

## **CHAPTER 6: FAILURES OF THE PENNSYLVANIA CCW MINE PLACEMENT PROGRAM**

### **6.1 INTRODUCTION**

This report reaches two important conclusions. The first is that coal ash placement in Pennsylvania mines has degraded water quality. The second is that Pennsylvania's regulatory program itself is deficient in many critical respects and that *these deficiencies will lead not only to degradation of water quality at many more sites, but they will also ensure that such degradation is not detected in most cases.* The deficiencies in Pennsylvania's program include problems with both the regulations establishing the program and the enforcement of existing requirements.

Before discussing those problems, however, it is important to recognize the potential for harm that large-scale placement of coal ash poses to the mine environment and that of surrounding lands. Therefore, just as the Committee on Mine Placement of Coal Combustion Wastes of the National Research Council concluded was needed on a national level,<sup>1</sup> a program is needed in Pennsylvania to encourage options for reusing coal ash and other coal combustion wastes that reduce the threat of environmental contamination from this waste before placement in mines is pursued. These would include use of CCW components as additives in concrete and road pavements (placed above the water table) and in the manufacture of wall board or other similar uses. The failure to appreciate the threat that lax management of coal ash in mines is posing to water supplies, human health and the environment will undercut the expeditious development of such a program in Pennsylvania. Conversely, the development and enforcement of sensible safeguards in mine placement permits will encourage safer uses.

This chapter identifies and documents the many critical deficiencies of Pennsylvania's Coal Ash Beneficial Use Program and provides examples of the impact of these deficiencies in the permits for the placement of coal ash examined in this report.

### **6.2 INADEQUATE GROUNDWATER AND SURFACE WATER MONITORING**

#### **6.2.1 The duration of monitoring at coal ash mine placement sites is fundamentally deficient**

PADEP approves requests by mine operators to stop groundwater monitoring at coal ash placement sites after the operator has backfilled and contoured the placement area and reestablished vegetation.<sup>2</sup> At minefills involving a few hundred thousand tons or less of coal ash this can occur one to three years after mining and ash placement has started and

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<sup>1</sup> NRC, *Managing Coal Combustion Residues in Mines*, 2006, page 178.

<sup>2</sup> At the Phase II release of the mine bonds, water monitoring by the operator is waived unless there is an indication of groundwater degradation of the baseline pollution load, defined by the iron and acid loadings, and other parameters at the Department's discretion. 25 Pa Code 87.205.

concluded. This is a far shorter monitoring period than required at coal ash landfills and is clearly insufficient to determine whether degradation of water quality will occur, much less whether impacts, if occurring, are starting to subside. The temporary water quality degradation that occurs during most active mining or re-mining operations magnifies the need for longer term monitoring at ash minefills to distinguish impacts caused by the ash from temporary changes in water quality caused by the mining itself.

Long term monitoring is essential because coal ash includes a host of materials of highly varying chemical and mineralogical composition. One common characteristic of almost all of these materials is that they react with water and they continue to react as time goes on. The ash that forms in the burner is not the material that exists when it initially comes into contact with water, and that is not the material that will exist 5, 10, or 50 years later in the mine. Contamination at a given site may not even be detected for many years after placement occurs. And even when detected early contamination may still be worsening 30 years later. There are ash disposal sites in the U.S. where contamination has increased with age. Yet there are sites in Pennsylvania coal mines where monitoring ceases within three years of the beginning of ash placement. A lack of identifiable degradation after this length of time offers absolutely *no* guarantee that degradation will not occur in the future.<sup>3</sup>

PADEP has acknowledged the importance of monitoring coal ash placement, particularly at alkaline addition sites. In their guidance document entitled *Alkaline Addition for Surface Coal Mines*, PADEP states,

Monitoring of mine sites is necessary, not just to determine the success of mining, but for refinement of the science. There is still much to learn as to acceptable application rates, the effectiveness of various types of materials, the most advantageous placement(s) of alkaline materials, and so forth. *Without good water monitoring, success cannot be determined.*<sup>4</sup>

