R. Paul Smith Power Station Landfill Reclamation Project

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ABSTRACT

The Maryland Environmental Restoration Group (MERG) and the Paul Blum Company (PBCo LLC) report the completion of their project to reclaim and restore the coal combustion product (CCP) landfills and sedimentation ponds of the R. Paul Smith Power Station Landfill in Berkeley County, West Virginia. Over the course of the 12-year project, the team excavated and reclaimed all of the 3.2-million tons of comingled fly ash and bottom ash from 80-acres of R. Paul Smith Power Station impoundments.

To the best of the project team's knowledge, this is the first-ever 100% beneficial use of a coal-fired power producer's coal ash impoundment and landfill anywhere in North America.

By completely removing all of the coal ash and restoring the natural vegetation, the project team significantly reduced the potential groundwater contamination and associated monitoring, as well as eliminating any stormwater runoff into the adjacent Potomac River. With all the ash removed and the site certified clean, the owner will likely request a release of its West Virginia landfill permit.

To the nearby Portland cement producers, the beneficial reuse project offered a long-term, uninterrupted and less expensive supply of kiln feedstock. Replacing shale with fly ash in the manufacture of Portland cement reduces the heat and fuel required, thereby saving production costs as well as significantly reducing CO_2 emissions from the plant and eliminating emissions from the alternative raw material mining operations.

BACKGROUND

Over the last decade or more, worldwide geo-political environmental pressures have increased to reduce the carbon footprint and emissions from stationary industrial sources, such as coal-fired power plants.

Faced with escalating operating costs, an uncertain future, and increasing competition from alternative energy sources, this has led to the closure or refueling (gas) of large numbers of coal-fired power plants across the USA.

One consequence of this action is that, increasingly, there is a shortage of quality coal ash from active power plants. This, coupled with the shortage of blast-furnace slag from iron ore processing, has also introduced a challenge for materials sourcing for the cement and concrete industry – itself under increasing pressures to reduce its carbon footprint.

Along with the pressure to close power plants, electrical utilities are facing additional challenges to close ash landfills and impoundments to address potential long-term environmental upset contamination, and equally well to reduce or eliminate legacy liability.

The outcome of all this is that there has been a considerable uptick in activities to environmentally restore decommissioned coal ash landfills – either to transfer the ash to a secure engineered landfill, or to reclaim raw materials for beneficial use, such as cement making and concrete pozzolan production. Clearly, the beneficial use option is preferable if feasible. As is often true in the coal ash industry, out of challenges come opportunities.

This paper provides an overview of a 12-year project by the MERG-PBCo team to restore the landfills and sedimentation ponds for the R. Paul Smith Station and to beneficially reuse the recovered coal ash.

PROJECT DESCRIPTION

The R. Paul Smith Station is situated in Williamsport, Washington County, MD, adjacent to the Potomac River. When active, it was a 2-unit, 116 MW, peak demand plant that burned eastern bituminous coal. The power units were commissioned in 1947 (U1) and 1958 (U2), and both were decommissioned in 2012 (Fig. 1). There was no FGD system on the plant.

Comingled fly ash and bottom ash from the power plant was transferred across the Potomac River to sedimentation ponds and landfills (~80 acres) in Berkeley County, WV, as shown in the aerial view (Fig. 2).

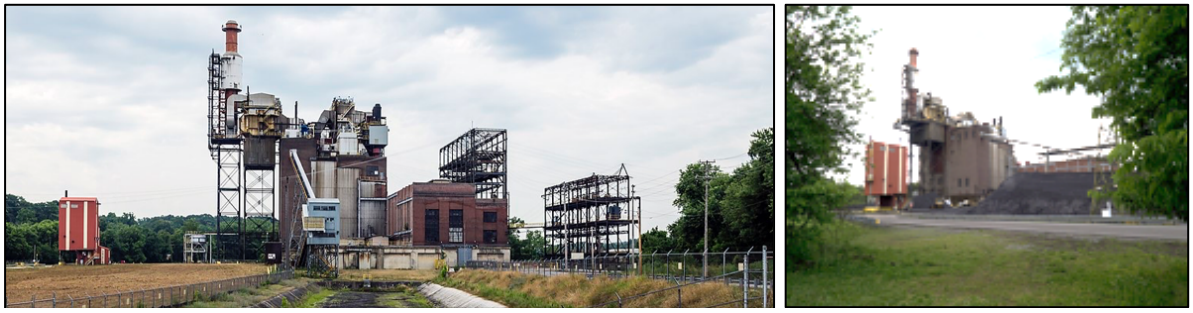


Figure 1. Decommissioned R. Paul Smith Power Station.

