throughout the country.

295 *State ex rel. Utils. Comm'n v. AG*, 829 S.E.2d 488 (N.C. 2019), https://www.ncappellatecourts.org/search-results.php?sDocketSearch=271A18&exact=1.

B. North Carolina Rate Case: Leading the Way on CCR Costs Recovery

The North Carolina Utilities Commission (NCUC) issued decisions in two rate cases filed by Duke Energy's utility subsidiaries in 2018,[296] approving recovery of nearly $800 million in combined costs between the two utilities for coal ash remediation costs they had incurred between 2015 and 2017. None of these costs were attributable to or associated with clean-up costs and other damages for the Dan River spill at Duke's generation facilities in 2014, which were prohibited by legislation. The costs were incurred in association with Duke's other coal ash ponds to comply with CAMA, as well as EPA's Final Rule, and were consistent with the NCDEQ permit requirements. Still, the North Carolina Attorney General (AG), joined by the Sierra Club, appealed both NCUC's decisions, specifically on the issue of the NCUC's approval of these costs and allowing their recovery in rates. The Attorney General's position was also reflected in proposed bills filed by several legislators in 2019 that would prevent Duke from recovery of any further coal ash clean-up costs, even costs unrelated to the Dan River spill.[297]

The NCUC's decisions allowed Duke to recover $800 million in coal ash remediation costs, which had accumulated in a deferral account, amortized over 5 years, with a rate of return on unamortized amounts. The NCUC, however, reduced the initial amount of costs Duke requested for recovery by imposing a $100 million management penalty that would be offset against the costs that Duke asked to recover. The NCUC also deemed an additional $9.5 million to be non-recoverable. Duke had filed for $200 million for inclusion in future rates based on the amount it anticipated it would spend on coal ash remediation in the future test year. The NCUC denied recovery of these costs in current rates but required Duke to put the $200 million into a deferral account to be included in the next rate case.[298]

Three parties appealed the NCUC decisions to the North Carolina Supreme Court (NC Supreme Court): the North Carolina AG, the Sierra Club, and the Public Staff[299] of the NCUC. These parties filed briefs in April 2019.[300] Duke filed reply briefs on September 24, 2019, defending the NCUC order.[301] As of the date this white paper was finalized, oral argument had not been set, nor has a decision been issued by the NC Supreme

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296 The first case was filed by Duke Carolinas, Duke Energy's larger utility subsidiary serving North and South Carolinas; the second was for Duke Progress, also a utility subsidiary serving part of North and South Carolinas which had formerly been owned by Progress Energy. The two cases were joined for purposes of appeal. Consequently, reference to the companies and to the underlying NCUC cases will be simply to Duke. *In the Matter of Application of Duke Energy Carolinas, LLC, for Adjustment of Rates and Charges Applicable to Electric Util. Serv. in N.C.*, Nos. E-7, Sub 1146; E-7, Sub 819; E-7, Sub 1152; E-7, Sub 110, at 23-24 (Jan.-Mar. 2018), https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=80a5a760-f3e8-4c9a-a7a6-282d791f3f23; and Nos. E-2, Sub 1131; E-2 Sub 1142; E-2 Sub 1103; E-2 Sub 1153 (Sept.-Nov. 2017), https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=d2b2a1a0-dae1-45de-af9c-c987d4aeddc8.

297 Bruce Henderson, NC House Democrats file bills to block Duke from passing coal ash costs to consumers, *Charlotte Observer* (Apr. 5, 2019), https://www.charlotteobserver.com/news/local/article228874829.html.

298 Duke filed another rate case on Sept. 30, 2019. Hannah Smoot, The Charlotte Observer, Duke Energy files new NC rate case. Here's what it means for your bill, (September 30, 2019), https://www.wbtv.com/2019/10/01/duke-energy-files-new-nc-rate-case-heres-what-it-means-your-bill/.

299 N.C. Gen. Stat. § 62-15 (Session Laws 2018-145 of the 2018 Regular Session and the 1st, 2nd, and 3rd Extraordinary Sessions of the General Assembly, but not including Session Laws 2018-146 or corrections and changes made to Session Laws 2018-132 through 2018-145 by the Revisor of Statutes, and through Session Laws 2019-3 of the 2019 Regular Session of the General Assembly, but not including corrections and changes made to the 2019 legislation by the Revisor of Statutes) (holding that the Public Staff represents consumers, stating "It shall be the duty and responsibility of the public staff to . . . intervene on behalf of the using and consuming public, in all Commission proceedings affecting the rates or service of any public utility).

300 Brief for Intervenor-Appellant AG, *State ex rel. Utils. Comm'n v. AG*, 829 S.E.2d 488 (N.C. 2019) (Nos. 271A18 & 401A18), https://www.ncappellatecourts.org/show-file.php?document_id=246329; Brief for Intervenor-Cross-Appellant Pub. Staff N.C. Utils. Comm'n, 829 S.E.2d 488 (N.C. 2019) (Nos. 271A18 & 401A18), https://www.ncappellatecourts.org/show-file.php?document_id=246337; *also see* Amicus Curiae Brief of the N.C. DEQ, 829 S.E.2d 488 (N.C. 2019) (Nos. 271A18 & 401A18), https://www.ncappellatecourts.org/show-file.php?document_id=254510.

301 Joint Brief of Appellees Duke Energy Carolinas, LLC & Duke Energy Progress, *State ex rel. Utils. Comm'n v. AG*, 829 S.E.2d 488 (N.C. 2019) (Nos. 271A18 & 401A18), https://www.ncappellatecourts.org/show-file.php?document_id=254504; Brief of Appellee Duke Energy Carolinas, LLC in Response to Joint Brief of Intervenor-Appellants N.C. Sustainable Energy Assoc., *et. al*, 829 S.E.2d 488 (N.C. 2019) (Nos. 271A18 & 401A18), https://www.ncappellatecourts.org/show-file.php?document_id=254506.

Court. The NCUC's two orders and the five briefs filed with the NC Supreme Court consider the recovery of coal ash remediation costs in the context of the following six principles of ratemaking. This Section provides a summary of how these principles underlie the parties' positions in the appeal.

1. Known and Measurable Principle
2. Just and Reasonable Principle
3. Prudency Principle
4. Used and Useful Principle
5. Cost Causation Principle, and
6. Expenses/Property Distinction.

1. Known and Measurable

To be recoverable, coal ash costs must be "known and measurable." Ordinarily, the known and measurable principle applies to whether certain costs can be included in a future test year,[302] in those states that have a future test year methodology. In the Duke case, known and measurable came up in two contexts. First, the NCUC found that the roughly $800 million in the historic deferral account met the "known and measurable" test, and no party disputed that Duke had spent that amount on coal ash remediation between 2015 and 2017. On the other hand, the NCUC also determined that about $200 million could NOT be included in the future test year on grounds that it was speculative, i.e., not "known and measurable." The NCUC did, however, allow future expended costs to continue to be included in a deferral account for a future rate case, presumably when it would be known and measurable.

2. Just and Reasonable and Prudency

Just and reasonable rates is a principle enunciated in the Federal Power Act and most states' public utility statutes.[303] Similarly, PUCs are usually required to ensure that costs were prudently incurred before allowing them into rates.[304] In analyzing the Duke rate case, the parties rarely distinguished between the principles of reasonableness and prudence, often seemingly using the terms interchangeably. This is not unusual in the practical application of these principles in real world cases. Quoting from energy lawyer and analyst Steve Isser's *Just and Reasonable: The Cornerstone of Energy Regulation:*

> " 'Just and Reasonable' is the standard language in both the Federal Power Act and most state regulatory acts, yet it is rarely defined. Parsing the terms provides little illumination as to their meaning. Just is defined as 'conforming to or consonant with what is legal or lawful.' Reasonable is 'fair, proper, just, moderate, suitable under the circumstances.' Fit and appropriate to the end in view."[305]

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302 Ken Costello, *Future Test Years: Challenges Posed for State Util. Comm'rs*, National Regulatory Research Institute. (July 2013), https://pubs.naruc.org/pub/FA86C105-05F5-9766-BC78-29829AC50361. (discussing deeper the test year concept and the impact of "known and measurable costs.").

303 Steve N. Isser, *Just and Reasonable: The Cornerstone of Energy Regulation*, SSRN (June 30, 2015), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2625131 (providing an in-depth scholarly discussion of just and reasonable).

304 Robert E. Burns, *The Prudent Investment Test in the 1980s*, National Regulatory Research Institute (Apr. 1985), http://ipu.msu.edu/wp-content/uploads/2016/12/Burns-Prudent-Investment-Test-84-16-85-1.pdf.

305 Isser, *supra* note 303, at 1.

In an interesting article on prudence, Isser noted:

> Does "Prudence" Get Sufficient Attention? … To prevent excess costs, we must insist on utility prudence. We have the legal tool: the "just and reasonable" standard. … "Just and reasonable" and "prudence" are only chapter headings. Commissions define "prudent" as "what a reasonable person would do." What would a "reasonable person" do with a billion-dollar choice among nuclear, clean coal, transmission, and demand response? Courts have defined prudence circularly, as avoiding "unreasonable costs," operating at "lowest feasible cost," and "operat[ing] with all reasonable economies."[306]

Just and reasonable and prudency principles have two implications in the coal ash context:

1. Was the utility reasonable in its historic actions relating to coal ash ponds?

2. Was the utility reasonable in how they have chosen to comply with federal and state regulations relating to treatment of coal ash ponds going forward?

Accordingly, the parties argued in their Supreme Court briefs whether Duke's historic decisions were reasonable and prudent, and whether Duke's coal ash mitigation costs were just and reasonable and/or prudently incurred. To answer these questions, the briefs extensively discussed the history of coal ash management practices in the U.S., particularly in the Southeast. Duke argued that it followed the industry standard and its coal ash management practices were consistent with all state and federal regulations relating to solid waste disposal. Environmentalists argued that it was always imprudent to dispose of coal ash in unlined ponds regardless of industry practice or state and federal law.

A refinement of this argument relates to timing. Assuming it was reasonable to dispose of coal ash in unlined ponds initially, the debate over the past decades in EPA's RCRA proceedings centered on whether coal ash should be classified as hazardous or nonhazardous. Consequently, environmentalists argued that Duke had notice of the environmental risks for which Duke should have prepared. At some point, the environmentalists argue, it should have been apparent that there was potential for leaching of coal ash contaminants into groundwater and that "reasonableness" and "prudence" required utilities to take more aggressive action to protect against groundwater contamination.

Commission determinations of just and reasonable and prudence will depend on the specific and unique circumstances of the utility's policy and actions regarding coal ash units. Indeed, the federal government took nearly four decades to determine the national policy on remediation of coal ash, maintaining an environment of regulatory uncertainty for utilities.

3. Used and Useful

The "used and useful" principle protects current customers. It provides that they will benefit from a utility's investment during the period in which they pay for services. In the case of coal ash, however, utilities are incurring costs for cleaning coal ash produced from the generation of electricity that benefited past customers over the decades coal ash waste was deposited in these CCR units. Charging current customers for costs

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306 Scott Hempling, "Prudence": Who's Minding The Store? (January 2011), (footnotes deleted) https://www.scotthemplinglaw.com/essays/prudence.

associated with electricity services provided to prior customers raises questions about the application of the "used and useful" principle. Before he was a FERC commissioner and chairman, Dr. James Hoecker had considered the continued significance of the used and useful doctrine:

> Regulators still determine whether utility investments are or are not used and useful in the public service and thereby establish whether or when certain investments are recoverable. It is a credible practice [but nevertheless is applied flexibly]. Used and useful no longer necessarily requires that there be a direct and immediate benefit to identifiable ratepayers. It is often used interchangeably with other equitable ideas and modern risk allocation concepts and, regrettably, is invoked without explanation. Its continued viability as a substantive rule of policy will therefore depend on the quality of agency decision making. Given the limited importance of used and useful in the era of end results and its constitutional limitations under Hope Natural Gas, the usefulness of used and useful is imperiled.[307]

The North Carolina Attorney General directly confronted this argument:

> To qualify under the ratemaking statute for a return, Duke's expenses had to be spent on property that is used and useful. Property is used and useful when it is employed to provide current service to a utility's customers. Duke's coal-ash expenditures fail this test. Duke has spent money on dewatering coal ash, digging it out of the ground, and hauling it to a landfill. Those are waste-management expenses, not investments in facilities that provide current service to customers. The coal ash at issue in these cases, moreover, was created when Duke burned coal to generate power years ago. Indeed, many of the basins and plants at issue in this case have been retired for years.[308]

Duke argued that coal ash costs are "property used and useful." The term "used and useful," although not defined by statute, encompasses that which both (1) serves the public, and (2) is funded by debt and/or equity investors.[309] The NCUC agreed with Duke's position, and observed:

> In general, the [North Carolina] Supreme Court's treatment of the concept has been in the negative, i.e., asserting as a basis for its decision that something is not "used and useful" – for example, excess common facilities are not "used and useful" as a matter of law, see Thornburg II, 325 N.C. at 495-96, 385 S.E.2d at 469, and a water treatment plant that was not in service as of the end of the test year and would never again be in service was not "used and useful" within the meaning of N.C. Gen. Stat. § 62-133(b)(1). State ex rel. Utils. Comm'n v. Carolina Water Serv., Inc., 335 N.C. 493, 508, 439 S.E.2d 127, 135 (1994). The reverse, of course, is that if the expenditures do support and provide service to customers, the costs are "used and useful."[310]

The NCUC thus concluded that "[c]apital expenditures undertaken to enable compliance with the law qualify as 'used and useful,' in that the Company does not have the option to fail to comply, and . . . are routinely recoverable in rates."[311]

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307 James J. Hoecker, "Used and Useful": Autopsy of a Ratemaking Policy, 8 Energy L.J. 303 (1987), https://www.eba-net.org/assets/1/6/25_8EnergyLJ303(1987).pdf.

308 AG Brief, *supra* note 300, at 39 (including the AG's used and useful argument which goes to whether the NCUC should grant a return on the coal ash costs not whether it should grant recovery of the costs themselves).

309 Duke Carolinas Brief, *supra* note 301, at 2 n.1 (citing *Utilities Comm'n v. Virginia Elec. & Power Co.*, 285 N.C. 398, 414-15, 206 S.E.2d 283, 295-96 (1974))..

310 *Re Duke Energy Carolinas,* N.C. Utils Comm'n, Nos. E-7, Sub 1146; E-7, Sub 819; E-7, Sub 1152; E-7, Sub 110 (June 22, 2018), at 259.

311 *Id.* at 268-69.

4. Cost Causation

Similar to used and useful, there is a timing issue in the application of the cost causation principle in the context of remediation of legacy coal ash units. Causation is less problematic to demonstrate in support of rate recovery for active CCR units that continue to receive coal burning waste. Costs caused by retrofitting or converting surface impoundments into dry CCR storage or landfills, arguably, meet the causation test. Current customers receive the benefit of EPA compliant disposal of coal ash waste when it is produced from the generation of electricity currently serving customers' needs.

Causation is more complicated to demonstrate relative to compliance costs, where the utility is incurring those costs to resolve environmental risks that it accrued in the past. Arguably, CCR units used for disposal of coal ash waste from the coal burned to generate electricity for past ratepayers do not benefit current ratepayers, because it is the byproduct of the electric needs for a different set of ratepayers, perhaps decades in the past. Indeed, many of the coal ash units have been inactive for years, and several of those are located at generation stations that are retired. Some utility customers might challenge whether it is fair be held responsible for such historical costs. On the other hand, it is impossible for the utilities to retroactively collect these costs from past ratepayers. These are not costs that benefit the shareholders either. The utilities complied with existing environmental law and only incur these costs because both the circumstances and the law changed.

Whereas the "cost causation" principle requires a connection between the costs imposed on a ratepayer and the incurrence of the cost: "[u]nder cost causation, 'all approved rates [must] reflect to some degree the costs actually caused by the customer who must pay them,'"[312] it is not typically used to exclude costs from recovery, but rather used to determine the allocation of costs among different customer classes. The NCUC applied the cost causation principle to coal ash mitigation costs in just this way. It did not propose to use cost causation to limit the recovery costs, but chose to use an energy allocation factor, rather than a demand factor, to allocate the CCR costs among all customer classes. The NCUC stated:

> [The witness] argued that this approach is contrary to cost causation principles because coal ash is a by-product of consumption of a fuel, and the volume of coal ash produced is associated with overall energy use, not demand during a single hour of the year. He recommended that all coal ash remediation costs approved for recovery be allocated using an energy allocator.[313]

5. Operating versus Capital Expenses

Utilities are entitled to recover all of their costs, but their costs are separated into two categories of expenses: (i) operating expense, generally defined as operation and maintenance costs (O&M), depreciation, and all taxes; and (ii) capital expenses that constitutes a utility's rate base, which is the net amount of investment in the utility's plants and other assets that are committed to rendering electricity service to customers, i.e., they are used and useful. Although a utility can only pass through its operating expenses, it is entitled to also earn a rate of return on its capital expenses. Regarding assets, both real and personal properties, utilities are entitled to a return on their investment through recovery of depreciation expense.[314] In the context of coal ash costs, the question arises as to whether they should be classified as operating expenses or capital expenses relating to property.

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312 *Principles of Cost Causation and Cost Allocation*, PJM (Nov. 13, 2014), https://pjm.com/-/media/committees-groups/task-forces/emustf/20141113/20141113-item-03c-cost-causation-slides.ashx (citing *KN Energy, Inc. v. FERC*, 968 F.2d 1295, 1300 (D.C. Cir. 1992)).

313 *Re Duke Energy Carolinas, supra* note 310, at 324.

314 Darryl Tietjen, *Tariff Development I--Basic Ratemaking Process*, Pub. Util. Comm'n Tex. (last visited Oct. 6 2019), https://pubs.naruc.org/pub.cfm?id=538E730E-2354-D714-51A6-5B621A9534CB.

In the Duke rate case, the AG characterizes the costs as "expenses" rather than "property that is used and useful." On the other side, Duke characterizes such costs as "property that is used and useful." The parties seem to agree that if the coal ash costs are "expenses" then there should be no rate of return allowed on such costs. The Public Staff agrees with the AG that no return should be allowed on coal ash costs. If characterized as "property that is used and useful" then a return would be appropriate. The NCUC concluded that coal ash remediation costs accounted for in the deferral account were subject to a rate of return, inferring that they were not merely operating expenses but rather represented a capital investment on which a return was appropriate:

> While arguments by the parties through analogy to cases on other issues provide some helpful context, the issue of amortization of deferred CCR remediation costs required to comply with EPA CCR requirements and CAMA is sui generis and distinguishable. These expenditures, as FERC and GAAP refer to them, are "costs" or an "asset" of remediation. They have been deemed by the Commission without objection as extraordinary, as not being recovered through current rates and have for those reasons been deferred. As such, they are investor-supplied funds, not ratepayer-supplied funds and under principles of equity, law and fairness are eligible for a return. Otherwise the investor supplying these funds is deprived of the time value of money and is inadequately compensated resulting in an increased risk and ultimately increasing the Company's cost of capital. The Commission in its discretion hereby authorizes a return, but discounts it as discussed below.[315]

The application of these principles to utilities' cost recovery application may not be a one-size fits all resolution of the issues. Analysis of these doctrines and the specific facts of individual cases may lead PUCs to myriad conclusions in individual cases. Many of these decisions may turn on specific facts relevant to a particular situation. PUCs may conclude, as did the NCUC, that it is unfair to disallow all the coal ash remediation costs because utilities were following the industry practice at the time. On the other hand, a PUC may also conclude that it is unfair to require today's ratepayers to pay for retired assets that represent costs that benefited historic customers. Still yet, the PUC may conclude that the utility may bear some responsibility for not anticipating that unlined coal ash ponds near groundwater would require some remediation at some point.

PUCs may raise the prudency of a specific plan that the state environmental agency has approved but which is much more costly than an alternative that the utility had included in its permit application. Illinois's Coal Ash Pollution Prevention Act[316] requires that all closure plans submitted for approval with its environmental agency must include a closure alternative analysis across all considered closure methods. In the context of regulatory rate recovery, this Illinois requirement is moot because Illinois is a retail choice state. In a regulated utility jurisdiction, this requirement to consider other options could create an opportunity for parties to challenge prudency of one choice over another.

The NCUC Public Staff, possibly recognizing the conundrum of cost recovery in the context of coal ash remediation, had recommended an "equitable sharing" of the costs between current ratepayers and Duke's shareholders. However, the NCUC rejected NCUC Public Staff's equitable sharing approach. The AG and the NCUC Public Staff also recommended a solution to balance the equities identified by the application of the above rate principles. Duke would be allowed to create a deferral account for ongoing incurrence of coal

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315 *Re Duke Energy Carolinas, supra* note 270, at 276.

316 415 Ill. Comp. Stat. Ann. 5/3.140 (through P.A. 101-309, except for portions of P.A. 101-48, 101-221, 101-238, and 101-275 of the 2019 Regular Session of the 101st General Assembly) (July 30, 2019), http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=101-0171.

ash costs and to amortize these costs over time. The utility would collect the full costs incurred for coal ash remediation but would not be allowed to earn a rate of return on the deferred account. This could possibly ameliorate any potential rate shock from such extraordinary costs.

C. Addressing Future Coal Ash Costs in the Present

Other sectors of the energy industry have learned to anticipate the possibility of and appropriately allocate costs relating to future environmental impacts, cleanup, and facility decommissioning. For example, it is interesting to contrast the issue of coal ash disposal with the policy on nuclear waste disposal.[317] Largely as a result of the Three Mile Island failure in 1979, Congress passed the Nuclear Waste Policy Act (NWPA) in 1982,[318] which established the Nuclear Waste Fund (NWF).[319] The act requires that electric utilities contribute $720 million annually to the NWF that would be used to pay for the central disposal of spent nuclear fuel (with the balance having grown to $40 billion[320]). While the goal of centralized disposal has not been realized, as the site continues to be debated, the concept of internalizing the cost of waste disposal in the energy price might be a worthy consideration even now relating to coal ash.

Unlike the nuclear power sector, the coal burning power sector did not establish any contingency fund to deal with the future financial risks associated with the accumulating environmental challenge from its waste practices. No contingency fund was established to pay for the eventual costs relating to onsite disposal of coal ash, which at the time was the most cost-effective method. The prevailing thought was that unlined coal ash units could just be covered in place and these limited costs would then be included in the utility's rates. Environmental sensitivity was not what it was when coal ash units were being constructed as it is now. The industry, and by extension, regulators, did not anticipate the costs relating to the cleanup of coal ash units.

Although the financial and environmental focus is on the closure of non-compliant active and inactive CCR units, many utilities will continue to operate monofills (landfills used for disposal of one type of waste) on their generation site. As offsite, remote landfill capacity becomes more constrained, particularly in the event of excavate and haul scenarios, utilities and IPPs may need to manage coal ash waste onsite more often. While future closure of active sites that have been operating in compliance with federal and state CCR regulations should therefore result in lower costs, the industry still could learn from the nuclear power sector to consider the regulatory establishment of a closure fund. Such a fund may be similar to the NWF in providing a mechanism by which current customers – not future customers – will bear the responsibility for future environmental costs caused by their demand for electricity service.

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317 Another example is in the offshore wind sector that requires financial assurances for eventual decommissioning as part of the federal government's offshore lease: "The Lessor will require a decommissioning bond or other form of financial assurance based on the anticipated decommissioning costs in accordance with applicable BOEM regulations (30 CFR 585.515-537). The decommissioning obligation must be guaranteed through an acceptable form of financial assurance, and will be due on a schedule to be approved by BOEM in accordance with the number of facilities installed or being installed." U.S. Department of Interior Bureau of Ocean Energy Management, *Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf, Mayflower Wind Energy,* Section III(b)(3) (April 1, 2019), https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MA/Lease-OCS-A-0521.pdf; also see 30 CFR 585.515-537. Interestingly, in the original notice for comment of the standardized lease terms for offshore wind projects, the Bureau of Ocean Energy Management did not require financial assurances for eventual decommissioning. See, BOEM, Notice, *Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf*, (February 3, 2012), https://www.federalregister.gov/documents/2012/02/03/2012-2496/commercial-lease-of-submerged-lands-for-renewable-energy-development-on-the-outer-continental-shelf.

318 Nuclear Waste Policy, 42 U.S.C.S. §§ 10101-10108 (through Public Law 116-56, approved August 23, 2019), https://www.law.cornell.edu/uscode/text/42/chapter-108; *Nuclear Waste Fund Activities Management Team,* Energy.gov (last visited Oct. 9, 2019), https://www.energy.gov/gc/nuclear-waste-fund-activities-management-team.

319 42 U.S.C. § 10222, https://www.law.cornell.edu/uscode/text/42/10222.

320 *Audit Report*, DOE-OIG-19-08, U.S. DOE (Nov. 2018), https://www.energy.gov/sites/prod/files/2018/11/f58/DOE-OIG-19-08_0.pdf.

D. Afterthoughts for Regulatory Consideration

Several conclusions can be made at this early stage in the development of a state PUC response to the coal ash challenge.

- First, coal ash remediation will be a significant cost center for utilities over the next two decades. Both the EPA rule and state legislation and regulation on nearly a thousand CCR units will be a significant challenge in an economy sensitive to electricity prices. In addition, depending on the timing and method of closure of a CCR unit, some units may have monitoring responsibility for 30 years with a requirement to take corrective action in the event that environmental impacts are found. For a utility that uses cap-in-place as its closure method, it is penalized by the liability that attaches to the value of its property, as evidence by the title notation required under the Final Rule.

- Second, coal ash remediation will be expensive. The early actions in Virginia and North Carolina suggest that the costs will be in the billions for complying with the state's response to evidence of water contamination and that the costs projections are still in flux. There is no evidence of the cost impact from hundreds of CCR units contracting for labor and services in order to complete closure within the same time frame or on disposal costs as an already constrained landfill industry attempts to respond to coal ash requirements.

- Third, the costs spent on coal ash remediation will be competing with many other cost challenges to electric utilities, including EPA's effluent standards under the CWA. As a result, electric utilities are at a crossroads in many respects. In addition to other environmental regulatory costs, there are demands for significant investment in infrastructure for grid modernization, build-out of electric vehicle infrastructure and renewable energy. There are potential climate change mandates that require significant challenges to the traditional electric utility business model. Utilities are needing to look forward to new demands as sectors of our economy become more reliant on electricity. The challenge to electric utilities to balance these demands will be enormous.

- Fourth, the role of PUCs is both heightened and uncertain with the potential of legislative cost directives as states wrestle with CCR remediation costs. Only four states have passed legislation and there has not yet been a state court decision on a major rate case that challenges coal ash recovery costs, though a decision in North Carolina can be expected soon.

- Fifth, major decisions relating to coal ash will likely be made by state legislatures and state environmental permitting agencies. So, agencies other than PUCs are directing coal ash remediation, while PUCs, if North Carolina's Duke rate case is emblematic, will decide who bears the costs of disposal facility closure and clean-up. If Virginia and North Carolina are portents of things to come, it will be a very political process, involving a broad and diverse group of stakeholders, other than the PUC. Yet, the PUC will be bound by the dictates of the ratemaking process to be objective, analytical, and fair.

All this suggests that coal ash management and remediation will create significant challenges for PUCs, which might be better served to be proactive where possible in working with state legislatures, environmental agencies, and state energy offices in decisions regarding how utilities should address coal ash management going forward.

SECTION 9:
Conclusion

As a result of the coal ash spills affecting major rivers and neighboring communities in Tennessee and North Carolina, regulation of coal ash has become a public policy priority. This Comprehensive Survey serves to build an informed context to the regulatory issues underlying the choices facing utilities and IPPs regarding cleaning up the accumulation of coal ash that presents growing concerns for potential environmental and public health threats.

Disposal is not the only alternative solution. Beneficial use markets for coal ash have been developing over the same time duration as coal ash has been accumulating. In 2017, 64 percent of coal ash produced was used in a beneficial end use, and more would have been used except for the lack of quality coal ash availability. Private markets are investing in means and methodologies to improve the production of coal ash during the coal combustion process at coal burning plants. Concerned with a potential decline in the supply of coal ash byproducts as a result of the decline in coal-based electricity generation and closure of CCR units, private and public investment is also supporting research in extracting marketable byproducts from legacy coal ash. While this research continues and while new applications for coal ash become commercially deployable, there is a need for long-term storage of coal ash inventory as opposed to disposal facilities.

Before closure of CCR units, regulatory policy may consider re-examination to find regulatory pathways that incentivize the conservation of coal ash as a commercial resource consistent with RCRA's conservation objectives. Meanwhile, it appears certain that the next phase of litigation is commencing, as utilities attempt to recover cleanup and compliance costs from ratepayers, especially as environmentalists engage on groundwater quality issues. How these costs will be recovered will have significant impacts on the electricity customers served by public utilities.

1.6. Kansas City Fly Ash Safety Data Sheet (Kansas City Fly Ash, 2015)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

SAFETY DATA SHEET

FLY ASH

1. IDENTIFICATION

Company Identification	**Corporate Address**	**Generator Address**
	Kansas City Fly Ash 15100 E. Courtney-Atherton Road Sugar Creek, MO 64058 816-257-3675 (8am to 4pm CST)	Kansas City Fly Ash 15100 E. Courtney-Atherton Road Sugar Creek, MO 64058

24-Hour Emergency Telephone Number: 1-800-451-8346 (3E Hotline)

Synonyms: Coal ash, fly ash, coal fly ash
CAS Number: 68131-74-8

2. HAZARD IDENTIFICATION

GHS Symbol:

GHS Signal Word: Warning

GHS Hazard Statement:

GHS – Hazard Statement for Health Hazards
H315 – Causes skin irritation
H320 – Causes eye irritation

GHS Precautionary Statements – Prevention
P264 – Wash skin and contaminated clothing thoroughly after handling
P280 – Wear protective gloves/protective clothing/eye protection/face protection

GHS Precautionary Statements – Response
P305 + P351 + P338 – IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313 – If eye irritation persists: Get medical advice/attention.
P302 + P352 – IF ON SKIN: Wash with plenty of soap and water.
P321 – Specific treatment (see First Aid information on product label and/or Section 4 of the SDS)

P332 + P313 – If skin irritation occurs: Get medical advice/attention.
P362 – Take off contaminated clothing and wash before reuse.

HAZARD OVERVIEW

Color: gray to brown
Physical State: powder
Odor: Not available
Signal Word: Warning

MAJOR HEALTH HAZARDS: May be irritating to respiratory tract, skin, and eyes. May be harmful if large amounts are inhaled.

PRECAUTIONARY STATEMENTS: Avoid breathing dust. Wear protective gloves, protective clothing, and eye protection. Use personal protective equipment as required. Wash thoroughly after handling. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood.

POTENTIAL HEALTH EFFECTS:

Inhalation: May cause irritation.
Skin contact: May cause irritation.
Eye contact: May cause eye irritation.
Ingestion: Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause injury.
Chronic Effects: Prolonged or repeated exposure may cause lung injury. Risk of injury depends on duration and level of exposure.

Medical Conditions Aggravated by Exposure: Respiratory disorders
See Section 11: TOXICOLOGICAL INFORMATION

3. COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous Components	CAS No.	Percentage
Silicon dioxide, SiO_2	7631-86-9	42.3
Aluminum oxide, Al_2O_3	1344-28-1	17.4
Iron oxide, Fe_2O_3	1309-37-1	5.8
Calcium oxide, CaO	1305-78-8	22.9
Magnesium oxide, MgO	1309-48-4	4.9
Sodium oxide, Na_2O	1313-59-3	1.8
Potassium oxide, K_2O	12136-45-7	< 1.0
Titanium dioxide, TiO_2	13463-67-7	1.4
Manganese dioxide, MnO_2	1313-13-9	< 1.0
Phosphorus pentoxide, P_2O_5	1314-56-3	1.0
Strontium oxide, SrO	1314-11-0	< 1.0
Barium oxide, BaO	1304-28-5	< 1.0
Sulfur trioxide, SO_3	7446-11-9	< 1.0

NOTE: CONCENTRATIONS ARE APPROXIMATE AND MAY VARY WITH COAL SOURCE AND BOILER OPERATING CONDITIONS.

4. FIRST-AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area.
IF IRRITATION OCCURS, GET MEDICAL ATTENTION.

SKIN CONTACT: Wash contaminated areas with soap and water.
IF IRRITATION OCCURS, GET MEDICAL ATTENTION.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes.
IF IRRITATION OCCURS, GET MEDICAL ATTENTION.

INGESTION: No hazard expected.
IF LARGE AMOUNTS ARE INGESTED, GET MEDICAL ATTENTION.

5. FIRE-FIGHTING MEASURES

General Fire Hazards
See Section 9 for Flammability Properties
Not flammable

Hazardous Combustion Products
None

Extinguishing Media
Use water

Unsuitable Extinguishing Media
None

Fire Fighting Equipment / Instructions
Firefighters should wear full protective gear

6. ACCIDENTAL RELEASE MEASURES

Recovery and Neutralization
None

Materials and Methods for Clean-Up
Contain the spill or leak. Avoid generating dust.

Emergency Measures
Isolate area. Keep unnecessary personnel away.

Personal Precautions and Protective Equipment
Wear appropriate protective equipment and clothing during clean-up.

Environmental Precautions
This material is a water pollutant: prevent material from entering drains, sewers, ditches or waterways.

Prevention of Secondary Hazards
None

7. HANDLING AND STORAGE

Handling Procedures
Avoid contact with skin and eyes. Wear the appropriate eye protection against dust. Minimize dust generation and accumulation. Avoid breathing dust. Use good safety and industrial hygiene practices.

Storage Procedures
Keep containers closed when not in use. Store in ventilated area away from sources of heat, moisture, and incompatible materials.

Incompatibilities
Strong acids, boric oxide, boron trifluoride, phosphorus pentoxide, chlorates, chlorine trifluoride, chlorine, ammonium salts, and fluorine.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Component Exposure Limits

Silicon dioxide (7631-86-9)
ACGIH: 10 mg/m^3 TWA
OSHA: 2.3 mg/m^3 TWA (<1% Crystalline silica)
NIOSH: 6 mg/m^3 TWA

Aluminum oxide (1344-28-1)
ACGIH: 10 mg/m^3 TWA
OSHA: 15 mg/m^3 TWA (total dust); 5 mg/m^3 TWA (respirable fraction)

Iron oxide (Fe_2O_3) (1309-37-1)
ACGIH: 5 mg/m^3 TWA (respirable fraction)
OSHA: 10 mg/m^3 TWA (fume)
NIOSH: 5 mg/m^3 TWA (dust and fume, as Fe)

Calcium oxide (1305-78-8)
ACGIH: 2 mg/m^3 TWA
OSHA: 5 mg/m^3 TWA
NIOSH: 2 mg/m^3 TWA

Magnesium oxide (1309-48-4)
ACGIH: 10 mg/m^3 TWA
OSHA: 15 mg/m^3 TWA (total dust), 5 mg/m^3 TWA (respirable fraction)

Titanium dioxide (13463-67-7)
ACGIH: 10 mg/m^3 TWA
OSHA: 15 mg/m^3 TWA

Manganese dioxide (1313-13-9)
ACGIH: 0.2 mg/m^3 TWA
OSHA: 5 mg/m^3 TWA

Engineering Measures
Use local exhaust or general dilution ventilation to control exposure within applicable limits.

Personal Protective Equipment: Respiratory
Avoid actions that cause extensive dust exposure to occur. Use local or general ventilation to control exposures below applicable exposure limits. NIOSH or MSHA approved particulate filter respirators may be used in the context of respiratory protection program meeting the requirements of the OSHA respiratory protection standard [29 CFR 1910.134] to control exposures when ventilation or other controls are inadequate. Respirator and/or filter cartridge selection should be based on American National Standards Institute (ANSI) Standards Z88.2 Practices for Respiratory Protection.

Personal Protective Equipment: Hands
Where prolonged exposure to products might occur, wear impervious gloves to eliminate skin contact.

Personal Protective Equipment: Eyes
When engaged in activities where ingredients could contact the eye, wear approved safety glasses or goggles. In extremely dusty environments and unpredictable environments, wear unvented or indirectly vented goggles to avoid eye irritation or injury. Contact lenses should not be worn when working with ingredients.

Personal Protective Equipment: Skin and Body
Normal work clothing (long sleeved shirts and long pants) is recommended.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Opaque fine powder
Physical State: Solid/Fine Powder
Vapor Pressure: Not Applicable
Boiling Point: Not Applicable
Solubility (H_2O): Mostly insoluble
Evaporation Rate: Not Applicable
Octanol/H_2O Coeff.: Not Determined
Flash Point Method: Not Determined
Burning Rate: Not Determined
Auto Ignition: Not Determined
Odor: Slight odor
pH: 11.9
Vapor Density: Not Applicable
Melting Point: > 1400°C
Specific Gravity: 2.4-3.4
VOC: Not Determined
Flash Point: Not Determined
Upper Explosion Limit: Not Determined
Lower Explosion Limit: Not Determined

10. STABILITY AND REACTIVITY

Chemical Stability
This is a stable material under recommended conditions of storage.

Conditions to Avoid
The fly ash, itself - particularly if moist or wet - or solutions that are or have been in contact with fly ash may be corrosive to metals.

Incompatible Products
Strong acids, boric oxide, boron trifluoride, phosphorus pentoxide, chlorates, chlorine trifluoride, chlorine, ammonium salts, and fluorine.

Hazardous Decomposition Products
Unlikely to evolve toxic gases when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

Toxicity Data

Silicon dioxide (7631-86-9)
Oral LD_{50} Rat: >5000 mg/kg; Inhalation LC_{50} Rat: >2.2 mg/L 1 hour; Dermal LD_{50} Rabbit: >2000 mg/kg

Aluminum oxide (1344-28-1)
Oral LD_{50} Rat: >5000 mg/kg

Iron oxide (Fe_2O_3) (1309-37-1)
Oral LD_{50} Rat: >10000 mg/kg

Calcium oxide (1305-78-8)
Oral LD_{50} Rat: 500 mg/kg

Phosphorus pentoxide (1314-56-3)
Inhalation LC_{50} Guinea pig: 61 mg/m^3 1 hour

Manganese oxide (1317-35-7)
Ingestion LD_{50} Rat: 9000 mg/kg

Skin
Slightly corrosive. Prolonged and repeated contact with powder or wetted form may result in skin rash, dermatitis and sensitization.

Eye
Slightly corrosive. Severe irritant upon contact with powder/dust. Over exposure may result in pain, redness, corneal burns, and ulceration with possible permanent damage.

Ingestion
Slightly corrosive. Ingestion may result in burns to the mouth and throat, with vomiting and abdominal pain. Due to product form, ingestion is not considered a likely exposure route.

Inhalation
Irritant – slightly corrosive. Over exposure at high levels may result in irritation of the nose and throat with coughing. Prolonged and repeated inhalation of respirable silica may result in lung injury.

Carcinogenicity

Silica, amorphous (7631-86-9)
IARC: Monograph 68 [1997]; Supplement 7 [1987] (Group 3 (not classifiable))

Other Toxicological Information
Repeated exposure to calcium oxide has shown to cause ulceration of the nasal septum, bronchitis and pneumonia. Chronic inhalation of silica quartz may cause autoimmune disease. Chronic exposure to an ingredient in this mixture has been reported to cause renal injury and adverse effects on visual acuity.

12. ECOLOGICAL INFORMATION

Limited ecotoxicity data was available for this product at the time this report was prepared. Ensure appropriate measures are taken to prevent this product from entering the environment.

13. DISPOSAL CONSIDERATIONS

Waste Disposal Instructions
See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging
Dispose of contents/container in accordance with local/regional/national/international regulations.

14. TRANSPORT INFORMATION

DOT Information
Not Regulated

15. REGULATORY INFORMATION

TSCA: Not applicable.

CERCLA: Contains no known hazardous substances.

SARA TITLE III:

Section 302 Extremely Hazardous Substances: None at or above *de minimis* concentrations.

Section 311/312 Health and Physical Hazards: Delayed health hazard.

Section 313 Toxic Chemicals: Aluminum Oxide – only if in fibrous form.

16. OTHER INFORMATION

NFPA/HMIS Definitions: 0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme
Protective Equipment: Safety glasses, gloves
NFPA Ratings: Health: 1 Flammability: 0 Reactivity: 1

Key/Legend
EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration.

Literature References
None

Other Information
The information provided herein was believed by KCP&L to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use.

ATTACHMENT B

[Sample Spreadsheet to Track FGD Gypsum Information]

2020 (Plant) FGD supply

0

As of:
5/6/2020

Week of:	Supplier 1 CONVEYOR	Supplier 1 Truck	Supplier 2 RAIL	Supplier 2 TRUCK	Supplier 3 RAIL	Supplier 3 BARGE	Supplier 3 TRUCK	Supplier 4 TRUCK	Supplier 4 OTHER	OTHER RAIL	OTHER TRUCK	OTHER	Delivered Tonnage	Beginning Inventory	Available Tonnage	Usage	Inventory in wet tons
1/1													0		0		0
1/6													0		0		0
1/13													0		0		0
1/20													0		0		0
1/27													0		0		0
January Totals:	0	0	0	0	0	0	0	0	0	0	0	0	0			0	
Inventory Adjustment																	0
																	0
2/1													0	0	0		0
2/3													0	0	0	0	0
2/10													0	0	0	0	0
2/17													0	0	0	0	0
2/24													0	0	0	0	0
February Totals:	0	0	0		0	0			0	0	0	0	0			0	0
Inventory Adjustment																	0
																	0
3/1													0	0	0		0
3/2													0	0	0	0	0
3/9													0	0	0	0	0
3/16													0	0	0	0	0
3/23													0	0	0	0	0
3/30													0	0	0	0	0
March Totals:	0	0			0	0	0		0	0	0	0	0			0	
Inventory Adjustment																	0
																	0
4/1													0	0	0		
4/6								**0**					0	0	0		
4/13								**0**					0	0	0		
4/20								**0**					0	0	0		
4/27								**0**					0	0	0		
April Totals:	0	0			0	0	0	0	0	0	0	0	0				
Inventory Adjustment																	
5/1								**0**					0	0	0		
5/4								**0**					0	0	0		
5/11								0					0	0	0		
5/18								0				0	0	0	0		
5/25					0							0	0	0	0		
May Totals:	0	0			0	0	0	0	0	0	0	0	0			0	
Inventory Adjustment																	0
																	0
6/1													0	0	0		
6/8												0	0	0	0		
6/15												0	0	0	0		
6/22												0	0	0	0		
6/29													0	0	0		
June Totals:	0	0							0	0	0	0	0			0	
Inventory Adjustment																	0
																	0
7/1													0	0	0		
7/6													0	0	0		
7/13													0	0	0		
7/20													0	0	0		
7/27													0	0	0		
July Totals:		0							0	0	0	0	0				
Inventory Adjustment																	0
																	0
8/1													0	0	0		0
8/3													0	0	0		
8/10													0	0	0		
8/17													0	0	0		
8/24													0	0	0		
8/31													0	0	0		
August Totals:		0							0	0	0	0	0				
Inventory Adjustment																	0
																	0
9/1													0	0	0		
9/7													0	0	0		
9/14													0	0	0		
9/21													0	0	0		
9/28													0	0	0		
September Totals:	0	0							0	0	0	0	0				
Inventory Adjustment																	0
																	0
10/1													0	0	0		
10/5													0	0	0		
10/12													0	0	0		
10/19													0	0	0		
10/26													0	0	0		
October Totals:	0	0							0	0	0	0	0				
Inventory Adjustment																	0
																	0
11/1																	0
11/2																	
11/9																	
11/16																	
11/23																	
11/30																	
November Totals:		0							0	0	0	0				0	
Inventory Adjustment																	0
																	0
12/1																	
12/7																	
12/14																	
12/21													0	0	0		
12/28													0	0	0		
December Totals:		0							0	0	0	0	0			0	
Inventory Adjustment																	
																	0

	Supplier 1		Supplier 2		Supplier 3			Supplier 4		OTHER			TOTAL DELIVERIES	BEGIN INVENTORY	USAGE		TOTAL
TOTAL RECEIPTS	0	0	0	0	0	0	0	0	0	0	0	0	- -	-	-	-	

1.7. Information from ACAA and CCR Marketers as Follow-Up to Stakeholder Engagement (2020)

In August 2020, EPA hosted a stakeholder engagement conference call with the American Coal Ash Association (ACAA) and an array of CCR marketer representatives. As a follow-up to this engagement effort, ACAA provided EPA with a listing of information and other resources relevant to the beneficial use of CCR. These resources include: (1) past information developed by EPA in support of prior regulatory efforts; (2) comments submitted by CCR marketers on the August 2019 proposed rule; and (3) additional materials available through ACAA's website. These resources are described and linked below.

Per ACAA and the participating CCR marketer representatives, EPA presently possesses technical information and data on the topic of beneficial use of CCR, based on its past regulatory efforts. This information includes:

- Data and analyses supporting EPA's 2000 Final Regulatory Determination: https://www.regulations.gov/searchResults?rpp=25&po=0&s=FRL-6588-1&fp=true&ns=true;
- Data and analyses supporting EPA's 2015 CCR Final Rule: https://www.regulations.gov/searchResults?rpp=25&po=0&s=EPA%E2%80%93HQ%E2%80%93RCRA%E2%80%932009%E2%80%930640&fp=true&ns=true; and
- EPA's beneficial use risk evaluation of fly ash concrete and synthetic gypsum wallboard: https://www.epa.gov/coalash/coal-combustion-residual-beneficial-use-evaluation-fly-ash-concrete-and-fgd-gypsum-wallboard.

In addition, ACAA and some CCR marketer representatives submitted comments on the 2019 proposed rule. These comments include:

- Comments submitted by ACAA: https://www.regulations.gov/document?D=EPA-HQ-OLEM-2018-0524-0138;
- Comments submitted by Geocycle/LafargeHolcim: https://www.regulations.gov/document?D=EPA-HQ-OLEM-2018-0524-0178;
- Comments submitted by The SEFA Group: https://www.regulations.gov/document?D=EPA-HQ-OLEM-2018-0524-0163;
- Public hearing transcript, including comments from ACAA during the October 2, 2019 public hearing: https://www.regulations.gov/document?D=EPA-HQ-OLEM-2018-0524-0048.

Further, as follow-up, ACAA provided additional information resources in an email attachment. These resources have been incorporated into other files in this compilation, as described below:

- ACAA Comments in Docket ID No. EPA-HQ-OLEM-2018-0524
    - File located in *PDF 3A, Section 1: CCR Management and Storage for Beneficial Use, 1.4*
- "A COMPREHENSIVE SURVEY OF COAL ASH LAW AND COMMERCIALIZATION: Environmental Risks, Disposal Regulation, and Beneficial Use Markets" - National Association of Regulatory Utility Commissioners, January 2020
    - File located in *PDF 3A, Section 1: CCR Management and Storage for Beneficial Use, 1.5*
- Sample Fly Ash SDS Sheet
    - File located in *PDF 3A, Section 1: CCR Management and Storage for Beneficial Use, 1.6*

Lastly, ACAA also referenced the following resources on this topic, available on its website:

- ACAA CCP Production and Use Reports: https://www.acaa-usa.org/publications/productionusereports.aspx;
- ACAA Summary of CCP types and uses: https://www.acaa-usa.org/Portals/9/Files/PDFs/ACAA-Brochure-Web.pdf;
- ACAA CCPs and Sustainability Backgrounder: https://www.acaa-usa.org/Portals/9/Files/PDFs/Sustainability_Construction_w_CCPs(Consolidated).pdf; and
- ACAA ASH at Work articles index: https://www.acaa-usa.org/Portals/9/Files/PDFs/AAWIndex.pdf

Section 2. Information Regarding CCR Management and Placement On-Site at Utilities

2.1. URL for EPA's List of Utility Compliance Websites (EPA, 2019)

The Disposal of Coal Combustion Residuals (CCR) from Electric Utilities final rule was published on April 17, 2015 and became effective on October 19, 2015. The rule includes a number of technical requirements that have various implementation deadlines. Many of these technical requirements also have Internet posting requirements associated with them. EPA included Internet posting requirements so that compliance information would be readily available because this rule is self-implementing and is enforced by citizens and states using the citizen suit provisions of section 7002 of the Resource Conservation and Recovery Act (RCRA).

EPA maintains a list of the Internet sites EPA found for facilities posting CCR rule compliance information organized alphabetically by state. All of these links are outside of EPA's website and EPA is not responsible for the content of these websites. The list can be found at https://www.epa.gov/coalash/list-publicly-accessible-internet-sites-hosting-compliance-data-and-information-required.

2.2. Comments from the Hoosier Environmental Council (HEC) on EPA's August 2019 Proposed Rule; Docket No. EPA-HW-OLEM-2018-0524 (Hoosier Environmental Council, 2019)

This document was originally submitted as a public comment in response to the August 2019 proposed rule.

Comments from the Hoosier Environmental Council on:

Hazardous and solid waste management system: Dosposal of coal combustion residuals from electric utilities; enhancing public access to information; reconsideration of beneficial use criteria and piles

Docket number EPA-HQ-OLEM-2018-0524
October 15, 2019

These comments include the concerns of the Hoosier Environmental Council (HEC) in response to the EPA's proposed revisions to the 2015 Coal Combustion Residuals Rule (or CCR Rule) as described in the Federal Register, volume 84, No. 157, page 40353, August 14, 2019. We appreciate the opportunity to submit comments.

The HEC opposes the proposed revisions to the 2015 coal ash rule that change the beneficial use criteria; and we oppose the weakening of the rule language governing coal ash piles.

Decades of minimal or nonexistent regulatory oversight of coal ash disposal in Indiana has left residents with a legacy of groundwater, soil, and surface water contamination. Every power plant site with unlined surface impoundments in Indiana has documented groundwater contamination, and assessments of corrective measures as provided in the coal ash rule are underway or complete at many of these sites. Even with EPA's adoption of a federal coal ash rule in 2015, Indiana's water resources remain at risk since most of the coal ash impoundment closure plans submitted to date propose to leave the coal ash in place, even where it is inundated by the underlying aquifer -- which is the case for at least seven ash pond systems in Indiana.

Prior to the 2015 EPA coal ash rule and Indiana legislation to implement this rule, the use of coal ash as a fill material in Indiana occurred with virtually no protection for water resources and served as a cheap means of disposal for the electric utilities that produced the ash. Until February 2017, state law prohibited regulation of the beneficial use of coal ash. This law was amended in 2017 to remove this prohibition (HEA 1230).[1]

In Indiana, there are many examples of the inappropriate use of coal ash as fill.

One proposed ash fill project, in Owen County, Indiana, would have served to level out a farm field for use as a private airplane landing strip. If not for objections by neighbors and county officials, this fill project would have gone forward with no consideration of the fact that it was directly above a karst formation. There were no state or federal regulations that governed this fill project.

[1]Indiana Coal Combustion Residuals Part 256 Solid Waste Management Plan Amendment, Indiana Department of Environmental Management Office of Land Quality, February 23, 2017, page 6

Another proposed project sought to use 180,000 cubic yards of coal ash as fill in the construction of a barge-loading facility on the Ohio River.[2] Ultimately the project did not go forward, but no state or federal rule prevented this highly risky use of coal ash.

Coal ash was routinely used as fill at many Indiana power plant sites, where it was dumped on the ground or in low areas of the site with no environmental controls, and the filled area was then built upon or otherwise used for power plant operations. This practice occurred at six sites at least. For example, at IPL's Harding Street power plant in Indianapolis, a storage structure was built atop an area filled with 50,000 tons of coal ash in the floodway of Highland Creek, a tributary to the White River.[3]Groundwater at this power plant is contaminated with arsenic,antimony, lithium, and molybdenum.[4,5]

At the former Tanners Creek Generating Station (AEP/Indiana & Michigan Power) in Lawrenceburg, Indiana, coal ash was used as fill in several areas of the power plant grounds. Two areas -- 2 acres and 17 acres in size, respectively –where coal ash was dumped are the subject of an Indiana Department of Environmental Management enforcement action for open dumping violations.[6]

The Old Ash Disposal Area at the Tanners Creek site covers 23 acres with coal ash deposits 20 to 40 feet deep, where it is inundated by the shallow aquifer underneath the site that is hydraulically connected to the neighboring Ohio River during periods of high water in the river.[7]At all other times, the groundwater flow at this heavily contaminated site is directly toward public drinking water supply wells operated by two separate municipal water utilities.[8]Besides the two coal ash fills mentioned above, the Tanners Creek site also contains the Fly Ash Pond, the unlined Main Ash Pond, and a Restricted Waste Site coal ash landfill. Groundwater contamination is present throughout the site, with concentrations of arsenic, barium,boron, chromium, cadmium, lead, manganese, lithium, selenium, and molybdenum exceeding their respective MCLs or the State's Remediation Closure Guide Screening Levels. For example, seven well samples for arsenic exceeded 100 ug/l, over 10 times the arsenic MCL, with one sample reflecting a concentration of 139 ug/l.[9]

At the Gallagher Generating Station (Duke Energy) the Primary Pond Ash Fill area covers 7.5 acres and contains 465,330 cubic yards of ash and the Coal Pile Ash Fill Area contains 377,145 cubic yards of ash.[10] Both of these ash fill areas are adjacent to two of the coal ash ponds at the site that have recorded groundwater protection

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[2]Rockport River Terminals, Inc., Construction in a Floodway permit application FW-22856, April 26, 2004

[3]Indiana Department of Natural Resources Certificate of Approval, Construction in a Floodway, Application No. FW-22843, 2005

[4]Notice of Groundwater Protection Standard Exceedance, Indianapolis Power & Light Company (IPL) – Harding Street Generating Station, January 14, 2019

[5]ATC (2018): CCR Annual Groundwater Monitoring and Corrective Action Report: IPL Harding Street Generating Station

[6] Commissioner of Department of Environmental Management v. Tanners Creek Development LLC, Case Nos. 2018-25690-S, 2018-25691-S, Agreed Order, May 8, 2019

[7]Closure Plan, Indiana & Michigan Power Company, Tanners Creek Plant, Lawrenceburg, Indiana, TRC Environmental Corporation, February 2015, page 12

[8]Groundwater Monitoring Plan, Former American Electric Power Tanners Creek Power Plant, Main Ash Pond, Lawrenceburg, Indiana, Tanners Creek Development, LLC, June 2019, Revision 3, EnviroAnalytics Group, page 3

[9]Phase II Limited Subsurface Investigation, Former AEP Tanner's Creek Generating Station, ATC Group Services LLC, December 4, 2018, page 12& Table 2B

[10] Proposed Closure and Post-Closure Plans, Gallagher Generating Station Ash Ponds System, ATC Group Services LLC, December 16, 2016, page 7

standard exceedances for arsenic and molybdenum and likely contribute to the groundwater contamination given the massive volume of CCR fill.[11,12,13]

At the Cayuga Generating Station (Duke Energy) the Ash Disposal Area #1 covers 119 acres and contains 7,456,380 cubic yards of coal ash. The West Ash Fill area covers 63 acres and contains 2,901,105 cubic yardsof coal ash.[14] The massive quantity of CCR in the fill is likely a significant contributor to the groundwater, which is contaminated with antimony, arsenic, boron, lead, molybdenum, and sulfate at levels exceeding drinking water standards or health advisories[15].

CCR Fill at Michigan City

The ground at NIPSCO's Michigan City Generating Station (MCGS) in Michigan City, Indiana, is loaded with coal ash due to decades of using ash as fill. The extent of the fill is documented in the RCRA Facility Investigation where Appendix D, the Waterfront Facilities Inspection[16], lists 1,350 linear feet of sheet pile along Trail Creek and 2,500 feet of sheet pile shore protection along Lake Michigan and the 'Site Geology' section of the RCRA report states:

> *"One purpose of the sheet pile walls was to facilitate the creation of "made land", which resulted from filling behind the structures with CCR produced at the generating station"*[17]

The result of filling behind these long sections of sheet pile is a massive collection of CCR. The fill thickness in the Power Generation Area of the MCGS site

> *"varies from approximately 6 to 19 ft below ground surface (bgs) in the northern portion of the Site near SWMU12 (Sargent & Lundy borings). The fill materials consist of black ash, cinders, and fly ash comingled with sand*."[18]

The CCR Management Area of MCGS covers the western two-thirds of the property:

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[11] Notices of Groundwater Protection Standard Exceedance, Gallagher Generating Station, for Ash Pond A and Primary Ash Pond, October 15, 2018

[12]ATC Group Services (2018). CCR Annual Groundwater Monitoring and Corrective Action Report: Ash Pond A Gallagher Generating Station

[13]ATC Group Services (2018). CCR Annual Groundwater Monitoring and Corrective Action Report: Primary Pond Gallagher Generating Station

[14]Proposed Modification to Existing Closure and Post-Closure Plans, Ash Pond System, Cayuga Generating Station, ATC Group Services LLC, December 16, 2016, pages 7-8

[15]ATC Group Services (2017). CCR Annual Groundwater Monitoring and Corrective Action Report: Lined Ash Disposal Area Cayuga Generating Station; ATC Group Services (2017). CCR Annual Groundwater Monitoring and Corrective Action Report: Secondary Ash Settling Pond Cayuga Generating Station; ATC Group Services (2017). CCR Annual Groundwater Monitoring and Corrective Action Report: Primary Ash Settling Pond Cayuga Generating Station

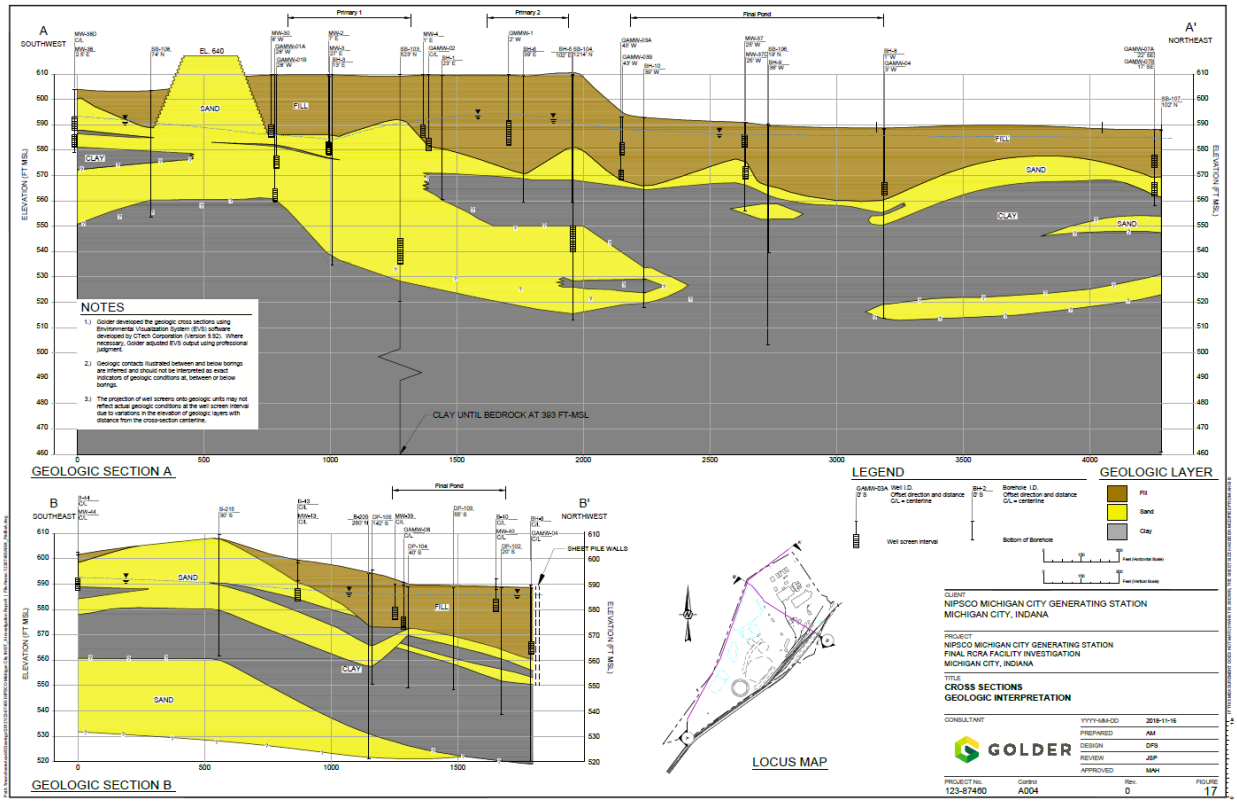
[16] Marine Solutions, Inc (July 12, 2018).Waterfront Facilities Inspections and Assessments. In Appendix D of the RCRA Facility Investigation Report, Michigan City Generating Station, pdf page 365

[17]Golder Associates (Dec 2018). RCRA Facility Investigation Report, Michigan City Generating Station. p. 9 (pdf page 20)

[18]Golder Associates (Dec 2018). RCRA Facility Investigation Report, Michigan City Generating Station. p. 10 (pdf page 21)

"Fill is present beneath the current ash ponds from approximately ground surface to at least 40 ft. bgs near the East Primary Fly Ash Settling Basin (Boring BH-7, Golder 2012) and near the Final Pond (BH-8, Golder 2012). The fill material includes a mixture of fly ash, boiler slag, and sand."[19]

The extent of the fill is also documented in the following cross sections found in the RCRA Facility Investigation[20]. The brown color represents fill.



[19] Ibid p. 10 (pdf page 21)
[20] Ibid, pdf pages 138-139.

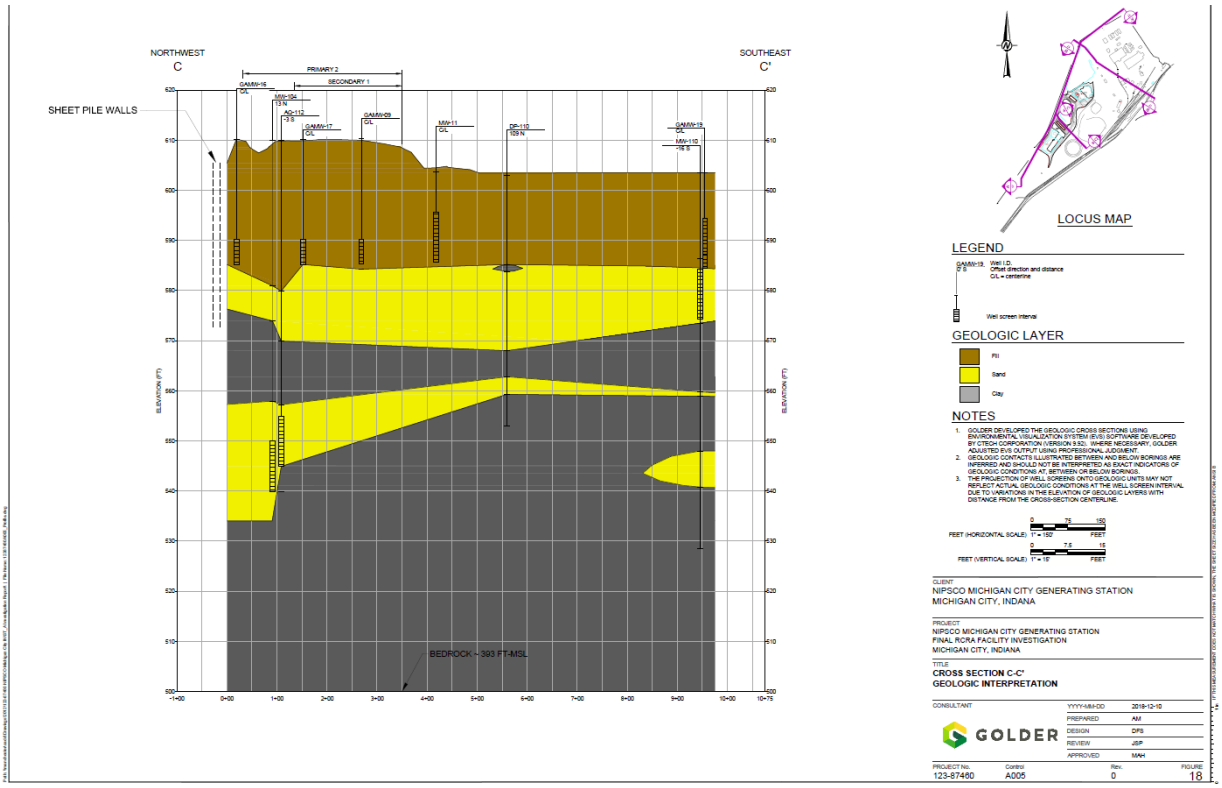


Figure 1. NIPSCO Michigan City Generating Station, Cross Sections, Geologic Interpretation. From Figure 17 of the 2018 RCRA Investigation Report.

The plan for coal ash closure also documents the extensive fill on the MCGS site.

> *"A layer of fill material approximately 14 feet in thickness beneath the Boiler Slag Pond and thickening from east to west to at least 40 feet in thickness beneath Primary Settling Pond No. 2."*[21]

The extensive presence of coal ash in fill at MCGS complicates closure of the coal ash impoundments at the site. NIPSCO's plan is to close the CCR impoundments by removal[22]. However, as the impoundments are excavated, it will not be possible to verify removal of the CCR because beneath the designated bottom of the impoundments, the excavation will still be encountering CCR.

Another complication the CCR fill brings to the impoundment closure at MCGS is the likely continued contamination of the groundwater after closure. The CCR present in the fill at MCGS is as likely to leach contaminants into the groundwater as the CCR in the impoundments. In fact, the fill may be more likely to contaminate the groundwater, since there is more of it and since cross sections submitted in the Addendum to the Closure Application show that a good portion of the fill is below the water table.[23]Where the CCR fill is below

[21] Wood Environment & Infrastructure Solutions, Inc (2018). Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, p. 22 (pdf page 33)
[22] Ibid.
[23] Wood Environment and Infrastructure Solutions, Inc (Feb 28, 2019). Supplemental Addendum Monitoring Well Network Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, Michigan City Generating Station. Pdf pages 14-15. IDEM Virtual File Cabinet document # 82709758

the water table, and much of it is, it is soaking in the groundwater continuously increasing the leaching of contaminants.

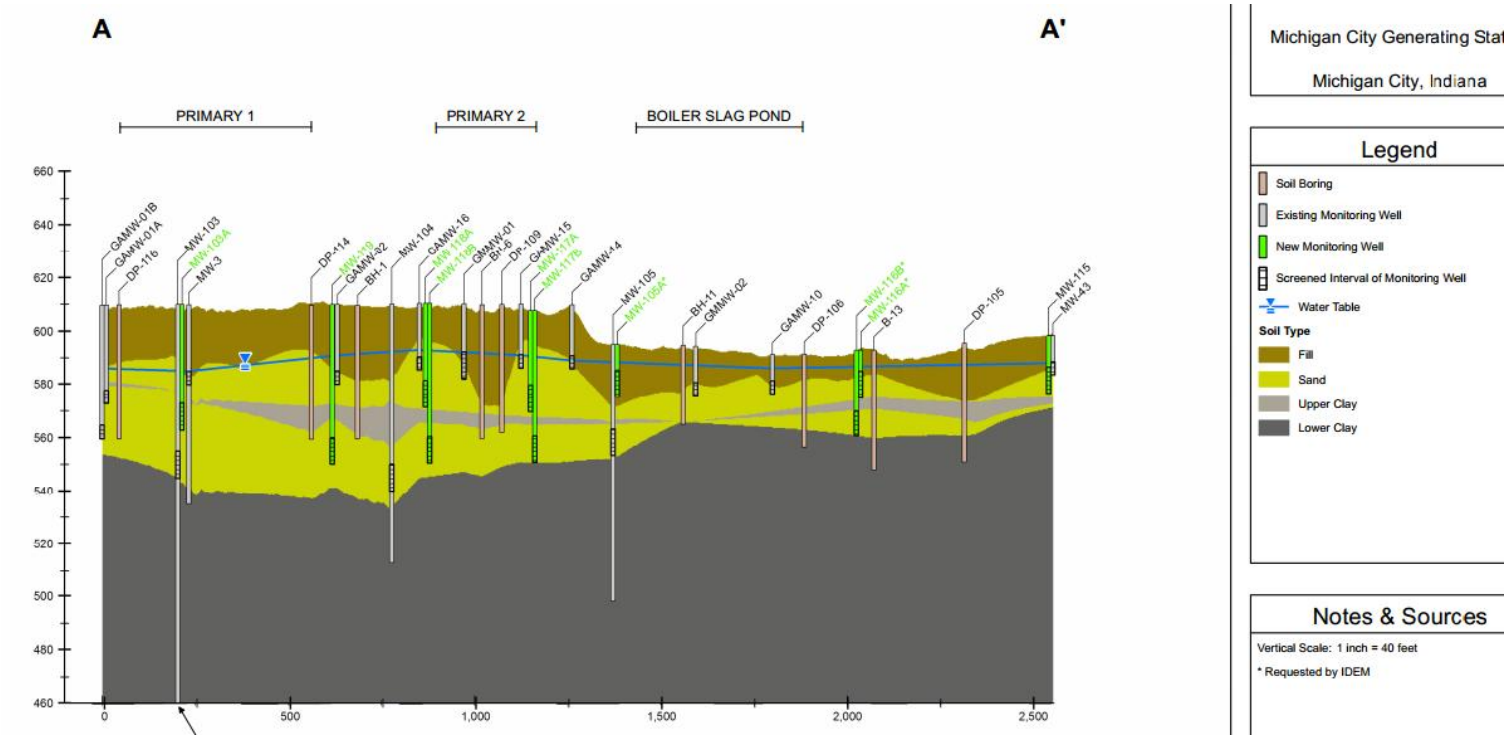


Figure 2. Cross section showing fill and water table. From the Michigan City Closure Addendum, Feb 2019.

The only comment in the Closure Application about groundwater contamination from the CCR fill is a vague one as follows:

> *"Minor concentrations of CCR materials may be present upon completion of closure by removal activities. Measures will be incorporated into the groundwater corrective action process to address residual concentrations of CCR constituents of concern"*[24].

The word 'minor' does not seem appropriate since the volume of CCR present in the fill probably exceeds the volume present in the impoundments. According to the Closure Application, the five impoundments will have a total of approximately 170,600 cubic yards excavated[25]. Given that the MCGS site is 123 acres[26] and the cross sections show fill occupying more than half the site to a depth of at least 10 feet, then a very conservative estimate is that there are at least 950,000 cubic yards of fill[27]. If CCR makes up 20%or more of the fill (190,000 cubic yards), then the amount of CCR in the fill exceeds the amount in the impoundments. Therefore, the CCR fill is likely to be contributing significantly to the documented groundwater contamination at MCGS. The

[24] Wood Environment & Infrastructure Solutions, Inc (2018). Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, p 11 (pdf page 22)
[25] Ibid, p 15 (pdf page 26)
[26] Ibid, p. 2 (pdf page13)
[27] 61 acres x 4840 yards^2/acre x 3.3 yards deep = 974,292 cubic yards

groundwater at MCGS has concentrations of arsenic, lithium, sulfate, and thallium that exceed drinking water standards or advisories[28].

Unfortunately, the monitoring wells at MCGS designated "background" were drilled through thick layers of CCR fill[29] and have elevated concentrations of boron, sulfate, lithium and molybdenum[30], consistent with coal ash contamination. Since the wells used as "background" were themselves contaminated with coal ash from the CCR fill, the notice issued by NIPSCO that arsenic is the only contaminant present in the groundwater at Statistically Significant Levels (SSL)[31] is inaccurate.

There is evidence that the contaminated groundwater at the Michigan City Generating Station is leaking into Lake Michigan and Trail Creek. The evidence includes a) the groundwater flow direction, b) the groundwater flow velocity, c) the history of the sheet pile construction, and d) the most recent sheet pile inspection.

The groundwater at MCGS is flowing toward Lake Michigan and Trail Creek. The groundwater flow diagrams included in the Closure Application and RCRA Facility Investigation Report indicate flow toward Lake Michigan to the north and west and toward Trail Creek to the northeast.[32,33] The Closure Application includes a calculation of the horizontal flow of groundwater at MCGS:

> *"Based upon site-specific data, average horizontal groundwater flow velocity was calculated at approximately 230 feet/year"*[34].

[28] 2018 Annual Groundwater Monitoring and Corrective Action Report for NIPSCO Michigan City Generating Station. https://www.nipsco.com/our-company/about-us/our-environment/ccr-rule-complianceNo.Michigan
[29] Wood Environment & Infrastructure Solutions, Inc (2018). Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, pdf pages 95 and 101.
[30] 2018 Annual Groundwater Monitoring and Corrective Action Report for NIPSCO Michigan City Generating Station. https://www.nipsco.com/our-company/about-us/our-environment/ccr-rule-complianceNo.Michigan
[31] NIPSCO (Aug 10, 2019). Michigan City Generating Station SSL Boiler Slag Pond Notification
[32] Wood Environment & Infrastructure Solutions, Inc (2018). Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, pdf page 53
[33] Golder Associates (Dec 2018). RCRA Facility Investigation Report, Michigan City Generating Station. pdf page 126
[34] Wood Environment & Infrastructure Solutions, Inc (2018). Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, pdf page 34

Figure 5. August 2008 Groundwater Surface Map, from the MCGS RCRA Investigation Report, pg 126. Sheet pile is indicating by the black and white dashed lines.

The groundwater flow meets the sheet pile along the majority of the site boundary, but the fact that the groundwater is flowing horizontally at 230 feet per year indicates that the groundwater is not stopping at the sheet pile. If it is headed in the direction of Lake Michigan or Trail Creek, as documented, at 230 feet per year, then it must be leaking into Lake Michigan and Trail Creek.

In fact, the sheet pile at MCGS has been documented to be leaking. Appendix D of the RCRA Investigation Report is the *Waterfront Facilities Investigations and Assessments*[35], which is a report on the 2018 inspection of the MCGS sheet pile, above and below water. The inspection documented leakage through the sheet pile bulkhead along Trail Creek and the shore protection along Lake Michigan.

> *The bulkhead is in Fair condition. . . surfaces below water typically exhibit minor to moderate corrosion over 100 percent of the surface area consisting of scaling up to ¼-inch thick and pitting up to 1/16-inch deep. Water seepage is evident through the interlocks.*[36]

[35] Golder Associates (Dec 2018). RCRA Facility Investigation Report, Michigan City Generating Station. pdf page 366
[36] Ibid, pdf page 371

> *The shore protection is in Satisfactory Condition. The steel sheet pile bulkheads exhibited minor to moderate corrosion with evidence of water seepage between the interlocks on the inner bulkhead.*[37]

The RCRA Facility Investigation acknowledges the leak through the sheet pile:

> *Although the sheet-pile is present around the downgradient perimeter of the Site, the underlying clay is not always shallow enough in all locations to allow the sheet pile to key into the clay, possibly allowing groundwater to flow beneath the sheet pile adjacent to Lake Michigan (e.g., near GAMW-01A/01B, and MW-30). Water table elevation maps created based on both recent and historical data suggest areas where leakage beneath or through the sheet pile may be occurring.*[38]

The CCR fill at Michigan City also threatens Lake Michigan because it is in the floodplain of the lake. Eventually the site will be flooded putting Lake Michigan at risk for a large coal ash spill. The risk is likely higher than expressed by the current 100-year floodplain map since the map is based on historical data. Current climate projections are that there will be a 6 - 8% increase in annual precipitation in Indiana by 2050 relative to recent decades and an increased frequency of extreme precipitation events[39]. The flood maps do not account for those projections. The projected changes in precipitation will increase the frequency and extent of flooding. During a flood, the sheet pile and rip rap that currently protect the lake could fail causing a coal ash spill.

The CCR fill at Michigan City poses a threat to human health and the environment via contamination of groundwater, movement of contaminated groundwater into the lake, and via the threat of a spill into Lake Michigan. There are public drinking water intakes of surface water in the vicinity of the Michigan City Generating Station that could be affected[40].

Coal Ash Fill in the Town of Pines, Indiana

In the Town of Pines, Indiana, the local power company placed coal ash in an unlined landfill for decades and coal ash wasused extensively as fill for building roads and in landscaping around the town[41]. In the year 2000, a resident of Pines complained of odors in her well water. That complaint eventually led to testing wells all around town and finding that they were contaminated by the coal ash[42,43]. These private wells, that residents had been using for decades, had arsenic as high as 1100 parts per billion, boron as high as 14,000 parts per

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[37] Ibid, pdf page 372

[38] Golder Associates (Dec 2018). RCRA Facility Investigation Report, Michigan City Generating Station. pdf page 3

[39] Widhalm, M, et. al. (2018). Indiana's Past and Future Climate: A Report from the Indiana Climate Change Impacts Assessment. Purdue Climate Change Research Center, Purdue University. https://ag.purdue.edu/indianaclimate/indiana-climate-report

[40] Indiana Finance Authority (Oct 2015). Utility Planning in Indiana. Map of Indiana surface water intakes on pdf page 27

[41] EPA (Sept 2016). Town of Pines Superfund Site: Record of Decision

[42] Aecom (Nov 2014). Supplemental Soil Characterization Work Plan: Pines Area of Investigation, AOC II.

[43] EPA (July 2002). Factsheet: Town of Pines Ground-water Sampling Activities Continue. Accessed from Town of Pines Superfund Site Reports and Documents at https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.scs&id=0508071&doc=Y&colid=30229&region=05&type=SC

billion, manganese up to 15,000, molybdenum up to 929 and lead up to 199 parts per billion[44]. They had been drinking water which exceeded drinking water standards by more than 10 fold.

The power company, landfill owner and hauling company were required to pay to pipe municipal water from a nearby town to 263 homes and businesses in Pines to replace their ruined wells[45,46]. The residents there are now haunted by how they drank that water and the effects it may have had on their health and their children's health.

In 2002 Indiana requested that the Town of Pines be placed on the National Priorities List[47] - essentially the entire town was declared a Superfund site because of the coal ash fill. That started an investigation and clean-up of the coal ash fill[48] that has dragged slowly along and the clean-up of the fill is still going on. During the course of the investigation, it was documented that along with contaminating the groundwater, the ash used as fill was contaminating soil to levels that posed an unacceptable exposure risk.[49] The investigation has confirmed the presence of coal ash fill on private properties throughout the Town of Pines. A map of "Field Verified" coal ash in Pines from the Supplemental Soil Characterization Work Plan is attached at the end of these comments.[50]

One of the Pines property owners contacted the Hoosier Environmental Council (HEC) for assistance in July of 2019. This property is 1.2 miles to the east of the landfill and so less likely to be impacted by it. The property owner shared with HEC documents they had received from NIPSCO and Haley-Aldrich, the consultant conducting the coal ash fill clean-up, including soil testing data and the plans for excavating coal ash fill from part of the property. They also shared a report from a private lab that had tested water from the pond on the property. The pond is located just a few yards outside the area of coal ash fill being excavated by NIPSCO. It is also downhill from the area of coal ash fill. The pond has high levels of arsenic, boron and manganese consistent with contamination by coal ash[51]. It appeared that leachate from the coal ash fill had contaminated the pond.

	Pond Water at private property in Pines, IN
Arsenic	0.0987 mg/L
Boron	0.437 mg/L
Manganese	0.651 mg/L

[44] Clean Air Task Force (April 2004). Not in My Lifetime: The Fight for Clean Water in the Town of Pines, Indiana.
[45] EPA (Sept 2016). Town of Pines Superfund Site: Record of Decision
[46]Aecom (Nov 2014). Supplemental Soil Characterization Work Plan: Pines Area of Investigation, AOC II. IDEM Virtual File Cabinet document #919280.
[47] EPA (July 2002). Factsheet: Town of Pines Ground-water Sampling Activities Continue. Accessed from Town of Pines Superfund Site Reports and Documents at https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.scs&id=0508071&doc=Y&colid=30229&region=05&type=SC
[48] EPA (Sept 2016). Town of Pines Superfund Site: Record of Decision
[49] EPA (Sept 2016). Town of Pines Superfund Site: Record of Decision
[50]Aecom (Nov 2014). Supplemental Soil Characterization Work Plan: Pines Area of Investigation, AOC II.
[51] Eurofins Lancaster Laboratories Environmental (July 20, 2019). Analysis Report: Pond Water (North Site)

The property owner had been using that pond to water his vegetable garden and provide water to his animals. HEC recommended that he stop using it. HEC also talked with the EPA Remedial Project Manager about getting the pond addressed. He responded that surface water wasn't part of the clean-up plan.

Coal Ash Piles in Noblesville, Indiana

In Noblesville, Indiana, Duke Energy operated a coal-fired power plant starting in the 1950's. Duke placed the coal ash from the plant into piles on their property. They stopped using the piles in 1989 and stopped burning coal in 2003. In 2015, Duke investigated the Noblesville ash piles as part of an "internal environmental audit" [52]. The piles are not in a high hazard area - the groundwater is at least 15 feet below the surface; it is not a wetland or floodplain, nor is it an unstable or seismic area. This location would have met the criteria in this proposed rule revision for allowing unlimited use of coal ash fill. Yet, the piles contaminated the groundwater and impacted private wells in the neighborhood adjacent to Duke's property. Duke is now paying to provide alternative sources of drinking water to that neighborhood[53], and the residents are wondering about all the years they were drinking that water.

Conclusion

As is evident from the description of the coal ash "fill" areas, these sites can also be considered coal ash "piles" as defined at 40 CFR 257.53. With respect to the proposed rule changes, coal ash pilesshould continue to be regulated as CCR landfills, whether considered temporary or not. The evidence at nearly all the Indiana sites indicates that the coal ash piles are permanent, and in some cases were considered fill. Yet we are concerned that the rule change may allow some of these sites to be redesignated as temporary, with a resulting reduction in oversight. Given that these coal ash piles are contributing to the groundwater contamination occurring at a number of these sites, they should be subject to rigorous clean up requirements.

It is this record of neglect and resulting contamination that leaves many residents of Indiana with no confidence that coal ash disposal characterized as "beneficial use" will occur without creating substantial environmental risk to public health and our state's water resources. Clean fill material alternatives are available so there is no need to further endanger our state from irresponsible use of this toxic waste. What's more, the lack of notification requirements (Federal Register, Vol. 84, No. 157, page 40361, "The EPA also solicits comments on whether the regulations should impose a notification requirement. . .") in the proposed rule revision means the public, neighboring landowners, and state and local officials will have no knowledge that a coal ash fill project is about to occur.

---

[52] Agreed Order between the State of Indiana and Duke Energy Indiana, Noblesville Station (Jan 2018). Case no. 2017-24922-S

[53] Duke Energy (July 2018). Proposed Site Closure Implementation Plan. IDEM Virtual File Cabinet document#82582356 (pdf page 43)

The Hoosier Environmental Council is opposed to any changes that weaken environmental protections from coal ash. In particular, we believe that storage of coal ash in piles and use of coal ash as fill should not be permitted. Coal ash fill and piles are just unlined landfills by another name. Giving coal ash a different name, like 'pile' or 'fill', doesn't change its behavior. As demonstrated in the many examples above, coal ash used as fill or left in piles can cause contamination of soil, surface water, and groundwater. In fact, everywhere we have coal ash in Indiana without a liner under it, we have contaminated groundwater. The Hoosier Environmental Council believes that unencapsulated reuse of coal ash should not be considered a beneficial use.

Further, easing the limits on coal ash piles and coal ash fill creates an enormous loophole in the regulation. Why would a regulated entity go to the trouble and expense of building a properly lined landfill when they're allowed to leave coal ash in piles and distribute it wherever they like as "fill". HEC urges the EPA to abandon the proposed regulatory changes on coal ash fill and piles.

Thank you for your consideration of the concerns raised in these comments.