This report's examination of PADEP minefill permits reveals that the agency is not requiring the type of monitoring that their guidance asserts is necessary regardless of the size or purpose of the ash placement involved. For example, at the Buterbaugh Mine (Permit #17990112), ash placement commenced during January 2001 and finished in August 2004. Some 24,539 tons of pulverized coal (PC) ash was put on approximately 20 acres for the beneficial purpose of "placement." The latest data that could be located from any ash monitoring points in repeated trips to the permit file extends only through September 2004. At the Bloom #1 Mine (Permit #17950111), 45,000-50,000 tons of FBC ash was placed as an alkaline addition in an area substantially less than 50 acres from December 1996 up to an undisclosed date before mid 2005. Yet the latest

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<sup>3</sup> Norris, Charles H. *Minefill Practices for Power Plant Wastes: An Initial Review and Assessment of the Pennsylvania System*, August 29, 2003. Examples include the 3 years of monitoring at the Jacksonville minefill, (SMP #102360-32980108) and the less than 2 years of monitoring at Lucerne No. 2 minefill (SMP # 1387-32940105-05).

<sup>4</sup> PADEP, *Alkaline Addition for Surface Coal Mines*, Document Number 563-2112-217, BMR PGM Section II, Part 2, Subpart 17. Emphasis added.

monitoring data for trace elements and other more exclusive ash parameters (such as calcium and magnesium) that could be located in the permit file from examinations through 2005 extended only through March 2004 for one ash monitoring point and through December 2003 for all of the other ash monitoring points.

At the C&K Coal Mine (Permit # 16703006), ash placement started in May 1995 and ended in early 1999. Yet, data for trace elements and other ash parameters were collected for only a three year period from April 1996 through April 1999 and data for major and minor elements (sulfate, iron, manganese, pH, acidity, alkalinity, TDS, etc.) extended only through October 1999. This despite some 200,000 tons of FBC and PC ash being placed over 135 acres at the site. The placement purposes were ostensibly for “placement” and a small amount (few thousand tons) for soil amendment.

At the Swamp Poodle Mine (Permit # 17950115), after mining and ash placement started in February 1996, the data in the permit file indicate that monitoring extended through April 1999 for trace elements and other more exclusive ash parameters and September 1999 for major and minor elements. Yet mining and ash placement had only ceased in April 1999. Some 214,000 tons of FBC ash was placed on approximately 50 acres at the Swamp Poodle Mine primarily as an alkaline addition.

At the Sandy Hollow Mine (Permit # 16910104), 342,000 tons of FBC and PC ash were placed on the site as an alkaline addition. Mining and ash placement occurred from August 1996 through September 2000. Researchers could find only up to three measurements for trace elements and more exclusive ash parameters at any monitoring points after operations started, taken from September 1999 through September 2001. The latest data for major element concentrations at ash monitoring points extended to June 2001, nine months after mining and ash placement ended.

At the Wildwood waste coal reining operation (Permit #02940201) approximately 450,000 tons of FBC ash were placed over a 32 acre site from April 1995 to August 1999, serving as a barrier to infiltration for abating AMD and to stop persistent fires. Monitoring at three of five ash monitoring wells had stopped by the spring of 2000 (as they had gone dry and were then destroyed) and the last data from the other two wells was collected in April 2002.

At the Russelton waste coal reining operation (Permit #02930201) approximately 1,500,000 tons of FBC ash were placed in a 56-acre site to abate AMD. Ash placement started in early 1997 and finished in late 2002/early 2003. The latest monitoring for trace elements and other ash parameters in the permit file extended through November 2001, not even through the completion of ash placement, while monitoring for subchapter F mining parameters extended only through the summer of 2005.

Thus at seven of the 15 sites studied in this report the length of monitoring after ash placement was completed ranged from barely one month to approximately two and a half years. Indeed, for trace elements and other ash parameters at ash monitoring points monitoring apparently stopped at the Bloom #1 and Russelton sites before ash placement

was even finished. While there may be more data, project researchers made repeated attempts in every case to verify that they had obtained all monitoring data from these sites. These consisted of written requests for missing data, multiple visits to the permit files at PADEP offices, meetings with PADEP staff and follow up phone calls to verify that they had obtained all data for the sites. To complete the project, researchers eventually had to assume that the data retrieved from these efforts represented all data available.

