Maryland Power Plant Research Program Promotes the Beneficial Use of CCPs as a Means to Protect Maryland's Natural Resources

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ABSTRACT

The Maryland Department of Natural Resources Power Plant Research Program (PPRP) is a non-regulatory program that ensures that Maryland meets electricity demands at reasonable costs, while protecting the State's valuable natural resources. PPRP conducts research on power plant impacts to Maryland's natural resources and recommends balanced, long-term solutions to minimize impacts. PPRP's efforts with respect to natural resource protection has focused recently on developing innovative approaches to meet the State's goal of controlling development through a smart growth ethos (i.e., minimizing greenfield development). Maryland has recognized that uncontrolled development has an adverse impact to the Chesapeake Bay, one of Maryland's greatest natural resources.

PPRP recognizes that beneficial use of CCPs can provide substantial environmental benefits, including minimizing greenfield development by avoiding construction of new CCPs fill areas, as well as avoiding the production of aggregate materials that can be replaced by CCPs. Thus, PPRP has undertaken an initiative to promote beneficial use of the 1.2 million tons of generated annually at Maryland's power plants. The overall objective of PPRP's program is to increase the beneficial use of CCPs generated in Maryland as a means of minimizing greenfield development and protecting Maryland's natural resources. PPRP activities include: disseminating information on the availability, quality, and potential environmental effects of CCPs; field studies to determine the environmental effects of high volume CCP uses being implemented in Maryland; and a field demonstration to determine the technical and economic feasibility of a beneficial CCP use application considered to be viable in Maryland.

These studies have generated useful information that has increased the overall understanding of users, regulators, and the public regarding the advantages of beneficial use of CCPs. However, PPRP believes that an increase in the amount of CCPs beneficially used in Maryland will not occur until two additional steps are taken. First, the State needs to employ the concept of balancing impacts across all environmental media to determine the suitability of a beneficial use application. Second, the public needs to accept the multi-media environmental impact balancing approach. PPRP is developing approaches to implement these two steps.

INTRODUCTION

Background

PPRP is a non-regulatory program that ensures that Maryland meets electricity demands at reasonable costs, while protecting the State's valuable natural resources. PPRP conducts research on power plants to assess impacts to Maryland's natural resources and recommends balanced, long-term solutions to minimize impacts. PPRP's efforts with respect to natural resource protection has focused recently on developing innovative approaches to meet the State's goal of controlling development through a smart growth ethos (i.e., minimizing greenfield development). Maryland has recognized that uncontrolled development has an adverse impact to the Chesapeake Bay, one of Maryland's greatest natural resources.

Maryland power plants generate about 1.2 million tons of CCPs annually, which consist primarily of fly ash and bottom ash. CCP generation in Maryland is expected to grow within the year to nearly 1.8 million tons annually due to a scheduled coal-fired capacity addition. The majority of the CCPs generated in Maryland are placed in captive fill areas. However, fill areas consume valuable land and have the potential to adversely affect Maryland's terrestrial, aquatic and ground water resources. PPRP recognizes that beneficial use of CCPs can provide substantial environmental benefits, including minimizing greenfield development (i.e., construction in a previously undeveloped area) by avoiding construction of new CCP fill areas, as well as avoiding the production of aggregate materials that can be replaced by CCPs.