Sincerely,

Indra Frank, MD, MPH
Director of Environmental Health and Water Policy
Hoosier Environmental Council

Tim Maloney
Senior Policy Director
Hoosier Environmental Council

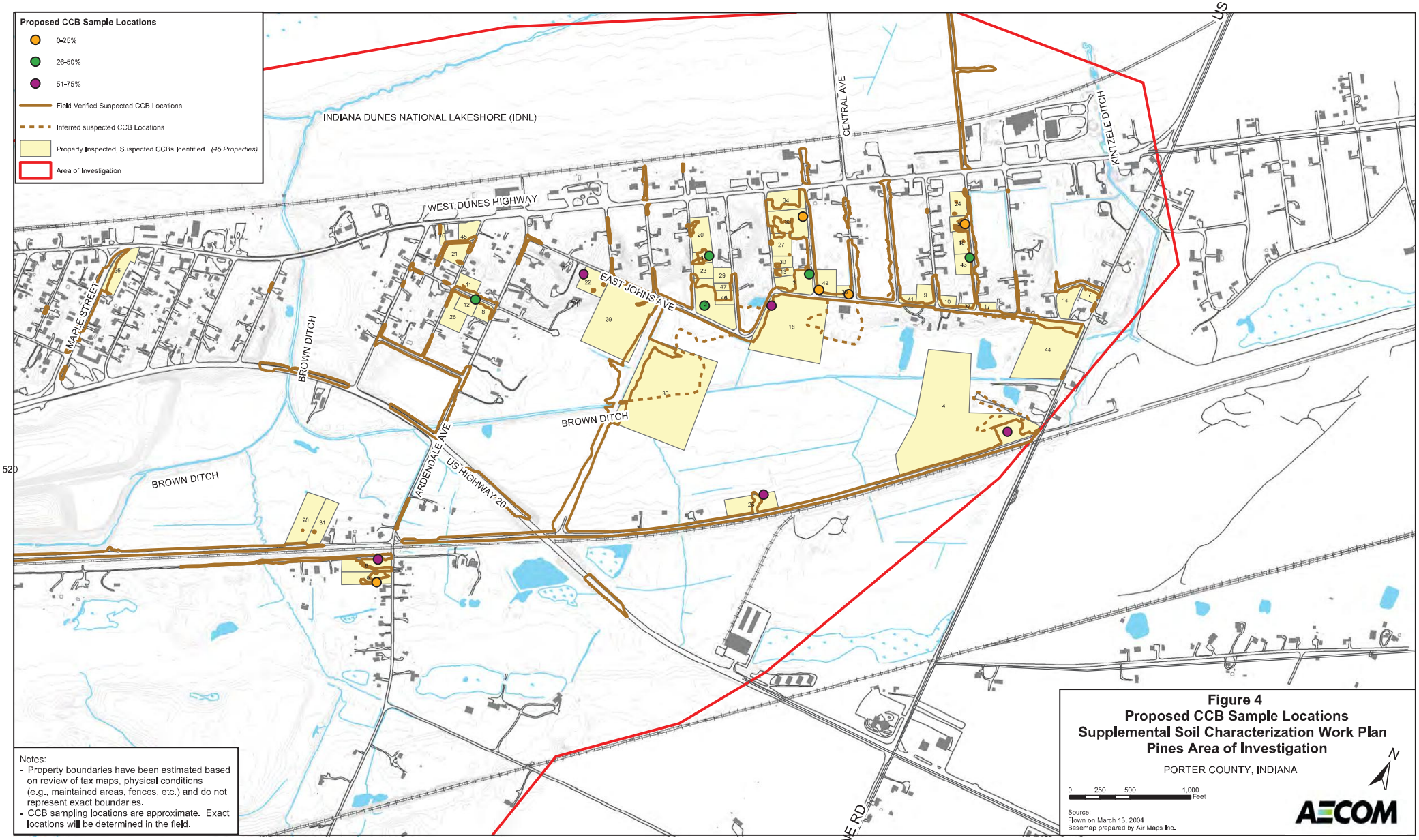

Figure 4
Proposed CCB Sample Locations
Supplemental Soil Characterization Work Plan
Pines Area of Investigation

PORTER COUNTY, INDIANA

2.2.1. Noblesville Generating Station Closure/Post-Closure Plan, Submitted to the Indiana Department of Environmental Management (IDEM), VFC #82582356 (Duke Energy Indiana, LLC, 2018)

https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=82581794&dDocName=82582356&Rendition=web&allowInterrupt=1&noSaveAs=1&fileName=82582356.pdf

Information about the Noblesville Generating Station was originally submitted in response to the August 2019 proposed rule. This document pertains to the Noblesville Generating Station and was accessed by EPA through the Indiana Department of Environmental Management (IDEM) "virtual cabinet" file management system. Pages 1-29 of the document are included here and pages 30-1,835, which contain technical data, are omitted. To access the full posting of the document, please use the link above.

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July 18, 2018

Hand Delivered

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Re: Proposed Site Closure Implementation Plan
Duke Energy Noblesville Generating Station
Hamilton County
Agreed Order Case No. 2017-24922-S
SW Program ID 84-UP-05

Dear Ms. O'Brien and Mr. Kreke

Duke Energy Indiana, LLC, respectively submits to the Indiana Department of Environmental Management (IDEM) the proposed closure/post closure plan for the Noblesville Generating Station. This plan has been prepared in accordance with the Agreed Order for the facility (Case No. 2017-24922-S) and the Noblesville Generating Station Compliance Plan submitted to IDEM on May 1, 2018. Three (3) hard copies and one (1) complete copy of the entire document on CD, in PDF format no greater than 100 megabytes per file, of the closure/post closure plan are enclosed with this letter.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for gathering the information, submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information.

If you have any questions or need additional information regarding this submittal, please contact Jim Thorp at Jim.Thorp@Duke-Energy.com (317) 838-1798.

Respectfully Submitted,

George T. Hamrick

George T. Hamrick
Senior Vice President

Attachment:	Closure Implementation Plan, Noblesville Generating Station, July 9, 2018
IDEM cc:	Daniela Klesmith, Leo Kurylo, Becky Joniskan
Duke Energy cc:	Skip Steele, Mark Foster, Jim Thorp, Tim Thiemann, Owen Schwartz, Rebecca Warren, Randy Hart

July 9, 2018

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Mr. George Hamrick
Senior Vice President
Coal Combustion Products
Duke Energy
400 South Tryon Street
Charlotte, NC 28202

Re: **Ash Management Areas - Closure Implementation Plan**
Noblesville Generating Station
Noblesville, Indiana 46062
ATC Project No. 170LF00498

Dear Mr. Hamrick:

In accordance with your request, ATC Group Services LLC (ATC) assisted Duke Energy Indiana, LLC with the preparation of the enclosed Ash Management Areas Closure Implementation Plan for the Noblesville Generating Station located in Noblesville, Indiana.

We appreciate the opportunity to be of assistance with this project. If you have any questions regarding this information, please contact our office.

Sincerely,
ATC Group Services LLC

John R. Noel, L.P.G.
Principal Geologist

Brent A. Miller, CHMM
Principal Scientist

Donald L. Bryenton, P.E.
Principal Engineer

LICENSED PROFESSIONAL GEOLOGIST
JOHN R. NOEL
No. 1681
STATE OF INDIANA

DONALD LEE BRYENTON
REGISTERED
№ 17877
STATE OF INDIANA
PROFESSIONAL ENGINEER

Closure Implementation Plan

July 9, 2018

Duke Energy Indiana, LLC
Noblesville Generating Station
21225 Riverwood Ave.
Noblesville, Indiana 46062

Agreed Order Case No.
2017-24922-S
Indiana Department of Environmental Management
and Duke Energy Indiana, LLC

Table of Contents

1.0 Introduction 1

2.0 Site Conditions 3

2.1 Regional Geologic and Hydrogeologic Setting 3

2.2 Site & Vicinity Geology and Hydrogeologic Setting 3

2.3 Observations of the Historic Materials on Site 4

2.4 On-site Drinking Water and Production Wells 5

2.5 Subsurface Investigations 5

2.5.1 1943 Geotechnical Investigation 5

2.5.2 Initial Ash Pile Soil Borings 5

2.5.3 Installation of Nested Monitoring Wells MW-1, MW-2, MW-3 and MW-4 6

2.5.4 Installation of Nested Monitoring Wells MW-5, MW-6, MW-7, MW-8, MW-9 and MW-10 7

2.5.5 Installation of Nested Monitoring Wells MW-11, MW-12, and MW-13 8

2.5.6 Installation of Nested Monitoring Wells MW-14, MW-15, MW-16, MW-17, and MW-18 9

2.5.7 Installation of Unconsolidated Monitoring Wells MW-19, MW-20, MW-21, MW-22, and MW-23 10

2.5.8 Ash Delineation Borings 10

2.5.9 Surface Visual Observations 11

2.5.10 Extraction Well Pilot Study 11

2.5.11 Geologic Cross Section Interpretation 12

2.5.12 Ash Delineation Cross Section Interpretation 13

2.6 Groundwater Sampling and Analysis 15

2.6.1 Groundwater Flow Directions 15

2.6.2 Groundwater Quality Summary 16

3.0 Proposed Closure Plans 18

3.1 Closure Plan 18

3.1.1 Summary of Existing Conditions 18

3.1.2 Proposed Closure Plan 18

3.1.3 Proposed Surface Water Control Plan 19

3.2 Proposed Groundwater Monitoring System 20

3.3 Financial Assurance for Closure and Post Closure Care 21

4.0 Proposed Implementation Schedule 22

5.0 Summary 23

Figures
Tables
Historic Photographs
Appendices

Appendix A: Closure Implementation Plan Drawings
Appendix B: Logs of Test Borings and Monitoring Wells
Appendix B1: 1943 Geotechnical Boring Logs
Appendix B2: 2015 Ash Stockpile Boring Logs
Appendix B3: Monitoring Well Boring Logs
Appendix B4: Ash Delineation Boring Logs
Appendix B5: Geotechnical Boring Logs
Appendix B6: Test Pit Logs and Cross Sections
Appendix B7: Hand Auger Logs
Appendix B8: Pump Test Logs
Appendix C: Monitoring Well Construction Diagrams
Appendix D: Water Well Records
Appendix D1: IDNR Water Well Records with UTM Coordinates
Appendix D2: IDNR Water Well Records without UTM Coordinates
Appendix D3: Private Water Wells Located by Mapping Grade GPS
Appendix E: Summary of Soil Laboratory Test Results
Appendix F: Summary of Monitoring Well Hydraulic Conductivity Test Results
Appendix G: Time Series Plots
Appendix H: Groundwater Analytical Summary Tables
Appendix I: Geotechnical Analyses of Consolidated Ash Pile
Appendix J: Stormwater System and Final Cover Erosion Calculations
Appendix K: Closure and Post-Closure Plan Cost Estimates
Appendix L: Quality Assurance Manual

1.0 Introduction

The Noblesville Station (Station), located in Noblesville, Indiana, operated coal-fired units from the early 1950s until it was converted to natural gas combined-cycle operations in 2003 (Figure 1). The site never wet-sluiced coal ash to any coal ash surface impoundments. Ash was handled dry and regularly placed on-site in two contiguous historic ash management areas (dry piles of ash), known as the Eastern Hill and the Northwest Mound, until around 1989 (Figure 2). After that time, the dry ash was managed by sending it off-site for beneficial reuse or placing it dry in the existing on-site process water ponds. At times the ash was also beneficially used on-site, for example, for structural fill for the creation of a construction lay down area. When the combined cycle units were built in 2003 and coal fired operations were ceased, all ash was dredged out of those process water ponds. These ponds continue to be operated as process water ponds today in accordance with the Station's NPDES permit.

In 2015, based upon the results of an internal environmental audit, Duke Energy voluntarily and proactively disclosed to IDEM the existence of the historic ash management areas at the Site. Duke Energy voluntarily installed on-site monitoring wells in conjunction with its investigation activities for the Station. In addition, Duke Energy voluntarily offered to sample many private drinking water wells in the area near Noblesville Station, and it has obtained samples from a number of the neighboring properties.

The results from on-site monitoring wells and off-site private drinking water sampling indicate the existence of boron at certain locations above what would be expected to be naturally occurring. Duke and IDEM determined that the historic ash management areas are the source of the elevated boron levels. Duke shared all of the private well sampling results with IDEM, the Indiana State Department of Health and the Hamilton County Health Department.

While there are no federal or Indiana regulations governing boron concentrations in groundwater or drinking water, the U.S. EPA has developed informal health advisory guidelines for boron in drinking water. While Duke Energy identifies a permanent alternate drinking water solution for residents with elevated boron, bottled water has been offered for potable use to property owners who have boron elevations near or above the most stringent EPA advisory guideline.

On January 31, 2018, Duke Energy and the IDEM entered into an Agreed Order related to the historic materials and potential/actual off-site impacts. The Agreed Order requires that:

> Within one hundred eighty (180) days of the Effective Date, Respondent shall submit three (3) hard copies and one (1) complete copy of the entire document on CD in PDF

> format no greater than 100 megabytes per file, of a closure/post closure plan for the Historic Ash Placement Areas at the site to IDEM for review and approval. This closure/post closure plan shall be in accordance with the provisions of 329 IAC 10-30 and 10-31 for Restricted Waste Sites, Type I, unless IDEM approves otherwise in writing.
>
> The closure/post closure plan shall include an implementation and completion schedule, including specific milestone dates.
>
> The closure/post closure plan shall include a proposal for financial assurance for closure and post closure care of the Historic Ash Placement Areas at the Site in accordance with 329 IAC 10-39. Within thirty (30) days after IDEM approves the closure/post-closure plan, Respondent shall demonstrate to IDEM financial assurance for closure and post closure care of the Historic Ash Placement Areas at the Site is in accordance with 329 IAC 10-39.

The purpose of this Closure Implementation Plan is to review the work that has been performed to date, and outline the proposed closure and post closure activities that will be performed to ultimately satisfy the requirements of the Agreed Order and achieve compliance for the Station.

2.0 Site Conditions

2.1 Regional Geologic and Hydrogeologic Setting

The Station is located at 21225 Riverwood Avenue, approximately 3 miles north of Noblesville, Indiana in Hamilton County. The Station is located in the Central Till Plain physiographic region of Indiana. The Central Till Plain is recognized as an area of "limited topographic diversity" that extends throughout central Indiana and into adjacent areas in Ohio and Illinois.

The Station and Hamilton County are located west of the axis of the Cincinnati arch in an area of the state where unconsolidated glacial deposits cover the former erosional surface formed on Paleozoic bedrock that dips gently to the southwest into the Illinois basin (Figure 3). The Silurian age Wabash Formation (Fm) underlies the unconsolidated glacial and alluvial deposits at the site. Silurian bedrock in Hamilton County consists predominately of limestone and dolomite. According to information available from Indiana's online Geologic Names Information System, the Wabash Fm occurs as four principal lithofacies: gray calcareous silty dolomite and dolomitic silty limestone; finely granular cherty limestone, dolomitic limestone, and dolomite; light tan to dark brown dolomite and dolomitic limestone; and light-colored granular massive vuggy, nearly pure dolomite and limestone and bluish-gray carbonate mudstone.

As shown on Figure 4, unconsolidated deposits classified as Wisconsinan undifferentiated outwash extend northeast to southwest along the White River corridor from the area of the Station. Unconsolidated materials over larger areas to the east and west of the White River corridor are identified as Wisconsinan loam till. Unconsolidated deposits are relatively thin in the northeast and east areas of the Station. Regionally, unconsolidated deposits thicken westward where they fill the valley formed on the erosional bedrock surface.

2.2 Site & Vicinity Geology and Hydrogeologic Setting

Well records located east of the Station along Riverwood Drive and in the Riverwood subdivision typically show six (6) to 32 ft of unconsolidated deposits overlying bedrock. The majority of logs show that unconsolidated deposits include clay and interbedded sand or sand and gravel overlying bedrock limestone. The wells in this area are typically cased through the unconsolidated materials and produce from bedrock. The eroded bedrock surface occurs at notably lower elevations north, west, and southwest of the Station. IDNR Water Well records located in areas to the north, west, and southwest typically exhibit much thicker deposits of unconsolidated material, and utilize that aquifer as a water source. The Approximate Top of Bedrock Surface contour map included as Sheet 7 in Appendix A shows posted elevations for the contact between bedrock and

overlying unconsolidated materials and shows, in map view, the relative bedrock high under the Station.

2.3 Observations of the Historic Materials on Site

The Station was coal-fired until its conversion to natural gas combined-cycle operations in 2003. Prior to that time, the Station managed its coal ash in various ways. The Station never wet-sluiced coal ash to any on-site impoundment. Rather, from the 1950s until about 1989, fly ash (at various times) and bottom ash were either transported from the Station's dry ash handling silos to two contiguous ash disposal areas on the northwest portion of the Station's property or sent off-site for beneficial reuse.

From the 1950s until sometime in the 1980s, small amounts of trash and other refuse (some originating from the Station and some from third parties) were disposed in the historic ash management areas (e.g., garbage, small pieces of equipment, and tires). Although all of these items were initially covered by the ash, some of the items have been subsequently exposed via erosion that has occurred over time. There is no information indicating that liquid waste was disposed in the historic ash management areas. The best evidence indicates that the practice of depositing small amounts of non-ash substances was likely discontinued when the Station retained a trash removal service in the 1980s.

At the time the Station ceased disposing ash in the historic ash management areas, some soil was placed over the ash (from a couple of inches up to two (2) feet in some locations), grass was sown, and trees were planted. At the time when the ash was deposited, there was no evidence that it caused any off-site groundwater or surface water impacts or posed any significant threat to human health or the environment. Historical photographs of the Station are included as an attachment to this report.

In addition to the Eastern Hill and the Northwest Ash Mound, the Station also placed ash as structural fill to provide parking and equipment storage areas in the West Structural Fill Area and to backfill the Former Coal Pile Area. The West Structural Fill Area is located west of the Station and received about 2 to 4 feet of ash structural fill to generate a relatively flat area and has been covered with geotextile and gravel to provide a functional surface. The Former Coal Pile Area is located immediately north of the Station and received up to about 8 to 12 feet of ash structural fill to backfill the area and promote surface drainage. The area is currently vegetated and maintained by the Station.

Ash can also be observed at several isolated areas north of the historic ash management areas. Specifically, it appears ash was placed along the north property boundary in three isolated areas identified as Ash Mound 1, Ash Mound 2 and Ash Mound 3 on Drawing No. 005 in Appendix A. It appears this material was possibly

staged for use to establish access along the northern property boundary but was never used. The mounds are currently vegetated with brush and small trees.

An ash/soil mixture is located on the north side of the ditch that is located north of the Northwest Ash Mound. It is likely that this ash/soil mixture was excavated from the ditch alignment during a previous dredging effort and included some ash that eroded from the Northwest Ash Mound. The area is currently vegetated with brush and trees.

Based on the results test borings, test pits, hand auger probes and general observations, the total volume of ash present within the ash management areas and the structural fill areas is estimated to be approximately 582,500 cubic yards as noted on Sheet 16 in Appendix A.

2.4 On-site Drinking Water and Production Wells

Currently, the Station is supplied by an on-site drinking water well (IDNR Well #49288) which was installed in 1993. This well replaced the previous drinking water well drilled in 1948 and properly abandoned in 2008. Both wells were completed in the Silurian Limestone bedrock beneath the site. The IDNR Water Well Records are included in Appendix D**.** As a part of the Station's compliance with 327 IAC 8-2, the drinking water well is routinely sampled to ensure that it meets the requirements of the U.S. EPA Safe Drinking Water Act. During past sampling required by IDEM, the analytical results did not indicate any impact from CCR material. However, since boron is not typically included in the list of parameters required for monitoring, in 2014 Duke Energy sampled the on-site drinking water and the two production wells for parameters typical of other Indiana facilities with coal-fired generation. The 2014 sampling results did not indicate any impact from the historic ash management area.

2.5 Subsurface Investigations

2.5.1 1943 Geotechnical Investigation

Twenty-six test borings were installed at the Site in 1943 as part of a geotechnical study related to construction of the generating station. Unconsolidated materials encountered generally consisted of a thin layer of cohesive materials to shallow limestone bedrock. The locations of the borings are shown on Sheet 6 in Appendix A. Boring logs are provided as a sheet in Appendix B.

2.5.2 Initial Ash Pile Soil Borings

As a part of an evaluation of the conditions of the pile in October 2015, four borings (B1 through B4) were advanced, two at the toe of the pile and two at the crest of the pile. B1 and B3 were at the crest and B2 and B4 were at the toe. The borings did not extend to

bedrock. Three of the borings were converted to piezometers to assess water elevation within and directly under the pile. When monitored, the piezometers were all dry.

2.5.3 Installation of Nested Monitoring Wells MW-1, MW-2, MW-3 and MW-4

Ten monitoring wells (MW-1S, MW-1I, MW-1D, MW-2S, MW-2I, MW-2D, MW-3S, MW-3I, MW-4S and MW-4D) were completed at four nested locations during the period July 19, 2016 through February 1, 2017 during initial subsurface investigation activities to obtain groundwater quality data in the bedrock aquifer along the east property boundary. The locations of the borings are shown on Sheet 6 in Appendix A.

Boreholes were advanced by Cascade Drilling utilizing a MiniSONIC drill rig and ancillary equipment. Continuous unconsolidated soil samples were collected using an 8-inch core barrel and 10-inch nominal rotasonic override casing. Continuous rock cores were drilled and collected in five (5) foot runs using PQ Diamond Coring drilling techniques.

The unconsolidated materials encountered generally consisted of cohesive sandy loams, loams, and loamy sands interbedded with sand and gravel deposits to bedrock. The underlying bedrock generally consists of a Silurian age competent unfractured to moderately fractured gray dolomite or limestone of the Wabash Fm, with fractured and weathered zones of stylolites, secondary mineralization, and pyrite filled vugs. Depths to competent bedrock along the eastern property boundary range from 6 feet below ground surface (bgs) at MW-4 to 28 feet bgs at MW-1. Rock Quality Designation (RQD) values range from 20% (very poor) to 100% (excellent) at MW-1, 71.7% (fair) to 90% (good) at MW-2, 51.7% (fair) to 100% (excellent) at MW-3, and 38.3% (poor) to 100% (excellent) at MW-4.

Based on field observations, visual inspections of the rock core, and double packer test results, three monitoring wells were completed at well cluster 1 (MW-1S, MW-1I, and MW-1D) and well cluster 2 (MW-2S, MW-2I, and MW-2D); and two wells were completed at well cluster 3 (MW-3S and MW-3I) and well cluster 4 (MW-4S and MW-4D). Shallow monitoring wells were screened in fractured or weathered bedrock zones ranging over depths of 17.5 feet to 51.0 feet bgs; intermediate wells were screened 54.0 feet to 86.4 feet bgs; and deep wells between 78.0 feet and 114.4 feet bgs. Boring logs and monitoring well construction diagrams are provided in Appendices B and C, respectively. Details of the monitoring well installation activities were provided under separate cover in ATC's *Bedrock Monitoring Well Installation Report* dated May 25, 2017 (IDEM VFC Document #80462846).

Representative soil samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits. The laboratory reports of all soil testing are provided in Appendix E. Where fractures are present within the bedrock, hydraulic conductivity values range from 0.0000146 to 0.000104 centimeters per

second (cm/s). The values of hydraulic conductivity (K) calculated for the packer tests are provided in Appendix F.

2.5.4 Installation of Nested Monitoring Wells MW-5, MW-6, MW-7, MW-8, MW-9 and MW-10

Fourteen monitoring wells (MW-5S, MW-5I, MW-5D, MW-6S, MW-6I, MW-6D, MW-7S, MW-7I, MW-7D, MW-8I, MW-8D, MW-9D, MW-10S, and MW-10I) were completed at six nested locations during the period December 20, 2016 through April 13, 2017 to investigate subsurface geology, preferential groundwater flow zones, and groundwater quality in the bedrock aquifer beneath the site. The locations of the borings are shown on Sheet 6 in Appendix A.

Boreholes were advanced by Layne Christensen utilizing a GeoProbe 8150LS drill rig with rotasonic capabilities and ancillary equipment. Continuous unconsolidated soil samples were collected in five (5) foot runs using an 8-inch core barrel and 10-inch nominal rotasonic override casing. Continuous rock cores were drilled and collected in 5 foot runs using PQ Diamond Coring drilling techniques.

Unconsolidated materials encountered generally consist of cohesive loam and sandy loam underlain by outwash sand and gravel deposits to bedrock. The underlying bedrock generally consists of a Silurian age competent unfractured to moderately fractured gray dolomite or limestone of the Wabash Formation, with fractured and weathered zones of stylolites, secondary mineralization, and pyrite filled vugs. Depths to competent bedrock at these locations range from 20 feet bgs at MW-6D to 102 feet bgs at MW-9D. RQD values range from 70% (fair) to 100% (excellent) at MW-5, 70% (fair) to 100% (excellent) at MW-6, 33% (poor) to 100% (excellent) at MW-7, 70% (fair) to 100% (excellent) at MW-8, 66% (fair) to 100% (excellent) at MW-9, and 68.3% (fair) to 100% (excellent) at MW-10.

Based on field observations, visual inspections of the rock core, and double packer test results, three monitoring wells were completed at well cluster 5 (MW-5S, MW-5I, and MW-5D), well cluster 6 (MW-6S, MW-6I, and MW-6D) and well cluster 7 (MW-7S, MW-7I, and MW-7D); two wells were completed at well cluster 8 (MW-8I and MW-8D) and well cluster 10 (MW-10S and MW-10I); and one well was completed at well location 9 (MW-9D). Shallow monitoring wells were screened in fractured or weathered bedrock zones ranging in depths of 32.5 feet to 77.0 feet bgs; intermediate wells were screened from 50.0 feet to 96.2 feet bgs; and deep wells between 77.5 feet and 120.4 feet bgs. Boring logs and monitoring well construction diagrams are provided in Appendices B and C, respectively. Details of the monitoring well installation activities were provided under separate cover in ATC's *Additional Bedrock Monitoring Well Installation Report* dated March 7, 2018 (IDEM VFC Document #pending).

Representative soil samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits. The laboratory reports of all soil testing are provided in Appendix E. Where fractures are present within the bedrock, hydraulic conductivity values range from 0.000103 to 0.00000735 cm/s. The values of hydraulic conductivity (K) calculated for the packer tests are provided in Appendix F.

2.5.5 Installation of Nested Monitoring Wells MW-11, MW-12, and MW-13

Eight monitoring wells (MW-11S, MW-11I, MW-11D, MW-12S, MW-12I, MW-12D, MW-13S, and MW-13I) were completed at three nested locations during the period February 20, 2017 through April 13, 2017 for investigation of groundwater quality in the unconsolidated material along the north property boundary of the site. The locations of the borings are shown on Sheet 6 in Appendix A.

Boreholes were advanced by ATC utilizing a Diedrich D-50 hollow stem auger drill rig with nominal 8.25 inch bore and 4.25 inch inside diameter. Continuous split spoon samples were collected in each boring. Two distinct soil lithologies were encountered along the northern property boundary of the Site. A fine grained upper unit ranging from 23 feet to 32 feet in thickness generally consists of a stiff cohesive silty loam. A course grained lower lithologic unit consists of dense fine grained sand to coarse outwash sand and gravel to bedrock. The amount of gravel in these former valley-fill outwash deposits is up to 50 percent, as indicated by grain size analysis results.

Based on depths to bedrock observed in the boreholes, three monitoring wells were completed at well cluster 11 (MW-11S, MW-11I, and MW-11D) and well cluster 12 (MW-12S, MW-12I, and MW-12D); and two wells were completed at well cluster 13 (MW-13S and MW-13I). Shallow monitoring wells were screened in saturated zones ranging over depths of 27.4 feet to 40.0 feet bgs; intermediate wells were screened from 46.2 feet to 65.2 feet bgs; and deep wells between 66.8 feet and 90.8 feet bgs. Boring logs and monitoring well construction diagrams are provided in Appendices B and C, respectively. Details of the monitoring well installation activities were provided under separate cover in ATC's *Unconsolidated Monitoring Well Installation Report* dated July 27, 2017 (IDEM VFC Document #80503593).

Representative soil samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits. The laboratory reports of all soil testing are provided in Appendix E. Results from single well slug tests performed on each well ranged from 0.00269 to 0.0218 cm/s. The values of hydraulic conductivity (K) calculated for the rising and falling head slug tests are provided as AQTESOLV® plots provided in Appendix F.

2.5.6 Installation of Nested Monitoring Wells MW-14, MW-15, MW-16, MW-17, and MW-18

Thirteen monitoring wells (MW-14S, MW-14I, MW-14D, MW-15S, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-17D, MW-18S, MW-18I, and MW-18D) were completed at five nested locations during the period June 5, 2017 through June 16, 2017 for investigation of groundwater quality in the unconsolidated material along the west property boundary of the site and around the northwest ash mound. The locations of the borings are shown on Sheet 6 in Appendix A.

Boreholes were advanced by ATC utilizing a Diedrich D-50 hollow stem auger drill rig with nominal 8.25 inch bore and 4.25 inch inside diameter. Continuous split spoon samples were collected in each boring. Two distinct soil lithologies were encountered along the western property boundary of the site. A fine grained upper unit ranging from 26 feet to 30 feet in thickness generally consists of a stiff cohesive silty loam. A coarse grained lower lithologic unit ranging from 30 feet to 70 feet in thickness generally consists of dense fine grained sand to coarse outwash sand and gravel to bedrock. The amount of gravel in these former valley-fill outwash deposits is up to 50 percent, as indicated by grain size analysis results.

Based on depths to bedrock observed in the boreholes, three monitoring wells were completed at well cluster 14 (MW-14S, MW-14I, and MW-14D), well cluster 16 (MW-16S, MW-16I, and MW-16D), well cluster 17 (MW-17S, MW-17I, and MW-17D) and well cluster 18 (MW-18S, MW-18I, and MW-18D). Due to auger refusal near well cluster 15, a single monitoring well was completed as MW-15S. Shallow monitoring wells were screened in saturated zones ranging in depths of approximately 27 to 45 ft bgs; intermediate wells were screened from approximately 44 to 70 ft bgs; and deep wells between 59 and 95 ft bgs. Boring logs and monitoring well construction diagrams are provided in Appendices B and C, respectively. Details of the monitoring well installation activities were provided under separate cover in ATC's *Unconsolidated Monitoring Well Installation Report* dated December 27, 2017 (IDEM VFC Document #80583105).

Representative soil samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits. The laboratory reports of all soil testing are provided in Appendix E. Results from hydraulic conductivity testing performed on each well ranged from 0.00030 to 0.02719 cm/s. The values of hydraulic conductivity (K) calculated for the rising and falling head slug tests are provided as AQTESOLV® plots provided in Appendix F.

2.5.7 Installation of Unconsolidated Monitoring Wells MW-19, MW-20, MW-21, MW-22, and MW-23

Five monitoring wells (MW-19, MW-20, MW-21, MW-22, and MW-23) were completed during the period November 13, 2017 through January 11, 2018 for investigation of groundwater quality in the unconsolidated material around the two surface impoundments at the Site. The locations of the borings are shown on Sheet 6 in Appendix A.

Boreholes were advanced by ATC utilizing a Diedrich D-50 hollow stem auger drill rig with nominal 8.25 inch bore and 4.25 inch inside diameter. Continuous split spoon samples were collected in each boring. Soil lithologies encountered generally consisted of a cohesive silty loam unit ranging from 4 feet to 8 feet in thickness underlain by sand and gravel deposits ranging from 0 feet to 25 feet in thickness at MW-22 and MW-23, respectively, to carbonate bedrock.

Monitoring wells MW-19, MW-20, and MW-23 were screened in saturated zones ranging in depths of approximately 8.7 to 31.2 ft bgs; monitoring wells MW-21 and MW-22 were screened in an unsaturated zone immediately above the bedrock interface and range in depths of approximately 6.2 to 12.2 ft bgs. Boring logs and monitoring well construction diagrams are provided in Appendices B and C, respectively. Details of the monitoring well installation activities were provided under separate cover in ATC's *Unconsolidated Monitoring Well Installation Report* dated March 12, 2018 (IDEM VFC Document #80628226).

Representative soil samples were collected and tested for grain size and hydrometer analysis, cation exchange capacity, and Atterberg limits. The laboratory reports of all soil testing are provided in Appendix E. Results from hydraulic conductivity testing performed on each well ranged from 0.0050 to 0.1167 cm/s. The values of hydraulic conductivity (K) calculated for the rising and falling head tests are provided as AQTESOLV® plots provided in Appendix F.

2.5.8 Ash Delineation Borings

Eighty-seven (87) soil borings, geotechnical borings, test pits, and hand augers were completed in and around the Northwest Ash Mound, Eastern Hill, West Structural Fill Area, and former railroad alignment by ATC between January 22, 2018 and February 15, 2018 to delineate the vertical and horizontal extent of coal ash at the site. Twelve (12) additional soil borings were completed in the vicinity of the former coal pile and an adjacent former railroad alignment between March 26 and March 28, 2018. The testing locations and the approximate ash area boundaries are shown on Sheet 14 in Appendix A.

Six (6) soil borings, 7 geotechnical borings, 22 hand augers, and 10 test pits were completed in and around the Northwest Ash Mound. Three (3) soil borings, two (2) hand augers, and fourteen (14) test pits were completed in and around the Eastern Hill. Fourteen (14) test pits were completed in and around the Western Structural Fill Area. Six (6) hand augers were completed in the area associated with the north end of the former railroad alignment, and three (3) soil borings were advanced in the area north of the primary pond. Soil borings ranged from 16 feet to 30 feet in depth. Geotechnical borings ranged from 30 feet to 67.5 feet in depth. Test pits ranged from 3 feet to 12.7 feet in depth. Hand augers were limited to the upper 5 feet of surface material. Soil boring logs and monitoring well construction diagrams are provided in Appendices B and C, respectively.

2.5.9 Surface Visual Observations

In March, 2017 ATC field personnel conducted a site walk to visually assess the surficial extents of the Northwest Ash Mound and Eastern Hill and identify surface features north of the Northwest Ash Mound and Eastern Hill. The surface soil delineation included visual observations and photo documentation of isolated piles of coal ash on the surface prior to spring-time vegetative foliage to optimize visual identification of surface soil material. A hand-held GPS unit was used to verify field points on a site map. In addition, visual inspections of the elevated grade of the former railroad spur identified the presence of bottom ash. The locations and extent of isolated surface ash piles in the northern portion of the Site are depicted on Sheet 5 in Appendix A.

2.5.10 Extraction Well Pilot Study

Duke Energy is proposing to utilize a system of groundwater extraction wells to limit the migration of groundwater off-site. The groundwater extracted by this system will be discharged to the White River under the Station's National Pollutant Discharge Elimination System (NPDES) permit (IN0002801).

To assist with the design of the extraction well system, an extraction well pilot test was performed. On February 5-6, 2018, ATC Group Services, LLC installed one extraction well and three observation wells for a pilot test. The extraction well was constructed with a six-inch diameter Schedule 80 PVC casing with a 0.010-inch slotted, wire-wrapped stainless steel screen from 45 to 65 feet below ground surface. The zone around and approximately two feet above the screen was backfilled either with unconsolidated sediments that cave into the boring when the drill string was removed or with granular material supplied by the driller. The upper one to two feet of the filter pack consists of fine, inert sand. The remainder of the well casing was backfilled with bentonite grout. The observation wells were installed using hollow-stem augers and constructed with one-inch diameter Schedule 40 PVC casing with a 0.010-inch slotted screen from 45 to 65 feet below ground surface. The observation wells were placed approximately five, 25 and 100 feet from the extraction well. Boring logs and monitoring

well construction diagrams from the installation of the extraction well and observation piezometers are included in Appendices B and C, respectively.

An 8-hour, constant discharge test with a pumping rate of 85 gallons per minute was conducted on the extraction well on February 10, 2018. Groundwater extracted during the development of the wells and during the test was containerized in frac tanks onsite for disposal. Pressure transducers were utilized to collect water level data throughout the test. The recorded data were transferred to AQTESOLV® software to create displacement versus time plots. For this investigation, the collected data were analyzed using the Moench analytical model for unconfined aquifers. Transmissivities ranged from 138.6 to 145.2 cm^2/sec. For a saturated aquifer thickness of 36 feet, the transmissivity translates to $1.3x10^{-1}$ to $1.8x10^{-1}$ cm/s hydraulic conductivity. AQTESOLV® plots for the pilot test are provided in Appendix F.

2.5.11 Geologic Cross Section Interpretation

An interpretation of the site geology, bedrock depth, and groundwater monitoring zones is included on the set of six (6) geological cross sections provided on Sheets 8 - 13 in Appendix A. The Approximate Top of Bedrock Surface contour map shows posted elevations for the contact between bedrock and overlying unconsolidated materials and shows, in map view, the relative bedrock high under the generating station. The bedrock surface is relatively shallow to the east and slopes west under much of the historic ash management area.

Cross section A runs from the northwest corner of the Site generally along the northern property boundary to the present day White River channel. The northern portion of the Site is underlain by a fine grained upper unconsolidated cohesive loam or clay unit ranging from 20 feet to 30 feet in thickness. A coarse grained lower unconsolidated unit generally consisting of dense fine grained sand to coarse outwash sand and gravel ranges from 35 feet at the northeastern property line to 80 feet in thickness to bedrock along the northwestern property line. The eroded limestone bedrock surface dips significantly towards the west near the east property boundary. IDNR Water Well records located east of the Site along Riverwood Drive and in Riverwood subdivision typically show 6 to 32 ft of unconsolidated deposits overlying bedrock.

Cross section B runs from the north-central portion of the western property boundary across the north-central portion of the Site, through the Northwest Ash Mound, the Eastern Hill, and the northern surface impoundment to the Riverwood Subdivision east of the Site. Subsurface conditions across the north-central portion of the Site generally identify a fine grained upper unconsolidated cohesive loam or clay unit at least 40 feet in thickness along the western property boundary and thins towards to the east. Apparent discontinuous sand and gravel lenses exist throughout the cohesive material. A coarse grained unconsolidated unit generally consisting of dense fine grained sand to

coarse outwash sand and gravel underlies the cohesive unit along the western portion of the Site. IDNR Water Well record 49177 located east of the Site in the Riverwood Subdivision indicates less than10 ft of unconsolidated deposits overlying bedrock. In areas where bedrock occurs at elevations greater than 760 ft MSL, such as location MW-6D, valley fill outwash sand and gravel is thin or absent and granular deposits are dry or hydraulically isolated from the unconsolidated groundwater monitoring zone at well clusters MW-11 through MW-18.

Cross section C runs west to east through the south-central portion of the Site, through the Northwest Ash Mound, West Structural Fill Area, and former coal pile area, eastward to the White River channel. Subsurface conditions are consistent with the rest of the Site. However, the outwash sand and gravel aquifer is absent from the south-central portion of the Site eastward due to a thick sequence of cohesive material overlying a bedrock high.

Cross section D runs west to east through the southern portion of the Site to the White River channel. Subsurface conditions across the southern portion of the Site typically include 30 feet of fine-grained unconsolidated deposits typically described as sandy loam or clay. The limestone bedrock dips significantly to the west to depths of 80 feet at the western property boundary. Similar to cross section C, the outwash sand and gravel aquifer is absent from the south-central portion of the Site eastward due to a thick sequence of cohesive material overlying a bedrock high.

Cross section E runs north to south through the western portion of the Site, including the Northwest Ash Mound. Subsurface conditions across the western portion of the Site include 20 to 30 feet of fine-grained unconsolidated deposits described as sandy loam or clay underlain by a thick course grained unconsolidated unit generally consisting of dense fine grained sand to coarse outwash sand and gravel to bedrock. The depth to the eroded bedrock surface ranges from 70 to 100 feet along the western portion of the property. The presence of coal ash is discussed in Section 2.5.13 below.

Cross section F runs north to south through the eastern portion of the Site, including the two surface impoundments and the former coal pile area. Subsurface conditions across the eastern portion of the Site include a thin fine-grained cohesive unit underlain by a thin coarse-grained non-cohesive unit generally consisting of dense fine grained sand to coarse outwash sand and gravel to bedrock. The depth to bedrock ranges from 20 to 30 feet along the eastern portion of the property. The presence of coal ash in the former coal pile area is discussed in Section 2.5.13 below.

2.5.12 Ash Delineation Cross Section Interpretation

The information obtained from 99 soil borings, geotechnical borings, test pits, and hand augers, visual observations of the exposed materials, and a review of the historic photographs and site development plans was utilized to estimate the horizontal and

vertical limits of the Northwest Ash Mound, Eastern Hill, West Structural Fill Area, former railroad alignment, and former coal pile area. The approximate horizontal limits of each of the areas are provided on Sheet 5 in Appendix A. The testing locations and the approximate ash area boundaries are shown on Sheet 14 in Appendix A. Six (6) ash inventory cross sections are provided on Sheets 17 - 20 in Appendix A.

In general, the subsurface investigations revealed 0 to 25 feet of coal ash underlain by a 10 to 40 ft layer of unconsolidated loam or clay. At most locations the test borings revealed 35 to 80 ft of dense fine-grained sand to coarse outwash sand and gravel underlying the fine-grained cohesive soils. However at some locations the granular soils are absent and the fine-grained cohesive soils are underlain directly by limestone bedrock. The depth to bedrock across the site ranges from approximately 10 to 110 feet.

Cross section A runs north to south through the middle of the Northwest Ash Mound. Coal ash in the northern portion of the Northwest Ash Mound ranges in thickness from 10 feet to over 20 feet at the north end to up to 25 feet at the south end of the mound. The Northwest Ash Mound is underlain by a fine grained upper unconsolidated cohesive loam or clay. A coarse grained lower unconsolidated unit generally consisting of dense fine grained sand to coarse outwash sand and gravel ranges from 35 feet at the northeastern property line to 80 feet in thickness to bedrock along the northwestern property line. The contact between overlying coal ash and underlying cohesive silt loam is interpreted as the former natural ground surface. This surface slopes from south to north under the Northwest Ash Mound.

Cross section B runs north to south between the Northwest Ash Mound and the Eastern Hill, and continues south through the West Structural Fill Area. Coal ash in the area between the Northwest Ash Mound and the Eastern Hill ranges in thickness from 1 to 7 feet and is underlain by a fine grained upper unconsolidated cohesive loam or clay unit. A loamy fill material ranging from 1 to 5 feet in thickness covers the layer of coal ash in this area. Test pits completed within the Western Structural Fill Area indicate 1 to 4 feet of coal ash overlain by a geotextile membrane and less than a foot of coarse stone. The West Structural Fill Area is underlain by a fine grained upper unconsolidated cohesive loam or clay unit.

Cross section C runs west to east through the northern part of the Northwest Ash Mound and Eastern Hill. Coal ash in the northern portion of the Northwest Ash Mound ranges in thickness from 25 feet on the western edge to 13 feet on the eastern edge. Coal ash in the northern portion of the Eastern Hill ranges in thickness from 1 to 6 feet. The northern portion of the Northwest Ash Mound is underlain by up to 40 feet of fine grained unconsolidated cohesive loam or clay. Discontinuous sand lenses are present within the cohesive unit. A loamy fill material ranging from 1 to 5 feet in thickness covers portions of the Eastern Hill.

Cross section D runs west to east through the central portions of the Northwest Ash Mound and Eastern Hill and terminates near the western edge of the north surface impoundment. Coal ash in the central portion of the Northwest Ash Mound ranges in thickness from 16 feet on the western edge to 10 feet on the eastern edge. Coal ash in the area between the Northwest Ash Mound and the Eastern Hill is approximately 5 feet in thickness. Coal ash in the central portion of the Eastern Hill ranges in thickness from 4 to 6 feet and is covered by a loamy fill material ranging from 4 to 7 feet in thickness. The Northwest Ash Mound and Eastern Hill are underlain by a fine grained unconsolidated cohesive loam or clay unit.

Cross section E runs west to northeast through the southern portion of the Northwest Ash Mound and the northern portion of the West Structural Fill Area. Coal ash in the southern portion of the Northwest Ash Mound ranges in thickness from 20 feet on the western edge to less than 10 feet on the eastern edge. Test pits completed within the northern portion of the Western Structural Fill Area indicate approximately four feet of coal ash overlain by a geotextile membrane and less than a foot of coarse stone. The northern portion of the West Structural Fill Area is underlain by a thick unit of fine grained unconsolidated cohesive loam or clay.

Cross section F runs from the southwest edge to the east-central edge of the Former Coal Pile Area. Coal ash present in the former coal pile generally ranges from 2 to 11.5 feet thick and is underlain by fine grained unconsolidated cohesive loam or clay or unconsolidated sand. Up to a foot of coal is still present under the coal ash along the eastern edge of the Former Coal Pile Area.

2.6 Groundwater Sampling and Analysis

2.6.1 Groundwater Flow Directions

Groundwater flow maps showing groundwater elevation contours for the unconsolidated aquifer and the bedrock aquifer are provided as Figures 6 and 7, respectively.

In the unconsolidated zone (Figure 6), interpretations of the groundwater flow regime on the eastern portion of the site were aided by the recent installation (November 2017) of five monitoring wells (MW-19 through MW-23) that are screened in the overburden. As expected, flow in this portion of the aquifer is consistent with the regional pattern toward the White River.

With the expanded monitoring well network, the expected radial flow from site sources is confirmed. Additionally, the distribution of elevated detections of boron and sulfate confirm this flow regime, along with a pump test that was conducted near the southwestern corner of the site on February 10, 2018. The aquifer in this portion of the site has a saturated thickness of approximately 36 ft with a computed hydraulic

conductivity of approximately 375 ft/d. A second pump test was recently performed on the northern boundary of the site to assist in understanding the flow and unconsolidated aquifer parameters in that portion of the site. Details of the second pump test will be submitted under separate cover.

The complex nature of the local hydrogeology is particularly evident in the southeast corner of the site. While the water level in MW-22 was not detected (dry) as shown in Figure 6, well logs from the site production wells indicate a 6-7 feet of overburden material. Recorded water levels in these wells during the time of drilling combined with the estimated stage of the White River (~ EL 765), suggest that the groundwater flow in the unconsolidated aquifer overlying bedrock exists. Additional well/piezometer installations could be used to confirm in future sampling events.

Figure 7 is a groundwater flow map of the shallow bedrock aquifer. The unconsolidated and bedrock aquifers at the site are in good hydraulic connection as evidenced by the minimal head differences in locations where well clusters are screened in each zone (e.g., MW-5 (bedrock) and MW-19 (shallow unconsolidated); MW-6 (bedrock) and MW-20 (shallow unconsolidated)).

2.6.2 Groundwater Quality Summary

The current groundwater monitoring system at the Station consists of 24 bedrock monitoring wells (MW-1S, MW-1I, MW-1D, MW-2S, MW-2I, MW-2D, MW-3S, MW-3I, MW-4S, MW-4D, MW-5S, MW-5I, MW-5D, MW-6S, MW-6I, MW-6D, MW-7S, MW-7I, MW-7D, MW-8I, MW-8D, MW-9D, MW-10S, and MW-10I), and 26 monitoring wells which are screened in unconsolidated materials (MW-11S, MW-11I, MW-11D, MW-12S, MW-12I, MW-12D, MW-13S, MW-13I, MW-14S, MW-14I, MW-14D, MW-15S, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-17D, MW-18S, MW-18I, MW-18D, and MW-19 through MW-23). In addition to the monitoring wells, samples are collected and analyzed from one onsite drinking water well (DW), two onsite production wells (PW Well North and PW Well South), and two onsite surface water impoundments (SM and NW).

Groundwater samples are collected quarterly at Noblesville Station. Initial groundwater quality samples were collected in October 2016 from nested bedrock well locations MW-1, MW-2, MW-3, and MW-4. These wells were resampled in November 2016. Additional bedrock monitoring wells at locations MW-5, MW-6, MW-7, MW-8, MW-9, and MW-10 and additional unconsolidated wells at nested locations MW-11, MW-12, and MW-13 were added to the groundwater monitoring network for the March 2017 sampling event. Nested unconsolidated well locations at MW-14, MW-15, MW-16, MW-17, and MW-18 were added for the June 2017 quarterly event, and wells MW-19, MW-20, MW-21, MW-22, and MW-23 were added for the March 2018 sampling event.

Groundwater quality results have been submitted to IDEM in prior reports following each sampling event.

Groundwater samples are tested for 64 metals and water quality parameters specified in the August 2017 groundwater sampling and analysis plan. Metals investigation includes testing for both total metals and dissolved metals.

Based on monitoring results, groundwater quality in bedrock is unaffected by the historic ash management areas. With the exception of dissolved and total arsenic, bedrock groundwater quality results do not exceed Environmental Protection Agency (EPA) drinking water maximum contaminant levels (MCLs). Parameters such as aluminum, iron, manganese, sulfate, and total dissolved solids that exceed EPA secondary maximum contaminant levels are naturally occurring in groundwater and are interpreted to reflect normal groundwater quality in the Silurian carbonate bedrock aquifer. Many metals tested as both total and dissolved parameters are either not detected or are detected rarely in bedrock monitoring wells. Metals such as total aluminum, total arsenic, and total manganese are detected more frequently in unfiltered samples suggesting that suspended solids affect water quality analytical results.

Total and dissolved arsenic are detected in bedrock monitoring wells MW-1S, MW-1I, MW-2S, MW-5S, and MW-10S above the EPA drinking water MCL. Arsenic is a naturally occurring element and the presence of arsenic in bedrock groundwater samples is interpreted to reflect dissolution of sulphide minerals that contain arsenic in association with iron. Total arsenic exceedances of the MCL in bedrock wells MW-1I and MW-2S are not matched by dissolved arsenic concentrations suggesting that suspended solids impose a high bias at these two well locations.

Based on testing results from wells screened in unconsolidated deposits overlying bedrock, groundwater quality is good with respect to drinking water MCLs. As with wells screened in bedrock, a few unconsolidated wells have total arsenic concentrations that exceed the MCL, including MW-11S, MW-12S, and MW-17S. Dissolved arsenic at these monitoring locations is less than the MCL suggesting that turbidity and suspended solids are affecting total arsenic analytical concentrations.

Groundwater quality results from on-site monitoring wells screened in unconsolidated deposits and off-site private drinking water wells indicate the existence of boron at concentrations that are greater than expected for natural groundwater. There are no federal or Indiana regulations addressing boron concentrations in groundwater. The highest boron concentrations occur in nested wells closest to the Northwest Ash Mound at well nests MW-16 and MW-14.

3.0 Proposed Closure Plans

The findings of the site investigations described in the preceding section were utilized to define the limits of the historic ash management areas. As outlined in the following sections of this plan, the Facility will be closed in accordance with 329 IAC 10-4 utilizing closure methods approved by the Commissioner.

3.1 Closure Plan

3.1.1 Summary of Existing Conditions

In general, the majority of the approximately 23 acres within the Northwest Mound and the Eastern Hill are currently vegetated with brush and trees. The approximately 10 acres of the West Structural Fill Area are generally covered with gravel and currently utilized for equipment/vehicle parking and material storage. The approximately 2.5 acres of the Former Coal Pile Area is generally grass covered. The majority of the approximately 0.8 acre ash/soil mixture area located north of the Northwest Mound and the approximately 0.4 acre area occupied by three mounds of ash located along the northern boundary of the property are generally vegetated with brush and trees.

It is noted that an 8 to 12 inch diameter active gas line, which supplies the Noblesville Generating Station, crosses both the Eastern Hill and the West Structural Fill Area. The presence of this gas line will have an impact on the closure options in these areas. The approximate limits of all of these areas and the gas line, are noted on Sheet 25 in Appendix A.

3.1.2 Proposed Closure Plan

In general, CCR materials present in the Eastern Hill, the West Structural Fill Area, the Former Coal Pile Area, the Ash/Soils Mixture Area (north of the Northwest Ash Mound), and the three isolated Ash Mounds along the northern property line will be removed and placed to form one consolidated ash management area within the general footprint of the Northwest Ash Mound. In addition, approximately 150 ft of the southern end of the Northwest Ash Mound will be excavated and moved into the consolidated area. Due to the presence of the existing gas line, it will be necessary to leave an approximately 10 ft wide strip of CCR materials on either side of the gas line. Details regarding the closure of this strip are outlined below. The total volume of CCR materials scheduled to be moved to the consolidated ash management area is currently estimated to be approximately 245,500 cubic yards.

When encountered during the consolidation process, municipal waste (e.g., garbage, small pieces of equipment and tires) will be isolated and disposed of off-site in a municipal landfill. Minor amounts of construction debris (e.g., gravel, concrete, etc.) currently on-site in the historic ash management area will be consolidated on-site with the CCR material in a manner that will not compromise the final cover system.

The proposed final grading of the consolidated ash management area consists of 4H:1V slopes up to approximately EL 837. The proposed top of the consolidated ash management area then slopes at a 3 percent slope up to a peak of approximately EL 840. The proposed consolidated ash management area occupies an area of approximately 16 acres. The proposed final cover system for the consolidated ash management area consists of a 6 inch layer of cohesive soil structural fill, a textured geomembrane, a geocomposite drainage layer, a 30 inch layer of uncompacted protective soils and a 6 inch vegetative layer. The 30 inch layer of protective soils will consist of 12 inches of soil (i.e., granular or cohesive) overlain by 18 inches of cohesive soils.

The proposed grading plan for the final cover of the consolidated pile is illustrated on Sheet 25 in Appendix A. Results of the slope stability and settlement analyses performed on the consolidated ash management area are provided in Appendix I. The results of the geotechnical investigation indicate that the factors of safety relative to long-term static, seismic and end-of-construction slope stability all exceed the required minimums. Further, the settlement analyses estimate post-construction settlement at approximately 2 inches.

The proposed final cover system over and adjacent to the active gas line consists of a 2 ft cohesive soil layer and a 1 ft vegetative layer. Due to safety concerns relative to working along the active gas line it will not be possible to compact the cohesive soils with a sheepsfoot or brickfoot compactor. Rather, the 2 ft cohesive soil layer will be placed in one lift with the surface of the material compacted with a dozer as the material is spread. The proposed cover soils will be sloped to drain with a minimum slope of 2% and a maximum slope of 33%. As noted on Sheet 27 in Appendix A, the gas line final cover corridor will extend approximately 10 ft beyond the side of the pipe and then transition down to meet the surrounding final grade on an ~3H:1V slope.

The areas scheduled for excavation will be visually inspected to document that all visible CCR materials have been removed. The resulting subgrade will generally be graded to establish a minimum slope of 2% and a maximum slope of 33% prior to conditioning the exposed soil and placing a 1 ft vegetative layer. The majority of the 1 ft vegetative layer is anticipated to be imported from an offsite source.

The proposed Quality Assurance Manual that will be utilized during these closure activities is provided in Appendix L.

3.1.3 Proposed Surface Water Control Plan

Details of the surface water control system to be utilized both during construction and following closure will be submitted to the Hamilton County officials for review and approval prior to the start of construction. In general, the plan will include the construction of sedimentation/detention basins at the locations noted on the drawings.

These basins will receive contact water during the consolidation of the CCR materials. The contact water will be filtered as needed and discharged through an existing NPDES outfall.

Following the placement of the final cover systems, the base of the basins will be excavated to remove all visible CCR materials. The basins will then serve as detention basins to receive runoff from the consolidated pile. Calculations regarding the surface diversion berms and downdrain pipe proposed for the consolidated ash management area are provided in Appendix J. Details of the proposed drainage ditches and sedimentation/detention basins will be provided upon request following approval of the designs by Hamilton County.

3.2 Proposed Groundwater Monitoring System

The current groundwater monitoring system at the Site consists of 24 bedrock monitoring wells (MW-1S, MW-1I, MW-1D, MW-2S, MW-2I, MW-2D, MW-3S, MW-3I, MW-4S, MW-4D, MW-5S, MW-5I, MW-5D, MW-6S, MW-6I, MW-6D, MW-7S, MW-7I, MW-7D, MW-8I, MW-8D, MW-9D, MW-10S, and MW-10I), and 26 monitoring wells which are screened in unconsolidated materials (MW-11S, MW-11I, MW-11D, MW-12S, MW-12I, MW-12D, MW-13S, MW-13I, MW-14S, MW-14I, MW-14D, MW-15S, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-17D, MW-18S, MW-18I, MW-18D, and MW-19 through MW-23). In addition to the monitoring wells, samples are routinely collected and analyzed from one onsite drinking water well (DW), two onsite production wells (PW Well North and PW Well South), and two onsite surface water impoundments (SM and NW). The existing groundwater monitoring system is shown on Sheets 4 and 5 of Appendix A.

Additionally, twelve (12) monitoring wells and four (4) piezometers were proposed in a Work Plan submitted to IDEM on May 29, 2018. The proposed monitoring wells consist of six (6) bedrock monitoring wells, six (6) monitoring wells screened in unconsolidated materials, and four (4) piezometers screened in unconsolidated materials. The proposed additional monitoring wells and piezometers are shown on Sheets 4 and 5 of Appendix A.

As the monitoring network is being established at the site, Duke Energy and IDEM have agreed that the network will be sampled quarterly. Surface and groundwater sampling will be conducted in accordance with the Sampling and Analysis Plan (SAP) and results submitted to the IDEM quarterly. Sampling information and procedures such as field observations, purging techniques, sample collection techniques, decontamination techniques, sample bottles and preservatives, laboratory analytical results, QA/QC, and Chain-of- Custody protocols will be documented during each groundwater monitoring event and will be submitted in a report to the IDEM. The samples will be analyzed for

the parameters listed in the SAP, unless an alternate list is agreed upon by both Duke Energy and the IDEM.

If samples cannot be collected in a specific quarter due to weather or other unanticipated developments, then the IDEM will be notified within seven (7) days of the end of the quarter and an additional sampling event will be conducted during the subsequent quarter, if possible.

3.3 Financial Assurance for Closure and Post Closure Care

Duke Energy will utilize the Financial Test Option to meet the requirements of 329 IAC 10-39. Closure and post closure plan cost estimates are provided in Appendix K.

4.0 Proposed Implementation Schedule

This Closure Implementation Plan provides the conceptual plans for the closure of the historic ash management areas. Once IDEM approves these conceptual plans it will be necessary to develop additional details necessary for the completion of construction drawings and technical specifications. Based on this progression of events, Duke Energy proposes the implementation schedule provided in the table below.

ANTICIPATED MILESTONES; DEPENDING UPON PERMITTING FACTORS

Activity	**Proposed Timeline**
Submittal of Closure Implementation Plan (CIP)	July 30, 2018
Meeting with IDEM Following Initial Review of CIP	On or about September 30, 2018
	Proposed Months After IDEM Approval
Rule 5 Storm Water Pollution Prevent Plan	3
Prepare 401/404 Application	4
Prepare NPDES Permit Modification	4
Prepare Construction Specifications and Drawings	6
Bid Event and Contact Award	7
Begin Site Preparation	9
Begin Construction	12
Complete Closure Construction	30

After approval of the Closure Implementation Plan from IDEM, additional permits will be evaluated and applied for prior to initiating construction activities. Based on the current scope of the closure plan, it is anticipated that the following permits will be required for the project: IDEM Rule 5 Construction Storm Water Pollution Prevention Plan, wetland disturbance under ACOE 404/IDEM 401, and possible modification to the storm water requirements of the site's IDEM NPDES individual permit.

5.0 Summary

The purpose of this Closure Implementation Plan is to present the results of work performed to date and to describe the proposed closure activities that will be performed to achieve compliance for the Facility and with the Agreed Order. Concurrent with the review of this plan and the development of associated construction drawings/specifications, Duke Energy will continue regular sampling of the monitoring well network at the facility. The results of these sampling events will be submitted to IDEM on a schedule agreed upon by Duke Energy and IDEM. Additionally, updates of the Closure Implementation Plan progress will be submitted to IDEM on a schedule agreed upon by Duke Energy and IDEM in a separate submittal.

Duke Energy looks forward to IDEM's review and comments regarding this proposed Closure Implementation Plan. At IDEM's convenience, Duke Energy is available to meet with IDEM representatives to discuss potential revisions to this plan.

2.2.2. Noblesville Generating Station Closure/Post-Closure Additional Information, Submitted to IDEM, VFC #82679884) (Duke Energy Indiana, LLC, 2019)

https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=82679004&dDocName=82679884&Rendition=web&allowInterrupt=1&noSaveAs=1&fileName=82679884.pdf

Information about the Noblesville Generating Station was originally submitted in response to the August 2019 proposed rule. This document pertains to the Noblesville Generating Station and was accessed by EPA through the Indiana Department of Environmental Management (IDEM) "virtual cabinet" file management system. Pages 1-14 of the document are included here and pages 15-125, which contain technical data, are omitted. To access the full posting of the document, please use the link above.

CLOSURE IMPLEMENTATION PLAN
RAI RESPONSE

JANUARY 10, 2019

DUKE ENERGY INDIANA, LLC
NOBLESVILLE GENERATING STATION
21225 RIVERWOOD AVE.
NOBLESVILLE, INDIANA 46062

Agreed Order Case No.
2017-24922-S
Indiana Department of Environmental Management
and Duke Energy Indiana, LLC

George T. Hamrick
Senior Vice President
Coal Combustion Products

400 South Tryon Street, ST06A
Charlotte, NC 28202

Phone: 980-373-8113
Email: george.hamrick@duke-energy.com

January 22, 2019

Hand Delivered

Debbie O'Brien, Enforcement Case Manager
Office of Land Quality
Indiana Department of Environmental Management
100 North Senate Avenue
Indiana polis IN 46204-2251

John Hale, Permit Manager
Indiana Department of Environmental Management
Solid Waste Permits
IGCN 1101
100 North Senate Avenue
Indianapolis, IN. 46204-2251

Re: Response to Request for Additional Information
Proposed Site Closure Implementation Plan
Duke Energy Noblesville Generating Station
Hamilton County
Agreed Order Case No. 2017-24922-S
SW Program ID 84-UP-05

Dear Ms. O'Brien and Mr. Hale

Duke Energy Indiana, LLC, received a letter from the Indiana Department of Environmental Management (IDEM) dated November 27, 2018 concerning their review of our proposed closure/post closure plan for the Noblesville Generating Station submitted on July 18, 2018. The letter identified additional information and/or changes that were needed to allow IDEM to continue their review. The attached clarifications and additional information demonstrate our compliance with state and federal rules and our commitment to work constructively with IDEM as we safely close ash basins.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for gathering the information, submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information.

If you have any questions or need additional information regarding this submittal, please contact Jim Thorp at Jim.Thorp@Duke-Energy.com (317) 838-1798.

Respectfully Submitted,

George T. Hamrick
Senior Vice President

Attachment:	Closure Implementation Plan RAI Response, Noblesville Generating Station, January 10, 2019
IDEM cc:	Mugdha Priyadarshini, Leo Kurylo, Amy McClure
Duke Energy cc:	Mark Foster, Jim Thorp, Tim Thiemann, Owen Schwartz, Rebecca Warren, Randy Hart

January 10, 2019

ATC Group Services LLC

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Mr. George Hamrick
Senior Vice President
Coal Combustion Products
Duke Energy
400 South Tryon Street
Charlotte, NC 28202

Re: Closure Implementation Plan RAI Response
Noblesville Generating Station
Noblesville, Indiana 46062
ATC Project No. 170LF0498

Dear Mr. Hamrick:

In accordance with your request, ATC Group Services LLC (ATC) assisted Duke Energy Indiana, LLC (Duke Energy) with the preparation of a response to the Request for Additional Information (RAI) issued by IDEM on November 27, 2018.

We appreciate the opportunity to assist you with this project. If you have any questions concerning information contained in this report, please contact our office.

Sincerely,

ATC Group Services LLC

Charles Dewes, P.E., CFM, CESSWI
Project Engineer

John R. Noel, L.P.G
Principal Geologist

DONALD LEE BRYENTON
REGISTERED
Nº
17877
STATE OF
INDIANA
PROFESSIONAL ENGINEER

Donald L. Bryenton, P.E.
Principal Engineer

RAI Response

To maintain clarity, the items identified in the RAI Engineering and Geology Enclosures have been reproduced herein in bold italics followed by our responses.

ENGINEERING ENCLOSURE

Please address the following comments developed from an engineering review of your Closure Implementation Plan (the Plan), received on July 18, 2018:

1. ***Section 3.1.3 (page 20) of the Plan discusses sedimentation/detention basins that will receive contact water during consolidation of the coal combustion residual (CCR) materials. Keeping this in mind please respond to the following questions:***

   a. ***The contact water will be filtered as needed and discharged through an existing NPDES outfall. Please state how the contact water be filtered.***

      Erosion control measures such as silt fences and rock check dams will be used to help minimize the transport of sediment from areas disturbed during the closure activities. The entire project area will drain to the temporary wet (retention) sediment retention basins noted on the drawings, where further sediment control will occur. Water which flows from the temporary sediment basins will discharge to the White River through an NPDES monitored outfall.

   b. ***The Plan also mentions that after placement of final cover systems, the base of the basins will be excavated to remove all visible CCR material. Please specify where this CCR material will be disposed of.***

      To the extent possible, the removal of CCR materials from the temporary wet sediment basins will be staged to allow at least a portion of that material to be placed in the Consolidated Ash Management Area. CCR materials removed from the temporary wet sediment basins following completion of the final cover in the Consolidated Ash Management Area will be transported off-site to a permitted landfill. Following removal of the CCR materials from the temporary wet sediment basins, soil structural fill will be placed to form the base of the permanent dry detention basins.

2. ***Drawing 005 (Appendix A) shows the presence of a rectangular structural fill area east of Ash Mound 3. The report and Plan do not describe any excavation of the materials from that area. Please state if that area has any CCR material and, if so, please update your plans and design to show the same. Please discuss plans for closing this area.***

   CCR materials present in the noted rectangular structural fill area were lawfully placed in that location as structural fill along the former railroad that previously

serviced the Noblesville Generating Station for coal fired generation. See Ind. Code 13-19-3-3. This corridor is still utilized to maintain the 12-inch gas main, installed following removal of the rail line, to supply the current gas-fired generation. Currently, there are no plans to disturb or modify this beneficial reuse area due to the presence of the gas line. Because this beneficial use area is not located within the footprint of the historic ash management area at issue in the Agreed Order, it is not included in the proposed Closure Implementation Plan

3. ***Cross section F shown in Drawing 006 (Section Line passes through SB13, SB15, and SB18) and Drawing 013 (Section Line passes through SB14, SB17, and SB20) are different. Please make appropriate changes in the cross section.***

   The alignment for Cross Section F has been revised on Drawing 006 to be consistent with the alignment noted on Drawing 013. A revised copy of Drawing 006, renamed Drawing 006R1, is included in Appendix A of this document.

4. ***Drawing 026 (Appendix A) shows the components of the final cover for the Consolidated Ash Management Areas. Please address the following for each of these items:***

   a. ***Six inches structural fill layer: Specify the type and classification of soil.***

      The 6 inch layer of soil structural fill will generally consist of cohesive-like soils which fall into the following Unified Soil Classification groups: CH, CL-CH, CL, ML-CL, ML, SC and SM-SC.

   b. ***Geotextile/Geonet Composite: Specify if the geotextiles are bonded to one side or both sides of the geonet.***

      The geotextiles will be bonded to both sides of the geonet to form the geocomposite.

5. ***As per the Proposed Closure Plan (Section 3.1.2 of the Report), the two-foot cohesive soil cover for the proposed final cover over and adjacent to the gas line will not be compacted due to safety reasons. Instead, the two-foot cohesive soil layer will be placed in one lift with the surface of the material compacted with a dozer as the material is spread. IDEM recommends spreading the cohesive soil in one-foot lifts with a minimum number of passes. Please discuss if this can be an acceptable course of action for the area in question.***

   Due to safety restrictions associated with the presence of the live gas line, it will not be possible to place the cover soils in 1 ft compacted lifts. The soil cover materials for the area over and adjacent to the gas line will be placed as originally described prior to seeding.

6. ***Drawing 027 shows the Typical Gas Line Cover. The Quality Assurance Manual (Appendix L) does not include any information regarding construction of the gas line cover. Please provide a construction quality assurance plan for the gas line cover. State if clay soil will be used for the final cover. Also, include the procedures for verification of the following:***

   Section 5.0 of the Quality Assurance Manual has been revised to include the construction of the soil cover over the gas line. As noted in the revised plan, the soil cover over the gas line will consist of cohesive-like soils that are classified as CH, CL-CH, CL, ML-CL, ML, SC and SC-SM in accordance with the Unified Soil Classification System. The updated Quality Assurance Manual is provided in Appendix A of this document.

   Field survey data will be obtained at a maximum spacing of 100 ft to document the elevation of the subgrade prior to placement of the cover soils and again following placement of the cover soils to verify that the total thickness of the soil layer and the vegetative layer is a minimum of 3 ft.

   a. ***Clay cover thickness***

      See response above.

   b. ***Vegetative cover thickness***

      See response above.

7. ***Please describe erosion and sedimentation controls that will be provided during excavation activities.***

   The Storm Water Pollution Prevention Plan will be submitted to Hamilton County for review and approval prior to the start of construction activities associated with the closure of the ash management areas. This detailed plan will outline the use of erosion control measures which will include silt fence, rock check dams, straw wattles and temporary wet sediment retention basins.

8. ***Please provide a dust control plan for the excavation and construction activities.***

   The construction specifications will require the Contractor to provide dust control to meet all Site, Local, State and Federal requirements for controlling fugitive dust at all times, including weekends and holidays. A water truck will be required onsite at all times to assist in dust control as a part of this plan. Further, the Contractor will be required to apply and maintain commercial dust control materials (such as Soil-Sement or Eco-Flex) on an as-needed basis.

9. ***Please provide a detailed description on the screening, staging, handling, and storage methods you will use until final disposal for other solid waste, potentially hazardous waste, and leachate encountered during the excavation.***

   The construction specifications will require the contractor to isolate non-CCR materials such as municipal waste, tires, appliances, abandoned vehicles, etc., when encountered during the excavation and consolidation of the CCR materials. Observations for these materials will also be made by Duke Energy and its consultants on an on-going basis during the construction activities. Ash will generally be removed from the non-CCR materials isolated during the closure activities prior to placing these materials in dumpsters and transported off-site to a permitted landfill. Waste identified as potentially hazardous will be segregated pending characterization for proper disposal. Based on the results of test borings performed to date, we do not anticipate encountering any leachate during excavation activities.

10. ***Please provide the following for the areas proposed to be excavated:***

    a. ***A plan showing the proposed final grade and contours after the completion of excavation and backfilling.***

       Drawing 022 has been revised to show the final cover grading plan for both the Consolidated Ash Management Area and the areas where CCR materials will be removed. The revised plan is renamed Drawing 022R1 and is provided in Appendix B of this document.

    b. ***Information regarding the following: The Plan states the areas excavated will be visibly inspected to document that all CCR material have been removed. What is the verification procedure to ensure that all CCR material was removed? IDEM recommends removal of two feet of soil underneath the CCR material to ensure complete removal.***

       The visual inspections will be performed under the direction of a registered professional engineer. Each visual inspection will include photographs and daily reports to document the removal of CCR material from the inspected area. Further, the horizontal and vertical limits of each inspection area will be documented by a licensed surveyor.

       The closure activities do not include the removal of any of the soils that will remain following the removal of the CCR materials. This additional removal is not planned since the overall compliance plan for the facility includes the use of a groundwater extraction system to control migration of any impacted groundwater from the site.

    c. ***A description of surface water run-off control and erosion control after the completion of the project.***

The surface water run-off control system will consist of a series of diversion berms, downdrain pipes, perimeter ditches and permanent dry detention basins, as noted in the Drawings provided with the Closure Implementation Plan. The locations of these features have been updated on Sheet 025R1 in Appendix D. The surface water run-off and erosion control plan will be submitted to Hamilton County for review and approval prior to the start of the closure activities.

11. ***The geotechnical analysis of the Consolidated Ash Pile (Appendix I) seems to have been intended for a compacted clay cover system. Whereas, the information in the Plan, Appendix A, Appendix K, Appendix L, etc. provides information for a geomembrane liner cover system. Please clarify which type of cover system will be used and make necessary changes.***

    The final cover system over the Consolidated Ash Management Area will consist of a geomembrane, geocomposite drainage layer and a total of 3 ft of protective soils. The stability analyses submitted with the Closure Implementation Plan provided documentation of the global stability of the proposed Consolidated Ash Management Area. Additional analyses are provided in Appendix B of this report to document the stability of the composite final cover system. The geomembrane liner was not included in Appendix I of previous submittal was because conservative strata profiles were adopted for stability analyses. The cover system which includes geomembrane liner and compacted clay will be used.

12. ***Section 6 d. (Appendix I) mentions possibly using Lime-Kiln-Dust (LKD) to stabilize existing soil before placing the structural fill. To use LKD as soil amendment you must obtain a separate beneficial use approval from the Office of Land Quality, Industrial Compliance Section.***

    Any Lime Kiln Dust (LKD) utilized during the closure activities for this project will be a commercial product consistent with similar amendments utilized by INDOT on highway projects and by developers on commercial projects. The LKD utilized on this project is not a byproduct of operations at the Noblesville Generating Station. Therefore, it is our understanding that it will not be necessary to obtain a separate beneficial use approval for this application.

13. ***Section 6.e (Appendix I) recommends performing field density tests on each lift of structural fill to ensure adequate compaction (structural fill should be compacted to a dry density of at least 95% of the standard proctor maximum density). Please clarify if this refers to the CCR structural fill, soil structural fill, or both.***

    This reference is to soil structural fill. CCR materials placed in the Consolidated Ash Management Area will be placed as follows:

CCR materials placed in the Consolidated Ash Management Area at locations in excess of 5 ft below the base of the final cover elevation will be placed in two foot lifts (maximum) and compacted with a minimum of two passes (back and forth equals one pass) of a smooth drum compactor.

CCR materials placed in the Consolidated Ash Management Area at locations within 5 ft of the base of the final cover will be placed in one foot lifts (maximum). The required number of passes of the compaction equipment will be established by the construction of a test pad prior to the start of the earthwork phase of the project.

14. ***Section 4.2 (Appendix L) indicates a test pad will be constructed to determine the minimum number of passes needed to achieve proper density, and that no tests will be performed on the CCR materials placed as structural fill (except the test pad area). However, Section 6.e (see comment #13 above) recommends each lift of structural fill will be field tested for density. The Quality Assurance Manual does not mention to what density the CCR material will be compacted. Please clarify these discrepancies.***

    Please note IDEM recommends placement of CCR material more than five feet below the final cover subgrade in lifts two feet thick and compacted with normal construction traffic and a minimum of two passes (up and back equals one pass) of a smooth drum roller or as determined by the test pad. The CCR structural fill placed within the five feet of the final cover subgrade should be placed in one-foot thick lifts and compacted to 85% of a standard proctor maximum dry density.

    As noted in the response to Item 13, the project specifications will require soil structural fill be placed in lifts compacted to a minimum of 95% of the standard Proctor maximum dry density. The project specification will further require CCR materials to be placed as follows:

    CCR materials placed in the Consolidated Ash Management Area at locations in excess of 5 ft below the base of the final cover elevation will be placed in two foot lifts (maximum) and compacted with a minimum of two passes (back and forth equals one pass) of a smooth drum compactor.

    CCR materials placed in the Consolidated Ash Management Area at locations within 5 ft of the base of the final cover will be placed in one foot lifts (maximum). The required number of passes of the compaction equipment will be established by the construction of a test pad prior to the start of the earthwork phase of the project.

    This additional information is included in the revised Quality Assurance Manual provided in Appendix A of this document.

15. Please provide additional information for the following items in the Quality Assurance Manual:

a. To what density will the soil structural fill be compacted?

95% of the standard Proctor maximum dry density.

b. What procedure will be followed to test and confirm the density of the soil structural fill? How often will this test be performed?

Field density testing will be performed on the soil structural fill at a frequency of not less than four tests per acre per lift.

This additional information is included in the updated Quality Assurance Manual provided in Appendix A of this document.

16. Please update the following in Appendix K (Closure and Post Closure Plan):

a. Section VI. A., the Notation of Property Deed ($10,000.00) does not seem to be added in the Total Cost (Section VI. C).

The Notation of the Property Deed has been added to the Total Cost. The updated Closure and Post-Closure Cost Estimate is provided in Appendix C of this document.

b. There is no cost estimated for the final cover which is over and adjacent to the gas line.

The cost of the final cover over and adjacent to the gas line was inadvertently included in the cost for placement of 12 inches of vegetated cover over the estimated 22.5 acre area where CCR materials will be removed. This oversight has been corrected in the updated Closure and Post-Closure Cost Estimate provided in Appendix C. The closure cost has been revised to account for 21.5 acres where the 12 inch vegetated cover will be placed and 1 acre where a total of 3 ft of soil cover will be place over and adjacent to the gas line.

17. Please add to the Plan a statement closure certification documentation will be prepared to document establishment of cover and completion of the closure activities and submitted to IDEM for approval. Please include the following for the certification documentation:

a. A legal description of the Consolidated Ash Management Area.
b. Environmental Restrictive Covenant

The updated Closure Plan included in Appendix C includes a statement that the closure certification document will include a legal description of the Consolidated

Ash Management Area and a copy of the Environmental Restrictive Covenant.

18. ***Based on the Interceptor Well System Conceptual Design (dated May 30, VFC #82550841), Extraction Well 2 is designed to be situated in the Northwest Ash Mound and Extraction Well 6 is designed to be situated in between Ash Mound 1 and Ash Mound 2. What measures will be taken to protect the wells and the pipeline during and after closure excavation and backfilling activities. Also, discuss how these wells will affect the backfill and vegetative cover.***

    The locations of the extraction wells have been added to the updated final grading plan (Drawing 022R1) included in Appendix D. As noted in this drawing, Extraction Well 2 was installed in an area where CCR materials were present. Prior to the installation of that extraction well, the CCR materials were consolidated into the larger pile in anticipation of closure activities. The limits of the Consolidated Ash Management Area do not extend to the location of Extraction Well 2.

    As noted, Extraction Well 6 is in close proximity to the northeast corner of Ash Mound 1. Precautions will be taken when removing existing CCR materials from this area during the closure operations.

    Based on the depth of these extraction wells, no negative impact is anticipated regarding the vegetative cover in these areas. In the event that any impact is noted, a gravel pad will be installed to replace the vegetative cover.

GEOLOGY ENCLOSURE

Please address the following comments developed from a geology review of your Closure Implementation Plan (the Plan), received on July 18, 2018:

1. ***The Plan uses the same names for different cross-sections contained within the Plan. For efficient reviews and to help avoid confusion in the future, the facility should use different cross-section names for the geologic cross–sections, ash inventory/delineation cross-sections, and engineering cross-sections. However, it is not necessary to revise cross-section names currently in the Plan.***

   This request is noted and will be addressed during the preparation of any future Closure Implementation Plans.

2. ***Section 2.6.1 of the Plan refers to ground water monitoring wells MW-19 through MW-23, and specifically mentions MW-22. The Plan states that Figure 6 shows the wells, in addition to all the other wells screened in the unconsolidated aquifer. However, MW-22 does not appear on Figure 6. The facility needs to revise the Plan accordingly.***

   MW-22 was dry at the time of gauging and therefore was not used in the contouring of the groundwater flow map. A revised version of Figure 6 that shows well MW-22 is attached in Appendix E.

3. ***Section 3.2 of the Plan states that Sheets 4 and 5 show the existing ground water monitoring system, in addition to the proposed additional monitoring wells detailed in the Monitoring Well Work Plan dated May 29, 2018 (VFC #82552684). Sheets 4 and 5 do not show any monitoring wells. The Plan shows the existing monitoring well network on Sheets 6 and 15, and on Figures 6 and 7. The Plan does not contain any figures or sheets showing locations of the proposed additional monitoring wells detailed in the May 2018 monitoring well work plan. Please revise the Plan to correct these inconsistencies.***

   As correctly noted above, the existing monitoring well network is shown on Sheets 6 and 15, and on groundwater flow figures. Please note, Sheet 6 has been revised in response to Engineering Enclosure comment # 3. The revised version is attached in Appendix D. Locations of proposed unconsolidated and bedrock monitoring wells and proposed piezometers are shown on Drawing No. 014 in Appendix A of the July 18, 2018 Closure Implementation Plan.

Appendices

Appendix A – Updated Quality Assurance Manual

Appendix B – Final Cover Slope Stability Calculations

Appendix C – Updated Closure and Post-Closure Cost Estimate

Appendix D – Updated Drawings

- Drawing No. 006R1
- Drawing No. 022R1
- Drawing No. 025R1

Appendix E – Revised Figure 6: Groundwater Flow Map – Unconsolidated Aquifer

2.2.3. Noblesville Generating Station Closure Plan Addendum 1, Submitted to IDEM, VFC #82755832 (Duke Energy Indiana, LLC, 2019)

https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=82756027&dDocName=82755832&Rendition=web&allowInterrupt=1&noSaveAs=1&fileName=82755832.pdf)

Information about the Noblesville Generating Station was originally submitted in response to the August 2019 proposed rule. This document pertains to the Noblesville Generating Station and was accessed by EPA through the Indiana Department of Environmental Management (IDEM) "virtual cabinet" file management system. Pages 1-7 of the document are included here and pages 8-35, which contain technical data, are omitted. To access the full posting of the document, please use the link above.

George T. Hamrick
Senior Vice President
Coal Combustion Products

400 South Tryon Street, ST06A
Charlotte, NC 28202

Phone: 980-373-8113
Email: george.hamrick@duke-energy.com

April 18, 2019

Hand Delivered

Debbie O'Brien, Enforcement Case Manager
Office of Land Quality
Indiana Department of Environmental Management
100 North Senate Avenue
Indiana polis IN 46204-2251

John Hale, Permit Manager
Indiana Department of Environmental Management
Solid Waste Permits
IGCN 1101
100 North Senate Avenue
Indianapolis, IN. 46204-2251

Re: Addendum No. 1
Proposed Site Closure Implementation Plan
Duke Energy Noblesville Generating Station
Hamilton County
Agreed Order Case No. 2017-24922-S
SW Program ID 84-UP-05

Dear Ms. O'Brien and Mr. Hale

During a meeting between Duke Energy Indiana, LLC, and the Indiana Department of Environmental Management (IDEM) on March 26, 2019, it was identified that revisions would be required for the closure/post closure plan for the Noblesville Generating Station submitted on July 18, 2018, and supplemented via letter dated January 22, 2019. These revisions were necessary to allow IDEM to continue their review. The attached addendum 1 to the Noblesville closure plan demonstrates our compliance with state and federal rules and our commitment to work constructively with IDEM as we safely close ash basins.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for gathering the information, submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information.

If you have any questions or need additional information regarding this submittal, please contact Jim Thorp at Jim.Thorp@Duke-Energy.com (317) 838-1798.

Respectfully Submitted,

George T. Hamrick
Senior Vice President

Attachment:	Closure Implementation Plan Addendum No. 1, Noblesville Generating Station, April 18, 2019
IDEM cc:	Mugdha Priyadarshini, Leo Kurylo, Amy McClure
Duke Energy cc:	Mark Foster, Jim Thorp, Tim Thiemann, Owen Schwartz, Rebecca Warren, Randy Hart

CLOSURE IMPLEMENTATION PLAN
ADDENDUM NO. 1

APRIL 18, 2019

DUKE ENERGY INDIANA, LLC
NOBLESVILLE GENERATING STATION
21225 RIVERWOOD AVE.
NOBLESVILLE, INDIANA 46062

Agreed Order Case No.
2017-24922-S
Indiana Department of Environmental Management
and Duke Energy Indiana, LLC

April 18, 2019

ATC Group Services LLC

7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256

Phone **+1 317 849 4990**
Fax +1 317 849 4278

www.atcgroupservices.com

Mr. George Hamrick
Senior Vice President
Coal Combustion Products
Duke Energy
400 South Tryon Street
Charlotte, NC 28202

Re: Closure Implementation Plan
Addendum No. 1
Noblesville Generating Station
Noblesville, Indiana 46062
ATC Project No. 170LF0498

Dear Mr. Hamrick:

In accordance with your request, ATC Group Services LLC (ATC) assisted Duke Energy Indiana, LLC (Duke Energy) with the preparation of Addendum No. 1 to the Closure Implementation Plan for the Noblesville Generating Station. This information provided as a follow-up to a meeting with IDEM's technical staff on March 26, 2019.

We appreciate the opportunity to assist you with this project. If you have any questions concerning information contained in this report, please contact our office.