### **6.2.2 Monitoring is stopped even when data indicates degradation is occurring**

In several cases, monitoring stopped not only before success was determined, but when the most recent data revealed water quality had worsened at ash monitoring points. For example, at the Swamp Poodle Mine, arsenic, cadmium, lead and selenium were measured at their highest concentrations and very toxic levels in the last sample collected at downgradient monitoring well, MW-2D in March 1999. The concentration of dissolved arsenic in this sample was 3.89 mg/L, 389 times the federal drinking water standard and by far the highest arsenic measured before or after ash placement. Likewise, the dissolved cadmium concentration was the highest measured before or after ash placement at 0.230 mg/L, 46 times the DWS. Lead was measured at its highest concentration at 0.069 mg/L, more than four times the DWS, and selenium was measured at its second highest concentration at 0.177 mg/L, more than three times the DWS. These trace elements were also measured at toxic levels and, in the case of arsenic, again at its highest dissolved concentration, 0.415 mg/L, at another downgradient monitoring well, MW-3D in the final March 1999 sample. And while major parameters such as acidity, sulfate and TDS had declined sharply in this final sample at MW-2D, they were rising to their highest levels ever at MW-3D and were well beyond baseline concentrations at another downgradient ash monitoring well, MW-4D.

At the Sandy Hollow and Buterbaugh Mines, the highest sulfates and TDS have occurred at downgradient monitoring points during ash placement (not before it during baseline monitoring) and overall trends in average concentrations during the permit operations were rising when monitoring stopped. At downgradient ash well MW-3 in Sandy Hollow the highest sulfate concentration during ash placement was 942 mg/L compared to the highest sulfate concentration during baseline monitoring of 137 mg/L. The highest TDS during ash placement was 1377 mg/L, compared to highest TDS during baseline monitoring of 410 mg/L. In three measurements during the final six months of monitoring at MW-3 the average sulfate concentration was 426 mg/L and average TDS was 662 mg/L, compared to average sulfates of 126 mg/L and average TDS of 368 mg/L from the six baseline measurements (over six months) at MW-3. Thus sulfate and TDS concentrations had risen from below secondary DWS (250 mg/L for sulfate and 500 mg/L for TDS) during baseline monitoring to levels substantively exceeding these DWS when monitoring stopped.

At downgradient ash well BC-3 in the Buterbaugh Mine, the highest sulfate during baseline monitoring was 248 mg/L. The highest TDS during baseline monitoring was 374 mg/L. The highest sulfate after mining and ash placement started was 743 mg/L in

May 2003 seven months before monitoring ended and the highest TDS was the last measurement taken, 927 mg/L in December 2003. Average sulfate of 188 mg/L and average TDS of 344 mg/L in baseline measurements rose to 573 mg/L (more than twice the DWS) and 794 mg/L (more than 1.5 times the DWS) respectively in the last year of measurements at BC-3.

Manganese concentrations were also notably higher in the Buterbaugh Mine in the last monitoring at BC-3. Average manganese during baseline monitoring of 2.43 mg/L (48.6 times the DWS) compared to an average concentration in the last 13 months of monitoring of 6.65 mg/L (133 times the DWS). The highest manganese during baseline monitoring was 4.1 mg/L, whereas the highest, second highest, and third highest manganese concentrations after mining and ash placement occurred in the summer of 2003 when manganese ranged from 8.2 to 9.6 mg/L, more than twice the highest baseline level and only five months before the end of monitoring at BC-3.