The goals of the project were established as follows:

- To recover / harvest all of the coal ash in the R. Paul Smith Power Station Impoundment in Berkley County, WV, leaving a certified clean site.
- To confirm the suitability of the coal ash in the impoundment for beneficial use by conducting a sampling and materials characterization program and contacting prospective customers.
- To conduct a controlled coal ash recovery operation with environmental controls appropriate for a project close to the Potomac River, meeting the requirements of State DEP.
- To meet the production and quality requirements of prospective customers for the coal ash.

IMPOUNDMENT CHARACTERIZATION

Characterization of the impoundment involved the following activities:

- Review of survey maps, history, fuels, pollution controls, dates, and disposal practices. It was determined that the impoundment contained comingled fly ash and bottom ash, with no FGD material.

- A Geoprobe coring grid (Fig. 3) was designed with 6 Sections, three in Pond #3 (A, B, C) and three in the landfill area (D, E, F), each with 4 boreholes per section, for a total of 24 boreholes. Each borehole was drilled to a depth of 24 ft and 6 individual samples were recovered per borehole, for a total of 144 samples. The coring and sampling was conducted by Marshall Miller Associates under sub-contract.

- Physical, chemical, and mineralogical analysis was conducted on the samples, typical examples of which are collected in Figures 4-7 and Table 1. The materials characterization was conducted by AMEC Earth & Environmental, under sub-contract to Hemmings & Associates.[1]

Figure 2. Aerial view of R. Paul Smith Power Station, landfill, and ponds, c.2009.