Sincerely,

ATC Group Services LLC

Martin Brungard, P.E., D.WRE
Senior Project Engineer

John R. Noel, L.P.G
Principal Geologist

DONALD LEE BRYENTON
REGISTERED
№ 17877
STATE OF INDIANA
PROFESSIONAL ENGINEER

Donald L. Bryenton, P.E.
Principal Engineer

The following information is provided as a follow-up to a meeting with IDEM's technical staff on March 26, 2019. To maintain clarity, a general description of the items which were discussed during the meeting are identified in bold italics followed by our responses.

ENGINEERING ISSUES

1. ***Provide a description of the design of the proposed drainage ditches and sedimentation/detention basins upon approval by Hamilton County.***

   Duke Energy agreed to provide this information following receipt of approval from Hamilton County.

2. ***Sheet 022R1 (Final Cover Grading Plan) and Sheet 025R1 (Surface Water Drainage Plan) indicated certain sections of the Consolidated Ash Management Area which lie outside the approximate boundary of the Historic Ash Management Area. These sections are also encroaching on wetlands. Please provide a plan that depicts all ash will be consolidated within the approximate boundary of the Historic Ash Management Area.***

   The limits of the Consolidated Ash Management Area have been modified to eliminate the placement of ash outside the historic ash boundary. Drawings which have been revised to reflect this modification are provided in Appendix B. Due to the revision to the final cover grading plan, the Closure and Post-Closure Cost Estimates have been revised accordingly. The revised cost estimates are provided in Appendix A.

3. ***Section K of the Closure/Post-Closure Cost Estimate (Appendix C) indicates that the cost for 1 acre is $88,288.39. This amount would appear to be adequate if the final cover over and adjacent the gas line cover would include 2 feet cohesive soil and 6 inch vegetative layer. As per the plan submitted to IDEM, the gas line cover consists of 2 feet cohesive soil and 12 inch vegetative layer. Please update the plan to resolve this discrepancy.***

   The requested modifications to the Closure and Post-Closure Cost Estimates are included in Appendix A.

4. ***Sheet 025R1 shows a gravel parking lot in the Approximate Ash Boundary. Please provide the following:***

   a. ***Update the Closure/Post-Closure Cost Estimate to reflect this information.***

      The updated cost estimates are provided in Appendix A. The revisions to the cost estimates are based on the reuse of gravel removed from existing parking areas and placed to form the new parking area.

b. A Maintenance Plan for the gravel parking lot.

The updated Post-Closure Cost Estimate includes an allowance for the maintenance of the gravel parking lot.

GEOLOGY ISSUES

1. ***IDEM's Geology Section indicated that information provided in the RAI Response dated January 22, 2019 was adequate with regard to hydrogeologic concerns. However, several requests were made regarding proposed modifications to the format of Ground Water Monitoring Reports submitted for the Noblesville Station.***

   Duke Energy agreed to modify the format of the Ground Water Monitoring Reports as requested.

Appendices

Appendix A – Updated Closure and Post-Closure Cost Estimates

Appendix B – Updated Drawings

- Drawing No. 022R2
- Drawing No. 023R1
- Drawing No. 024R1
- Drawing No. 025R2

2.2.4. Noblesville Generating Station Closure/Post-Closure Approval and Requirements from IDEM, Sent to Duke Energy Indiana, LLC, VFC #82851197 (IDEM, 2019)

https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=82852192&dDocName=82851197&Rendition=web&allowInterrupt=1&noSaveAs=1&fileName=82851197.pdf

Information about the Noblesville Generating Station was originally submitted in response to the August 2019 proposed rule. This document pertains to the Noblesville Generating Station and was accessed by EPA through the Indiana Department of Environmental Management (IDEM) "virtual cabinet" file management system. The document is included here, but to access the original posting of the document, please use the link above.

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
We Protect Hoosiers and Our Environment.
100 N. Senate Avenue • Indianapolis, IN 46204
(800) 451-6027 • (317) 232-8603 • www.idem.IN.go

Eric J. Holcomb
Governor

Bruno L. Pigott
Commissioner

October 17, 2019

Duke Energy Indiana, LLC
Attn: George T. Hamrick
400 South Tyron Street
Charlotte, North Carolina 28202

Dear Mr. Hamrick:

Re: Approval of Closure/Post-Closure Plan
Duke Noblesville Generating Station
Closure Implementation Plan
Hamilton County
SW Program ID 29-UP-01

Duke Energy Indiana, LLC's closure and post-closure plan for the Duke Noblesville Generating Station Ash Management Area is approved under 329 IAC 10 and the Agreed Order in IDEM Case No. 2017-24922-S. This approval is contingent upon compliance with the closure and post-closure plans referenced in this document, and the enclosed requirements.

The disposal site is located at 21225 Riverwood Avenue in Noblesville and contains approximately 38.5 acres, of which 16 acres will be closed in-place. Ash will be removed from approximately 22 acres and placed in the 15 acre Consolidated Ash Management Area to be closed in-place.

Public records for your facility are available in IDEM's Virtual File Cabinet at www.in.gov/idem. Documents related to this approval include the closure/post-closure plan dated July 18, 2018 (VFC #82582356), and supplemental information dated January 10, 2019 (VFC #82679884), and April 18, 2019 (VFC #82755832).

This approval does not: convey any property rights of any sort or any exclusive privileges; authorize any injury to any person or private property or invasion of other private rights or any infringement of federal, state, or local laws or regulations; or preempt any duty to comply with other state or local requirements.

If you wish to appeal this decision, you must file a request for administrative review with the Office of Environmental Adjudication within 18 days after the postmark of this letter. The enclosed guidance provides information on the appeal process and your rights and responsibilities for filing an adequate and timely appeal.

If you have any questions, please contact Anna Mishel, the Permit Manager assigned this facility, by dialing (317) 233-6725 or by e-mail at Amishel@idem.IN.gov.

Sincerely,

Rebecca Eifert Joniskan

Rebecca Eifert Joniskan, Chief
Permits Branch
Office of Land Quality

Enclosures: Approval Requirements
Guidance on How to Appeal IDEM Decision

cc with enclosures Hamilton County Health Department
Hamilton County Commissioners
Hamilton County Solid Waste Management District
Mayor, City of Noblesville

CLOSURE AND POST-CLOSURE APPROVAL REQUIREMENTS

A. General Requirements

B. Closure Requirements

C. Post-Closure Requirements

D. Ground Water Monitoring Requirements

E. Financial Responsibility for Closure and Post-Closure

F. Compliance Schedule Requirements

A. GENERAL REQUIREMENTS

A1. The owner or operator must comply with 329 IAC 10 except where alternative specifications or requirements are noted in approved plans or this permit.

A2. The owner or operator must close and maintain the facility as described in the approved plans and specifications in the document titled "Proposed Site Closure Implementation Plan," dated July 18, 2018 (VFC #82582356), the requirements of this approval, and the following submittals:

a. The response to request for additional information dated January 10, 2019 (VFC #82679884)
b. Document dated April 18, 2019 (VFC #82755832, Addendum No. 1)

A3. The owner or operator must request approval from IDEM before modifying the approved closure and post-closure requirements and procedures by submitting a proposal (including revised plans or drawings if applicable) as specified in Requirement A5.

A4. The owner or operator must call **(888) 233-7745** (IDEM's emergency response line) as soon as possible after learning of any event that may cause an imminent and substantial endangerment to human health or the environment, such as a reportable spill (327 IAC 2-6.1) or a fire or explosion that requires the response of the local fire department.

The owner or operator must follow up by sending a written report to the Solid Waste Permits Section at the address given in Requirement A5 within 5 business days after the event. The report must describe the event, and actions taken or planned to correct the event and prevent its recurrence.

A5. Unless otherwise noted, submittals must be sent to the permit manager assigned your facility at the following address:

Indiana Department of Environmental Management
Office of Land Quality
Solid Waste Permits Section
IGCN 1101
100 North Senate Avenue
Indianapolis, IN 46204-2251

Please provide three copies printed double-sided. We greatly appreciate an electronic copy in Acrobat PDF format on CD or DVD, in place of one of the printed copies.

A6. Records of all monitoring information and activities which are required to be submitted by this approval or specified in the closure or post-closure plan, must contain information listed in 329 IAC 10-1-4(a). Records must be maintained as specified in 329 IAC 10-1-4(b) and (c).

A7. Reports must be signed as specified in 329 IAC 10-11-3(b).

B. CLOSURE REQUIREMENTS

B1. The owner or operator must follow the facility closure/post-closure plan titled "Closure Implementation Plan," dated July 18, 2018 (VFC #82582356) and documentation dated January 10, 2019 (VFC #82679884) and April 18, 2019 (VFC #82755832).

B2. The owner or operator must follow the schedule included in the closure/post-closure plan titled "Proposed Implementation Schedule," dated July 18, 2018 (VFC #82582356, p. 28), unless an alternate schedule is approved by IDEM, for completing the preparation activities and final closure of the ash disposal area.

B3. The owner or operator must notify IDEM in writing at least 15 days before the intended date to begin closure of ash disposal area.

B4. The owner or operator must place Coal Combustion Residual (CCR) structural fill as described in the documentation dated January 10, 2019 (VFC #82679884, p. 10 of 125).

B5. The owner or operator must adopt measures that will effectively minimize CCR from becoming airborne and manage waste that generates fugitive dust and fugitive particulate matter as described in approved plans, and in a way that does not violate the rule for fugitive dust (326 IAC 6-4) or fugitive particulate matter (326 IAC 6-5), including 326 IAC 6-5-4(g) for solid waste handling control measures (329 IAC 10-8.2-2). The owner or operator must take any additional steps necessary to prevent violations for fugitive dust rules.

B6. The owner or operator must manage surface water as described in the approved plans and meet the following requirements:

a. Maintain drainage ditches and erosion control structures to prevent off-site deposition of waste and sediment. Remove waste deposits and sediments from drainage ditches to properly convey storm water.
b. Construct temporary run-off structures in areas which are unable to drain to sedimentation basin.

B7. The owner or operator must properly dispose water that has been in contact with waste in accordance with all applicable local, state, and federal laws (329 IAC 10-28-16 and IC 13-30-2-1).

B8. The owner or operator must follow confirmation procedure for the removal of CCR material as described in the documentation dated January 10, 2019 (VFC #82679884, p. 8 of 125).

B9. The owner or operator must construct the final cover as specified in the approved final cover grading plan shown on the drawing titled "Sheet 022R2, Final Cover Grading Plan Closure Implementation Plan," and on the drawing titled "Sheet 025R2, Surface Water Drainage Plan Ash Management Areas Closure Implementation Plan," dated April 17, 2019 (VFC #82755832, p. 32 and p. 35 of 35, respectively), and the following cover specifications. The owner or operator must construct the cover for each of the areas identified as follows:

a. Consolidated Ash Management Area (15 acres):

(1) 6 inches of compacted soil meeting the Unified Soil Classification System (USCS) classifications of CH, CL-CH, CL, ML-CL, ML, SC, and SM-SC.
(2) 30-mil PVC, 40-mil LLDPE, or 60-mil HDPE geomembrane liner installed over soil layer.
(3) Geotextile cushion or geocomposite drainage layer.
(4) 30 inches of uncompacted protective soil. The upper 18 inches of protective soil must consist of soils meeting the USCS classifications of CL, ML-CL, ML, CH, SC, and SM-SC. The bottom 12 inches of the protective soil may include soils that are classified as SM, SM-SP, or SP.
(5) 6 inches of vegetative cover.

b. Areas containing the gas line (1 acre):

(1) 24 inches of cohesive soils such as CL, ML-CL, ML, CH, SC, and SM-SC.
(2) 12 inches of vegetative cover.

c. Former Coal Pile Area (2.5 acre):

(1) Average 10 feet soil grade raise fill to reestablish drainage.
(2) 12 inches of vegetative layer

d. Gravel Parking Area (2 acre):

(1) Geotextile cushion or geocomposite drainage layer.
(2) 24 inches of gravel.

e. Areas with ash excavation and removal (i.e., Ash Mound 1, Ash Mound 2, Ash Mound 3, Ash-Soil Mixture, and West Structural Fill Area) (17.5 acres):

(1) Following removal of the ash, area to be graded to establish a minimum 2% slope prior to conditioning the exposed soil.
(2) 12 inches of vegetative layer.

Grading and stabilization of final cover must be accomplished as described in 329 IAC 10-28-14.

B10. Upon selecting the specific materials for the composite liner system, the owner or operator must test the materials to verify that the interface friction values meet or exceed the values in the approved design. If the tests show that the interface friction values do not achieve the minimum factor of safety assumed in the approved plans, the permittee must select and test alternate materials and rerun the slope stability analysis.

B11. The owner or operator must test and install final cover components as specified in the document titled, "Quality Assurance Manual Installation of Final Cover System," revised in January 2019 (VFC #82679884, Appendix A, pp. 16-58 of 125), except as otherwise noted in this approval.

B12. Upon completion of the final cover system and establishment of vegetation, the owner or operator must submit to IDEM a final closure certification report and an Environmental Restrictive Covenant (ERC) for the entire ash disposal area with deed notation that meets the specifications in 392 IAC 10-30-7.

B13. The owner or operator must submit quarterly progress reports detailing activities toward completion of each milestone. After closure activities are completed, progress reports must be submitted on an annual basis until IDEM issues a Resolution of Case (close out) letter.

C. POST-CLOSURE REQUIREMENTS

C1. The owner or operator must perform 30 years of post-closure monitoring and maintenance including the activities specified in the facility revised post-closure plan dated April 18, 2019, Appendix A (VFC #82755832 pp. 22-30 of 35), and the performance standards, post-closure duties, and post-closure certification process specified in 329 IAC 10-31, as applicable.

C2. The owner or operator must correct and control nuisance conditions occurring at the facility (329 IAC 10-31-5), eliminate any threat to human health or the environment (329 IAC 10-31-6), and perform remedial actions as necessary (329 IAC 10-31-7).

D. GROUND WATER MONITORING REQUIREMENTS

D1. The owner or operator must comply with 329 IAC 10-29 (Ground Water Monitoring and Corrective Action).

D2. The owner or operator must conduct ground water monitoring throughout the post-closure care period of the facility (329 IAC 10-29-3). IDEM may extend the post-closure care period if ground water monitoring results show that the facility has not stabilized (329 IAC 10-31-4).

MONITORING DEVICES

D3. The owner or operator's ground water monitoring system (System) includes the following:

- Bedrock ground water monitoring wells: MW-1S, MW-1I, MW-1D, MW-2S, MW-2I, MW-2D, MW-3S, MW-3I, MW-4S, MW-4D, MW-5S, MW-5I, MW-5D, MW-6S, MW-6I, MW-6D, MW-7S, MW-7I, MW-7D, MW-8I, MW-8D, MW-9D, MW-10S, and MW-10I: the on-site drinking water well DW, and onsite production wells: PW-North and PW-South.
- Ground water monitoring wells screened in unconsolidated materials: MW-11S, MW-11I, MW-11D, MW-12S, MW-12I, MW-12D, MW-13S, MW-13I, MW-14S, MW-14I, MW-14D, MW-15S, MW-16S, MW-16I, MW-16D, MW-17S, MW-17I, MW-17D, MW-18S, MW-18I, MW-18D, MW-19, MW-20, MW-21 and MW-22.
- One surface water monitoring location, SM, from the surface impoundment.

At least 60 days before installing new monitoring devices, the owner or operator must submit a device-installation plan for IDEM approval. The plan must provide the following:

a. A map showing the location of each device with respect to the facility's entire System and a current potentiometric surface.
b. A demonstration that each device yields representative ground water samples at an appropriate location and depth within the same aquifer or aquifers as the existing System.
c. Drilling methods and installation procedures that follow 329 IAC 10-21-4; well construction materials and details, including protocol for collecting, describing, and analyzing consolidated or unconsolidated materials (329 IAC 10-24-3(3)).
d. An example of a borehole log that includes information specified under 329 IAC 10-24-3(2).
e. Environmental qualifications of all field personnel.

The owner or operator must submit all field documentation to IDEM within 60 days after completing all related field work.

D4. The owner or operator must label all ground water monitoring wells and piezometers (see Requirement F4). When reporting well and piezometer information, the owner or operator must include the identification for each well or piezometer.

D5. The owner or operator must secure the access ways to all monitoring wells and piezometers, as weather permits, to prevent unauthorized access and maintain the access ways so they are passable year round with the exception of flooding conditions.

D6. The owner or operator must maintain all ground water monitoring wells and piezometers as follows:

a. Complete necessary repairs, other than replacement (see Requirement D8), within 10 days after discovery or other time frame approved by IDEM.
b. Keep the wells and piezometers securely capped and locked when not in use.
c. Repair all cracks in and around the casings and well pads that may affect the integrity of the wells.
d. Control vegetation height.
e. Redevelop the wells as needed.

D7. When abandoning a ground water monitoring well or piezometer that is part of the facility's approved System, the owner or operator must:

a. Submit a written proposal for approval explaining the reasons for and detailing the method of abandonment.
b. Use methods that comply with Indiana Department of Natural Resources (IDNR) regulation 312 IAC 13-10-2.
c. Notify the IDEM Geology Section by phone, e-mail, or letter at least 10 days before the date the abandonment work will occur.
d. Provide written notification of abandonment to IDEM and IDNR within 30 days after plugging is complete. (IDNR (312 IAC 13-10-2(f)) requires written notice).

D8. The owner or operator must notify IDEM by phone, e-mail, or letter within 10 days after discovering that a ground water monitoring well or piezometer has been destroyed or is not functioning properly. The owner or operator must repair the well or piezometer if possible. If the well or piezometer cannot be repaired, then within 30 days after discovery, the owner or operator must submit a proposal for abandonment or replacement.

PLANS

D9. The owner or operator must follow the Sampling and Analysis Plan (SAP) dated August 9, 2017 (VFC #80505404), with clarifications noted in IDEM correspondence dated November 7, 2017 (VFC #80553528) and September 24, 2018 (VFC #82623062), and amendments dated August 1, 2018 (VFC #82591609).

D10. The owner or operator must follow the Quality Assurance Project Plan (QAPjP), contained within the SAP under Appendix G, dated August 9, 2017 (VFC #80505404).

D11. The owner or operator must follow an IDEM approved Statistical Evaluation Plan (StEP) that meets the minimum requirements listed in 329 IAC 10-29-5 (See Requirement F3).

D12. If IDEM requests a revision to a SAP, QAPjP, or StEP, the owner or operator must submit the revised plan(s) for approval. The owner or operator must submit the plan(s) within 60 days after receiving the request. This submittal must include one original paper copy and one PDF electronic file of each plan. The owner or operator must not implement the revised plan(s) before receiving approval.

D13. If the owner or operator makes design changes to the existing System listed in Requirement D3, the owner or operator must submit a revised SAP, QAPjP, and StEP for approval. The owner or operator must submit the plans within 60 days after completing all field activities associated with the design changes. This submittal must include one original paper copy and one PDF electronic file of each plan. The owner or operator must not implement the revised plans before receiving approval.

MONITORING PROGRAMS

D14. The owner or operator must sample the facility's ground water monitoring wells listed in Requirement D3 quarterly during each year. Each sample collected quarterly must be analyzed for the following Phase I constituents:

a. Field pH
b. Antimony (total)
c. Arsenic (total)
d. Barium (total)
e. Boron (total)
f. Cadmium (total)
g. Calcium (total)
h. Chloride
i. Chromium (total)
j. Cobalt (total)
k. Fluoride
l. Lithium (total)
m. Molybdenum (total)
n. Selenium (total)
o. Sulfate
p. Total dissolved solids (TDS)

The following Phase I constituents must be analyzed annually:

a. Aluminum (total)
b. Ammonia (as nitrogen)
c. Beryllium (total)
d. Bicarbonate alkalinity (as $CaCO_3$)
e. Total alkalinity (as $CaCO_3$)
f. Copper (total)
g. Cyanide
h. Field specific conductance
i. Iron (total)
j. Lead (total)

k. Manganese (total)
l. Magnesium (total)
m. Mercury (total)
n. Nitrate
o. Silver (total)
p. Sodium (total)
q. Strontium (total)
r. Sulfide
s. Total Radium (Radium 226 and Radium 228 concentrations combined)
t. Thallium (total)
u. Zinc (total)

Whenever results of total chromium occur at or above its background concentration or U.S. Environmental Protection Agency maximum contaminant level, whichever is the higher concentration, the owner or operator must speciate and report both trivalent and hexavalent chromium concentrations.

D15. The owner or operator must use the results of the static water level measurements from the System listed in Requirement D3 to prepare potentiometric surface maps or ground water flow maps for each screened interval (shallow bedrock, intermediate bedrock, deep bedrock, shallow unconsolidated, intermediate unconsolidated, and deep unconsolidated). The maps must contain the following:

a. Location and identification of each ground water monitoring well and piezometer.
b. Ground water elevations for each well and piezometer, and the surface water elevation of the surface impoundment. The owner or operator must measure all static water levels on the same day and as close in time as possible before the purging and sampling event.
c. Date and time of static water level measurement for each well and piezometer.
d. Ground-surface elevation at each well and piezometer.
e. Facility property boundaries.
f. Identification of the aquifer represented, either by a name or elevation.
g. Solid waste fill boundaries.
h. Facility name and county.
i. Map scale, north arrow, ground water flow direction arrows, and potentiometric-surface contour intervals.
j. Indications of which monitoring wells are considered background, upgradient, downgradient, or intrawell.
k. Locations and elevations of all site benchmarks.

D16. If a ground water flow map indicates that the ground water flow direction (including flow reversals) is other than anticipated in the design of the System listed in Requirement D3, then the owner or operator must notify IDEM of the difference in the ground water monitoring report submitted for Requirement D22. The notification must include either of the following: information demonstrating

that the monitoring well system still complies with 329 IAC 10-29-1(b); or a proposal to revise the monitoring system design for IDEM approval.

The owner or operator must determine if the System complies with 329 IAC 10-29-1(b) within 7 days of initiating the scheduled semiannual sampling event. With IDEM approval, the facility may postpone the scheduled semiannual sampling event in 30-day increments if they determine that the System does not comply with 329 IAC 10-29-1(b).

If the owner or operator determines a ground water flow reversal occurred during a scheduled sampling event, then data from that sampling event must not be utilized in statistical evaluations or incorporated into the background ground water quality calculations specified in the StEP. Additionally, the facility must immediately schedule a replacement sampling event in order to complete the required evaluation for ground water releases from the facility. Within 7 days of scheduling the replacement sampling event, the facility must notify IDEM of the schedule.

If design changes to the existing System listed in Requirement D3 are necessary, then the owner or operator must make the changes within 30 days after receiving IDEM approval of the revised design or other time frame approved by IDEM.

D17. The owner or operator must determine the background ground water quality (See Requirement F1) for any background well added to the System listed in Requirement D3 by sampling each new well for four consecutive quarters within one year after their installation, unless the facility can justify to IDEM an extended period of no more than 12 additional months. The owner or operator must establish background ground water quality for the Phase I constituents listed in Requirement D14.

If the facility or IDEM determines that the current System (see Requirement D3) does not have the required background well(s), then within 60 days the facility must submit a plan per Requirement D3 proposing to establish new or additional background wells for the current System for IDEM review and approval. This plan must include well location(s) for obtaining background ground water quality samples that satisfy the specifications of this requirement.

D18. The owner or operator must implement the StEP identified in Requirement D11 to determine whether the constituent concentrations in ground water are stable using Mann-Kendall trend analysis to the 95% confidence level for each Phase I constituent. The owner or operator must include the outcome of each statistical determination in a statistical evaluation report (see Requirement D22.d).

D19. If the owner or operator determines there is a statistically significant increasing trend (increasing or decreasing for pH) for two or more of the Phase I constituents at any of the downgradient ground water monitoring wells, then the owner or operator must comply with the following requirements:

a. Notify IDEM in writing within 14 days after the finding. The notification must state which constituents showed statistically significant increasing trends (increasing or decreasing for pH) and which well(s) showed the elevated concentrations.
b. Collect and analyze the ground water from all monitoring wells for the constituents determined from 329 IAC 10-29-7(d). The owner or operator must submit the results to IDEM within 60 days after determining the statistically significant increasing trend(s).
c. Establish a Phase II monitoring program based on the results obtained from Requirement D19.b and consult with the IDEM Geology Section within 30 days after completing Requirement D19.b.

The owner or operator must continue the scheduled Phase I monitoring as described in Requirement D14 and 329 IAC 10-29 throughout the establishment and implementation of the Phase II monitoring program.

D20. In lieu of Requirements D19.b and D19.c, the owner or operator may attempt to demonstrate that a source other than the solid waste facility caused the increasing trend (increasing or decreasing for pH) or that the increasing trend (increasing or decreasing for pH) resulted from error in sampling, analysis, or evaluation. For IDEM to approve the demonstration, the owner or operator must comply with the following requirements:

a. Notify IDEM in writing of the intent to make a demonstration. The owner or operator must submit the notification within 7 days after determining a statistically significant increasing trend (increasing or decreasing for pH).
b. Submit a report to IDEM within 90 days after determining a statistically significant increasing trend (increasing or decreasing for pH). The report must demonstrate that a source other than the solid waste facility caused the increasing trend (increasing or decreasing for pH), or that the increasing trend (increasing or decreasing for pH) resulted from error in sampling, analysis, or evaluation. The report must state what efforts the owner or operator will take to prevent these errors from recurring.
c. Continue to monitor ground water at all monitoring wells according to the scheduled Phase I monitoring established under 329 IAC 10-29-6.

If a demonstration is not acceptable to IDEM, the owner or operator must continue with Requirements D19.b and D19.c.

D21. If necessary, the owner or operator must implement a corrective action program as required under 329 IAC 10-29-9. The corrective action program is complete when ground water protection standards have been met at all points of the plume beyond the monitoring boundary for a period of three consecutive years using the statistical procedures outlined in 329 IAC 10-29-5 and procedures approved through this IDEM Approval Letter.

REPORTING

D22. No later than 60 days, except for radium-specific information which will be allowed no later than 90 days, after each ground water monitoring event completed for Requirement D14, the owner or operator must submit the information in a ground water monitoring report to the IDEM Solid Waste Permits Section in one unbound paper copy and in one electronic PDF file. The report must include the following:

a. One original unbound laboratory-certified report with analytical and field parameters results, field sheets, and chain-of-custody forms. The laboratory-certified report must include the following: detection limit for each chemical constituent, date samples collected, date the laboratory received the samples, date the laboratory analyzed the samples, date the laboratory prepared the report, method of analysis the laboratory used for each constituent, sample identification number for each sample, and results of all sample analyses.
b. All information specified in Requirement D15 and a table summarizing the static water level and ground water elevation for each well and piezometer.
c. Comments regarding ground water quality, recent notifications of any compliance issues related to a problematic well or piezometer (see Requirement D8), special field observations and procedures, and deviations from the SAP.
d. One original unbound copy of the statistical evaluation report (see Requirement D18).

The owner or operator may mail the PDF copy and electronic data file specified in Requirement D23 on a CD-ROM or DVD. The owner or operator must clearly label the PDF copy and electronic data file with the facility name and a brief description of the file. Alternatively, the owner or operator may e-mail the PDF copy and electronic data file to the IDEM Solid Waste Permits Section at the address listed in Requirement A5 and carbon copy olqdata@idem.IN.gov. The e-mail must include the facility name and a brief description typed in the e-mail's subject heading.

D23. The owner or operator must submit one electronic data file of the analytical and field parameters results formatted as an ASCII, tab-delimited text file. The electronic data file must contain the facility's name, solid waste program identification number, and the name of the analytical laboratory. Additionally, the file must include the fields listed below for the analytical results and the following field parameters: pH, specific conductance, temperature, well depth, depth to water, and static water elevation.

a. SamplingDate: month, day, and year (mm/dd/yyyy). Value should be formatted as a date if possible.
b. SamplePointName: names of ground water monitoring wells, piezometers, leachate wells, surface water collection points, etc.

c. LaboratorySample ID: ID assigned to the sample by the laboratory.
d. SampleType: regular, duplicate(s), trip blank(s), equipment blank(s), field blank(s), verification re-sample(s), and replicate(s).
e. SpeciesName: chloride, sodium, ammonia, field pH, etc. The order of constituents is not critical. However, it is best to reflect the order that is on the laboratory data sheets and keep all field data grouped together. Metals should indicate "dissolved" phase or "total" phase. Associated static water levels do not have their own header, but must be entered as "GW WaterLevel" under the header "SpeciesName." The actual elevations must be entered under the header "Concentration."
f. Concentration (results): The entry must be a number. Please do not enter text, such as "NA," "ND," or "<."
g. ConcentrationUnits: mg/l, µg/l, standard units for pH, degrees Celsius (°C) or degrees Fahrenheit (°F) for temperature, and umhos/cm for specific conductance.
h. Detected: yes or no.
i. DetectionLimit.
j. AnalyticalMethods.
k. EstimatedValue: Indicate "Yes" if the reported concentration is an estimated value. If a value recorded was not estimated, enter "No." If a concentration is estimated, use the "Comment" field to explain why the concentration was estimated.
l. Comment: analytical laboratory and/or field personnel comments regarding the reported results.
m. SampleMedium: ground water, leachate, surface water, etc.
n. ProgramArea: Solid Waste.

Additional guidance on electronic data file submittals is available on IDEM's website at http://www.in.gov/idem/landquality/2369.htm or by e-mailing questions to olqdata@idem.IN.gov.

D24. The owner or operator must retain laboratory quality assurance/quality control (QA/QC) documentation from valid analyses of ground water samples for at least three years.

Upon IDEM request, the owner or operator must submit the laboratory QA/QC for a specified ground water monitoring data package, in one paper copy and one electronic copy in PDF format, within 60 days after receiving the request. The *Solid & Hazardous Waste Programs, Analytical Data Deliverable Requirements: Supplemental Guidance* provides additional information about laboratory QA/QC. The guidance is available on IDEM's website at www.in.gov/idem/landquality/files/sw_resource_data_deliverable_reqs.pdf.

E. FINANCIAL RESPONSIBILITY FOR CLOSURE AND POST-CLOSURE

E1. The owner or operator must establish and maintain financial assurance in an amount not less than the approved updated closure and post-closure cost estimates in the documentation dated April 18, 2019 (VFC #82755832, pp. 9-30 of 35) using a financial assurance mechanism specified in 329 IAC 10-39. The owner or operator must submit signed originals of the financial assurance mechanism used to meet this requirement.

E2. The owner or operator must annually review and submit an update by June 15 addressing the following items as detailed in 329 IAC 10-39-2(c) and (d), and 329 IAC 10-39-3(c):

a. The owner or operator must adjust the closure and post-closure cost estimates for inflation.

b. The owner or operator must revise the cost estimates to account for changes which increase the cost of closure or post-closure.

c. The owner or operator may revise the cost estimates to account for changes which reduce the cost of closure or post-closure. The permittee must provide documentation supporting reduced cost-estimates, for example, letters and maps documenting areas certified as closed.

d. The owner or operator must submit an existing contour map of the approved solid waste land disposal facility that delineates the boundaries of all areas into which waste has been placed, and the boundaries of areas certified as closed. The map must be certified by a professional engineer or a registered land surveyor.

e. The owner or operator must submit documentation showing that the financial assurance mechanism is current to cover the estimated costs of closure and post-closure. The permittee must submit signed originals of the financial assurance and/or updates used to meet this requirement.

F. COMPLIANCE SCHEDULE REQUIREMENTS

F1. Within 60 days after receiving this IDEM Approval Letter, the owner or operator must submit a plan proposing to establish background ground water quality for the System specified in Requirement D3 for IDEM review and approval. This plan must include well location(s) for obtaining background ground water quality samples that represent historical conditions unaffected by a CCR unit or facility activities that may contribute constituents of concern listed in Requirement D14 against which background comparisons occur.

F2. Within 60 days after installing the proposed wells in F4, the owner or operator must submit a new SAP describing sampling protocol, equipment, and methods for collecting samples to be analyzed for constituents listed in Requirement D14 and Requirement D17. The new SAP will replace the current SAP (see Requirement D9). The owner or operator must implement the new SAP upon IDEM's written approval. The submittal must include one original paper copy and one PDF electronic file.

F3. Within 60 days after the owner or operator establishes background ground water quality, the owner or operator must submit a StEP following 329 IAC 10- 29-5. The StEP is effective upon IDEM's written approval. The submittal must include one original paper copy and one PDF electronic file.

In the StEP, the owner or operator must present the data distribution assumptions. The statistical procedures must be appropriate for the data distribution and provide a balance between the probability of falsely identifying a significant difference and the probability of failing to identify a significant difference. To achieve the balance, the owner or operator should consider the background sample sizes, the number of individual statistical tests performed, and the specific verification resampling method. The statistical procedures must account for analytical results below method detection limits.

F4. Within 180 days after receiving this IDEM Approval Letter, the owner or operator must complete installation of the following ground water monitoring wells and piezometers, according to the *Monitoring Well Work Plan* dated May 29, 2018 (VFC #82552684), with clarifications and comments included in the IDEM correspondence dated June 26, 2018 (VFC #82572298):

- Bedrock ground water monitoring wells: MW-24D, MW-25D, MW-27I, MW-27D, and MW-30D.
- Ground water monitoring wells screened in unconsolidated materials: MW-15I, MW-15D, MW-26S, MW-26I, and MW-26D.
- Piezometers: PZ-1, PZ-2, PZ-3, and PZ-4.

Within 180 days after completeing the closure activities, the owner or operator must complete the installation of the following groundwater monitoring wells and piezometers, according to the *Monitoring Well Work Plan* dated May 29, 2018 (VFC #82552684), with clarifications and comments included in the IDEM correspondence dated June 26, 2018 (VFC #82572298):

- Bedrock groundwater monitoring wells: MW-28S.
- Unconsolidated groundwater monitoring wells :MW-29S

Within 60 days after completing all ground water monitoring well and piezometer installations noted above, the owner or operator must submit a Ground Water Monitoring Well and Piezometer Completion Report to IDEM describing the methods and procedures used to install the wells and piezometers. In addition, the report needs to include soil and/or rock core logs, well completion diagrams, and IDNR well completion forms for each well and piezometer location.

F5. Within 30 days after receiving this IDEM Approval Letter, the owner or operator must submit to IDEM for approval an updated schedule for the Closure Implementation Plan for completing the preparation activities and final closure of the ash disposal site.

F6. Within 45 days after receiving this IDEM Approval Letter, the owner or operator must establish a financial assurance mechanism as provided in 329 IAC 10-39 for the amount required by Requirement E1. The owner or operator must submit proof of financial assurance to IDEM no later than 60 days after establishing the mechanism.

F7. Within 30 days after receiving approval from IDEM, the owner or operator must submit the approval from Hamilton County including a description of the designs of the drainage ditches and sedimentation/detention basins.

F8. Within 12 months after receiving this IDEM Approval Letter, or other time frame approved by IDEM, the owner or operator must install a river staff gauge along the facility's property boundary at the White River. The gauge must be installed so that the owner or operator can determine the White River's elevation north of the low head dam during ground water monitoring events. After installation of the gauge, the owner or operator must include the elevation of the White River on the potentiometric surface maps or ground water flow maps required by D15. The owner or operator must measure all surface water levels on the same day and as close in time as possible before the purging and sampling event.

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
We Protect Hoosiers and Our Environment.
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(800) 451-6027 • (317) 232-8603 • www.idem.IN.gov

Eric J. Holcomb
Governor

Bruno L. Pigott
Commissioner

What if you are not satisfied with this decision and you want to file an appeal?

Who may file an appeal?
The decision described in the accompanying Notice of Decision may be administratively appealed. Filing an appeal is formally known as filing a "Petition for Administrative Review" to request an "administrative hearing".

If you object to this decision issued by the Indiana Department of Environmental Management (IDEM) and are: 1) the person to whom the decision was directed, 2) a party specified by law as being eligible to appeal, or 3) aggrieved or adversely affected by the decision, you are entitled to file an appeal. (An aggrieved and adversely affected person is one who would be considered by the court to be negatively impacted by the decision. If you file an appeal because you feel that you are aggrieved, it will be up to you to demonstrate in your appeal how you are directly impacted in a negative way by the decision).

The Indiana Office of Environmental Adjudication (OEA) was established by state law – see Indiana Code (IC) 4-21.5-7 – and is a separate state agency independent of IDEM. The jurisdiction of the OEA is limited to the review of environmental pollution concerns or any alleged technical or legal deficiencies associated with the IDEM decision making process. Once your request has been received by OEA, your appeal may be considered by an Environmental Law Judge.

What is required of persons filing an appeal?
Filing an appeal is a legal proceeding, so it is suggested that you consult with an attorney. Your request for an appeal must include your name and address and identify your interest in the decision (or, if you are representing someone else, his or her name and address and their interest in the decision). In addition, please include a photocopy of the accompanying Notice of Decision or list the permit number and name of the applicant, or responsible party, in your letter.

Before a hearing is granted, you must identify the reason for the appeal request and the issues proposed for consideration at the hearing. You also must identify the permit terms and conditions that, in your judgment, would appropriately satisfy the requirements of law with respect to the IDEM decision being appealed. That is, you must suggest an alternative to the language in the permit (or other order, or decision) being appealed, and your suggested changes must be consistent with all applicable laws (See Indiana Code 13-15-6-2) and rules (See Title 315 of the Indiana Administrative Code, or 315 IAC).

The effective date of this agency action is stated on the accompanying Notice of Decision (or other IDEM decision notice). If you file a "Petition for Administrative Review" (appeal), you may wish to specifically request that the action be "stayed" (temporarily halted) because most appeals do not allow for an automatic "stay". If, after an evidentiary hearing, a "stay" is granted, the IDEM-approved action may be halted altogether, or only allowed to continue in part, until a final decision has been made regarding the appeal. However, if the action is not "stayed" the IDEM-approved activity will be allowed to continue during the appeal process.

Where can you file an appeal?
If you wish to file an appeal, you must do so in writing. There are no standard forms to fill out and submit, so you must state your case in a letter (called a petition for administrative review) to the Indiana Office of Environmental Adjudication (OEA). Do not send the original copy of your appeal request to IDEM. Instead, send or deliver your letter to:

The Indiana Office of Environmental Adjudication
100 North Senate Avenue, Room N103
Indianapolis, IN 46204

If you file an appeal, also please send a copy of your appeal letter to the IDEM contact person identified in the Notice of Decision, and to the applicant (person receiving an IDEM permit, or other approval).

Your appeal (petition for administrative review) must be received by the Office of Environmental Adjudication in a timely manner. The due date for filing an appeal may be given, or the method for calculating it explained, on the accompanying Notice of Decision (NOD). Generally appeals must be filed within 18 days of the mailing date of the NOD. To ensure that you meet this filing requirement, your appeal request must be:

1) Delivered in person to OEA, by the close-of-business on the eighteenth day (if the 18th day falls on a day when the Office of Environmental Adjudication (OEA) is closed for the weekend or for a state holiday, then your petition will be accepted on the next business day on which OEA is open), or
2) Given to a private carrier who will deliver it to the OEA on your behalf, (and from whom you must obtain a receipt dated on or before the 18th day), or
3) For those appeal requests sent by U.S. Mail, your letter must be postmarked by no later than midnight of the 18th day, or
4) Faxed to the OEA at (317) 233-9372 before the close-of-business on the 18th day, provided that the original signed "Petition for Administrative Review" is also sent, or delivered, to the OEA in a timely manner.

What are the costs associated with filing an appeal?
The OEA does not charge a fee for filing documents for an administrative review or for the use of its hearing facilities. However, OEA does charge a fifteen cent ($.15) per page fee for copies of any documents you may request. Another cost that could be associated with Your appeal would be for attorney's fees. Although you have the option to act as your own

Attorney, the administrative review and associated hearing are complex legal proceedings; therefore, you should consider whether your interests would be better represented by an experienced attorney.

What can you expect from the Office of Environmental Adjudication (OEA) after you file for an appeal?

The OEA will provide you with notice of any prehearing conference, preliminary hearings, hearings, "stays," or orders disposing of the review of this decision. In addition, you may contact the OEA by phone at (317) 233-0850 with any scheduling questions. However, technical questions should be directed to the IDEM contact person listed on the Notice of Decision.

Do not expect to discuss details of your case with OEA other than in a formal setting such as a prehearing conference, a formal hearing, or a settlement conference. The OEA is not allowed to discuss a case without all side being present. All parties to the proceeding are expected to appear at the initial prehearing conference.

2.2.5. Noblesville Generating Station National Pollutant Discharge Elimination System (NPDES) Information, Submitted to IDEM, VFC #82858496 (Duke Energy Indiana, LLC, 2019)

https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=82859291&dDocName=82858496&Rendition=web&allowInterrupt=1&noSaveAs=1&fileName=82858496.pdf

Information about the Noblesville Generating Station was originally submitted in response to the August 2019 proposed rule. This document pertains to the Noblesville Generating Station and was accessed by EPA through the Indiana Department of Environmental Management (IDEM) "virtual cabinet" file management system. Pages 1-12 of the document are included here and pages 13-698, which contain technical data, are omitted. To access the full posting of the document, please use the link above.

Duke Energy
WP994 / 1000 East Main Street
Plainfield, IN 46168

RECEIVED
OCT 23 2019
DEPARTMENT OF
ENVIRONMENTAL MANAGEMENT
OFFICE OF LAND QUALITY

October 22, 2019

Ms. Anna Mishel
Environmental Manager
Permitting Branch
Office of Land Quality, IDEM
100 North Senate Avenue, IGCN 1154
Indianapolis, IN. 46204

RE: Noblesville Generating Station SW ID# 29-UP-01
21225 Riverwood Avenue, Noblesville Indiana 46062
Agreed Order Case No. 2017-24922-S

Ms. Mishel:

Duke Energy Indiana, LLC. (DEI) respectfully submits to the Indiana Department of Environmental Management (IDEM) the documentation regarding the Hamilton County Storm Water Management Permit / Storm Water Pollution Prevention Plan prepared by ATC Group Services, LLC for the Noblesville Generating Station SW ID# 29-UP-01 closure project.

This document is submitted in accordance with the Section F7 of the partial closure and post-closure plan approval dated October 17, 2019.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information. If you have any questions or require additional information regarding this submittal please call me at 317-838-2161.

Sincerely,
Duke Energy Indiana, LLC.

Rebecca Warren

Rebecca Warren, L.P.G.
Senior Environmental Specialist
EHS CCP Waste & Groundwater Programs

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
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Eric J. Holcomb
Governor

Bruno L. Pigott
Commissioner

August 20, 2019

65-42 WQS/RJB
Jim Thorp, Duke Energy Indiana LLC
1000 E Main St
Plainfield, IN 46168

Dear Mr. Jim Thorp, Duke Energy Indiana LLC:

Re: **Notice of Sufficiency (NOS)**
Notice of Intent Submittal
Construction Site Stormwater Run-off
327 IAC 15-5
Closure of Historical Ash Management &
Beneficial Use Areas-Noblesville Station
Hamilton County
Permit #: INRA03964

The Notice of Intent (NOI) submitted for the project referenced above has been reviewed by staff of the Indiana Department of Environmental Management (IDEM). The items contained in the NOI are sufficient and meet the requirements of the National Pollutant Discharge Elimination System (NPDES) General Permit Rule for stormwater discharges associated with construction activity (327 IAC 15-5). This letter is notification of permit coverage for 327 IAC 15-5 and does not constitute approval to conduct activities that are related to other local, state, or federal permits.

A permit number is assigned to each project for which an NOI has been submitted to obtain coverage under 327 IAC 15-5. This number is used for identification and should be included with any future correspondence submitted to IDEM. The general permit number assigned to this facility is: INRA03964.

Construction site stormwater run-off general permit coverage is automatically limited to a maximum term length of five (5) years (327 IAC 15-5-12). The general permit issued for the project referenced above will expire on July 10, 2024. If this project requires coverage beyond this date, the applicant must reapply for a new permit 90 days prior to the expiration date.

IDEM Watermark
INRA03964 v1.0
Approved
Issued On:07/11/2019
Expires On:07/10/2024

It is important that all activities associated with your site are in compliance with the requirements of 327 IAC 15-5 and all local stormwater permits. In accordance with 327 IAC 15-5-10, you are required, at a minimum to implement your construction /stormwater pollution prevention plan, implement and maintain all stormwater quality measures, and monitor the effectiveness of the measures until the project is complete and terminated.

Upon completion of the project, you are required to terminate the permit. Information for termination can be found in 327 IAC 15-5-8. If this project is also within and/or permitted through a Municipal Separate Storm Sewer System (MS4), there may be local requirements (established through a local ordinance) for approval to terminate a project. If an MS4 has adopted a requirement for termination, you are responsible to comply with all local provisions prior to submitting the Notice of Termination to IDEM.

For more information related to the Stormwater Program and permit requirements, please visit: http://www.idem.IN.gov/2331.htm. Program forms are also available at this website or at http://www.IN.gov/idem/5157.htm.

Permittees can now manage their construction site stormwater run-off permit activities on-line, including renewals, amendments, and terminations through the IDEM Regulatory ePortal. All permittees are required/encouraged to utilize this new service. The service may be accessed at https://stormwater.idem.in.gov .

Any questions regarding this letter may be directed to the Stormwater Permit Coordinator at 317-233-1864 or 800-451-6027, extension 1864. Questions may also be emailed to the program email account of Stormwat@idem.IN.gov.

Sincerely,

Randy J. Braun, CPESC, CMS4S
Stormwater and Wetlands Section
Surface Water, Operations, & Enforcement Branch
Office of Water Quality

IDEM Watermark
INRA03964 v1.0
Approved
Issued On:07/11/2019
Expires On:07/10/2024

Construction/Stormwater Pollution Prevention Plan
Technical Review and Comment *(Form 1)*

Project Information

Project Name:	Duke Energy Noblesville Generating Station - Closure of Historic				**County:**	Hamilton	
Plan Submittal Date:	5/23/19			**Hydrologic Unit Code:**			
Project Location Description:	21225 Riverwood Ave. , Noblesville, IN 46060						
Latitude & Longitude of point of discharge:	85° 58' 15.45" and 40° 05' 47.72"						
Civil Township:	Noblesville Twp	**Quarter:**		**Section:**	16	**Township:** 19N	**Range:** 5E

Project Owner Name:	Duke Energy of Indiana, LLC				
Contact:	Tena Hopkins				
Address:	1000 East Main St.				
City:	Plainfield	**State:**	IN	**Zip:**	46168
Phone:	317-838-1798	**FAX:**	-	**E-Mail:**	tena.hopkins@duke-energy.com

Plan Preparer Name:	Jim Luckiewicz				
Affiliation:	ATC Group Services, LLC				
Address:	7988 Centerpoint Drive, Suite 100				
City:	Indianapolis	**State:**	IN	**Zip:**	46256
Phone:	317-849-4990	**FAX:**		**E-Mail:**	jim.luckiewicz@atcgs.com

Plan Review

Review Date:	06/03/19				
Principal Plan Reviewer:	Steve Cash				
Agency:	Hamilton County Surveyor's Office				
Address:	1 Hamilton County Square, Suite 188				
City:	Noblesville	**State:**	IN	**Zip:**	46060
Phone:	(317) 776-8495	**FAX:**	(317776-9628	**E-Mail:**	steve.cash@hamiltoncounty.in.gov
Assisted By:					

☑ **PLAN IS ADEQUATE: A comprehensive plan review has been completed and it has been determined that the plan satisfies the minimum requirements and intent of 327 IAC 15-5.**

- ☑ **Please refer to additional information included on the following page(s).**
- ☑ **Submit Notice of Intent (NOI):** *Attach a copy of this cover page when submitting the NOI to the Indiana Department of Environmental Management. Construction activities may begin 48 hours following the submittal of the NOI. A copy of the NOI must also be sent to the HCSO.*

☐ **A preliminary plan review has been completed; a comprehensive review will not be completed within the 28-day review period. The reviewing authority reserves the right to perform a comprehensive review at a later date and revisions to the plan may be required at that time to address deficiencies.**

- ☐ **Please refer to additional information included on the following page(s).**
- ☐ **Submit Notice of Intent (NOI):** *Attach a copy of this cover page when submitting the NOI to the Indiana Department of Environmental Management. Construction activities may begin 48 hours following the submittal of the NOI. A copy of the NOI must also be sent to the HCSO.*

☐ **PLAN IS DEFICIENT: Significant deficiencies were identified during the plan review.**

- ☐ **Please refer to additional information included on the following page(s).** 4
- ☐ **DO NOT file a Notice of Intent for this project.**
- ☐ **DO NOT commence land disturbing activities until all deficiencies are adequately addressed, the plan re-submitted, and notification has been received that the minimum requirements have been satisfied.**

☐ **Plan Revisions** ☐ **Deficient Items should be mailed or delivered to the Principal Plan Reviewer identified in the Plan Review Section above.**

Construction/Stormwater Pollution Prevention Plan - Technical Review and Comment *(Form 1)*

Project Name:	Duke Energy Noblesville Generating Station - Closure of Historic Ash Mgt & Benefit Use Areas
Date Reviewed:	06/03/19

The technical review and comments are intended to evaluate the completeness of the Construction/Stormwater Pollution Prevention Plan for the project. The Plan submitted was not reviewed for the adequacy of the engineering design. All measures included in the plan, as well as those recommended in the comments should be evaluated as to their feasibility by a qualified individual with structural measures designed by a qualified engineer. The Plan has not been reviewed for other local, state, or federal permits that may be required to proceed with this project. Additional information, including design calculations may be requested to further evaluate the Plan.

All proposed stormwater pollution prevention measures and those referenced in this review must meet the design criteria and standards set forth in the "Indiana Stormwater Quality Manual" from the Indiana Department of Natural Resources, Division of Soil Conservation as well as the Hamilton County Stormwater Design Manual.

Please direct questions and/or comments regarding this plan review to:

Steve Cash

Please refer to the address and contact information identified in the Plan Review Section on page 1.

Assessment of Construction Plan Elements *(Section A)*

The Construction Plan Elements are adequately represented to complete a plan review:

☑ **Yes** ☐ **No**

The items checked below are deficient and require submittal to meet the requirements of the rule.

A			A		
☐	1	Index showing locations of required Plan Elements	☐	2	11 by 17 inch plat showing building lot numbers/boundaries and road layout/names
☐	3	Narrative describing the nature and purpose of the project	☐	4	Vicinity map showing project location
☐	5	Legal Description of the Project Site (Include Latitude and Longitude - NOI Requirement)	☐	6	Location of all lots and proposed site improvements (roads, utilities, structures, etc.)
☐	7	Hydrologic unit code (14 Digit)	☐	8	Notation of any State or Federal water quality permits
☐	9	Specific points where stormwater discharge will leave the site	☐	10	Location and name of all wetlands, lakes and water courses on and adjacent to the site
☐	11	Identification of all receiving waters	☐	12	Identification of potential discharges to ground water (abandoned wells, sinkholes, etc.)
☐	13	100 year floodplains, floodways, and floodway fringes	☐	14	Pre-construction and post construction estimate of Peak Discharge (10 Year storm event)
☐	15	Adjacent landuse, including upstream watershed	☐	16	Locations and approximate boundaries of all disturbed areas (Construction Limits)
☐	17	Identification of existing vegetative cover	☐	18	Soils map including soil descriptions and limitations
☐	19	Locations, size and dimensions of proposed stormwater systems (e.g. pipes, swales and channels)	☐	20	Plans for any off-site construction activities associated with this project (sewer/water tie-ins)
☐	21	Locations of proposed soil stockpiles and/or borrow/disposal areas	☐	22	Existing site topography at an interval appropriate to indicate drainage patterns
☐	23	Proposed final topography at an interval appropriate to indicate drainage patterns	☐	24	Name, contact info, and qualifications of the individual in charge of SWPPP inplementation*

*** Note #24 is required.**

Construction/Stormwater Pollution Prevention Plan - Technical Review and Comment *(Form 1)*

Project Name: Duke Energy Noblesville Generating Station - Closure of Historic Ash Mgt & Benefit Use Areas
Date Reviewed: 06/03/19

Assessment of Stormwater Pollution Prevention Plan *(Sections B & C)*

Stormwater Pollution Prevention Plan - Construction Component *(Section B)*

The construction component of the Stormwater Pollution Prevention Plan includes stormwater quality measures to address erosion, sedimentation, and other pollutants associated with land disturbance and construction activities. Proper implementation of the plan and inspections of the construction site are necessary to minimize the discharge of pollutants. The Project Site Owner should be aware that unforeseen construction activities and weather conditions may affect the performance of a practice or the effectiveness of the plan. The plan must be a flexible document, with provisions to modify or substitute practices as necessary.

Adequate	Deficient	Not Applicable	B	
☑	☐		1	**Description of potential pollutant sources associated with construction activities**
☑	☐		2	**Sequence describing stormwater quality measure implementation relative to land disturbing activities**
☑	☐		3	**Stable construction entrance locations and specifications (at all points of ingress and egress)**
☑	☐	☐	4	**Sediment control measures for sheet flow areas**
☑	☐	☐	5	**Sediment control measures for concentrated flow areas**
☑	☐	☐	6	**Storm sewer inlet protection measure locations and specifications**
☑	☐	☐	7	**Runoff control measures** (*e.g. diversions, rock check dams, slope drains, etc.*)
☑	☐	☐	8	**Storm water outlet protection specifications**
☑	☐	☐	9	**Grade stabilization structure locations and specifications**
☑	☐		10	**Location, dimensions, specifications, and construction details of each stormwater quality measure**
☑	☐		11	**Temporary surface stabilization methods appropriate for each season** (*include sequencing*)
☑	☐		12	**Permanent surface stabilization specifications** (*include sequencing*)
☑	☐		13	**Material handling and spill prevention plan**
☑	☐		14	**Monitoring and maintenance guidelines for each proposed stormwater quality measure**
☐	☐	☑	15	**Erosion & sediment control specifications for individual building lots**

Stormwater Pollution Prevention Plan - Post Construction Component *(Section C)*

The post construction component of the Stormwater Pollution Prevention Plan includes the implementation of stormwater quality measures to address pollutants that will be associated with the final landuse. Post construction stormwater quality measures should be functional upon completion of the project. Long term functionality of the measures are critical to their performance and should be monitored and maintained. See the Hamilton County Stormwater Design Manual for guidance.

Adequate	Deficient	Not Applicable	C	
☑	☐		1	**Description of pollutants and their sources associated with the proposed land use**
☑	☐		2	**Sequence describing stormwater quality measure implementation**
☑	☐		3	**Description of proposed post construction stormwater quality measures** *(Include a written description of how these measures will reduce discharge of expected pollutants)*
☑	☐		4	**Location, dimensions, specifications, and construction details of each stormwater quality measure**
☑	☐		5	**Description of maintenance guidelines for post construction stormwater quality measures**

Construction/Stormwater Pollution Prevention Plan - Technical Review and Comment

Project Name:	Duke Energy Noblesville Generating Station - Closure of Historic Ash Mgt & Benefit Use Areas
Date Reviewed:	06/03/19

1. To set up a pre-construction meeting and to coordinate inspection of the SWPPP, please contact HCSO Inspector, Jerry Liston, at 317-776-8495 or email at: Jerry. Liston@hamiltoncounty.in.gov. Please contact the Inspector at least 48 hours prior to installation.

These comments reflect only the SWPPP and do not address other plan review agencies.

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

ATC Group Services LLC

7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256

Phone +1 317 849 4990
Fax +1 317 849 4278

www.atcgroupservices.com

July 10, 2019

Indiana Department of Environmental Management
Storm Water Program, IGCN, Room 1255
100 North Senate Avenue
Indianapolis, Indiana 46204-2251
Rule 5 Stormwater Coordinator

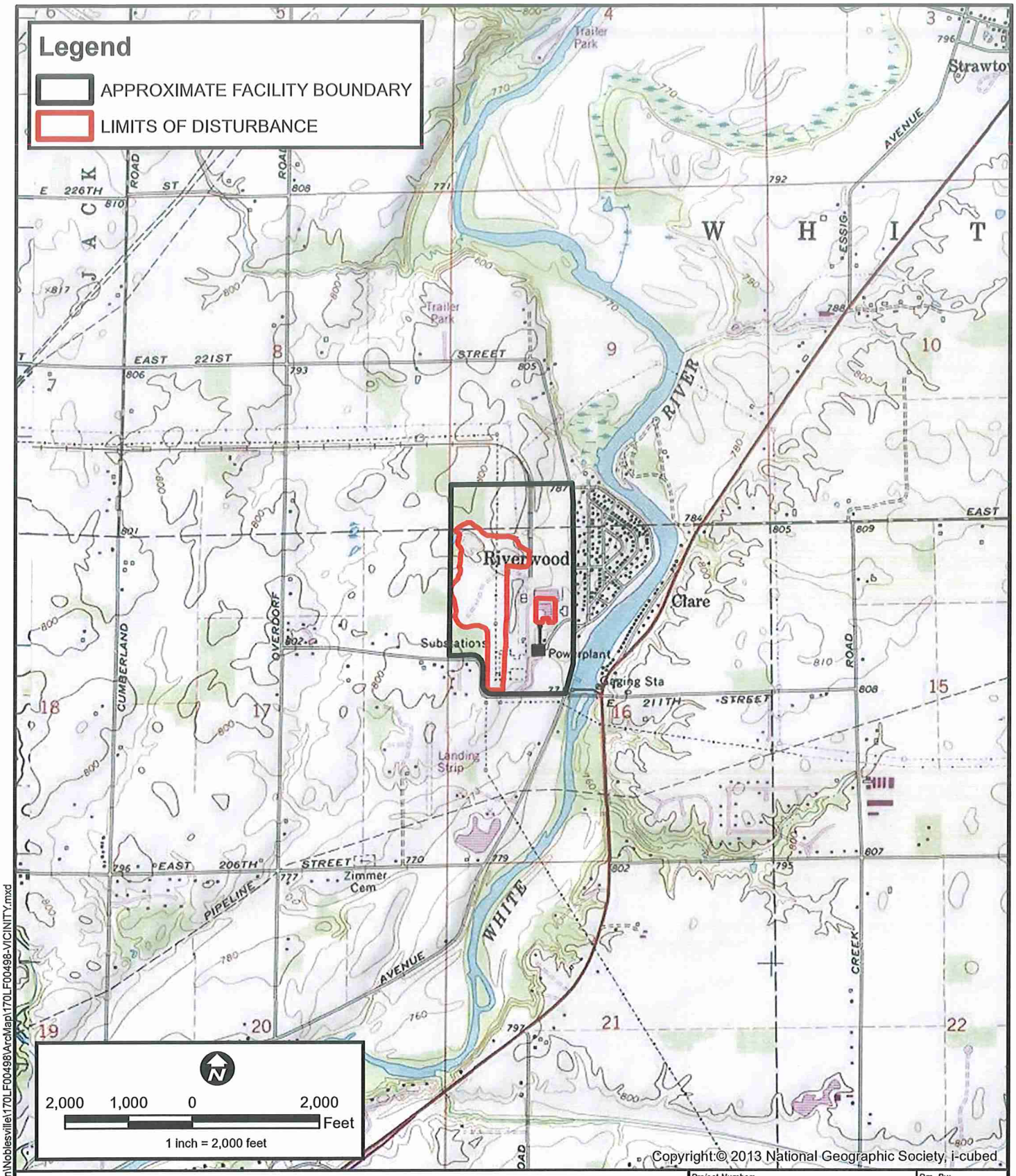
Re: Rule 5 Notice of Intent (NOI) Letter & Associated Information
Duke Energy Noblesville Generating Station
Closure of Historic Ash Management
& Beneficial Use Areas
21225 Riverwood Avenue
Hamilton County; Noblesville, IN 46062
ATC Job Number 170LF00498

Dear Madam/Sir:

ATC Group Services LLC (ATC) has been retained by Duke Energy Indiana, Inc. to assist in the preparation and submittal of this Rule 5 (327 IAC 15-5) Notice of Intent (NOI) Letter and associated information for a project site at the Duke Noblesville Generating Station located at 21225 Riverwood Avenue, Noblesville, IN 46062 in Hamilton County. The project site is located in Sections 16 and 9, Township 19 North, and Range 5 East as shown on the Riverwood, IN USGS Quad and Aerial Maps on the following pages and the attached Site Plan.

Specifically, this project involves earthwork within the Duke Noblesville Station property area. The Duke Noblesville Station has voluntarily entered into an agreement with IDEM to prepare a Closure Implementation Plan (CIP) for areas of the property that had historically served as materials management areas. The CIP includes the regrading of these property areas and the consolidation of the soils/materials into one (1) location and that will then be covered/capped in-place. This consolidated area will be vegetated and designed to drain to two (2) dry stormwater/sediment control detention ponds.

The total area of disturbance for this project is estimated to be about 45 acres. The project area will primarily be returned to existing or improved ground cover conditions and is not expected to increase stormwater runoff off-site.



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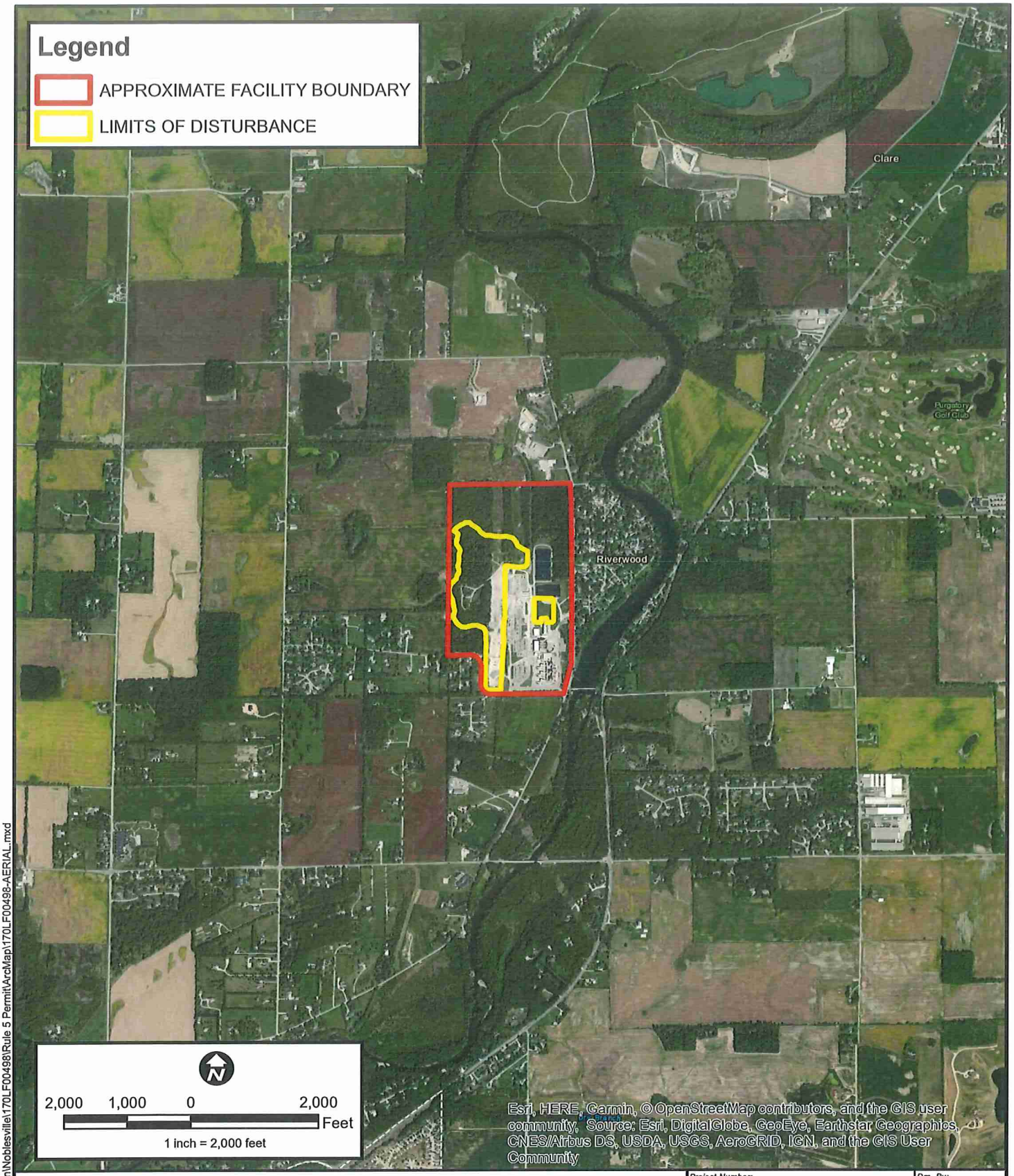
VICINITY MAP
CLOSURE IMPLEMENTATION PLAN - RULE 5 SWP 3
DUKE ENERGY INDIANA
NOBLESVILLE GENERATING STATION
HAMILTON COUNTY, INDIANA

Project Number: 170LF00498		Dm. By: AK
Drawing File: 170LF00498-VICINITY		Ckd. By: JL
Date: 1/25/2019	Scale: 1" = 2000'	App'd By: .
ATC		Figure:



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AERIAL MAP

CLOSURE IMPLEMENTATION PLAN - RULE 5 SWP 3
DUKE ENERGY INDIANA
NOBLESVILLE GENERATING STATION
HAMILTON COUNTY, INDIANA

Project Number: 170LF00498		Dm. By: AK
Drawing File: 170LF00498-AERIAL		Ckd. By: JL
Date: 1/25/2019	Scale: 1" = 2000'	App'd By: .
ATC		Figure:

Stormwater will primarily run off and be controlled within the limits of the project site during construction. Two (2) dry stormwater/sediment detention basins will be created within the project area to collect and control the stormwater runoff. During the construction phase, the stormwater runoff collected in the north side basin will be drained or pumped to the south side basin. The south side basin will be allowed to release a controlled amount of discharge into the existing drainage system on the south side of the project area. Stormwater discharge from the south basin will travel south then east within a vegetated drainage swale along 211th Street through a concrete culvert, which serves as the Noblesville Station's NPDES Stormwater Outfall 101, under Riverwood Avenue and to the White River.

The construction activities for this project are proposed to begin in July 2019 and the permit coverage will be renewed and amended as necessary. A Notice of Termination (NOT) letter will be submitted once the construction site has been stabilized and all temporary erosion and sediment control measures have been removed.

Ms. Rebecca Warren (317-838-2161; rebecca.warren@duke-energy.com) will serve as the Duke Energy project contact and should be contacted for any site inspections during the construction phase at the Noblesville Station.

In addition, Ms. Tena Hopkins (317-838-1462; tena.hopkins@duke-energy.com) is the Duke Energy Environmental Permitting and Compliance Coordinator for this project and should be contacted regarding details associated with this SWP3.

Upon completion of your review, please email a copy of the Notice of Sufficiency (NOS) to Ms. Hopkins of Duke @ tena.hopkins@duke-energy.com and Mr Luckiewicz of ATC @ jim.luckiewicz@atcgs.com.

Should you have any questions concerning the information we have provided here, please do not hesitate to call Ms. Warren or Ms. Hopkins of Duke Energy or the undersigned at 317-849-4990.

Sincerely,

ATC Group Services, LLC (ATC)

James R. Luckiewicz, P.E., CFM
Principal Engineer

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2.2.6. Noblesville Generating Station Closure Implementation Plan Addendum 2, Prepared by ATC Group Services LLC for Duke Energy, VFC #82883999 (ATC Group, 2019)

https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=82884594&dDocName=82883999&Rendition=web&allowInterrupt=1&noSaveAs=1&fileName=82883999.pdf

Information about the Noblesville Generating Station was originally submitted in response to the August 2019 proposed rule. This document pertains to the Noblesville Generating Station and was accessed by EPA through the Indiana Department of Environmental Management (IDEM) "virtual cabinet" file management system. Pages 1-5 of the document are included here and pages 6-11, which contain technical data, are omitted. To access the full posting of the document, please use the link above.

CLOSURE IMPLEMENTATION PLAN
ADDENDUM NO. 2

December 16, 2019

DUKE ENERGY INDIANA, LLC
NOBLESVILLE GENERATING STATION
21225 RIVERWOOD AVE.
NOBLESVILLE, INDIANA 46062

Agreed Order Case No.
2017-24922-S
Indiana Department of Environmental Management
and Duke Energy Indiana, LLC

December 16, 2019

ATC Group Services LLC

7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256

Phone **+1 317 849 4990**
Fax +1 317 849 4278

www.atcgroupservices.com

Mr. George Hamrick
Senior Vice President
Coal Combustion Products
Duke Energy
400 South Tryon Street
Charlotte, NC 28202

Re: Closure Implementation Plan
Addendum No. 2
Noblesville Generating Station
Noblesville, Indiana 46062
ATC Project No. 170LF0498

Dear Mr. Hamrick:

In accordance with your request, ATC Group Services LLC (ATC) assisted Duke Energy Indiana, LLC (Duke Energy) with the preparation of Addendum No. 2 to the Closure Implementation Plan for the Noblesville Generating Station.

We appreciate the opportunity to assist you with this project. If you have any questions concerning information contained in this addendum, please contact our office.

Sincerely,

ATC Group Services LLC

Martin Brungard, P.E., D.WRE
Senior Project Engineer

Donald L. Bryenton, P.E.
Principal Engineer

DONALD LEE BRYENTON
REGISTERED
№ 17477
STATE OF INDIANA
PROFESSIONAL ENGINEER

The following information is provided to document information presented to the IDEM technical staff on December 11, 2019, regarding a request to modify the approved closure plan in the vicinity of the Former Coal Pile Area and the West Structural Fill Area at the Noblesville Generating Station.

Former Coal Pile Area

Duke Energy received approval of the Closure and Post-Closure Plans regarding the historic ash management and beneficial use areas at the Noblesville Generating Station from the Indiana Department of Environmental Management (IDEM) on October 17, 2019. The plans approved by IDEM include the removal of ash placed as backfill within a portion of the limits of the former coal pile area as noted on Drawing No. 22R2 (copy attached) which was submitted in Duke Energy's Closure Implementation Plan Addendum No. 1 dated April 18, 2019.

As noted in the approved closure and post-closure plans, the removal of ash from the Former Coal Pile Area did not include the northeast corner of that area (due to the presence of an existing structure) or the southwest corner of that area (due to the presence of existing utilities).

While preparing the Former Coal Pile Area for closure activities, additional existing utility lines have been encountered. Drawing No. 029 (copy attached) illustrates the location of utility lines identified to date within the limits of the Former Coal Pile Area. As noted on Drawing 029, Duke Energy plans to relocate the existing sanitary sewer line, the existing 8-inch diameter neutralization pipe and the existing buried electric line in order to safely remove the coal ash. However, Duke Energy proposes to modify the limits of the proposed initial ash removal within the Former Coal Pile Area to protect critical plant infrastructure which includes the foundation of the existing cooling tower, the existing system of subsurface perimeter drains that support the operation of the cooling tower, and the buried 12-inch diameter ductile iron pipe and cathodic protection system located in the northwest corner of the Former Coal Pile Area. The proposed revised ash excavation limits are noted on Sheet 029. As noted previously, ash that remains within the limits of the Former Coal Pile Area following this initial phase of closure activities will be removed at a future date when the Noblesville Generating Station is decommissioned.

In the portions of the Former Coal Pile Area where ash will remain in place until decommissioning of the Station, approximately one additional foot of cover soils will added over the existing soils and the disturbed areas will be revegetated. Drawing 030 (copy attached) identifies the approximate limits of the areas where the additional 1 ft of soil will be added.

West Structural Fill Area

The approved closure and post-closure plans also include the removal of ash from below the gravel parking surface in the West Structural Fill Area. As noted on the approved plans (Drawing 022R2), Duke Energy planned to remove ash around the majority of the single wooden poles of the transmission corridor while not disturbing the gravel or the ash within the footprint of the metal transmission towers.

The wooden power poles which support the eastern-most transmission line within the West Structural Fill Area were set before the ash and gravel were placed to form the existing parking/storage area. Therefore, the stability of those poles is not dependent on the presence of the ash and gravel, so those materials can be removed at those locations. However, the

power poles which support the western-most transmission line were installed after the ash and gravel was placed. Further, several of those poles are within 20 ft of the gas transmission line that services the Station. Since the stability of those poles relies on the support of the ash and gravel, those materials will remain in place approximately 5 ft beyond the edge of each pole and then taper to the final grades on a 3H:1V slope. The sides of the remaining cones will be covered with a minimum 2 ft thick vegetative layer and a 1 ft vegetative layer will be place over the gravel that surrounds the poles. A typical detail of the grading and vegetated cover that will be utilized in the vicinity of the wooden poles and guy wires in the western-most transmission line has been added to Drawing No. 028R1. The location of those poles and the proposed offset of the ash removal have been added to Drawing No. 022R3. This ash will be removed during the decommissioning of this portion of the transmission line, or when the poles are replaced.

It has also been determined that it is not possible to safely remove ash from the general vicinity of the single wooden poles which are stabilized with guy wires. The alignment of the transmission lines has been added to Drawing No. 022R3 along with the location of the existing poles and guy wires in question. Duke Energy requests a modification to the closure plan to defer removal of the ash below the gravel surface in the vicinity of those poles/guy wires (~15,000 sf). This ash will be removed during the decommissioning of this portion of the transmission line, or when the poles/guy wires are replaced.

Drawing No. 023R2 is attached to document the revised volume of ash that will be removed to establish the proposed subgrade. The proposed revisions to the limits of ash removal described above with the Former Coal Pile Area and the West Structural Fill Area result in a reduction of approximately 1,700 cy in the volume of ash excavated and placed in the Consolidated Ash Management Area. This reduction is less than 1 percent of the total volume of ash that will be excavated during the closure project.

Updated Closure and Post-Closure Cost Estimates

As discussed during the December 11, 2019 meeting, the proposed changes to the closure plan outlined above would result in a minor reduction to the Closure and Post-Closure Cost Estimates. However, in an effort to help reduce review time of this proposed modification, Duke Energy agrees to utilizing the approved Closure and Post-Closure Cost Estimates until such time that IDEM approves the final closure certification documentation. At that time, adjustments will be made as necessary to reflect the final closure area.

Environmental Restrictive Covenant

As discussed during the December 11, 2019 meeting, Duke Energy understands that the Environmental Restrictive Covenant (ERC) established as part of the closure certification will include a commitment to remove the remaining ash from the Former Coal Pile Area when the Station is decommissioned. Further, the ERC will contain a commitment to complete the removal of ash in the vicinity of the transmission line poles and guy wires when those features are replaced or upon decommissioning of the transmission line.

Appendices

Appendix A – Additional and Updated Drawings

- Drawing No. 022R2 (Approved Closure Plan)
- Drawing No. 022R3 (Proposed Modification to Closure Plan)
- Drawing No. 023R2
- Drawing No. 028R1
- Drawing No. 029
- Drawing No. 030

2.3. Mark Hutson Report for Earthjustice: Responses to EPA Solicitation for Comments on EPA's August 2019 Proposed Rule; Docket No. EPA-HW-OLEM-2018-0524 (Mark Hutson, Geo-Hydro, Inc., 2019)

This document was originally submitted in response to the August 2019 proposed rule.

GEO-HYDRO, INC.
Consulting in Geology and Hydrogeology

16 Mesa Oak
Littleton, Colorado 80127
(303) 948-1417

Responses to EPA Solicitation for Comments on: Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles

Docket Number: EPA-HQ-OLEM-2018-0524

Prepared for:
Earthjustice

October 14, 2019

The United States Environmental Protection Agency (EPA) recently published a Solicitation for Comments on, among other topics, Reconsideration of Coal Combustion Residual (CCR) piles. At the request of Earthjustice I have reviewed the subject request for information and prepared this report that describes my responses to EPA questions pertaining to CCR piles.

1. Background

CCR is managed at electric generating stations in several ways including storage of wet ash in surface impoundments, disposal of dry ash in landfills, collection and sale for beneficial use, and unfortunately, by creating ash piles. Unlike other forms of solid waste such as municipal solid waste (MSW), inorganic coal combustion residuals and the metals they contain do not biodegrade. Coal ash that is present in waste piles, lined landfills, or ash basins will be capable of leaching toxic metals into the environment at any time in the present, or the near or distant future for as long as soluble metals contained in ash are allowed to come into contact with water. Therefore, effective management of coal ash requires that the waste be isolated from water: including precipitation, surface water, and groundwater.

Failure to isolate coal ash waste from water will result in leaching of contaminants, i.e. formation of leachate. "Leachate" "includes liquid, including any suspended or dissolved constituents in the liquid, that has percolated through or drained from waste or other materials placed in a landfill, or that passes through the containment structure (e.g., bottom, dikes, berms) of a surface impoundment."[1] If released to soils, groundwater, or surface water, coal ash leachate impairs and degrades soil and/or water quality and the environment.

Piles of CCR have the potential to impact environmental quality similarly to the well-known and documented impacts from lined and unlined CCR landfills and impoundments. Precipitation that falls on the pile can cause erosion of CCR sediments which can then be transported to adjacent areas. Precipitation can infiltrate into the waste causing generation of leachate. Leachate can run off and transport contaminants off-site and/or can infiltrate into underlying soils and/or groundwater. In addition to impacts to soils, groundwater and surface water, storage of CCR in waste piles carries an additional elevated risk related to dispersal of CCR dust from the pile and subsequent exposure to nearby receptors.

Dust emissions from CCR piles are generated by various processes including loading CCR onto the pile, loading CCR out of the pile, and wind erosion of the CCR while in the pile. Transport of CCR to the pile through the use of trucks, conveyors, or other equipment, involve one or more "drop operations" that generate dust emissions at uncontained CCR piles. At a number of generating stations with CCR piles the CCR is transported onto the pile via conveyors. At these locations emissions result from the release of CCR onto the piles, particularly, when the drop height from the conveyor and the moisture content are not properly controlled.[2] Unloading CCR from a conveyor onto a CCR pile is an example of a continuous drop operation. Depending on

[1] EPA, 2015, at 67,838 and 67,847

[2] Pless Environmental, 2010, Appendix A

the transport system employed, drop operations may occur several times for each load of CCR removed from the pile. Loading waste onto the pile, redistributing waste in the pile, and loading waste off the pile could all be emission points for one load of CCR eventually removed from the pile.

CCR that is dropped onto an outside pile unprotected from wind and precipitation is subject to higher erosion and resultant transport as particulate matter than is a similar volume of CCR placed in an impoundment or landfill. Increased wing erosion is related to both increased surface area and impinging wind velocity. The elevated portions of a CCR pile present a considerably larger surface area that is subject to wind erosion than the footprint of a similarly sized landfill or impoundment. For example, a circular active working face of a coal ash landfill that is 10 meters (m) across has an exposed surface of 78.5 square meters (m^2).[3] A cone-shaped storage pile of the same diameter (10 m) and a height of 3 m has the same footprint (78.5 m^2) but an exposed surface area of 91.6 m^2, a 17% increase.[4,5] In addition, landfilled ash is generally compacted and covered on a regular basis to minimize dust releases and surface water transport. These operational procedures are not applicable to waste stored in piles.

Exposed CCR placed in a pile is subject to higher wind speeds than is contained waste or waste placed in a landfill or impoundment. Wind speed is known to increase with elevation above the surrounding ground surface. Increasing wind velocity with elevation above ground surface causes ash piled high on a waste pile to be subject to increased wind erosion. The erosion potential for most materials tends to decay during a high wind event as easily erodible material is removed from the pile, leaving larger particle sizes to armor the surface. The small size of CCR, however, provides an unending supply[6] of erodible material that can sustain dust emissions for substantial periods without decreasing emission rates. In addition, CCR is continuously added to many piles so there is a constant supply of readily erodible source materials.

Dispersal of CCR dust by the wind can transport CCR in different directions than CCR transported through surface or groundwater transport. Wind dispersed dust can be inhaled or ingested, contaminate the top of the soil layer, and be incorporated into topsoil soil to contaminate plants and animals.

USEPA makes several specific requests for information, including:

- Are there cases where it is acceptable to manage releases retroactively?
- Are there situations where piles are placed for a short period of time, are then removed, and that present no reasonable probability of adverse effects?

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[3] Area of a circle: $A = \pi r^2$

[4] Pless Environmental, 2010, Appendix A

[5] Footprint of cone: $\pi * r^2 = \pi (5m^2)^2 = 78.5\ m^2$;
exposed surface area of cone: $\pi * r \times \sqrt{(r^2 + h^2)} = \pi\sqrt{(5m^2 + 3m^2)} = 91.6\ m^2$

[6] The supply can be thought of as unending as new CCR is continuously being placed on the pile to replace what has been removed

- Is a requirement that a pile be temporary a key element of controlling risks of releases from piles of CCR?
- Is there data documenting instances in which releases from temporary CCR piles have caused adverse effects?
- EPA solicits comments on whether to retain a mass-based threshold.

My comments on each of these requests are provided in Section 3 of this report.

2. Qualifications

I express the opinions in this letter based on my formal education in geology and over thirty-nine years of experience on a wide range of environmental characterization and remediation sites. My education includes Bachelor of Science and Masters of Science degrees in geology from Northern Illinois University and the University of Illinois at Chicago, respectively. I am a registered Professional Geologist (PG) in Kansas, Nebraska, Indiana, Wisconsin, and North Carolina, a Certified Professional Geologist by the American Institute of Professional Geologists, and am a Past President of the Colorado Ground Water Association.

My entire professional career has been focused on regulatory, site characterization, and remediation issues related to waste handling and disposal practices and facilities, for regulatory agencies and in private practice. I have worked on contaminated sites in over 35 states and the Caribbean. My site characterization and remediation experience includes activities at sites located in a full range of geologic conditions, including soil and groundwater contamination in both consolidated and unconsolidated geologic media, and a wide range of contaminants. I have served in various technical and managerial roles in conducting all aspects of site characterization and remediation, including definition of the nature and extent of contamination (including developing and implementing monitoring plans to accurately characterize groundwater contamination), directing human health and ecological risk assessments, conducting feasibility studies for selection of appropriate remedies to meet remediation goals, and implementing remedial strategies. Much of my consulting activity over the last 13 years has been related to groundwater contamination and permitting issues at coal ash storage and disposal sites in numerous states, including Alabama, Arizona, Colorado, North Carolina, Illinois, Indiana, Kansas, Maryland, Minnesota, Mississippi, Montana, New Mexico, Nevada, North Carolina, South Carolina, Pennsylvania, Virginia, Wisconsin.

3. Discussion of Requested Items

The following are my responses to requests for information from USEPA:

3.1 Are there cases where it is acceptable to manage releases retroactively?

The EPA asks if in some cases, it is acceptable to manage releases retroactively. For example, are there situations in which CCR will only enter the topmost layer of soil over the time the CCR is in place at the site, in which retroactive management of these

releases combined with an active management of releases to air and water, could avoid all reasonable probability of adverse effects on human health and the environment. For example, commenters may have information to show that the placement of CCR at a construction site, which typically occurs over a brief, one- time period, is precisely one such situation in which releases to soil and groundwater can retroactively be managed by removing the CCR and the contaminated soil beneath it, at the completion of the project.

A central tenet of responsible waste management is that it be prevention-based. The EPA articulated this tenet in its 1993 guidance for owners and operators of solid waste disposal facilities stating: "Ground water is … used extensively for agricultural, industrial, and recreational purposes. Landfills can contribute to the contamination of this valuable resource if they are not designed to prevent waste releases into ground water … Cleaning up contaminated ground water is a long and costly process and in some cases may not be totally successful."[7]

Unfortunately, environmental and human health impacts from placing CCR on a property, even temporarily, are not restricted to contamination of localized on-site materials. Wind-blown dust from temporarily placed CCR is readily transported from the site and creates opportunities for off-site exposures. Once dust leaves the property, it may enter homes, lungs, etc., producing harm that cannot be remedied.

The Illinois Pollution Control Board recently found that a temporary CCR pile contributed to exceedances of state groundwater standards for arsenic, boron, sulfate, and total dissolved solids, as well as boron and sulfate pollution in excess of state background levels.[8] The extent of soil, groundwater, and particulate dust contamination resulting from even temporary storage of CCR in an uncontained pile would be unknown until testing was completed and may prove to be irreversible. The operator would not be able to assume that removal of, for instance, the top six-inches of soil would retroactively manage the waste. Remediation of groundwater contamination is often a long-term commitment of time, effort and money that often continues for decades. Even once closure is achieved, some residual groundwater impacts remain. A more cost-effective regulatory strategy is to prevent releases to the environment and avoid potential exposures to local human and biological populations. Also, see response to section 3.2, below.