Sulfate, TDS, and manganese levels were higher in the latter monitoring data at the C&K mine although the most notable increases were at MW-1A, the well that PADEP staff asserted was placed to measure shallow groundwater not effected by the mining and ash placement operation. Here average sulfate increased from 456 mg/L during baseline monitoring to 930 mg/L in the last year of monitoring. Average TDS also more than doubled from 665 mg/L to 1427 mg/L as did average manganese, increasing from 10.18 mg/L during baseline monitoring to 25.25 mg/L in the last year of monitoring. Acidity increased by almost five times, from an average concentration of 17.2 mg/L during baseline monitoring to 82 mg/L in the last year of monitoring and alkalinity increased by more than three times from 8.2 to 28.5 mg/L. While there were only 4 annual measurements for calcium and magnesium during mining and ash placement, average calcium doubled from a baseline level of 71.2 mg/L to 157 mg/L during mining and ash placement and average magnesium increased from 50.2 mg/L to 127 mg/L.

Although their increases were not as sharp, these constituents were found in higher concentrations after mining and ash placement started at C&K at the monitoring well designated as downgradient of the ash by PADEP, MW-3A and in a well dug deeper at this location to the Vanport Limestone, MW-3B. Furthermore, even though the frequency of measurements dropped significantly for trace elements at MW-1A, MW-3A and MW-3B after mining and ash placement began, the two highest arsenic concentrations were measured at MW-3A and the highest selenium concentration was measured at MW-3B after these operations were underway. In the case of arsenic at MW-3A, both measurements exceeded the new DWS, at 0.011 mg/L in April 1997 and 0.037 mg/L (nearly four times the DWS) in April 1998. The selenium measured at MW-3B of 0.030 mg/L in April 1998, while not exceeding the DWS, was still the highest measurement found at any time at any monitoring point and was the last measurement taken from this point.

While this report's researchers do not know when mining and ash placement stopped at the Hartley Strip Mine (Permit #30713008), the last data they could locate for this permit extended through September 1998 for the mine's ash monitoring points. In addition, they

were able to locate data extending through August 2000 for two other monitoring points inside the mine that are part of the monitoring system for the Hatfield Coal Ash Landfill. When assessed collectively, the latest concentrations and trends from this data warrant concern that monitoring should have been continuing at the Hartley mine's monitoring wells. There was little if any baseline data available for review from the permit file but levels of antimony, cadmium, and lead measured have been substantially higher than their concentrations in 1988, the first year of data available, when operations also began at Hartley. Antimony has reached several concentrations at ash monitoring points exceeding the DWS, including a concentration of 0.11 mg/L at MW-2 in July 1995, more than 18 times the DWS. While MW-2 is designated an "upgradient well" in the permit, it is located well inside the ash placement area and trends such as spikes in acidity and oscillating alkalinity in MW-2's data suggest it is picking up impacts of mining and ash placement. Antimony was also measured in August 1991 at downgradient MW-1 at 0.03 mg/L, six times the DWS. Lead has been measured in at least five samples exceeding the DWS (0.015 mg/L). Three of those were above the highest lead concentration measured in 1988. These included 0.06 mg/L at MW-1 in July 1993, and 0.10 mg/L and 0.050 mg/L at MW-2 in July 1993 and July 1996 respectively. Cadmium was measured at 0.10 mg/L, twice the DWS in the final measurements in September 1998 at both MW-1 and MW-2. It should be noted that researchers could only find seven measurements at MW-1 and nine measurements at MW-2 for trace elements during the nine years between the permit issuance in 1988 and final monitoring in 1998.

Although researchers did not find regulator monitoring results for molybdenum at the mine ash monitoring wells, they did find this trace metal measured at MW-1 at 0.004 mg/L in September 1997 and 0.19 mg/L in September 1998, the last available data from this well. This latter concentration is 19 times the Superfund Removal Action Level for molybdenum and 9.5 times EPA's short term child health advisory for ingestion of this metal. Both molybdenum and antimony leach in elevated levels in tests from many Pennsylvania coal ashes, and ample monitoring data documents their leaching from ash deposits at many ash disposal sites. In addition, molybdenum has been found in high levels at downgradient ash monitoring points in the neighboring Hatfield coal ash landfill and has been monitored at very harmful levels in Little Whately Creek, which drains the watershed that shallow groundwaters at MW-1 flow to <sup>5</sup>.