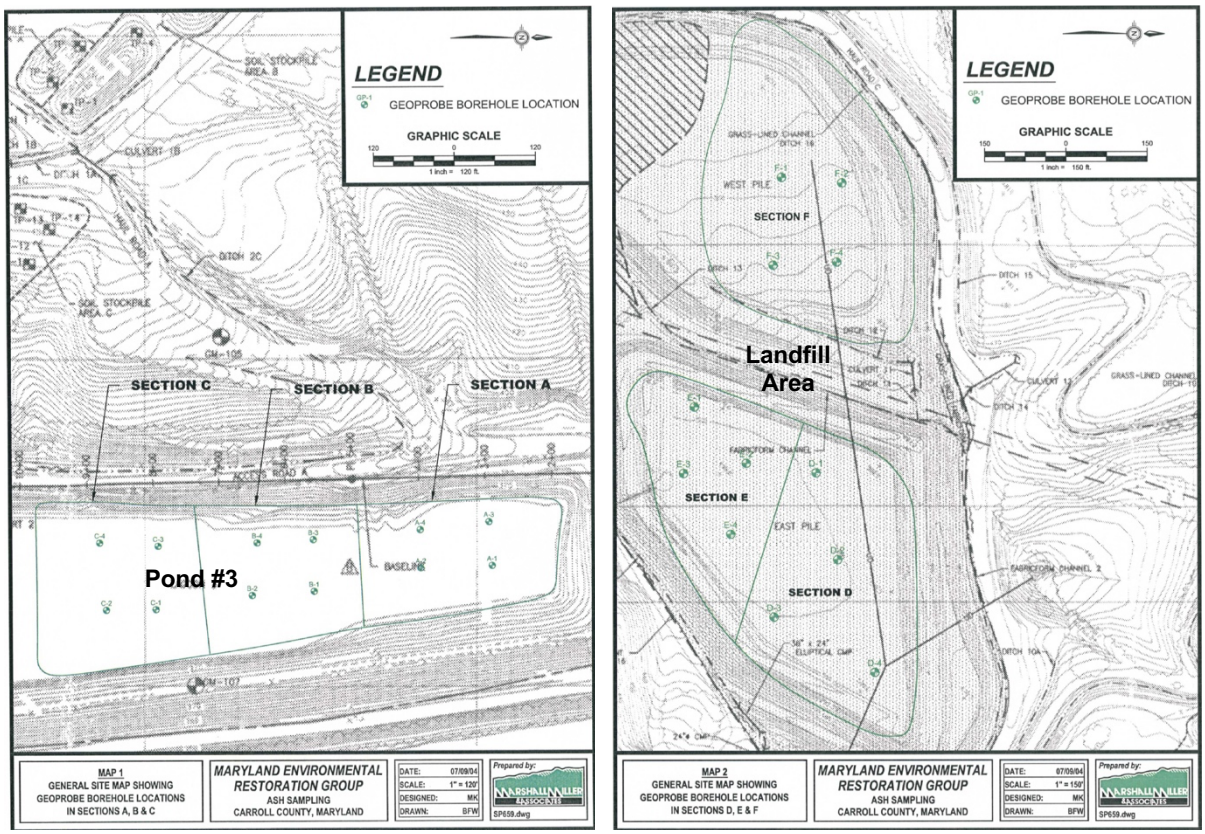


Figure 3. General site maps showing 6 sampling sections
and location of Geoprobe boreholes.

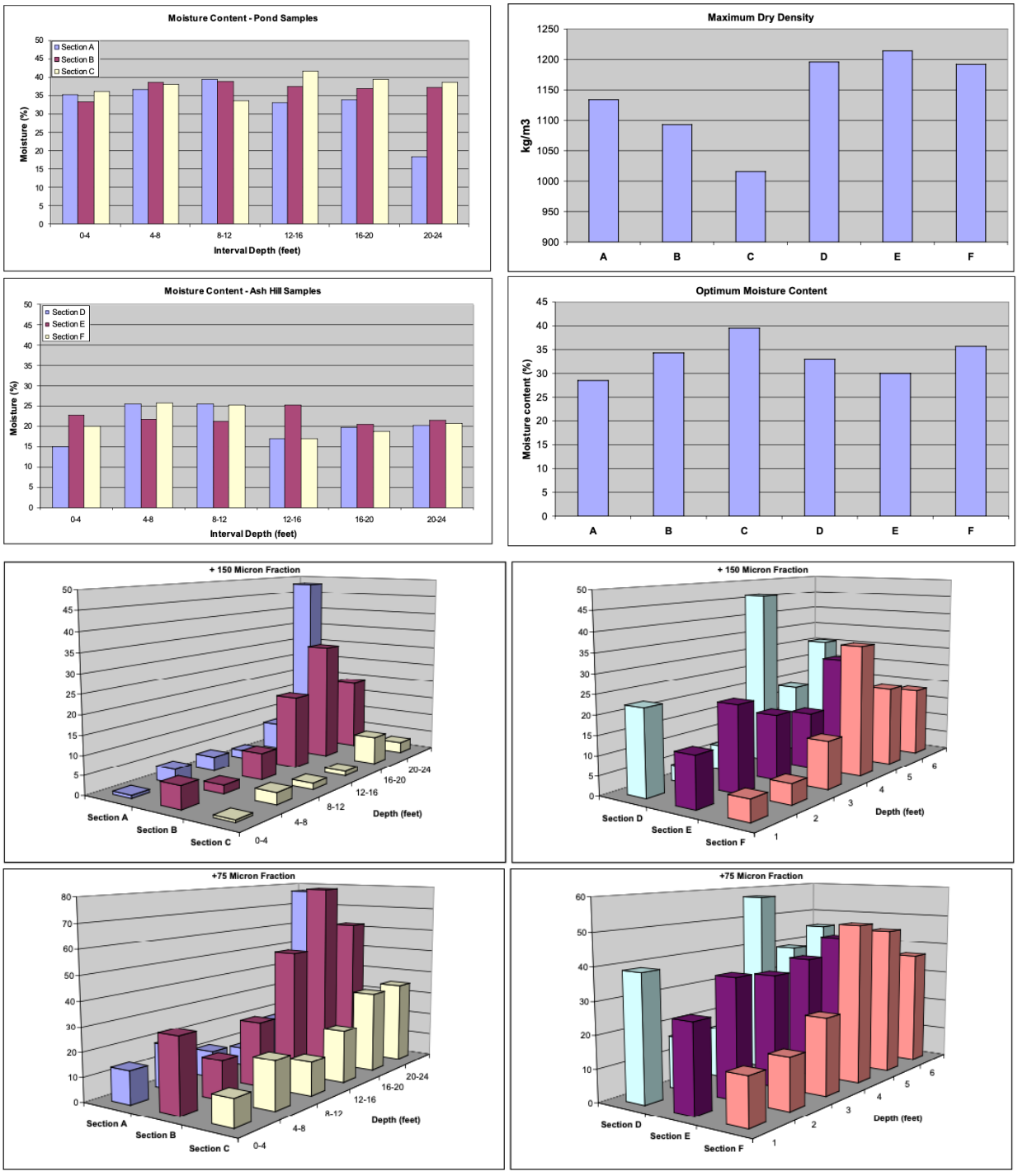
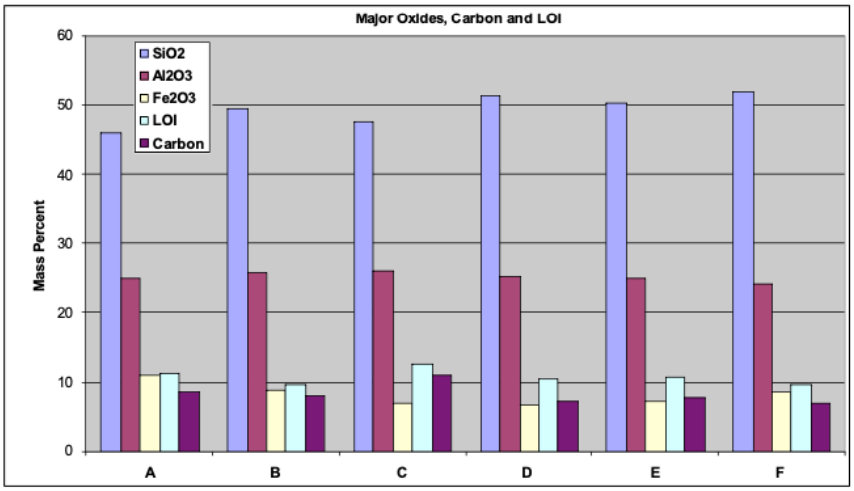