3.2 <u>Are there situations where piles are placed for a short period of time, are then removed, and that present no reasonable probability of adverse effects?</u>

The EPA also seeks comment and data on whether there are additional situations where piles are commonly in place for a short period of time (e.g., 90 days or less), at the end of

[7] EPA, 1993, p.3

[8] Illinois Pollution Control Board, 2019, Sierra Club et al v. Midwest Generation, LLC, PCB No. 2013-15, at 42, 48-51, 86 (Illinois Pollution Control Board June 20, 2019)

> *which the CCR is fully removed and presents no reasonable probability of adverse effects on human health or the environment, thus supporting an exemption from having to meet the requirement to control releases. The EPA also asks for information about key characteristics of such piles that would make them readily identifiable in practice.*

There are no CCR pile characteristics or situations that would dependably render a CCR waste pile safe to leave exposed to the environment for even a short period of time. In fact, the Illinois Pollution Control Board recently found that a temporary ash pile – in existence for a mere "two to three" months – contributed to exceedances of state groundwater standards for arsenic, boron, sulfate, and total dissolved solids, as well as boron and sulfate pollution in excess of state background levels.[9]

In practice, the ability to pile CCR on the ground surface for a "short" period of time and remove said pile and contaminated underlying soils without leaving lasting environmental effects is highly contingent on a variety of factors including:

- The type and amount of CCR as well as the type and concentrations of environmental contaminants contained within the waste.
- Leaching of some contaminants such as boron from CCR can be highest as the first few pore volumes of water pass through the waste. A pile of CCR that contains rapidly leaching contaminants could conceivably lose a considerable volume of contaminants during even very short-term storage in a waste pile, especially if a period of significant precipitation occurs before the CCR is removed.
- The physical characteristics of the ground surface upon which the waste would be placed. Waste piled on a substantial naturally occurring clay bed would be much less likely to spread subsurface contamination than would a pile placed on a sandy surface.
- Weather and environmental factors would also play an important part in determining the extent of redistribution of piled CCR. A significant rain or wind event that occurred while CCR was piled on the ground surface could cause significant mobilization and transport of waste from the original location.

The above bullets provide examples of just a few of the many site–specific variables that impact the potential for adverse effects from CCR piles. These examples should provide an indication of the folly of proposing a blanket authorization to store CCR in an uncontained pile on the ground and why such an authorization would not be protective of the environment. Requiring an Environmental Determination[10], at the very least, causes operators to think about and plan to avoid potential problems with short-term storage of CCR in waste piles and should continue to be required as well as specific and meaningful safeguards preventing releases from short-term storage piles.

[9] Illinois Pollution Control Board, 2019, p. 42.
[10] Campbell, 2019

3.3 *<u>Is a requirement that a pile be temporary a key element of controlling risks of releases from piles of CCR?</u>*

EPA requests comment on whether requiring that a pile must be temporary is a key element of controlling risks associated with the potential releases from piles of CCR; for example, do commenters have information to show that the size of a pile is sufficiently controlled by the ability to use pollution control measures to control releases of CCR and that the temporary element is not needed.

"Temporary" piles of CCR are constant or nearly-constant features at sites that manage their CCR in waste piles. In practice CCR stored in piles is routinely added-to and taken-from as new waste is added to the pile and other waste is loaded out. Releases of CCR contaminants are nearly inevitable at sites where a large uncontained accumulation of CCR is allowed; whether or not there are records available indicating that each cubic yard of ash has been present in a pile for a defined period of time. Examples of sites that handle CCR in "temporary' CCR piles and have documented groundwater contamination as a result of these waste handling practices include the AES –Puerto Rico Guayama Plant, the Southwestern Electric Power Company Pirkey Plant, and the Powerton Coal Ash Pile. Descriptions of environmental impacts from CCR piles at these facilities are provided in my response to item 3.4, below.

3.4 *<u>Is there data documenting instances in which releases from temporary CCR piles have caused adverse effects?</u>*

The EPA also solicits comment on the existence of any data documenting instances in which releases from temporary placement of CCR on the land caused adverse effects even though releases had been managed consistently with current regulatory standards.

There are numerous sites that store, or have stored, CCR in uncontained piles. Unfortunately the environmental monitoring practices required by EPA are commonly insufficient to definitively attribute detected environmental contaminants to waste piles rather than adjacent or nearby CCR landfills or waste impoundments that are monitored together as one unit. In effect, EPA has allowed monitoring systems to collect data covering multiple CCR units and is now asking for waste pile specific data, data that EPA has not generally required be collected. Despite the difficulty of attributing environmental contamination solely to CCR piles, there are examples of CCR waste piles that do show documented impacts to groundwater. Short descriptions of documented environmental impacts from CCR stored in temporary piles are provided below.

<u>AES Puerto Rico - Guayama, Puerto Rico</u>
AES-PR has stored a mixture of fly ash and bottom ash formed into a material called AGREMAX in piles on the plant site since approximately 2005. According to AES inspection reports posted in 2016, 2017 and 2018, the volume of the CCR pile maintained at the power plant site and regulated under the CCR rule was 120,000, 430,000 and 400,000 tons,

respectively. The height of the pile was approximately 120 feet. Air pollution and groundwater contamination has been documented in required groundwater monitoring reports and annual site inspection reports.

Groundwater monitoring required by the federal CCR rule at the AES-PR Power Plant indicates statistically significant increases of several coal ash constituents including boron, chloride, fluoride, sulfate, pH, and TDS in downgradient groundwater. In addition, the 2017 Site Inspection Report posted to the CCR compliance website documents the presence of fugitive dust on the west slope of the CCR stockpile. The report indicates that the water truck that is reportedly used to moisten CCR and control dust was not operational at the time of the inspection. Both the statistically significant increases in CCR-related groundwater contamination and observable blowing dust issues documented on the AES-PR CCR compliance website directly result from uncontained storage of CCR in piles on the site.

H.W. Pirkey Power Station, Hallsville, TX

Southwest Electric Power Company operates an approximately 7-acre Flue Gas Desulfurization (FGD) sludge storage area to collect and temporarily store CCR materials in piles. The FGD Stackout area is utilized as a temporary staging area for CCR material, including fly ash and FGD Sludge.[11] Reports of inspections conducted on the Stack-Out Pad in 2016, 2017, and 2018 indicate that the waste volume in storage at the time of the inspections were 30,000 cubic yards; 10,000 cubic yards; and 500 cubic yards, respectively. A photograph of CCR piles at the Pirkey stakeout area taken during the 2016 CCR inspection[12] is provided below.

Photograph #13	September 28, 2016
Direction:	Facing south southwest
Description:	Typical CCR material pile staged on FGD Stackout Area.

[11] Braun Intertec, 2016
[12] Braun Intertec, 2016

Runoff from the Stackout Area drains by gravity to surge ponds where the runoff is supposedly collected and recirculated back to the plant. A photograph of the Stackout Area Surge Pond taken during the 2016 CCR inspection[13] is provided below.

Photograph #9	September 28, 2016
Direction:	Facing northwest
Description:	Discharge pipe in Surge pond north of FGD Stackout Area.

The Annual Groundwater Monitoring Report for the Pirkey FGD Stackout Area[14] showed statistically significant increases in concentrations of the Appendix III constituents boron, chloride, and sulfate in downgradient groundwater. In addition, Southwestern Electric Power Company recently placed a notice of Statistically Significant Levels above the Groundwater Protection Standards for the Appendix IV constituent Beryllium in groundwater at the FGD Stackout Area. These results provide documentation of impacts to groundwater quality from a CCR waste pile.

Powerton Coal Ash Pile

Even very short-duration coal ash piles are sources of contamination. In June 2019, the Illinois Pollution Control Board found that a temporary ash pile – in existence for a mere "two to three" months – contributed to exceedances of state groundwater standards for arsenic, boron, sulfate, and total dissolved solids, as well as boron and sulfate pollution in excess of state background levels.[15] The Board likewise concluded that the temporary coal ash pile constituted a "water pollution hazard."[16]

Examples of sites where the monitoring systems are or were insufficient to distinguish between contamination from CCR waste piles and other CCR units include the Prairie Creek Generating Station in Cedar Rapids, IA; the Lewis & Clark Station located near Sidney, MT; and the Healey

[13] Braun Intertec, 2016
[14] American Electric Power Service Corporation, 2019
[15] *See* In the Matter of: Sierra Club et al v. Midwest Generation, LLC, PCB No. 2013-15, at 42, 48-51, 86 (Illinois Pollution Control Board June 20, 2019)
[16] Id. at 86

Power Plant, in Healy, AK. Short descriptions of these sites coal ash piles for which current monitoring is ineffective are provided below.

Prairie Creek Generating Station

CCR piles at the Prairie Creek Generating Station originally included a Fly Ash Stockpile, Bottom Ash Pile, and a Beneficial Use Storage Area. The fly ash stockpile has not received CCR since October 19, 2015 and is therefore not counted as a CCR unit. The PCS Bottom Ash Pile was located immediately east of the where the sluiced CCR entered Pond 1. After the CCR was dewatered at the Bottom Ash Pile, the CCR was either hauled directly offsite or transported to the Beneficial Use Storage Area. The Closure Plan[17] for these waste piles estimated quantity of CCR in the inactive fly ash stockpile as 58,000 cubic yards. The estimated quantity of CCR in the Bottom Ash Pile and Beneficial Use Storage Area were estimated as 2,500 cubic yards and 7,000 cubic yards, respectively. The closure footprint likely does not theoretically include the former waste pile footprints, but the waste piles could have contributed to contamination. Notification of Closure Completion for the Bottom Ash Pile and Beneficial Use Storage Area was posted to the site operating record in December, 2018.

The Prairie Creek Generating Station posted a notification of concentrations of arsenic and molybdenum groundwater at statistically significant levels above Groundwater Protection Standards (GWPS).[18] The Bottom Ash Pile was located outside of the monitoring network, but the Fly Ash Pile and Beneficial Use Storage Area were located between the upgradient and downgradient wells along with other closure units, so contaminants from the units may have been detected along with overall site contamination.

Lewis & Clark Station

CCR from two scrubber ponds at the Lewis & Clark Station was stockpiled, until 2018, on a temporary CCR storage pad located adjacent to the scrubber ponds until it could be transported to the permanent ash disposal facility. As operations permit, the stockpiled CCR was loaded into trucks and transported offsite for disposal at an abandoned coal mine. The Lewis & Clark station posted a notification of concentrations of lithium and selenium in groundwater at statistically significant levels above Groundwater Protection Standards (GWPS).[19] Other groundwater contaminants detected at concentrations above background included boron, cobalt, molybdenum, and sulfate. Attribution of the detected groundwater contamination to either the scrubber ponds or the temporary storage pad has not been made since the ponds and pad are located within the same groundwater monitoring network.

Healy Power Plant

CCR handling and storage at the Healy Power Plant consisted of dredging settled ash from the Ash Pond and its subsequent placement in piles on the Ash Drying Area where excess water

[17] Alliant Energy 2018
[18] Alliant Energy, 2019
[19] BARR, 2019

infiltrated to the subsurface and evaporated. Once dry, the ash was then transported for disposal in the mine that supplied the coal. A photograph of the of the groundwater monitoring results reported in 2019[20] showed that seven appendix IV constituents (antimony, arsenic, chromium, fluoride, lithium, molybdenum, and selenium) were detected in at least one monitoring well at concentrations above the GWPS. The exceedances in groundwater appeared to originate from suspected source areas including the Ash Pond, Recirculating Pond, and Ash Drying Area. Attribution of the detected groundwater contaminants to a specific source location has not been made since the ponds and Ash Drying Area are located within the same groundwater monitoring network.

3.5 EPA solicits comments on whether to retain a mass-based threshold.

> EPA is proposing to eliminate *the mass-based numerical threshold and replace it with specific location-based criteria, derived from the existing location criteria for CCR disposal units, to trigger an environmental demonstration. As discussed further below the available information does not appear to provide strong support for a single numerical mass-based threshold as a general matter; however, EPA solicits comments on whether to retain a mass-based threshold. Assuming EPA determines a threshold to be appropriate, EPA also solicits comments on whether an appropriate value for a mass threshold to trigger and environmental demonstration should be based on the state beneficial use programs' lower tonnage thresholds, discussed above, or to retain the current 12,400-ton numerical criterion.*

Placement and storage of CCR in piles should trigger an environmental demonstration regardless of the size of the pile or duration of the planned storage. All waste piles should also be subject to meaningful storage regulations that prevent releases of CCR to the environment, regardless of the size of the pile or duration of storage. The requirement for an environmental demonstration causes CCR users to actively consider their plans and procedures for containment of CCR prior to potential impacts to human health or the environment. I hold this opinion based on my previous experience as a technical advisor for the citizen's group at the Town of Pines Groundwater Plume Alternative Superfund Site in Town of Pines, IN. Sampling conducted during a Remedial Investigation in Town of Pines identified that fly ash was used as landscaping fill in and around the town. Concentrations of CCR constituents that presented and unacceptable exposure risk to human health were found on at least 45 properties. CCR used as fill on residential and public properties had created risks for residents who unknowingly lived with waste at or very near the surface of their properties.

Residents of the Town of Pines were exposed to elevated risks from CCR through direct exposure to soils, CCR-contaminated groundwater in their wells, and exposure to CCR dust. Laboratory analysis of surficial soil samples collected at the Pines Town Hall playground showed arsenic concentrations of up to 430 milligrams per kilogram (mg/kg), nearly an order of

[20] Golden Valley Electric Association, 2019

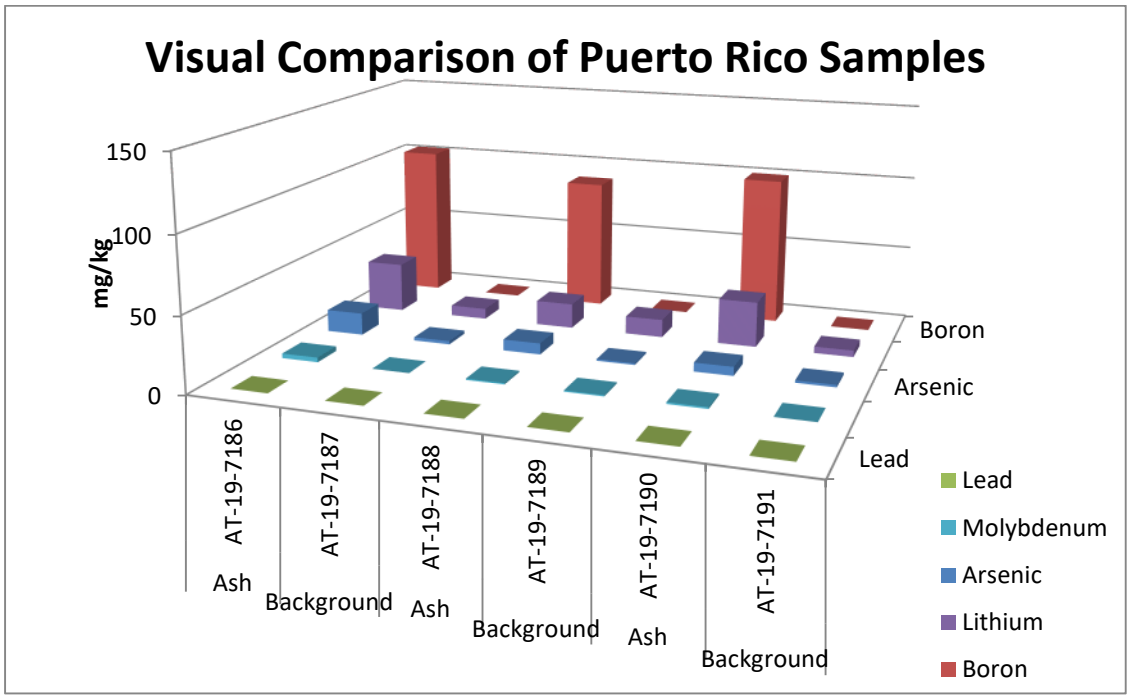
magnitude above the 67 mg/kg USEPA Removal Management Level for arsenic. In some cases residents had consumed vegetables produced in gardens and allowed children to play and dig in CCR contaminated areas. None of the residential properties would likely have triggered the 12,400-ton numerical criterion to trigger a demonstration, yet the risk posed by these wastes was sufficient to trigger an EPA removal action. Soil removal in progress at the Town of Pines Park is shown in the photograph below.[21]

A current example of human health and environmental exposures through small volume use of CCR as fill material can be found in Puerto Rico, near the AES-PR plant in Guayama, PR. Materials reported by residents to be CCR obtained from the AES-PR plant have been spread as fill in many public areas, including roadways, and remain on the surface where human and animal receptors are directly exposed, and contaminants are spread by wind and precipitation. I have examined and reviewed chemical analyses of these materials. The tested samples are amorphous solids that are enriched in arsenic, boron, and lithium (see below) as compared to local background soils, consistent with CCR from a fluidized bed generating station.

The concentration of arsenic detected in samples of CCR exposed on the ground surface were found to exceed the USEPA Regional Screening Level and thus, would pose a human health hazard in residential areas, where some of the materials are in fact located. None of the many dispersed areas where CCR has been spread on the surface around Guayama, PR would likely trigger the need for a demonstration at the current 12,400-ton trigger volume. Maintaining and strengthening a requirement for an environmental demonstration before CCR can be used as fill,

[21] Picture from South Bend Tribune, June 27, 2016

in any volume, and applying CCR landfill standards to all fill projects, would help to avoid drive these types of exposures in the future.



The reported CCR deposits located around the Guayama area are shown in the following photographs.

The above findings are based on my review of the USEPA request for information, available sources including previous USEPA policies and guidance, available information and data about example sites, and my education, qualifications, experience, and expertise.

I would be happy to discuss my thoughts on these or other CCR–related issues with USEPA at any time.

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References

Data and information sources reviewed included the following documents:

Akron Consulting, 2016, Initial CCR Inspection, H.W. Pirkey FGD Stackout Area, Hallsville, Harrison County, Texas, January 19, 2016

Alliant Energy, 2018, Closure Plan for Existing CCR Surface Impoundments and CCR Landfills, August 28, 2018

Alliant Energy, 2019, Notification of Groundwater Protection Standard Exceedance pursuant to 40 CFR 257.95, February 13, 2019

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Illinois Pollution Control Board, 2019, Sierra Club et al v. Midwest Generation, LLC, PCB No. 2013-15, at 42, 48-51, 86 (Illinois Pollution Control Board June 20, 2019)

Pless Environmental, 2010, Review of EPA's Inhalation of Fugitive Dust: A Screening Assessment of Risks Posed by Coal Combustion Waste Landfills, prepared for Environmental Integrity Project.

APPENDICES

Pless Report

Pless Environmental, Inc.
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BY EMAIL

November 16, 2010

Eric Schaeffer
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Washington, DC 20005

Re: Review of EPA's Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills

Dear Mr. Schaeffer,

Per your request, I have reviewed *Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills* (hereafter "Screening Assessment") published by the U.S. Environmental Protection Agency ("EPA") for review in September 2009.[1] My review concentrates on EPA's assumptions for the development of emission factors for airborne particulate emissions from coal combustion waste ("CCW") landfills.

My qualifications as an environmental expert include a doctorate in Environmental Science and Engineering ("D. Env.") from the University of California Los Angeles. My résumé is attached to this letter.

Background

In 2009, EPA published the *Human and Ecological Risk Assessment of Coal Combustion Wastes* ("2009 Risk Assessment"). During the peer review and notice of data availability to the public for the draft of this document, EPA received comments pointing out that health risks from fugitive dust particulate matter emissions during operation of a CCW landfill via the inhalation pathway were not addressed. In response, the EPA prepared the Screening Assessment as a companion document to the 2009 Risk Assessment intended to examine the potential for uncontrolled fugitive dust emissions from dry handling of CCW to lead to significant human health risks.[2]

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[1] U.S. Environmental Protection Agency, Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills, Draft, September 2009.

[2] *Ibid*, p. 2.

The stated purpose of the Screening Assessment is "to assess whether the national ambient air quality standards … for particulate matter could be violated through CCW landfilling operations without fugitive dust controls ... via a conservative screening analysis."[3]

Executive Summary

After reviewing the Screening Assessment, I find that the methodology employed is overly simplistic, not sufficiently conservative and contains several errors. As a result, the Screening Assessment generally underestimates risks to receptors. For example, it is nonsensical to analyze the percentiles of landfill sizes and distances to receptors without acknowledging the extreme variability of emission factors for wind erosion, drop operations, and entrained road dust from equipment travel on unpaved landfill roads and their considerable contribution to total emissions of airborne particulates from a CCW landfill.

My comments should be viewed as suggestions regarding how the Screening Assessment could be improved and best used by the EPA in developing recommendations for CCW landfill management. Revision of the Screening Assessment taking into account the issues in my following comments would considerably improve the reliability of its results and conclusions. However, since the Screening Assessment for the most part underestimates risks to receptors, its conclusion to require daily controls as a safeguard for not causing excess levels of particulates at CCW landfills can be upheld without further review. In particular, daily landfill cover, rather than watering, is recommended for the best control, as watering alone is not sufficiently effective.

In addition, because of the substantial risks for residents living near CCW landfills, I recommend that the EPA conduct a full-scale health risk assessment that addresses both toxic constituents of fugitive dust emissions from landfills and emissions of diesel particulate matter from haul trucks, on-site heavy-duty landfill equipment, and diesel-powered pumps and generators.

Sincerely,

Petra Pless, D.Env.

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[3] *Ibid*, p. 3.

Comments

The following table of contents summarizes the organization of this letter:

I. Summary of Screening Assessment Methodology and Results 4

II. Discussion of Screening Assessment Methodology 5

II.A Assumption of Wind Erosion of CCW Landfill as Sole Source of Particulate Matter Emissions Is Not Adequate 5

1. Entrained Road Dust from Equipment Traffic on Unpaved Roads 9
2. Emissions Associated with Drop Operations 13
3. Emissions Associated with Landfill Equipment 17

II.B Assumptions for Estimating Particulate Emissions due to Wind Erosion Are Not Sufficiently Conservative 17

II.C The Choice of 10th Percentile of Landfill Distance to Nearest Receptor Is Not Acceptable 20

II.D Assumed Control Efficiency for Wind Erosion via Cover or Spraying of Active Portion of Landfill Is Unrealistic 21

II.E Assumed Sizes of Active Portions of Landfill Are Unrealistic 21

II.F Assumption of Active Portion in Center of Landfill Does Not Constitute Worst Case Scenario 22

III. Potential Human Health Risks from Fugitive Dust via Inhalation Pathway Have Not Been Adequately Assessed 25

IV. Recommendations for Landfill Management 28

V. Typographical Errors 29

I. Summary of Screening Assessment Methodology and Results

The Screening Assessment includes the following steps to determine whether airborne particulate matter from CCW landfills would potentially exceed the national ambient air quality standards ("NAAQS") for particulate matter smaller than or equal to 10 micrometers ("PM10") and smaller than or equal to 2.5 micrometers ("PM2.5"):

Initial Scenario (Uncontrolled Landfill)

1. Determined the receptors with the highest exposure to CCW particulate emissions as residents living near CCW landfills and the most important source of particulate matter at the CCW landfill as wind erosion. Emissions from unloading of CCW at the landfill were excluded assuming they would have an increasingly lower contribution relative to total emissions from the entire landfill area exposed to wind erosion as the landfill approaches capacity over its useful life. (Section 2.1.)
2. Determined an emission factor for particulates resulting from wind erosion of CCW landfills based on the equation for "Continuous Fugitive/Windblown Dust Emissions" in EPA's 1992 *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. Calculation of the emission factor is based on the assumption that the CCW consists of fly ash and the landfill is not covered does not have any controls to reduce wind erosion. (Section 2.2.)
3. As conservative assumptions for modeling, determined the 50th through 90th percentiles of landfill sizes and side length assuming that the landfills were square; determined the 10th through 50th percentiles of landfill distances to residential receptors based on available data on the distance of residential wells to landfills. The maximum size of landfills and minimum distance from landfill to receptor were excluded as being too conservative to be considered reasonable. Taken together, the combination of sizes and distances do be modeled were assumed to provide both a true median (50th/50th) and upper tail (90th/10th) of the input distribution that would be modeled in a probabilistic assessment. (Section 2.3.)
4. Determined other input parameters for SCREEN3, a single-source Gaussian plume screening model which provides maximum ground-level concentrations for point, area, flare, and volume sources. (Section 2.4.)
5. SCREEN3 modeling for both 50th percentile values for landfill side length and distance to receptors found that uncontrolled particulate matter emissions from wind erosion of CCW landfills (13,390 $\mu g/m^3$) would exceed the 24-hour NAAQS for PM10 (150 $\mu g/m^3$) by almost two orders of magnitude. Thus, risks posed by fugitive dust cannot be screened out if no dust controls are applied to the landfill before closure. (Section 2.5.)

Secondary Scenarios (Controlled Landfill)

6. Assumed that only a fraction of the CCW landfill would be exposed to wind erosion and the other remaining portion of the landfill would be controlled 100% assuming yearly, monthly, weekly, or daily control via spraying or covering over the landfill's useful life of 40 years. It was assumed that the exposed fraction of the landfill would be square and located in the center of the landfill. (Section 3.0.)
7. SCREEN3 modeling for both 50th percentile values for landfill side length and distance to receptors found that fugitive dust emissions with yearly and monthly controls of the landfill

would exceed the 24-hour NAAQS for PM10. Since emission estimates for weekly and daily controls for fugitive dust were below the 24-hour NAAQS for PM10, further permutations of inputs were entered into the model to determine the likelihood that operating with those frequencies of controls would be adequate to protect human health. (Section 3.1.)

8. The Screening Assessment concludes that only daily controls of landfills would guarantee particulate matter concentrations below the NAAQS for PM10 and PM2.5. (Sections 4.0 and 5.0.)

II. Discussion of Screening Assessment Methodology

In general, the Screening Assessment's approach to evaluating the potential of airborne particulate matter from CCW landfills exceeding the NAAQS is reasonable. However, the methodology relies on several overly simplistic or not sufficiently conservative assumptions and contains a number of errors. A revision of the Screening Assessment to address these issues would greatly improve the reliability of its conclusions and any recommendations for CCW landfill management that can be derived from them.

II.A Assumption of Wind Erosion of CCW Landfill as Sole Source of Particulate Matter Emissions Is Not Adequate

Total fugitive dust emissions into the air from dry-handling CCW result from several distinct source activities: loading onto trucks, conveyors, railcars, or barges; emissions during transport from the power plant to a landfill; direct unloading from trucks or conveyors or unloading of railcars or barges via mobile equipment; wind erosion of piles in open trucks, railcars or conveyors; wind erosion from a landfill; and entrained road dust from truck and heavy-duty equipment traffic on paved and unpaved roads to and at a landfill. Potential receptors of airborne emissions include residents near the power plant, along the transportation route and at the landfill.

The Screening Assessment concludes that residents living near a CCW landfill would be exposed to higher emissions and for longer periods of time than residents living near power plants where CCW is handled or near roads where CCW is transported because residents near landfills would be exposed to emissions from both unloading and windblown emissions of CCWs. The Screening Assessment therefore only further considers residents near landfills as a highly exposed receptor population. The Screening Assessment further reasons that, the closer an uncovered landfill gets to capacity towards the end of its operating life, the less relative influence unloading emissions would have on total (uncontrolled) emissions. Consequently, the Screening Assessment considers windblown emissions as representative for its preliminary scenarios because they would dominate and, thus, only quantifies windblown emissions.[4] This assumption is overly simplistic and not supported by evidence as discussed in the following comments.

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[4] Screening Assessment, p. 4.

First, the Screening Assessment fails to provide even a preliminary estimate for sources of fugitive dust emissions other than windblown erosion and their relative contribution to total emissions from the landfill to verify that its assumption that wind erosion is the dominating emission source and other sources of emissions are negligible is defensible.

These other sources, *e.g.*, fugitive dust emissions associated with unloading of fly ash[5] at a CCW landfill, entrained road dust from equipment travel on unpaved roads at the landfill, and unloading can be substantial.

The Screening Assessment fails to even recognize entrained road dust emissions from equipment travel on unpaved roads at the landfill as a potential source of airborne particulates. Equipment at the landfill includes both haul trucks and mobile equipment such as dozers or scrapers. At CCW landfills the temporary roads frequently consist of the deposited material, *i.e.*, flyash, and are therefore, without proper management, prone to releasing clouds of dust when equipment travels over them. Entrained road dust emissions can be a major contributor to airborne fugitive dust, as shown in the photographs below. (Note plumes of dust emanating from vehicle tires.)

Figure 1: Dust clouds from vehicle travel on unpaved road at CCW landfill in Bokoshe, OK

Photo courtesy of Linda Evans, EarthJustice

[5] Fly ash is fine powder with a mean particle size of 50 micrometers ("µm"); between 60 and 90 percent of fly ash particles are finer than 75 µm.

Figure 2: Dust clouds from vehicle travel on unpaved road at a surface mine

From: Reed WR, Organiscak JA, Haul Road Dust Control Fugitive Dust Characteristics from Surface Mine Haul Roads and Methods of Control; http://www.cdc.gov/Niosh/mining/pubs/pdfs/hrdcf.pdf

The following photograph shows clouds of dust released during unloading of fly ash at a CCW landfill.

Figure 3: Fly ash dumping at CCW landfill in Bokoshe, OK

Source: Fly Ash in the Air We Breathe; http://www.intheairwebreathe.com/html/what_is_fly_ash_.html

In addition, dust is released when on-site equipment such as dozers and scrapers move, compact and contour the deposited fly ash. The following photographs show the variety of heavy-duty equipment operating simultaneously at a CCW landfill.

Figure 4: Fly ash management at Arrowhead Landfill, AL
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 5: Fly ash management at Arrowhead Landfill, AL,
From: New York Times, Clash in Alabama Over Tennessee Coal Ash, August 29, 2009;
http://www.nytimes.com/2009/08/30/us/30ash.html?_r=2&ref=earth

Clearly, emissions of entrained road dust from equipment travel on unpaved roads, unloading, and compacting and contouring the landfill can be substantial and should not be excluded from the Screening Assessment without a quantitative demonstration that these

emissions are indeed negligible compared to the total emissions from wind erosion. This is particularly important for the daily and weekly control scenarios evaluated in the Screening Assessment's Section 3.0 when emissions associated with wind erosion are restricted to a small active portion of the landfill and entrained road dust emissions and emissions from unloading and entrained road dust from vehicle travel on unpaved roads will contribute a larger percentage to total emissions.

At a number of coal-fired power plants, the landfill is directly adjacent and CCW is transported via conveyor belts to the landfill. At such landfills, emissions result from the release of fly ash onto the piles at the landfill, particularly, when the drop height from the conveyor and the moisture content of the material are not properly controlled. Railcar transport results in emissions at the landfill from unloading railcars into dozers or other landfill equipment and unloading of that equipment.

The following sections provide estimates of particulate matter emission factors for equipment traffic on unpaved roads and drop operations and compare them to the emission factor developed by the Screening Assessment for particulate matter emissions from wind erosion.

1. Entrained Road Dust from Equipment Traffic on Unpaved Roads

Emission Factors Based on Vehicle Distance Traveled

Emission factors for entrained road dust from equipment traffic (trucks, front-end loaders, dozers, etc.) on unpaved roads to the active section of the landfill can be estimated using an equation in EPA's *Compilation of Air Pollutant Emission Factors* ("AP-42") for *Unpaved Roads* at industrial sites, *i.e.*, sites that are not publicly accessible:

$$E_{VMT} = k\,(s/12)^{a}\,(W/3)^{b} \qquad \textbf{Equation 1}$$

where:

E_{VMT} = particle size-specific emission factor (lb/VMT)
k = particle size-specific empirical constant (lb/VMT)
s = surface material silt content (%)
a = particle size-specific empirical constant (dimensionless)
W = mean vehicle weight (tons)
b = particle size-specific empirical constant (dimensionless)[6]

Because many landfills build their internal temporary roads out of the deposited material itself, the silt content of the fly ash can be assumed as a worst-case estimate for the unpaved road surface material silt content at a CCW landfill. For the following estimate, a

[6] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.2 Unpaved Roads, updated November 2006.

lower-end value for the surface material silt content, 20%, was chosen based on the silt content determined for various roads in western surface coal mining, including haul roads to/from pit, plant road, scraper route, and freshly graded haul road (range 2.8%-29%; mean 5.1%-24%).[7] An upper-end value for the surface material silt content, 80%, was based on the silt content of fly ash as assumed by the Screening Assessment. Thus, based on Equation 1 and assuming a surface material silt content of 20% or 80% and a mean vehicle weight of 30 or 40 tons (average of vehicle weight full/vehicle weight empty) as lower and upper end variables, and the respective particle size-specific constants k, a, and b[8] for particulate matter equal to or smaller than 30 micrometers ("PM30")[9], PM10 and PM2.5, emission factors ("E_{VMT}") for the respective particle sizes in pounds per vehicle mile traveled ("lb/VMT") and grams per vehicle kilometer traveled ("g/VKmT") can be estimated as shown in Table 1 and Table 2 below.

Table 1: Particle size-specific emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads (mean vehicle weight 30 tons)

Particulate Size	A Surface material silt content 20% E_{VMT} (lb/VMT)	A Surface material silt content 20% E_{VMT} (g/VKmT)[a]	B Surface material silt content 80% E_{VMT} (lb/VMT)	B Surface material silt content 80% E_{VMT} (g/VKmT)[a]
PM30	19.7	5,567	52.1	14,690
PM10	6.7	1,887	23.3	6,572
PM2.5	0.7	189	2.3	657

a 1 lb/VMT = 281.9 g/VKmT

Table 2: Particle size-specific emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads (mean vehicle weight 40 tons)

Particulate Size	C Surface material silt content 20% E_{VMT} (lb/VMT)	C Surface material silt content 20% E_{VMT} (g/VKmT)[a]	D Surface material silt content 80% E_{VMT} (lb/VMT)	D Surface material silt content 80% E_{VMT} (g/VKmT)[a]
PM30	22.5	6,336	59.3	16,721
PM10	7.6	2,148	26.5	7,480
PM2.5	0.8	215	2.7	748

a 1 lb/VMT = 281.9 g/VKmT

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[7] *Ibid*, Table 13.2.2-1.

[8] *Ibid*, Table 13.2.2-2:

Constant	PM30	PM10	PM2.5
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

[9] Particulate matter with an aerodynamic diameter less than or equal to 30 micrometers is sometimes termed "suspendable particulate" and is often used as a surrogate for total suspended particulate matter ("TSP").

As shown in Table 1 and Table 2, emissions per vehicle mile traveled increase proportionally with silt content. As shown, the surface material silt content of the road has greatly influences the emission factors: from 20% to 80% silt content, emission factors rise by a factor of 2.6 for PM10 and 3.5 for PM10 and PM2.5. (*See* Table 1, Columns A and B, and Table 2, Columns C and D.)

A higher mean vehicle weight also increases emission factors: at 20% silt content, the emission factors rise by 43% for PM30 and 33% for PM10 and PM2.5 with increasing mean vehicle weight from 30 to 40 tons. (*See* Table 1, Column A, and Table 2, Column C.) At higher silt contents, the influence of mean vehicle weight on emission factors is not as pronounced: at 80% silt content, an increase in mean vehicle weight increases emission factors by 14%. (*See* Table 1, Column B, and Table 2, Column D.)

Area-specific Emission Factors

The following provides estimates for area-specific emission factors for fugitive dust emissions from unpaved roads that can be compared to the area-specific emission factor determined by the Screening Assessment for wind erosion:

On an area (unit square meter)-basis, it depends how many vehicles travel over the same road on a given day. Conservatively assuming that each vehicle travels twice over the same portion of the road while driving to and from the active portion of the landfill as landfill roads are often narrow, *i.e.*, traveling a distance of two meters ("m") on each square meter unit road, and assuming that vehicles would access the landfill over the entire 24-hour day, the unit emission factors ("E"), in grams per second and square meter ("g s^{-1} m^{-2}") for the respective particle sizes for 1, 10, 20, and 50 vehicles per day can be estimated as shown in Table 3 for a road surface material silt content of 20% and assuming the landfill operates 24 hours per day and in Table 4, as a worst-case assumption, for a road surface material silt content of 80% and assuming the landfill operates 8 hours per day.

Table 3: Particle size-specific unit emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads based on 20% silt content, mean vehicle weight of 30 tons, and 24 hours/day landfill operation

	E[a]			
Particulate Size	**1 vehicle/day (g s^{-1} m^{-2})**	**10 vehicles/day (g s^{-1} m^{-2})**	**20 vehicles/day (g s^{-1} m^{-2})**	**50 vehicles/day (g s^{-1} m^{-2})**
PM30	1.29E-04	1.29E-03	2.58E-03	6.44E-03
PM10	4.37E-05	4.37E-04	8.74E-04	2.18E-03
PM2.5	4.37E-06	4.37E-05	8.74E-05	2.18E-04

a E = (E_{VMT} in g/VKmT) x (2 m traveled/vehicle) x (number of vehicles/day) x (Km/1,000 m) x (day/24 hours) x (hours/28,800 seconds) x (m^{-2})

Table 4: Particle size-specific unit emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads based on 80% silt content, mean vehicle weight of 40 tons, and 8 hours/day landfill operation

Particulate Size	E[a] 1 vehicle/day ($g\ s^{-1}\ m^{-2}$)	10 vehicles/day ($g\ s^{-1}\ m^{-2}$)	20 vehicles/day ($g\ s^{-1}\ m^{-2}$)	50 vehicles/day ($g\ s^{-1}\ m^{-2}$)
PM30	1.16E-03	1.16E-02	2.32E-02	5.81E-02
PM10	5.19E-04	5.19E-03	1.04E-02	2.60E-02
PM2.5	5.19E-05	5.19E-04	1.04E-03	2.60E-03

a E = (E_{VMT} in g/VKmT) x (2 m traveled/vehicle) x (number of vehicles/day) x (Km/1,000 m) x (day/8 hours) x (hours/28,800 seconds) x (m^{-2})

As the results in Table 3 and Table 4 show, the fugitive dust emission factors for PM30 for a unit square meter of road range from the same order of magnitude (1.29E-04 g s^{-1} m^{-2} for one vehicle per day, a silt content of 20%, and 24-hours of landfill operation per day; *see* shaded cell in Table 3) to being two orders of magnitude higher (5.10E-02 g s^{-1} m^{-2} for 50 vehicles per day, a silt content of 80%, and 8-hours of landfill operation per day compared to the Screening Assessment's unit emission factor (2.43E-04 g s^{-1} m^{-2}) for wind erosion; *see* shaded cell in Table 4). These emission factors are based on the mean vehicle weight of haul trucks only and do not take into account that the mean vehicle weight could be considerably higher due to operation of heavy-duty equipment on those roads, which would further increase emission factors.

Based on a three meter wide road leading to the active portion of a landfill (conservatively assumed at the opposite end of the landfill) and assuming a) 20% surface material silt content, a mean vehicle weight of 30 tons, and 24 hours of landfill operations per day as the lower bound variables and b) 80% surface material silt content, a mean vehicle weight of 40 tons, and 8 hours of landfill operation per day as the upper bound variables for one or 50 vehicles traveling the unpaved road per day, uncontrolled entrained road dust emissions in grams per second ("g/s") for the 50th and 90th percentile size landfills for PM30, PM10 and PM2.5 can be estimated as shown in Table 5.

Table 5: Uncontrolled entrained dust emissions from unpaved road assuming daily cover of landfill

	Landfill		Road		Emissions (g/s) PM30		PM10		PM2.5	
	Total	Active portion	Length	Area	20% 30 tons 24 hours	80% 40 tons 8 hours	20% 30 tons 24 hours	80% 40 tons 8 hours	20% 30 tons 24 hours	80% 40 tons 8 hours
Percentile	Side (m)	Side (m)	(m)	(m^2)	1 vehicle	50 vehicles	1 vehicle	50 vehicles	1 vehicle	50 vehicles
50th	518.8	4.3	515	1,544	1.99E-01	2.99E+01	6.74E-02	1.34E+01	6.74E-03	1.34E+00
90th	1097.4	9.1	1,088	3,265	4.21E-01	6.32E+01	1.43E-01	2.83E+01	1.43E-02	2.83E+00

Based on the Screening Assessment's assumptions, airborne particulate emissions due to wind erosion of the active portions of landfill with daily cover for the 50th and 90th percentile

can be estimated at 4.37E-03 to 1.99E-02 g/s.[10] Compared to these estimates for wind erosion from active portions of a landfill with daily cover, entrained road dust PM30 emissions are orders of magnitude higher for both the 50th and 90th percentile size landfills and assuming either one or 50 vehicles traveling the unpaved road. (*See* shaded cells in Table 5).

This comparison illustrates the necessity of including fugitive emissions from unpaved roads in the estimates of fugitive dust emissions from CCW landfills and providing sound management requirements for their control. For further discussion of wind erosion from the active portion of a landfill, *see* Comment II.E.

These emission estimates do not account for trackout and re-entrainment of particulates through vehicle travel on paved roads. These emissions should be estimated separately with EPA's AP-42, Section 13.2.1, for *Paved Roads*.

2. Emissions Associated with Drop Operations

Unloading of CCW from trucks, conveyors, railcars, or barges at a landfill involves one or more so-called "drop operations," *i.e.*, dropping materials onto receiving surfaces. For example, truck dumping onto a pile is an example of a batch drop operation. Barge and railcar unloading requires loadout via on-site mobile equipment which then unload the materials at the active portion of the landfill in a batch drop operation. Unloading materials from a conveyor is an example of a continuous drop operation. Drop operations occur more or less instantaneously, often resulting in large clouds of dust released into the atmosphere, particularly, if the fly ash is uncontrolled, as shown in Figure 3.

The quantity of particulate emissions generated by a drop operation (*e.g.,* unloading of truck at landfill), in kilogram per metric ton ("kg/metric ton") of material transferred, may be estimated using the following empirical expression:

$$E = k\,(0.0016)\,(U/2.2)^{1.3} / (M/2)^{1.4} \qquad \textbf{Equation 2}$$

where:

E = particle size-specific emission factor (kg/metric ton)
k = particle size-specific multiplier (dimensionless)
U = mean wind speed, meters per second (m/s)
M = material moisture content (%)

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[10] Emissions from 50th percentile landfill area with daily cover: (2.43E-04 g s^{-1} m^{-2}) × (18 m^2 active landfill area) = 4.37E-03 g/s;
emissions from 90th percentile landfill area with daily cover: (2.43E-04 g s^{-1} m^{-2}) × (82 m^2 active landfill area) = 1.99E-02 g/s.

Equation 2 requires the assumption of wind speed for determining the emission factor. Table 6 shows the Beaufort wind force scale including a description of various wind speeds in meters per second ("m/s") and the resulting conditions on land.

Table 6: Beaufort wind force scale

Beaufort number	Wind speed (m/s)	Description	Land conditions
0	<0.3	Calm	Calm. Smoke rises vertically.
1	0.3-1.5	Light air	Smoke drift indicates wind direction, still wind vanes.
2	1.6-3.4	Light breeze	Wind felt on exposed skin. Leaves rustle, vanes begin to move.
3	3.4-5.4	Gentle breeze	Leaves and small twigs constantly moving, light flags extended.
4	5.5-7.9	Moderate breeze	Dust and loose paper raised. Small branches begin to move.
5	8.0-10.7	Fresh breeze	Branches of a moderate size move. Small trees in leaf begin to sway.
6	10.8-13.8	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	13.6-17.1	High wind, moderate gale, near gale	Whole trees in motion. Effort needed to walk against the wind.
8	17.2-20.7	Gale, fresh gale	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	20.9-24.4	Strong gale	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10	24.5-28.4	Storm, whole gale	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	28.5-32.6	Violent storm	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	≥32.7	Hurricane force	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris may be hurled about.

Adapted from Wikipedia; http://en.wikipedia.org/wiki/Beaufort_scale

For purposes of establishing emission factors for drop operations, wind speeds of 5, 10, 20, and 30 m/s were chosen to demonstrate the influence of wind speed on emissions at the landfill. Based on these wind speeds and assuming a fly ash moisture content of 27%[11] and the particle size-specific multipliers k[12], the particle size-specific emission factors E can be estimated as shown in Table 7.

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[11] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.4 Aggregate Handling and Storage Piles, updated November 2006: mean moisture content for fly ash from four samples.

[12] *Ibid*, p. 13.2.4-4: k = 0.74 for PM30, 0.35 for PM10 and 0.053 for PM2.5.

Table 7: Particle size-specific emission factors for PM30, PM10, and PM2.5 for drop operations at various wind speeds

Particulate Size	E (kg/metric ton) at wind speed			
	5 m/s	10 m/s	20 m/s	30 m/s
PM30	9.00E-05	2.22E-04	5.46E-04	9.25E-04
PM10	4.26E-05	1.05E-04	2.58E-04	4.37E-04
PM2.5	6.45E-06	1.59E-05	3.91E-05	6.62E-05

As shown in Table 7, particulate matter emission factors increase by an order of magnitude for wind speeds between 5 m/s and 30 m/s. The wind speeds of interest for determining whether fugitive dust emissions from the landfill would potentially exceed the short-term NAAQS for PM10 and PM2.5 are those that provide a worst-case scenario, *i.e.*, windy or stormy conditions above 10 m/s.

Based on the emission factors Table 7 particulate matter emissions for one drop operation can be estimated assuming a 20 ton[13] load of CCW per truck as shown in Table 8.

Table 8: Particle size-specific emissions for PM30, PM10, and PM2.5 for 1 drop operation (20 tons) at various wind speeds

Particulate Size	Emissions (kg) at wind speed			
	5 m/s	10 m/s	20 m/s	30 m/s
PM30	1.63E-03	4.02E-03	9.90E-03	1.68E-02
PM10	7.73E-04	1.90E-03	4.68E-03	7.94E-03
PM2.5	1.17E-04	2.88E-04	7.09E-04	1.20E-03

As an example of the magnitude of drop operation emissions: A 1,000 Megawatt ("MWe") power plant with an average daily consumption of 12,000 tons of sub-bituminous coal produces about 2,400 tons of fly ash per day.[14] Since capture efficiencies range from 95% to 99.95%, most of this fly ash is captured for either landfilling (or reuse). Thus, assuming 2,300 tons of fly ash would be disposed of per day and assuming a 20-ton load for each truck, about 115 drop operations would occur every day at a landfill to dispose of the fly ash from one 1,000-MWe power plant (in addition, the power plant generates bottom ash and other CCW wastes).[15] Some landfills receive CCW from several facilities; some of the largest commercial landfills receiving industrial waste are permitted to receive up to 15,000 tons of

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[13] 1 ton = 0.907 metric tons; 20 tons = 18.1 metric tons.

[14] Chen Y, Shah N, Huggins EE, Huffman GP, and Dozier A, Characterization of Ultrafine Coal Fly Ash Particles by Energy-filtered TEM, Journal of Microscopy, Vol. 217, Pt. 3, March 2005, pp. 225-234.

[15] (2,300 tons fly ash) / (20 ton load/truck) = 115 trucks/day.

waste per day.[16] Table 9 summarizes particulate emissions in kilogram per day ("kg/day") for drop operations of 2,300 tons of fly ash per day via 20 ton loads.

Table 9: Particle size-specific emissions for PM30, PM10, and PM2.5 for drop operation of 2,300 tons* of fly ash per day via 20 ton loads at various wind speeds

Particulate Size	Emissions (kg/day) at wind speed			
	5 m/s	10 m/s	20 m/s	30 m/s
PM30	1.88E-01	4.63E-01	1.14E+00	1.93E+00
PM10	8.88E-02	2.19E-01	5.39E-01	9.13E-01
PM2.5	1.35E-02	3.31E-02	8.16E-02	1.38E-01

* (2,300 tons) × (0.907 metric tons/ton) = 2,087 metric tons

As Table 9 shows, at wind speeds of 5 to 30 m/s, PM30 emissions attributable to truck drop operations at a landfill to dispose of fly ash from one 1000-MW coal-fired power plant range from 0.2 to 1.9 kg/day; PM10 emissions range from 0.09 kg/day to 0.9 kg/day. These emissions, which occur only during the operating hours of the landfill, must be added to the emission factors from wind erosion and entrained road dust from vehicle travel on unpaved roads.

Drop operations may occur several times for disposal of one load of fly ash: for example, if delivered via railcar or barge, the material will be dumped into a transfer vehicle (*see* Figure 4), moved to the active portion of the landfill and dropped off there. Thus, there will be two emission points (loading and unloading) for one load of CCW.

Figure 6: Fly ash unloading from rail cars at Arrowhead Landfill, AL
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

[16] *See*, for example, the Arrowhead Landfill in Alabama: http://www.arrowheadlandfill.com/.

3. Emissions Associated with Landfill Equipment

Typically at a landfill, trucks dump their loads onto piles and then large off-road equipment, such as scrapers or dozers, move and compact the materials and smooth and contour the landfill. (*See* Figure 4, Figure 5, and Figure 7.)

Figure 7: Heavy-duty equipment at fly ash landfills
Left: from Center for Environment, Commerce and Energy;
http://cenvironment.blogspot.com/2010/03/constellation-energy-proposing-fly-ash.html
Right: from The Star Online: Grappling with Garbage, May 27, 2008;
http://snipurl.com/1fci88 [thestar_com_my]

Fugitive dust emissions from material handling with off-road equipment can be substantial and must be included in the estimates of total emissions from disposal of CCW at landfills. Emissions can be estimated following the instructions in EPA's AP-42, Section 11.9, for *Western Surface Coal Mining*.

II.B Assumptions for Estimating Particulate Emissions due to Wind Erosion Are Not Sufficiently Conservative

The Screening Assessment determined the emission factor for windblown particulate emissions from a CCW landfill using the equation for "Continuous Fugitive/Windblown Dust Emissions" in EPA's 1992 *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*:[17]

[17] Screening Assessment, pp. 4-5.

$$E = 1.9\ (s/1.5)\ (365-p)\ /\ (235)\ (w/15) \qquad \textbf{Equation 3}$$

where:

E = emission factor (kg day^{-1} $hectare^{-1}$)
s = material silt content (%)
p = number of days per year with more than 25 mm of precipitation (dimensionless)
w = percent of time wind speed exceeds 5.4 m/s (%)

The Screening Assessment assumed a material silt content for fly ash of 80% and the default values in EPA's workbook of 0 for p and 20% for w to determine an emission factor of 2.43E-04 g s^{-1} m^{-2}.[18] Neither the Screening Assessment's assumptions nor the equation used provide a sufficiently conservative estimate for emissions from fly ash landfills.

Equation Is Only of Limited Value for Determining Worst-Case Emissions from CCW Landfills

First, the equation used by the Screening Assessment is of limited value for determining worst-case emissions from large-scale wind erosion of a CCW landfill. The equation had been developed to determine fugitive dust releases from "process losses, generated by mechanical action in material handling or windblown dust" originating "from a surface or a collection of small, poorly defined point sources," as shown in the following Figure.[19]

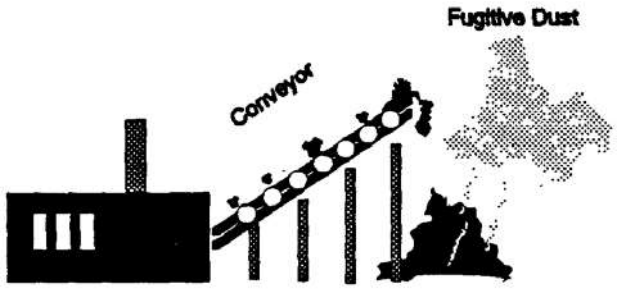

Figure 8: Fugitive dust from material handling or windblown dust
from: EPA, Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants, 1992, p. 4-11

The equation developed for this purpose is independent of wind speed (*see* Equation 3), assuming only a threshold wind speed at which particulates become airborne (5.4 m/s). Erosion potential has been found to increase rapidly with higher wind speeds resulting in considerably more airborne dust. Therefore, emissions should be related to wind gusts of highest magnitude.[20]

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[18] *Ibid*.

[19] U.S. Environmental Protection Agency, Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants, 1992, p. 4-11.

[20] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.5 Industrial Wind Erosion, updated November 2006, p. 13.2.5-1.

While for most materials the erosion potential, *i.e.*, the finite availability of erodible material (mass/area), tends to decay during an erosion event, fly ash due to its small size can act as an *unlimited reservoir of erodible material* and can sustain emissions for periods of hours without substantial decreases in emission rates. Some natural crusting of the surface may bind available erodible material, thereby reducing the erosion potential when fly ash is stored without disturbance. However, at most landfills, the piles of fly ash are continuously added to, moved, compacted, etc.

Percentage of Wind Speed Exceeding 5.4 m/s Is Not Sufficiently Conservative

Second, while the Screening Assessment's assumptions may be acceptable for determining whether airborne particulate matter emissions through wind erosion of CCW landfills may lead to a violation of the *annual* NAAQS for PM10; the assumption for w of 20%, *i.e.*, the percent of time wind speed exceeds 5.4 m/s, is not acceptable for determining whether emissions would exceed short-term NAAQS, *i.e.*, the *24-hour* standards for PM10 and PM2.5. As shown in Table 6, a wind speed of 5.4 m/s is only a gentle breeze. A conservative screening assessment for this purpose must therefore assume that the wind speed exceeds 5.4 m/s for the entire 24-hour period of a day, *i.e.*, 100%. Thus, the Screening Assessment underestimated potential emissions from wind erosion at a CCW landfill by a factor of five.[21]

Terrain Assumptions for Wind Erosion from Landfill Are Not Representative

The Screening Assessment calculates emissions and models dispersion of fugitive dust based on the emission factor of 2.43E-04 g s^{-1} m^{-2} and based on the 50th through as 90th percentiles of landfill sizes. The Screening Assessment calculates these emissions as if the landfill were a flat, even grade area, *i.e.*, it assumes the footprint of the landfill for emission estimates.

In reality, a landfill is rarely a flat, even grade area but typically consists of elevated areas with piles of recently dumped material that are then moved, compacted, and contoured by off-road equipment, as shown in Figure 4 through Figure 5 and Figure 7.

The elevated portions of the landfill and the piles of fly ash present a considerably larger surface area subject to wind erosion than the footprint of the landfill alone. For example, a cone-shaped storage pile with a diameter of 10 meters and a height of 3 meters has a footprint of 78.5 square meters ("m^2")[22] but an exposed surface area of 91.6 m^2, a 17% increase.[23]

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[21] (100%) / (20%) = 5.

[22] Footprint of cone: $\pi \times r^2 = \pi \times (5\ m^2)^2 = 78.5\ m^2$;
exposed surface area of cone: $\pi \times r \times \sqrt{(r^2 + h^2)} = \pi \times (5\ m) \times \sqrt{(5\ m^2 + 3\ m^2)} = 91.6\ m^2$.

[23] $(91.6\ m^2) \times (78.5\ m^2) = 1.17$.

Use of AP-42, Industrial Wind Erosion, Appears to Be More Representative for Estimating Wind Erosion from Fly Ash Storage Piles

The EPA's AP-42, Section 13.2.5, provides a methodology to estimate emissions from frequently disturbed storage piles and exposed areas within an industrial facility. This section takes into account the shapes of the piles (conical and oval with flattop), the surface area created by piles, and the frequency of disturbance of piles, amongst other variables. This methodology appears to be more representative to determine worst-case emissions for particulate emissions due to wind erosion from CCW landfill than the equation used by the Screening Assessment.

The Screening Assessment's Conclusion that Elevated Landfills Result in Fewer Fugitive Particulate Emissions Is Incorrect

The Screening Assessment determines maximum emissions from the landfill for two scenarios: a) at zero meters height and b) at 10 meters height. The Screening Assessment finds "that landfills that are built up, as opposed to dug into the ground, would actually lead to lower particulates nearby."[24] As explained above, the Screening Assessment's assumptions and calculations are not representative of actual landfill conditions and, thus, the modeling fails to provide accurate results. If emissions are calculated as detailed above, ambient concentrations of particulate matter resulting from wind erosion of CCW landfills will be higher for elevated rather than for at-grade landfills.

II.C The Choice of 10th Percentile of Landfill Distance to Nearest Receptor Is Not Acceptable

The Screening Assessment determined distances of landfills to residential receptors based on available data on the distance of residential wells to landfills. The Screening Assessment determined that the closest recorded distance between a resident (well) and the landfill is 0.6 meters (2 feet) and recognizes that some residences may be even closer.[25] Yet, the Screening Assessment excluded the minimum distance from landfills to receptors as being too conservative to be considered reasonable.[26] In my opinion, excluding the potential receptors who reside directly adjacent to a landfill from a risk assessment is unconscionable. These receptors exist and their risk from exposure to airborne dust from the landfill should therefore be evaluated.

The conventional way of evaluating potential violations of NAAQS for industrial facilities is to determine pollutant concentrations in ambient air at the fence line. This convention should be used here as well.

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[24] Screening Assessment, p. 10.

[25] Screening Assessment, p. B-1.

[26] Screening Assessment, p. 5.

II.D Assumed Control Efficiency for Wind Erosion via Cover or Spraying of Active Portion of Landfill Is Unrealistic

For its secondary scenarios, the Screening Assessment estimated emissions due to wind erosion from a landfill assuming that only a portion of the landfill would be active and the inactive portion would be controlled by covering or spraying on a regular basis. The Screening Assessment calculates emissions from the active portion of the landfill assuming a 40-year operating life of the landfill and daily, weekly, monthly, or annual control via covering or spraying of the inactive portions assuming 100% control. These assumptions are overly simplistic and fail to provide a worst-case scenario of fugitive dust emissions from wind erosion of fly ash at a landfill.

Covering the inactive portions of the landfill or spraying on a regular basis does not result in 100% control of fugitive dust emissions. For example, continuous chemical treating of material loaded onto piles, coupled with watering or treatment of roadways, has been estimated to reduce total particulate emissions by up to 90 percent.[27] The control efficiency of watering an exposed area before high winds has been estimated at 90%. Further, spraying with water is only effective as long as the surface material is sufficiently wetted: in dry climates or high wind conditions, watering during the operating hours of the landfill may be insufficient to control fugitive dust during the night and result in increasing emissions as the surface material dries out again. The efficiency of using dust suppressants or gravel has been estimated at 84%. For landfill covers, depending on the type and the timing of its application, control efficiencies may also be far lower than 100%. For example, the effect of revegetation on wind erosion has been estimated at only 90%.[28] Thus, the Screening Assessment underestimates emissions from the active portion of the landfill for its daily, weekly, monthly, and annual scenarios.

II.E Assumed Sizes of Active Portions of Landfill Are Unrealistic

For its controlled exposure scenarios, the Screening Assessment assumed that only a fraction of the CCW landfill would be exposed to wind erosion and the other remaining portion of the landfill would be controlled 100% assuming yearly, monthly, weekly, or daily control via spraying or covering over the landfill's useful life of 40 years. It was assumed that the exposed fraction of the landfill would be square and located in the center of the landfill. The Screening Assessment determined the following distributions of areas in square meters (m^2) and sides in meters (m) for the active portions of landfills:

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[27] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.4 Aggregate Handling and Storage Piles, updated November 2006, p. 13.2.4-5.

[28] Western Governors' Association, WRAP Fugitive Dust Handbook, September 7, 2006, p. 3; http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf.

	Yearly		Monthly		Weekly		Daily	
%ile	Area	Side	Area	Side	Area	Side	Area	Side
50th	6,728	82.0	561	23.7	129	11.4	18	4.3
60th	8,600	92.7	717	26.8	165	12.9	24	4.9
70th	12,282	110.8	1024	32.0	236	15.4	34	5.8
80th	21,084	145.2	1757	41.9	405	20.1	58	7.6
90th	30,109	173.5	2509	50.1	579	24.1	82	9.1

[29]

Review of these estimates shows that at least some of the exposure scenarios evaluated in the Screening Assessment are unrealistic. For example, the 50th and 90th percentiles for the sides of an active portion of the landfills assuming daily control are only 18 to 82 square meters (194 to 883 square feet) with side lengths of 4.3 to 9.1 meters (14 to 30 feet). An area of 18 square meters can basically be covered by unloading the contents of one haul truck onto a pile. Managing this pile would involve spreading and compacting the CCW, resulting in a larger active area than 18 square meters. Clearly, the areas considered in the Screening Assessment for daily cover are too small to be managed with heavy-duty equipment on site and are orders of magnitude smaller than what is typically managed as an active portion at CCW landfills even with daily controls. Thus, the Screening Assessment underestimates wind erosion from landfills. As discussed in Comment II.A, emissions from drop operations, entrained road dust and managing the CCW on site would by far exceed emissions from those small areas. Consequently, daily cover should definitively be recommended to minimize fugitive dust emissions and resulting risks to receptors.

II.F Assumption of Active Portion in Center of Landfill Does Not Constitute Worst Case Scenario

To simplify modeling, the Screening Assessment assumes that the operating or active portion is at the very center of the landfill to "give results that estimate an average concentration over the entire lifetime of the landfill for a receptor located in any direction."[30] This assumption, which would be acceptable for determining long-term impacts of fugitive dust emissions from the landfill, *e.g.*, for determining cancer risks over the lifetime of nearby receptors, is *not* sufficiently conservative as a worst-case scenario to determine whether fugitive dust emissions would lead to exceedances of short-term 24-hour ambient air quality standards. In order to assess short-term exceedances, the Screening Assessment should be revised to assume that the operating portion of the landfill is at the fence line closest to a potential receptor.

For example, landfill operators frequently fill in a portion of the landfill nearest to the fence line first before moving to the more central portions of the landfill. For example, at the Arrowhead Landfill in Perry County, AL, where over three million tons of fly ash from the 2008 Tennessee Valley Authority ("TVA") Kingston Plant fly ash pond spill are currently being

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[29] Screening Assessment, Table 5, p. 8.

[30] Screening Assessment, p. 9.

disposed off, the landfill operator started unloading in an area nearest to residents, as shown in the photographs below. (Note the proximity of residences to the active (black) portion of the landfill. The dust and odor from this fly ash disposal were so noxious that nearby residents filed suit against the landfill owners.)

Figure 9: Arrowhead Landfill, AL, disposal of fly ash from TVA Kingston pond spill
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 10: Arrowhead Landfill, AL, disposal of TVA fly ash waste
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 11: Proximity of Arrowhead Landfill, AL, to residence
Courtesy: John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 12: Arrowhead Landfill, AL, TVA fly ash waste with remnants of plastic cover as seen from a resident's porch
Courtesy: John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Thus, the risks of fugitive dust emissions from the landfill leading to violations of the 24-hour NAAQS for PM10 and PM2.5 should be based on the active portion of the landfill being at the fence line to the closest receptor.

III. Potential Human Health Risks from Fugitive Dust via Inhalation Pathway Have Not Been Adequately Assessed

As summarized above, the Screening Assessment limits its analysis to the incremental risks of human exposure to particulate emissions in excess of NAAQS resulting from dry handling of CCW at landfills. As such, it addresses neither background concentrations of particulate matter nor a constituent-based exposure pathway.[31] In addition, it ignores the substantial emissions of carcinogenic diesel particulate emissions from haul trucks, on-site landfill equipment, and diesel-powered pumps and generators.

Coal combustion waste consists of fly ash, bottom ash, boiler slag, flue gas desulfurization ("FGD") residues, and fluidized bed combustion ("FBC") wastes and contains varying levels of toxic constituents, including metals such as arsenic, lead, mercury, cadmium, chromium, selenium and varying levels of alkalinity and crystalline silica. Trace element content also varies with the individual types of CCWs from a single boiler. Fly ash in particular, tends to be enriched in arsenic, boron, mercury, and lead. Table 10 shows concentration data in various CCWs in parts per million ("ppm").

Table 10: Concentrations of trace elements in various CCWs

	Fly Ash (ppm)		Bottom Ash (ppm)		Boiler Slag (ppm)	
Constituent	Median	Range	Median	Range	Median	Range
Aluminum[a]	—	—	—	—	—	—
Antimony[b]	4.6	0.2-205	4.0	0.18-8.4	0.8	0.25-1.0
Arsenic[b]	43.4	0.0003-391.0	4.7	0.80-36.5	4.5	0.01-254
Barium[b]	806.5	0.02-10,850	633	24-9,630	413	6.19-1,720
Beryllium[b]	5.0	0.200-2,105	2.2	1.4-2.9	7.0	7.0-7.0
Boron[b]	311	2.98-2,050	90.0	1.79-390	49.5	0.10-55.0
Cadmium[b]	3.4	0.01-76.0	3.1	0.050-5.5	40.5	0.01-40.5
Chromium[c]	136	3.6-437	120	3.4-350	—	—
Chromium VI[b]	90	0.19-651	121.0	3.41-4,710	158	1.43-5,981
Cobalt[c]	35.9	4.90-79.0	24	7.1-60.4	—	—
Copper[c]	112	0.20-655	61.1	2.39-146.3	32.0	1.37-156
Fluorine[c]	29.0	0.40-320	50.0	2.5-104	—	—
Iron[a]	—	—	—	—	—	—
Lead[b]	56.8	0.02-273	13.2	0.86-843.0	8.0	0.40-120
Manganese[c]	250	24.5-750	297	56.7-769	—	—
Mercury[b]	0.1	0.013-49.5	0.009	0003-0.040	9.5	0.016-9.5
Molybdenum[a]	—	—	—	—	—	—
Nickel[b]	77.6	0.1-1,270	79.6	1.9-1,267	83.0	3.3-177
Potassium[a]	—	—	—	—	—	—
Selenium[b]	7.7	0.0003-49.5	0.8	0.007-9.0	4.5	0.10-14.0
Silver[b]	3.2	0.01-49.5	3.0	0.06-7.1	37.0	0.01-74.0
Strontium[c]	775	30.0-3,855	800	170-1,800	—	—
Thallium[b]	9.0	0.15-85.0	na	2.0	38.5	33.5-40.0
Vanadium[b]	252	43.5-5,015	141	24.0-264	75.0	75.0-320.0
Zinc[b]	148	0.28-2,200	52.6	3.80-717	35.8	4.43-530

[31] Screening Assessment, p. 3.

Table 10 contd.: Concentrations of trace elements in various CCWs

FGD (ppm)		FBC: Fly Ash (ppm)		FBC: Bed Ash (ppm)	
Median	Range	Median	Range	Median	Range
—	—	42,300	20-88,900	18,000	9-68,800
6.0	3.65-90.0	7.75	0.125-259	10	0.125-361
32.5	0.0075-341.0	27.55	2.8-176	14.6	2.5-80
162.5	0.08-2,280	348	31.3-2,690	184	7.3-453
29.3	0.900-49.5	2.23	1.08-11.5	1.21	0.5-8
60.0	5.00-633	39.1	0.025-2,470	14.1	0.025-304
3.9	0.005-81.9	1.25	0.013-6.68	1.02	0.0125-7.16
—	—	44.8	5.17-97.1	37	4.1-86
73.0	0.17-312	—	—	—	—
—	—	19	2.5-79.8	11.3	1.4-75.8
46.1	0.04-251.0	41.1	2-99	13.8	1.65-37.1
—	—	—	—	—	—
—	—	25,300	22.2-76,500	11,100	6.2-19,300
25.3	0.01-527.0	25	1.03-105	12.5	0.848-58
—	—	165	0.05-548	241	52.2-751
4.8	0.073-39.0	0.323	0.00005-129	0.05	0.00005-16.2
—	—	6.25	2.35-48.6	14.7	6-63.4
68.1	3.7-191.0	41.4	6.25-923	22	1-945
—	—	3510	1.13-10,200	584	1.3-8,980
4.5	0.0150-162.0	8.36	0.47-166	0.952	0.152-45
3.3	0.01-10.3	1.03	0.05-11.6	1	0.05-87.6
—	—	—	—	—	—
9.0	9.0-9.0	3.28	1.25-39	3.03	0.5-25
65.0	0.01-302.0	194	36.4-3,830	69	12-5,240
90.9	0.01-5,070	38.5	25-143	34	17.4-399

From: National Research Council, Managing Coal Combustion Residues in Mines, 2006, p. 42; http://www.nap.edu/openbook.php?record_id=11592&page=42#, pp. 42 and 43.

EPA recently published total metal concentration ranges in CCWs, which for some constituents, *e.g.*, arsenic ("As") are higher than shown in Table 10.

Table 11: Total metals concentration in CCWs (ppm)

Constituent	Mean	Minimum	Maximum
Antimony	6.32	0.00125	3100
Arsenic	24.7	0.00394	773
Barium	246.75	0.002	7230
Beryllium	2.8	0.025	31
Cadmium	1.05	0.000115	760.25
Chromium	27.8	0.005	5970
Lead	25	0.0074	1453
Mercury	0.18	0.000035	384.2
Nickel	32	0.0025	54055
Selenium	2.4075	0.0002	673
Silver	0.6965	0	3800
Thallium	1.75	0.09	100

From: U.S. Environmental Protection Agency, 40 CFR Parts 257, 261, 264 et al., Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities; Proposed Rule, Fed. Reg. Vol. 75, No. 118, June 21, 2010, p. 35169

Risks from exposure to these hazardous materials, including cancer risks and chronic and acute health risks, must be assessed in order to adequately characterize human health risks resulting from dry handling of CCW. The Screening Assessment does not evaluate these risks, nor were they adequately assessed in other EPA documents.

In response to a comment by peer reviewer Dr. William Hopkins, Virginia Polytechnic Institute and State University, regarding the lack of inhalation risks in the 2009 Risk Assessment, the EPA referred the commenter to a 1998 human and ecological risk analysis (*Non-groundwater Pathways, Human Health and Ecological Risk Analysis for Fossil Fuel Combustion Phase 2*; hereafter "1998 Risk Analysis") that evaluated cancer and chronic risks via the inhalation pathway by modeling chronic exposures to constituents in airborne CCW erosion from landfills. However, that assessment did not evaluate acute exposures to particulates. The EPA stated that it conducted the Screening Assessment to correct this deficiency.[32] There are several problems with this approach.

First, the potential exceedance of NAAQS due to airborne particulate matter from CCW landfills evaluated in the Screening Assessment is not an adequate substitute for assessing acute risks from exposure to toxic constituents of particulate matter.

Second, the 1998 Risk Analysis analyzed emissions from an active portion in the center of the landfill. While acceptable for long-term analyses, *i.e.*, cancer and chronic health impacts, this assumption is not acceptable for assessing short-term acute impacts.

Third, the 1998 Risk Analysis analyzed only non-mercury metals associated with emissions of particulates. The major reason for not including mercury in the analysis was that the risk assessment methodology for mercury is much more complex than for other metal constituents and that the methodology was, at the time under review by EPA's Office of Research and Development.[33] Yet, emissions of mercury are of particular concern due to its toxicity and its accumulation in fly ash. Implementation of the Clean Air Mercury Rule will further increase mercury content in fly ash. For example: according to EPA's *Preamble to the National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry* published December 20, 2006, sorbent injection processes significantly increase the mercury content of fly ash. Testing to date reveals that mercury in fly ash increases by a median factor of 8.5 and, in one case, the mercury content increased by a factor of 70. At the same time, other contaminant in fly ash such as arsenic and selenium also increase also increase concurrently increasing risks to human health via inhalation of fugitive dust.[34]

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[32] U.S. Environmental Protection Agency, Responses to Review Comments on Human and Ecological Risk Assessment for Coal Combustion Wastes, Final Draft, September 1, 2009, pp. 41-42.

[33] *Ibid*, pp. 24 and 45.

[34] U.S. Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry, Federal Register, Vol. 71, No. 244, December 20, 2006.

Fourth, the 1998 Risk Analysis did not analyze another fly ash component of concern, lime ("CaO"). This chemical reacts with water to form calcium hydroxide ("$Ca(OH)_2$"), giving fly ash a pH somewhere between 10 and 12, a medium to strong base. The presence of lime in fly ash can cause lung damage if present in sufficient quantities.[35]

Fifth, 1998 Risk Analysis did not analyze the presence of fine crystalline silica in fly ash which has been linked with lung damage, in particular silicosis. The Occupational Health and Safety Administration ("OSHA") allows a maximum concentration of crystalline silica in ambient air of 0.10 milligram per cubic meter ("mg/m^3").

The 1998 Risk analysis found incremental cancer risks from hexavalent chromium of 3.5 in one million, below the threshold of 10 in one million; all other contaminants did not have appreciable cancer risks, *i.e.*, incremental cancer risks were below one in one million. However, as mentioned above, this health risk assessment did not take into account mercury, crystalline silica, or diesel particulate matter emissions from haul trucks, landfill mobile equipment, and diesel-powered pumps and generators at the landfill. Thus, cancer risks can be assumed to be considerably higher than estimated by the 1998 Risk Analysis and may well exceed the 10 in one million cancer threshold.

The Screening Assessment should be revised and used as a companion document for an in-depth health risk assessment examining inhalation exposure to airborne particulate emissions associated with CCW landfill operations.

IV. Recommendations for Landfill Management

Based on the above discussion and the risks found by Screening Assessment for airborne fugitive dust emissions associated with dry handling of fly ash at CCW landfills, daily cover should be recommended for all landfills. In addition, enclosure, watering and the use of chemical wetting agents are recommended as the principal means for control of temporary emissions at the landfill. Watering is useful mainly to reduce emissions from vehicle traffic in the storage pile area. Watering of the storage piles themselves typically has only a very temporary slight effect on total emissions. A much more effective technique is to apply chemical agents (such as surfactants) that permit more extensive wetting. Continuous chemical treating of material loaded onto piles, coupled with watering or treatment of roadways, can reduce total particulate emissions from storage operations by up to 90 percent.[36]

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[35] National Research Council, Managing Coal Combustion Residues in Mines, 2006, p. 36.

[36] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.4 Aggregate Handling and Storage Piles, updated November 2006, p. 13.2.4-5.

The following summarizes recommendations for landfill management:

- Cover active areas of landfill daily;
- Stabilize, cover, or water exposed CCW piles at landfill;
- Place windbreaks upwind of storage piles;
- Stabilize or water unpaved roads at landfill;
- Minimize CCW freefall distance from drop operations from trucks, conveyors, or loaders;
- Avoid overloading of onsite equipment.
- Keep two feet of freeboard on trucks and cover during transport; and
- Avoid trackout onto public streets by installing wheel washers.

Additional recommendations for dry handling of materials can be found in the Western Governors' Association's *WRAP Fugitive Dust Handbook*, which is in part based on EPA's AP-42.[37]

V. Typographical Errors

The following typographical errors in the Screening Assessment should be corrected:

- In Section 4.4, Controls Applied Daily, the Screening Assessment incorrectly refers to "*weekly* fugitive dust control," rather than "*daily* fugitive dust control."[38]
- In Section 5.0, Conclusions, the Screening Assessment concludes that "*even* the most conservative evaluation of daily dust controls led to particulate concentrations well below the NAAQS," instead of "*only* the most conservative evaluation..."[39]

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[37] Western Governors' Association, WRAP Fugitive Dust Handbook, September 7, 2006; http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf.

[38] Screening Assessment, p. 11.

[39] Screening Assessment, p. 11.

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Doctorate in Environmental Science and Engineering (D.Env.), University of California Los Angeles, 2001

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University of California Los Angeles, Graduate Research Assistant/Teaching Assistant, 1994–1996

ECON Research and Development, Environmental Scientist, Ingelheim, Germany, 1992–1993

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Air Quality and Pollution Control

Projects include CEQA/NEPA review; attainment and non-attainment new source review ("NSR"), prevention of significant deterioration ("PSD") and Title V permitting; control technology analyses (BACT, LAER, RACT, BARCT, BART, MACT); technology evaluations and cost-effectiveness analyses; criteria and toxic pollutant emission inventories; emission offsets; ambient and source monitoring; analysis of emissions estimates and ambient air pollutant concentration modeling. Some typical projects include:

- Critically reviewed and prepared technical comments on the air quality, biology, noise, water quality, and public health and safety sections of CEQA/NEPA documents for numerous

commercial, residential, and industrial projects (*e.g.*, power plants, airports, residential developments, retail developments, hospitals, refineries, slaughterhouses, asphalt plants, food processing facilities, printing facilities, quarries, and mines) and provided litigation support in a number of cases filed under CEQA.

- Critically reviewed and prepared technical comments on the air quality and public health sections of the Los Angeles Airport Master Plan (Draft, Supplement, and Final Environmental Impact Statement/Environmental Impact Report) for the City of El Segundo. Provided technical comments on the Draft and Final General Conformity Determination for the preferred alternative submitted to the Federal Aviation Administration.
- For several California refineries, evaluated compliance of fired sources with Bay Area Air Quality Management District Rule 9-10. This required evaluation and review of hundreds of source tests to determine if refinery-wide emission caps and compliance monitoring provisions were being met.
- Critically reviewed and prepared technical comments on Draft Title V permits for several refineries and other industrial facilities in California.
- Evaluated the public health impacts of locating big-box retail developments in densely populated areas in California and Hawaii. Monitored and evaluated impacts of diesel exhaust emissions and noise on surrounding residential communities.
- In conjunction with the permitting of several residential and commercial developments, conducted studies to determine baseline concentrations of diesel exhaust particulate matter using an aethalometer.
- For an Indiana steel mill, evaluated technology to control NOx and CO emissions from fired sources, including electric arc furnaces and reheat furnaces, to establish BACT. This required a comprehensive review of U.S. and European operating experience. The lowest emission levels were being achieved by steel mills using selective catalytic reduction ("SCR") and selective non-catalytic reduction ("SNCR") in Sweden and The Netherlands.
- For a California petroleum coke calciner, evaluated technology to control NOx, CO, VOCs, and PM10 emissions from the kiln and pyroscrubbers to establish BACT and LAER. This required a review of state and federal clearinghouses, working with regulatory agencies and pollution control vendors, and obtaining and reviewing permits and emissions data from other similar facilities. The best-controlled facilities were located in the South Coast Air Quality Management District.
- For a Kentucky coal-fired power plant, identified the lowest NOx levels that had been permitted and demonstrated in practice to establish BACT. Reviewed operating experience of European, Japanese, and U.S. facilities and evaluated continuous emission monitoring data. The lowest NOx levels had been permitted and achieved in Denmark and in the U.S. in Texas and New York.
- In support of efforts to lower the CO BACT level for power plant emissions, evaluated the contribution of CO emissions to tropospheric ozone formation and co-authored report on same.
- Critically reviewed and prepared technical comments on applications for certification ("AFCs") for numerous natural-gas fired, solar, biomass, and geothermal power plants in California permitted by the California Energy Commission. The comments addressed construction and operational emissions inventories and dispersion modeling, BACT

determinations for combustion turbine generators, fluidized bed combustors, diesel emergency generators, etc.

- Critically reviewed and prepared technical comments on draft PSD permits for several natural gas-fired power plants in California, Indiana, and Oregon. The comments addressed emission inventories, greenhouse gas emissions, BACT, case-by-case MACT, compliance monitoring, cost-effectiveness analyses, and enforceability of permit limits.
- For a California refinery, evaluated technology to control NOx and CO emissions from CO Boilers to establish RACT/BARCT to comply with BAAQMD Rule 9-10. This required a review of BACT/RACT/LAER clearinghouses, working with regulatory agencies across the U.S., and reviewing federal and state regulations and State Implementation Plans ("SIPs"). The lowest levels were required in a South Coast Air Quality Management District rule and in the Texas SIP.
- In support of several federal lawsuits filed under the federal Clean Air Act, prepared cost-effectiveness analyses for SCR and oxidation catalysts for simple cycle gas turbines and evaluated opacity data.
- Provided litigation support for a CEQA lawsuit addressing the pollution control equipment at a proposed biomass cogeneration plant.
- Prepared comments and provided litigation support on several proposed regulations including the Mojave Desert Air Quality Management District Rule 1406 (fugitive dust emission reduction credits for road paving); South Coast Air Quality Management District Rule 1316, San Joaquin Valley Air Pollution Control District Rule 2201, Antelope Valley Air Quality Management District Regulation XIII, and Mojave Desert Air Quality Management District Regulation XIII (implementation of December 2002 amendments to the federal Clean Air Act).
- Critically reviewed draft permits for several ethanol plants in California, Indiana, Ohio, and Illinois and prepared technical comments.
- Reviewed state-wide average emissions, state-of-the-art control devices, and emissions standards for construction equipment and developed recommendations for mitigation measures for numerous large construction projects.
- Researched sustainable building concepts and alternative energy and determined their feasibility for residential and commercial developments, *e.g.*, regional shopping malls and hospitals.
- Provided comprehensive environmental and regulatory services for an industrial laundry chain. Facilitated permit process with the South Coast Air Quality Management District. Developed test protocol for VOC emissions, conducted field tests, and used mass balance methods to estimate emissions. Reduced disposal costs for solvent-containing waste streams by identifying alternative disposal options. Performed health risk screening for air toxics emissions. Provided permitting support. Renegotiated sewer surcharges with wastewater treatment plant. Identified new customers for shop-towel recycling services.
- Designed computer model to predict performance of biological air pollution control (biofilters) as part of a collaborative technology assessment project, co-funded by several major chemical manufacturers. Experience using a wide range of environmental software, including air dispersion models, air emission modeling software, database programs, and geographic information systems ("GIS").

Water Quality and Pollution Control

Experience in water quality and pollution control, including surface water and ground water quality and supply studies, evaluating water and wastewater treatment technologies, and identifying, evaluating and implementing pollution controls. Some typical projects include:

- Evaluated impacts of on-shore oil drilling activities on large-scale coastal erosion in Nigeria.
- For a 500-MW combined-cycle power plant, prepared a study to evaluate the impact of proposed groundwater pumping on local water quality and supply, including a nearby stream, springs, and a spring-fed waterfall. The study was docketed with the California Energy Commission.
- For a 500-MW combined-cycle power plant, identified and evaluated methods to reduce water use and water quality impacts. These included the use of zero-liquid-discharge systems and alternative cooling technologies, including dry and parallel wet-dry cooling. Prepared cost analyses and evaluated impact of options on water resources. This work led to a settlement in which parallel wet dry cooling and a crystallizer were selected, replacing 100 percent groundwater pumping and wastewater disposal to evaporation ponds.
- For a homeowner's association, reviewed a California Coastal Commission staff report on the replacement of 12,000 linear feet of wooden bulkhead with PVC sheet pile armor. Researched and evaluated impact of proposed project on lagoon water quality, including sediment resuspension, potential leaching of additives and sealants, and long-term stability. Summarized results in technical report.

Applied Ecology, Industrial Ecology and Risk Assessment

Experience in applied ecology, industrial ecology and risk assessment, including human and ecological risk assessments, life cycle assessment, evaluation and licensing of new chemicals, and fate and transport studies of contaminants. Experienced in botanical, phytoplankton, and intertidal species identification and water chemistry analyses. Some typical projects include:

- Conducted technical, ecological, and economic assessments of product lines from agricultural fiber crops for European equipment manufacturer; co-authored proprietary client reports.
- Developed life cycle assessment methodology for industrial products, including agricultural fiber crops and mineral fibers; analyzed technical feasibility and markets for thermal insulation materials from natural plant fibers and conducted comparative life cycle assessments.
- For the California Coastal Conservancy, San Francisco Estuary Institute, Invasive Spartina Project, evaluated the potential use of a new aquatic pesticide for eradication of non-native, invasive cordgrass (*Spartina spp.*) species in the San Francisco Estuary with respect to water quality, biological resources, and human health and safety. Assisted staff in preparing an amendment to the Final EIR.
- Evaluated likelihood that organochlorine pesticide concentrations detected at a U.S. naval air station are residuals from past applications of these pesticides consistent with manufacturers' recommendations. Retained as expert witness in federal court case.
- Prepared human health risk assessments of air pollutant emissions from several industrial and commercial establishments, including power plants, refineries, and commercial laundries.