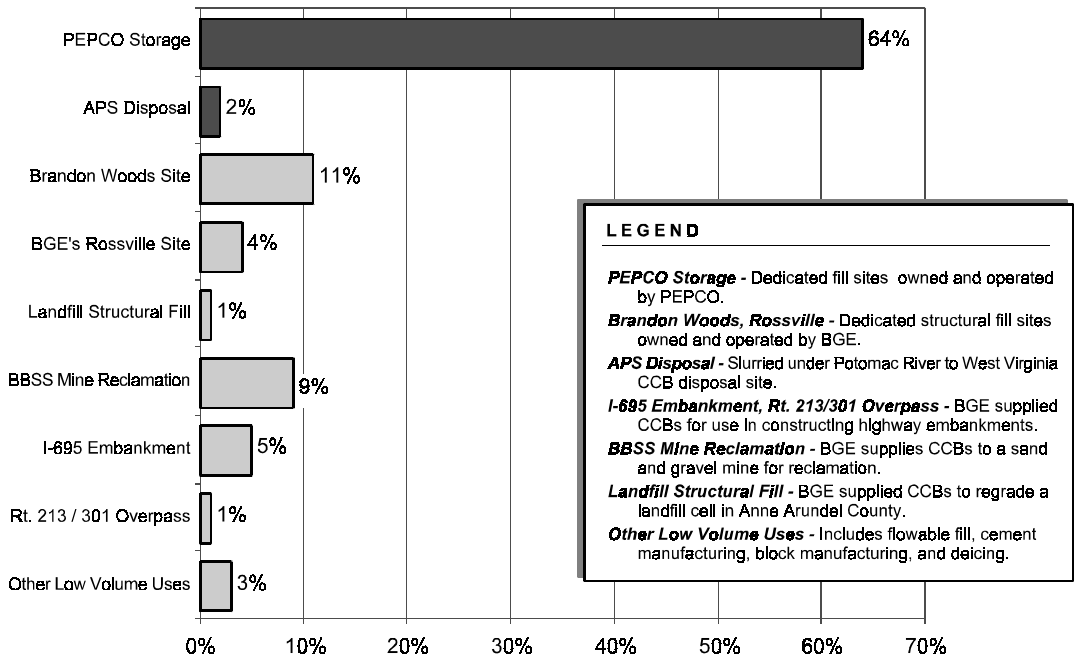

Figure 1. Disposition of CCPs Generated in Maryland, 1993 - 1997

As shown in Figure 1, approximately 34 percent of CCPs generated in Maryland in the past five years have been beneficially used rather than landfilled. An impediment to increasing CCP use is the unfamiliarity of regulators and potential users with technical and economic benefits, and the environmental implications of replacing raw materials with CCPs. The uncertainty of potential users regarding CCP use is an institutional barrier that can be removed by government agencies involved in CCP use or approvals. In fact, the U.S. Department of Energy's Report to Congress regarding institutional constraints to further use of CCPs recommended that state governments take an active role to remove the barriers[1].

Purpose

PPRP has undertaken a program to promote CCP use in Maryland with assistance from Maryland's electric utilities, other state agencies, and private sector stakeholders. The overall objective of PPRP's program is to increase the beneficial use of CCPs generated in Maryland as a means of controlling growth and protecting Maryland's natural resources. This objective can be accomplished by ensuring that: 1) potential users, regulators and the public are aware of the environmental, technical and economic benefits that can result from beneficially using CCPs; and 2) regulators and the public recognize that beneficial use of CCPs may require a certain amount of environmental impact balancing.

The scope of PPRP's activities include:

- Disseminating information on the availability, quality, and potential environmental effects of CCPs generated in Maryland;
- Studies to determine the environmental effects of high volume CCP uses being implemented in Maryland; and
- A field demonstration to determine the technical and economic feasibility of a beneficial CCP use application considered to be viable in Maryland.

This paper examines the scope and effectiveness of our efforts to date. These approaches to promoting CCP use provide useful models for other states to consider.

PROGRAM SCOPE

Information Dissemination

One of the barriers to increasing CCP use is the uncertainty users may have regarding the State's regulatory approval process. PPRP compared and evaluated the regulatory frameworks for CCP use and management in Maryland and neighboring states to identify potential regulatory approaches to encourage CCP use[2]. Based on the survey, PPRP concluded that Maryland should develop a uniform regulatory approach for CCP beneficial use that is mutually recognized by the State, CCP generators, and CCP users. This approach should identify a uniform set of procedures for State review of CCP use projects, and provide a list of pre-approved CCP uses. PPRP is working with the Maryland Department of the Environment (MDE) and CCP generators to develop the approach.

Another effort undertaken by PPRP to promote CCP use is to provide information to potential users regarding the availability, quality, and environmental effects of CCPs. PPRP has prepared a technical report to describe the status of CCP generation, disposition, and beneficial use in Maryland for the purpose of assisting potential users in evaluating the viability of CCPs use[3]. The report documents the source, type, amount, chemical and physical properties, and potential environmental effects of CCPs generated in Maryland, and is being prepared with assistance from two of the state's largest CCP generators, Baltimore Gas & Electric (BGE) and Potomac Electric Power Company (PEPCO).