Figure 4. Typical physical properties of composite borehole ash samples.



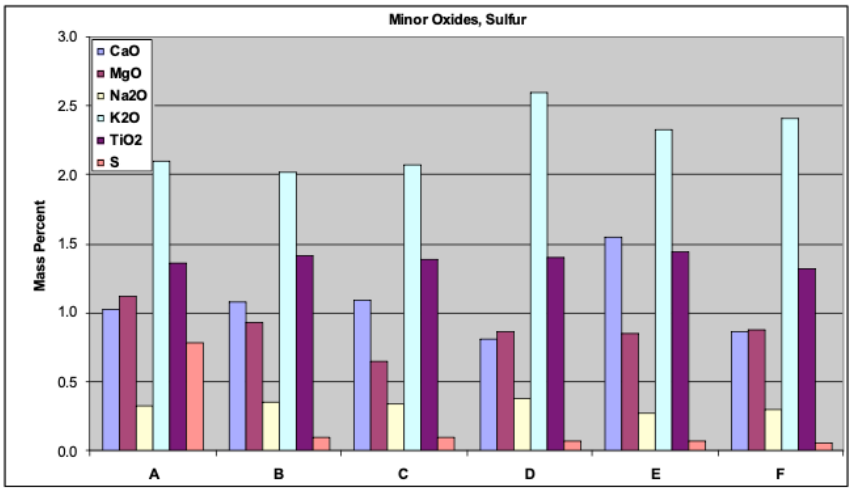


Figure 5. Typical chemical composition of composite ash samples showing major and minor elements.

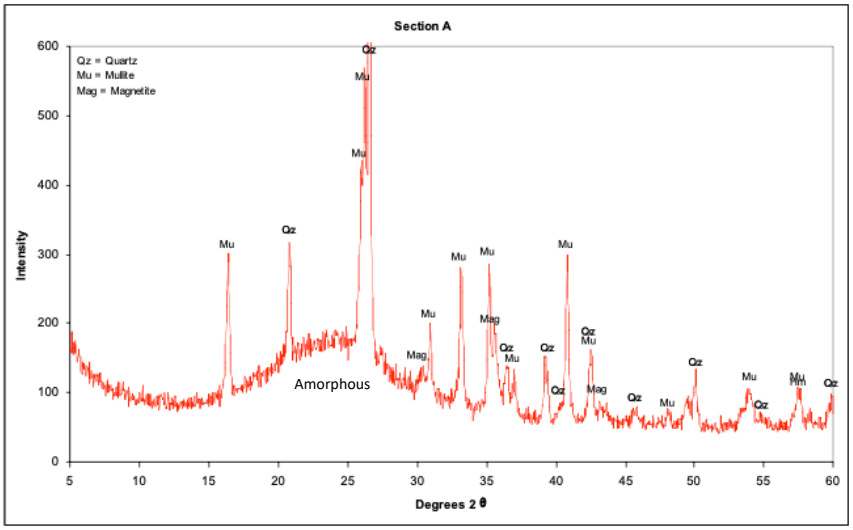


Figure 6. Typical mineralogy of borehole samples by X-ray (CuK_{α}) powder diffraction.