- Managed and conducted laboratory studies to license pesticides. This work included the evaluation of the adequacy and identification of deficiencies in existing physical/chemical and health effects data sets, initiating and supervising studies to fill data gaps, conducting environmental fate and transport studies, and QA/QC compliance at subcontractor laboratories. Prepared licensing applications and coordinated the registration process with German environmental protection agencies. This work led to regulatory approval of several pesticide applications in less than six months.
- Designed and implemented database on physical/chemical properties, environmental fate, and health impacts of pesticides for a major multi-national pesticide manufacturer.
- Designed and managed experimental toxicological study on potential interference of delta-9-tetrahydrocannabinol in food products with U.S. employee drug testing; co-authored peer-reviewed publication.
- Critically reviewed and prepared technical comments on applications for certification for several natural-gas fired, solar, and geothermal power plants and transmission lines in California permitted by the California Energy Commission. The comments addressed avian collisions and electrocution, construction and operational noise impacts on wildlife, risks from brine ponds, and impacts on endangered species.
- For a 180-MW geothermal power plant, evaluated the impacts of plant construction and operation on the fragile desert ecosystem in the Salton Sea area. This work included baseline noise monitoring and assessing the impact of noise, brine handling and disposal, and air emissions on local biota, public health, and welfare.
- Designed research protocols for a coastal ecological inventory; developed sampling methodologies, coordinated field sampling, determined species abundance and distribution in intertidal zone, and conducted statistical data analyses.
- Designed and conducted limnological study on effects of physical/chemical parameters on phytoplankton succession; performed water chemistry analyses and identified phytoplankton species; co-authored two journal articles on results.
- Organized and conducted surveying and mapping of aquatic plant species in several lakes and rivers in Sweden and Germany as ecological indicators for the health of limnological ecosystems.

PRO BONO ACTIVITIES

Founding member of "SecondAid," a non-profit organization providing tsunami relief for the recovery of small family businesses in Sri Lanka. (www.secondaid.org.)

PROFESSIONAL AFFILIATIONS

Association of Environmental Professionals

PUBLICATIONS

Available upon request

2.3.1. Illinois Pollution Control Board Court Order for Midwest Generation Utility, as Referenced in 2.3, Mark Hutson Report for Earthjustice (2019)

This document, which was originally referenced for data in a comment, was downloaded by EPA.

ILLINOIS POLLUTION CONTROL BOARD
June 20, 2019

SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT,	)	
Complainants,	)	
v.	)	PCB 13-15
	)	(Enforcement – Water, Land)
MIDWEST GENERATION, LLC,	)	
Respondent.	)	

GREG WANNIER OF SIERRA CLUB; FAITH BUGELAND LINDSAY DUBIN OF ENVIRONMENTAL LAW AND POLICY CENTER; ABEL RUSS AND SYLVIA LAM OF ENVIRONMENTAL INTEGRITY CENTER APPEARED ON BEHALF OF COMPLAINANTS;

JENNIFER T. NIJMAN AND KRISTEN GALE APPEARED ON BEHALF OF RESPONDENT.

INTERIM OPINION AND ORDER OF THE BOARD (by K. Papadimitriu)[1]:

On October 3, 2012, Sierra Club, Environmental Law and Policy Center, Prairie Rivers Network, and Citizens Against Ruining the Environment (collectively, Environmental Groups) filed a seven-count complaint against Midwest Generation, LLC (MWG). The complaint alleges groundwater contamination and open dumping in violation of the Environmental Protection Act (Act) and Board regulations. The Environmental Groups allege that MWG discarded contaminants into the environment through the coal ash disposal ponds and historical coal ash storage sites at MWG's four electric generation stations (EGUs or Stations) in Illinois: (1) the Joliet #29 Station, in Joliet, Will County (Joliet 29); (2) the Powerton Station, in Pekin, Tazewell County (Powerton); (3) the Will County Station, in Romeoville, Will County (Will County); and (4) the Waukegan Station, in Waukegan, Lake County (Waukegan).

After partially granting and partially denying MWG's motion to dismiss, the Board held 10 days of hearings. In today's order, the Board finds that the Environmental Groups met their burden in establishing that it is more probable than not that MWG violated the Act and Board regulations as alleged in the amended complaint. Specifically, the Board finds that MWG

[1] Daniel Pauley, who externed at Chicago Legal Clinic while a law student and prior to joining the Board as a staff attorney, took no part in the Board's drafting or deliberation of any order or issue in this matter.

violated Section 12(a) of the Act at all four Stations. 415 ILCS 5/12(a) (2016). The Board finds that MWG caused or allowed discharge of coal ash constituents into groundwater at all four Stations, thereby causing exceedances of the Board's Class I antimony (Joliet 29, Will County), arsenic (Powerton, Will County), boron (Powerton, Will County, and Waukegan), sulfate (Joliet 29, Powerton, Will County, and Waukegan) and TDS (Joliet 29, Powerton, Will County, and Waukegan) GQS during 2010-2017, violating Sections 620.115, 620.301(a), and 620.405 of the Board's regulations (35 Ill. Adm. Code 620.115, 620.301(a), 620.405). 415 ILCS 5/12(a) (2016).).

The Board also finds that MWG violated Section 12(a) of the Act at all four Stations by causing or allowing discharge of contaminants into groundwater causing water pollution. Specifically, the Board finds that MWG exceeded the statewide 90th percentile levels for sulfate and boron at all four Stations between 2010 and 2017. 415 ILCS 5/12(a)(2016). The Board, however, finds no violation of Section 12(a) of the Act at Joliet 29, Powerton, and Will County during the performance of corrective actions in October 2013 under the GMZs established at those three Stations.

The Board finds that MWG also violated Section 12(d) of the Act at Powerton Station by depositing coal ash cinders directly upon the land, thereby creating a water pollution hazard. 415 ILCS 5/12(d) (2016). The Board, however, finds that the Environmental Groups did not establish violations of Section 12(d) of the Act at Joliet 29, Will County, or Waukegan Stations.

Lastly, the Board finds that MWG violated Section 21(a) of the Act at all four Stations by allowing coal ash to consolidate in the fill areas around the ash ponds and in historical coal ash storage areas. The Board finds that MWG did not take measures to remove it or prevent its leaking of contaminants into the groundwaters.

The Board finds the record is insufficient to determine the appropriate relief in this proceeding. Therefore, the Board directs the hearing officer to hold additional hearings to determine the appropriate relief.

GUIDE TO THE BOARD'S OPINION

The Board first summarizes the procedural history of this case at page 4, before providing the relevant legal background including the standard of review and applicable law at page 10. The Board then summarizes the parties' positions starting at page 15. Next, the Board makes its factual findings, both regarding the general facts relating to all four MWG Stations (page 15) and separate facts specific to each of the Stations beginning on: page 22 for Joliet 29, page 35 for Powerton, page 51 for Will County, and page 63 for Waukegan. The Board then discusses and makes its legal findings regarding the alleged violations starting 77. After summarizing its conclusions at page 92, the Board issues its order page 92.

TABLE OF CONTENTS

I. PROCEDURAL HISTORY
II. LEGAL FRAMEWORK
1. Standard of Review
2. Applicable Law
A. Water pollution
B. Open dumping
III. PARTIES' ALLEGATIONS
1. Environmental Groups' Allegations
2. MWG Response
IV. FACTS
1. General Facts that apply to all Stations
2. Joliet 29
A. Uncontested Facts
B. Contested Facts
3. Powerton
A. Uncontested Facts
B. Contested Facts
4. Will County
A. Uncontested Facts
B. Contested Facts
5. Waukegan
A. Uncontested Facts
B. Contested Facts
V. BOARD DISCUSSION
A. Section 12(a) of the Act, Water Pollution
B. Section 12(d) of the Act, Water Pollution Hazard
C. Section 21(a) of the Act, Open Dumping
VI. CONCLUSIONS

I. PROCEDURAL HISTORY

i. Complaint

The Environmental Groups filed a seven-count complaint on October 3, 2012 (Comp.). The complaint alleges that MWG caused open dumping and water pollution, violating Sections 12(a), 12(d) and Section 21(a) of the Act (415 ILCS 5/12(a), 12(d), 21(a) (2016)), as well as Sections 620.115, 620.301(a), 620.405 of the Board's regulations (35 Ill. Adm. Code 620.115, 620.301(a), 620.405). Counts 1-3 also alleged violations of United States Environmental Protection Agency's regulations (40 C.F.R. §§ 257.1 and 257.3-4) implementing the federal Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §§ 6901 *et seq*.). The complaint alleges that through coal ash disposal ponds at its four stations, MWG has caused or contributed to contamination of groundwater, discarded contaminants into the environment and caused water pollution and exceedances of Illinois' Class I and II Groundwater Quality Standards (GQS). The Environmental Groups ask that the Board order MWG to cease and desist from the violations, modify its coal ash disposal practices, and remediate contaminated groundwater. The complaint also calls for civil penalties on MWG.

ii. Motion to Dismiss

On November 5, 2012, MWG filed a motion to dismiss the complaint (Mot. Dis.). In the motion, MWG argues that the complaint is duplicative and frivolous because, among other things, in 2012, MWG entered into compliance commitment agreements (CCAs) with the Illinois Environmental Protection Agency (IEPA or Agency) regarding the ash ponds at each of the four Stations. Mot. Dis. at 5. MWG contended that because there is no disagreement with IEPA, the complaint fails to meet requirements of Section 31(d) of the Act (415 ILCS 5/32(d) (2016)). *Id*. MWG also moved to strike parts of counts 1-3 alleging violations of federal regulations.

iii. Stay of the Proceedings

On December 28, 2012, the Environmental Groups and MWG separately notified the Board that, due to the December 17, 2012 filing of a bankruptcy petition, this enforcement proceeding was automatically stayed under Section 362(a) of the Bankruptcy Code (11 U.S.C. § 362(a)). On February 7, 2013, the Board issued an order that acknowledged the automatic stay and granted the Environmental Groups' motion for extension of time to reply to MWG's dismissal motion. Sierra Club, PCB 13-15, slip op. at 1, 4 (Feb. 7, 2013). The Board directed parties to notify the Board within 30 days of the stay's expiration. *Id*. at 4. On May 22, 2013, the Environmental Groups filed a notice stating that on April 22, 2013, the Bankruptcy Court partially lifted the automatic stay solely to permit the Board to rule on MWG's motion to dismiss.

On October 3, 2013, the Board partially denied and partially granted MWG's motion to dismiss. Specifically, the Board partially granted the motion by striking those portions of counts 1-3 alleging violations of federal regulations. Sierra Club, PCB 13-15, slip op. at 23-25 (Oct. 3, 2013). In partially denying the motion to dismiss, the Board found that the existence of CCAs does not render the complaint frivolous or duplicative. *Id*. at 18-23, 27 (Oct. 3, 2013). The Board stated that it "never treated as an additional requirement for citizen's suits the existence of

a disagreement between the Agency and the person complained against" and that "the existence of a CCA does not preclude the filing by the People or any citizen of an enforcement action." *Id*. at 18. The Board also noted that "because a CCA resolves and is an inextricable part of a non-adjudicatory process, it is not akin to a settlement agreement in an actual enforcement proceeding." *Id*. at 22. The Board also refused to dismiss the open dumping counts as insufficiently pled. The Board rejected MWG's arguments that ash ponds cannot be open dumps because they are properly "permitted and regulated as water pollution treatment units" under MWG's NPDES permit. *Id*. at 8. The Board concluded that "Section 21(a) [of the Act] may apply to permitted or otherwise lawful facilities that improperly fail to contain waste." *Id*. at 25-27.

On January 10, 2014, the Environmental Groups filed a copy of the Bankruptcy Court's order of December 11, 2013, lifting the automatic stay as to this enforcement proceeding but prohibiting enforcement of any monetary penalty award. On January 23, 2014, the Board accepted the complaint for hearing, finding the complaint, as modified by the order striking parts of counts 1-3, neither duplicative nor frivolous. Sierra Club, PCB 13-15, slip op. at 3 (Jan. 23, 2014).

On February 19, 2014, MWG filed a motion to stay the enforcement proceeding for at least one year. MWG argued that a stay was necessary to: (1) avoid potential conflicts from the coal ash rulemaking initiated by USEPA as well as the IEPA's proposed coal ash rules; (2) allow the pending acquisition of MWG by NRG Energy, Inc. to proceed; and (3) allow continued groundwater monitoring to assess the effect of MWG's actions taken under the CCAs. MWG further asserted that no ongoing environmental harm is occurring, and a stay would not prejudice the Environmental Groups. The Environmental Groups opposed the motion. On April 17, 2014, the Board denied the stay.

On May 5, 2014, MWG filed its answer and defenses to the complaint. On May 27, 2014, the Environmental Groups filed a reply to MWG's defenses.

iv. Amended Complaint

On December 15, 2014, the Environmental Groups moved to amend the complaint, attaching a first amended complaint. The Environmental Groups stated that, during discovery, they "have become aware of additional coal ash storage, disposal, and/or fill areas at each site that may be contributing to the coal ash-related contamination alleged in the Complaint." Sierra Club, PCB 13-15, slip op. at 5 (Feb. 19, 2017). After the Environmental Groups withdrew that motion, they filed another motion to amend, and a second amended complaint on January 30, 2015. On February 19, 2015, the Board granted the Environmental Groups' motion to file the second amended complaint. *Id.* at 6. For brevity, today's order refers to the second amended complaint, as the "amended complaint" (Am. Comp.). On April 20, 2015, MWG filed its answer and defenses to the second amended complaint (MWG 2nd Ans. Def.).

v. Summary Judgment

On June 1, 2016, the Environmental Groups filed a motion for partial summary judgment regarding coal ash areas outside of the ash ponds, referred to as "Historic Ash Areas." Sierra Club, PCB 13-15, slip op. at 4 (Jan. 19, 2017). MWG responded on July 19, 2016. The Board

denied the motion on January 19, 2017. At that time, the Board found genuine issues of material facts precluding summary judgment: whether the evidence confirms the presence of coal ash in the historic ash areas; whether coal ash constituents are present at all four Stations; and whether historic ash areas are the source of contamination. The Board added that weighing competing evidence to resolve a dispute over material facts was appropriate not at summary judgment but after hearing. Sierra Club, PCB 13-15, slip op. at 5 (Jan. 19, 2017).

vi. Hearings and Testimony

The Board held two sets of hearings before Board Hearing Officer Bradley Halloran, the first from October 23 through October 27, 2017 (10/23/17 Tr. - 10/27/17 Tr.), and the second from January 29 through February 2, 2018 (1/30/18 Tr. - 2/2/18 Tr.). Hearing Officer Halloran listed all hearing exhibits admitted into evidence in his April 25, 2018 order.[2]

The Environmental Groups presented a July 2015 expert report of James R. Kunkel, Ph.D., P.E. (EG Exhs. 401, 407, 408), who testified at the hearings. Dr. Kunkel is a licensed professional civil engineer (not in Illinois) and a retired registered professional hydrologist. *See* EG Exh. 400; 10/26/17 p.m. Tr. 24-144; 10/27/17 Tr. at 87 (Kunkel Test.). He holds a Ph.D. in Hydrology and Water Resources from the University of Arizona, an M.S. in Civil Engineering from the University of Connecticut, and a B.S.C.E in Civil Engineering from St. Martin's University. *Id*. Dr. Kunkel has about 40 years of relevant professional experience. *Id*.

MWG presented an expert report on the condition of the four Stations by John Seymour (MWG Exh. 903, 901), who testified at the hearings. *See e.g*. 2/1/18 Tr. at 213-214 (Seymour Test.); MWG Statement of Facts (SOF) at 1-2 ¶¶ 8-11. Mr. Seymour is a Senior Principal at Geosyntec Consultants and a geotechnical engineering and remediation practices specialist, with about 40 years of relevant experience. MWG Exh. 900. He holds an M.S. in Geotechnical Engineering from the University of Michigan and a B.S. in Civil Engineering from Michigan Technological University. *Id*.

The following expert witnesses also testified at the hearings:

- Maria Race, MWG's Director of Federal Environmental Programs, former manager of general environmental compliance for the Stations, and former Asset Manager. 10/23/17 Tr. at 29-211; 10/24/17 Tr. at 8-32 (Race Test.); SOF at ¶ 2.
- Mark Kelly, MWG's Chemical Specialist at the Powerton Station since 1992, responsible for water related matters. 1/31/18 Tr. at 67-68 (Kelly Test.); SOF at ¶ 6.
- Richard Gnat, Principal at MWG's consultant KPRG & Associates (KPRG), which performed relevant projects at the four Stations. 10/25/17 Tr. at 39-234; 10/26/17 a.m. Tr. at 5-84; 10/26/17 p.m. Tr. at 4-22; 2/1/18 Tr. at 82-83 (Gnat Test.); SOF at ¶ 5.
- Christopher Lux, MWG's Engineering Manager at the Waukegan Station, who has worked at the Station since 1992, before MWG began operating the Station in 1999. 10/24/17 Tr. 33-172 (Lux Test.); SOF at ¶ 3.

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[2] All admitted hearing exhibits are available in the Board's website (pcb.illinois.gov) in the sub-docket "PCB 2013-015Exh".

- Rebecca Maddox, former MWG Environmental Specialist at the Will County Station between 2008 and April 2015. 10/24/17 Tr. 173-315; 10/25/17 Tr. at 10-38 (Maddox Test.); SOF at ¶ 4.
- Fredrick Veenbaas, MWG's Senior Compliance Specialist at the Waukegan Station since 2012; he had been the Chemistry Systems Specialist at the Will County Station since 1999. 1/31/18 Tr. at 221-222 (Veenbaas Test.); SOF at ¶ 7.

vii. Evidentiary Appeals

After the first set of hearings, the Environmental Groups and MWG objected to certain hearing officer's evidentiary rulings. On January 25, 2018, the Board granted the parties' respective motions for interlocutory appeal and affirmed the hearing officer's rulings to exclude Environmental Groups' Exhibit 37 from the evidence and to admit the Environmental Groups' Exhibits 5.5, 6, 7, 16, 204G–209G, 210H–215H, 222J–228J, and 236L–241L. In the same order, the Board reversed the hearing officer's ruling to admit the Environmental Groups' Exhibit 261 and excluded it from the record. *See* Sierra Club, PCB 13-15, slip op. at 5 (Jan. 25, 2018).

The parties also appealed certain hearing officer's evidentiary rulings made during the second set of hearings. On April 26, 2018, the Board affirmed the hearing officer's rulings to admit MWG's Exhibit 649 and to exclude MWG's Exhibit 662. *See* Sierra Club, PCB 13-15, slip op. at 2-4 (Apr. 26, 2018).

During the hearings, the hearing officer allowed 1998 Phase I and Phase II Environmental Site Assessment reports, prepared by ENSR for the previous owner of the Stations, into evidence over MWG's objections. At the same time, the hearing officer limited the use of the exhibits to the questions asked of, and the responses elicited from, the witness. 10/23/17 Tr. at 126-127; Hearing Officer Order, PCB 13-15 (Jan. 11, 2018); EG Exhs. 17D (1998 Phase II report for the Powerton Station), 18D (Phase II Will County), 19D (Phase II Waukegan) 20D (Phase II Joliet 29), 21 (Phase I Joliet 29), and 38 (Phase I Waukegan); MWG Exhs. 632 (Phase I Powerton), and 652 (Phase I Will County).

On February 26, 2018, the Environmental Groups filed a motion, amended on March 21, 2018, asking the Board to strike parts of the expert report and related testimony and demonstrative exhibit of Mr. Seymour, MWG's expert. On March 20, 2018, MWG filed a motion for sanctions, arguing that the Environmental Groups' motion to strike was untimely and their appeal of a hearing officer ruling was meritless. On May 10, 2018, the Board denied both motions. The Board found the evidence presented by Mr. Seymour to be reliable, given his professional qualifications. The Board also found that MWG had not demonstrated any unreasonable failure by the Environmental Groups to comply with a Board procedural rule or a hearing officer order. On October 2, 2017, the parties filed joint stipulations of facts (Joint Stip.).

viii. Post-Hearing Briefs

On July 20, 2018, the Environmental Groups and MWG filed their respective post-hearing briefs (EG Br. and MWG Br.). On August 30, 2018, the parties filed their respective response briefs (Env. Gr. Rep. Br. and MWG Rep. Br.). MWG' post hearing brief includes, as

an Appendix A, MWG's "Statement of Facts" (SOF), setting forth what MWG believes are the facts established at hearing.

ix. Table of Abbreviations Used in this Opinion

"Act"	Illinois Environmental Protection Act
"Agency"	Illinois Environmental Protection Agency
"Am. Comp."	The Environmental Groups' second amended complaint, filed with the January 30, 2015 motion for leave to reply
"ASTM"	ASTM International
"CCAs"	2012 compliance commitment agreements between MWG and IEPA for each of the four Stations
"CCB"	"Coal combustion by-product" as defined in the Act (415 ILCS 5/3.135 (2016))
"CCR Rules"	USEPA's Coal Combustion Residual Rule at 40 C.F.R. Part 257 Subpart D
"C.F.R."	Code of Federal Regulations
"Proposed CCR regulations"	IEPA's rulemaking proposal in Coal Combustion Waste (CCW) Ash Ponds and Surface Impoundments at Power Generating Facilities: Proposed New 35 Ill. Adm. Code 841, R14-10
"EG. Br."	The Environmental Groups' initial post-hearing brief
"EG. Rep. Br."	The Environmental Groups' post-hearing response brief
"ELUC"	Environmental Land Use Control
"Exh."	Hearing Exhibit; due to a large variety and inconsistency of page numbering though the documents in the record, page numbers of the exhibits refer to the consecutive page number as displayed in electronic document opened in PDF; page numbers starting with "#" refer to the document bates numbers, if available.
"GMZ"	Groundwater Management Zone
"GQS"	Groundwater Quality Standards
'IDOT"	Illinois Department of Transportation
"IEPA"	Illinois Environmental Protection Agency

"Joint Stip."	The parties' October 2, 2017 Joint Agreed Stipulations
"MWG Br."	MWG's initial post-hearing brief
"MWG Rep. Br."	MWG's post-hearing response brief
"NLET"	Neutral Leaching Extraction Test
"SOF"	MWG's "Statement of Facts" attached as Appendix A to MWG's initial post-hearing brief
"Tr."	Transcript
"VN"	Violation Notice
USEPA	United States Environmental Protection Agency

II. LEGAL FRAMEWORK

1. Standard of Review

In an enforcement proceeding before the Board, the complainant must prove by a preponderance of evidence that the respondent violated the Act, Board rules, or permits. People v. Packaging Personified, Inc., PCB 04-16, slip op. at 11 (Sept. 8, 2011); People v. General Waste Services, Inc., PCB 07-45, slip. op. at 12 (Apr. 7, 2011); Nelson v. Kane County Forest Preserve, PCB 94-244, slip op. at 5 (July 18, 1996); Lefton Iron & Metal Company, Inc. v. City of East St. Louis, PCB 89-53 slip op. at 3 (Apr. 12, 1990); Industrial Salvage Inc. v. County of Marion, PCB 83-173 slip op. at 3-4, (Aug. 2, 1984) *citing* Arlington v. Water E. Heller International Corp., 30 Ill. App. 3d 631, 640, 333 N.E.2d 50, 58 (1st Dist. 1975). A proposition is proved by a preponderance of evidence when it is more probably true than not. Nelson v. Kane County Forest Preserve, PCB 94-244, slip op. at 5 (July 18, 1996); Village of South Elgin v. Waste Management of Illinois, PCB 03-106, slip op. at 2 (Feb. 20, 2003); Industrial Salvage at 4, 59, 233, 236, *citing* Estate of Ragen, 79 Ill. App. 3d 8, 13, 198 N.E.2d 198, 203 (1st Dist. 1979). Once the complainant presents sufficient evidence to make a *prima facie* case, the burden of going forward shifts to the respondent to disprove the propositions. People v. Packaging Personified, Inc., PCB 04-16, slip op. at 11 (Sept. 8, 2011).

2. Applicable Law

In this case, the Environmental Groups allege violations of Sections 12(a). 12(d), and 21(a) of the Act (415 ILCS 5/12(a), (d), 21(a) (2016)). To establish these violations, the Board and the courts set specific elements that the Environmental Groups must prove. Below are the legal standards at issue in this proceeding.

A. Water pollution

Sections 12(a) and (d) of the Act state no person shall:

(a) Cause or threaten or allow the discharge of any contaminants into the environment in any State so as to cause or tend to cause *water pollution* in Illinois, either alone or in combination with matter from other sources, or so as to *violate regulations or standards* adopted by the Pollution Control Board under this Act.

* * *

(d) Deposit any contaminants upon the land in such place and manner so as to create a *water pollution* hazard. 415 ILCS 5/12(a), (d) (2016) (emphasis added).

"**Contaminant**" is defined as "any solid, liquid, or gaseous matter, any odor, or any form of energy, from whatever source." 415 ILCS 5/3.165 (2016); 35 Ill. Adm. Code 620.110. "**Waters**" are defined as "all accumulations of water, surface and underground, natural, and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this State." 415 ILCS 5/3.550 (2016). "**Water pollution**" is defined as:

> such alteration of the physical, thermal, chemical, biological or radioactive properties of any *waters* of the State, or such discharge of any contaminant into any waters of the State, as will or is likely to create a *nuisance* or render such waters *harmful* or *detrimental* or *injurious* to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or other aquatic life. 415 ILCS 5/3.545 (2016) (emphasis added).

To find a violation of Section 12(a) of the Act, the Board must find that a contaminant was discharged, or threatened to be discharged that is likely to render waters harmful, detrimental, or injurious to public health. People v. CSX, PCB 7-16, slip op at 16 (July 12, 2007). A violation of the Board's GQS constitutes violation of Section 12(a) of the Act. International Union, at all v. Caterpillar, PCB 94-420 slip op. at 33-34 (Aug. 1, 1996).

To establish a violation of Section 12(d), evidence must demonstrate that contaminants deposited upon land are in "particular quantity and concentration . . . likely to create a nuisance or to render the waters harmful, detrimental, or injurious." Jerry Russell Bliss, Inc. v. IEPA., 138 Ill. App. 3d 699, 704 (5th Dist. 1985).

To find a violation of Section 12(d) of the Act (415 ILCS 5/12(d) (2016)), the Board must find that a contaminant is placed on land in such a place and manner as to create a water pollution hazard. CSX, PCB 7-16, slip op. at 17. If a site's hydrology and geology would allow migration of the contaminants left in the soil to groundwater, a violation of Section 12(d) is found. *Id*.

Section 620.115 of the Board's rules (35 Ill. Adm. Code 620.115) states:

> No person shall cause, threaten or allow a violation of the Act, the [Illinois Groundwater Protection Act] or regulations adopted by the Board thereunder, including but not limited to this Part. 35 Ill. Adm. Code 620.115.

Section 620.301(a) of the Board's rules (35 Ill. Adm. Code 620.301(a)) states:

a) No person shall cause, threaten or allow the release of any contaminant to a resource groundwater such that:

1) Treatment or additional treatment is necessary to continue an existing use or to assure a potential use of such groundwater; or

2) An existing or potential use of such groundwater is precluded. 35 Ill. Adm. Code 620.301(a).

Section 620.405 of the Board's rules (35 Ill. Adm. Code 620.405) states:

No person shall cause, threaten or allow the release of any contaminant to groundwater so as to cause a groundwater quality standard set forth in this Subpart to be exceeded. 35 Ill. Adm. Code 620.405.

The Act and Board rules define "**groundwater**" as "underground water which occurs within the saturated zone and geologic materials where the fluid pressure in the pore space is equal to or greater than atmospheric pressure." 415 ILCS 5/3.210; 35 Ill. Adm. Code 620.110. "**Resource groundwater"** is defined as "groundwater that is presently being, or in the future is capable of being, put to beneficial use by reason of being of suitable quality." 415 ILCS 5/3.430; 35 Ill. Adm. Code 620.110.

For the pollutants alleged in the complaints, Section 620.410 sets the following standards:

a) Inorganic Chemical Constituents
Except due to natural causes or as provided in Section 620.450, concentrations of the following chemical constituents must not be exceeded in Class I groundwater:

Constituent	Units	Standard
Antimony	mg/L	0.006
Arsenic*	mg/L	0.010
…		
Boron	mg/L	2.0
…		
Chloride	mg/L	200.0
…		
Iron	mg/L	5.0
Lead	mg/L	0.0075
Manganese	mg/L	0.15
Mercury	mg/L	0.002
…		
Nitrate as N	mg/L	10.0
…		
Selenium	mg/L	0.05
…		

Sulfate	mg/L	400.0
Thallium	mg/L	0.002
Total Dissolved Solids (TDS)	mg/L	1,200
…		

*Denotes a carcinogen. 35 Ill. Adm. Code 620.410(a).

Class I Potable Resource Groundwater include "[g]roundwater located 10 feet or more below the land surface" that meets requirements of Section 620.210. 35 Ill. Adm. Code 620.210. Class I Potable Resource Groundwater excludes groundwater specified in Sections 620.230 (Class III Special Resource Groundwater), Section 620.240 (Class IV Other Groundwater), or Section 620.250 (Groundwater Management Zone). *Id*.

Section 620.250(a) of the Board's rules specifies that:

> a) Within any class of groundwater, a groundwater management zone may be established as a three-dimensional region containing groundwater being managed to mitigate impairment caused by the release of contaminants from a site:
>
> 1) That is subject to a corrective action process approved by the Agency; or
>
> 2) For which the owner or operator undertakes an adequate corrective action in *a timely and appropriate manner* and provides a written confirmation to the Agency. Such confirmation must be provided in a form as prescribed by the Agency. 35 Ill. Adm. Code 620.250(a).

Section 620.250(b) states that a GMZ is established when conditions of subsection (a) are met and "for a period of time consistent with the action described in that subsection." 35 Ill. Adm. Code 620.250(b).

Section 620.250(c) further states:

> A groundwater management zone *expires* upon the Agency's receipt of appropriate documentation which confirms the completion of the action taken pursuant to subsection (a) and which confirms the attainment of applicable standards as set forth in Subpart D. The Agency shall review the on-going adequacy of controls and continued management at the site if concentrations of chemical constituents, as specified in Section 620.450(a)(4)(B), remain in groundwater at the site following completion of such action. The review must take place no less often than every 5 years and the results shall be presented to the Agency in a written report. 35 Ill. Adm. Code 620.250(c).

Section 620.450(a) establishes quality standards for groundwater within a GMZ. Section 620.450(a) states:

1) Any chemical constituent in groundwater within a groundwater management zone is subject to this Section.

2) Except as provided in subsections (a)(3) or (a)(4), the standards as specified in Sections 620.410, 620.420, 620.430, and 620.440 apply to any chemical constituent in groundwater within a groundwater management zone. 35 Ill. Adm. Code 620.450(a)(1)-(2).

Section 620.450(a)(3) and (4) further define standards that apply to groundwater in a GMZ before and after completion of the corrective action:

3) Prior to completion of a corrective action described in Section 620.250(a), the standards as specified in Sections 620.410, 620.420, 620.430, and 620.440 are not applicable to such released chemical constituent, provided that the initiated action proceeds in a timely and appropriate manner.

4) After completion of a corrective action as described in Section 620.250(a), the standard for such released chemical constituent is:

A) The standard as set forth in Section 620.410, 620.420, 620.430, or 620.440, if the concentration as determined by groundwater monitoring of such constituent is less than or equal to the standard for the appropriate class set forth in those Sections; or

B) The concentration as determined by groundwater monitoring, if such concentration exceeds the standard for the appropriate class set forth in Section 620.410, 620.420, 620.430, or 620.440 for such constituent, and:

i) To the extent practicable, the exceedance has been minimized and beneficial use, as appropriate for the class of groundwater, has been returned; and

ii) Any threat to public health or the environment has been minimized. 35 Ill. Adm. Code 620.450(a)(3)-(4).

Section 620.450(a)(5) specifies the actions the IEPA must take with respect to standards applicable under subsection (a)(4)(B):

> The Agency shall develop and maintain a listing of concentrations derived pursuant to subsection (a)(4)(B). This list shall be made available to the public and be updated periodically, but no less frequently than semi-annually. This listing shall be published in the Environmental Register. 35 Ill. Adm. Code 620.450(a)(5).

B. <u>Open dumping</u>

Section 21(a) of the Act states "no person shall: cause or allow the open dumping of any waste." 415 ILCS 5/21(a) (2016).

The Act defines "**open dumping**" as "the consolidation of refuse from one or more sources at a disposal site that does not fulfill the requirements of a sanitary landfill." 415 ILCS 5/3.305 (2016). "**Refuse"** is defined as "waste" (415 ILCS 5/3.385 (2016)) and "**waste**" is defined as:

> any garbage, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility or *other discarded material*, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations, and from community activities, *but does not include* solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows, or *coal combustion by-products as defined in Section 3.135*, or industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as now or hereafter amended, or source, special nuclear, or by-product materials as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 921) or any solid or dissolved material from any facility subject to the Federal Surface Mining Control and Reclamation Act of 1977 (P.L. 95-87) or the rules and regulations thereunder or any law or rule or regulation adopted by the State of Illinois pursuant thereto. 415 ILCS 5/3.535 (2016).

"**Coal combustion by-product**" (CCB) is defined as "coal combustion waste when used beneficially in any of the [ways listed in this section]." 415 ILCS 5/3.135 (2016). The Act also defines "**Coal combustion waste**" as "any fly ash, bottom ash, slag, or flue gas or fluid bed boiler desulfurization by-products generated as a result of the combustion of … coal, or … coal in combination with [other material]." 415 ILCS 5/3.140 (2016).

"**Disposal**" means "discharge, deposit, injection, dumping, spilling, leaking or placing of any waste or hazardous waste into or on any land or water or into any well so that such waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters." 415 ILCS 5/3.185 (2016).

"**Sanitary landfill**" means "a facility permitted by the Agency for the disposal of waste on land meeting the requirements of the Resource Conservation and Recovery Act, P.L. 94-580, and regulations thereunder, and without creating nuisances or hazards to public health or safety, by confining the refuse to the smallest practical volume and covering it with a layer of earth at the conclusion of each day's operation, or by such other methods and intervals as the Board may provide by regulation. 415 ILCS 5/3.445 (2016).

For a violation of Section 21(a), although knowledge is not an element of a violation, the Environmental Groups "must show that the alleged polluter has the capability of control over the pollution or that the alleged polluter was in control of the premises where the pollution occurred." Gonzalez v. Pollution Control Bd., 2011 IL App (1st) 093021, ¶ 33; People v. A.J. Davinroy Contractors, 249 Ill. App. 3d 788, 793, 618 N.E.2d 1282, 1286 (5th Dist. 1993). Property owners are responsible for the pollution on their land unless the facts establish that the

owners either "lacked the capability to control the source" or "had undertaken extensive precautions to prevent vandalism or other intervening causes." *Id*; Perkinson v. Pollution Control Bd., 187 Ill. App. 3d 689, 695, 543 N.E.2d 901, 904 (3rd Dist. 1989).

III. PARTIES' ALLEGATIONS

1. Environmental Groups' Allegations

The Environmental Groups allege that MWG violated Sections 12(a), 12(d), and 21(a) of the Act (415 ILCS 5/12(a), 12(d), 21(a) (2016)) and Sections 620.115, 620.301(a) and 620.405 of the Board's groundwater quality rules (35 Ill. Adm. Code 620.115, 620.301(a) and 620.405). Am. Comp. at 17, ¶ 51; EG Br. at 4. The Environmental Groups allege that MWG discharged contaminants into the environment "through coal ash disposal ponds, landfills, unconsolidated coal ash fills, and/or other coal ash and coal combustion waste repositories" at all four Stations. Am. Comp. at 17, ¶ 51.

The Environmental Groups allege that at "all MWG Plants coal ash can be found in onsite impoundments (or 'ash ponds') and in ash landfills and other coal ash fill areas outside of the ash ponds." EG Br. at 4. The Environmental Groups allege that MWG has owned and operated the Stations since 1999, has known about coal ash both in and outside ash ponds, and has not exercised adequate control to prevent groundwater contamination. *Id*.

Historical sites. The Environmental Groups allege that all four Stations include large onsite historical coal ash storage areas, or landfills. In support of this allegation, the Environmental Groups rely on the 1998 Phase I and Phase II reports and Dr. Kunkel's testimony and reports to establish historic locations at the four Stations. EG Br. at 26, 29, 31; EG Resp. Br. at 37; EG Exh. 20D at Fig. 2 (#23339); EG Exh. 21 at 12 (#25150); 10/26/17 p.m. Tr. at 34-36, 39, 83 (Kunkel Test.); 10/27/17 Tr. at 12, 25-26 (Kunkel Test.); 1/29/18 Tr. at 73 (Kunkel Test.); EG Exh. 401 at 2. The Environmental Groups assert that MWG employees and consultants were well aware of these areas. 10/25/17 Tr. at 81-82, 95 (Gnat Test.); 10/23/17 Tr. at 100, 103-104, 110-114, 121-122, 134-137, 226 (Race Test.); 1/29/18 Tr. at 183; 2/1/18 Tr. at 193-194; 2/2/18 Tr. at 142, 158-160, 172, 184, 192 (Seymour Test.), MWG Exh. 903 at 43.

The Environmental Groups also allege that contaminants are leaking from the berms of the ash ponds, and, that certain Stations were constructed in part with coal ash and contain ash as deep as 10-120 feet as evidenced by soil borings. EG Br. at 59 *citing* EG Exh. 14C at 19 (#7166-7174); EG Exh. 401 at 24-25, Tab. 7; 27/10/17 Tr. 24:9-26:3.

The Environmental Groups argue that historic ash caused some or all of the groundwater contamination. EG Br. at 33. They argue that MWG expert Mr. Seymour confirmed that MWG is aware of the coal-ash related constituents in the monitoring wells, noting in his testimony that "[i]t's a power plant and so there's ash-related constituents at the site. It's just that we haven't identified a specific source." 2/2/18 Tr. at 46, 158; EG Br. at 33-34. "The power plant is over 50 years old and there are many historic uses at the site that may have caused the impacts that we're seeing, and they have caused the impacts that we're seeing, and they may be related to coal ash from historic uses." *Id*. at 158-160; EG Br. at 34. The Environmental Groups also note that MWG's experts cannot rule out historic coal ash landfills as the cause of contamination

because MWG has not taken samples or borings from many of these sites, did not conduct leachate testing there, and did not monitor groundwater close to those areas. EG Br. at 34; 2/2/18 Tr. at 21, 160-165; 1/30/18 Tr. at 258-260; 10/23/17 Tr. at 77.

Coal Ash Constituents. The Environmental Groups maintain that many of the pollutants exceeding GQS are "constituents" of coal ash. Am. Comp. at 4, ¶ 11; EG Br. at 4. Boron and sulfate are primary indicators of potential coal ash. *Id*. These pollutants make groundwater unusable when "at the concentrations found in MWG's wells." Am. Comp. at 4. The Environmental Groups argue that concentrations of these pollutants present human health risk or endanger aquatic ecosystems. Am. Comp. at 4-8, ¶¶ 13-27. The Environmental Groups argue this poses a significant concern because contaminated groundwater is migrating into adjacent surface water bodies. *Id*.

Class I GQS Exceedances. The Environmental Groups assert that groundwater at the four Stations has exceeded Illinois Class I GQS for coal ash constituents since monitoring began in 2010:

1) 69 times at Joliet 29, including eight exceedances in 2016 and four exceedances in the first half of 2017 (EG Br. at 29);

2) 406 times at Powerton, including 81 exceedances in 2016 and 45 exceedances in the first half of 2017 (EG Br. at 39);

3) 443 times at Will County, including 70 exceedances in 2016 and 37 exceedances in the first half of 2017 (EG Br. at 63, App. A);

4) 396 times at Waukegan, including 87 exceedances in 2016 and 55 exceedances in the first half of 2017 (EG Br. at 52, App. A).

Background Exceedances. Additionally, the Environmental Groups contend that onsite concentrations of coal ash constituents are higher than IEPA's state wide background values (both statewide median[3] and 90th percentile) from the IEPA ambient monitoring network and are not naturally occurring. EG Br. at 29. The Environmental Groups' expert, Dr. Kunkel, explained that "there are specific Illinois ground-water quality data which are representative of background on a state-wide level for the three indicator pollutants." EG Exh. 401 at 8. Dr. Kunkel compared median concentrations of coal ash constituents in each well at Joliet 29, Will County, and Waukegan to the statewide background values developed by IEPA. Env. Br. at 21. At Powerton, Dr. Kunkel employed MW-16 as the background well. EG Exh. 401 at 8. The Environmental Groups rely on IEPA's Technical Support Document filed in R14-10 in 2013 to establish statewide median and upper-bound 90th percentile values for boron, sulfate, and other pollutants. EG Br. at 21; EG Exh. 405 at 5 (#19071).

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[3] Median is determined by arranging all the data in the background dataset from highest value to lowest and taking the center value of that dataset. 2/1/18 Tr. at 103 (Gnat Test.); EG Exh. 405 at 5-9 (#19071-75). 90th percentile is a statistical representation of monitoring data expected by the Illinois EPA that indicates the level of confidence above which a value can be considered above background. If a number is above the 90th percentile level, then it can be said with 90 percent confidence that the value is above background. 2/2/18 TR. at 32-33 (Seymour Test.)

The Environmental Groups allege that, at Joliet 29, boron and sulfate concentrations exceed the median background values in all 11 monitoring wells, as well as upper-bound 90th percentile background value for boron in MW-11 and sulfate in MW-09. EG Br. at 30. At Powerton, the concentrations of boron and sulfate were exceeded in 15 downgradient wells (MW-1 through MW-15) and the upper-bound 90th percentile background values were exceeded for sulfate in nine wells (MW-4, 5, 8, 9, and 11 through 15) and boron in seven wells (MW-6, 8, and 11 through 15). EG Br. at 40-41. At Will County, boron concentrations exceed the upper-bound 90th percentile background values in all ten wells. *Id.* at 64. Although monitoring well MW-04 is the only well's whose sulfate concentration exceeded the upper-bound 90th percentile value, the sulfate concentrations in all ten wells are three to five times higher than the statewide median value. *Id.* At Waukegan, the boron and sulfate concentrations in most of the wells are higher than the statewide upper-bound 90th percentile background value and not naturally occurring. EG Br. at 53.

Dr. Kunkel noted that all four Stations' sites overlay sand and gravel or shallow bedrock aquifers that are the same aquifers from which the IEPA's background community water supply wells (CWS) are drawing water. EG Exh. 401 at 8. Dr. Kunkel further notes that the actual background median for sulfate at Powerton's background well (MW-16), which is completed in the sand and gravel aquifer, was within a few milligrams per liter of the median statewide sulfate value. Thus, Dr. Kunkel argued that the statewide median background values may be used to evaluate groundwater monitoring results even though the statewide CWS wells were not located in counties with MWG plants. 1/29/18 Tr. 83-84; EG Exh. 401 at 8.

The Environmental Groups note that MWG's expert concurred that, if the groundwater concentration is greater than the 90th percentile of the statewide background values, then the value is above the background value. EG Br. at 21 *citing* 2/2/18 Tr. at 32-33 (Seymour Test.).

GMZs and CCAs. The Environmental Groups also noted that although MWG established Groundwater Management Zones (GMZ) at the three Stations, groundwater monitoring recorded exceedances of GQS in violation of Sections 620.301(a) and 620.405, on many occasions before the GMZs were established. EG Br. at 5. No GMZ was established at the Waukegan Station. The Environments Groups also argued that MWG's four Compliance Commitment Agreements (CCAs) failed to address all possible sources of coal ash contamination because they did not address coal ash outside of the coal ash ponds. The CCAs also failed, according to the Environmental Groups, to provide for any controls to prevent contamination from any historic coal ash landfills or fill areas. EG Br. at 25-26.

2. MWG Response

MWG denied the Environmental Groups' allegations and believed that alleged exceedances are random, inconsistent, and do not show a connection to the ash ponds. MWG 2nd Ans. Def. at 23; MWG Br. at 4. MWG stated that all ash ponds are permitted under its NPDES permits as part of its wastewater treatment systems and are lined with HDPE liners. MWG 2nd Ans. Def. at 1-2; SOF ¶ 91.

Historical Sites. MWG asserted that any historical sites at the four Stations that may contain historical coal combustion debris were not created, filled, or used for storage or disposal

by MWG. MWG 2nd Ans. Def. at 22. MWG experts testified that the Phase II Reports were prepared for the previous owner of the Stations, before MWG began operating them. MWG Exh. 901 at 23 (Seymour); EG Exhs. 17D-20D; SOF at 12 ¶ 119; MWG Br. at 11. When MWG acquired the Stations, MWG assessed these historic areas and concluded, based on the Phase I and Phase II Reports, that no further remediation was necessary. MWG Resp. Br at 28; SOF ¶¶ 78-85, 121, 122, 162-165, 272, 368-370; 1/29/18 Tr. at 185, 205-207 (Race Test.). Neither USEPA nor IEPA asked MWG to investigate these areas. *Id*. MWG also noted that, between 2004 and 2015, MWG investigated and tested historic ash in fill materials at Joliet 29, Powerton, Will County, and Waukegan Stations to confirm that the historic ash met the Act's requirements for beneficial reuse. MWG Br. at 7. The results showed that the historic ash met the "CCB criteria and can be used for beneficial reuse" under 415 ILCS 5/3.135. *Id*. at 7-8.

Class I GQS Exceedances. MWG believed that no concentrations of constituents related to coal ash above the groundwater standards exist at the Joliet 29 or Powerton Stations. MWG Br. at 12. According to MWG, Seymour established that the groundwater conditions at the Stations do not pose a risk to public health or water receptors in the neighboring surface waters. MWG Br. at 29. Seymour concluded that ash ponds are not the source of the Part 620 standards exceedances. In fact, Seymour suggested that exceedances may be due to the historic contamination that remains at the site. 2/2/18 Tr. at 80.

MWG stated that, since sampling groundwater began in 2010, boron has been detected above the Class I GQS at Joliet 29 in one of the eleven wells in 2011 once and never since. MWG Br. at 9. Moreover, MWG maintained that groundwater monitoring around the known former ash area at Powerton shows no coal ash constituents above the Class I GQS. MWG Res Br. at 2. MWG's expert Seymour also stated that, based on the groundwater concentrations in the monitoring wells, no groundwater plume exists at any of the Stations, evidenced by a lack of spatial trend in the indicator constituents' concentrations in the direction of the groundwater flow. Accordingly, MWG contended that no evidence exists to indicate that the source area remaining at the site can be remediated. MWG Exh. 903 at 15, 18, 21, 23. MWG's expert, Seymour, however, admitted that key indicator constituents intermittently exceeded Class I groundwater standards. MWG Exh. 903 at 18. MWG's consultants performed Neutral Leaching Extraction Test (NLET) analyses of the bottom ash from ponds at Powerton (2007), Waukegan (2004) and Will County (2010). *Id.* at 41; MWG Exh. 901 at 8. According to Seymour, the results of the NLET analyses indicate whether the leachate in the ponds has the potential to cause groundwater impacts above the Class I groundwater standards. MWG Exh. 903 at 41. Based on the NLET results, he concluded that the leachate in ponds at all four stations does not have the potential to impact groundwater above the Class I standard. *Id*.

Mr. Seymour compared the groundwater monitoring results from 2014 with the results of the NLET analyses of the bottom ash leachate. He noted a low percentage of constituents in the monitoring wells that match leachate indicator constituents (including barium, boron, sulfate, TDS and several metals): 11-37% at Joliet 29; 5-37% at Powerton; 16-26% at Waukegan; and 21-37% at Will County. Exh. 903 at 42-43. Mr. Seymour claimed that low matching percentages show substantial and widespread mismatch between the characteristics of recent groundwater analyzed near the ash ponds and the characteristics of leachate from ash currently stored in the ash basins. *Id.* at 43. Thus, he contended that the likely sources of groundwater impacts are not the ash stored in the ash basins but, rather, historical uses of the sites and surrounding industrial sites . *Id*.

Background Exceedances. MWG also disagreed with the Environmental Groups use of statewide median background values. MWG's expert Mr. Seymour asserted that the background levels employed by the Environmental Groups are based upon monitoring data from community water supply wells that are not representative of site-specific groundwater quality. 2/2/18 Tr. at 31-32 (Seymour Test.). He maintained that it is inaccurate to consider statewide background as representative of background at the sites where upgradient monitoring data is available. Mr. Seymour maintained that background concentrations must be evaluated based upon site specific data from monitoring wells installed at upgradient site boundaries in locations without the presence of ash materials in fill. MWG Exh. 903 at 60.

Mr. Seymour also noted that the IEPA's proposed CCR regulations explain the procedure for establishing background on site specific basis. The IEPA's proposal in R14-10 specifies that the groundwater monitoring system must include wells to represent the quality of groundwater at the site not affected by activities and units (background) and sets forth requirements for establishing background. EG Exh. 405 at 25-28. Additionally, MWG's consultant, Gnat, explained why a direct comparison of the median values from a monitoring well with the statewide median value is inappropriate. He noted that a monitoring well median above the statewide median means the well median value is above the median of community water supply wells' background values and not above background itself because the statewide median has a range of median values. 2/1/18 Tr. at 105-106. Mr. Seymour agreed that the comparison, according to the IEPA, must be based upon a statistical evaluation that employs a 90 percent confidence level, (i.e. a value above the 90 percent confidence level is considered above background levels with 90 percent assurance). 2/2/18 Tr. at 32-33 (Seymour Test.).

GMZ, ELUC, and CCA Compliance. MWG argued that Illinois law does not establish strict liability for water pollution and "simply being an owner or operator of a facility is not enough to find liability in this case." MWG Br. at 4. MWG noted that it took extensive precautions, including extensive corrective actions required by the CCAs: relined ash ponds, established GMZs and ELUCs, and performed regular inspections and repairs to the ash ponds' lining. MWG Br. at 3, 4. MWG believed that the law "is clear that a party does not cause or allow contamination if it took extensive precautions, as MWG did." MWG Br. at 4. MWG established ELUCs under 35 Ill. Adm. Code 742.1010 at Powerton, Will County, and Waukegan. MWG Br. at 29; SOF 646. An ELUC "is another institutional control tool in which a designated parcel of land has certain use restrictions, such as not allowing the placement of any potable water wells within the area." MWG Br. at 29; SOF 647.

MWG, further, argued that, because it performed all measures required by the IEPA, even if the Board finds violations of the Act, "no penalty or other response is warranted, and no further proceedings are warranted." MWG Br. at 5. MWG maintained that the Board may not grant relief requested by the Environmental Groups to modify MWG coal ash disposal practices and to remediate contamination because it has no enforcement powers and cannot grant injunctive relief. MWG 2nd Ans. Def. at 23.

MWG also asserted the following affirmative defenses:

I. MWG did not violate Board's Class I GQS[4] standards and Sections 620.301(a) and 620.405 because the groundwater at the Stations is within the GMZ which, under Section 620.450(a)(3), is exempt from those standards; and

II. There is no nuisance, harm or injury to public health, safety or welfare at or around the Stations because of low level of constituents in the groundwater and absence of human and environmental receptors. MWG 2nd Ans. Def. at 24-26 ¶¶ 82-97; 2/1/18 Tr. at 107.

IV. FACTS

1. General Facts Applicable to all Stations

x. Coal Ash and Constituents

The parties agreed that coal combustion for electricity generation creates two types of coal ash - fly ash and bottom ash. Joint Stip. at 4; MWG Br. at 6; 10/26/18 Tr. p.m. at 31 (Kunkel Test.). While fly ash consists of lightweight particles that go up the stack, the bottom ash consists of heavy particles that fall to the bottom of the furnace. Bottom ash is mixed with water, then removed by transporting out of the plant through a pipe to the ash ponds or a settling basin. MWG Br. at 6; EG Br. at 18; 2/1/18 Tr. at 7 (Veenbaas Test.); 10/26/18 Tr. p.m. at 31 (Kunkel Test.); *see also* EG Exh. 43; 10/24/17 Tr. at 38. "Slag" is a form of bottom ash that is a bi-product of coal combustion. 10/23/17 Tr. at 128 (Race Test.); 10/24/17 Tr. at 38, 179 (Lux Test.). The terms "coal ash" and "slag" are used interchangeably in the record by the parties and experts to refer to bottom ash.

Constituents found in the bottom ash depend on the source of coal and the combustion process. 10/23/17 Tr. at 13. The parties agreed that all four MWG Stations burned the same coal in a similar manner, thus the resulting coal ash from each Station possessed similar constituents. Joint Stip. at 4; MWG Br. at 6; 10/27/18 Tr. at 177 (Kunkel Test., noting that he heard that "there may have been some Illinois coal mixed in with the coal from one of the plants"); 2/1/18 Tr. at 266 (Seymour Test.); MWG Exh. 903 at 41 (Seymour Test.).

The parties agreed that boron and sulfate are typical indicators of coal ash and are constituents typically found in bottom ash. Env. Gr. Br at 4, 17, 28 and MWG Br. at 6. Coal ash indicators may also include other contaminants recognized by the USEPA in 40 CFR 257, App. III, such as, calcium, chloride, fluoride, pH, and total dissolved solids (TDS). Env. Gr. Br at 17, 20 and MWG Br. at 6. Environmental Groups note that 40 CFR 257, Appendix IV, also lists antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, lead, lithium, mercury, molybdenum, selenium, thallium, and radium.

The Environmental Group's expert Dr. Kunkel noted that coal ash leachate is characterized by one or more of the following constituents: boron, molybdenum, lithium, sulfate, bromide, potassium, sodium, fluoride, chloride, or calcium. EG Exh. 401 at 7. However, boron,

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[4] MWG refers to 35 Ill. Adm. Code 620.410, 620.420, 620.430 and 620.440. *See* MWG 2nd Ans. Def. at 25 ¶ 86.

manganese, sulfate, and TDS were chosen as indicators of GW contamination from coal ash ponds. *Id*. Dr. Kunkel stated that it is highly unlikely that the combination of boron, sulfate, and manganese in concentrations above groundwater standards or background water quality concentrations beneath or down-gradient from ash ponds would be caused by any source other than coal ash. *Id.* MWG's expert concurred that indicator constituents for coal ash in MWG's ash ponds, at a minimum, include barium, boron, and sulfate; and may also include antimony, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, and zinc. MWG Exh. 901 at 21-25.

xi. <u>Hydrogeological Assessment and 2012 Violation Notices</u>

In 2010 MWG agreed to the IEPA's request to perform hydrogeological assessments around the ash ponds at the four Stations, even though MWG believed it "was under no legal obligation to do so." EG Exh. 8B at 1; MWG Answer and Defenses 5/5/14 at 21; MWG Br. at 3; EG Exhs. 12C, 13C, 14C, and 15C.

Upon completion of the assessments, on June 11, 2012, the IEPA issued Violation Notices (VN) to MWG under Section 31(a)(1) of the Act (415 ILCS 5/31(a)(1) (2016)), alleging violation of groundwater quality standards at all four Stations. MWG 2nd Ans. Def. at 4, 22; Joint Stip. at 4. The VNs alleged violations of Section 12 of the Act (415 ILCS 5/12 (2016)) and Sections 620.115, 620.301, 620.401, 620.405 and 620.410 of the Board's regulations (35 Ill. Adm. Code 620.115, 620.301, 620.401, 620.405, 620.410). EG Exhs. 3A, 4A. VNs alleged that "operations at ash impoundments have resulted in violations of Groundwater Quality Standards" between 2010 - 2012. *Id*.

xii. <u>CCAs for All Four Stations</u>

On July 27, 2012, MWG responded to the IEPA by requesting a meeting to discuss the VNs and included a proposed Compliance Commitment Agreements (CCA) for each of the four Stations. EG Exhs. 8B and 9B. MWG did not admit to any alleged violations and disagreed with the VNs. MWG argued that the VNs provided no information as to why the IEPA concluded that the ash ponds caused alleged groundwater impacts. EG Exhs. 8B at 2 and 9B at 2. "[A]lleged violations in the VN are based solely on the results of the hydrologic assessment" which "do not show that the coal ash ponds at the [Stations] are impacting the groundwater and do not provide the necessary evidence to support the alleged violations." *Id*. On August 14, 2012, the IEPA met with MWG to discuss the VNs. MWG Exh. 622 at 1. In August and September 2012, the IEPA received MWG's supplemental response to the VNs at the four Stations; MWG's supplemental response proposed revised terms for four CCAs based upon the August 14th discussions. MWG Exhs. 626 at 3; 624 at 2; 625 at 1; 622 at 1; 623 at 1.

On October 24, 2012, MWG entered into separate CCAs with IEPA with respect to the four Stations. MWG 2nd Ans. Def. at 24. The CCAs stated that, "pursuant to [VNs] the Illinois IEPA contends that Respondent has violated" Section 12 of the Act (415 ILCS 5/12 (2016)) and Sections 620.115, 620.301, 620.401, 620.405, and 620.410 (35 Ill. Adm. Code 620.115, 620.301, 620.401, 620.405, 620.410). MWG Exhs. 626 at 2 ¶ 3; 636 at 2 ¶ 3; 656 at 2 ¶ 3; 647 at 2 ¶ 3.

xiii. <u>Groundwater Monitoring</u>

In 2010 MWG installed groundwater monitoring wells around the ash ponds at the four Stations. The wells were screened to ensure collection of representative groundwater samples from the uppermost aquifer. EG Exh. 12C at 4. Beginning in the fourth quarter of 2010, MWG undertook a quarterly sampling program. MWG Exh. 809. The groundwater samples were analyzed for 35 parameters. *Id*. These parameters included the indicator constituents associated with coal ash. MWG Br. at 6. The quarterly monitoring reports, included in the record, for all four Stations provide results from December 2010 through April 2017 for 35 parameters, including antimony, arsenic, boron, manganese, and other indicator constituents associated with coal ash. MWG Exh. 809-812; s*ee also* EG Br. at 17 and App. A; MWG Br. App. A/SOF ¶¶508, 509, 520-523, 526, 528.

2. Joliet 29

A. Uncontested Facts

xiv. The Station

MWG leases and operates Joliet 29 Electric Generating Station, located in Joliet, Will County (Joliet 29). Joint Stip. at 1; MWG 2nd Ans. Def. at 1; 1/29/18 Tr. at 178-179 (Race Test.). The Station is located in a primarily industrial area, bordered on the west by a former Caterpillar, Inc. manufacturing facility. 1/29/18 Tr. at 179 (Race Test.). The north side of Joliet 29 is bordered by Channahon Road (East James St), beyond which are Illinois and Michigan Canal Trail, industrial facilities, and neighborhoods of Rockdale. 1/29/18 Tr. at 179-180 (Race Test.). The east side is bordered by Brandon Road, and the south side is bordered by the Des Plaines River. 1/29/18 Tr. 179-180 (Race test); MWG Exh. 667 at 2; EG Exh. 20D at 28 (Fig.1); MWG Exh. 246M at 4 (Fig.1); SOF at 8 ¶ 68, 69, 73; 10/26/17 Tr. A.m. at 36-37 (Gnat Test.).

The Station has operated since the mid-1960s. EG Exh. 201 at 2-4 (#24265-24267); EG Exh. 242 at 7; MWG Exh. 663 at 1; MWG Exh. 901 at 14; 1/29/18 Tr. at 182 (Race Test.). MWG operated the Station as a coal-fired plant from 1999 until March 18, 2016, when it ceased burning coal. Joint Stip. at 1-2; SOF ¶ 67; 1/29/18 Tr. at 186 (Race Test.). On May 26, 2016, Joliet 29 began generating electricity with natural gas. Joint Stip. at 2; MWG Br. at 11; SOF at ¶ 67; 1/29/18 Tr. at 186 (Race Test.). Joliet 29 Station burned subbituminous coal from Wyoming's Power River Basin until it ceased burning coal for electricity generation. Joint Stip. at 4.

xv. Ash Ponds

Three active coal ash ponds exist at Joliet 29: Pond 1, 2, and 3, all constructed in 1978 with a poz-o-pac liner. Joint. Stip. at 1; MWG 2nd Ans. Def. at 1; SOF ¶ 86; MWG Exh. 901 at 16; MWG Exh. 667 at 4. All three ponds were relined with a 60 mil. high density polyethylene (HDPE) liner: Pond 1 in 2007, pond 2 in 2008, and pond 3 in 2013. Joint Stip. at 1. All three ash ponds are included in the MWG's NDPES Permit #IL0064254, issued September 30, 2014, (effective November 1, 2014,) as part of the wastewater treatment system. MWG Exh. 603 at 1, (Joliet 29 NPDES Permit); MWG 2nd Ans. Def. at 1-2; SOF ¶ 91.

At the time MWG began operating Joliet 29, and until 2016, the majority of the bottom ash was conveyed automatically by an enclosed pipe system across the Des Plaines River to a

permanent permitted landfill operated by Lincoln Stone Quarry. 1/29/18 Tr. at 192-194 (Race Test.). When the enclosed pipe system was not operating, on rare occasions bottom ash from Joliet 29 was pumped to either Ash Pond 1 or Ash Pond 2. *Id*. at 194.

Ash Ponds 1 and 2 were operated one at a time and were emptied in succession, every two to four years, with the removed ash taken to a permitted landfill. MWG Exh. 901 at 16 (Seymour test); MWG Exh. 903 at 15-16, 30; MWG Exh. 500 at 30-31; 1/29/18 Tr. at 194. Ponds 1 and 2 were dredged regularly, approximately every year or every other year. Joint Stip. at 1. The ponds' lining includes (described bottom up): 12" poz-o-pac on the bottom, a bottom geotextile cushion, the 60 mil HDPE liner, a top geotextile cushion, a sand cushion and a limestone warning layer. MWG Exh. 901 at 17. The ponds' bottom elevation is at 516 ft; the average groundwater elevation is at 505.5 – 506 feet (about 10 feet below the pond's bottom). *Id*. By October 12, 2015, MWG removed Pond 1 from service with all coal ash removed from it. Joint Stip. at 2; 1/29/18 Tr. at 198 (Race Test.). Ash pond 2 closed as well, and, at the time of the January 29 hearing, MWG was in the process of removing the remaining ash was in the process of being removed to the Lincoln Stone Quarry landfill, scheduled to complete in 2018. 1/29/18 Tr. at 198-199 (Race Test.).

Ash Pond 3 was used as a finishing pond and received only a *de minimis* amount of ash. Because no ash accumulated in the pond, Pond 3 never needed to be emptied between 1978, when it was placed into operation, and 2013, when it was emptied and relined. 1/29/18 Tr. at 188-191 (Race Test.); 1/30/18 Tr. at 39-40 (Race Test.). The pond's lining is the same as Ash Ponds 1 and 2 and includes (described bottom up): 12" poz-o-pac on the bottom, a bottom geotextile cushion, the 60 mil HDPE liner, a top geotextile cushion, a sand cushion and a limestone warning layer. MWG Exh. 901 at 18. The pond's bottom elevation is at 517.5 ft; the average groundwater elevation is at 505.5 feet (about 12.5 feet below the pond's bottom). *Id*. The effluent entering Ash Pond 3 from Ash Pond 2 was sampled in 2015 for total suspended solids. The samples showed only 20 mg/L of total suspended soils in the water, which means that "influent looked like a clear water." 1/29/18 Tr. at 190-191 (Race Test.); MWG Exh. 602 at 6 (bates #49747). MWG removed coal ash from Pond 3 for the first time in 2013 when it was relined. Joint Stip. at 2; EG Br at 29; 1/29/19 Tr. at 191-192 (Race Test.).

xvi. Joliet 29 Violation Notice

The, IEPA issued Violation Notice W-2012-00059for Joliet 29 Station (Joliet 29 VN) which alleged that "operations at ash impoundments have resulted in violations of Groundwater Quality Standards" during 2010 - 2012 at monitoring wells MW-2 through MW-11, including for Chloride (all monitoring wells), Antimony (MW-2), manganese (MW-4, 7, 9), and boron (MW-11). EG Exh. 3A at 3-6. MW-9 also included sulfate, iron, and TSD. *Id*. at 5-6.

xvii. Joliet 29 CCA

The Joliet 29 CCA (MWG Exh. 626) states that:

> Operations at ash impoundments have resulted in violations of the Groundwater Quality Standards at monitoring wells MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-10 and MW-11. MWG Exh. 626 at 2 ¶ 3.

The Joliet 29 CCA notes that "respondent agrees to undertake the following actions, which the Illinois EPA has determined are necessary to attain compliance" with the Act and Board rules. MWG Exh. 626 at 3 ¶ 5. Subsections (a) through (h) of paragraph 5 list activities MWG must undertake, that include:

5(a)	prohibiting the use of ash ponds as permanent disposal sites, but only as treatment ponds to precipitate ash, and to continue periodic removal of ash;
5(b)	maintaining and operating ponds in a manner that protects integrity of their liners;
5(c)	conducting visual inspections of the ponds during ash removal to identify breach of liners integrity and to promptly inform IEPA and repair (implement corrective action plan approved by IEPA) if signs of breach are found;
5(d)	continuing quarterly monitoring of the 11 monitoring wells "for constituents in 35 Ill. Adm. Code 620.410(a)" and record and report elevations to IEPA;
5(e)	apply to IEPA for a construction permit to reline Ash Pond 3 with HDPE liner;
5(f), (g)	submitting an application to IEPA to establish and establish a GMZ under section 620.250 within one year from the date of CCA; and
5(h)	within one year of the date of CCA, and upon realigning Ash Pond 3 and establishing GMZ, submit a certification of compliance. MWG Exh. 626 at 3 ¶ 5.

On October 9, 2013, MWG filed a certification with the IEPA that all Joliet 29 CCA measures were completed. Joint Stip. at 4; MWG Exh. 630.

xviii. <u>Joliet 29 GMZ</u>

As required by the Section 5 of the Joliet 29 CCA, on January 18, 2013, MWG submitted an application to establish a GMZ (Joliet 29 GMZ Application, EG Exh. 242), that would include the area around the ash ponds. EG Exh. 242 at 1; MWG Exh. 901 at 23 (Seymour Pres.). The IEPA approved the application on August 8, 2013. Joint Stip. at 4; MWG Exh. 627; MWG 2nd Ans. Def. at 25. The application describes the GMZ borders:

> groundwater flow in the vicinity of the subject ash ponds is in southerly direction with discharge to the adjourning station water intake channel of the Des Plaines River. The southern (downgradient) extent of the proposed GMZ corresponds with this hydraulic boundary. The northern (upgradient) boundary is defined by the placement of the three upgradient monitoring wells (MW-8, MW-10 and MW-11). The east and west sides of the proposed GMZ are based on the flow system and location of the three ash ponds. EG Exh. 242 at 1.

The application noted that "Class I" is the groundwater classification "the facility will be subject to at the completion of the remediation." *Id*. Att. 2 Part I, ¶ 10. The GMZ application noted that:

> The agreed upon remedy is specified in Item 5(a) through (h) of the executed [CCA]… The remedy includes lining of Ash Pond 3 with HDPE. This [GMZ] application fulfills requirements set forth under Item 5(f) of the CCA. EG Exh. 242 Att. 2, Part III ¶ 1.

The application also noted that "[at] the completion of the corrective process, a final report is to be filed which includes the confirmation statement included in Part IV." *Id*. Att. 2 at 1, Note 1.

B. Contested Facts

i. *Ash Ponds Dredging and Liner Ruptures*

The record shows that three ash ponds at Joliet 29 have been lined and regularly dredged as needed. The liners are prone to damage in certain conditions. MWG took actions to identify and repair any damages to the liners, or to avoid rapturing the liners while dredging the ponds.

The three ash ponds at Joliet 29 were all constructed in 1978 with a poz-o-pac liner before they were relined with the HDPE (high-density polyethylene) liner in 2007 - 2013 (Ash Pond 1 in 2007, Ash Pond 2 in 2008, and Ash Pond 3 in 2013). Joint. Stip. at 1; MWG 2nd Ans. Def. at 1; SOF ¶ 86; MWG Exh. 901 at 16; MWG Exh. 667 at 4.

Poz-o-pac is a material that can crack in certain weather conditions or leak. 2/2/18 Tr. at 148; *see also e.g*. EG Exh. 303, 286 at 2; 10/24/18 at 215; 10/26/17 p.m. Tr. at 34-35 (Kunkel Test.). MWG relined the ponds on the assumption that they were in a "poor" condition. EG Exh. 34 at (#23614); MWG Exh. 606 at (#23647); *see also* 10/23/17 Tr, at 16; 10/24/17 Tr. at 12-13. In 2005 and 2006 MWG consultant, NRT, investigated the liners at Joliet 29 ponds and rated the condition of all three ponds as "poor." EG Exh. 34 at (#23614); MWG Exh. 606 at #23644. The report also rated these ponds as "high" for "contamination potential." *Id*. The same report rated a poz-o-pac liner in the "Environmental Criteria" as "1" on the scale of 0-10, with "0" being no liner (worth more than asphalt in unknown condition, which has "2" rating). MWG Exh. 606 at (#23631); EG Exh. 34 at (#23608). It also noted that "Poz-O-Pac liner systems were constructed more than 25 years ago and are reportedly in poor condition." *Id*. Race testified, however, that when the ponds were relined, the original 1978 poz-o-pac liner was found to be in a "good condition." 10/24/17 Tr. at 12-14 (Race Test.); 1/29/18 Tr. at 236 (Race Test.). When relining ponds in 2007, NRT suggested leaving bottom ash between poz-o-pac and HDPE liner at Joliet 29, noting that "this will make an excellent bedding layer for the geomembrane". EG Exh. 22. Maria Race agreed to that, noting "[i]t is fine to leave the ash there—it is poz o pac and is stable enough-and I agree with your assessment of risk/benefits." *Id*.

An HDPE liner is designed to prevent releases to soil and groundwater and is "the least permeable type of liner, resistant to chemicals, and is the same liner used for hazardous waste landfills." 1/29/18 Tr. at 224-226 (Race Test.); 2/1/18 Tr. at 243, 256 (Seymour Test.); MWG 2nd Ans. Def. at 1-2; SOF ¶¶ 26, 91. An HDPE liner, however, can be damaged during the pond

dredging process by the heavy equipment. *See e.g.* EG Exh. 306, 307; 10/26/17 p.m. Tr. at 35 (Kunkel Test.). Ash Ponds 1 and 2 were dredged approximately every one to two years. Joint Stip. at 1. The record indicates that MWG consultants took actions to avoid, identify, and repair any damage to the liners during ash removal and during the relining process. MWG Exh. at 903 at 38-39 (Seymour Test.).

After a careful review of the facts, the Board finds that the Environmental Groups established that both poz-o-pac and HDPE liners at Joliet 29 can and do crack or become damaged on occasions. Based upon the preponderance of the evidence in the instant record, including the quarterly groundwater monitoring results, MWG practices in pond relining and dredging, the Board concludes that it is more likely than not that the ash ponds did leach contaminants into the groundwater.

ii. <u>Historical Coal Ash Sites</u>

Three historical unlined areas exist at Joliet 29 where coal ash was deposited before MWG began operating: 1) the Northeast Area; 2) the Southwest Area; and 3) Northwest Area. 1/30/18 Tr. at 259-264, 272-273 (Race Test.); 2/1/18 Tr. at 193-198 (Gnat Test.); EG Exh. 21 at 12 (#25150) (noting that "the site was used for coal ash disposal by Joliet #9 Station prior to the construction of Joliet #29 in 1964-65. Coal ash was primarily disposed in a landfill on the eastern portion of the site. A second abandoned ash disposal landfill lies on the southwest portion of the site between the coal pile and Caterpillar, Inc. site.").

Unlined areas that contain coal ash pose a risk of groundwater contamination due to the water moving through the coal ash, thereby increasing the risk of leaching and contamination. EG Br. at 19; 10/24/17 Tr. at 39 (Lux Test.); 10/26/17 Tr. p.m. at 34-35, 83-84 (Kunkel test); 1/29/18 Tr. at 208 (Race Test.); 1/30/18 at 29 (Race Test.); MWG Exh. 636 at 4 (#555) (sec. 5(m) of the Joliet 29 CCA, stating that MWG "shall not use any unlined areas for permanent or temporary ash storage or ash handling."). No monitoring wells are installed around any of these areas. 2/1/18 Tr. at 196-198 (Gnat Test.); MWG Exh. 901 at 19; MWG Exh. 667 at 3. MWG possesses only partial knowledge of the content of these areas or their potential to contaminate the groundwater.

<u>The Northeast Area</u> is part of the Station's NPDES stormwater permit. MWG Br. at 11; MWG Exh. 603 at 1, 9, and 15; 1/29/18 Tr. at 183 (Race Test.). MWG admits, and the record indicates, that this area contains historic coal ash. MWG Br. at 11; 2/2/18 Tr. at 323 (Seymour Test.); EG Exh. 248N at 1 (#19442); EG Exh. 20D at (#23342; 23357); EG Exh. 401 at 11. MWG's experts testified that, as required by the NPDES permit, MWG consistently inspected the area, the soils, and seeding grasses growing in the area, to make sure it is properly covered. 1/29/18 Tr. at 185 (Race Test); 1/30/18 Tr. at 258 (Race test); MWG Br. at 11; SOF at 12-13. MWG's consultants conduct annual visual walk-over inspections of the area to identify "erosional features" and repair any issues within a few weeks of each inspection. *Id*., SOF at 13 ¶ 127; EG Exhs. 248-251 (2009-2012 Joliet 29 Northeast Area Inspections); MWG Exh. 803-805 (2012 - 2014 Joliet 29 Northeast Area Repair Documentations); 2/1/18 Tr. at 115-123 (Gnat Test.). The record shows that, in 2009 - 2012 these inspections on various occasions identified erosional features that required repairs (e.g. five areas identified in 2009 "where either sheet wash erosion or rilling has exposed the underlying ash slag and may transport the material to the Des Plaines River" (10/25/17 Tr. at Tr. 116; EG Exh. 248N) and suggested repairs were

performed. No issues requiring repairs were identified and no repairs were performed in 2013 - 2016. *See e.g*. SOF at 13 ¶¶ 129-135; 2/1/18 Tr. at 115-124, 204-205; 10/25/17 Tr. at 116 (Gnat Test.); 10/26/17 A.m. Tr. at 31-32 (Gnat Test.); 1/30/18 Tr. at 259; MWG Exh. 800-805; EG Exh. 248N-251N. No monitoring wells exist in this area. 2/2/18 Tr. at 21 (Seymour test); 10/23/17 Tr. at 77; EG Br. at 37. The closest monitoring well is MW-1 or MW-08 but considering the groundwater flow and the distance to this historic area, MW-01 or 08 are unlikely to show conclusive results of any contaminants emanating from this historical area. MWG Exh. 901 at 19 and 23. Other than visual inspections, MWG did not investigate the area or the soil cover to determine if it was impermeable. Moreover, MWG did not cap it with an impermeable cap did not investigate if it had a liner, and did not install a liner. 1/30/18 Tr. at 259-260; 272-273 (Race Test.); 2/1/18 Tr. at 193-195 (Gnat Test.). MWG also never took samples from this area. 1/29/18 Tr. at 184 (Race Test.); 1/30/18 Tr. at 259-260 (Race Test.).

The Southwest Area is adjacent to the former "Caterpillar/Center Point" site and is covered by the ELUC established by the Caterpillar's property owners. SOF 136-140. MWG Exh. at 611. MWG Br. at 12. MWG admits, and the records indicates, that this area contains historic coal ash. MWG Br. at 11; 2/2/18 Tr. at 293:3-294:24, 323:12-20 (Seymour Test.); EG Exh 248N at 1 (#19442); EG Exh. 20D at (#23342; 23357); EG Exh. 401 at 11. Several investigations have indicated that soils at the former Caterpillar site are contaminated with various heavy metals, including barium, chromium, selenium, and thallium. Further modeling has shown the potential for metals contamination to leach into groundwater and migrate to Joliet Station. MWG Exh. 611 at 1. Center Point established the ELUC on August 5, 2010. The ELUC restricts MWG from using any soil and groundwater from the ELUC area. *Id*. at 2; 1/30/18 Tr. at 6-12 (Race Test.); MWG Exh. 612 at 1-2; MWG Exh. 667 at 6; MWG Exh. 901 at 23. No monitoring wells exist in this area. 2/2/18 Tr. at 21 (Seymour Test.); 10/23/17 Tr. at 77. The closest monitoring well is MW-7, but considering the groundwater flow and the distance to this historic area, it is unlikely that MW-07 can show conclusive results of any contaminants emanating from this historical area. MWG Exh. 901 at 19, 20. In 2005, as part of the geotechnical testing at the four Stations, KPRG took six soil borings at Joliet 29, one of which was from this historical area. EG Exh. 201 at 1, 27 (#24264, 90); 2/2/18 Tr. at 161: 11-14, 164:22-24 and 293:5, 294:17-24 (Seymour Test.). The soil borings indicated a layer of coal ash mixed with gravel at the level zero to one foot below surface (GT-6). EG Exh. 201 at 27, 34 (#24290, 97). MWG did not take leach tests, did not evaluate the volume of ash in this area, did not cap it, and did not install a liner. 1/30/18 Tr. at 260-261, 273-274 (Race Test.).[5] MWG has not fully evaluated the content of the area and its potential to contaminate the groundwater. 1/30/18 Tr. at 260-61; 273 (Race Test.); 2/1/18 Tr. at 196-198 (Gnat Test.). Although the ELUC includes measures aimed to protect against exposure to contaminated soil and groundwater at the former Caterpillar site, the ELUC does not include measures to prevent contamination and migration of coal ash constituents from MWG's property. MWG Exh. 611 at 4-5.

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[5] In parts of his testimony during the hearings, Mr. Seymour stated that KPRG conducted tests at the north (2/2/18 Tr. at 163:7) or southwest (Id. at 293:3-9) areas. It appears from his own reports and presentations that he misspoke, or referred to geotechnical testing referred above, because he relies upon KPRG's 2005 report in all his conclusions EG Exh. 293. This indicates that the only CCB samples taken at Joliet 29 were from the Northwest area. *See* EG Exh. 293 #19585; MWG Exh. 901 at 23; EG Exh. 201.

The Northwest Area is another area at Joliet 29 that contains coal ash fill material, as admitted by MWG and supported by the record. MWG Br. at 11; 2/2/18 Tr. at 323 (Seymour Test.); EG Exh. 20D at (#23342; 23357); MWG Exh. at 401 at 11. In 2005, MWG had the fill material analyzed by its consultant to determine if it meets the requirements of CCB and could be used beneficially. EG Exh. 293 at 1 (#19576). The testing report indicates that the area is appropriately 13.2 acres in size and contains interlayered fly ash and bottom ash and slag from the bottom of the coal combustion process. The borings indicate a coal ash layer as deep as 17 feet below the surface, lowest layers of which indicated as "moist" on some borings. *Id*. at 1-2, 7, 16-34 (#19576-77, 582, 591-609). The report indicates, and MWG experts testified, that most of the evaluated samples showed that the materials met the Act's criteria for beneficial use, had levels of boron, manganese and barium below Class I GQS and leached less metals than allowed by the Act. 10/26/17 A.m. Tr. at 39-40 (Gnat Test.); 1/29/18 Tr. at 184-185, 210-213 (Race Test.); 2/1/18 Tr. at 275-276 (Seymour Test.); MWG Exh. 901 at 9 (Seymour Test.); MWG Exh. 293 at 7, 10 (#19582, 85). The report, however, also states that NLET metal data from certain sample locations (GP-14A) "displayed elevated levels of lead and coper at concentrations at least two times higher than the Class I groundwater standards. The ash from this portion of the site should not be considered for potential beneficial reuse." MWG Exh. 293 at 7 (#19582). The record does not include information as to whether MWG separated or removed this part of the material from the sampled area. No monitoring wells exist in this area. 2/2/18 Tr. at 21 (Seymour Test.); 10/23/17 Tr. at 77 (Race Test.). The closest monitoring well is MW-11 or 07 but, considering the groundwater flow and the distance to this historic area, it is unlikely that MW-011 or 07 can show conclusive results of any contaminants coming from this historical area. MWG Exh. 901 at 19, 20; MWG Exh. 667 at 3.

Coal Ash in Fill Areas Outside Ash Ponds. During the 2005 geotechnical testing, KPRG also took five soil borings around the coal ash ponds. EG Exh. 201 at 1, 27 (#24264, 90); 2/2/18 Tr. at 164:23 and 293:5, 294:17-24. The soil borings indicated a layer of coal ash mixed with gravel at the level zero to one foot below surface in the areas near MW-11 and between MW-09 and 10 (GT-1, GT-3). EG Exh. 201 at 27, 29, 31 (#24290, 92, 94).

The Board finds that the evidence establishes that it is more probable than not that these historical coal ash storage and fill areas are contributing to the groundwater contamination. It is also more likely than not, however, that the exceedances appearing in the monitoring wells are not representing contamination from the historic coal ash storage areas, but, do show contaminants leaking from historic fill areas outside of the ash ponds and historic storage areas.

iii. Monitoring Wells

MWG installed 11 groundwater monitoring wells around the three ash ponds at Joliet 29 (MW-1 through MW-11) in 2010 and monitored groundwater quality since the final quarter of 2010. Env. MWG 2nd Ans. Def. at 2. Gr. Br. at 16-17, 29; MWG Br. at 3; MWG Exh. 667 at 2; 2/1/18 Tr at 86-87, 110 (Gnat Test.); MWG Exh. 809. Quarterly monitoring reports for Joliet 29 monitoring wells MW-1 through MW-11 from December 2010 through April 2017 tested for 35 parameters, including antimony, arsenic, boron, manganese, and other indicator constituents associated with coal ash. These quarterly reports are in the record. MWG Exh. 809; s*ee also* EG Br. at 17; EG Br., Att. A at 76-116; SOF ¶¶ 508, 509, 520-523, 526, 528.

Monitoring wells MW-8, 10 and 11 are located upgradient (north) of the ash ponds with respect to direction of groundwater flow and, thusly, are considered "upgradient" or "background" wells. MWG Exh. 901 at 19; 2/1/18 Tr. at 19 (Gnat Test.). These wells indicate potential chemicals that might migrate with the groundwater from outside of MWG's property. *See e.g.* 1/29/18 Tr. at 30-31 (Kunkel Test.); 2/1/18 Tr. at 109 (Gnat Test.); 2/2/18 Tr. at 8 (Seymour Test.);EG Exh. 12C at 3 and MWG Exh. 667 at 3. The other wells – MW-02, 03, 04, 05, 06, 07 and 09 - are located downgradient of the ponds. These wells measure the impact of the ash ponds on the groundwater quality. *Id.*; 10/23/17 Tr. at 220. No potable water wells are downgradient of Joliet 29. 10/27/17 Tr. at 181 (Kunkel Test.).

The record indicates that groundwater in the area has a potential to reverse the direction of groundwater flow, which can alter the monitoring wells treated as upgradient. The record, however, does not support the argument that a groundwater flow directional reversal occurred during the time-frame at issue in this proceeding. MWG's hydrogeological assessment determined that the direction of flow of groundwater in the shallow aquifer at the Joliet #29 Station is in the southerly direction towards the Des Plaines River. MWG Exh. 621 at 4-5 (#296297) (2009 Hydrogeological Assessment of MWG Electric Generating Stations); 1/29/18 Tr. at 253 (Race Test.); EG Exh 12C at 2; 2/1/18 Tr. at 97-98, 109-110 (Gnat Test.) and 2/2/18 Tr. at 13 (Seymour Test.). Dr. Kunkel testified that groundwater at the Joliet #29 site is strongly influenced by changes in Des Plaines River surface water elevations as well as potentially leaking ash ponds. EG Exh. 401 at 12. He stated that the Des Plaines River water-surface elevations strongly influences the groundwater elevations and groundwater gradients at site, causing seasonal flow from the River into the unconsolidated materials beneath the ash ponds. *Id.* at 13; 1/29/18 at 30-31 (Kunkel Test.); Exh. 411.