Environmental Effects Studies

Recent projects conducted by the private sector in Maryland indicate that the use of CCPs in structural fill is a high volume use that is technically and economically feasible for implementation in Maryland. Future road construction projects in Maryland, including the replacement of the Wilson Bridge over the Potomac River, provide potential opportunities for the use of large quantities of CCPs as structural fill. However, potential users, regulators and the public have expressed uncertainty about the potential for CCPs to degrade ground water quality. In response to uncertainty about environmental effects, PPRP has conducted four studies to evaluate the environmental effects of CCPs on ground water quality in Maryland in the past several years (study locations are shown in Figure 2):

- Brandon Woods Structural Fill Site. 3.8 million tons of CCPs were used for structural fill beneath a commercial office park.
- Route 213/301 Overpass. 60,000 tons of CCPs were used to create embankments for a highway overpass.
- I-695 Embankment. 320,000 tons of CCPs were used to create embankments for several highway overpasses.
- BBSS Mine Site. A projected 3 million tons of CCPs are being used for reclamation of a sand and gravel mine.

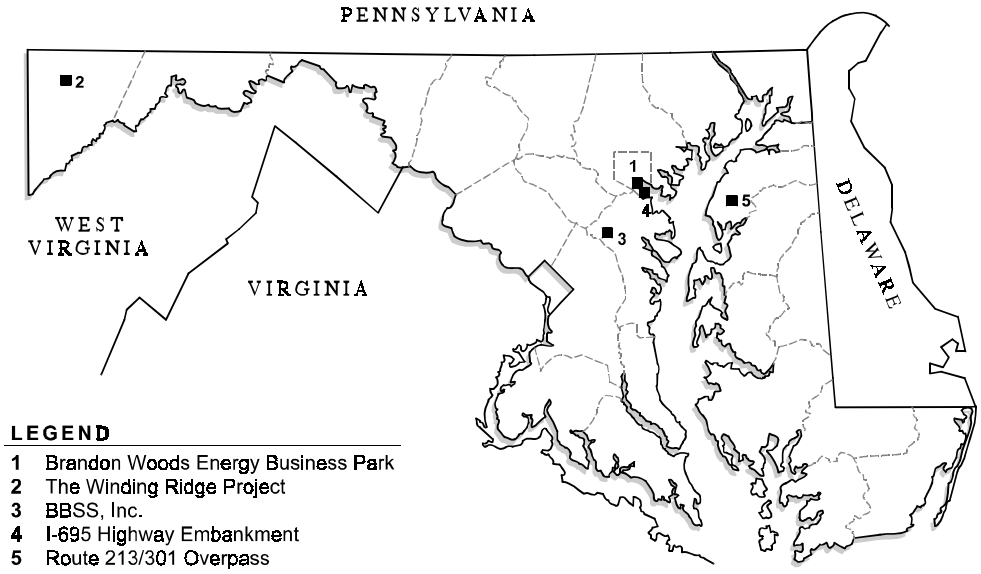

Figure 2. Location of CCP Beneficial Use Projects in Maryland

In the first study, PPRP evaluated the potential environmental effects of CCPs used as structural fill material at the Brandon Woods site, focusing primarily on the underlying ground water system[4,5]. BGE placed 3.8 million tons of CCPs at the 466-acre between 1982 and 1998 to raise the site to uniform grade and facilitate construction of light industrial and warehouse buildings. The purpose of the study was to determine whether the structural fill application at Brandon Woods was protective of ground and surface water quality.

Ground water quality conditions were evaluated using data collected from the time the facility began CCP filling operations in 1982, through September 1998. Ground water quality at the site is monitored in the shallow aquifer, which is generally present 2 to 10 feet below the bottom of the CCP fill, and a deep semi-confined unit 30 to 70 feet below the bottom of the fill. Sulfate, iron and manganese derived from the fill have been detected in downgradient monitoring wells completed in the shallow aquifer. The extent of sulfate, iron and manganese derived from the fill in the shallow ground water is localized to the within the property boundary, and these constituents are not adversely affecting surface water quality. Furthermore, no sulfate, iron, manganese, or trace elements, such as arsenic and selenium, have been detected in the deep ground water.