Table 1. Physical properties of Composite Borehole Samples

Section		Specific Gravity	Loose Density (g/cm^3)	Vibrated Density (g/cm^3)	Specific Surface Area (cm^2/g)	Maximum Dry Density (g/cm^3)	Optimum Moisture (%)
Pond	**A**	2.16	0.84	0.95	4500	1.13	28.5
	B	2.15	0.85	0.97	3180	1.09	34.3
	C	2.16	0.76	0.87	5610	1.02	39.5
Landfill	**D**	2.18	0.93	1.10	4190	1.20	33.0
	E	2.18	0.92	1.16	3990	1.21	30.0
	F	2.19	0.99	1.11	3910	1.19	35.7
			ASTM C29		ASTM C204	Standard Proctor ASTM D698	

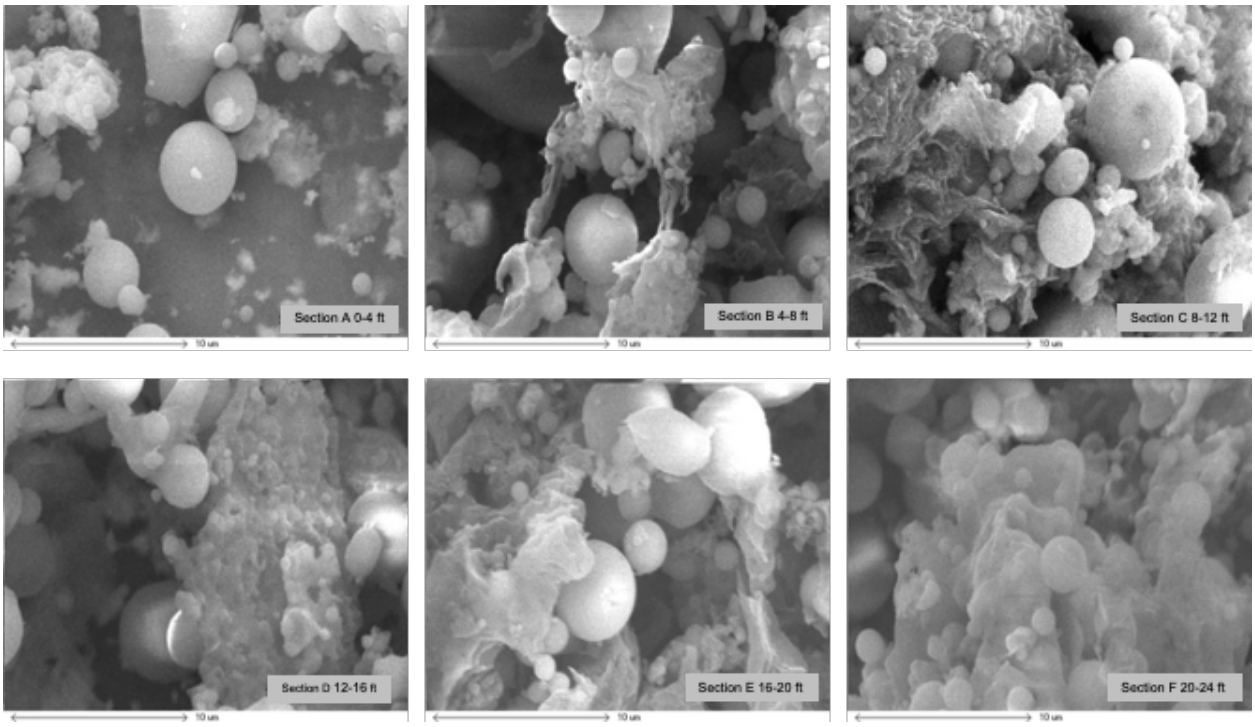


Figure 7. Representative scanning electron microscope (SEM) images showing spherical particles and UBC relics.