MWG witness Mr. Gnat testified that although reversal of flow described by Dr. Kunkel is a well-known phenomenon, more than 27 quarterly rounds of groundwater measurements do not indicate a reversal of groundwater flow beneath the ash ponds at Joliet Station. He noted that the flow directions, from quarter to quarter, is consistent from the north to the south towards the Des Plaines River. 2/1/18 Tr. at 109-110, 124-127 (Gnat Test.). The groundwater monitoring results support his position. MWG Exh. 809. The Board finds, therefore, that the record does not support consideration of the upgradient monitoring wells as downgradient wells, and vise versa, when interpreting the groundwater monitoring results.

iv. <u>Exceedances of Part 620 Standards</u>

Groundwater monitoring results in the record indicate 69 exceedances of the Board's Part 620 GQS for coal ash constituents at Joliet 29. MWG Exh. 809. The 69 exceedances are based upon the monitoring results from December 6, 2010, to April 25, 2017. *Id*. The constituents above the Class I GQS are as follows with number of exceedances shown in parenthesis: sulfate (29), TDS (32), antimony (4), boron (2), lead (1) and cadmium (1). The monitoring results indicate that, during the seven-year period, 53 of the 69 exceedances (78%) occurred in MW-09, while the remaining 16 exceedances occurring in MW-2, 3, 4, 8 and 11.

Among the 16 exceedances in the wells other than MW-09, nine were in the upgradient (background) wells MW-08 and MW-11. These wells exceeded standards for boron, cadmium, lead, sulfate and TDS once or twice during the seven-year monitoring period. During the same period, the downgradient wells MW-02, 03, and 04 exceeded antimony 7 times and TDS once.

Thus, monitoring well MW-09 is the only downgradient well that shows levels of sulfate and TDS consistently above the groundwater standards during the seven years of monitoring data considered by the Environmental Groups. A summary of the groundwater monitoring data exceeding Part 620 GQS standards for Joliet 29 is presented below in Table 1. EG Br. App. A; MWG Exh. 809; MWG Exh 901 at 20.

Table 1. Joliet 29 Groundwater Monitoring Results Summary

Monitoring Wells	Closest Ash Pond (AP)	Location	Constituents	Number of Exceedances of Part 620 Standards	Year(s)
MW-02	AP 3	Downgradient	Antimony	1	2010
MW-03	AP 2	Downgradient	Antimony	3	2011-2012
			TDS	1	2013
MW-04	AP 2	Downgradient	Antimony	2	2013
MW-08	AP 3	Upgradient	Sulfate	2	2014, 2015
			TDS	2	2014, 2015
MW-09	Between AP 3 and 2	Downgradient	Sulfate	26	2010 - 2017
			TDS	27	2010 -2017
MW-11	AP 1	Upgradient	Boron	2	2011
			Cadmium	1	2015
			Lead	1	2015
			TDS	1	2015

Table 1.B: Joliet 29 Groundwater Monitoring Results Summary (by year)

Year	Monitoring Wells	MW-2	MW-3	MW-4	MW-8	MW-9	MW-11
	Constituent						
2010	Antimony	1					
	Sulfate					1	
	TDS					1	
2011	Antimony		2	1			
	Boron						2
	Sulfate					3	
	TDS					4	
2012	Antimony		1				
	Sulfate					4	
	TDS					4	
2013	Antimony			1			
	Sulfate					4	
	TDS		1			4	
	Sulfate				1	4	

2014	TDS				1	4	
2015	Cadmium						1
	Lead						1
	Sulfate				1	4	
	TDS				1	4	1
2016	Sulfate					4	
	TDS					4	
2017	Sulfate					2	
	TDS					2	
Total		1	4	2	4	53	5

Table 1.C: Joliet 29 Groundwater Monitoring Results Summary (by wells)

Chemical Constituent	Antimony	Boron	Cadmium	Lead	Sulfate	TDS	Total
Monitoring Wells	**Number of Exceedances**						
MW-2	1						1
MW-3	3					1	4
MW-4	2						2
MW-8					2	2	4
MW-9					26	27	53
MW-11		2	1	1		1	5
Total	6	2	1	1	28	31	69

Antimony. As noted above six exceedances of the antimony standard occurred in downgradient wells MW-02, 03, and 04, during the early monitoring period of 2010 - 13. MWG Exh. 809. Since 2013, no exceedance of the antimony standard has occurred in any of the downgradient wells. *Id*. Dr. Kunkel stated that antimony may be present in coal ash leachate. EG Exh. 401 at 7. Both the Environmental Groups and Mr. Seymour identified antimony as one of the indicators for leachate from MWG's ash ponds. MWG Exh. 903 at 42. Also, all three ash ponds were operational during the period of observed exceedances, i.e., 2010 - 2013. The long-term monitoring data, however, shows that, during the seven-year monitoring period, all three wells had no exceedances of other coal ash indicator constituents such as boron, sulfate, or manganese. Also, because no exceedances of antimony were recorded after 2013, relining Ash Pond 3 and other measures required by the CCA might have eliminated antimony contamination. However, the monitoring results show that antimony was not detected in the upgradient wells, which indicates that upgradient off-site sources did not contribute to the exceedances of the antimony standard. Accordingly, the Board finds that the Environmental Groups have not proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside of the ash ponds is causing or contributing to the exceedances of antimony standard in Joliet 29's downgradient wells MW-02, 03, and 04 during 2010 - 13.

Cadmium and Lead. The monitoring results indicate a single exceedance of cadmium and lead standards in the upgradient monitoring well MW-11 in 2015. These metals were not

detected in any of the other monitoring wells. MWG Exh. 809. Although Dr. Kunkel included these metals in his list of coal ash associated chemical constituents, Seymour includes both metals in his "maximum" criteria of the second tier list of coal ash leachate constituents. MWG Exh. 901 at 42. Accordingly, there is a likelihood that an exceedance of cadmium and lead may be associated with coal ash leachate. Given that a single exceedance of both metals occurred during the seven-year monitoring period and both occurred in one upgradient well, the Board finds that the Environmental Groups have not proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside the ash ponds caused or contributed to the exceedances of cadmium and lead standards in monitoring well MW-11 at Joliet 29.

Boron. Both the Environmental Groups and MWG agree that boron is an indicator of coal ash contamination. *Id;* MWG SOF 57. The monitoring results indicate two exceedances of the Part 620 boron standard during the seven-year monitoring period, both occurring in the upgradient well MW-11 in 2011. Since then, the monitoring results do not indicate any exceedance of boron standard in any of the monitoring wells. Although the Environmental Groups asserted that Joliet 29 exceeded the boron standard, their expert, Dr. Kunkel, admitted that it would be difficult to draw conclusions for the overall site based upon the results from one well. 1/29/18 Tr. at 65.

MWG asserted that boron is below Class I standards at all monitoring wells around the Joliet 29 ponds. MWG Rep Br. at 6. Further, MWG's expert Seymour stated, based upon the analytical results of bottom ash taken from the ash ponds, the leachate from MWG ash ponds does not have the potential to cause groundwater impact above the GQS because the leachate levels were below such standard. MWG Exh. 903 at 41. Given that the seven-year monitoring results show only two exceedances of the boron standard in one upgradient monitoring well and no exceedances in any of the other wells, the Board finds that the Environmental Groups have not proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside the ash ponds caused or contributed to the exceedances of the boron standard in the upgradient well at Joliet 29.

Sulfate and TDS. As noted earlier, except for five exceedances in the upgradient wells MW-08 and 11 and one exceedance in MW-03 (in 2013), all exceedances of sulfate and TSD standards occurred in one downgradient well, MW-09 (2010-2017). MW-09 is located between Ash Pond 2 and Ash Pond 3 at the southwest edge of Ash Pond 3. Additionally, MW-09 exceeded sulfate and TDS standards every quarter of the seven-year groundwater monitoring period. Regarding the elevated levels of sulfate and TDS in monitoring well MW-09, the Environmental Groups' expert, Dr. Kunkel, stated that the groundwater elevation data from third quarter 2012 indicated that Ash Pond 3 must have been leaking because of groundwater mounding.[6] He noted that the ground-water elevation in MW-9 was higher (505.66 feet) than in MW-8 (505.22 feet) which is generally upgradient from MW-9. EG Exh. 401 at 12-13. He further asserted an alternative explanation that coal ash deposits outside of the ash pond may be affecting the groundwater. *Id.*

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[6] "Ground-water mounding" is a phenomenon usually created by the recharge to groundwater from a manmade structure, such as a surface impoundment, into a permeable geologic material, resulting in outward and upward expansion of the free water table. EG Exh. 401 at 5.

MWG's expert Seymour argued that Dr. Kunkel's assertion regarding groundwater elevation is based on selection of the single highest water level in MW-09, even though years of data show the average level in MW-09 is lower than in MW-08. MWG Exh. 903 at 8. Seymour noted that the groundwater elevation in MW-08 was higher than MW-09 in the 11 of the 16 quarterly monitoring events. *Id.* at 59. Additionally, Seymour maintained that any groundwater mounding would be too subtle to detect because of the accuracy of the elevation readings combined with small differences and variations of groundwater elevations at the site. *Id.*; 2/2/18 Tr. at 12-13 (Seymour Test.).

The monitoring results continue to show exceedances of sulfate and TDS standards even after relining Ash Pond 3 in 2013, as well as after MWG removed Ash Pond 1 from operation in 2015. MWG experts testified that no ash was found in Ash Pond 3 when it was drained for relining in 2013 and that the poz-o-pac liner was intact. 1/30/18 Tr. at 39 (Race Test.). MWG experts admitted that they considered leaving coal ash between layers when relining some of the ponds at some of the Stations. *See e.g.* EG Exh. 32; 10/23/17 Tr. at 156:18-162:21 (Race Test.). The consistent exceedance of Class I GQS as it appears in the groundwater monitoring results for MW-9 suggest that some active source of contamination persists. This persistent source of contamination may be coal ash remaining in Ash Pond 3, between its layers, or coal ash deposited outside the ash ponds. The sulfate and TDS also exceeded Class I GQS in 2014 and 2015 in monitoring well MW-08, which, although generally upgradient, is located near the northern side of Ash Pond 3.

Sulfate and TDS are indicators of coal ash contamination in groundwater. The monitoring results show consistent exceedances of the GQS of both constituents during the seven-year monitoring period at MW-09. Also, the record does not indicate that contamination has been caused by an off-site source because upgradient monitoring wells show no exceedances of the groundwater standards. Therefore, the Board finds that it is more probable than not that the source of the exceedances of sulfate and TDS in well MW-09 at Joliet 29 is either coal ash stored in Ash Pond 3 or any coal ash deposited in fill areas outside of but close to that pond.

v. <u>Exceedance of Background Concentrations</u>

The Environmental Groups asserted that the median[7] concentrations of boron and sulfate in all eleven monitoring wells exceed the statewide median background values developed by the IEPA. EG Br. at 30-31. Additionally, the median concentration of sulfate in MW-09, and boron in MW-11 exceeded the upper-bound 90th percentile background values. *Id.* at 31.

Regarding the use of IEPA's statewide background, Dr. Kunkel noted that the Joliet 29 site overlays the sand and gravel/shallow bedrock aquifers, which are the same aquifers from which the IEPA's background community water supply wells are drawing water. EG Exh. 401 at 8. Moreover, he noted that the actual background median for sulfate from a background well at the Powerton Station was within a few milligrams per liter of the median statewide sulfate value. Thus, Dr. Kunkel argued that the statewide median background values may be used to evaluate groundwater monitoring results at Joliet 29 even though the statewide CWS wells were not located in counties with MWG plants. 1/29/18 Tr. at 83-84 (Kunkel Test.).

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[7] Median is determined by arranging all the data in the background dataset from highest value to lowest and taking the center value of that dataset. 2/1/18 Tr. at 103.

Additionally, Dr. Kunkel asserted that statewide median background values can be utilized to assess the severity of groundwater contamination because there are no background wells at Joliet 29. EG Exh. 401 at 8-9. He explained the upgradient wells (MW-8, 10 and 11) at Joliet 29 are not "background" wells because not only are the wells too close to the ash ponds, but they are also completed in areas where screened interval showed ash from construction of the dikes. 1/29/18 Tr. at 82 (Kunkel Test.). He asserted that the close proximity of the wells to the ponds makes them vulnerable to impact from the ponds, especially if the gradient reverses due to rise in Des Plaines River. *Id.* Kunkel asserts that the wells in question "are not background, but during certain times, maybe the majority of the time, they are upgradient but they're clearly not background." *Id.* at 83.

MWG's consultant, Seymour, disagreed. He argued that the IEPA's statewide background values are based on monitoring data from CWS wells and, therefore, are not representative of the site-specific groundwater quality because few CWS are sited wells near the Joliet 29 site. 2/2/18 Tr. at 31-32 (Seymour Test.). He maintained that it is inaccurate to consider statewide background as representative of background values at the sites where upgradient monitoring data is available. Additionally, MWG's consultant, Gnat, explained why a direct comparison of the median values from a monitoring well with the statewide median value is inappropriate. He noted that a monitoring well median above the statewide median means that the well median value is above the median of CWS wells' background values and not above background itself because the statewide median has a range of median values. 2/1/18 Tr. at 105-106 (Gnat Test.). Seymour explained that the comparison, according to the IEPA, must be based upon statistical evaluation using a 90 percent confidence level, i.e. a value above the 90 percent confidence level, which is considered above background with 90 percent assurance. 2/2/18 Tr. at 32-33 (Seymour Test.).

Seymour stated, however, that at MWG sites, background concentrations must be evaluated based upon site-specific data from monitoring wells installed at upgradient site boundaries in locations without the presence of ash materials in fill. MWG Exh. 903 at 60. Here, Seymour noted that the IEPA's proposed CCR regulations explain the procedure for establishing background on site-specific basis. The IEPA proposal specifies that the groundwater monitoring system must include wells to represent the quality of groundwater at the site not impacted by activities and units (background) and sets forth requirements for establishing background. EG Exh. 405 at 25-28.

Seymour maintained that the procedure followed by MWG at Joliet 29 is consistent with the IEPA's proposal in R14-10. 2/2/18 Tr. at 34-35 (Seymour Test.). Hence, the background at the site is the concentration in the upgradient wells MW-8, 10, and 11. *Id.* at 35. He asserted that the background concentrations at Joliet reflect sources other than the ponds and historical ash fill affected groundwater because the monitoring wells near the upgradient site boundary exceed Class I groundwater standards prior to migrating below the ponds. MWG Exh. 903 at 61. Seymour also clarified that all three upgradient wells are not installed in ash fill, as noted by Dr. Kunkel. *Id.*; 2/2/18 Tr. at 36-37 (Seymour Test.).

Although Dr. Kunkel raised concerns regarding the validity of background values from the upgradient wells, as noted by Seymour, the long-term groundwater elevation measurements do not indicate a reversal of groundwater flow. MWG Exh. 903 at 101 (Table 4.1). Thus, given

the availability of site-specific upgradient groundwater monitoring data, the evaluation of any potential groundwater contamination at the site would have benefitted from the use of such data rather than statewide background levels, which may not represent the groundwater at the site. Here, the Board notes that neither the Environmental Groups nor MWG experts can establish background values on a site-specific basis by using the groundwater monitoring results from upgradient wells MW-8, 9, and 11.

Because the Environmental Groups claim exceedance of the statewide background, such exceedance must be evaluated by using appropriate statistical measure. MWG's consultants, Gnat and Seymour, stated that the comparison must be done using the upper bound 90th percentile background value. Because the parties agreed that the appropriate comparison for background values is the upper bound 90th percentile value, the Board limits the groundwater monitoring results comparison to the 90th percentile statewide values.

The Environmental Groups provided a comparison of the median values of boron and sulfate in the monitoring wells with the 90th percentile statewide values from the statewide database. This comparison indicated exceedances of 90th percentile statewide value of: boron in well MW-11; and sulfate in well MW-09. EG Br. at 31. All other wells have no exceedances of either boron or sulfate above the 90th percentile values.

The exceedances of the statewide background are consistent with the exceedances of groundwater standards of sulfate and boron in MW-09 and MW-11, respectively. As noted above, seven years of monitoring showed two exceedances of the boron standard in the upgradient well MW-11 in 2011 and none thereafter in any of the monitoring wells. The median value of boron of 1.20 mg/L is below the groundwater standard of 2.0 mg/L. The Board finds that, given that MW-11 is an upgradient well and no exceedances of 90th percentile statewide value for boron occurred in any other well, the coal ash stored in ash ponds or coal ash deposits outside of the ash ponds at the Joliet 29 site are not the likely sources causing boron exceedances in MW-11.

Regarding sulfate, as noted above, the monitoring results show consistent exceedances of the groundwater standard during the seven-year monitoring period in well MW-09. Although two sulfate exceedances occurred in the upgradient well MW-08 (one in 2014 and one in 2015), a comparison of the sulfate levels in MW-08 (460 -600 mg/L) to MW-09 (560-1900 mg/L) clearly shows that the contamination in MW-09 is not caused by an off-site source. Therefore, the Board finds it more probable than not that the exceedances in MW-09 at Joliet 29 of the 90th percentile Statewide value for sulfate is either coal ash stored in Ash Pond 3 or any coal ash deposited in fill areas outside the pond.

3. Powerton

A. Uncontested Facts

i. The Station

MWG leases and operates Powerton Electric Generating Station, located in Pekin, Tazewell County, Illinois since 1999. Joint Stip. at 2; MWG Answer and Defenses 5/5/14 at 2. The plant began operations in the 1920s with four coal-fired units, which were replaced in the

early 1970s by the currently operating Units 5 and 6. Joint Stip. No. 18, MWG Exh. 664 at 1, 1/30/18 Tr. at 51:21-52 (Race Test.); MWG Exh. 635 at 1 (#11305).

The plant is bordered on the north by the Illinois River. MWG Exh. 901 at 33. The Powerton Lake and Wild Life Area surround the Station on the west. *Id.* Industrial and residential areas border the Station on the east, and agricultural land borders the Station on the south. EG Exh. 13C at 1; MWG Exh. 901 at 27, 33; 1/31/18 Tr. at 68:5-8 (Kelly Test.); MWG Exh. 667 at 10.

The fly ash at the station is collected through a dry system by electrostatic precipitators and then collected at silos and hauled off-site to Buckheart Mines for mine reclamation. The fly ash is never directed to the ash ponds. 1 /31/18 Tr. at 69:18-70:7 (Kelly Test.). The bottom ash from the bottom of the boilers and slag tanks is quenched with water and sluiced out to dewatering bins. The bottom ash is then decanted and sent to the ash surge basin. *Id*. at 70:8-14. The water from the Ash Surge Basin is either recycled back to the cooling pond or is discharged into the Illinois River through the NPDES permitted outfalls. *Id*. at 70:18-71:2. The ash is collected in the basin and periodically removed to the mines for mines reclamation. *Id*. at 71:3-11. The ash sent to the mines is periodically sampled. *Id*. at 71:9-73; MWG Exh. 700 at (#10965). The February 27, 2007, samples from the Ash Surge Basin identified barium at 0.027. 1/31/18 Tr. at 73:21-74:11; MWG Exh. 700 at (#10951).

ii. <u>Ash Ponds</u>

Powerton Station has four ash ponds, all under the Station's NPDES permit (#IL0002232): 1) the Ash Surge Basin, 2) the Ash Bypass Basin; 3) the Secondary Ash Settling Basin and 3) the Metal Cleaning Basin. Joint Stip. at 2; MWG Answer and Defenses 5/5/14 at 2; MWG Exh. 901 at 27, and SOF 166. The Station also has a Limestone Runoff Basin. MWG Exh. 901 at 27.

All four ponds were constructed in 1978; the Surge Basin, Bypass Basin, and the Metal Cleaning Basin with a poz-o-pac liner on the bottom and a Hypalon liner on the sides: the Secondary Settling Basin only was lined with a Hypalon liner. Joint Stip. at 2; MWG Exh. 901 at 28. All ponds were relined with HDPE liners in 2010 - 2013: the Bypass Basin and Metal Cleansing Basin in 2010, and the other two ponds in 2013. Joint Stip. at 2; MWG Exh. 901 at 28.

The Ash ***<u>Surge Basin's</u>*** is a primary ash basin, used to collect and settle bottom ash and hold it until removal. 1/30/18 Tr. at 58. The pond's lining includes (described bottom up): 12" poz-o-pac on the bottom, a bottom geotextile cushion, a 60 mil HDPE liner, a top geotextile cushion, a sand cushion and a limestone warning layer. MWG Exh. 901 at 30. The pond's bottom elevation is at 452 ft; average groundwater elevation is at 447 feet (about 5 feet below the pond's bottom). *Id*.

The ***<u>Bypass Basin</u>*** receives ash when the Station empties the Surge Basin. Joint Stip. at 2. The pond's lining includes (described bottom up): 12" poz-o-pac on the bottom, a bottom geotextile cushion, a 60 mil HDPE liner, a top geotextile cushion, a sand cushion and a limestone warning layer. MWG Exh. 901 at 31. The pond's bottom elevation is at 459 ft; average groundwater elevation is at 450.5 feet (about 8.5 feet below the pond's bottom). *Id*. MWG

removes the ash in the Surge Basin and Bypass Basin when the basins are full, every 6 to 8 years. MWG Exh. 901 at 28; SOF 174, 179; Joint Stip. at 2; 1/30/18 Tr. at 58:22-59:6 (Race Test.).; 1/31/18 Tr. at 78:2-3 (Kelly Test.). MWG last removed coal ash from the Surge Basin in 2013 before relining. MWG Exh. 901 at 28.

The ***Secondary Settling Basin*** is used as a finishing pond and receives *de minimis* ash from the Surge Basin. 1/31/18 Tr. at 126-127; Joint Stip. at 2. The pond's lining includes (described bottom up): a geotextile separator fabric, gravel underdrain system 18-24" thick, another geotextile separator fabric, a sand cushion layer, a bottom geotextile cushion, and a 60 mil HDPE liner. The sides also have prepared subgrade rip-rap on the very bottom. MWG Exh. 901 at 32. The pond's bottom elevation is at 440 ft; average groundwater elevation is at 441.5 feet (about 1.5f t above the pond's bottom). *Id*. It was only emptied for relining; when emptied, MWG found "less than a foot of material and it really want ash." 1/31/18 Tr. at 127:17-128:2 (Kelly Test.). MWG Exh. 901 at 28; 1/31/18 Tr. at 127:17-128:2 (Kelly Test.); 1/30/18 Tr. at 60:15-19 (Race Test.). It has never been dredged because no dredging was needed. 1/31/18 Tr. at 128:8-15 (Kelly Test.).

The ***Metal Cleaning Basin*** is not a part of the ash sluice system and is used during temporary outages to temporarily laydown ash removed from boiler tubes. 1/31/18 Tr. at 115; MWG Exh. 901 at 28. The pond's lining includes (described bottom up): 12" poz-o-pac on the bottom, a bottom geotextile cushion, a 60 mil HDPE liner, a top geotextile cushion, and a sand cushion and limestone warning layer. MWG Exh. 901 at 29. The pond's bottom elevation is at 457.5 ft; average groundwater elevation is at 445 feet (about 12.5 feet below the pond's bottom). *Id*. Ash is removed from the Metal Cleaning Basin approximately annually. Joint Stip. at 2.

iii. Powerton VN

The IEPA issued Violation Notice #W-2012-00057 (Powerton VN) for the Powerton Station (EG Exh. 4A) that alleged that "operations at ash impoundments have resulted in violations of Groundwater Quality Standards" during 2010-2012 at monitoring wells MW-1 through MW-15, including for Chloride (MW-6, 8, 12, 14, 15), Antimony (MW-2), manganese (MW-4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15), boron (MW-1, 9, 11, 13), arsenic (MW-7), iron (MW-7, 11, 12), sulfate (MW-13, 14, 15), TDS (MW-7, 13, 14, 15), and selenium (MW-7, 9, 13, 14), as well as pH, mercury, thallium, and nitrate. EG Exh. 4A at 3-11.

iv. Powerton CCA

The Powerton CCA (MWG Exh. 636) states that:

> Operations at ash impoundments have resulted in violations of the Groundwater Quality Standards at monitoring wells MW-1, MW-2, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14 and MW-15. MWG Exh. 636 at 2 (#553) ¶ 3.

The CCA notes that "respondent agrees to undertake the following actions, which the Illinois EPA has determined are necessary to attain compliance" with the statute and Board rules. MWG Exh. 636 at 3 (#554) ¶ 5. Subsections (a) through (m) of paragraph 5 list activities MWG

must undertake, subsections (a) though (d) are identical to Joliet 29 CCA. The other subsections require:

5(e)	apply to IEPA for a construction permit to reline Ash Surge Basin and the Secondary Ash Settling Basin with HDPE liner;
5(f)	installing additional monitoring well south of MW-9 in a location approved by IEPA to better define upgradient groundwater quality;
5(g), (j)	submitting an application to IEPA to establish and establishing a GMZ under section 620.250 within one year from the date of CCA; and
5(h), (i)	entering into an Environmental Land Use Control (ELUC) to cover area underlying GMZ, submit proposed ELUC to IEPA and record ELUC upon its approval;
5(k)	submitting a certification of compliance upon completing CCA requirements within one year of the date of CCA;
5(l)	not allowing East Yard Run-off to be part of the ash sluicing flow system and submitting monitoring results, for constituents in sec. 620.410(a)-(d), from water contained in it close to the outfall monitoring point 003 within 60 days from the date of CCA and for at least four monitoring quarters;
5(m)	not using any unlined areas for permanent or temporary ash storage or ash handling. MWG Exh. 636 at 3-4 (#554-5) ¶ 5.

On October 17, 2013, MWG filed a certification with the IEPA that all CCA measure were completed. Joint Stip. at 4; MWG Exh. 637.

v. <u>Powerton GMZ and ELUC</u>

As required by the CCA, on January 18, 2013, MWG filed applications with the IEPA to establish a GMZ (MWG Exh. 254) and also an ELUC (MWG Exh. 253) at the Powerton Station. Joint Stip. at 4; MWG Answer and Defenses 5/5/14 at 23; MWG Exhs. 253 and 254. IEPA approved the ELUC on August 26, 2013 and the GMZ on October 3, 2013. MWG Exhs. 638 and 639.

Both the GMZ and the ELUC cover the same area that includes all of the ash ponds. EG Exh. 253 at 1, 12; EG Exh. 254 at 1; MWG Exh. 901 at 39-40; MWG Exhs. 638 and 639. The borders of the GMZ and the ELUC are defined as follows:

> the western (downgradient) extent corresponds with the hydraulic boundary formed by the intake channel. The northern extent corresponds with the hydraulic boundary formed by the Illinois River. The southern and eastern boundaries are defined by the property boundary. The vertical extent of the GMZ is defined by the top of the Carbondale Formation which is approximately 70 feet below ground surface. EG Exh. 254 at 1; MWG Exh. 639.

The GMZ is established under 35 Ill. Adm. Code 620.250(a). EG Exh. 254 Att. 2 at 1, Note 1. The application notes that "Class I" is the groundwater classification "the facility will be subject to at the completion of the remediation". EG Exh. 254, Att. 2 ,Part I ¶ 10. The GMZ application notes the following:

> The agreed upon remedy is specified in Item 5(a) through (m) of the executed [CCA]… The remedy includes lining of the Ash Surge Basin and Ash Settling Basin with HDPE. This [GMZ] application fulfills requirements set forth under Item 5(g) of the CCA. EG Exh. 254 Att 2, Part III ¶ 1.

The application also notes that "[at] the completion of the corrective process, a final report is to be filed which includes the confirmation statement included in Part IV." *Id*. Att. 2 at 1, Note 1.

B. Contested Facts

i. Ash Ponds Dredging, Liner Ruptures and Flooding

Both poz-o-pac and HDPE liners are prone to damage in certain conditions, i.e. severe weather or rupture by heavy equipment during dredging. In 2005 and 2006 MWG consultant investigated the liners at Powerton ponds and rated the condition of the Ash Surge and Metal Cleaning Basin as "poor", the Secondary Ash Settling Basin as "no liner" and Bypass Basin as "unknown." Comp Exh. 34 at #23615; MWG Exh. 606 at 23646. MWD took precautions to ensure that dredging the Ash Surge Basin, Bypass Basin or the Metal Cleaning Basin was performed by trained MWG personnel instructed on the liners' safety procedures. 1/31/18 Tr. at 99:23-100:2, 116:15-22 (Kelly Test.). However, there were occasional issues with the liners, or the liners weren't installed correctly. EG Exh. 109 at 1, 3 ("several areas if liner to the north of the weir wall pulled the backing strips away and the liner is loose."); EG Exh. 108 ("couple of issues have emerged while de-watering the Secondary Basin . . . the liner on the east wall of the basin may not have been constructed as designed or it may have been damaged in the past or altered…."); *see also* EG Exh. 107. MWG's witness, Mr. Kelly, Powerton's Chemical Specialist, testified that the tears in the pond liners did happen, although not very often. 1/31/18 Tr. 146:12-21 (Kelly Test.). He noted that they mostly happened at the very top of the basin and above the water line. *Id*. Station operators inspected ponds regularly and reported any issues to Mr. Kelly. Any issues with the liners were repaired within one to two weeks. 1/31/18 Tr. at 80:9-12, 80:22-81:1, 101:11-13, 146:4-145:5 (Kelly Test.). Some coal ash might have been left between the layers when relining the Former Ash Basin. EG Exh. 32; 10/23/17 Tr. at 156:18-162:21 (Race Test.).

In addition, MWG employees recalled ash ponds and historical ash storage flooded on several occasions, with water rising 30 feet above the bottom of the Secondary Ash Settling Basin, and the Illinois River flowing in and out of the Former Ash Basin. EG Exh. 33; 10/23/17 Tr. at 164:18-21; 1/31/18 Tr. at 211:10-21 (Race Test.); 1/31/18 Tr. at 211:10-21 (Kelly Test.); 10/24/18 Tr. at 95:24-96:3 (Lux Test.); EG Exh. 107 10/24/17 Tr. at 94:0-11, 93:7. MWG confirmed that the area of the Secondary Ash Basin has high groundwater levels. MWG Br. at 15; SOF 606-609. To address this issue, MWG installed an underdrain system around the Secondary Ash Basin, composed of stones, drain tiles and riprap on the sides, "to move any water that may seep near the pond, away from the pond liner." MWG Br. at 15; SOF 606-609. MWG also noted that since the relining of the Secondary Ash Basin "there have not been any issues related to the river water impacting or moving the liner." MWG Br. at 15; SOF 616-617.

After a careful review of the facts, the Board finds that the Environmental Groups established that both poz-o-pac and HDPE liners at Powerton can and do crack or experience damage on occasions. Based on preponderance of all the evidence in the record, including the groundwater monitoring results, MWG practices in ponds relining and dredging, and flooding at the area, the Board concludes that it is more likely than not that the ash ponds did leach contaminants into the groundwater.

ii. Historical Coal Ash Sites

The record indicates three historical coal ash storage areas at Powerton: 1) East Yard Run-off Basin; 2) Limestone Runoff Basin; and 3) Former Ash Basin. Only the Limestone Runoff Basin is lined, and had its content tested for CCB. The record, however, shows no evidence that material from the Limestone Runoff Basin that was successfully tested for CCB, was ever beneficially used in compliance with 415 ILCS 5/3.135.

East Yard Run-off Basin is located southwest of the Ash Surge Basin and west of the Ash Bypass Basin and is neither part of the ash sluicing flow system, nor used by MWG to store or receive ash. MWG Exh. 254 at 4; 1/31/18 Tr. at 138:5-22 (Kelly Test.); MWG Exh. 667 at 12. It is used for stormwater run-off from east half of the Station. 1/31/18 Tr. 138:12-14 (Kelly Test.). The closest monitoring wells are MW-12 and MW-13. The record does not provide information about the content or condition of this basin. However, the consistent exceedances of the Class I GQS for coal ash indicators in the wells MW-12 and MW-13 that are downgradient to this area indicate that this basin may contain coal ash that is leaking into groundwater.

Limestone Runoff Basin is located east of the Ash Surge Basin. MWG Exh. 901 at 27. It is lined with poz-o-pac on the bottom and Hypalon liner on the sides. Joint Stip. at 2. There is no evidence in the record showing the condition of this liner. The closest downgradient monitoring well is MW-18; MW-10 might act as an upgradient well for this basin. MWG Exh. 901 at 33, 38. The basin has been used historically to temporarily store fly ash during equipment changes at the station. 1/30/18 Tr. at 70:2-7 (Race Test.);1/31/18 Tr. at 144:2-6, 144:13-24, 183:13-24 (Kelly Test.). It has been used twice to temporarily store coal ash during equipment changes, last time in 2013. MWG Br. at 17; SOF 237-238. In 2004, there was coal ash in the basin from when equipment was taken off service. 1/30/18 Tr. at 70:2-71:4 (Race Test.);1/31/18 Tr. at 144:2-6, 144:13-24 (Kelly Test.); MWG Exh. 635. The basin was empty since 2013. 1/31/18 Tr. 144:7-145:1 (Kelly Test.). In 2004, Anders Engineering analyzed samples from the test pits in the nine locations in the basin using the NLET method to confirm that the historic ash met the criteria for beneficial reuse as CCB. MWG Br. at 7-8; MWG Exh. 901 at 9; MWG Exh. 635 at 1 (#11305); 1/30/18 Tr. at 74:7-76:14 (Race Test.). The report identified that the basin contains 8,250 cubic yards of material. MWG Exh. 635 at 8 (#11312). The report concluded that MWG should either remove the material to a landfill or enroll the Basin in the IEPA's Site Remediation Program. *Id*. at 8 (#11312). Tested samples indicated boron levels ranging from 0.1 to 1.5 mg/L. MWG Exh. 635 at App. B Table 1 (#11341). Barium and zinc were also detected in the samples; selenium and chromium were detected above Class I GQS in two of the test pits (TP-03 and TP-15). 1/30/18 Tr. at 74:11-19 (Race Test.); MWG Exh. 635 at 10 (#11314), App. B Table 2 (#11342). The report noted that "material in the grid sections containing test pits TP-03 and TP-15 would need to be disposed at a permitted landfill." MWG Exh. 635 at 10 (#11314). If MWG wanted to use material as CCB, it had to separate it from the

non-CCW material found in three pits (TP-16, 25 and 29)[8] and from the material found in two pits that did not meet Class I GQS (Tp-03 and 15). *Id*. The record does not provide evidence that MWG separated it. The record also does not provide evidence that MWG used material from this basin as CCB under 415 ILCS 5/3.135. It appears from the record that due to easily cracked poz-o-pac liner, material from this basin may be leaking contaminants into groundwater.

Former Ash Basin is located northeast of the ash ponds and is part of the Station's NPDES permit as emergency overflow for Ash Surge Basin. MWG Exh. 901 at 38. 1/30/18 Tr. at 142:14-18 (Race Test.). It was previously used as ash impoundment. 1/30/18 Tr. at 61:14-22 (Race Test.); 1/31/18 Tr. at 142:14-18 (Kelly Test.); EG Br. at 39. Ms. Race testified that on rare occasions water from Ash Surge Basin may flow to this former basin, which happened once in 2015 and at the end of 2017. 10/23/17 Tr. at 164:18-21; 1/31/18 Tr. at 158:23-160:3; see also 1/31/18 Tr. at 143:19-144:2 (Kelly Test.). MWG has not sent coal ash to this basin since taking over the Station in 1999. 1/31/18 Tr. 142:10-13 (Kelly Test.). The closest downgradient monitoring well is MW-2 through 5, and MW-1 is side-gradient to this basin. MW-18 is also located close to the east side of the basin. MWG Exh. 667 at 11; MWG Exh. 901 at 33, 38 (Seymour); 10/27/18 Tr. at 205:20-206:9 (Kunkel Test.). MWG Exh. 901 at 38. Groundwater samples taken downgradient of this basin showed no coal ash constituents. SOF 248-251; MWG Br. at 17; 10/27/17 Tr. at 206:12-210:22; 2/1/18 Tr. at 277:1-13; 2/2/18 Tr. at 70:17-71:22. Thus, the board find that the Environmental Groups did not prove that it is more likely than not that this basin is a source of contamination at the Station.

Coal Ash Fill through the site. Environmental Groups also allege that numerous soil borings taken at Powerton at different times show extensive presence of coal ash in fill at elevation that allows up to nine feet of buried ash to be saturated with groundwater. EG Br. at 44. The record supports this. EG Exh. 401 at 48-49 (Table 6). Powerton's Phase II Environmental Site Assessment show that nine borings taken in 1998 showed coal ash "in fill that extends from the surface to as deep as sixteen feet below surface." MWG Exh. 17D at 57-72 (#3309-3324). Another five borings taken in 2005 by KPRG during the geotechnical testing showed coal ash fill starting at around two feet below surface and going as deep as 14 feet, mainly in areas around Secondary Basin, Ash Surge Basin and Ash Bypass Basin. The deepest coal ash fill coming from the area between the Ash Surge Basin and Ash Bypass Basin. MWG Exh. 201 at 37, 41, 43-46 (#24300, #24304, 06-09, -24310) (*see* GT-7 (2-12 feet deep), GT-8 (2.5-12 feet deep), GT-9 (3-14 feet deep)). Soil borings from December 2010, when MWG installed monitoring wells, particularly borings for wells MW-9, 11 and 12, show cinders "in fill that extends from the surface to as much as 24.5 feet below the surface." EG Br. at 44; EG Exh. 13C at 22-41 (#7102-7121); EG Exh. 30.5E; EG Exh. 24E at 16-19 (#40059-40062); 10/23/17 Tr. at 77:20-86:1. Also, Environmental Groups argue that coal ash is buried as low as 443 feet above mean seas level (MSL), which allows it to be saturated with groundwater at times up to nine feet, based on groundwater elevation fluctuations at the site between 430 to 452 feet above MSL. EG Exh. 13C at 33 (#7113); MWG Exh. 903 at 17 (Table 403); EG Br. at 44. Thus, the Board finds that the Environmental Groups proved that it is more likely than not that the coal ash is spread out across the Stations in the fill and is contributing to the exceedances in the Stations' monitoring wells.

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[8] The report finds that material in TP-16, 25 and 29 was not a coal combustion waste (CCW).

Ash Cinders Stored on Land. MWG's employee, Mr. Kelly, testified that coal ash cinders at some point were temporarily stored on the ground in an open area directly south of the Bypass Basin for two to three months during the winter before 2012, because a contractor, Reed Mineral, could not get them offsite. 1/31/18 Tr. 184:20-185:21 (Kelly Test.); MWG Exh. 667 at 12; EG Br. at 45. When the cinders were removed, they went to Reed Mineral to be used in shingles and as sandblasting material. *Id.* at 187:23-188:3 (Kelly Test.). The closest downgradient monitoring wells to the area identified by Kelly at that time frame are MW-13, 12 and 14. An intermediate or side gradient well is MW-9. MWG Exh. 903 at 33; MWG Exh. 667 at 11-12. The groundwater monitoring results for these wells show exceedances of arsenic, sulfate, boron, TDS in 2011 - 2012. MWG Exh. 810. The Board, thus finds, that temporary storage of the cinders contributed to contamination at the Station.

Weighing the facts presented, the Board finds that Environmental Groups have proven that it is more likely than not that the historic areas and fill containing coal ash are causing or contributing to GQS exceedances at the Station.

iii. Monitoring Wells

Powerton Station's groundwater monitoring system consists of 19 monitoring wells (MW-1 through 19). MWG Exh. 901 at 33. MWG installed initial 15 groundwater monitoring wells (MW-1 through MW-15) in 2010. MWG Answer and Defenses 5/5/14 at 2. MWG installed MW-16 in a location south of MW-9, to comply with section 5(f) of the Powerton CCA, which requires the well "in a location approved by IEPA to better define upgradient groundwater quality." MWG Exh. 636 at 3 ¶ 5(f). Additional wells, MW-17, 18 and 19, were installed later to comply with proposed CCR rules. 2/1/18 Tr. at 135:6-9.

The groundwater monitoring through the initial 15 monitoring wells (MW-1 though MW-15) was conducted from the last quarter of 2010 through second quarter of 2017. 2/1/18 Tr. at 85:24-86:14, 110:2-20; MWG Exh. 810. The monitoring in MW-16 began in last quarter of 2012. MWG Exh. 810 at 31. Monitoring at wells MW-17 and MW-18 started in November 2015, and at MW-19 in November 2016. *Id.*; 2/1/18 Tr. at 135.

While wells MW-6, 8, 12, 14 and 15 are screened in the shallow silt/clay unit, the other wells are screened in the deeper sand/gravel unit. EG Exh. 401 at 17, 2/1/18 Tr at 130. The monitoring wells MW-1 through MW-10 wells were also used to characterize the site hydrogeology. These wells were spaced approximately 400 feet apart around the perimeter of ash ponds and screened approximately 10 feet past the intersection of the groundwater table to ensure collection of representative groundwater samples. EG Exh. 13C at 3.

Monitoring well MW-16, which is located outside of the area of groundwater impact associated with ash handling activities, is identified as an "**upgradient well**" with respect to direction of groundwater flow, or a "background" well, showing potential impact from off-site sources. EG Exh. 255 at 2. EG Br. at 40, 1/30/18 Tr. at 83. Monitoring wells MW-1, MW-9 and M-10 that are located upgradient of specific ash basins but are considered "intermediate" or "side gradient" wells because they are within area of impacted groundwater from historical ash related activities. MWG Exh. 639 at 1 ("Illinois EPA does not agree that MW-1, MW-9 and MW-10 are readily up gradient of historical ash related activities that may impact groundwater quality proximate to these wells…would characterize [them] as side gradient or intermediate wells");

EG Br. at 40, EG Exh. 255 at 2. All other wells (MW-2 through MW-8, MW-11 though MW15, and MW-17 through MW-19) are considered "downgradient" wells, showing the impact of MWG's operations on the groundwater quality. EG Exh. 255 at 2. A potable water well survey indicates six wells within 2,500-foot radius of the ash pond, but none of the wells are located downgradient from the ash ponds. MWG Exh. 621 at 14.

Starting from December 2010, quarterly groundwater samples from monitoring wells MW-1 through MW-16 were analyzed for 35 parameters. MWG Exh. 810. Monitoring wells MW-17 through 19 were analyzed for 22 parameters, including coal ash indicator constituents. 2/1/18 Tr. at 33-35. The monitored parameters from all 19 wells included coal ash indicator constituents – boron, chloride, sulfate, and TDS. MWG Br. at 6.

The site hydrogeologic conditions at the Powerton station were determined by Patrick Engineering using the soil boring logs of ten groundwater monitoring wells installed around the perimeter of the ash pond. EG Exh. 13C at 3. The site is predominantly fine sand fill underlain by sand and gravel with a silt seam running through a portion of the site. *Id.* at 7. There are two groundwater flow units at the Powerton Station that are distinct and hydraulically connected. 2/1/18 Tr. at 129-130, MWG Exh. 901 at 34. The first is on a discontinuous silty-clay unit with groundwater flowing from east to west. *Id*. The second is a sandy gravel unit at depths ranging from 18 to 28 feet below surface, with groundwater flow north towards the Illinois River. *Id.*; 2/1/18 Tr. at 133. The Board finds that hydrogeologic investigation performed by MWG consultants adequately represents the groundwater flow conditions at the Powerton Station and support designation of the wells as upgradient and downgradient.

iv. <u>Exceedances of Part 620 Standards</u>

The groundwater monitoring results at Powerton indicate 403 exceedances of the Board's Part 620 groundwater quality standards for coal ash constituents between December 2010 and April 2017 in 14 of the 19 monitoring wells. MWG Exh. 810. These include wells MW-2, MW-6 through MW-15, and MW-17 through MW-19. The groundwater monitoring results show no comparative exceedances of the standards in the upgradient monitoring well MW-16, as well as MW-1 (intermediate well) or wells MW-3, MW-4 and MW-5 (that show whether contamination may be moving north of the Former Ash Basin). Further, the results indicate the number of exceedances ranging from:

a) 1 to 3 in wells MW-2, MW-10, MW-18 and MW-19; and
b) 12 to 101 in wells MW-6 through MW-9, MW-11 through MW-15, MW-17 and MW-18.

The constituents above the Class I standard are as follows with number of exceedances shown in parenthesis: antimony (1), arsenic (83), boron (64), lead (2), selenium (4), sulfate (104), thallium (26) and TDS (119). A summary of the exceedances is presented in Tables 2.A-2.C, below. MWG Exh. 810; MWG Exh. 901 at 33.

Table 2.A: Powerton Groundwater Monitoring Results Summary

Monitoring Wells	Closest Ash Pond, hist storage	Location	Constituents	Number of Exceedances of Part 620 Standards	Year(s)
MW-02	ASB, FAB	Downgradient	Antimony	1	2013
MW-06	SSB	Downgradient	Arsenic	1	2014
			TDS	7	2012-2016
			Sulfate	9	2012-2017
MW-07	SSB	Downgradient	Arsenic	26	2010-2017
			TDS	12	2011-2016
			Lead	1	2010
MW-08	ASB	Downgradient	Sulfate	3	2012-2015
			TDS	9	2013-2017
MW-09	ABB	Intermediate	Boron	21	2010-2017
MW-10	ASB, LRB	Intermediate	Boron	2	2014
			Lead	1	2013
MW-11	ASB, LRB	Downgradient	Arsenic	15	2012-2016
			Boron	2	2012
			Sulfate	1	2017
			TDS	1	2017
MW-12	ASB, ABB, EYRB	Downgradient	Arsenic	7	2011-2016
			Boron	1	2013
			Sulfate	14	2012-2017
			TDS	10	2014-2016
MW-13	ASB, MCB, EYRB	Downgradient	Arsenic	22	2010-2017
			Boron	26	2014-2017
			Sulfate	27	2010-2017
			TDS	26	2010-2017
MW-14	MCB	Downgradient	Arsenic	3	2010-2011
			Boron	7	2014-2017
			Selenium	2	2011-2013
			Sulfate	26	2010-2017
			Thallium	20	2011-2017
			TDS	27	2010-2017
MW-15	ASB, MCB	Downgradient	Arsenic	2	2011-2012
			Boron	1	2016
			Selenium	2	2015
			Sulfate	16	2011-2017

			TDS	18	2011-2017
MW-17	ASB, MCB	Downgradient	Arsenic	7	2016-2017
			Sulfate	8	2015-2017
			Thallium	6	2016-2017
			TDS	8	2015-2017
MW-18	ASB, FAB	Downgradient	TDS	1	2016
MW-19	ABB, EYRB	Downgradient	Boron	3	2017

Table 2.B: Powerton Groundwater Monitoring Results Summary (by year)

Year	**Monitoring Wells**	**MW-2**	**MW-6**	**MW-7**	**MW-8**	**MW-9**	**MW-10**	**MW-11**
	Constituent	**# of Exceedances Above Part 620 Class I Groundwater Standards**						
2010	Arsenic			1				
	Boron					1		
	Lead			1				
2011	Arsenic			4				
	Boron					2		
	TDS			3				
2012	Arsenic			4				1
	Boron					4		2
	Sulfate		2		1			
	TDS		1	3				
2013	Antimony	1						
	Arsenic			4				4
	Boron	1				3		
	Lead						1	
	Sulfate		2		1			
	TDS		1	1	3			
2014	Arsenic		1	3				4
	Boron					2	2	
	Sulfate		2					
	TDS		2	2	2			
2015	Arsenic			4				4
	Boron					4		
	Sulfate		1		1			
	TDS		2	1				
2016	Arsenic			4				2
	Boron					3		
	Sulfate		1					
	TDS		1	2	2			
2017	Arsenic			2				
	Boron					2		
	Sulfate		1					1
	TDS				2			1

Total	2	17	39	12	21	3	19

Table 2.B: S Powerton Groundwater Monitoring Results Summary (by year) (contd)

Year	Monitoring Wells	MW-12	MW-13	MW-14	MW-15	MW-17	MW-18	MW-19
	Constituent	# of Exceedances Above Part 620 Class I Groundwater Standards						
2010	Arsenic		1	1				
	Boron		1					
	Sulfate		1	1				
	TDS		1	1				
2011	Arsenic	1	1	2	1			
	Boron		6					
	Selenium			1				
	Sulfate		6	6	1			
	Thallium			3				
	TDS		5	6	1			
2012	Arsenic	3	2		1			
	Boron		2					
	Sulfate	1	2	2				
	Thallium			2				
	TDS		2	2				
2013	Arsenic	2	4					
	Boron	1	3					
	Selenium			1				
	Sulfate	2	4	3	3			
	Thallium			4				
	TDS		4	4	3			
2014	Arsenic		4					
	Boron		4	1				
	Sulfate	3	4	4	2			
	Thallium			3				
	TDS	2	4	4	4			
2015	Arsenic		4					
	Boron		4	2				
	Selenium				2			
	Sulfate	3	4	4	4	1		
	Thallium			3				
	TDS	4	4	4	4	1		
2016	Arsenic	1	4			4		
	Boron		4	2	1			
	Sulfate	3	4	4	4	4		
	Thallium			4		3		
	TDS	4	4	4	4	4	1	

2017	Arsenic		2			3		
	Boron		2	2				3
	Sulfate	2	2	2	2	3		
	Thallium			1		3		
	TDS		2	2	2	3		
Total Exceedances		32	101	85	39	29	1	3

Table 2.C: Powerton Groundwater Monitoring Results Summary (by wells)

Chemical Constituent	**Antimony**	**Arsenic**	**Boron**	**Lead**	**Selenium**	**Sulfate**	**Thallium**	**TDS**	**Total**
Class I GWQS (mg/L)	**0.006**	**0.01**	**2**	**0.0075**	**0.05**	**400**	**0.002**	**1200**	
Monitoring Well	**Number of Exceedances**								
MW-2	1		1						2
MW-6		1				9		7	17
MW-7		26		1				12	39
MW-8						3		9	12
MW-9			21						21
MW-10			2	1					3
MW-11		15	2			1		1	19
MW-12		7	1			14		10	32
MW-13		22	26			27		26	101
MW-14		3	7		2	26	20	27	85
MW-15		2	1		2	16		18	39
MW-17		7				8	6	8	29
MW-18								1	1
MW-19			3						3
Total exceedances	1	83	64	2	4	104	26	119	403

Antimony. Over the entire seven-year monitoring period, only one exceedance of antimony Class I GQS was registered in all monitoring wells: in MW-2, during the second quarter of 2013. MWG Exh 810. Except for this event, the antimony level in MW-2 was below detection level at all other sampling periods. MWG Exh 810. Environmental Groups' expert, Dr. Kunkel, states that antimony may be present in coal ash leachate. EG Exh. 401 at 7. Further, MWG's expert Seymour identifies antimony as one of the indicators for leachate from MWG's ash ponds. MWG Exh. 903 at 42. However, MWG's bottom ash NLET results indicate that the level of antimony in the ash leachate was below the Part 620 Class I standard of 0.006 mg/L. MWG 903 (Table 5-3). Other than the one exceedance in MW-2, there were none observed in any of the remaining 18 monitoring wells. Thus, the single exceedance maybe attributable to

sampling or analytical error rather than by coal ash storage or handling activities at the site. Also, given that MW-2 is located at the north/northeast edge of the northern most former ash basin and had only two exceedances of Part 620 standards (1 antimony and 1 boron) during the seven-year monitoring period, the well may not be in area of impacted groundwater. MWG Exh. 810; MWG Exh. 901 at 35. The Board finds that the Environmental Groups have not proven that it is more likely than not that this single exceedance is caused by MWG operations.

Arsenic. The monitoring results indicate 83 exceedances of the Part 620 Class I arsenic standard in 6 monitoring wells from 2010 through 2017. These wells include (the number of exceedances shown in parenthesis): MW- 6 (1), MW-7 (26), MW-11 (15), MW-12 (7), MW-13 (22), MW-14 (3), MW-15 (2), and MW-17 (7). These wells are all located downgradient of the ash basins. While some of the wells (MW-6, 12, 14, and 15) had intermittent exceedances of the arsenic standard over the seven-year monitoring period, the results for wells MW-7, MW-11 and MW-13 indicate exceedances over a period of four to six years.

Like antimony, arsenic is listed by both Dr. Kunkel and Mr. Seymour as a constituent that may be present in coal ash leachate. EG Exh 401 at 7; EG Exh. 903 at 42. In this regard, MWG's bottom ash Neutral Leaching Extraction Test (NLET) result of 0.05 mg/L or less for arsenic suggests the presence of arsenic in the ash leachate at levels higher than the Part 620 Class I standard of 0.01 mg/L. MWG 903 (Table 5-3). While there were 83 exceedances in the downgradient wells, arsenic was not detected in the upgradient well MW-16 during the seven-year period. This indicates that upgradient off-site sources did not contribute to the exceedances of the arsenic standard. Given these observations, the Board finds that the Environmental Groups have proven that it is more probable than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to exceedances of arsenic standard in wells MW-6, MW-7, MW-11, MW-12, MW-13, MW-14, MW-15, and MW-17.

Boron. The groundwater monitoring results indicate 64 exceedances of the Part 620 boron standard during the seven-year monitoring period in nine monitoring wells. EG Br. at 77-110 (App A); MWG Exh 810, also see Table 2 above. Most of the exceedances (shown in parenthesis) were observed in three monitoring wells MW-9 (21), MW-13 (26), and MW-14 (7). The other six wells had one to three exceedances over the seven-year period. Also, the upgradient well MW-16 with boron levels ranging from 0.13 mg/L to 1.0 mg/L did not have any exceedances of the boron standard of 2.0 mg/L. However, the boron levels in monitoring wells MW- 9, 13 and 14 ranging between 1.5 mg/L to 4.3 mg/L were higher than the upgradient well. This indicates that onsite sources, rather than any offsite sources, are contributing to groundwater exceedances.

Both the Environmental Groups and MWG agree that boron is an indicator of coal ash contamination. EG Exh 401 at 7, Exh. 903 at 42. Further, Seymour's comparison of the monitoring results from 2014 with indicator constituents in leachate shows that boron is an indicator of leachate from Powerton ash ponds. MWG Exh 903 (Table 5-4). However, Seymour argues that the leachate from MWG ash ponds does not have the potential to cause groundwater impact above the GWQS because the leachate levels were below such standard. MWG Exh. 903 at 41. Here, MWG's bottom ash NLET results indicate that the level of boron ranged from less than 0.1 mg/L to 2.0 mg/L, which the Part 620 Class I standard. MWG 903, Table 5-3. Dr. Kunkel asserts that boron is present in concentrations above Class I standard in wells sampling lower sand and gravel unit (MW-2, 9, 10, 11, and 13), as well as the upper silt/clay unit (MW-12

and 14). EG Exh. 403 at 42. He maintains that exceedances remain even after relining four of the ash ponds in 2010 and 2013, suggesting contribution from a leak in the new liner or coal ash deposited historically outside the basins. *Id.*

As noted above, MW-9, MW-13, and MW-14 had boron exceedances over four or more years and accounted for 83% of the exceedances. While MW-9 is located upgradient of the ash ponds, it is not considered an "upgradient" well because it is within an area of impacted groundwater from historical ash related activities. EG Br. at 41; EG Exh. 255 at 2 (#11236). Other wells (e.g. MW-11, 12, 15, and 19) had few intermittent exceedances that correlated with exceedances of other constituents in other wells in the same area and time. With respect to boron, exceedances in other wells appear to be less representative. The MW-2 single exceedance in 2013, and two exceedances in MW-10 in 2014, appear to be more random and not correlating to any other comparative exceedances in the same time. Given that any offsite boron contribution was below the groundwater standards and significantly lower than the levels in the onsite wells, the Board finds that the Environmental Groups have proven that it is more probable than not that the coal ash stored at the site in the ash ponds or outside the ash ponds is causing or contributing to exceedances of boron standard in wells MW-9, MW-11, MW-12, MW-13, MW-14 and MW-19 at Powerton.

Lead. The monitoring results indicate two exceedances of the Part 620 lead standard during the seven-year monitoring period: first in 2010 in MW-7 located on the western edge of ash settling basin; and second in 2013 in MW-10 located east of ash surge basin. EG Br. App. A., MWG Exh 901 at 35. In all other monitoring wells lead was either below detection level or below the Part 620 standard. MWG Exh. 810. While lead is not included in Dr. Kunkel's list of coal ash constituents, Seymour includes it in his "maximum" or second tier list of coal ash leachate constituents. MWG Exh. 901 at 42. MWG's bottom ash NLET results indicate that the level of lead in the coal ash leachate was below the Part 620 Class I standard of 0.0075 mg/L. MWG 903 (Table 5-3). Thus, the Board finds that the Environmental Groups have not proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside the ash ponds is causing or contributing to the two exceedances of the lead standard at the Powerton Station.

Selenium. There were two exceedances of the Class I GQS selenium standard in MW-14 (in 2011 and 2013), and one in MW-15 (in 2015) during the seven-year monitoring period. Selenium levels were below the groundwater standard in all other monitoring wells. MWG's bottom ash NLET results indicate that the level of selenium was below the Part 620 Class I standard of 0.050 mg/L. MWG 903, Table 5-3. Also, selenium is not considered as a primary indicator of coal ash leachate. Therefore, the Board finds that the Environmental Groups have not proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside the ash ponds is causing or contributing to the few sporadic selenium exceedances at Powerton.

Thallium. The monitoring results show that there were 20 exceedances of the Class I thallium standard in MW-14 (2011 through 2017) and 6 in MW-17 (2016-17). Neither Environmental Groups' experts nor MWG's experts consider thallium as a coal ash leachate indicator. EG Exh. 401 at 7 and MWG Exh. 903 at 42. Further, MWG's bottom ash NLET results indicate that the level of thallium was below the Part 620 Class I standard of 0.0020 mg/L. MWG 903, Table 5-3. Thus, the Board finds that the Environmental Groups have not

proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside the ash ponds is causing or contributing to the thallium exceedances at Powerton.

Sulfate and TDS. There were 104 exceedances of sulfate standard and 119 exceedances of TDS standard during the seven-year monitoring period. MWG Exh. 810. All exceedances occurred in downgradient wells, with sulfate in nine wells (MW-6, 8, 11 through 15 and 17) and TDS in 10 wells (same as sulfate wells plus MW-7 and 18). While some wells had intermittent exceedances, wells MW-12, 13, 14, and 15 had sulfate and/or TDS exceedances over a period of four or more years. *Id.* There were no exceedance of sulfate or TDS in the upgradient monitoring well MW-16 during the seven-year monitoring period.

Both Environmental Groups and MWG list sulfate as an indicator constituent of coal ash, and Dr. Kunkel notes that higher concentration of sulfate may be accompanied by high concentrations of TDS. EG Exh. 401 at 7; MWG Exh. 903 at 40. Further, Seymour's comparison of the monitoring results from 2014 with indicator constituents in leachate shows that sulfate is an indicator of leachate from Powerton ash ponds. MWG Exh 903, Table 5-4. However, Seymour argues that the leachate from MWG ash ponds does not have the potential to cause groundwater impact above the sulfate and TDS standards because the leachate levels are below the standards. He relies on MWG's Will County Station bottom ash NLET results of sulfate at 49 mg/L and TDS at 200 mg/L. MWG Exh. 903 at 41 and MWG Exh. 901 at 8.

Sulfate and TDS are indicators of coal ash contamination in groundwater. Further, the monitoring results show consistent exceedance of the Class I standard for both constituents during the seven-year monitoring period at multiple downgradient monitoring wells. Also, there is no indication of contamination being caused by an off-site source since upgradient monitoring well show no exceedances of either sulfate and TDS groundwater standards. The Board, therefore, finds that the Environmental Groups have proven that it is more likely than not that the coal ash stored at the site in the ash ponds or outside the ash ponds is causing or contributing to the 104 sulfate (wells MW-6, 8, 11, 12, 13,14, 15 and 17) and 119 TDS (MW-6, 7, 8, 11, 12, 13, 14, 15, 17 and 18) exceedances at Powerton Station.

v. Background Concentrations Exceedance

Environmental Groups allege that at Powerton, the median concentrations of boron and sulfate in fifteen downgradient wells (MW-1 through MW-15) exceeded the median concentration of those constituents in the upgradient well (MW-16). EG Exh. 405 at 7. They also assert that the median concentration of sulfate in nine wells (MW-4, 5, 8, 9, 11, 12, 13, 14, and 15), and boron in seven wells (MW-6, 8, 11, 12, 13, 14, and 15) exceed the upper-bound 90th percentile background values from the IEPA's statewide background data. *Id.* at 40-41. Dr. Kunkel also notes that Powerton site overlays the sand and gravel/shallow bedrock aquifers, which are the same aquifers from which the IEPA's background community water supply wells are drawing water. EG Exh. 401 at 8. Further, he notes that the actual background median for sulfate from the background well (MW-16) at the Powerton Station was within a few milligrams of the median statewide sulfate value. Thus, Dr. Kunkel argues that the statewide median background values may be used to evaluate groundwater monitoring results even though the statewide community water supply wells were not located in counties with MWG plants. 1/29/18 Tr. 83-84.

Dr. Kunkel asserts that the groundwater monitoring data at Powerton allows the comparison of the downgradient well concentrations of indicator constituents, boron and sulfate, with both the statewide area background and site-specific background (MW-16). EG Exh. 405 at 7. While the median values of sulfate and boron in all fifteen downgradient wells are above the median values of those constituents in the upgradient well, neither the Environmental Groups' nor MWG's experts established the 90th percentile upper bound background value for well MW-16. The parties agree that the appropriate comparison for background values would the upper bound 90th percentile value. Thus, the Board limits the groundwater monitoring results comparison to the 90th percentile statewide values. The Board finds that, as asserted by the Environmental Groups, a comparison of the median values of boron and sulfate in the downgradient wells with the 90th percentile statewide values indicate exceedances in 10 wells: boron (MW-04, 05, 08, 09, 11, 12, 13,14 and 15) and sulfate (MW-06, 08, 11, 12, 13, 14, and 15). The Board finds that these exceedances of the statewide background and site-specific upgradient median appear to be consistent with the exceedances of groundwater standards of sulfate and boron in many of the downgradient wells.

Given that there is no indication of contamination being caused by an off-site source, the Board finds that the Environmental Groups have proven that it is more probable than not that the coal ash stored at the site in the ash ponds or outside the ash ponds is causing or contributing to the exceedances of the upper-bound 90th percentile background values of boron (in wells MW-4, 5, 8, 9, 11, 12, 13, 14 and 15) and sulfate (in wells MW-6, 8, 11, 12, 13, 14 and 15) at Powerton Station.

4. Will County

A. Uncontested Facts

i. The Station

The Will County Station began operations in 1955 with four coal-fired electric generating units, Units 1-3 were deactivated between 2010 and 2015. Only one active unit, Unit 4, constructed in 1963, operates now. Joint Stip. No. 40, MWG Exh. 666 at 1, 1/30/18 Tr. at 188:20-22, 189:19 (Race Test.); MWG Exh. 903 at 21. MWG has been operating the plant since 1999. Joint. Stip. No. 41.

The Station is located on a peninsula, between the Chicago Sanitary and Ship Canal (CSSC) on the east and the Des Plaines River on the west, with surface water on either side. 2/2/18 Tr. at 172:5-20; MWG Exhs. 901 59 and 903 at 21. The Station is bordered on the north by Romeo Road and on the south Hanson Materials (f/k/a Material Services Corp.). EG Exh. 15C , SOF 358. There is also ComEd switchyard further west across the Des Plaines River. MWG Exh. 903 at 21, 901 at 59; MWG Exh. 652 at 2-1 (#29509).

At Will County, fly ash is collected using electrostatic precipitators and transported off-site for beneficial use. 1/29/18 Tr. at 177-178; MWG Exh. 903 at 21 (Seymour citing Phase I Wil County Environmental Site Assessment report at #28 (#29516)). Bottom ash that falls to the bottom of the furnace is mixed with water to form a slurry and is pumped to Ash Ponds 2S and 3S for settling. MWG Exh. 903 at 21-22 (Seymour report, citing Phase I Will County Environmental Site Assessment report at #28 (#29516)); 1/29/18 Tr. at 192. Bottom ash is then

collected from the ponds and transported off-site for beneficial reuse. The slurry water is recycled back to the Station for treatment. MWG Exh. 903 at 22 (Seymour report).

ii. Ash Ponds

Will County has four ash ponds: 1N, 1S, 2S and 3S. All ponds were constructed in 1977 with 36" thick Poz-o-Pac liners. MWG Exh. 901 at 5; MWG Exh. 500 at #5-9; 1/30/18 Tr. at 191:9-19 (Race Test.). Ponds 2S and 3S also had bituminous seal coat. *Id*. The ponds are regulated under NPDES permit #IL0064254. MWG Exhs. 652; 653, 655; 1/30/18 Tr. at 202:3-20 (Race Test.).

Ponds 1N and 1S were removed from service in 2010. MWG Exh. 901 at 60; 903 at 22. These ponds are further discussed in the Contested Facts section below.

Ponds 2S and 3S remain in operation and have been relined, 2S in 2013 and 3S in 2009. MWG Exh. 901 at 60; MWG Exh. 510 (2S line replacement documentation). Seymour described the ponds lining as (described bottom up): 36+" poz-o-pac, a bottom geotextile cushion, a 60 mil HDPE liner, a top geotextile cushion, and a sand cushion and limestone warning layer on the bottom 2S also has geocell liner on the sides. MWG Exh. 901 at 61; MWG Exh. 903 at 34-35. The ponds' bottom elevation is at 582 ft; average groundwater elevation at 3S is at 581 (about 1.5 feet below the ponds' bottom) and at 2S at 282.5 feet (about the same level as the pond's bottom). *Id*. The two active ash ponds are used interchangeably, only on in service at a time, while the other is designated for cleaning. MWG Exh. 903 at 35. These ponds are dredged approximately on an annual basis. In 2010 MWG performed the ASTM D3987-85 analysis of bottom ash taken from Will County ash pond 3S, the results of which indicate presence of boron, sulfate and TDS. MWG Exh. 901 at 8.

iii. Will County VN

The IEPA issued Violation Notice #W-2012-00058 (Will County VN) for the Will County Station (EG Exh. 2A) alleging that "operations at ash impoundments have resulted in violations of Groundwater Quality Standards" during 2010-2012 at monitoring wells MW-1 through MW-10, including for chloride (MW-1, 2, 3, 6, 7, and 8), antimony (MW-1, 2), manganese (MW-1, 3, 4, 7, 8, and 10), boron (MW-2, 4, 5, 6, 7, 8, 9, and 10), arsenic (MW-7), sulfate (MW-1, 2, 4, 5, 6, 7, 8, 9, and 10), TDS (MW-4, 5, 7 and 8), as well as pH (MW-5, 6). EG Exh. 2A at 3-9.

iv. Will County CCA

The Will County CCA (MWG Exh. 656) states that:

> Operations at ash impoundments have resulted in violations of the Groundwater Quality Standards at monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, and MW-10. MWG Exh. 656 at 2 ¶ 3.

The CCA notes that "respondent agrees to undertake the following actions, which the Illinois EPA has determined are necessary to attain compliance" with the statute and Board rules. MWG Exh. 636 at 3 ¶ 5. Subsections (a) through (m) of paragraph 5 list activities MWG must

undertake, subsections (a) though (d) are identical as in the Joliet 29 and Powerton CCAs. The other subsections require:

5(e)	removing ponds 1 North (1N) and 1 South (1S) from service and diverting all water from these ponds to the existing ponds 2 South (2S) and 3 South (3S); and developing and implementing a dewatering system which will not allow water to exceed a depth of one foot above the bottom of ponds 1N and 1S;
5(f)	apply to IEPA for a construction permit to reline 2S with HDPE liner;
5(g), (i)	submitting application to IEPA to establish and establishing a GMZ under section 620.250 within one year from the date of CCA;
5(h), (i)	entering into ELUC to cover area underlying GMZ, except for ComEd owned area, submit proposed and final ELUC to IEPA; and
5(j)	submitting certification of compliance upon completing CCA requirements within one year of the date of CCA. MWG Exh. 656 at 3-4 ¶ 5.

On October 17, 2013, MWG filed a certification with the IEPA that all CCA measure were completed. Joint Stip. at 4; MWG Exh. 661.

v. Will County GMZ and ELUC

As required by Items 5(g), (h) and (i) of the Will County CCA,MWG on January 18, 2013, filed applications with the IEPA to establish a GMZ (MWG Exh. 276) and also a proposed an ELUC (MWG Exh. 659). Joint Stip. at 4; MWG Answer and Defenses 5/5/14 at 23; MWG Exhs. 276 and 659.

Both the GMZ and the ELUC cover the same area, including ash ponds and the eastern part of the site, with the following borders:

> Groundwater flow in the vicinity of the subject ash ponds is in a westerly direction with discharge to the adjoining Des Plaines River. The western (downgradient) extent of the proposed corresponds with this hydraulic boundary. The eastern boundary is defined by the Chicago Sanitary and Ship Canal (CSSC) which forms a hydraulic boundary on the east side of the facility. The north and south sides of the proposed ELUC are based on the flow system and location of the four ash ponds. The vertical extent of the ELUC would be the first underlying aquitard identified as the Maquoketa Shale, approximately 140 feet below ground surface. The ELUC would therefore vertically include the unconsolidated overburden and the Silurian dolomite, both of which are hydraulically connected and overlie the Maquoketa Shale. EG Exh. 276 at 1 and MWG Exh. 659 at 1-2.

On July 2, 2013, IEPA replied, approving GMZ with several modifications and requesting that MWG submit the revised ELUC. MWG Exh. 658 at 1. IEPA modifications required excluding of the non-community wells from the ELUC area and ensuring that any unused non-community wells are properly. *Id*.

On September 4, 2013 KPRG (Mr. Gnat) on behalf of MWG submitted requested modifications to the ELUC and GMZ boundary map and on September 26, 2013 IEPA approved the modification. MWG Exh. 660.

The GMZ is established under 35 Ill. Adm. Code 620.250(a). EG Exh. 276 Att. 2, at 1 Note 1. The application notes that "Class I" is the groundwater classification "the facility will be subject to at the completion of the remediation". EG Exh. 276, Att. 2, Part I ¶ 10 (#630). The GMZ application notes the following selected remedy:

> The agreed upon remedy is specified in Item 5(a) through (j) of the executed [CCA]… The remedy includes lining of the Ash Pond 2S with HDPE, removing Ash Ponds 1S and IN from service and installing a dewatering system within those ponds to keep liquid levels to within no more than one foot of the bottoms of those units. This [GMZ] application fulfills requirements set forth under Item 5(g) of the CCA. EG Exh. 276 Att. 2, Part III ¶ 1 (#637).

The application also notes that "[at] the completion of the corrective process, a final report is to be filed which includes the confirmation statement included in Part IV." *Id*. Att. 2, at 1 Note 1.

B. Contested Facts

i. Ash Ponds Dredging, Liner Ruptures and Flooding

Dr. Kunkel asserts that boron is present at Will County in concentrations above Class I standard because of past and current leaks in the liners of the four ash ponds and past and ongoing leachate from ash utilized for fill or construction materials outside of the ponds. EG Exh. 401 at 32. He also argues that "there has been ground-water table mounding beneath the ash ponds, as shown on ground-water table contour maps in the MWG quarterly monitoring reports, and all ground-water monitoring wells at the site should be considered down-gradient." *Id.* He maintains that exceedances remain even after relining the four ash ponds between 2010 and 2013, suggesting a leak in a new liner or contribution from coal ash deposited historically outside the basins. *Id*.

As noted with all other Stations, both poz-o-pac and HDPE liners are prone to damage in certain conditions, i.e. severe weather or rupture by heavy equipment during dredging. MWG relined the ponds at Will County on the assumption they were in a "poor" condition. MWG Exh. 607; EG Exh. 34 at 7 (#23614); MWG Exh. 606 at 18 (#23647); *see also* 10/23/17 Tr, at 16; 10/24/17 Tr. at 12-13. In 2005 and 2006 MWG consultant, NRT, investigated the liners at Will County ponds and rated condition of all four ponds as "poor." EG Exh. 34 at #23614; MWG Exh. 606 at 23647. The reports also rated these ponds as "high" for "contamination potential". *Id*. When the ponds were relined, however, the original poz-o-pac liners in 2S and 3S were found to be in a "good condition." 10/24/17 Tr. at 304:7-10 (Maddox Test.); SOF at ¶ 621. When relining the 2S pond, MWG employees discovered that "existing poz-o-pac floor is different than the sites drawing" and commissioned NRT to take borings. EG Exh. 300. Boring taken at 2S in 2013 during relining showed that the bottom poz-o-pac layer goes deeper than 36". MWG Exh. 510 at 4 (#34271); 1/30/18 Tr. at 200:2-201:1 (Race Test.). Further, the record also

suggests that some coal ash may have been left between the poz-o-pac and HDPE layers when relining the ponds, since that was a practice approved by MWG employees at that time. *See e.g.* EG Exhs. 22, 32; 10/23/17 Tr. at 156:18-162:21 (Race Test.).

MWG employees were also concerned that even after relining with HDPE, the liners will be easily damaged by equipment during dredging. Rebecca Maddox noted in 2008 to Christopher Lux that LaFarge employees have "serious apprehension about working on this liner" and that MWG employees had to "reiterate over and over to be careful." She further noted that "[n]o matter how much we would reiterate to them to be careful, the possibility of the liner being punctured is much greater now than w/ just a poz-o-pac type "liner." We really feel this liner, even w/ the cushion and warning layers, will not be able to withstand the constant heavy equipment traffic that will continue." EG Exh. 306 at 1. The record shows that the liner in at least one of the ponds had cracked. An inspection of 3S in October 2009 during the liner replacement indicated that the liner cracked, and the water was seeping in. EG Exh. 303 at 1; 10/24/17 Tr. at 214:5-215:12. In 2012 KPRG did permeability testing and found hairline cracks in the poz-o-pac liner of one of the ponds. EG Exh. 286 at 2 (#14745); 10/25/17 Tr. at 221:6-223:2. In July 2010, Maddox noted that repairs were needed on 2S weir because there were "numerous breaks within the weir that is compromising the effectiveness of it." EG Exh. at 311. In June 2012, Ms. Maddox found the south section of the HDPE liner in the 3S pond "extremely damaged," with the felt lining and the HDPE "completely torn up" and "buried under some of the ash for a bit." MWG Exh 307 at 1. She attributed the damage to the cleaning performed by LaFarge "many months ago". *Id*.

Will County also had at least one instance of ash sluice water getting out of the ponds and into the nearby waterbody. In 2008 MWG also notified IEPA and Illinois Emergency Management Agency that on November 3, 2008, water was "flowing over the concrete barrier of the Unit 1 & 2 ash pond and traveling into a ravine that leads to the Des Plaines River" on the northwest part of the property. EG Exh. 309.

The record also indicates dewatering coal ash in areas outside of the ponds. In July 2010, Pond 3S got very close to overflowing on the east side, with "water and material … running to the east." EG Exh. 311 at 2. The contractor suggested that MWG "take the material from Pond 2S and pile it on our property until it dewaters." *Id*. at 1. MWG's Rebecca Maddox instead suggested to put the material from Pond 2S "in the area south of the contractor parking lot," noting that "[w]e used that area last year to dewater the material from 3S." She further noted that the water from that runoff "should make its way eventually to the south area runoff," noting that the "material will be there for a while until it dewaters - like it was last year." *Id*.

After a careful review of the facts, the Board finds that the Environmental Groups established that both poz-o-pac and HDPE liners at Will County can and do crack or get damaged on occasions. Based on preponderance of all the evidence in the record, including the groundwater monitoring results, MWG practices in ponds relining and dredging, storing coal ash from the ponds outside of the ponds, the Board concludes that it is more likely than not that the ash ponds and the material from those ash ponds did leach contaminants into the groundwater.

ii. <u>Historical Coal Ash Sites</u>

The record shows that there are several areas that have been historically used to store coal ash: 1) ponds 1N and 1S; 2) fill areas outside of the ponds; and 3) alleged Slag and Bottom Ash Placement Area.

Ponds 1N and 1S still contain one inch of water. MWG Exh. 901 at 58. The water level in the ponds is not allowed to exceed one foot above the base. MWG Exh. 903 at 22. Mr. Seymour notes that no additional ash was deposited in these ponds since they were removed from operation in 2010. *Id*. They also still contain ash and are not capped. 10/23/17 Tr. at 169:18-21, 170:1-19; 10/24/17 Tr. at 14:2-15:19. The ponds have 36-inch-thick poz-o-pac liners with bituminous carrying coat. MWG Exh. 500 at 5, 7; 1/30/18 Tr. at 193:11-23 (Race Test.). MWG admitted that ponds liners are in poor condition being 40 year old poz-o-pac. EG Exh. 34 at (#23614); MWG Exh. 606 at (#23647); EG Exh. 15C at 22-27 (#7251-7256); 1/30/18 Tr. at 191:20-23; EG Exh. 201 at 19-24 (#24282-24287). In June and August of 2015 KPRG took 20 soil borings of "historical ash samples" at an area right outside the east side of 1N to test for compliance with CCB. EG Exh. 284 at 1; MWG Exh. 901 at 59; MWG Exh. 903 at 48. The report indicates that the ash deposits consist of bottom ash and slag from the coal combustion process. The study area was four by seven squares, with each square equaling 25 feet. EG Exh. 284 at 4 (#49568). The samples were analyzed using the NLET method (ASTM D3987-85) for metals. EG Exh. 284 at 1-2 (#49565-66). The test concluded that ash deposits consist of bottom ash or slag from coal combustion process and the 20 samples taken meet the criteria of Section 3.135 of the Act to be considered CCB for beneficial use and there were no outlier samples. *Id.*; EG Exh. 284 at 4 (#49568).

Ponds 1N and 1S are at least one foot below average groundwater elevations. 2/2/18 Tr. at 309:21-310:19, 143:5-148:4. Because the bottom of these ponds is sitting below the water table, the cracks in the poz-o-pac liners allow groundwater to seep into the ponds and for ash constituents to leak out into the groundwater. 2/2/18 Tr. at 149:15-18. Groundwater leaked through poz-o-pac at 1N and 1S ponds. EG Exh. 302; 10/24/17 Tr. at 211:18-213:20, 213:1-6 (contractors were requested to "cut holes in liner to pump out groundwater" and "then patch the holes").

Coal ash buried around the ash ponds. The coal ash has been buried here since at least 2005. EG Exh. 34 at 7 (#23614); MWG Exh. 606 at 18 (#23647); EG Exh. 15C at 22-27 (#7251-7256); 1/30/18 Tr. at 191:20-23; EG Exh. 201. In 2005, MWG consultant KPRG, took five soil borings around the ash ponds and the samples identified "slag/bottom ash/coal" in four of the borings, at depths ranging from zero to two feet through eight to nine and a half feet deep beneath the surface. EG Exh. 201 at 4, 29-24 (#24267, 24282-24287). In 2010 and 2011, when installing groundwater monitoring wells MW-01 through 10 around the ash ponds, Patrick Engineering took the borings for the wells, that also showed a thick layers of coal ash buried along the eastern edge of the four ponds to a depth of 12 feet. EG Exh. 15C at 5, 22-25, 27 (#7234, 7251-54, 7256). Layers of fill, going down to six to twelve feet, containing ash cinders were found in borings for MW-1, 2, 3, 4 and 6, all along the eastern edge of the ash ponds. EG Exh. 15C at 22-25, 2727 (#7251-54, 7256). Borings for MW-02 showed black coal cinders a depth of up to 12 feet as "wet." *Id*. at 27 (#7256).

Former Slag and Bottom Ash Placement Area is located on the southeast corner of the Station. MWG Exh. 901 at 59; 2/2/18 Tr. at 119:21-120:1 (Seymour Test.). This area was identified in the 1998 Phase II Environmental Site Assessment report as ash disposal area. EG

Exh. 18D at 6, Fig. 5 (#5708, 5742). Borings taken from this area in 1998 (B-1 through B-4) show coal ash mixed with gravel as deep as three feet below surface. EG Exh. 18D at 6, Fig. 5, App. A B-1- B-4 (#5708, 5747-50). Although, there was a monitoring well (MW-1) in this area in 1998, there are no current monitoring wells in this area. EG Exh. 18D at 6, Fig. 5 (#5708, 5742). is the area is not covered by ELUC or GMZ. *Id*. at 67 and 68.

Weighing the facts presented, the Board finds that Environmental Groups have proven that it is more likely than not that the historic areas and coal ash in the fill areas at the Station are causing or contributing to GQS exceedances at the Station.

iii. <u>Monitoring Wells</u>

The groundwater monitoring network at Will County consist of 12 monitoring wells. Ten monitoring wells (MW-01 through MW-10) were installed in 2010. They are located around the perimeter of the four ash ponds. EG Exh. 15C at 2, 19 (#7234, 7248). These wells were spaced approximately 150 – 300 feet apart and screened approximately 10 feet past the intersection of the groundwater table to ensure collection of representative groundwater samples. EG Exh. 15C at 3 (#7234). Two additional monitoring wells (MW-11 and 12), referred to as CCR wells, were installed in 2015 to address the new USEPA's Coal Combustion Residual (CCR) rule. 2/1/18 Tr. at 89:13-90:7, 165:17-166:4. Starting from December 2010, quarterly groundwater samples from monitoring wells MW-1 through MW-10 were analyzed for 35 constituents. MWG Exh. 812. The additional CCR wells, MW-11 and 12, were sampled quarterly from November 2015. *Id.* at 21-23. These samples were analyzed for 15 constituents, and did not include boron, sulfate and TDS. *Id.* at 21.

The site hydrogeologic conditions at the Will County station were determined in 2011 by Patrick Engineering using the soil boring logs of ten groundwater monitoring wells installed around the perimeter around all four the ash ponds. EG Exh. 15C at 3 (#7234). The site geology consists of approximately 1 to 5 feet of unconsolidated deposits or fill, underlain by Silurian Dolomite to approximately 140 feet below ground surface, underlain by the Maquoketa shale, which is generally considered to be an aquitard that separates the shallow groundwater in the unconsolidated units and the Silurian dolomite from the underlying aquifers. EG Exh. 15C at 2 (#7233). While the groundwater flow in the shallow aquifer is controlled by the Des Plaines River and the CSSC with groundwater likely flowing towards either of the rivers, the flow direction in the deep aquifer is towards the southeast. *Id.* However, the groundwater contour map prepared by KPRG in 2016 indicates flow towards the Des Plaines river. EG Br. App. F, MWG Exh. 901 at 63, 2/1/18 Tr. at 163:20-164:22. Seymour noted, "groundwater generally flows west to the Des Plaines River on the western portion of the site and is understood to flow east to the Chicago Sanitary and Ship Canal on the eastern portion of the site." MWG Exh. 903 at 23. Will County GMZ and ELUC also note that "[g]roundwater flow in the vicinity of the subject ash ponds is in a westerly direction with discharge to the adjoining Des Plaines River." MWG Exh. 659 at 1 (ELUC proposal); EG Exh. 276 at 1 (GMZ application).

While the Will County hydrogeologic report notes that the well locations were selected to represent both upgradient and downgradient with respect to direction of groundwater flow, the report does not identify specific wells as being up gradient or downgradient. EG Exh. 15C at (#7234). However, Mr. Gnat states that since the groundwater flow is to the west towards the Des Plaines River, the upgradient wells are MW-01 through MW-06. MWG Exh. 901 at 63,

2/1/18 Tr. at 164:18-22. The other six wells are considered downgradient wells (MW-07, 8, 9, 10, 11, and 12). 2/1/18 Tr. at 164:14-17. Seymour indicates that the highest groundwater elevation during each quarterly monitoring event varied between wells MW-01, 02, 03, 05 and 09; the lowest was in MW-10. MWG Exh. 903 at 23. Environmental Groups' expert Dr. Kunkel argues that "there has been ground-water table mounding beneath the ash ponds, as shown on ground-water table contour maps in the MWG quarterly monitoring reports, and all ground-water monitoring wells at the site should be considered down-gradient." EG Exh. 401 at 32.