The localized extent of ground water quality impacts beneath the CCP structural fill and the absence of trace elements indicate that several site characteristics minimize potential adverse environmental impacts from leachate generation. These characteristics include: 1) a shallow fill thickness of 16 feet on average which results in dilute leachate; 2) attenuation of the dilute leachate in the unsaturated zone; and 3) the presence of buildings and pavement over much of the site which limits the volume of infiltration through the fill.

In 1999, PPRP is conducting two studies at two highway embankment sites, namely the 213/301 overpass and the I-695 sites, to evaluate environmental impacts associated with the use of CCPs as structural fill[6]. PPRP is determining the potential for leachate to affect ground water quality beneath the two recently completed highway embankment beneficial use sites. In 1993 and 1994, BGE and Conectiv (formerly Delmarva Power) provided approximately 60,000 tons of CCPs to create the highway embankment for the Route 213 overpass near Centerville on Maryland's eastern shore. Between 1996 and 1998, BGE provided 320,000 tons of CCPs to construct highway overpasses on I-695 in Baltimore.

PPRP is conducting site-specific studies at both of these sites to identify whether leachate constituents are forming within the CCP fills, to identify the extent of the leachate constituents in fill pore water, and to determine whether the constituents are being attenuated in shallow soils. The field study for the 213/301 site began in March 1999. The field study at the I-695 site will begin in the late summer of 1999. The studies consist of the installation of exploratory borings, lysimeters, monitoring wells, and soil moisture probes in and beneath the CCP fill. Pore water and ground water samples were collected from the lysimeters and monitoring wells. Additionally, moisture content data will be analyzed to show where leachate is forming in the CCP fill and to illustrate the movement of water vertically through the CCP in response to precipitation events.

Water quality results indicate elevated concentrations of several trace elements (arsenic and manganese) and major ions (calcium, magnesium, chloride, and sulfate) were found in fly ash pore water, indicating that leachate is forming within the fly ash fill. However, the data also indicate that these constituents are being attenuated in underlying soils and ground water beneath the embankments. The water quality data collected to date indicate that the use of fly ash for highway embankments can adequately protect ground water quality.

The fourth study consists of an assessment of both existing and future potential ground water quality conditions beneath a former aggregate mine site in Maryland. In 1995 through 1999, BGE has placed over 1,000,000 tons of CCPs at this site to reclaim the 25 foot deep sand and gravel mine, and plans to place another 2,000,000 tons over the next few years. PPRP is conducting an independent assessment of ground water quality conditions at the site using a two-step approach. First, PPRP used empirical site-specific and regional hydrogeological data to determine the local ground water flow direction and rate. Second, the ground water flow data, coupled with laboratory testing to determine leachate quality over time, is being used as input for a two-dimensional analytical solute transport model to determine the potential long term water quality effects at the site.

The preliminary results of the first step of the study indicate that sulfate has been detected in the water table aquifer beneath the portion of the mine site that has been filled with CCPs at concentrations above background. The sulfate is derived from the CCP fill, and is attributed to the dissolution of gypsum in the fly ash. However, trace elements have not been detected in the wells to date at concentrations considered to be above background levels. The modeling step is being completed.

Demonstration Project

Another approach used by PPRP to promote CCP use involves demonstrations of the technical and economic feasibility, and associated environmental effects, of beneficial CCP use applications considered to be viable in Maryland. The Winding Ridge Demonstration Project is a successful example of a demonstration carried out through a joint private and public sector collaboration. PPRP, with participation from the MDE Mining Program, coal mining companies, and electric utilities, has undertaken the Demonstration Project to evaluate the technical and economic feasibility, and associated environmental effects, of using a CCP grout to abate acid mine drainage (AMD) from an underground coal mine[7].

Field injection at the Frazee Mine in Garrett County was completed in November 1996. Approximately 5,600 cubic yards of grout, which consisted of 6,000 tons of CCPs and 520,000 gallons of mine water, were injected into both dry and submerged mine conditions. The project demonstrated the engineering and economic feasibility and logistics of using 100 percent CCPs and acid mine water to create a grout that can be used to seal underground coal mines. At the time of the injection, no other field project in the U.S. had used 100 percent CCPs and mine water to create a flowable, cementitious grout.