Characterization Findings

The ash samples collected from the boreholes showed a wide range of physical properties, as would be expected from comingled fine fly ash and coarse bottom ash in varying proportions. The moisture content was typically in the range 20-25%; and the loss on ignition (LOI), corresponding approximately to the unburned carbon (UBC) content, was typically in the range 5-15%.

The chemistry (Fig. 5) and mineralogy (Fig. 6) of composite borehole samples showed less variance, as would be anticipated because the fly ash and bottom ash have substantially the same composition.

The characterization data confirm that the R. Paul Smith ash is typical of a bituminous coal ash (ASTM C618 “Class F”), with characteristic features including low calcium content (2.0-2.5% CaO) and major oxide sum (SiO_2+Al_2O_3+Fe_2O_3) > 50%, accompanied by a mineral assemblage consisting mainly of amorphous silicate (glass), quartz (SiO_2), mullite ($2Al_2O_3.SiO_2$), and ferrite spinel (Fe_3O_4).[2,3]

Evaluating these samples for potential beneficial reuse, it was determined that, in spite of the relatively high moisture and LOI contents, the chemical (i.e., SiO_2, Al_2O_3, Fe_2O_3, etc.) and mineralogical composition would be a good candidate as a shale substitute for *Cement Kiln Feed*. This was subsequently confirmed by prospective cement industry customers.

While the chemical and mineralogical compositions were generally acceptable for an ASTM C618 Class F pozzolan,[2] the high moisture, high LOI, wide particle size range, and uniformity issues dictate that post-recovery processing is needed to meet the requirements of the concrete industry. For this reason, the ASTM C618 pozzolan application was not considered further for the R. Paul Smith landfill ash.

IMPOUNDMENT RECLAMATION AND COAL ASH RECOVERY

A photolog showing various aspects of the impoundment reclamation and the coal ash recovery/harvesting is given in the accompanying Figures 8–10. The site reclamation and recovery work was conducted by C. William Hetzer, Inc., under sub-contract, responsible for site engineering and deconstruction management. In addition to ash excavation, emphasis throughout the project was on the strict control and management of drainage, both to keep it away from the Potomac River and to ensure that a uniform moisture content was maintained in the recovered material.

Figure 8. Aerial views of R. Paul Smith Power Station sedimentation ponds and landfill, c.2009 before restoration.

Figure 9. Views during ash recovery/harvesting at R. Paul Smith landfill.

Figure 9 (contd). Views during ash recovery/harvesting at R. Paul Smith landfill.

Figure 10. 12 years later: Restoration complete and certified clean.

DISCUSSION

To the best of our knowledge, this is the first-ever 100% landfill recovery / beneficial use of a coal-fired power producer's coal ash impoundment and landfill anywhere in North America. It marks a significant milestone in the drive for sustainability from both the power and cement industries and the communities they serve.

The MERG-PBCo team contracted with five local trucking companies for the delivery of the reclaimed ash for beneficial reuse at two nearby Portland cement manufacturers.

For the landfill owners, the project resulted in a complete restoration of a more than one-half century old ash landfill. By completely removing all of the ash and restoring the natural vegetation, the project significantly reduced the potential for groundwater contamination and associated monitoring, as well as eliminating any stormwater runoff into the adjacent Potomac River. Furthermore, the restoration of the site reversed what was a significant real estate *liability* into a real estate *asset*, on which other power-

producing renewable structures, such as solar farms, can be built. With all the ash removed and the site certified clean, the owner will likely request a release of its WV landfill permit.

To the nearby Portland cement producers, the beneficial reuse project offered a long-term, uninterrupted and less expensive supply of feedstock – a truly sustainable alternative to mining shale or importing bauxite. All of the 3.2-million tons of ash were used to make cement and nothing other than a handful of 50-year-old truck tires found buried in the 150 ft. high ash piles had to be sent for disposal. Replacing shale with fly ash in the manufacture of Portland cement reduces the heat and fuel required, saving production costs as well as significantly reducing CO_2 emissions from the plant and eliminating emissions from the alternative mining operations.

The neighboring communities have realized benefits too. Reclaiming the enormous mountains of ash completely removed a potential contamination of the Potomac River, local water supplies and air quality. Restoring the land to a greenfield status positively impacted residential real estate, local contractors and businesses, as well as many trucking companies. During the twelve-year project, from ground breaking to certified clean, the project team did not receive a single complaint from neighbors about the truck traffic, fugitive dust or noise.