Groundwater flow to the east on the eastern portion of the site towards CSSC, as well as the large number of exceedances of coal ash constituents (boron, sulfate and TDS) in the wells Mr. Gnat designates as upgradient (MW-1 through MW-6), indicate that these wells are in the area where groundwater is affected by either the ash ponds or historic ash disposal activities. *See. e.g.* EG Exh. 15C at 2, MWG Exh. 903 at 23. The Board, thus, finds that the Environmental Groups have proven that it is more likely than not that the wells MW-1 through MW-6 should not be treated as upgradient for the Station.

iv. <u>Exceedances of Part 620 Standards</u>

The groundwater monitoring results at Will County indicate 441 exceedances of the Board's Part 620 Class I GQS for coal ash constituents in all 10 initial monitoring wells (MW-1 through 10) installed in 2010. MWG Exh. 812. There were 281 exceedances in the wells (MW-1 through MW-6) and 159 exceedances in the down gradient wells (MW-7 through MW-10). No exceedances were observed in the two newly installed CCR wells (MW-11 and 12). *Id*. While MW-9 had the least number of exceedances (7), MW-4 had the most (81). The number of exceedances in the other 8 wells ranged from 15 to 66. *See* Tables 3.A. – 3.C below. The constituents above the Class I standards are: antimony (3 exceedances), arsenic (18), boron (207), selenium (1), sulfate (131), and TDS (80). As noted above, given the large number of exceedances of coal ash constituents (boron, sulfate and TDS) in the wells MW-1 through MW-6, the Board does not consider these wells as background wells.

Based on review of groundwater data, Seymour noted that historic use of property was causing the impacts. 2/2/18 Tr. at 122. The Board notes, however, that ash ponds may also be contributing to the impacts because the record indicates the groundwater flow in the shallow aquifer underlying the site is controlled by the Des Plaines River and the CSSC with groundwater flowing likely flowing towards the rivers. *See. e.g.* EG Exh. 15 C at 2 (#7233).

A summary of the groundwater monitoring data exceeding Part 620 standards for Will County is presented in Tables 3.A-3.C, below. EG Br. at 77-110 (App. A); MWG Exh. 812.

Table 3.A: Will County Groundwater Monitoring Results Summary

Monitoring Wells	Closest Ash Pond, historical storage	Location	Constituents	Number of Exceedances of Part 620 Standards	Year(s)
MW-01	AP1-N	Upgradient	Antimony	1	2011
			Boron	6	2012-2014
			Sulfate	5	2012-2013
			TDS	3	2013-2014
MW-02	AP1-N	Upgradient	Arsenic	5	2014-2016
			Antimony	2	2011
			Boron	19	2011-2017
			Sulfate	11	2010-2017
			TDS	7	2015-2017
MW-03	AP1-S	Upgradient	Boron	27	2010-2017
			Sulfate	12	2012-2017
			TDS	1	2012
MW-04	AP1-S	Upgradient	Boron	27	2010-2017
			Sulfate	27	2010-2017
			TDS	27	2010-2017
MW-05	AP2-S	Upgradient	Boron	27	2010-2017
			Selenium	1	2013
			Sulfate	23	2010-2017
			TDS	15	2013-2017
MW-6	AP3-S	Upgradient	Arsenic	1	2017
			Boron	27	2010-2017
			Sulfate	8	2010-2014
MW-7	AP1-N	Downgradient	Boron	27	2010-2017
			Sulfate	22	2010-2017
			TDS	14	2010-2017
MW-8	AP1-S	Downgradient	Arsenic	6	2011-2014
			Boron	17	2011-2017
			Sulfate	19	2010-2017
			TDS	13	2011-2017
MW-9	AP2-S	Downgradient	Boron	4	2010-2016
			Sulfate	3	2010-2014
MW-10	AP3-S	Downgradient	Arsenic	7	2013-2017
			Boron	26	2010-2017

			Sulfate	1	2011

Table 3.B: Will County Groundwater Monitoring Results Summary (by year)

Year	Monitoring Wells	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10
	Constituent	**# of Exceedances Above Part 620 Class I Groundwater Standards**									
2010	Boron			1	1	1	1	1		1	1
	Sulfate	1	1		1	1	1	1	1	1	
	TDS				1			1			
2011	Antimony	1	2								
	Arsenic								2		
	Boron		2	4	4	4	4	4	1		3
	Sulfate				4	4	4	4	3	1	1
	TDS				4	3		4	1		
2012	Arsenic								2		
	Boron	1	1	4	4	4	4	4	2		4
	Sulfate	1		3	4	2	2	4	1		
	TDS			1	4			2			
2013	Arsenic								1		1
	Boron	3	2	4	4	4	4	4	2	1	4
	Selenium					1					
	Sulfate	3		3	4	3		2	2		
	TDS	2			4	2			1		
2014	Arsenic		1						1		
	Boron	2	4	4	4	4	4	4	3		4
	Sulfate		1	4	4	4	1	3	3	1	
	TDS	1			4	4		4	3		
2015	Arsenic		2								3
	Boron		4	4	4	4	4	4	4	1	4
	Sulfate		3	1	4	4		3	4		
	TDS		1		4	3			3		
2016	Arsenic		2								2
	Boron		4	4	4	4	4	4	4	1	4
	Sulfate		4		4	3		3	4		
	TDS		4		4	2		1	4		
2017	Arsenic						1				1
	Boron		2	2	2	2	2	2	1		2
	Sulfate		2	1	2	2		2	1		
	TDS		2		2	1		2	1		
	Total	15	44	40	81	66	36	63	55	7	34

Table 3.C: Will County Groundwater Monitoring Results Summary (by wells)

Chemical	Antimony	Arsenic	Boron	Selenium	Sulfate	TDS	Total

Constituent							
Monitoring Well	**Number of Exceedances**						
MW-1	1		6		5	3	15
MW-2	2	5	19		11	7	44
MW-3			27		12	1	40
MW-4			27		27	27	81
MW-5			27	1	23	15	66
MW-6		1	27		8		36
MW-7			27		22	14	63
MW-8		6	17		19	13	55
MW-9			4		3		7
MW-10		7	26		1		34
Total	3	19	207	1	131	80	441

Antimony. The Board notes that here were three exceedances of the antimony standard over the entire seven-year monitoring period, one in MW-1 and two in MW-2. All three exceedances were observed in 2011. Both Environmental Groups' expert, Dr. Kunkel, and MWG's expert Seymour agree that antimony is one of the indicators for leachate from MWG's ash ponds. EG Exh. 401 at 7; MWG Exh. 903 at 42. However, MWG's bottom ash Neutral Leaching Extraction Test (NLET) results indicate that the level of antimony in the ash leachate was below the Part 620 Class I standard of 0.006 mg/L. MWG Exh. 903 at 117 (Table 5-3). The single exceedance in MW-1 at a level of 0.0063 mg/L when rounded is at the same level as the standard. Thus, the groundwater data indicates two exceedances in MW-2 over two consecutive quarters in 2011. Given that MW-2 had 42 exceedances of other coal ash indicator constituents, the antimony exceedance may be due to coal ash storage or handling activities at the site. The Board, thus, finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to the three antimony exceedances in MW-2 at the Will County Station in 2011.

Arsenic. The monitoring results indicate 18 exceedances of the Part 620 Class I arsenic standard of 0.01 mg/L in three monitoring wells from 2011 through 2017: MW- 2 (5), MW-8 (6) and MW-10 (7). While the arsenic levels in the upgradient well MW-2 ranged from 0.013 to 0.018 mg/L, the levels in downgradient wells MW-8 and 10 ranged from 0.012 to 0.025 mg/L. MWG Exh. 812, *see* Tables 3.A-3.C above. Also, the results indicate the exceedances in the four wells were intermittent during a period of one to four years. Both Dr. Kunkel and Mr. Seymour list arsenic as a constituent that may be present in coal ash leachate. EG Exh 401 at 7; MWG Exh. 903 at 42. MWG's bottom ash NLET result of 0.05 mg/L or less for arsenic suggests the presence of arsenic in the ash leachate at levels higher than the Part 620 Class I standard of 0.01 mg/L. MWG 903 at 117 (Table 5-3). All three arsenic-impacted wells also had exceedances of other coal ash constituents, including boron, sulfate and TDS. The Board, thus, finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to 18 arsenic exceedances in MW-02, 8 and 10 at Will County.

Boron. The monitoring results indicate 207 exceedances of the Part 620 Class I boron standard during the seven-year monitoring period in all ten initial monitoring wells: MW-1 (6),

MW- 2 (19), MW-3 (27), MW-4 (27), MW-5 (27), MW-6 (27), MW-7 (27), MW-8 (17), MW-9 (4) and MW-10 (26). EG Br. at 77-110 (App. A); MWG Exh. 812; *see* Tables 3.A-3.C above. Most of the wells had continuing exceedances over the seven-year monitoring period. Both parties agree that boron is an indicator of coal ash contamination. EG Exh. 401 at 7; MWG Exh. 903 at 42. Further, Seymour's comparison of the monitoring results from 2014 with indicator constituents in leachate shows that boron is an indicator of leachate from Will County ash ponds. MWG Exh. 903 at 118 (Table 5-4). However, Seymour argues that the leachate from MWG ash ponds does not have the potential to cause groundwater impact above the GQS because the leachate levels were below such standard. MWG Exh. 903 at 41. Here, MWG's bottom ash NLET results indicate that the level of boron ranged from less than 0.1 mg/L to 2.0 mg/L, which is at the same level as the Part 620 Class I standard. MWG Exh. 903 at 117, (Table 5-3). The Board finds that monitoring results indicate continuing exceedance of Class I boron standard in most of the wells. As noted above, the record indicates that groundwater flow at the site in both directions, toward the Des Plaines River and CSSC. This discounts the position that some of these wells are upgradient and show off-site impacts. Also, the peninsular location of the Will County Station suggests that contamination is not caused by an off-site source. Considering that boron is an indicator constituent of coal ash, the Board, thus, finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to the 207 boron exceedances in all ten monitoring wells at Will County.

Selenium. There was one exceedance of the Class I selenium standard in well MW-5 (2013) during the seven-year monitoring period. MWG Exh. 812 at 9-10. Selenium levels were below the groundwater standard in all other monitoring wells. MWG's bottom ash NLET results indicate that the level of selenium was below the Part 620 Class I standard of 0.050 mg/L. MWG Exh. 903 at 117 (Table 5-3). Also, selenium is not considered as a primary indicator of coal ash leachate. Therefore, the Board finds that the Environmental Groups have not proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to the single selenium exceedance at Will County.

Sulfate and TDS. There were 131 exceedances of the Class I sulfate standard and 80 exceedances of the Class I TDS standard during the seven-year monitoring period. MWG Exh. 812. While sulfate exceedances occurred in all ten initial monitoring wells (MW-01 through 10), TDS exceedances were observed in seven (MW-01, 02, 03, 04, 05, 07, and 08). While some wells had intermittent exceedances, wells MW-02, 04, 05, 07 and 08 had sulfate or TDS exceedances over a period of five or more years. *Id.*

Both parties list sulfate as an indicator constituent of coal ash leachate. Dr. Kunkel notes that higher concentration of sulfate may also be accompanied by higher concentrations of TDS. EG Exh. 401 at 7 and MWG Exh. 903 at 40. Further, Seymour's comparison of the monitoring results from 2014 with indicator constituents in leachate shows that sulfate is an indicator of leachate from Will County ash ponds. MWG Exh. 903 (Table 5-4). However, Seymour argues that the leachate from MWG ash ponds does not have the potential to cause groundwater impact above the sulfate and TDS standards because the leachate levels are below the standards. He relies on MWG's Will County Station bottom ash NLET results showing sulfate at 49 mg/L and TDS at 200 mg/L. MWG Exh. 903 at 41; MWG Exh. 901 at 8. Dr. Kunkel argues that except at MW-4 and MW-5, the sulfate concentrations in the monitoring wells have remained steady but

higher than Class I, thus, indicating that the ash pond liners continue to leak, or coal ash deposits located outside the ash ponds are leaching. EG Exh. 401 at 34.

The Board finds that sulfate and TDS are indicators of coal ash contamination in groundwater. The monitoring results show consistent exceedance of the Class I standard of both constituents during the seven-year monitoring period at multiple wells and, given the peninsular location of the Will County Station, there is no indication of contamination being caused by an off-site source. Therefore, the Board, finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to the 131 sulfate and 80 TDS exceedances in Will County monitoring wells (MW-6 through 8, 11 through 15, 17 and 18).

v. Background Concentrations Exceedance

The Environmental Groups assert that onsite groundwater concentrations of the coal ash indicators boron and sulfate are higher than background values developed by IEPA, and not naturally occurring. EG Br. at 64. The median concentrations of boron exceed the upper-bound 90th percentile background values all ten wells. *Id.* at 40. The Environmental Groups also note that while only monitoring well MW-04 median sulfate concentration exceeded the upper-bound 90th percentile value, the median concentrations of sulfate in all ten wells are three to five times more than the statewide median value. *Id.*

The Board finds that because upgradient wells at the Will County Station are in areas of impacted groundwater, the groundwater monitoring results of indicator constituents, boron and sulfate may be compared with the statewide area background. EG Exh. 405 at 7. Thus, the Board finds that a comparison of the median values of boron and sulfate in the down gradient wells with the 90th percentile statewide values indicate exceedances of boron above background in all 10 wells and sulfate in one well (MW-4). Further, the median values of sulfate and boron in all ten wells are above the statewide median values of those constituents in the upgradient well. MWG Exh. 812. These exceedances of the statewide background are consistent with the exceedances of Class I groundwater standards of sulfate and boron in most monitoring wells.

Given that there is no indication of contamination being caused by an off-site source, the Board finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to boron and sulfate statewide background exceedances at Will County.

5. Waukegan

A. Uncontested Facts

i. The Station

The Waukegan Station began operations in 1920s with five coal-fired electric generating units and later expanded to 8 generating units. MWG Exh. 901 at 44; 1/30/18 Tr. at 121:11-15 (Race Test.). However, at present the station has two active units which began operation in 1958

and 1962. MWG Exh. 665 at 1-2; 1/30/18 Tr. at 121:16-122:8. MWG has owned and operated the Station since 1999. Joint. Stip. No. 32, 33.

The area around the Station has been primarily industrial from 1930s. The Station uses salt on the roads in winter for safety. 1/31/18 Tr. at 240:16-241:12 (Veenbaas Test.). Mr. Veenbaas testified that this "is probably one of the highest density urban sites in the country right now." 1/31/18 Tr. at 223:20-21 (Veenbaas Test.). On the north, the Station is bordered by Johns Manville Company's property that is now a Superfund site, with cleanup operations ongoing but no industrial operations. 1/31/18 Tr. at 223:10-14 (Veenbaas Test.); 1/30/17 Tr. at 123:11-124:2 (Race Test.). To the south of the Station is the North Shore Sanitary District; further south is the Johnson Marine Plant, another active Superfund, and also liquified gas Superfund sites. 1/31/18 Tr. at 223:10-21 (Veenbaas Test.). On the east side of the Station is the Lake Michigan. MWG Exh. 667 at 25; 1/31/18 Tr. at 223:10-21 (Kelly Test.); 2/1/18 Tr. at 162:13-163:8 (Gnat Test.); MWG Exh. 667 at 27; MWG Exh. 807.

Fly ash at the Stations is collected using electrostatic precipitators and transported off-site for beneficial use. 1/31/18 Tr. at 224-225. The heavier bottom ash that falls to the bottom of the furnace is generally mixed with water and sluiced to the ash. *Id.* at 225. The results of the ASTM D3987-85 analysis of bottom ash taken from Waukegan ash pond 2010 indicate presence of barium and boron, however, samples were not analyzed for sulfate and TDS. MWG Exh. 901 at 8.

ii. <u>Ash Ponds</u>

Waukegan has two ash ponds: 1) East Pond and 2) West Pond. Both were constructed in 1977 with Hypalon liners. MWG Exh. 901 at 44. The ponds are in the southern portion of the site. EG Exh. 19D at 6, EG Br. (App. E). Both ponds were relined, the East Pond in 2003 and West Pond in 2004, with a 60 mil HDPE. MWG Exh. 901 at 46-47; 903 at 34. The East and West Ponds lining includes (described bottom up) a sand cushion and limestone warning layer on the bottom. MWG Exh. 901 at 47. The ponds'' bottom elevation is at 585 ft; average groundwater elevation is at 582-583 feet (about 2-3 feet below the ponds' bottom). *Id*. The ash ponds are regulated under an NPDES permit (#IL0002259). MWG Exh. 642. One pond is used at a time while the other is being dredged to remove the settled coal ash. 1/31/18 Tr. 230-231. Ash removal from the pond is scheduled every three to four years. *Id.*; MWG Exh. 901 at 46.

iii. <u>Waukegan VN</u>

The IEPA issued Violation Notice #W-2012-00056 (Waukegan VN) for the Waukegan Station (EG Exh. 1A) alleging that "operations at ash impoundments have resulted in violations of Groundwater Quality Standards" from 2010 to2012 at monitoring wells MW-1 through 5, including for chloride (MW-5), antimony (MW-1), manganese (MW-4 and 5), boron (MW-1 through 5), arsenic (MW-1), iron (MW-5), sulfate (MW-5), TDS (MW-5), as well as pH (MW-1, 2, and 3). EG Exh. 1A at 3-5.

iv. <u>Waukegan CCA</u>

The Waukegan CCA (MWG Exh. 647) states that:

> Operations at ash impoundments have resulted in violations of the Groundwater Quality Standards at monitoring wells MW-1, MW-2, MW-4, and MW-5. MWG Exh. 647 at 2 ¶ 3.

The CCA notes that "respondent agrees to undertake the following actions, which the Illinois EPA has determined are necessary to attain compliance" with the statute and Board rules. MWG Exh. 647 at 3 ¶5. Subsections (a) through (i) of paragraph 5 list activities MWG must undertake, subsections (a) though (c) are identical to all other CCAs. The other subsections require:

5(d)	installing two additional monitoring wells at locations approved by IEPA;
5(e)	continuing quarterly monitoring of the existing five and the newly installed additional two monitoring wells "for constituents in 35 Ill. Adm. Code 620.410(a)" and record and report elevations to IEPA;
5(f), (g)	entering into an Environmental Land Use Control (ELUC) to cover remaining area at the Station to the east not covered by existing ComEd Former Tannery Site ELUC, submit proposed ELUC to IEPA and record ELUC upon its approval;
5(i)	submitting a certification of compliance upon completing CCA requirements within one year of the date of CCA. MWG Exh. 647 at 3-4 ¶ 5.

On October 22, 2013, MWG filed a certification with the IEPA that all CCA measure were completed. Joint Stip. at 4; MWG Exh. 651.

v. <u>Waukegan ELUC</u>

On June 23, 2003, MWG recorded ELUC covering western part of the Waukegan Station, including the railway tracks north west of the ash ponds, "to protect against exposure to contaminated soil or groundwater, or both, that may be present on the property as a result of past industrial activities on adjacent property known as the Griess-Pfleger Tannery site." MWG Exh. 646 at 1, 7 and 9. On January 18, 2013, MWG submitted to IEPA proposed extension of ELUC to cover eastern part of the Station including the ash ponds, as required by Item 5(f) of the CCA. MWG Exh. 263. On August 26, 2013, IEPA approved MWG's request for ELUC extension, directly adjacent to the 2003 Griess-Pfleger Tannery ELUC. MWG Exh. 650; MWG Exh. 901 at 52; EG Exh. 263 at 8-12. The ELUC extension borders are:

> The western boundary of the ELUC extension abuts the boundary of the existing ELUC. The south boundary is defined by the existing property line. The east boundary is Lake Michigan and the north boundary is defined by the northern extent of the ash pond system. The proposed vertical extent of the ELUC is the unconsolidated overburden deposits overlying the Silurian dolomite bedrock beneath the site. The estimated vertical thickness of the unconsolidated deposits is 100 feet below ground surface based on information provided in the Hydrogeologic Assessment Report dated February 2011 that was submitted to the EPA. MWG Exh. 263 at 1.

The record indicates that MWG did not establish a GMZ at Waukegan. MWG Exh. 649.

B. Contested Facts

i. Ash Ponds Dredging, Liner Ruptures and Migrating Contaminants

As with all other Stations, the liners at Waukegan are prone to damage in certain conditions, particularly by the heavy equipment during dredging. In 2005 and 2006 MWG consultant, NRT, investigated the liners at Waukegan ponds and rated condition of West and East Ponds as "excellent" and the "Coal Pit Runoff Basin" as "unknown" with "high" for "contamination potential." EG Exh. 34 at 9 (#23616); MWG Exh. 606 at (#23645). MWG experts and employees testified that each pond was historically dredged approximately every other year; but only every 3-4 years lately, because less bottom ash has been generated recently. MWG Exh. 901 at 46; 10/24/17 Tr. at 162:10-163:4 (Lux Test.); 1/30/18 Tr. at 118:19-24 (Race Test.); 1/31/18 Tr. at 230:15-231:4 (Veenbaas Test.). Waukegan ponds are inspected at least once per day as part of operator's rounds, with any damage reported to supervisors and promptly repaired. 10/24/17 Tr. at 126:20-128:21, 143:11-144:1 (Lux Test.); 1/31/18 Tr. at 228:23-239:8 (Veenbaas Test.). MWG employees also testified to a system in place during the ponds dredging to ensure that heavy equipment operators do not damages the liners. The ponds have 20-foot tall warning posts at the edge of the bottom of the ponds to identify the bottom of the slope for the equipment operators. 10/24/17 Tr. at 131:23-132:11 (Lux Test.); 1/31/18 Tr. at 236:11-15 (Veenbaas Test.). Upon completion of dredging, Waukegan manager walks though the pond to ensure that contractors did not damage the liners or protective layers. Ponds are released for operations upon confirmation that the liners are intact. 10/24/17 Tr. at 131:17-132:11, 167:3-14 (Lux Test.); 1/31/18 Tr. at 235:20-237:11-17 (Veenbaas Test.).

The record, however, shows that liners in Waukegan ponds did have tears occasionally. About five to six tears were found since 2003, all above the water line in the ponds. All of the tears were typically repaired within one to two weeks. 10/24/17 Tr. at 144:2-145:17 (Lux Test.); 1/31/18 Tr. at 239:9-11 (Veenbaas Test.). In 2005, KPRG performed inspection of the liners in both ponds and found one tear on the south side of the East Ash Pond, which was shortly repaired. 10/25/18 Tr. at 193:10-15 (Gnat Test.); 10/26/18 A.m. Tr. at 52:9-53:24 (Gnat Test.); EG Exh. 274 at 6 (#12832).

After a careful review of the facts, the Board finds that the Environmental Groups established that the liners at Waukegan can and do crack or get damaged on occasions. Based on the preponderance of the evidence in the record, including the groundwater monitoring results, MWG practices in ponds relining and dredging, the Board concludes that it is more likely than not that the ash ponds did leach contaminants into the groundwater.

ii. Historical Coal Ash Sites

The record indicates at least one area where coal ash has been historically stored at the Waukegan station. The record also indicates the presence of coal ash in the fill areas outside of ash ponds and historic area.

Former Slag/Fly Ash Storage (or FSFS). The area immediately west of the West Pond is an unlined area that may contain historic slag, slag and fly ash. EG Exh. 19D at 36 (#45814); 10/23/17 Tr. 99:14-100:17; EG Exh. 38 at 15, 10 (#12017, 12012); 10/23/17 Tr. at 137:1-138:1.

The historic coal ash was placed in this area before 1998. 2/2/18 Tr. at 323:12-20 (Seymour Test.); EG Exh. 19D at 6, Fig. 2 and 5 (#45788, 45813, 45817). Borings from this area from the 1998 Phase II Environmental Site Assessment report shows a coal ash layer of up to a depth of one foot below the surface (B-22). EG Exh. 19D at 6, Fig. 5, App. A B-22 (#45788, 45817, 45841). The Environmental Groups claim this area to be the primary onsite source of groundwater contamination at the Stations. EG Br. at 54. Part of this area is covered by the 2003 Griess-Pfleger Tannery ELUC. MWG Exh. 646 at 1, 7, and 9. The other part is covered by the 2013 ELUC extension. MWG Exh. 263 at 8-12. The former Tannery owner semiannually samples groundwater in wells installed within the Tannery ELUC area on both the tannery site and Waukegan Station site. 1/30/18 Tr. at 146:9-23 (Race Test.); EG Exh. 39F, 40F, 42F, 42.5F. MWG concluded from the ELUC groundwater monitoring results that arsenic, iron, manganese, and TDS concentrations in the ELUC wells on the Waukegan Station site were higher than the concentrations predicted in the modeling to establish the ELUC and that contamination is migrating from the Tannery site onto the Waukegan Station. EG Exh. 41F at 5-8 (#46117-46118); 1/30/18 Tr. at 148:13-149:23 (Race Test.); MWG Exh. 901 at 56-57; EG Exh. 42.5F.

Coal Ash in Fill Areas. The record also shows the presence of coal ash buried around the ponds going as deep as 22 feet below ground surface. In 2005, when MWG's consultant KPRG performed geotechnical testing, it took five soil borings, three of which were taken around the ash ponds (GT 3-5). EG Exh. 201 at 10-16 (#24273-79). The results show bottom ash in those borings at depths below the surface ranging from 1 to 19 feet in GT-4 (taken west of the West Pond), and 1 to 22 feet in GT-5 (taken south of the East Pond). EG Exh. 201 at 15-16 (#24267, 24278-24279). Further, the boring logs indicate the condition of the samples at depths of 10 to 20 feet as "wet" or "slightly moist". *Id*. When MW-5 was installed in 2011 on the east side of the FSFS, in a location close to the GT-5 boring taken in 2005, the MW-5 boring also identified 16 feet of "black coal cinders" mixed with other material. EG Br. at 54; EG Exh. 14C at 19, 28 (#7166, 7175). MWG employees testified that they knew this area as a former ash storage area. 2/1/18 Tr. at 9:3-10:18, 62:16-18, (Veenbaas Test.); 1/30/18 Tr. 162:4-16, 264:9-13 (Race Test.); EG Exh. 16 at 14167; 10/23/17 Tr. at 86:23-87:18. The 2014 drillings for installation of monitoring wells MW-8 and MW-9 also indicated that ash and slag were buried along the northern and western edges of the FSFS area. EG Exh. 203 at 1-2 (#45648-45649); 10/25/17 Tr. at 53:5-54:17. Environmental Groups argue that MWG has done nothing to investigate or remediate this storage area. MWG has taken no borings from the center to determine how much ash is located there, and has not tested leachate to determine whether the area is leaching contaminants. EG Br. at 56. MWG employees confirm that no liners were installed here and that they do not have information of any liners present here. 10/23/17 Tr. at 137:20-138:1; 2/1/18 Tr. at 11:3-5. They also confirmed that no borings or samples were taken. 2/2/18 Tr. at 192:20-193:14 (Seymour Test.). MWG employees also testified that they were not aware of an impermeable cap over this area. 1/30/18 Tr. at 264:14-265:24; 2/1/18 Tr. at 9:3-11:15. MWG employees testified that they were not aware of ash having been ever removed from this area. 2/1/198 Tr. at 10:16-18. Groundwater elevation at Waukegan fluctuates between 579 and 582 feet above mean sea level, groundwater monitoring from wells around FSFS indicate potential ash buried around 582 feet, leaving about 3 feet of overlap. MWG Exh. 903 at 106 (Table 4-5); EG Exh. 203 at 1-2 (#45648-45649).

Weighing the facts presented, the Board finds that Environmental Groups have proven that it is more likely than not that the historic areas and coal ash in the fill areas at the Station are causing or contributing to GQS exceedances at the Station.

iii. <u>Monitoring Wells</u>

The groundwater monitoring network at Waukegan consisted of 16 monitoring wells. MWG Exh. 901 at 48. Patrick Engineering installed five wells (MW-1 through MW-5) as a part of the hydrogeologic investigation, and wells MW- 6 and 7 were added as upgradient wells at the request of IEPA in 2010. Wells MW-8 and 9 were added in 2014. Five additional wells (MW-10, 11, 12, 14 and MW-15) located west of the ash ponds have been monitored since August 2014 to assess the groundwater impacted by the former Griess-Pfleger Tannery and General Boiler properties. EG Exh. 14C at 2, 19 (#7152-7153, 7166), EG Exh. 401 at 23-24, MWG Exh. 811. These wells are called ELUC wells as they were installed as part of the Tannery ELUC. 2/1/18 Tr. at 148-149. MWG's expert, Mr. Gnat, also mentioned the installation of a new well MW-16 as part of CCR rules. *Id.* at 148.

The Waukegan hydrogeologic report identified well MW-5 as upgradient and wells MW-1 through 4 as downgradient. EG Exh. 14C at 3 (#7152); MWG Exh. 901 at 49. However, Mr. Gnat clarified that wells MW- 6, 8, 9, 10, 11, 12, 14 and 15 are also upgradient of the ash ponds and MW-7 is slightly side-gradient. 2/1/18 Tr. at 154. Monitoring wells were sampled on a quarterly basis: MW-1 through 7 from October 2010; MW-8 and 9 from May 2014; MW-10 through 15 from August 2014; and MW-16 from November 2015. MWG Exh. 811. The groundwater samples from all monitoring wells, except MW-16, were analyzed for 35 constituents, including boron, sulfate and TDS. *Id.* The samples from MW-16 were analyzed for 15 constituents, mostly metals. *Id*.

The Environmental Groups argue that because the groundwater flows through the Former Slag and Fly Ash Storage site from west/northwest to east/southeast, the upgradient groundwater quality for the FSFS is found in MW-11 through MW-14 and MW-6. EG Br. at 55. The Environmental Groups contend that MW-8 and 9 should not be considered upgradient for this area because they are screened in the FSFS. *Id.* at 57. The Environmental Groups note that boron levels (1 - 4 mg/L) in upgradient wells (MW–6, 11 through 14) increase more than tenfold (30 - 40 mg/L) after crossing the slag/fly ash storage area in wells MW-5 and 7 and the sulfate levels also show a similar pattern. *Id.* at 57-58.

The site hydrogeologic conditions at the Waukegan Station were determined in 2011 by Patrick Engineering using the soil boring logs of five groundwater monitoring wells installed approximately 150 to 300 feet around the perimeter of the ash ponds. These wells were screened approximately 10 feet past the intersection of the groundwater table to ensure collection of representative groundwater samples. EG Exh. 14C at 3 (#7152). The well locations were chosen to represent upgradient and downgradient wells with respect to expected groundwater flow direction to the east towards the Lake Michigan. *Id.* at 2-3 (#7151-7152). The well borings were advanced to depths ranging from 30 to 32 feet below ground surface (bgs). Borings were terminated after the field geologist determined that the borings were installed approximately 10 feet past the first intersection of the groundwater table. *Id.* at 3 (#7152).

The site geology, based on regional geologic information, consists of 100 feet of sand deposits, underlain by Silurian Dolomite to approximately 360 feet below ground surface, underlain by the Maquoketa shale. EG Exh. 14C at 2 (#7151). The hydrogeologic site investigation indicated predominantly fine sand and silt underlain by sand and gravel. *Id.* at 7 (#7156). Further, the uppermost groundwater unit underlying the site is found at 22.4 to 23 feet bgs with groundwater flow to the east/southeast towards Lake Michigan. Mr. Gnat agreed that the groundwater flow in the ash pond area is to the east, southeast. 2/1/18 Tr. at 154-155. However, he also noted that a component of groundwater flow goes north, northwest towards Lake Michigan intake channel. *Id.* at 155; MWG Exh. 901 at 49.

The Board notes that, given that the groundwater flow direction at the Waukegan Station generally flows the west/northwest to the east/southeast, wells MW-10 through 14 are showing the upgradient groundwater quality for the Station. These wells are also upgradient of the Former Slag and Fly Ash Storage area, as well as the ash ponds. EG Br. at 21 (Ap. E); MWG Exh. 901 at 49; MWG Exh. 813. These wells also are located downgradient of the Tannery site, showing constituents that might be migrating to the Station from the Tannery site.

Also, there are eight potable/industrial use wells within 2,500-foot radius of the ash ponds, all to the north or west of the ponds.

iv. <u>Exceedances of Part 620 Standards</u>

The groundwater monitoring results at Waukegan indicate 394 exceedances of the Board's Part 620 Class I GQS in all 15 monitoring wells (MW-1 through 16) during 2010-2017. MWG Exh. 811. While 102 of these exceedances are in wells downgradient of the ash ponds, the remaining 292 are in wells that are upgradient or side-gradient of the ash ponds. The constituents above the Class I standard are: antimony (2 exceedances), arsenic (97), boron (169), cadmium (1), chromium (2), selenium (2), sulfate (57), and TDS (63). *Id*. A summary of the groundwater monitoring data exceeding Part 620 standards for Waukegan is presented in Tables 4.A-4.C, below. EG Br. at 77-110 (App. A); MWG Exh. 811.

The Board also finds that while there are many exceedances (e.g. arsenic, boron, sulfate and TDS) in the wells upgradient of the ash ponds, as noted by the Environmental Groups, the location of these upgradient wells shed light on the potential source of contamination at the Waukegan site. Starting with the monitoring wells near the western property boundary and moving east/southeast along the groundwater flow direction, the number of exceedances were: 59 in wells MW-10 through 14 downgradient of former tannery and boiler sites and upgradient of the Former Slag and Fly Ash Storage area; 66 in wells MW-6, 8 and 9 along the western border (immediately upgradient) of the Former Slag and Fly Ash Storage area; 163 in wells MW-5, 7 and 15 which are downgradient of the Former Slag and Fly Ash Storage area and upgradient or side-gradient of the ash ponds; and 102 in wells MW-1 through 4 downgradient of the ash ponds. Even though the 59 exceedances in wells MW-10 through 14 suggest that contamination may be coming in from the former tannery and boiler sites, the 163 exceedances downgradient of the Former Slag and Fly Ash Storage area, along with higher concentrations of indicator constituents, show that the Former Slag and Fly Ash Storage area is contributing to the exceedances in wells MW-1 through 7.

Table 4.A: Waukegan Groundwater Monitoring Results Summary

Monitoring Wells	Closest Ash Pond, historical storage	Location	Constituents	Number of Exceedances of Part 620 Standards	Year(s)
MW-01	EP	Downgradient	Arsenic	26	2010-2017
			Boron	14	2010-2017
			Selenium	1	2013
MW-02	EP	Downgradient	Antimony	1	2010
			Arsenic	11	2010-2017
			Boron	21	2010-2017
MW-03	EP	Downgradient	Arsenic	1	2017
			Boron	10	2011-2017
			Selenium	1	2013
MW-04	EP	Downgradient	Arsenic	1	2017
			Boron	15	2011-2017
MW-05	WP	Upgradient	Arsenic	6	2012-2017
			Boron	27	2010-2017
			Sulfate	27	2010-2017
			TDS	27	2010-2017
MW-06	FSFA	Upgradient	Boron	12	2013-2017
MW-07	WP	Side-gradient	Arsenic	7	2013-2015
			Boron	19	2012-2017
			Sulfate	18	2012-2017
			TDS	19	2012-2017
MW-08	FSFA	Upgradient	Boron	13	2014-2017
			Cadmium	1	2017
			Sulfate	7	2014-2017
			TDS	5	2015-2016
MW-09	WP, FSFA	Upgradient	Boron	13	2014-2017
			Sulfate	5	2014-2017
			TDS	10	2014-2016
MW-10	FSFA, WP	Upgradient	Arsenic	11	2014-2017
MW-11	FSFA, WP	Upgradient	Arsenic	12	2014-2017
			Boron	11	2014-2017
MW-12	FSFA, WP	Upgradient	Arsenic	4	2015-2017
			Boron	5	2015-2017
			TDS	1	2015

MW-14	FSFA	Upgradient	Antimony	1	2017
			Arsenic	11	2014-2017
			Chromium	2	2017
			TDS	1	2014
MW-15	FSFA	Upgradient	Arsenic	4	2014-2017
			Boron	9	2014-2017
MW-16	EP and WP	Upgradient	Arsenic	3	2016-2017
			Thallium	1	2017

Table 4.B: Waukegan Groundwater Monitoring Results Summary (by year)

Year	Monitoring Wells	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9
	Constituent	**# of Exceedances Above Part 620 Class I Groundwater Standards**								
2010	Antimony		1							
	Arsenic	1	1							
	Boron	1	1			1				
	Sulfate					1				
	TDS					1				
2011	Antimony									
	Arsenic	4	2							
	Boron	3	1	2	2	4				
	Sulfate					4				
	TDS					4				
2012	Arsenic	4	2			2				
	Boron	1	2		4	4		1		
	Sulfate					4		1		
	TDS					4		1		
2013	Arsenic	3	1			1		3		
	Boron	4	3	1	4	4	4	4		
	Selenium	1		1						
	Sulfate					4		4		
	TDS					4		4		
2014	Arsenic	4						1		
	Boron	1	4	2	2	4	3	4	3	3
	Sulfate					4		3	1	1
	TDS					4		4		3
2015	Arsenic	4	2			1		3		
	Boron		4			4	1	4	4	4
	Sulfate					4		4	2	1
	TDS					4		4	1	4
2016	Arsenic	4	1			1				
	Boron	2	4	3	1	4	3	4	4	4
	Sulfate					4		4	3	2

	TDS					4		4	4	3
2017	Arsenic	2	2	1	1	1				
	Boron	2	2	2	2	2	1	2	2	2
	Cadmium								1	
	Sulfate					2		2	1	1
	TDS					2		2		
Total		41	33	12	16	87	12	63	26	28

Table 4.B: Waukegan Groundwater Monitoring Results Summary (by year) (cont)

Year	Monitoring Wells	MW-10	MW-11	MW-12	MW-14	MW-15	MW-16
	Constituent	# of Exceedances Above Part 620 Class I Groundwater Standards					
2014	Arsenic	2	2		2	1	
	Boron		2			2	
	Sulfate						
	TDS				1		
2015	Arsenic	3	4	2	3	1	
	Boron		4	1		1	
	Sulfate						
	TDS			1			
2016	Arsenic	4	4		4		1
	Boron		4	3		4	
	Sulfate						
	TDS						
2017	Antimony				1		
	Arsenic	2	2	2	2	2	2
	Boron		1	1		2	
	Chromium				2		
	Sulfate						
	Thallium						1
	TDS						
Total		11	23	10	15	13	4

4.C: Waukegan Groundwater Monitoring Results Summary (by wells)

Chemical Constituent	Antimony	Arsenic	Boron	Cadmium	Chromium	Selenium	Sulfate	Thallium	TDS	Total
Monitoring Well	**Number of Exceedances**									
MW-1		26	14			1				41
MW-2	1	11	21							33
MW-3		1	10			1				12
MW-4		1	15							16
MW-5		6	27				27		27	87
MW-6			12							12
MW-7		7	19				18		19	63
MW-8			13	1			7		5	26
MW-9			13				5		10	28
MW-10		11								11
MW-11		12	11							23
MW-12		4	5						1	10
MW-14	1	11			2				1	15
MW-15		4	9							13
MW-16[9]		3						1		4
Total	2	97	169	1	2	2	57	1	63	394

Antimony. There were only two exceedances of the antimony standard over the entire seven-year monitoring period, one in 2010 in MW-2 (downgradient of the ash ponds) and one in 2017 in MW-14 (upgradient near the western property line). Both parties agree that antimony is one of the indicators for leachate from MWG's ash ponds. EG Exh. 401 at 7; MWG Exh. 903 at 42. However, MWG's bottom ash Neutral Leaching Extraction Test (NLET) results indicate that the level of antimony in the ash leachate from Waukegan was below the Part 620 Class I standard of 0.006 mg/L. MWG Exh. 901 at 8; MWG Exh 903 at117 (Table 5-3). Because the antimony concentration in the bottom ash was below the Class I standard and there were only two exceedances over the seven-year monitoring period, the Board finds that the Environmental Groups have not proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to these exceedances.

Arsenic. The monitoring results indicate 97 exceedances of the Part 620 Class I arsenic standard in 12 of the 15 monitoring wells, upgradient and downgradient of both Former Slag and Fly Ash Storage site and ash ponds from 2010 through 2017. EG Br. at 77-110 (App. A); MWG Exh. 811, *also see* Table 4.A-4.C above. The number of exceedances include: MW-1 (26 exceedances), MW- 2 (11), MW-3 (1), MW-4 (1) MW-5 (6), MW-7 (7), MW-10 (11), MW-11 (12) MW-12 (4), MW- 14 (11), MW-15 (4), and MW-16 (3). Both parties list arsenic as a constituent present in coal ash leachate. EG Exh. 401 at 7; Exh. 903 at 42. MWG's bottom ash NLET result of 0.05 mg/L or less for arsenic suggests the presence of arsenic in the ash leachate

[9] While groundwater monitoring results for MW-16 for 2016-17 are included in MWG Exh. 811, the location of the monitoring well is not shown on any of the Waukegan maps.

at levels higher than the Part 620 Class I standard of 0.01 mg/L. MWG Exh. 903 at 117 (Table 5-3).

Seymour also notes that analytical results of the groundwater from the former Tannery site indicate that certain inorganic constituents, including arsenic, have migrated onto the Waukegan property. MWG Exh. 903 at 19. MWG asserts that the groundwater contamination at Waukegan site, particularly arsenic, is migrating from two industrial properties on the west of the Station, the former Griess-Pfleger Tannery and the former General Boiler. MWG Br. at 18. MWG notes that the General Boiler property contained arsenic above remediation benchmarks and the property included a fly ash fill area. *Id.* Both sites appear to be now closed and part of IEPA's Site Remediation Programs. *Id*. at 124:16-125:3 (Race Test.); MWG Exh. 667, at 25; MWG Exh. 901 at 56-57. Investigation at the General Boiler site in 1998-1999 also found arsenic concentrations above Class I GQS in a fly ash fill area. MWG Exh. 623 at 472. Soil boring at the Tannery found coal and angular slag. MWG Exh. 643 at 105-08 (#47180-4718); 1/30/18 Tr. at 131:6-134:2 (Race Test.). Groundwater investigation at the Tannery also found arsenic, chromium, cadmium, mercury, lead, manganese, iron and total dissolved solids contamination. MWG Exh. 644 at 31, 33-34 (#46627, 46629-46630); 1/30/18 Tr. at 135:23-139:3 (Race Test.). The former Tannery owner removed impacted soil and in 2003 established ELUC on the west side of Waukegan Station to prevent any use of the groundwater. Joint Stip. No.38, 39; MWG Exh. 645 at 55-56 (#46255-46256); 1/30/18 Tr. at 141:23-144:4 (Race Test.); MWG Exhs. 646; 667 at 22.

The Board notes that wells MW-10 through 14 are downgradient of the former Tannery site and upgradient of the Station, including the Former Slag and Fly Ash Storage area and the ash ponds. EG Br.at 120 (App. E); MWG Exh. 901 at 48-49; MWG Exh. 813. The Board, thus, finds that the exceedances in the wells MW-10 through 14 support Seymour's assertion that contamination is moving into the Waukegan site from the former Tannery site. The arsenic levels in the upgradient wells MW-10 through 14 were consistently higher, in the range of 0.06 to 1.3 mg/L, compared to the levels ranging from 0.013 to 0.21 in the wells downgradient of the Former Sag and Fly Ash Storage site, as well as the ash ponds. Thus, the Board finds that the it is more likely than not that the arsenic levels in groundwater at the Waukegan site are impacted by upgradient offsite contamination coming to the Tannery site. The Board, thus, finds that the Environmental Groups have not proven that it is more likely than not that coal ash stored on-site, either in the ash ponds or outside of the ponds, is causing or contributing to these exceedances.

Boron. The monitoring results indicate 169 exceedances of the Part 620 Class I boron standard in 12 of the 15 monitoring wells upgradient and downgradient of both Former Slag and Fly Ash Storage site and ash ponds from 2010 through 2017. EG Br. App. A; MWG Exh 810; *see also* Table 4.A-4.C above. These wells show the following exceedances: MW-1 (14), MW-2 (21), MW-3 (10), MW-4 (15) MW-5 (27), MW-6 (12), MW-7 (19), MW-8 (13), MW-9 (13), MW-11 (11) MW-12 (5), and MW-15 (9). Most of the wells had continuing exceedances over the four to seven-year monitoring period.

Both parties agree that boron is an indicator of coal ash contamination. EG Exh. 401 at 7; Exh. 903 at 42. Further, Seymour's comparison of the monitoring results from 2014 with indicator constituents in leachate shows that boron is an indicator of leachate from Waukegan Station ash ponds. MWG Exh. 903 at 118, 122 (Table 5-4). However, Seymour argues that the leachate from MWG ash ponds does not have the potential to cause groundwater impact above

the Class I standard because the leachate levels were below such standard. MWG Exh. 903 at 41. Here, MWG's bottom ash NLET results indicate that the level of boron ranged from less than 0.1 mg/L to 2.0 mg/L, which is the same as the Part 620 Class I standard. MWG Exh. 903 at 117 (Table 5-3). Seymour maintains that analytical results of the groundwater from the tannery site indicate that certain inorganic constituents, including boron have migrated onto the Waukegan site. MWG Exh. 903 at 19. Environmental Groups argue that the most likely source of coal ash contamination at the Waukegan site is the Former Slag and Fly Ash Storage area located west of the ash ponds.

The Board finds that given the groundwater flow direction at the Waukegan site wells MW-10 through 14 are downgradient of the Tannery site, showing contaminants that migrate from the Tannery site. These wells are also upgradient of the Former Slag and Fly Ash Storage area, as well as the ash ponds. EG Br. at 120 (App. E); MWG Exh. 901 at 49; MWG Exh 813. Well MW-6 is downgradient of the boiler site but also upgradient of the Former Slag and Fly Ash Storage area. The Board also finds that monitoring wells MW-8 and MW-9 are likely impacted by the Former Slag and Fly Ash Storage area as they are located in the ash at the edge of this area. The median values of boron in upgradient wells (MW-6, 10 through 14) range from 1 to 3.25 mg/L as compared to median boron value of 32-39 mg/L in wells MW-5 and 7 downgradient of the Former Slag and Fly Ash Storage site and 2 to 2.5 mg/L in wells MW-1 through 4 downgradient of the ash ponds. This comparison of the median boron values of the wells upgradient of the Former Slag and Fly Ash Storage area with those downgradient indicates that the Former Slag and Fly Ash Storage is area is contributing to the exceedances in the downgradient wells. The Board finds that the groundwater monitoring results indicate the Former Slag and Fly Ash Storage area is the likely source of boron exceedances at Waukegan Station in the wells downgradient of the area as well as the ash ponds. The Board, thus, finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to these exceedances.

Metals. The monitoring results indicate six exceedances of metallic constituents over the seven-year monitoring period: cadmium (1 in MW-8), chromium (2 in MW-14), selenium (2 in MW-1 and MW-3) and thallium (1 in MW-16). While some of these metals may be present in coal ash leachate, they are not considered as primary indicators of coal ash contamination. MWG's bottom ash NLET results indicate that the level of all four metals were below Part 620 Class I standards. MWG 903 (Table 5-3). The Board finds that given the very few sporadic exceedances of the metallic constituents and their low levels in the bottom ash leachate, the Environmental Groups have not proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to these exceedances.

Sulfate and TDS. There were 57 exceedances of the Class I sulfate standard and 63 exceedances of the Class I TDS standard during the seven-year monitoring period. MWG Exh. 811. Most of the exceedances occurred in two wells (MW-5 and 7) downgradient of the Former Slag and Fly Ash Storage area. There were only two exceedances of TDS in the upgradient wells (MW-12 and 14) and none in wells downgradient of the ash ponds (MW-1 through 4).

Both parties list sulfate as an indicator constituent of coal ash leachate. Dr. Kunkel notes that higher concentration of sulfate may also be accompanied by high concentrations of TDS. EG Exh 401 at 7; MWG Exh. 903 at 40. Further, Seymour's comparison of the monitoring

results from 2014 with indicator constituents in leachate shows that sulfate is an indicator of leachate from Waukegan ash ponds. MWG Exh. 903 at 118-22 (Table 5-4). However, Seymour argues that the leachate from MWG ash ponds does not have the potential to cause groundwater impact above the sulfate and TDS standards because the leachate levels are below the standards. He relies on MWG's bottom ash NLET results of sulfate at 49 mg/L and TDS at 200 mg/L. MWG Exh. 903 at 41; MWG Exh. 901 at 8. Environmental Groups note that sulfate follows the same pattern as boron with median sulfate concentrations approximately 100-200 mg/L upgradient of the Former Slag and Fly Ash Storage area, but 700-800 mg/L in wells MW-5 and MW-7 downgradient of that area. The Environmental Groups argue that this pattern shows that the Former Slag and Fly Ash Storage area is contributing coal ash constituents in the groundwater.

The Board notes that sulfate and TDS are indicators of coal ash contamination in groundwater. Further, the monitoring results show almost no exceedances of sulfate and TDS standards in the upgradient wells indicating there is no migration from offsite sources. Further, as noted by the Environmental Groups, the large percentage of exceedances of sulfate (79%) and TDS (73%) in wells (MW-5 and 7) downgradient of the Former Slag and Fly ash storage area indicate that the storage area is contributing to the exceedances. There were also some exceedances in monitoring wells MW-8 and MW-9, which are likely impacted by the Former Slag and Fly Ash Storage area as they are located in ash at the edge of the area. Therefore, the Board finds that the likely source of the 57 exceedances of sulfate and 63 exceedances of TDS in the downgradient monitoring wells MW- 5, 7, 8 and 9 at Waukegan is the Former Slag and Fly Ash Storage area located west of the ash ponds. The Board, thus, finds that the Environmental Groups have proven that it is more likely than not that coal ash stored onsite, either in the ash ponds or outside of the ponds, is causing or contributing to these exceedances.

v. <u>Background Concentrations Exceedance</u>

Environmental Groups contend that the median concentrations of indicator constituents, boron and sulfate, in most of the wells are higher than the statewide upper-bound 90th percentile background value and not naturally occurring. EG Br. at 64. Seymour asserts that the background levels used by Environmental Groups are based on monitoring data from CWS wells that are not representative of site-specific groundwater quality. 2/2/18 Tr. at 32. Seymour argues that comparing monitoring results with the median background value is not meaningful. He maintains that a valid comparison would be based on a statistical evaluation using an upper bound confidence level of 90 percent. *Id.* at 32-33.

The Board finds that while background values established using site-specific monitoring data is always preferable, in the absence of such data, statewide background values may be used to evaluate groundwater impacts. Because site-specific background values have not been established at the Waukegan site, the Board finds that median values of boron and sulfate in monitoring wells can be compared with the 90th percentile statewide values. This comparison indicates that median concentrations of boron (MW-1 through MW-15) and sulfate (MW-1, 2, 4 through 9, 12 and 15) exceed the 90th percentile statewide values. These exceedances of the statewide background also appear to be consistent with the exceedances of Class I groundwater standards of boron and sulfate in most monitoring wells at Waukegan. Regarding boron, except for upgradient wells MW-10 and 14, the wells exceeding the 90th percentile value also exceeded the Class I boron standard. As to sulfate, wells exceeding the 90th percentile value also

exceeded the Class I standard in downgradient wells MW-5, 7, 8 and 9. The Board, thus finds that the Environmental Groups have proven that it is more likely than not that coal ash stored on-site, either in the ash ponds or outside of the ponds, is causing or contributing to the exceedances of the 90th percentile statewide values for boron and sulfate at Waukegan.

V. BOARD DISCUSSION

The Environmental Groups allege that MWG violated Sections 12(a), 12(d), and 21(a) of the Act (415 ILCS 5/12(a), 12(d), 21(a) (2016)) and Sections 620.115, 620.301(a) and 620.405 of the Board's groundwater quality rules (35 Ill. Adm. Code 620.115, 620.301(a) and 620.405). Am. Comp. at 17 ¶ 51; EG Br. at 4. The Environmental Groups allege that MWG discharged contaminants into the environment "through coal ash disposal ponds, landfills, unconsolidated coal ash fill, and/or other coal ash and coal combustion waste repositories" at the four Stations. Am. Comp. at 17 ¶ 51.

A. Section 12(a) of the Act, Water Pollution

Section 12(a) of the Act prohibits any person from causing, allowing, or threatening a *discharge* of any contaminants into the environment so as to *cause or tend to cause water pollution* or to *violate regulations or standards* adopted by the Board. 415 ILCS 5/12(a) (2016). As discussed below, the Board finds that the record indicates that MWG caused or allowed a discharge of contaminants so as to cause water pollution and to violate the Board's Class I GQS.

The Act defines "water pollution" to include a discharge of any contaminant into any waters of the State that will or is likely to render such waters harmful or detrimental or injurious to public health, safety or welfare or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or other aquatic life. *See* 415 ILCS 5/3.545 (2016). The statutory definition of "waters" of the State includes groundwater. *See* 415 ILCS 5/3.550 (2016).

To find that a respondent violated Section 12(a) of the Act, the Board must find that a respondent discharged or threatened to discharge a contaminant that is likely to render waters harmful, detrimental, or injurious to public health. CSX, PCB 7-16, slip op at 16 (July 12, 2007). The Board has also found that a discharge of a contaminant that violated the Board's GQS violates Section 12(a) of the Act. International Union, PCB 94-420 at 33-34 (Aug. 1, 1996). In another case, the Board concluded that "[c]ompliance with a permitted GMZ would provide . . . immunity from violating the Part 620 standards" but not Section 12(a). People v. Texaco Refining and Marketing, Inc., PCB 2-03, slip op. at 9-10 (Nov. 6, 2003). The Board noted that "Section 12(a) of the Act provides no exemption from liability for parties that comply with another regulatory program" and that compliance with GMZ "is not an affirmative defense but rather a factor that may, if anything, mitigate any imposed penalty." *Id*.

The groundwater monitoring data, as discussed in Part IV *supra*, indicates the presence of contaminants in groundwater between December 2010 and April 2017 in concentrations that exceed Class I GQS at all four Stations.

At Joliet 29 Station, monitoring recorded 53 exceedances in monitoring well MW-9, which is a downgradient well located between Ash Pond 2 and Ash Pond 3 at the southwest edge of Ash Pond 3. Exceedances of sulfate occurred in 26 of 53, every quarter of the seven-year groundwater monitoring period of 2010-2017. The TDS standard was exceeded 27 of 53. The other three downgradient wells (MW-02, 03, and 04) also showed exceedances of Class I GQS for antimony seven times (from 2010 to2013) and for TDS once in 2013.

At Powerton Station, the Part 620 Class I arsenic standard was exceeded 83 times in eight downgradient monitoring wells (MW-6, 7, 11, 12, 13, 14, 15, and 17). While some of these exceedances were intermittent (in wells MW-6, 12, 14, and 15), others were consistent exceedances over a period of four to six years (in MW-7, 11, and 13). Monitoring showed 64 exceedances of the Part 620 boron standard in nine downgradient monitoring wells, 83% of which were observed in wells MW-9 (21 exceedances), MW-13 (26) and MW-14 (7). Monitoring also showed less consistent exceedances in MW-11, MW-12, and MW-19. There were 104 exceedances of sulfate standard in nine wells (MW-6, 8, 11, through 15 and 17) and 119 exceedances of TDS standard in the same eight wells and MW-7 and 18. While some wells had intermittent exceedances, MW-12, 13, 14, and 15 had consistent exceedances of sulfate or TDS or both over a period of four or more years.

At Will County, the groundwater monitoring results show 207 boron exceedances in 10 monitoring wells (MW-1 through 10) consistently from 2010 to 2017. The results also show three antimony exceedances in MW-2 in 2011 and 19 arsenic exceedances in MW-02, 6, 8, and 10 in 2011-2017. Between 2010 and 2017, there were consistent exceedance of the sulfate standard (131 exceedances in MW-01 through 10) and the TDS (80 standard in MW-01 through 08).

At Waukegan, monitoring showed 169 exceedances of the boron standard between 2010 and 2017 in 12 of the 15 monitoring wells in (MW-1 through 09, 11, 12, and 15). The Board also found 57 exceedances of the Class I sulfate standard and 63 exceedances of the TDS standard (MW-05, 07, 08, and 09) through the entire monitoring period of 2010-2017.

As discussed in detail in Part IV of this opinion, the Board finds that the preponderance of evidence establishes that it is more probable than not that these exceedances are caused by the MWG operations at the Station.

i. <u>MWG "caused" or "allowed" Release of Contaminants.</u>

Contaminants found in the monitoring wells in all four Stations are recognized by both parties as known constituents of coal ash. *See supra* Part IV (Facts). The record shows that MWG operations produce in coal ash, which MWG processes at its property, and stores temporarily on short or long-term basis before it is removed to permanent landfills. The record also shows that coal ash is present in multiple historical coal ash storage or fill areas, most of which are unlined and not monitored for leaching. Only some of those areas have been tested for beneficial reuse. The rest are just visually inspected. The groundwater monitoring results of the upgradient monitoring wells show that upgradient off-site sources did not contribute to the exceedances. The record provides no persuasive evidence that any of the indicator constituents recorded in these monitoring wells could have originated outside of MWG's property and migrated to the Stations, except for the arsenic at Waukegan. The record shows no other likely

sources of contamination. Thus, the Board finds that contaminants are leaking from MWG's property and that MWG's active coal ash ponds or historical coal ash storage sites of fill areas are the source of that contamination. Thus, the Board concludes that it is more probable than not that MWG caused contamination coming from the ash ponds and allowed contamination from the historic sites and ash fill areas. IEPA v. Rawe, AC 92-5, slip op. at 4 (Oct. 16, 1992); People ex.rel. Ryan v. McFalls, 313 Ill. App. 3d 223, 226-27, 798, 728 N.E.2d 1152, 1155 (3rd Dist. 2000).

It is immaterial whether any specific ash pond or any specific historic ash fill area can be pinpointed as a source to find MWG liable. The groundwater monitoring results narrow the contamination to defined areas within each of MWG Stations delineated by the monitoring wells. Davinroy at 796. As the owner or operator of these Stations, MWG has control over both its active ash ponds and historical coals ash storage areas. People v. Inverse Investments, LLC, PCB 11-79 slip op. at 9 (Feb. 16, 2012); Michel Grain, PCB 96-143, slip op. at 3-4 (Aug. 22, 2002); Meadowlark Farms, Inc. v. PCB, 17 Ill. App. 3d 851, 860, 308 N.E.2d at 836-37 (5th Dist. 1974); People v. Lincoln, 2016 IL App 143487 ¶¶ 48049, 70 N.E.3d 661, 678,; People v. State Oil Co., PCB 97-103, slip op. at 24-25 (Mar 20, 2003); Allaert Rendering, Inc. v. PCB, 91 Ill. App. 3d 153, 155-156, 414 N.E.2d 492, 494-95 (3rd Dist. 1980).

The monitoring results show that contamination persists after MWG concluded corrective actions required by its CCAs and GMZs. MWG is aware of these results but is not undertaking any further actions to stop or even identify the specific source: no further investigation of historic areas is taking place; no additional monitoring wells are installed; and, no further inspection of ash ponds or land around the ash ponds in the locations that show persistent exceedances is taking place. The Board is, thus, not persuaded that MWG took "extensive precautions" to prevent the releases. Davinroy, 249 Ill. App. 3d at 794; Perkinson v. PCB, 187 Ill. App. 3d 689 (3rd Dist. 1989); People v. William Charles, PCB 10-108, slip op. at 25-27 (Mar.17, 2011); City of Chicago v. Speedy Gonzales Landscaping, Inc, AC 06-39, AC 06-40, AC 04-41, AC 07-25, (Mar. 19, 2009); County of Jackson v. Taylor, AC 89-258, (Jan. 10, 1991); Phillips Petro. Co. v. PCB, 72 Ill. App. 3d 217 (2nd Dis. 1979); IEPA v. Coleman, AC04-46, at 7 (Nov. 4, 2004). Other than establishing an ELUC at Powerton, Waukegan, and Will County that restricts use of the area, for example for installing potable wells, MWG also did not take active actions to ensure that the contamination does not spread beyond its property. MWG knew that contaminants that include coal ash constituents are leaking from its property but did not fully investigate specific source or prevent further release, claiming that IEPA did not ask it to do so. MWG, however, cannot use IEPA's actions to excuse for MWG's violations of the Act or the Board rules.

While the VNs for the four Stations also alleged exceedances of Class I GQS for additional contaminants at other wells, the Board notes that the record shows other potential sources from outside of MWG property, that can be linked to those contaminants, as discussed in detail in Part IV of this opinion. The Board, therefore, concludes that the Environmental Groups failed to establish that it is more probable than not that MWG cause or allowed those other exceedances.

Based on the above, the Board finds that the preponderance of evidence indicates that during 2010-2017, MWG caused or allowed discharge of contaminants into the waters of the State with respect to the noted exceedances in monitoring wells at all four Stations.

Next the Board must determine if the discharge violated Board's GQS, or caused or tended to cause water pollution in violation of Section 12(a) of the Act. 415 ILCS 5/12(a) (2016).

ii. Violation of Board Rules

MWG asserts the establishment of GMZs at Joliet 29, Powerton, and Will County as one of its affirmative defenses. MWG 2nd Ans. Def. at 24-26 ¶¶ 82-97. MWG alleges that it did not violate the Board's GQS (35 Ill. Adm. Code 620.410, 620.420, 620.430, and 620.440) because the groundwaters within the GMZ are exempted from those standards by Section 620.450(a)(3). *Id*. at 25 ¶ 86; 2/1/18 Tr. at 107 (Gnat Test.). Because MWG did not violate the Board's GQS, MWG states, it is not in violation of Sections 620.301(a) and 620.405. *Id*. at ¶ 88. The Board disagrees.

The Board notes that, once a GMZ is established, groundwater underlying the GMZ is not subject to Board's Part 620 groundwater standards. *See* 35 Ill. Adm. Code 620.450. MWG relies on the GMZ as a defense from Part 620, even though the record establishes violation of the GQS prior to the development of the GMZ.

The Board finds that MWG is liable for any exceedances of the Part 620 standards that occurred at Waukegan, where no GMZ was established, and any exceedances before the GMZs were established at Joliet 29, Powerton, and Will County. While the establishment of a GMZ does obviate the need to meet standards of Part 620, the Board notes that a GMZ is not a permanent solution and expires upon completion of corrective action as specified in Sections 620.250(a) and 620.450(a). 35 Ill. Adm. Code 620.250(a) and 620.450(a). Based on the Board's rules, the Board finds that MWG failed to establish that the GQS are inapplicable in those GMZs at Joliet 29, Powerton, and Will County Stations because the record does not establish ongoing corrective action as specified in Section 620.450(a) at these sites. 35 Ill. Adm. Code 620.450(a).

a) Part 620 Exceedances at Waukegan

MWG did not establish a GMZ at Waukegan. Therefore, MWG's affirmative defense does not apply to exceedances of the Class I GQS at Waukegan. The record shows that at Waukegan, boron Class I GQS standard was consistently exceeded between 2010 and 2017, 169 times in 12 of the 15 monitoring wells in (MW-1 through 09, 11, 12 and 15). The record also shows 57 exceedances of the Class I sulfate standard and 63 exceedances of the TDS standard (MW-05, 07, 08, and 09) between 2010 and 2017. The preponderance of evidence indicates that these exceedances were caused or allowed by MWG operations at the Station. Thus, the Board concludes that MWG violated Board's Class I GQS in Section 620.410(a) and Sections 620.301(a) and 620.405 with respect to these exceedances.

b) Part 620 Exceedances at Joliet 29, Powerton, and Will County

Pre-GMZ Exceedances

MWG established GMZs at Joliet 29 on August 8, 2013, at Powerton on October 3, 2013, and at Will County on July 2, 2013. MWG Exh. 627 at 1; EG Exh. 638 at 1; MWG Exh. 658 at

1; MWG Exh. 660. The GMZs area is "a three-dimensional region containing groundwater being managed to mitigate impairment caused by the release of contaminants from a site". EG Exh. 242 at 6; EG Exh. 254 at 6; EG Exh. 276 at 6; Joint Stip. at 4; MWG 2nd Ans. Def. at 25; *see also* 35 Ill Adm. Code 620.250(a). Before each GMZ was established, groundwater resources at all three Stations fell into Class I category. EG Exh. 242 at 9; EG Exh. 254 at 9; EG Exh. 276 at 9.

The Board finds that any exceedances of Class I GQS that occurred before a GMZ was established, violate the Board's standards in Section 620.410, and thus Sections 620.301(a) and 620.405. The groundwater monitoring results show exceedance of Class I GQS at Joliet 29, Powerton, or Will County before the GMZs were established. At Joliet 29 these include: antimony (6 exceedances in MW-02, 03, and 04); sulfate (11 exceedances in MW-09); and TDS (13 exceedances in MW-03 and 09). At Powerton these include a total of: 1 exceedance of antimony standard in MW-02; 32 exceedances of arsenic standard in MW-07, MW-11 through 15; 15 exceedances of boron standard in MW-09, MW-11 through 13; 1 exceedance of selenium standard in MW-14; 15 exceedances of sulfate standard in MW-06, MW-08, MW-12 through 15; and 19 exceedances of TDS standard in MW-06, 07, 08, 13, 14, and 15. At Will County these include a total of: 3 exceedances of antimony standard in MW-01 and 02; 4 exceedances of arsenic standard in MW-08; 74 exceedances of boron standard in MW-01 through 10; 50 exceedances of sulfate standard in MW-01 through 9; and 24 exceedances of TDS standard in MW-03, 04, 05, 07, and 08. As noted in Part IV of this opinion, the Board finds that a preponderance of the evidence indicates that these exceedances were caused or allowed by MWG operation at the Stations.

The Board, therefore, finds that MWG did violate Board's Class I GQS in 620.410(a) and Sections 620.301(a) and 620.405 with respect to the exceedances that took place between 2010 and 2013 before the three GMZs were established at Joliet 29, Powerton, and Will County.

Exceedances During Corrective Actions

Groundwater within a GMZ is subject to standards specified in Section 620.450(a). 35 Ill. Adm. Code 620.450(a)(1). Section 620.450(a)(2) indicates that Sections 620.410, 620.420, 620.430, and 620.440 *do apply* to any chemical constituent in groundwater within a GMZ "[e]xcept as provided in subsections (a)(3) or (a)(4)." 35 Ill. Adm. Code 620.450(a)(2). Section 620.450(a)(3) indicates that Sections 620.410, 620.420, 620.430, and 620.440 do not apply to waters within GMZ prior to completion of a corrective action. 35 Ill. Adm. Code 620.450(a)(3).

The Board finds that under 35 Ill. Adm. Code 620.450(a)(3) any exceedances of Class I GQS during the period when MWG was performing corrective actions under the GMZs between August 8, 2013, and October 9, 2013, at Joliet 29; between October 3, 2013, and October 17, 2013, at Powerton; and between July 2, 2013, and October 17, 2013, at Will County and are exempt from the Board's Part 620 GQS in Section 620.410. The Board, thus, finds no violation of Sections 620.410, 620.420, 620.430, and 620.440 with respect to such exceedances. However, the Board finds that this record establishes serious questions regarding whether or not GMZs continue in effect at Joliet 29, Powerton, and Will County.

At Joliet 29, the GMZ application indicates the following remedy selected for the GMZ: "[t]he agreed upon remedy is specified in Item 5(a) through (h) of the executed [CCA]. . . The

remedy includes lining of Ash Pond 3 with HDPE. This [GMZ] application fulfills requirements set forth under Item 5(f) of the CCA." EG Exh. 242 Att. 2, Part III ¶ 1.

At Powerton, the GMZ application specifies a similar remedy: "[t]he agreed upon remedy is specified in Item 5(a) through (m) of the executed [CCA]. . . The remedy includes lining of the Ash Surge Basin and Ash Settling Basin with HDPE. This [GMZ] application fulfills requirements set forth under Item 5(g) of the CCA." EG Exh. 254 Att. 2, Part III ¶ 1.

And the similar remedy is in the GMZ application for Will County: "[t]he agreed upon remedy is specified in Item 5(a) through (j) of the executed [CCA] . . . The remedy includes lining of the Ash Pond 2S with HDPE, removing Ash Ponds 1S and IN from service and installing a dewatering system within those ponds to keep liquid levels to within no more than one foot of the bottoms of those units. This [GMZ] application fulfills requirements set forth under Item 5(g) of the CCA." EG Exh. 276 Att. 2, Part III ¶ 1.

All three GMZ applications also note that "[at] the completion of the corrective process, a final report is to be filed which includes the confirmation statement included in Part IV." EG Exhs. 242, 254, and 276 at Att. 2, at 1 Note 1. The record does not indicate whether MWG submitted such forms. On October 9, 2013, however, MWG filed a certification with the IEPA stating that all Joliet 29 CCA measures were completed. Joint Stip. at 4; MWG Exh. 630. On October 17, 2013, MWG filed a similar certification with respect to the Powerton CCA and Will County CCA. Joint Stip. at 4; MWG Exhs. 637, 661. MWG's certifications indicate that all CCA actions were completed by the dates of the respective certifications. MWG Exhs. 630, 637, 661. The record shows no other corrective action taking place or planned by MWG under any of the three GMZs after these dates.

The record shows that groundwater monitoring and visual inspections of the active ash ponds required by the CCAs are to continue permanently at Joliet 29, Powerton, and Will County. The CCAs require that "MWG shall continue quarterly monitoring of . . .groundwater monitoring wells for constituents in 35 Ill. Adm. Code 620.410(a) . . .and report its findings to the [IEPA]." MWG Exhs. 626, 636, 656, and 647 all at 3. This requirement comes from the CCAs rather than as a condition to establish a GMZ. Moreover, the same requirement is also present in Waukegan CCA, where no GMZ was required. MWG Exh. 647 at 3-4 ¶ 5; *see also* MWG Exh. 649 at 1 ("[t]he CCA that IEPA approved for Waukegan, didn't include a corrective action (hence no GMZ)"). The CCAs at all four Stations indicate that these actions are intended to avoid and detect any further contamination, or monitor effectiveness of a corrective action, rather than remedy any contamination or remove the contamination source. CCAs at Powerton, Will County, and Waukegan also require MWG to establish ELUC. The Board acknowledges that both ELUC and continuous groundwater monitoring can be effective corrective action tools. However, the record fails to establish that the continuous monitoring, by MWG at the Stations is in fact a corrective action.

While neither the Board rules nor the Act define "corrective action," the "corrective action process" is defined as "those procedures and practices that may be imposed by a regulatory agency when a determination has been made that contamination of groundwater has taken place, and are necessary to address a potential or existing violation of the standards set forth in Subsection D." 35 Ill. Adm Code 620.110. In this case, all three GMZs were established to remedy the violations alleged in the VNs and bring the groundwater at the Stations

into compliance with Class I GQS. EG Exh. 242 at 9 ¶ 10; EG Exh. 254 at 9 ¶ 10; EG Exh. 276 at 9 ¶ 10. Section 620.250(a) states that a GMZ may be established "if an owner or operator provides a written confirmation to the Agency that an adequate corrective action, equivalent to a corrective action process approved by the Agency is being undertaken in a *timely* and *appropriate* manner." EG Exh. 242 at 6; EG Exh. 254 at 6; EG Exh. 276 at 6; *see* 35 Ill. Adm. Code 620.250(a) (emphasis added). Thus, a corrective action process under a GMZ must be "necessary to address a potential or existing violation" of Part 620 standards and must be undertaken in a "timely and appropriate manner."

The continuous monitoring required by CCAs at Joliet 29, Powerton, and Will County does not show how that monitoring may be construed as "timely" or "appropriate" to remedy groundwater quality, or that it will "address a potential or existing violation" of the Class I GQS absent some other actions by MWG. There is no evidence in the record to expect that groundwater quality at Joliet 29, Powerton, and Will County will return to Class I standards naturally, considering the continuous exceedances at these stations that persist even after the relining of the ash ponds. There is also no indication under any of the GMZs that MWG will be taking any actions based on the results of the monitoring, or that it will trigger any actions by the Agency. The Board notes that all four CCAs have almost identical language in Item 5 requiring continuous monitoring of existing and newly installed wells. Items 5(a) though (c) are also almost identical in all the CCAs requiring operation of the ash ponds only as temporary disposal sites and in a manner that protects the liners integrity. MWG Exhs. 626, 636, 656 and 647 all at 3-4 ¶ 5. But, Waukegan's CCA does not require establishing a GMZ or relining the ash ponds. MWG Exh. 647 at 3-4 ¶ 5.

The Board also does not consider the ELUCs established by MWG at Powerton and Will County as part of a "corrective action". The Act and Board rules provide for ELUCs as "an institutional control in order to impose land use limitation or requirements related to environmental contamination so that persons conducting remediation can obtain a No Further Remediation determination." EG Exh. 253 at 3; MWG Exh. 659 at 3; 415 ILCS 5/58.17; 35 Ill. Adm. Code 742. An ELUC establishes limitations that are designed to protect "against exposure to contaminated groundwater," rather than to remedy the contamination. *Id*. Again, Waukegan's CCA did require establishing an ELUC, while it did not require a GMZ. MWG Exh. 647 at 3-4 ¶5.

A GMZ is established "for a period of time" necessary to "mitigate impairment caused by the release of contaminants" and the owner or operator must undertake "an adequate corrective action in a timely and appropriate manner." *See* 35 Ill. Adm. Code 620.250(a)(2), (b); 620.450(a)(3); *see* 35 Ill. Adm. Code 620.250(a). Section 620.250(c) provides that a GMZ "*expires* upon the Agency's receipt of appropriate documentation which confirms the completion of the action taken pursuant to subsection (a) and which confirms the attainment of applicable standards as set forth in Subpart D." 35 Ill. Adm. Code 620.250(c) (emphasis added). Appendix D of Part 620 contains the form entitled "Confirmation of an Adequate Corrective Action Pursuant to 35 Ill. Adm. Code 620.250(a)(2)," which confirms that remediation is completed. 35 Ill. Adm. Code 620.APPENDIX D.

Continuing the GMZ in the absence of pending corrective action appears to be contrary to the purpose of Part 620 and, in particular, Section 620.250(a). The Board promulgated GQS under Section 8 of the Illinois Groundwater Protection Act (IGPA) to protect groundwater from

"those contaminants which have been found in the groundwaters of the State and which are known to cause, or are suspected of causing, cancer, birth defects, or any other adverse effect on human health according to nationally accepted guidelines." IGPA, 415 ILCS 55/8(a) (2016); Groundwater Quality Standards (35 Ill. Adm. Code 620), R89-14(B), slip op. at 3 (Nov. 7, 1991). "[R]educed health risks through decreased exposure to contaminants in groundwater" is the primary benefit of promulgated GQS. *Id*. at 23. IGPA declares that "it is the policy of the State of Illinois to restore, protect, and enhance the groundwaters of the State, as a natural and public resource." 415 ILCS 55/2(b) (2016). It is further the policy of the State "that the groundwater resources of the State be utilized for beneficial and legitimate purposes; that waste and degradation of the resources be prevented; and that the underground water resource be managed to allow for maximum benefit of the people of the State of Illinois." *Id*; *see also* R89-14(B) at 6. Class I groundwaters are recognized as the most valuable groundwater resources, requiring the highest degree of protection, "any successful program of groundwater management must give special focus to potable groundwater". *Id*. at 10. When adopting the GMZ regulations, the Board noted that "in any management zone the goal is remediation, if practicable, of the groundwater to the level of the standards applicable to that class of groundwater." *Id*. at 66.

In this case, the GMZs were established to remedy violations alleged in VNs. However, the groundwater monitoring results indicate that exceedance of Class I GQS persisted at some of the monitoring wells at Joliet 29, Powerton or Will County even upon completion of GMZ corrective actions. Since the record does not indicate when, if, or even how, exceedances found in groundwater monitoring will be addressed, the Board finds MWG did not meet its burden of proving that groundwater in Joliet 29, Powerton, and Will County are exempt from Class I GQS under section 620.450(a)(3). The Board therefore finds that continued violations of the Board's Class I GQS, occurring at Joliet 29, Powerton, and Will County after MWG certified completion of the requirements of the CCA, violate the Class I GQS. Thus, the Board finds that it is more probable than not that MWG violated the Class I GQS at Joliet 29, Powerton, and Will County during those times, in violation of Section 620.410(a) of the Board rules.

c) Violation of Sections 620.115, 620.301(a) and 620.405.

The Board further finds that MWG also violated Sections 620.115, 620.301(a) and 620.405 of the Board rules with respect to exceedances noted above. Section 620.115 prohibits causing, threatening or allowing a violation of the Act or Board regulations, including Part 620. 35 Ill. Adm. Code 620.115. Section 620.405 also prohibits causing, threatening or allowing the release of any contaminant to groundwater so as to cause an exceedance of the Part 620 groundwater quality standards. 35 Ill. Adm. Code 620.405. By exceeding GQS in Section 620.410(a), MWG also violated Sections 620.115 and 620.405.

The Board also finds that MWG violated Section 620.301(a) of the Board rules. 35 Ill. Adm. Code 620.301(a). Section 620.301(a)(2) prohibits causing, threatening or allowing the release of any contaminant to a resource groundwater such that "[a]n existing or potential use of such groundwater is precluded." 35 Ill. Adm. Code 620.301(a). As discussed above, groundwater at the four Stations is defined as Class I in VNs, CCAs, and GMZs. The Board rules define Class I groundwater as "potable resource groundwater." *See* 35 Ill. Adm. Code 620.210. Section 620.302(c) indicates that "if a contaminant exceeds a standard set forth in Section 620.410 . . . the appropriate remedy is corrective action . . .." 35 Ill. Adm. Code

620.302(c). Thus, if the groundwater designated as Class I is contaminated by constituents that exceed Class I GQS standards in Section 620.410(a), the existing and potential use of such groundwater as Class I groundwater is precluded. Therefore, the Board finds that the Environmental Groups established that it is more probable than not that the potential use of the groundwater is precluded, and MWG violated Section 620.301(a).

iii. Water pollution caused by exceedances of background levels

The Board also finds that exceedances of the statewide 90th percentile in some of the monitoring wells for some of the coal ash indicator constituents also constitute water pollution and violation of Article 12(a) of the Act.

As discussed in Part IV *supra*, the Board finds that the monitoring results show consistent exceedances of the sulfate background levels at the Joliet 29 monitoring well MW-09. At Powerton, the Board finds that groundwater monitoring results indicate exceedance of the 90th percentile statewide values for boron and sulfate in 10 downgradient wells. Sulfate and boron in all fifteen downgradient wells are above the median values of those constituents in the upgradient well. The Board finds that these exceedances of the statewide background and site-specific upgradient median appear to be consistent with the exceedances of groundwater standards of sulfate and boron in many of the downgradient wells. At Will County, the Board finds that a comparison of the median values of boron and sulfate in the down gradient wells with the 90th percentile statewide values indicate exceedances of boron above background in all 10 monitoring wells and sulfate in one well (MW-4). At Waukegan, the Board finds exceedances of the 90th percentile statewide values for boron and sulfate.

As noted earlier, sulfate and boron are typical indicators of coal ash. The record shows no off-site source that can be causing such exceedance because upgradient monitoring wells show no similar exceedances. Therefore, the likely source of the exceedance of 90th statewide percentile value for these constituents is coal ash stored in coal ash ponds or deposited outside the ponds.

The Board considers the 90th statewide percentile appropriate to consider water pollution violations because those levels are established to show exceedance of state-wide background levels that IEPA considers to "have potential to degrade water and threaten/preclude its use." EG Exh. 405 at 2 (#019068). The Board finds that exceedance of the 90th statewide percentile as adequate to show water pollution. *See* 415 ILCS 5/3.545 (2016); *see also e.g.,* People v. CSX, PCB 7-16, slip op. at 17 (July 12, 2007) (the Board found violation of Section 12(a) of the Act when discharge of contaminants is likely to render waters harmful, detrimental or injurious to public health in case of exceedance of the remediation objective levels); Central Illinois Public Service Co. v. PCB, 116 Ill. 2d 397, 408, 507 N.E.2d 819, 824 (1987) (the court concurred with Board's interpretation of water pollution to include "any contamination which prevents the State's water resources from being usable" because it allows "the Board to protect those resources from unnecessary diminishment").

The Board thus, finds that MWG violated Article 12(a), because it caused, threatened or allowed the discharge of contaminants into the groundwater at all four Stations, so as to cause or tend to cause water pollution in Illinois, either alone or in combination with matter from other sources. *See* 415 ILCS 5/12(a) (2016).

B. Section 12(d) of the Act, Water Pollution Hazard

The Environmental Groups' amended complaint also alleged violation of Section 12(d) of the Act, but the post-hearing briefs only fully brief Section 12(a). *See* EG Br. at 4, 5-10, 28, 37, 73; EG Resp. Br at 7, 8, 12, 13, 18, 22, 24-25, 33, 34.

Section 12(d) of the Act prohibits depositing any contaminants upon the land in such place and manner so as to create a water pollution hazard. 415 ILCS 5/12(d) (2016). Environmental Groups argue that even though a prior owner or operator of the MWG sites may have deposited the ash in the fill areas, MWG has allowed the ash to remain on the site, and is therefore liable under Sections 12(a) and 12(d) for its inaction to remedy the leaching of contamination into the groundwater. According to the Environmental Groups, MWG's "passive conduct amounts to acquiescence sufficient to find a violation." EG Resp. Br at 24 *citing* Rawe, AC92-5, slip op. at 6 (Oct. 16, 1992). Environmental Groups also rely on Tri-County Landfill Company v. PCB, 41 Ill. App. 3d, 353 N.E.2d 316 (2nd Dist. 1976) to argue that a party is required to show less to establish a 12(d) violation than a 12(a) violation and that a violation of 12(d) exists when "pollution does not yet rise to the level of severity for a 12(a) violation." EG Resp. Br at 22, citing Tri-County, 353 N.E.2d at 324.

The Board notes that, in order to establish a violation of Section 12(d), a party must demonstrate that contaminants were "deposited" on "land." 415 ILCS 5/12(d) (2016). Environmental Groups' reliance on Rawe is misplaced, because Rawe addresses an alleged violation of Section 21 of the Act which prohibits "causing or allowing" open dumping of waste. 415 ILCS 5/12(d) (2016).

At Powerton, the record shows that MWG did deposit contaminants on the land when leaving coal ash cinders directly on the ground, without liners or any other apparent protection from leaching. *See* Part IV.3.B.iii *supra*. The record establishes that storage of coal ash on unlined areas risks of groundwater contamination due to the movement of water through coal ash. EG Br. at 19; 10/24/17 Tr. at 39 (Lux Test.); 10/26/17 Tr. p.m. at 34-35, 83-84 (Kunkel test); 1/29/18 Tr. at 208 (Race Test.); 1/30/18 at 29 (Race Test.). The Powerton CCA specifically prohibits using any unlined areas for permanent or temporary ash storage or ash handling. MWG Exh. 636 at 4 (#555) Item 5(m). The groundwater monitoring results show exceedances of arsenic, sulfate, boron, and TDS standards in the downgradient monitoring wells when the cinders were stored on the ground.

The Board thus concludes that the preponderance of evidence shows that MWG deposited contaminants upon the land at Powerton in such place and manner so as to create a water pollution hazard in violation of Section 12(d) of the Act. 415 ILCS 5/12(d) (2016). The Board, however, finds that Environmental Groups did not establish violation of Section 12(d) of the Act at Joliet 29, Will County, or Waukegan Stations.

C. Section 21(a) of the Act, Open Dumping

Environmental Groups allege that MWG violated the open dumping prohibition of Section 21(a) of the Act (415 ILCS 5/21(a) (2016)). They allege that MWG did so through its

"knowledge of and acquiescence to" coal ash deposited "at unlined repositories like ash landfills and ash fill areas" and "maintaining coal" at the disposal sites that do not fulfill the requirements of sanitary landfills. The Environmental Groups specifically contend that coal ash in the Former Ash Basin and widespread fill areas at Powerton, the coal ash landfills at Joliet 29, the Former Slag and Fly Ash Storage Area at Waukegan and Ponds 1N and 1S at Will County are "landfills, basins, or storage areas." They further contend that there is no evidence that the coal ash was placed there as structural fill." EG Resp. Br. at 31. They allege that water pollution resulted from these deposits. EG Br. at 5, 29, 51. The Environmental Groups maintain that MWG is liable even if they did not place the contaminants on the land or water. To support their argument, the Environmental Groups rely on Lincoln, 2016 IL App 143487 at ¶¶ 48-49; State Oil, PCB 97-103, slip op at 19; Rawe, AC 92-5slip op at 3-5 (Oct. 16, 1992); Coleman, AC 04-46, slip op. at 7 (Nov. 4, 2004). EG Br. at 51. They also contend that the Board must look at the exceedance of MCLs at 40 C.F.R. Part 257, Appendix I, to show violation of Section 21(a). EG Br. at 51. Environmental Groups state that since 2010, groundwater exceeded MCLs 62 times at Powerton, 25 times at Will County, and 106 times at Waukegan. EG Br. at 51, 62, 72.