The State is monitoring the site to evaluate both the effectiveness of the grout to seal the mine and abate AMD, and to determine whether there are any adverse impacts to water quality

attributed to the grout placement. AMD continues to discharge because the void space in the mine exceeded the total volume of grout injected into the mine, but the discharge quality has improved slightly over time. Monitoring over the last two years has shown gypsum dissolution reactions are occurring and calcium and sulfate released from the grout has mixed with the AMD. However, heavy metals or other trace elements have not been released from the grout.

The experience gained from the demonstration project will allow for a more streamlined and economical approach that can be applied to larger AMD sources. The ultimate goal of PPRP is to use CCPs to address the 12 square mile underground Kempton mine complex, which discharges approximately 3 to 6 million gallons per day of AMD into the Chesapeake Bay watershed in Maryland[8].

DISCUSSION

PPRP's studies have generated useful information regarding CCP quality, disposition, and use, which in turn, has increased the understanding of regulators and future potential users with the environmental aspects associated with using CCPs. These studies have provided Maryland-specific information to assuage concerns regarding ground water quality degradation derived from CCP use sites. However, increasing beneficial use of CCPs will continue to encounter institutional impediments, especially with respect to public acceptance. Competition in the electricity retail business will provide new challenges, as CCP generators will need to ensure that participation in CCP beneficial use projects are economically feasible compared to landfilling.

PPRP believes that despite the useful information generated on CCP use, an increase in the amount of CCPs beneficially used in Maryland will not occur until two additional steps are taken. The first step involves the use of an environmental balancing approach to evaluate CCP beneficial use projects. The second step consists of having the public accept the balancing approach.

With regard to the concept of balancing impacts, the State needs to evaluate impacts across all environmental media to determine the suitability of a beneficial use application. The concept of balancing environmental impacts requires an understanding that impacts associated with developing new CCP landfill sites needs to be balanced against the concern for potential ground water quality degradation.

The Brandon Woods, 213 Overpass and BBSS studies generated site-specific data that show that heavy metals or other trace elements have not affected ground water quality. Furthermore, although some structural fill sites like Brandon Woods have caused localized ground water quality degradation with respect to iron, manganese and sulfate, localized degradation by these low toxicity constituents can be acceptable when balanced against the technical and economic benefits of the beneficial use of CCPs. The costs associated with controls to mitigate ground water quality impacts from low toxicity constituents can make a beneficial use application uneconomic. Conversely, the 3.8 million tons of CCPs placed at Brandon Woods under buildings and pavement would have been placed in a 150-acre landfill developed on a greenfield site. Development of a greenfield site for a landfill may in certain instances result in

deforestation, wetland, and/or water quality impacts.

Public acceptance of an environmental balancing policy will depend on the effectiveness of communication that CCP beneficial use is a means of protecting natural resources. PPRP is developing an approach for an outreach program to promote the beneficial use of CCPs and evaluating the feasibility of implementing the approach. The outreach program will be designed to educate citizen groups in locations near either existing or proposed CCP beneficial use projects on the environmental benefits of beneficial use compared to landfilling of CCPs.

CONCLUSIONS

PPRP studies have generated useful information regarding CCP quality, disposition, and use, which provide a basis for regulators and future potential users to understand the environmental aspects associated with using CCPs. The next steps to promoting CCP beneficial use in Maryland are:

1. Implement a State policy that promotes the concept that some amount of localized ground water degradation by low toxicity constituents may need to be acceptable when balanced against the environmental and economic benefits of beneficial use of CCPs. Under this policy, beneficial use applications would be evaluated by comparing for their holistic technical, economic and environmental benefits, in concert with and assessment of environmental impacts.
2. Conduct public outreach to educate citizen groups in locations near either existing or proposed CCP beneficial use projects on the environmental benefits of beneficial use compared to landfilling of CCPs.
3. Conduct joint public and private sector demonstrations that evaluate the technical and economic feasibility, and associated environment effects of high volume, beneficial CCP use applications considered to be viable in the state, and alleviate institutional barriers by ensuring a shared commitment to promoting CCP use.

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