Prior to 2009, there had been little consideration for harvesting CCPs from landfills and impoundments. The success of the R. Paul Smith beneficial reuse project demonstrates that there is a sustainable economic alternative to the diminishing supply of dry fly ash for the cement and concrete industry where all stakeholders benefit. With the market demand for CCP cement feedstock ever increasing in the wake of closures of coal-fired plants across the USA, the MERG-PBCo team is excited about the growing prospects for CCP beneficial reuse.

COMMENTS ON BENEFICIAL USES

Cement Manufacture

Over the 12-year period of the project, 3.2M tons of R. Paul Smith coal ash were delivered to local cement plants and beneficially used for kiln feed, averaging 250–450 Ktons per year to two cement kilns (Fig. 11).

The coal ash met the chemical and mineralogical QC requirements for the cement kilns, while also satisfying the daily volume requirements. There were no rejections or stoppages experienced during the project.

It is important to note that logistics — particularly the distance from the coal ash impoundment to the cement kiln and the pricing — are key to the success of this type of project and have to work for both parties!

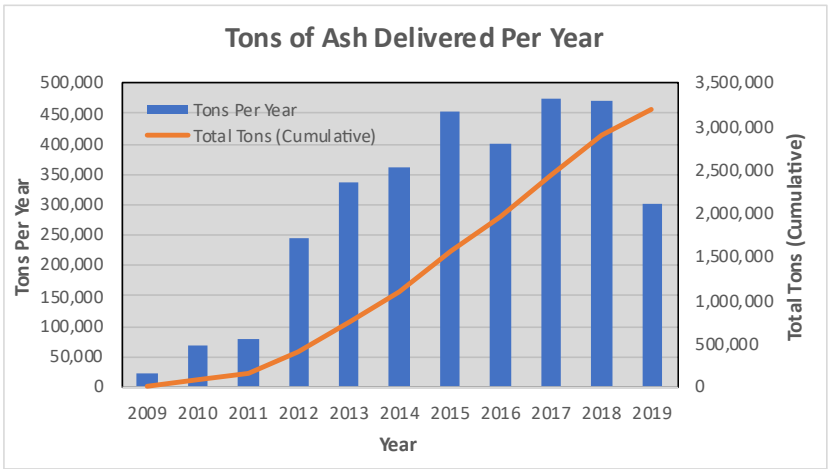


Figure 11. Tons of coal ash delivered per year and cumulative over project.

Concrete Ready-Mix

For the last 50 years or more, dry-collected fly ash, meeting the requirements of ASTM C618[2] or similar standards, has been used successfully as a pozzolan for concrete ready-mix (Fig. 12), precast, and other related applications. This conventional application was not considered to be feasible for the R. Paul Smith project as it would necessitate additional processing to control moisture, LOI, fineness, and uniformity to meet the requirements of the standard. With advances in processing technology, this application is becoming feasible, particularly where market demand for quality ash is significant and higher costs acceptable. The processed ash pozzolan is a higher value-added product than the kiln feed, meaning it is able to service a wider sales area.

Figure 12. Concrete ready-mix plant.

Incentives for Reclamation and Beneficial Use of Coal Ash Landfills

Owner / Operator:
- Reduced cost / liability to operate impoundments in perpetuity
- Mitigated risk of environmental upsets
- Stranded land values recovered

Customer:
- Competitive cost, sustainable raw materials
- Reduced carbon footprint for cement and concrete industry

All stakeholders benefit!

CLOSING REMARKS

- Over the 12 year duration of the project, a total of 3.2-million tons of coal ash from the R. Paul Smith impoundments were successfully recovered and beneficially reused as cement kiln feed, leaving a certified clean land asset. During this period, there were no stoppages or customer complaints.

- The R. Paul Smith project represents the first 100% ash landfill recovery / reuse project we are aware of in North America.

- The project demonstrates that there is a compelling opportunity for utilities / owners to reduce or eliminate long-term legacy liability and recover land values from their ash impoundments.

- The project also demonstrates that there is a compelling opportunity for the cement and concrete industry to continue using cost-effective, sustainable raw materials and reduce the carbon footprint of concrete.

- Good logistics are essential for a successful project.

ACKNOWLEDGMENTS

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