MWG contends that the Environmental Groups did not prove a violation of Section 21(a). MWG alleges that coal ash at the stations is not abandoned and is reused beneficially. MWG Br. at 54-57; MWG Resp. Br at 30. MWG relies on IEPA v. Michael Gruen and Jon Eric Gruen, d/b/a John's Tree Service, AC 06-49, (Jan. 24, 2008). In that case the Board found that the wood stored on a property for more than two years was not "discarded" and, thus, not waste, because it was eventually removed for beneficial reuse. MWG Resp. Br. at 31. MWG alleges that there is market for the coal ash reuse, and MWG reuses bottom ash beneficially such as structural fill. MWG Resp. Br. at 31. MWG also contends that it did not "allow" open dumping because it took extensive precautions to prevent open dumping and "has not been passive in its response to the coal ash at its Stations." MWG states that it analyzed coal ash inside the ponds, which shows that ash is not a source of contamination. *Id*. It also relined the ponds and established GMZs and ELUCs. *Id*.; MWG Resp. Br. at 56-57.

First, the Board considers whether coal ash at the four Stations is "waste" as defined by the Act and Board rules. Next, the Board reviews at the evidence showing whether areas where coal ash is abandoned fulfill requirements of sanitary landfills. Finally, the Board concludes that MWG caused or allowed open dumping of the coal ash at its Stations.

i. Coal Ash at the Stations is "Waste"

The Act defines "open dumping" as "the consolidation of *refuse* from one or more sources at a disposal site that does not fulfill the requirements of a sanitary landfill." 415 ILCS 5/3.305 (2016). The Act defines "refuse" as "waste." 415 ILCS 5/3.385 (2016). "Waste" is defined, among other, as "*discarded material*, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations . . .." 415 ILCS 5/3.535 (2016) (emphasis added). While the Act does not define "discarded material" or "discarded," the Act defines "disposal" as "discharge, deposit, injection, dumping, spilling, leaking or placing of any waste or hazardous waste into or on any land or water or into any well so that such waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters." 415 ILCS 5/3.185 (2016). The Act defines "waste disposal site" as a "site on which solid waste is disposed." 415 ILCS 5/3.540 (2016). The Board has found contaminants leaking into groundwater from

temporarily stored material to be "discarded material" for the purposes of Section 21(a) of the Act. *See* State Oil, PCB 97-103, slip op. at 21 (Mar. 20, 2003) ("once petroleum has leaked from underground storage tanks, it becomes a waste.").

Although MWG argues that coal ash stored at the Stations is not "waste" because it is beneficially reused, the record does not support this position. While MWG may send some coal ash to be used beneficially by third parties (1/29/18 Tr. at 172:1-178:15; 1/31/18 Tr. at 224:21-225:4, 249:23-250:6; 10/24/17 Tr. at 15:4-8, 248:9-249:8), significant amounts remain in historic areas. The record also shows the presence of coal ash in areas outside of ash ponds at all four Stations.

"[A]ny fly ash, bottom ash, slag, or flue gas or fluid bed boiler desulfurization by-products generated as a result of the combustion of . . . coal, or . . . coal in combination with [other material]" constitutes "coal combustion *waste*" (or CCW). 415 ILCS 5/3.140 (2016) (emphasis added). Coal combustion waste is not excluded from definition of "waste" under the Act. *See* 415 ILCS 5/3.535 (2016). "Waste" does not include "coal combustion by-products as defined in Section 3.135." 415 ILCS 5/3.535 (2016). "Coal combustion by-product" or (CCB) is defined as "coal combustion waste when used beneficially in any of the following ways: . . ." 415 ILCS 5/3.135 (2016). Coal combustion waste, including coal ash, meets the definition of CCB, and is excluded from definition of "waste" if it is used as specified in Section 3.135. 415 ILCS 5/3.135 (2016).

Strict requirements apply to uses permitted under Section 3.135(a). To be used beneficially as structural fill, foundation backfill, antiskid material, soil stabilization, pavement, or mine subsidence, CCW must satisfy certain quality requirements:

a) it must not be mixed with hazardous materials (415 ILCS 5/3.135(a-5)(A) (2016));
b) it must not exceed Class I GQS for metals when tested using ASTM D3987-85 method (415 ILCS 5/3.135(a-5)(B) (2016));
c) a notification must be provided to IEPA for each project using CCB "documenting the quantity of CCB utilized and certification of compliance with conditions (A) and (B) of [subsection 3.135(a-5)]" (415 ILCS 5/3.135(a-5)(C) (2016));
d) CCB must not be accumulated speculatively (less than 75% of CCB weight or volume accumulated at the beginning of the period) (415 ILCS 5/3.135(a-5)(E) (2016));
e) CCB must include any prescribed mixture of fly ash, bottom ash, boiler slag, flue gas desulfurization scrubber sludge, fluidized bed combustion ash, and stoker boiler ash and shall be tested as intended for use (415 ILCS 5/3.135(a-5)(F) (2016)).

To be used as structural fill, CCB must be designed and constructed "according to ASTM standard E2277-03" or "Illinois Department of Transportation specifications." It also must be "in an engineered application or combined with cement, sand, or water to produce a controlled strength fill material and covered with 12 inches of soil unless infiltration is prevented by the material itself or other cover material." 415 ILCS 5/3.135(a)(7) (2016).

Other uses do not qualify CCW as CCB, unless an applicant obtains a "beneficial use determination." To obtain a determination from IEPA, an applicant must demonstrate that coal-combustion waste satisfies all the following criteria:

- the use will not cause, threaten, or allow the discharge of any contaminant into the environment;
- the use will otherwise protect human health and safety and the environment; and
- the use constitutes a legitimate use of the coal-combustion waste as an ingredient or raw material that is an effective substitute for an analogous ingredient or raw material. 415 ILCS 5/3.135(b) (2016).

The record does not show that coal ash from the Stations met these requirements. First, the record shows that out of all identified historical areas and active ash ponds, coal ash was tested for compliance with CCB requirements under Section 3.135 only from three locations: 1) Northwest Area at Joliet 29; 2) Limestone Runoff Basin at Powerton; and 3) the area right outside the east side of 1N at Will County. *See* Part IV *supra* for details; EG Exh. 293; MWG Exh. 635; EG Exh. 284; MWG Exh. 901 at 9. The record provides no information on any CCB testing at Waukegan Station.

Second, MWG did not provide evidence showing that any of this material was used in compliance with the requirements of Section 3.135 of the Act. No evidence was provided to demonstrate that coal ash present in fill areas complies with IDOT specifications or ASTM standard E2277-03. Also, the record does not indicate whether or what material was removed from the Stations, sold or otherwise transferred to other entities for beneficial reuse. The existence of a market for a material that qualifies as CCB by itself does not qualify the material as CCB. To qualify as CCB, the material must comply with Section 3.135.

Accordingly, the Board concludes that a preponderance of evidence does not support MWG argument that coal ash from the Stations qualifies as CCB. The Board is not persuaded that coal ash from any of the historic coal ash storage locations or fill areas is "not discarded." MWG admits that "coal ash at various parts of the Stations was used at least 30 years ago or more as fill to support construction." MWG Resp. Br. at 55. The record also shows the widespread presence of coal ash outside of the ash ponds through the stations. Such as the widespread presence of coal ash in fill areas at Powerton and Will County, and coal ash left in historic storage areas at all four Stations. The evidence shows no plans to remove such coal ash from these areas for beneficial reuse or for any other purposes. The Board finds, thus, that coal ash at all four Stations left in areas outside of the ash ponds is "discarded" and constitutes "waste" for the purposes of Section 21(a) of the Act.

ii. <u>Coal ash stored in areas that are not sanitary landfills</u>

To establish an "open dumping," the evidence must show the presence of waste "at a disposal site that does not fulfill the requirements of a sanitary landfill." 415 ILCS 5/3.305 (2016). The Act defines "waste disposal site" as a "site on which solid waste is disposed" (415 ILCS 5/3.540 (2016) and "site" include "any location . . . used for purposes subject to regulation or control" by the Act or regulations under the Act (415 ILCS 5/3.460 (2016)). The Act defines "sanitary landfill" as "a facility permitted by the Agency for the disposal of waste on land" that

meets specific requirements does not "create nuisances or hazards to public health or safety" and confining the refuse "to the smallest practical volume and covering it with a layer of earth at the conclusion of each day's operation, or by such other methods and intervals as the Board may provide by regulation." 415 ILCS 5/3.445 (2016).

The Board has concluded that "under these definitions, an area on which waste is deposited can be a "disposal site" if the waste deposition is conducted in a manner that allows waste material to enter the environment, including groundwater" even if it is a permitted or otherwise lawful facility. Sierra Club, PCB 13-15, slip op. at 25-27 (Oct. 3, 2013). The Board found that Section 21(a) may apply to ash ponds because it applies "to permitted or otherwise lawful facilities that improperly fail to contain waste." *Id*.

As indicated in Part IV, the instant record shows that historic ash landfills at all four Stations contain ash, as evidenced by testing for CCB compliance, boring results, MWG admissions and testimony, and groundwater monitoring results. At Joliet 29, MWG admitted that all three historic coal ash sites (Northwest, Northeast, and Southeast areas) contain historic ash; additionally, the 1998 Phase II Environmental Assessment and 2005 testing for CCB confirmed the existence of the historic ash. MWG Br. at 11; MWG Exh. 901 at 23; EG Exh. 20D; EG Exh. 293. Soil borings also identified the presence of coal ash in fill areas outside of the ash ponds (near MW-11, MW-09, and MW-10) and historic ash areas (north of the Southwest Ash Placement Area). EG Exh. 201 at 27, 29, 31, 34 (#24290, 92, 94, 97).

The Board finds that evidence from groundwater monitoring shows that some of MWG ash ponds and historic coal ash storage areas are leaking contaminants that cause exceedances of Class I GQS. At Joliet 29, the record shows Ash Pond 3 or coal ash deposited outside of but close to that ash pond is the cause of consistent exceedances of Class I GQS in MW-09. At Waukegan, the evidence shows that the source of sulfate and of TDS exceedances is the Former Slag and Fly Ash Storage area located west of the ash ponds. At Will County and Powerton, the groundwater monitoring results show that consistent exceedances of Class I GQS are also caused by MWG operations at the Stations and are not coming from outside.

The record also shows soil borings taken in 1998, 2005, and 2010 by different consultants for different purposes. All of these borings indicate the presence of coal ash in the fill buried directly into the ground around the ponds and other unlined areas at all for Stations, going as deep as 9-20 feet below the surface at Powerton, Will County, and Waukegan. EG Exhs. 12C-15C and 17D-20D; EG Exh. 201.

And finally, the results of the CCB testing at Joliet 29, Powerton, and Will County indicate the presence of the historic coal ash in the tested areas. EG Exh. 284, 293, and 635; MWG Exh. 901 at 9. The testing showed some of these areas contain coal combustion waste that does not meet the quality criteria of CCB because it contains coal ash constituents in concentrations above Class I GQS. *Id*.; *see* Part IV for details.

None of these areas fulfill the requirements of a sanitary landfill. None of them are facilities "permitted by the Agency for the disposal of waste on land." None of the ash ponds at the four Station are permitted "for the disposal of waste". The four CCAs specifically prohibit using any of the ash ponds as permanent disposal sites. MWG Exhs. 626 at 2 ¶ 3; 636 at 2 ¶ 3; 656 at 2 ¶ 3; 647 at 2 ¶ 3. None of the fill areas of the historic coal ash storage areas has any

permits at all. None of them "confine the refuse" to ensure that no nuisances or hazards to public health or safety exists because, other than ash ponds, none of the other areas separate the coal ash from the ground or surface water infiltration and leaking into the groundwater. Other than the historical Northeast former coal ash placement area, record indicates no cover been placed over the area, either. The Board, thus, concludes, that the areas that contain coal ash at the four Stations do not fulfill requirements of sanitary landfill. 415 ILCS 5/3.445 (2016).

Next, the Board discusses whether MWG caused or allowed consolidation of coal ash in violation of Section 21(a) of the Act.

iii. MWG caused or allowed consolidation of coal ash at its Stations

To "cause or allow" open dumping, the alleged polluter must have the "capability of control over the pollution" or "control of the premises where the pollution occurred. Davinroy, 249 Ill. App. 3d at 793-96, *see also* Sierra Club, PCB 13-15, slip op. at 26 (Oct. 3, 2013). The record indicates that MWG, as the owner or operator at the four Stations had control over the areas that contain coal ash since 1999, when it began operating the Stations. Rawe, AC92-5, slip op. at 4 (Oct. 16, 1992); McFalls, 313 Ill. App. 3d at 226-27, Inverse Investments, PCB 11-79 at 9; Michel Grain, PCB 96-143, at 3-4, (Aug. 22, 2002); Meadowlark Farms, 17 Ill. App. 3d at 860, Lincoln, 70 N.E.3d at 678, State Oil, PCB 97-103, slip op at 24-25; Allaert Rendering, 414 N.E.2d at 494-95 .

MWG was aware of presence of coal ash buried at the four stations before it began operations. The 2005 and 2010 borings confirmed the presence of coal ash. Groundwater monitoring results showed the locations where contaminants were seeping into the groundwater at each of the Stations. MWG also recognizes that contaminants present in the groundwater monitoring results are known constituents of coal ash. The groundwater monitoring results do not indicate off-site sources as the cause of contamination with respect for constituents indicated in Part IV (Facts) of this opinion. Thus, the Board concludes that the record does not support MWG "took extensive precautions to prevent open dumping" and "has not been passive in its response to the coal ash at its Stations." Davinroy, 249 Ill. App. 3d 788; Perkinson, 187 Ill. App. 3d 689; People v. William Charles, PCB 10-108, slip op. at 25-27 (Mar.17, 2011); Gonzales, AC 06-39, AC 06-40, AC 04-41, AC0 7-25; County of Jackson v. Taylor, AC 89-258, (Jan. 10, 1991); Phillips Petro. Co. v. PCB, 72 Ill. App. 3d 217 (2nd Dis. 1979); IEPA v. Coleman, AC04-46, at 7 (Nov. 4, 2004).

The Board concluded that respondents "allowed" the waste to be consolidated on the site when they failed to conduct any soil removal. *See* State Oil, PCB 97-103, slip op. at 21-22 (Mar. 20, 2003). The record in this case shows the presence of coal ash in the fill areas and historic storage sites that have no liners, covers or any other protection from the surface of groundwaters. The record shows no actions by MWG to remove the coal ash from those areas or prevent leaking of contaminants from those areas in any other way. Thus, the Board finds that MWG did allow consolidation of coal ash by failing to remove it from the fill areas and historical coal ash storage areas, and by allowing contaminants to leak into the environment.

Accordingly, the Board finds that MWG violated Section 21(a) of the Act by allowing the coal ash to be consolidated in the fill areas around ash ponds and in historical coal ash storage areas at all four Stations.

VI. CONCLUSIONS

The Board finds that the Environmental Groups met their burden in establishing that it is more probable than not that MWG violated the Act and Board regulations as alleged in the amended complaint. Specifically, the Board finds that MWG violated Section 12(a) of the Act at all four Stations. 415 ILCS 5/12(a) (2016). The Board finds that MWG caused or allowed discharge of coal ash constituents into groundwater at all four Stations, thereby causing exceedances of the Board's Class I antimony (Joliet 29, Will County), arsenic (Powerton, Will County), boron (Powerton, Will County, and Waukegan), sulfate (Joliet 29, Powerton, Will County, and Waukegan) and TDS (Joliet 29, Powerton, Will County, and Waukegan) GQS during 2010-2017, violating Sections 620.115, 620.301(a), and 620.405 of the Board's regulations (35 Ill. Adm. Code 620.115, 620.301(a), 620.405). 415 ILCS 5/12(a) (2016).).

The Board also finds that MWG violated Section 12(a) of the Act at all four Stations by causing or allowing discharge of contaminants into groundwater causing water pollution. Specifically, the Board finds that MWG exceeded the statewide 90th percentile levels for sulfate and boron at all four Stations between 2010 and 2017. 415 ILCS 5/12(a)(2016). The Board, however, finds no violation of Section 12(a) of the Act at Joliet 29, Powerton, and Will County during the performance of corrective actions in October 2013 under the GMZs established at those three Stations.

The Board finds that MWG also violated Section 12(d) of the Act at Powerton Station by depositing coal ash cinders directly upon the land, thereby creating a water pollution hazard. 415 ILCS 5/12(d) (2016). The Board, however, finds that Environmental Groups did not establish violations of Section 12(d) of the Act at Joliet 29, Will County, or Waukegan Stations.

Lastly, the Board finds that MWG violated Section 21(a) of the Act at all four Stations by allowing coal ash to consolidate in the fill areas around the ash ponds and in historical coal ash storage areas. The Board finds that MWG did not take measures to remove it or prevent its leaking of contaminants into the groundwaters.

The Board finds the record is insufficient to determine the appropriate relief in this proceeding. Therefore, the Board directs the hearing officer to hold additional hearings to determine the appropriate relief.

ORDER

1. The Board finds that respondent Midwest Generation, LLC (MWG) violated Section 12(a) of the Environmental Protection Act (Act) (415 ILCS 5/12(a) (2016)).

2. The Board finds that MWG violated Section 12(d) of the Act (415 ILCS 5/12(d) (2016)).

3. The Board finds that MWG violated Section 21(a) of the Act (415 ILC21(a) (2016)).

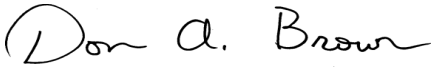
4. The Board finds that MWG violated Sections 620.115, 620.301(a), and 620.405 of the Board regulations (35 Ill. Adm. Code 620.115, 620.301(a), 620.405).

5. The Board finds the record lacks sufficient information to determine the appropriate remedy. Therefore, the Board directs the hearing officer to hold additional hearings to determine the appropriate relief and any remedy, considering Sections 33(c) and 42(h) of the Act (415 ILCS 5/33(c) and 42 (h) (2016)).

IT IS SO ORDERED.

Board Member Brenda Carter abstained.

I, Don A. Brown, Clerk of the Illinois Pollution Control Board, certify that the Board adopted the above order on June 20, 2019, by a vote of 4-0.



Don A. Brown Clerk
Illinois Pollution Control Board

Section 3. Information Regarding Potential Impacts from CCR Management and Storage

3.1. Henry S. Cole & Associates, Inc. July 2020 Recommendations for Managment of CCR (Cole, 2020)

This document was received in follow-up to a stakeholder meeting held between May 2020 and August 2020.

Science, Solutions and Leadership for the Environment
And Communities

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July 24, 2020

To: Ms. Rita Chow, for distribution to EPA staff

From: Henry S. Cole, Ph.D., President of Henry S. Cole Environmental Associates.

CC: Lisa Evens, Earthjustice

RE: Comments regarding proposed regulations: Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles

These comments focus on the potential health impacts of airborne coal ash from waste piles and other disposal facilities—a topic which until recently has received less attention than the impact of coal ash on ground and surface water. As a former EPA scientist, I am especially happy to share my concerns with the Agency's professionals regarding several issues related to EPA's Reconsideration of Beneficial Use Criteria and Piles.

Qualifications: I received my Ph.D. in Meteorology in 1969 from the U. Wisconsin, was an associate professor of environmental earth sciences at the U. Wisconsin-Parkside during the 1970'svand served as a senior scientist and section chief in EPA's Office of Air Quality Planning and Standards, in the Source-Receptor Branch of the Monitoring and Data Division in the late 1970's and early 1980's. From 1992 to 2003, I was science director of the Clean Water Fund/CW Action. For the past 27 years I have served as principal scientific consultant, researcher, and expert witness for a variety of clients on cases related to air pollution, toxic waste sites, landfills, and other environmental issues.

For complete company profile and resume, go to: https://henryscoleinc.wordpress.com/

Comments pertaining to regulations on CCR waste piles and other forms of unencapsulated disposal and processing. Henry S. Cole, Ph.D. President, Henry S. Cole Environmental Associates, Inc.

1.0 Introduction: These comments express my serious concerns regarding EPA's August 2019[1] proposed rule regarding CCR waste disposal and beneficial use which would replace and severely weaken the Agency's 2015 final rule.[2] The US Environmental Protection Agency (EPA) estimates the coal ash is stored in over 310 active landfills and an estimated 735 active surface impoundments across 47 states. The same report estimates that In the United States, the EPA estimates that 6 million people, including 1.5 million children, are exposed to coal ash.[3] As these comments and references demonstrate (a) that coal ash when processed, stored, used or disposed in an open manner can be carried on the wind to nearby communities and (b) that coal fly ash has physical, chemical and radiological properties that warrant stronger rather than weaker protection.

My findings and recommendations are based on my review of the existing and proposed revision of the CCR rules, a review of pertinent studies, and my personal experience as an expert in several cases involving coal ash disposal facilities located in close proximity to CCR disposal facilities where there is strong evidence for the release of fugitive coal ash from ash landfill. These include:

1. NRG's coal ash disposal site located on N. Keys Road in Brandywine, MD. The facility is located adjacent to a playground and T-ball field for pre-school and elementary school students. The site is predominantly used by the area's predominantly African-American families. Critical factors: release of airborne coal ash dust, location adjacent to a T-ball field and a playground for young children, lab measurements of toxic metals. Although Prince George's County Council acted to prohibit further CCR disposal at the site, the Council's decision was overruled by an appeals court on a technical issue without considering to risks to families using the adjacent recreational facility. For further information see Section 6.

2. NV Energy's ash disposal facility at the Reid Gardner Power Plant which abuts the Moapa River Paiute Indian Reservation in Nevada. Critical factors: photographic evidence of coal ash dust plumes, valley winds channel emissions towards Moapa homes (1000 feet from disposal facility), <u>indoor</u> wipe samples show microscopic evidence of fly ash contamination and chemical analysis showing hexavalent chromium in the homes tested. The evidence and major efforts to address the problems was undertaken by the Moapa community and environmental organizations—not by

[1] PROPOSED RULE, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles Posted by the Environmental Protection Agency on Aug 14, 2019

[2] 40 CFR Parts 257 and 261final rule to regulate the disposal of coal combustion residuals [EPA–HQ–RCRA–2009–0640; FRL–9919–44–OSWER] RIN–2050–AE81 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, April 17, 2015.

[3] Environmental Protection Agency . Hazardous and solid waste management system; identification and listing of special wastes; disposal of coal combustion residuals from electric utilities; proposed rule (Codified at 40 CFR Parts 257, 261, 264 et al.). Fed Reg. 2010;75(118):35128-35264.

EPA or the Nevada Division of Environmental Protection (NDEP). For further information see Section 6.

Figure 1: Airborne coal ash blowing off of NV Energy's CCR disposal facility exposing the Moapa River Reservation. From the *Las Vegas Review Journal*, March 20, 2013.

2.0 Recommendations: The evidence from numerous sites[4] including the Brandywine, MD and Moapa, NV sites indicate that EPA's 2015 regulations need to be tightened rather than rolled back. I fully support the recommendation made by Earthjustice and a coalition of national, state, and regional organizations that EPA ban the storage, disposal and use of unencapsulated coal ash due to the probable public health risks associated with .[5] Outdoor processing of CCR for "beneficial use" should also be banned. This prohibition should include all coal waste piles including those which EPA seeks to redefine as "storage piles" including those designated for beneficial use.

3.0 Weak points in EPA's current proposal: In its 2015 final rule on CCR disposal, EPA applied its protective landfill disposal rules to coal ash piles. However, in EPA's 2019 proposed revision, EPA defines all CCR waste piles into a single category called "CCR storage piles." According to comments submitted by Earthjustice et al. the term relies on a vague definition of "temporary accumulation" that would apply to most, if not all, coal ash waste piles on and off power plant sites.[6] One can only wonder whether "temporary" means a month, a year, or a decade and how long CCR piles can withstand the fs of wind and water. One can also ask who benefits and who is at risk if this loophole remains in the final revision.

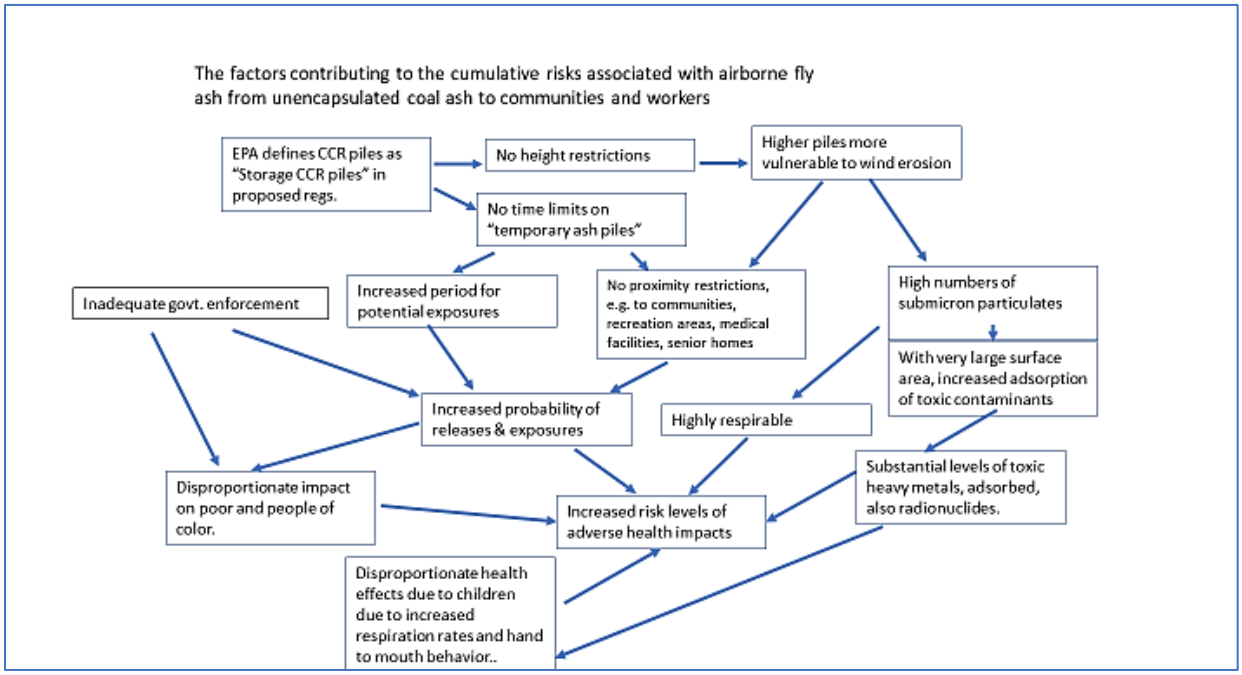
3.1 Serious gap in locational criteria: I am also concerned that EPA's document for the proposed regulations does not include a locational criteria for restrictions based on the distance of a CCW disposal or use location based on its proximity to a community, especially in those areas with large minority, poor, and indigenous communities—such as those in Brandywine, MD, and the Moapa Reservation, but in many other locations listed the comments by Earthjustice et al.[7] Earthjustice et al. also cite EPA's (2015) finding that "the single

[4] Comments Of Earthjustice, et al. regarding Reconsideration of Beneficial Use Criteria and Piles, 84 Fed. Reg. 40,353 (Aug. 14, 2019), EPA-HQ-OLEM-2018-0524, submitted to EPA October 15, 2019
[5] *Ibid.*
[6] *Ibid.*
[7] *Ibid, pp. 20-29.*

most frequent issue presented during the public hearings was the delegation by individual citizens of damage caused by fugitive dusts from neighboring CCR facilities."[8]

3.2 *Unprotected fly ash piles:* Another issue is the lack of restrictions on the height of coal ash piles or requirements for cover. These issues are critical with regard to the potential for airborne release of coal ash particulates. As Earthjustice et al. describe EPA's previous (2015) expressed particular concern about the impacts of coal ash blowing from piles which tend to have less protective cover than CCR landfills and which are exposed to faster wind speeds and entrainment due that their extended heights.

4.0 Factors that contribute to the airborne exposure of communities near to ash landfills and workers: A number of factors contribute to the vulnerability of those who live, use, and/or work in areas near coal ash disposal sites, including, unrestricted heights, particle size distribution, and the toxic metals and radionuclides adsorbed on particle surfaces. As the following diagram illustrates, these factors tend to reinforce one another and lead to situations that threaten the health and lives of the people of affected communities.



In addition there is evidence that persons with pre-existing conditions including respiratory and cardiovascular diseases are at heightened risks of COVID infection and greater morbidity and mortality.[9] According to EPA exposure to airborne particles below 2.5um in diameter contribute both chronic respiratory and cardiovascular disease.[10,11]

4.1 Unrestricted heights: As the Earthjustice et al. comments state, *"In fact, EPA was particularly concerned about the impact of CCR blowing from piles, since piles do not maintain the same degree of*

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[8] *Ibid, p. 93.*

[9] Preliminary Estimates of the Prevalence of Selected Underlying Health Conditions Among Patients with Coronavirus Disease 2019 — United States, February 12–March 28, 2020. MMWR Morb Mortal Weekly Rep 2020;69:382–386. DOI: http://dx.doi.org/10.15585/mmwr.mm6913e2

[10] https://www3.epa.gov/region1/airquality/pm-human-health.html

[11] https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm

cover as CCR landfills and their above-ground, vertical construction exposes CCR to increased levels of wind at higher velocities".[12]

Meteorologists have long described the relationship between height above surface and wind speed as being logarithmic such that wind speed increases exponentially especially in the first in the atmosphere's lowest layers; the relationship is dependent on the roughness of the surface (smooth water versus choppy terrain, etc.) and the speed of the wind above the surface layer. This principle is illustrated in the conceptual example in Figure 2. Note the large incremental increase in wind speed per meter of elevation in the lowest 10 meters. The relationship between wind speed and height illustrates that elevated piles are vulnerable to wind erosion (entrainment) than a flat landfill surface with higher particulate release rate.

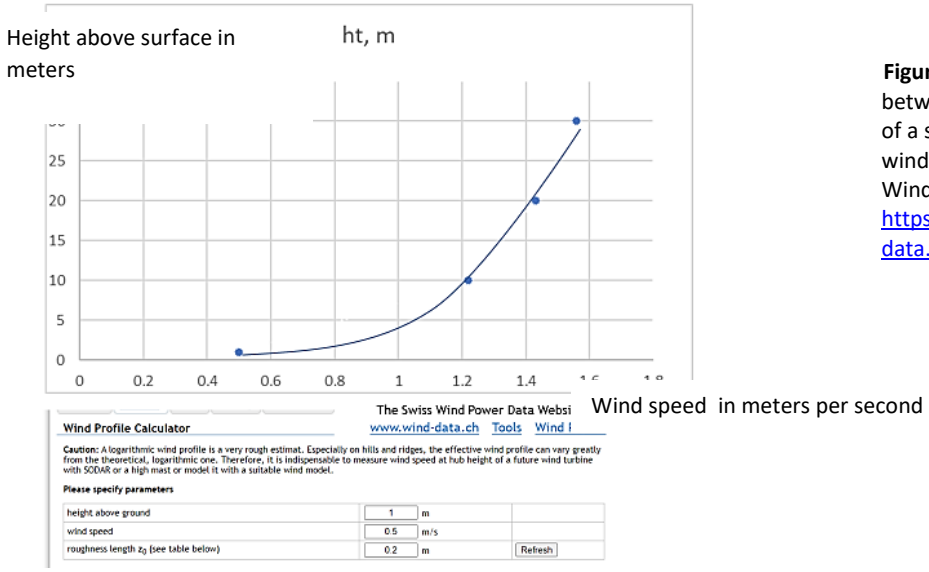

Figure 2: Theoretical relationship between wind speed and the height of a surface based on logarithmic wind profile . Source: The Swiss Wind Power Data Website, https://wind-data.ch/tools/profile.php

The following figures show visual evidence of unprotected coal ash being stored in piles or hills making the ash vulnerable to wind erosion.

Figure 3: According to Earthjustice, millions of tons of coal ash were transported by rail to Uniontown, Alabama from the TVA coal ash coal spill site in Tennessee. The photos (a) show mounds of unprotected coal ash and (b) posed of in large hill, tens of feet above ground level. Uniontown, AL, is more than 90% African-American, low-income community. The trash liners visible in (a) were used to hold the coal ash in place on the train area of Harriman, TN.

[12] *Op. Cit. Earthjustice*

However, liner was ripped off and the coal ash was dumped into the open landfill.
https://earthjustice.org/features/campaigns/photos-a-toxic-inheritance

The impact of wind on coal ash piles is captured in a 2010 Prince George's County Cable TV feature, https://www.youtube.com/watch?v=xiT5aK0CV88. [13] As the video shows clouds of exposed ash blowing off of raised piles of coal ash. Figure 4, from the video, shows the impacts of wind and turbulence in entraining and transporting the cloud of coal ash particles downwind. The video also shows the potential for workers at CCR waste facilities to be exposed to airborne coal ash.

Figure 4: See text and video.

Comments submitted by Earthjustice on the revised CCR rules state that families of the Navajo Nation near CCR disposal units at the at the Four Corners Power Plant have frequently reported clouds of toxic dust rising from CCR landfill that rises 110-feet above the desert surface.[14]

4.2 Differential particle distributions based on particle diameters: NAAQS PM2.5 standards are based on mass concentrations (ug/m3). Certain particle distribution studies also use ug/m3. .However, mass concentration does not consider that finer portions of PM2.5, i.e. in the submicron range are more likely to cause adverse health impacts than coarser portions. First, the concentrations of submicron particles in terms of number (rather than mass) coal ash tend to be orders of magnitude higher than larger particles. This finding is shown in Figure 5 for both fly ash and carbon particles present in coal ash from an experimental industrial boiler and collected in a cyclone.[15]

[13] I make no claim that these conditions have continued; but use the CTV video to illustrate what happens when CCR ash piles. The 2010 video was taken prior to NRG's ownership and operation of the site.

[14]

[15] Source: Lipeng Su, et al. An experimental study on the removal of submicron fly ash and black carbon in a gravitational wet scrubber with electrostatic enhancement, RSC Adv., 2020, 10, 5905, https://pubs.rsc.org/en/Content/ArticleLanding/2020/RA/C9RA10046F#!divAbstract

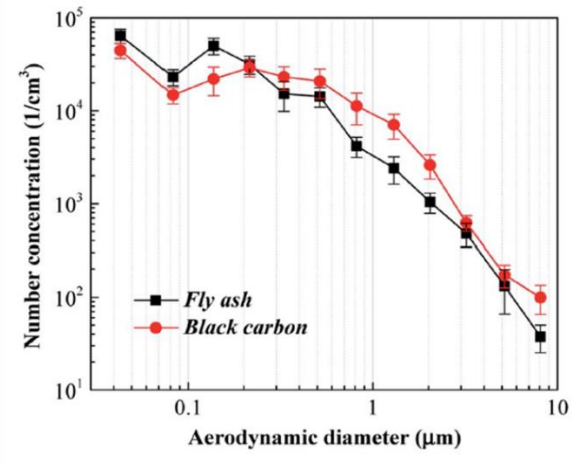

Figure 5: Particle size distributions for fly ash and black carbon contained in coal combustion residuals using number based distributions.

Source: Lipeng Su, et al. An experimental study on the removal of submicron fly ash and black carbon in a gravitational wet scrubber with electrostatic enhancement, RSC Adv., 2020, 10, 5905

4.3 Particle size distribution and surface area. The surface area is also a critical factor with regard to the potential health effects of coal ash respiration. The surface area of particulates is also a function of particle size. As Figure 6 shows, the volume concentration (approximately proportional to particle mass) is peaks in the 2-7 um range. However, the numbers of sub-micron particles exceed concentrations measured for particle numbers.

A second study shows the relationship between particle size and surface area which are maximal in the submicron range. [16] This is shown in Figure 6. Although this distribution does not specifically address coal ash, the finding matches well with the general relationship between particle size distribution and surface area. Note that the volumetric (and therefore mass) concentrations are maximal well above 1um.

As the following excerpt emphasizes, finer fly ash particles with large surface to volume ratios which leads to greater adsorption of toxic metals.

The As depletion on bottom ash probably occurs by volatilization and later condensation processes on fly ash matrix, because of the decreasing flue-gas temperature. As heterogeneous condensation is a surface area phenomenon, As should be enriched on the thin fly ash particles. In smaller extension, the same behavior is expected for Pb and Cd elements. According to Beck [2], the maximum enrichment occurs on the smallest fly ash particles, apparently due to volatilized compounds re-condensing onto particle surfaces. Since smaller particles have the largest surface to volume ratio, they exhibit the highest enrichment. [17]

[16] Characteristics of aerosol particle size distributions in urban Lanzhou, north-western China. Y. Yu1, 2011

[17]

Toxic elements mobility in coal and ashes of Figueira coal power plant, Brazil

M. Flues, I.M. Sato, M.A. Scapin, M.E.B. Cotrim, I.M.C. Camargo *

There is evidence that small diameter particles with high number concentrations and large surface to volume ratios can penetrate cell membranes and pass through the lung tissue and the blood-brain barrier. Particulate matter that crosses the blood-brain barrier introduces the components in the particles to the brain and bloodstream.[18]

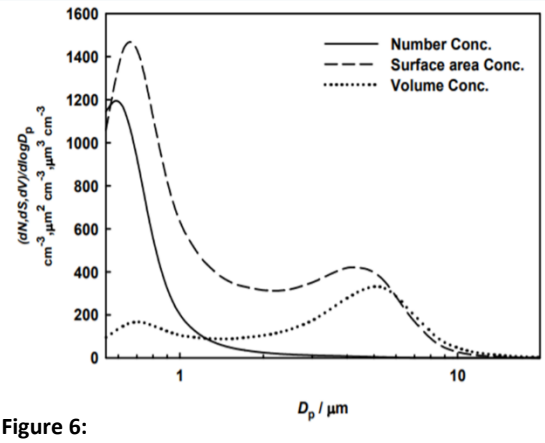

Figure 6:

Characteristics of aerosol particle size distributions in urban Lanzhou, north-western China. Y. Yu1, 2011

*4.4 Toxic metals found in coal ash: "*Coal ash contains at least fifteen toxic pollutants, including heavy metals such as arsenic, selenium, chromium, lead, uranium, and mercury, which alone are considered 'hazardous substances' under Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and can potentially damage all major organs systems in adults, pregnant women, and children."[19]

Another expert, Barbara Gottlieb of the Physicians for Social appearing before a panel of the Civil Rights Commission stated, *"fine ash particles can adhere to lungs and penetrate deep into the body. Many of these particles contain silica, scourge of the respiratory system, as well as metals such as arsenic, chromium and cadmium, which can cause pulmonary and neurological problems and cancer. The metals mix together in the dust and can attack the same organ at once – the kidneys, for example –amplifying the damage*."[20]

> *"Poorly managed storage facilities that hold dry ash are susceptible to winds that create fugitive dust that can impact communities living near the storage facilities. The smaller particles, those with diameters less than 10 µm when inhaled, can penetrate deep into the lungs leading to inflammation of cells and irritation of the*

Fuel, October 2012

[18] Zierold KM, Odoh C. A review on fly ash from coal-fired power plants: chemical composition, regulations, and health evidence. Reviews on Environmental Health. 2020 Apr. DOI: 10.1515/reveh-2019-0039.

[19] As summarized in Environmental Justice: Examining the Environmental Protection Agency's Compliance and Enforcement of Title VI and Executive Order 12,898, September 2016

[20] Panel of experts, January 22, 2016, contained in Commission on Civil Rights Report,

mucous membrane of the respiratory tract leading to respiratory and cardiovascular conditions associated with exposure to particulate matter (150–153)."[21]

See evidence for hexavalent chromium concentrations in coal ash particles found in the homes of the Paiute Moapa River Reservation in Nevada in Section__.

For a thorough summary of the evidence in a recent article by Zierold and Odoh.[22] The authors cite numerous references containing measurements that show that metal concentrations in fly ash tend to be multiple times higher than the content in the source coal. This just published article can be found in full article in Attachment 1 to these comments. Numbered references can be found in the attached article.

> Multiple researchers have studied the composition of fly ash and have reported that the concentrations of metals are higher in fly ash than in the parent coal (68–70). Spencer and Drake assessed fly ash from Iowa, United States, and found that the trace elements of metals existed in concentrations 2 times greater than metals found in the original coal (68). Bhangare et al. found that in ashes from India, concentrations of lead, copper, cadmium, zinc, iron, manganese, chromium, nickel, magnesium, lithium, cobalt, mercury, and arsenic were higher in fly ash, compared to bottom ash or coal (69). Yao et al. reported that trace element levels in Chinese coal may be 4–10 times higher than those found in the original coal (51). Verma et al. (70) reported concentrations of five metals in coal and in the corresponding fly ash. The concentration of lead in coal was 4 ppm and was found to be 35 ppm in fly ash. The concentration of chromium was 8 ppm in the parent coal and 65 ppm in the fly ash (70).

Research as also shown that metals can enter the brain through several pathways, including the nasal olfactory pathway and by crossing red blood cell membranes.[23]

Calderon-Garciduenas et al. showed that particulate matter <2.5 µm can passing through the nasal olfactory pathway into the circulatory system and brain. Large numbers of small diameter particles can also penetrate membranes and pass through the lung tissue. Particulate matter that crosses the blood-brain barrier may potentially allow concentrations of metals to access to the brain and caused diseases of the central nervous system.[24]

Research has also established that radioactive substances are also concentrated in fly ash. An article by Lauer et al. found that naturally occurring radioactive materials in coal ash have activities[25] order of are 7-10- and 3-5-fold higher than their activities in parent coals and average U.S. soil, respectively.[26] "This study lays the groundwork for future research related to the environmental and human health implications of CCR disposal and accidental release to the environment in the context of this elevated radioactivity."[27] A number of the heavy metals and radionuclides contained in coal fly ash have been classified as carcinogens.

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[21] Zierold KM, Odoh C. A review on fly ash from coal-fired power plants: chemical composition, regulations, and health evidence. Reviews on Environmental Health. 2020 Apr. DOI: 10.1515/reveh-2019-0039.

[22] *Ibid*.

[23] *Ibid.*

[24] Calderon-Garciduenas L. et al., Pediatric respiratory and systemic effects of chronic air pollution exposure: nose, lung, heart, and brain pathology. Toxicol Pathol 2007;35(1):154–62.

[25] Activity of a radioactive is defined as The strength of a radioactive source is called its activity, which is defined as the rate at which the isotope decays. Specifically, it is the number of atoms that decay and emit radiation in one second. Source: https://www.nde-ed.org/EducationResources/CommunityCollege/RadiationSafety/theory/activity.htm

[26] Lauer, N. et al. Naturally Occurring Radioactive Materials in Coals and Coal Combustion Residuals in the United States, Environ Sci Technol . 2015 Sep 15;49(18):11227-33. https://pubmed.ncbi.nlm.nih.gov/26328894/

[27] *Ibid.*

5. *Community health concerns related to airborne coal fly ash with additional recommendations:*
The physical and chemical characteristics as well as their radioactivity all indicate that exposure to CCR fly ash has a strong potential to adversely impact the health of people who live and/or frequent areas near CCR ash disposal areas. Several publications (as cited below) present evidence on the potential health effects associated with community exposure to airborne coal fly ash from CCR disposal facilities.

Children are more at risk than adults:

> *"Children tend to breathe through their mouths and have larger lung surface area per body weight, compared to adults. Children's lungs do not develop completely until late teen years, and developing organs like the lungs are more susceptible to toxic effects and environmental pollutants. In addition, children absorb more pollutants than adults and are more likely to retain them over time because they tend to spend more time outside. Children tend to be mouth breathers as well (not just nasal breathers) which increases their ventilation rate, thereby increasing the amount of pollutants taken up by the lungs."* [28]

> *"Children have higher rates of respiration relative to adults, increased hand-to-mouth behavior, and a tendency to play near the ground, which increases exposure to ambient particulate matter."* [29]

> A recent study found*: "… living near coal ash was found to be significantly associated with increased odds of adverse health outcomes and sleep problems for children. It is important to further assess the impact of coal ash exposure on the health and sleep of children living near coal ash storage facilities because exposure to particulate matter and heavy metals has been found to affect multiple organ systems and impair cognitive function.*[30]

Disproportionate impact on minority and poor communities: My involvement with NRG's coal waste landfill in Brandywine, MD and with NV Energy coal ash facility adjacent to the Moapa Paiute community is consistent with surveys and case studies presented in Earthjustice's Comments on EPA's 2019 proposed CCR regulations[31] and with those reported in the 2016 report of the Civil Rights Commission on coal ash and its impact on minority communities. The report states: *"Racial minorities and low income communities are disproportionately affected by the siting of waste disposal facilities and often lack political and financial clout to properly bargain with polluters when fighting a decision or seeking redress."*[32]

Evidence from the Brandywine, MD and Moapa sites also reinforce findings by both EPA and a host of environmental organizations that minority and indigenous communities are disproportionately affected by exposure to coal ash particulates with elevated risks of disease.

<u>The federal government should provide medical and financial assistance to residents of affected communities, and to communities for purposes of rebuilding, and the safe restoration of CCR disposal areas. Operators of all uncontained CCR disposal units, piles, should within a period of no more than 60 days stop the placement of CCR.</u>

Medical research and assistance to communities: There is an urgent need for additional to determine the full impacts of airborne coal fly ash on the health of residents that live, work, or play in close proximity to

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[28] *Ibid.*

[29] Clara G. Sears, Kristina M. Zierold, 2017, Health of Children Living Near Coal Ash, *Global Pediatric Health,* https://journals.sagepub.com/doi/10.1177/2333794X17720330

[30] *Ibid.*

[31]

[32] U.S. Commission on Civil Rights, Environmental Justice: Examining the Environmental Protection Agency's Compliance and Enforcement of Title VI and Executive Order 12,898. September 2016. Report available on the Commission's website at www.usccr.go

coal fly ash facilities. The federal government should provide medical and financial assistance to residents of affected communities and workers who have illness potentially related to coal ash exposure.

6. Additional evidence from the Brandywine and Moapa communities affected by CCR disposal sites:

6.1 NRG's Brandywine CCR landfill facility is located a few hundred feet from a pre-K playground and a T-ball field for young children. The coal ash comes from two coal burning power plants in S. Maryland, including the Chalk Point Power Plant one of four existing fossil fuel power plants within a 13 mile radius of the Brandywine area, a predominantly African-American area. The Maryland Public Service Commission has approved a fifth power plant located a half-mile east of the Brandywine elementary school. The area has been included as part of an environmental justice civil rights suit filed by several local organizations.

The Prince George's County Council in 2019 denied a permit that would have allowed NRG to disposal of coal ash for an additional eight years. However, the County's action was recently overturned by an appeals court. The land fill was used for 44 years to dispose of coal ash and currently has a permit to use the site for CCR disposal for another 8 years unless the County takes further action which is upheld in Courts.

See photographic evidence below and CTV cable video at https://www.youtube.com/watch?v=xiT5aK0CV88

Heavy Metal Analysis: The Brandywine CCR landfill receives coal ash from two coal fired power plants Morgantown in Charles Co. and Chalk Point in Prince George's Co. The following laboratory report shows the heavy metal content of coal fly ash from the Morgantown Power Plant.

Morgantown Power Plant

Unit F1 Flyash

14J0732-04 (Solid) Sampled: 10/09/2014

Analyte	Result	Reporting Limit	Units	Limits
Mercury	**0.32**	0.025	mg/kg dry	
Metals, Total by EPA 6000/7000 Series Methods				
Silver	ND	2.2	mg/kg dry	
Aluminum	**22000**	11	mg/kg dry	
Arsenic	**99**	4.5	mg/kg dry	
Boron	**300**	22	mg/kg dry	
Barium	**210**	2.2	mg/kg dry	
Beryllium	**4.7**	0.90	mg/kg dry	
Calcium	**12000**	22	mg/kg dry	
Cadmium	**1.9**	0.45	mg/kg dry	
Cobalt	ND	2.2	mg/kg dry	
Chromium	**49**	2.2	mg/kg dry	
Lead	**25**	4.5	mg/kg dry	

Coal ash, and especially fly ash is toxic containing known human carcinogens including arsenic, cadmium, and chromium (WHO) and other toxic metals including lead and mercury.

Fly ash particulates with these in the PM2.5 range are respirable; they can penetrate deep into the lungs and cause a variety of adverse health effects. (Dr. Wilson for details).

The laboratory analyses submitted to MDE by NRG detect these metals at many times their reporting levels.

See exhibits: Laboratory Reports for Chalk Point and Morgantown fly ash samples.

Examples from Microbac Laboratories, Inc. Nov. 10, 2014 Chemical Analysis Report

Location of NRG Ash Landfill (Phase 2) relative to Little League fields and Playground at N. Keys – Brandywine Community Park: Google Earth, April 2015, Labels and Google Earth Ruler distances, Henry S. Cole, Ph.D.

Figure 7: Location of pending coal ash Phase 2 disposal fill areas (currently permitted) located several hundred feet from the children's T-ball and playground.

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Figure 8

Cole Photo: Brandywine N. Keys Community Park, little league field looking North towards Phase 2 ash fill. Nov. 6, 2016. This is the further north of the two ball fields.

Cole Photos: Young boy and girl play T-Ball at the same ball field, Nov. Nov. 11, 2016

Climbing structure for young children in circular playground area. Photo H. Cole

November 11, 2016

Figure 9: See Figure 7 for location of playground.

Figure 10: Child in circular playground Nov. 6, 2016 Cole Photo: looking north towards ash landfill.

Figure 11 is a map of the Brandywine, MD area showing the concentration of sites which are known to release toxic substances and Clean Air Act Criteria Pollutants into the air and/or water. The Mattawoman Power Plant is a potential future emitter of Clean Air Act criteria pollutants was granted a license by the MD Public Service Commission in 2015, but has not started construction as of July 2020. Clearly this is a prime example of environmental injustice—one similar to those faced by minority and low income communities across the U.S.

The Google Earth satellite image of the landfill area shows the elevated ridge that was used, covered, and closed in the early stages of the disposal. The elevation, about 140 feet above the original surface. Higher wind speeds at elevation increase the likelihood that fly ash had become airborne.

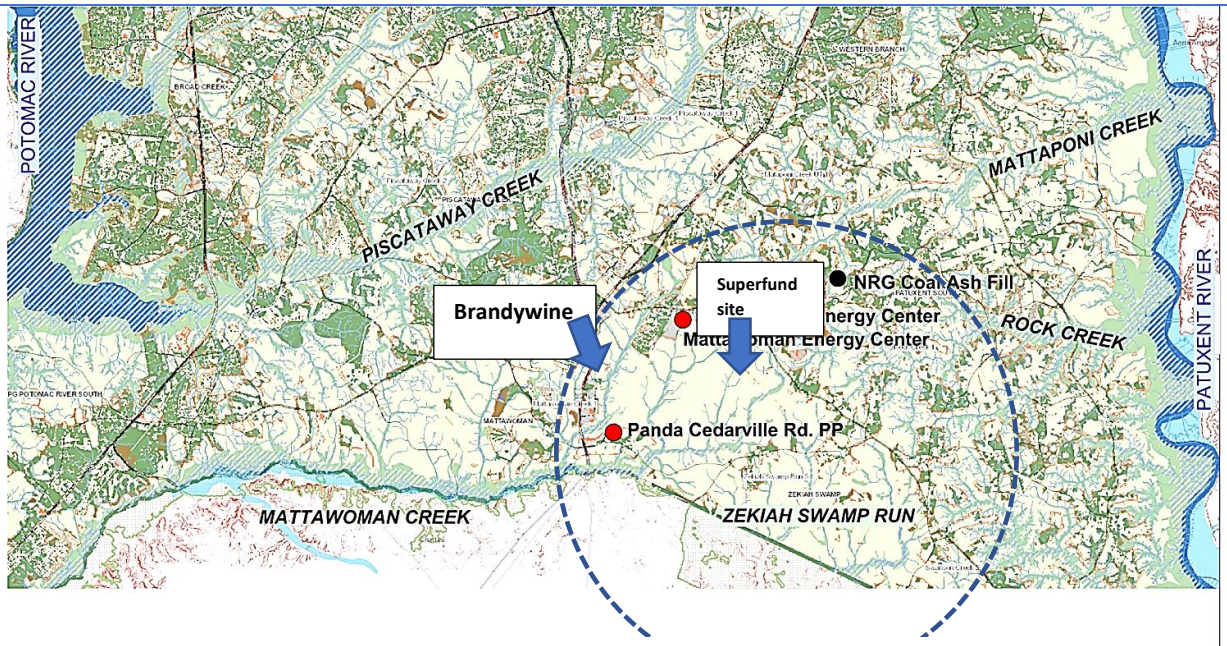

Figure 11: Cluster of sites within approx.. 5 miles of the NRG Coal Ash Site with potential for toxic releases. .

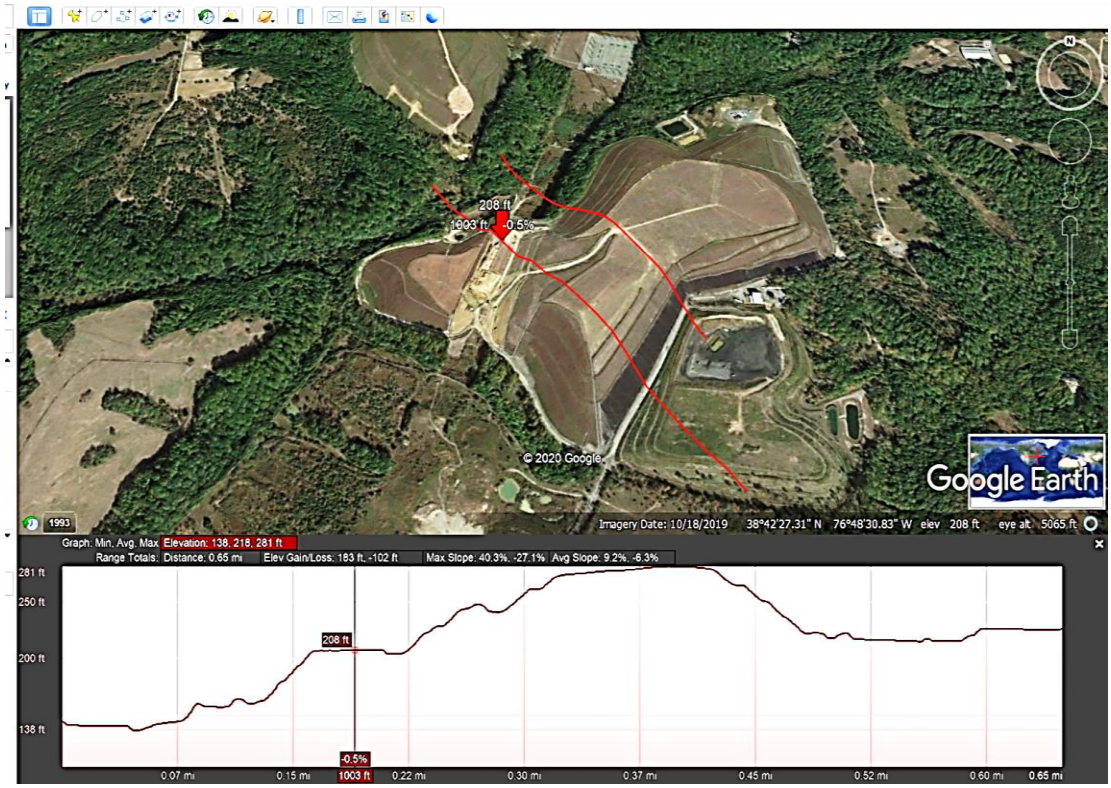

Figure 12: Google Earth 3-D and vertical profile showing height of early landfill disposal area, covered, and closed; The maximum height is about 140 feet above the original land surface (wooded area to the northwest).

6.2 *NV Energy coal ash ponds and fill impacts Moapa Paiute Reservation, Nevada.* Community members have been exposed to coal ash particles from the NV CCR disposal facility for many years. Pathways of exposure include airborne fly ash (either direct or re-entrained), and via contact with surfaces (e.g. hand to mouth contact). EPA should closely examine the history and current state of the site and reports by residents who believe their respiratory illness and other ailments are related to exposure to coal ash from the NV facility.

In April 2013, dust samples were collected from indoor surfaces in the homes of five Moapa families. The homes are located less than a mile from the NV ash disposal facility. However, The identities of residents are blocked to protect their privacy. Samples were taken by the reservation's environmental director. Labs that conducted the samples are identified in the table.

Samples were analyzed using scanning electron microscopy (SEM) and chemical analysis to determine hexavalent chromium concentrations. The following table shows the results of both analyses. Part A shows Cr+6, which EPA designates as a human carcinogen, was present in 7 of the 10 samples at levels above the quantifiable detection limit. Each of the 5 homes had at least sample with detectable level of Cr+6. Three of the samples were at least 4 times higher than the detection limit. From the results, it is likely that higher concentrations of Cr+6 are present on outdoor surfaces.

Chromium 6 Chemical Analysis by Phoenix Subcontractor to Pace Analyatical				
			Detects > Detect Level (mg)	Detection level
Sample	Location	Source Description	Result	
1A	[redacted]	Fridge Top	0.003	0.002
1B		Living room Vent	0.003	0.002
2A		Closet	0.004	0.001
2B		Window sill	Non Detect	0.001
3A		Top kitchen cabinet	Non Detect	0.001
3B		Top bathroom light	0.002	0.001
4A		Top of fridge	0.001	0.001
4B		Cabinet window sill	0.004	0.001
5A		Top washroom cabinet	Non Detect	0.001
5B		Top living room cabinet	0.005	0.001

Units are in mg and reflect amount collected from 100 square cm cloth (wipe)

Part A Cr6

Microscopy by MicroVision			
Sample	Location	Source Description	Result /
1C	[redacted]	Living room ceiling fan	1 % = ash, char, fly ash, coal ash
2C		Living room window sill	Trace: ash, char, fly ash, coal ash
2D		Top ceiling fan	1 % = ash, char, fly ash, coal ash
3C		Hallway thermostat	Trace: ash, char, fly ash, coal ash
3D		Top of closet door	Trace: ash, char, fly ash, coal ash
4C		Living room window sill	Trace: foam
4D		Bedroom window sill	Trace: coal ash
5C		Stuffed bobcat living room wall	Trace: char, coal ash
5D		Living room window sill	Trace: char, coal ash

Part B SEM

Fly ash: fine, light weight, spherical particulates, no carbon
Coal ash: denser, pitted, partially combusted contains carbon

Table Part B and Fig. 13 show that all homes had samples containing microscopic evidence of coal ash. Figure 13 provides SEM evidence for the presence of fly ash.

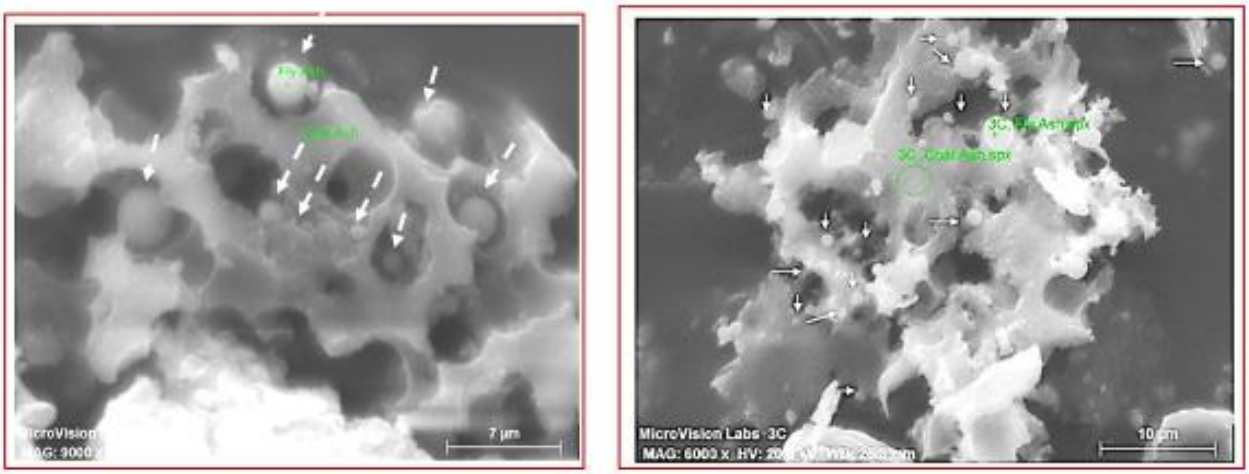

Figure 13: SEM photographs each showing a large porous ash particle with much smaller embedded fly ash particles, the spherical particles, identified by the white arrows. Fly ash particulates ranged in size from < 1 um to 3 um. Samples from indoor surfaces.

Figure 14 shows the location of the ash disposal units and the Moapa area. Ash disposal units are located less than a mile to the southeast and south-south east of the Moapa community. Figure 2 shows the wind rows for the summer months, the time when the Moapa community is most frequently downwind of the ash disposal areas.

Figure 15 shows the wind roses for summer in the Moapa area. (The directional bars indicate the direction from which the wind blows.) Note also that there is a relatively high percentage of the winds from the SSE-SE have relatively high wind speeds. High wind speeds coupled with extremely high temperatures and low relative humidity favor the release of CCW to air. Water sprayed to reduce releases of CCW will evaporate very quickly.

Figure 16 shows that there is an elongated valley oriented from SE-SW which is likely to channel winds and plumes of coal fly ash from the CCR disposal area toward the Moapa community as seen in Figure 1.

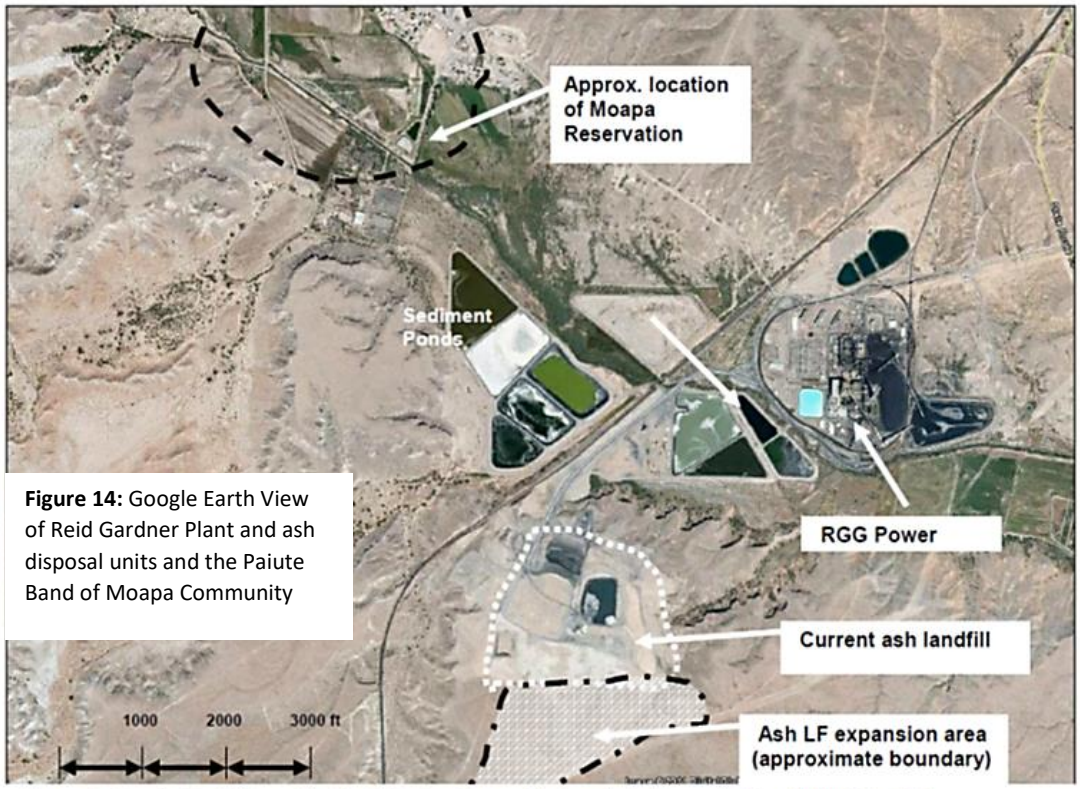

Figure 14: Google Earth View of Reid Gardner Plant and ash disposal units and the Paiute Band of Moapa Community

: Google Earth View of the Reid Gardner Power Plant and ash disposal units with the Paiute Moapa Reservation.

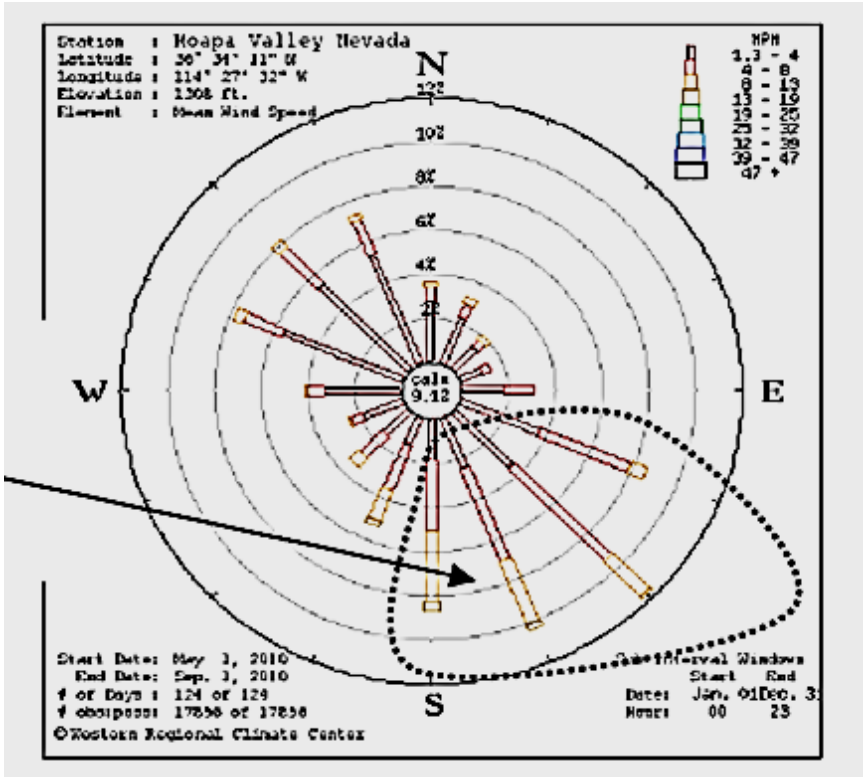

Figure 15: Wind rose diagram from summer months for the Moapa Valley weather station located

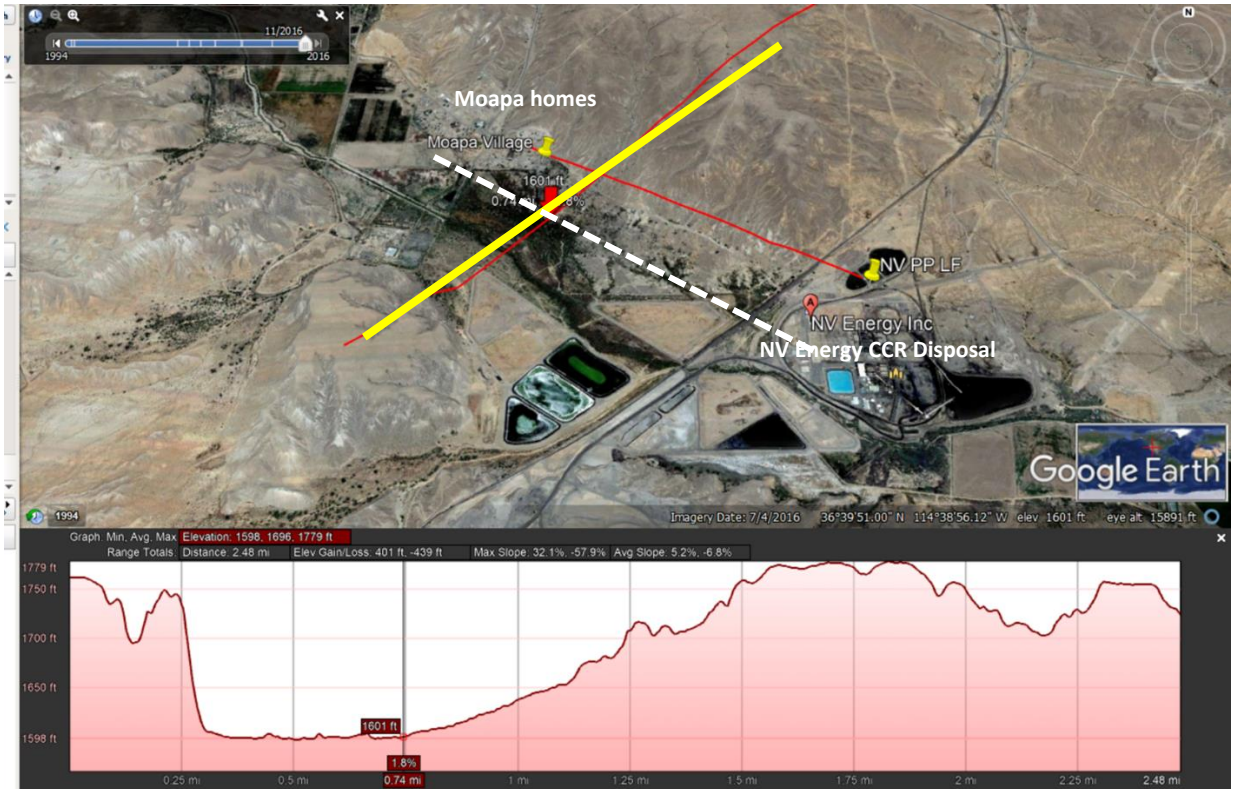

Fig. 16: Vertical cross section showing SE to NW oriented valley (relief several hundred feet) between Moapa village and NV CCR. Cross section, yellow; along valley white dashed.

3.2. Henry S. Cole & Associates, Inc. October 2019 Comments on EPA's August 2019 Proposed Rule; Docket No. EPA-HW-OLEM-2018-0524 (Cole, 2019)

This document, which was originally submitted in response to the August 2019 proposed rule, was re-provided in follow-up to a stakeholder meeting held between May 2020 and August 2020.

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Written Comments on U.S. EPA's Proposal: Enhancing Public Access to Information and Reconsideration of Beneficial Use Criteria and Piles: Supplement to oral comments presented via EPA's webinar on October 10, 2019.

Submitted by Henry S. Cole, Ph.D., President, Henry S. Cole Environmental Associates, Incorporated

October 15, 2019

1.0 Summary and Conclusions: EPA's coal ash proposal represents a significant rollback of regulations critically needed to protect people living near coal ash disposal sites. The ill-conceived revision would allow disposal practices that would increase—rather than prevent—the release of highly toxic coal ash particles into the environment—even in areas in close proximities to communities. Moreover, the proposed rule essentially guts regulations based on an abundance of evidence assembled by EPA (and scientific community) demonstrating the need for the protective and preventive measures required by the existing regulations.

In addition, this misguided proposal also serves as incentive for more coal burning. This despite the undeniable evidence that more coal combustion will contribute to rapidly accelerating and detrimental climate change.

These comments are based in part on my expert work on two existing coal ash disposal sites:

- NRG's Brandywine coal ash landfill site adjacent to a community playground and T-ball little league baseball field.

- NV Energy's Reid Gardner Power Plant landfills and lagoons with probable exposures to the Paiute Native American Community located in Moapa, Nevada.

2.0 Qualifications: I am an atmospheric and environmental scientists with more than 40 years of experience on a variety of issues including air pollution, hazardous waste sites, and the impacts of fossil-fuel power plants. During the late 1970's and early 80's I served as a senior scientist and Section Chief at U.S. EPA's Office of Air Quality and Planning. My work at OAQPS, involved the fate and transport of air pollutants, including air quality monitoring. From 1983 to 1992, I was the national science director for Clean Water Action and testified numerous times before U.S. House and Senate committees on Superfund, Dry cleaner releases of perchloroethylene, waste incinerators, and mercury contamination.

As President of Henry S. Cole Environmental Associates, I have served as an expert witness on the environmental impacts of landfills, power plants, and proposed land uses have adverse environmental impacts, including several coal ash disposal sites.

My business website and resume are available at: https://henryscoleinc.wordpress.com/ and https://henryscoleinc.wordpress.com/2017/03/12/henry-s-cole-ph-d-resume/ respectively.

3.0 The case against the proposed rollback: Coal ash is a highly toxic substance containing arsenic, boron, cadmium, hexavalent chromium, lead, lithium, mercury, other heavy metals and radioactive substances. These toxic contaminants raise the risk for cancer, heart disease, and stroke, and can inflict neurological damage on children. Although heavy metals may undergo chemical reactions in the environment, they do not breakdown or disappear. Therefore repeated deposition can therefore lead to increasing levels of contamination in soil and sediment.

Airborne ash particulates also pose respiratory risks, especially to those with childhood asthma, and those with chronic lung disease. Coal ash includes fly ash with substantial percentages of particles in the respirable range (less than 2.5um).[1]

> In the United States, the EPA estimates that 6 million people, including 1.5 million children, are exposed to coal ash.[11] Children have an increased risk of exposure to fly ash. Children have higher rates of respiration relative to adults, increased hand-to-mouth behavior, and a tendency to play near the ground, which increases exposure to ambient particulate matter.[2]

EPA also states that hexavalent chromium (Cr(VI)) and arsenic are two dangerous environmental pollutants, because they are known human lung carcinogens and exposure is widespread.[3]

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[1] Wang, X, et al., "Effects of the Duration of Landfill Disposal on the Physicochemical, Mineralogical and Toxicity Characteristics of Coal Ash, 2018, https://www.tandfonline.com/doi/full/10.1080/19392699.2018.1445622
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[2] Sears CG, Zierold KM. Health of Children Living Near Coal Ash. Glob Pediatric Health. 2017;4:2333794X17720330. Published 2017 Jul 25.

[3] https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/8511

In my judgment, EPA's coal ash rollback would allow energy companies to dispose of toxic coal ash in ways that will cause irreparable harm to people who live, work, play or go to school in the vicinity of the disposal site. A particular concern is the proposal's allowance of disposal of coal ash in *uncovered* piles with little or no restriction on height, slopes or location. Others have testified on the disastrous consequences of unprotected or poorly protected ash piles, lagoon when subjected to heavy rains and flooding—conditions likely to increase due to climate change.

3.1 NRG's Brandywine Coal Ash Landfill: Over the past few years, I have served as an expert witness in a case involving NRG's coal ash disposal landfill located in Brandywine, Prince George's County, Maryland. The coal ash disposed at this site comes from two large NRG power plants in Maryland, Chalk Point and Morgantown. A key element of my testimony was a video showing heavy coal ash particles being picked up by the wind and blown in heavy clouds towards the adjacent community.[4] The fugitive ash clouds occurred, despite NRG's regular spraying water on surfaces with freshly disposed coal ash. As shown in Figure 1, ash from exposed piles is readily entrained into the air with sufficient wind speed.

Figure 1: Fugitive ash from Brandywine ash disposal site Dec. 7, 2010 videographic evidence. The image is from a Prince George's County CTV program aired in December 2010, https://www.youtube.com/watch?v=xiT5aK0CV88\ "Fly Ash Threatens Air Quality of Maryland Community", by Patricia Villone.

Secondly, I presented photos showing a T-ball little league field and a playground for very young children located several hundred feet from NRG's landfill. (See Figures 2 and 3).

[4] Prince George's County TV, program on NRG's ash landfill in the Brandywine area: https://archive.org/details/Fly_Ash_Threatens_Air_Quality_of_Maryland_Community

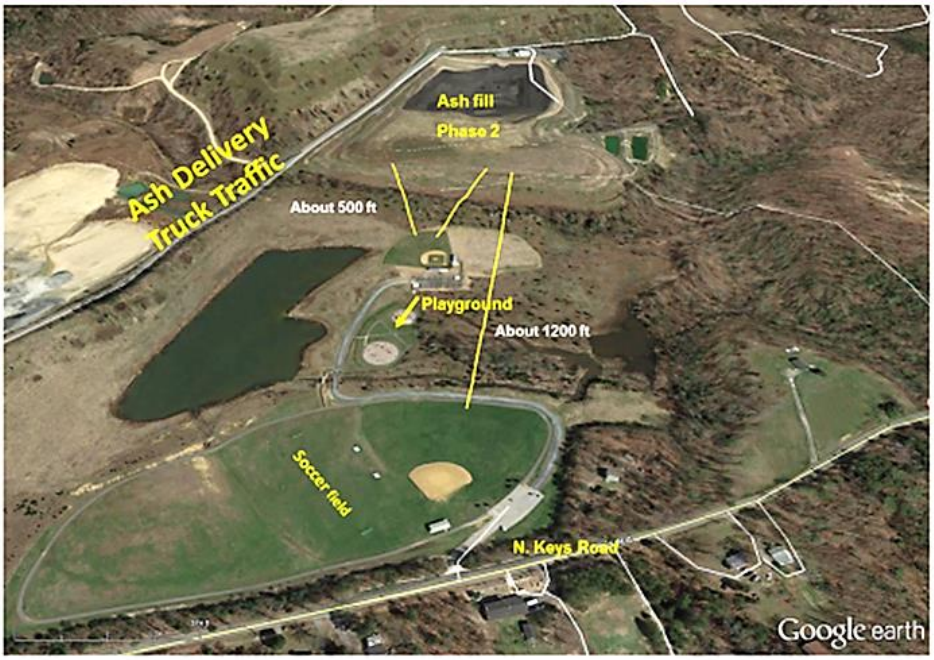

Figure 2: Location of NRG Ash Landfill (Phase 2) relative to Little League fields and Playground at N. Keys – Brandywine Community Park: Google Earth, April 2015, Labels and Google Earth Ruler distances, Henry S. Cole, Ph.D.

Figure 3a. Cole Photo: Brandywine N. Keys Community Park, little league field looking North towards Phase 2 ash fill. Nov. 6, 2016.

Figures 3b and c. Cole Photos: Young boy and girl play T-Ball at the same ball field, Nov. Nov. 11, 2016

Figure 4: Child in circular playground Nov. 6, 2016 Cole Photo: looking north towards ash landfill.

An additional factor was that the landfill had been the subject of a suit brought by the Patuxent Riverkeeper and the Maryland Department of the Environment—based on evidence showing that heavy metals from the site were contaminating nearby surface water with cadmium, arsenic, selenium and others, some with concentrations 50 times higher than federal regulatory levels. This action required NRG to increase discharge monitoring, conduct an extent of contamination study, and to implement corrective action measures.

This evidence, presented at administrative hearings, moved the Prince George's County Council to deny NRG's application to use the site for ten additional years beyond its expired permit.[5] The County's decision was upheld by the Court of Appeals. The case was brought by the Patuxent Riverkeeper (Frederick Tutman, Riverkeeper) and the University of Maryland Environmental Law Clinic (students and Director, Seema Kakade).

3.2 Where will NRG's ash go? As stated previously, the proposal would allow companies to dispose of their coal ash in uncovered piles without protections or restrictions on location or height. No liners, no vegetative covers, to prevent erosion by wind and water and transport to nearby receptors (e.g. streams, lungs, etc.). Given that NRG can no longer dispose of its coal ash at its Brandywine landfill, where and how will it dispose of the ash from its two Maryland power plants? Will it place large volumes of highly toxic coal ash near to schools, playgrounds, homes, senior living facilities or hospitals? The proposal calls the piles "temporary," without any definition ("Welcome, stay as long as you like.")

3.2 Coal ash contamination of the Moapa Paiute Community, Nevada. Detailed Findings of April 2013 sampling study confirm that fugitive airborne coal ash from the Reid Gardner Power Plant contaminated indoor surfaces in the homes of the Paiute Native American Community in Moapa, Nevada. The study involved electron microscopy to identify coal ash particles and a

[5] Complete description of County Council Decision at http://www.mncppcapps.org/planning/DC_Final_Decisions/SE-4765.pdf

chemical analysis of ash samples from Moapa family home interiors. The evidence is consistent with photographic evidence provided by the Moapa Paiute community as shown in Figure 5. The homes from which samples were take were more than 1000 feet from the Reid Gardner Power Plant ash landfills and lagoons.

FILE PHOTO COURTESY OF THE MOAPA BAND OF PAIUTES
An ominous cloud of coal ash blows over the Moapa River Indian Reservation on April 7, 2011.

Figure 5: From the *Las Vegas Review Journal*, March 20, 2013.

2.1 Evidence: Samples were taken on April 29, 2013 from interior surfaces in 5 homes. Cr+6 was present in 7 of the ten samples at levels above the quantifiable detection limit. All of the homes tested had a least one sample with a detectable level of Cr+6. Three of the samples were at least 4 times the detection limit. EPA designates hexavalent chromium as a human carcinogen. All of the homes had samples containing microscopic evidence of coal ash.[6]

4.0 More coal burning, more coal ash, more damage. Finally, let's call the proposed rollback, what it really is—an attempt by the Trump Administration to lower the cost of burning coal—that is to give NRG and other power companies an incentive to keep burning coal by lowering disposal costs despite the rapidly dropping costs of renewable energy. For example two coal burning power plants, Chalk Point and Morgantown located in southern Maryland collectively generate about 6 million tons of greenhouse gases per year according to the state's Power Plant Research Program. In 2016, coal burning caused 1.36 billion tons of CO2 emissions.[7] Both plants have disposed their coal ash at the Brandywine landfill prior to its shutdown.

[6] Analysis conducted by MicroVision Labs, Inc., Chelmsford, MA 01824

[7] https://www.eia.gov/tools/faqs/faq.php?id=79&t=11

So where will the ash go, and what levels of protection can we expect if the Administration's proposed regulations take effect?[8] Piles? Fill material? With what threats to public health and the environment. The many companies that incentive to keep burning coal, while avoiding the coal-ash protections that are urgently needed to protect public health and the environment.

4.1 Mercury contamination from coal ash. There is another danger associate with increased disposal of coal ash minus regulatory protections to control releases:

> *As time goes on, the partitioning of primary Hg releases among media is changing: In 1950, 77% of the Hg released from coal combustion went directly into the air; by 2010 this fraction had dropped to 55%.Withmore Hg now finding its way onto land and into water bodies, it is critical to ensure that discarded coal combustion wastes containing Hg are transferred to secure landfills or other repositories, so that the Hg is not re-emitted to the air or washed into rivers and streams and thus re-enter the ecosystem. There is also an urgent need to know more about what happens to trace Hg contaminants when coal wastes are used in commercial applications.*[9]

And as EPA states:

> *"Once mercury from the air reaches water, microorganisms can change it into methylmercury, a highly toxic form that builds up in fish. As larger fish eat many smaller fish, mercury concentrations increase in their body tissues. Mercury contamination affects populations of numerous fish species trout, bass, salmon and others. Waterfowl and mammals that eat fish, including loons and otters, and songbirds, bats, and amphibians that feed on insects can be exposed to high levels of mercury. Birds and animals suffering from mercury exposure behave differently and have less reproductive success."*[10]

5.0 A note to EPA's dedicated professionals: I left EPA in 1983, during the Reagan/Gorsuch an era where regulations, enforcement, and science were being gutted. I felt that I could do more good working as Science Director with Clean Water Action/Fund nationwide campaign to strengthen the Superfund Law. Thus, it appalls me to see history repeating itself. Every person must decide what to do when the agency you work for no longer acts to uphold its mandates under the law—in this case to protect the public health and the environment.

Do whatever you can, and whatever you believe is right.

Henry S. Cole, Ph.D.

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[8] Others have testified on the dangers with expanded use of coal ash for "beneficial" purposes.

[9] David G. Streets et al. "Historical releases of mercury to air, land, and water from coal combustion", Science of the Total Environment 615 (2018) 131–140

[10] https://www.epa.gov/mats/safer-environment#mercury