Data from upgradient wells MW206 and MW207 in the Hatfield coal ash landfill that are downgradient to the ash in the Hartley mine indicate further that degradation was occurring as mine monitoring stopped and has worsened since. The average concentration of dissolved boron, a well known ash indicator parameter more than doubled at MW206 from 5.32 mg/L in 1994-1996 to 12.27 mg/L in 1998-2000 and doubled at MW207 from 4.37 mg/L in 1994-1996 to 9.68 mg/L in 1998-2000. These concentrations are well beyond levels of concern for boron which has a Removal Action Level of 0.900 mg/L and health advisories ranging from 0.6 mg/L for an adult's lifetime exposure to 4 mg/L for the child's one day exposure to boron in drinking water (Drinking Water Regulations

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<sup>5</sup> PADEP Quarterly Monitoring Reports in 1999 and 2000 document molybdenum concentrations from over 0.500 mg/L to levels as high as 23.3 mg/L, 81.3 mg/L, 352 mg/L and 419 mg/L in the surface waters of this stream, levels thousands of times over the adult and child health advisories for this trace element.

and Health Advisories, US EPA, Office of Water, EPA 822-B-96-002, Oct. 1996). Thus boron has been rising from levels already of concern to levels far higher at these monitoring points in 1998-2000. Allegheny Energy, the operator of the Hatfield landfill and generator of the ash placed in the Hartley strip, stated in an August 20, 1997 revision to an application to modify the permit for the landfill that the elevated boron in these upgradient wells was “due to the fact that fly ash has been codisposed with mine spoil in the upgradient area, in addition to the permitted disposal area.”

The sulfate trend at MW-206 increased from average levels already more than six times over the DWS in 1994 to average levels just under 2500 mg/L, ten times the DWS, in 2000. Sulfate levels were even higher at MW-207 averaging 3500-3700 mg/L, although declining slightly from 1994 to 2000. Average molybdenum concentrations rose at MW-207 from 0.003 mg/L in 1994 to 0.010 mg/L in 2000 equal to EPA’s Removal Action Level and long-term child health advisory. This evidence that Hartley ash has been degrading water quality is corroborated further by rising field pH, alkalinity, calcium, magnesium, and potassium, additional indicators of ash leachate, at MW-206 and MW-207.

Clearly, even if PADEP does not believe that CCW placement poses a risk to water supplies in coal mines, these data do not suggest the time to stop monitoring had arrived at these sites. In every case, DWS that weren’t being exceeded during baseline monitoring were being exceeded in the last year of monitoring at these sites or DWS that were being exceeded during baseline monitoring were being exceeded by a greater degree in the final year of monitoring. Yet researchers could not find a single report or other document in the mine permit files indicating that such increases in concentrations or exceedances of DWS at ash monitoring points in the latest monitoring at these sites had any bearing on decisions to stop monitoring or relinquish bonds. The cessation of monitoring that occurred suggests that monitoring at ash monitoring points is merely a proforma exercise in this program.

For projects involving placement of significant quantities of ash, (i.e., all permits involving alkaline addition or reclamation to original contour), the authors of this report conclude that monitoring should be required until evidence establishes definitively that the following conditions are met: (1) post-mine flow directions and seasonal levels of groundwaters are restored to premine directions and levels underneath ash placement sites; (2) monitoring of those groundwaters and surface waters indicates that the specific goal of improvement has been achieved and is being sustained; and (3) adverse impacts such as exceedances of drinking water standards or water quality standards are not resulting from contamination by the ash. In addition, these conditions should include monitoring of CCW constituent concentrations within the CCW itself and throughout the placement area to demonstrate that the placement has achieved its goal and the environmental liability posed by generation of leachate in the CCW is negligible.

### **6.2.3 No groundwater monitoring is required when CCW is placed in abandoned mines**

Pennsylvania regulations do not require groundwater monitoring when coal ash is placed in an abandoned mine.<sup>6</sup> Monitoring at such sites is at the discretion of PADEP. Groundwater monitoring should be required at *all* CCW placement sites, regardless of whether the mine is active or abandoned. Determining the safety and success of ash placement at abandoned mines is no less important than evaluating impacts at active mine sites. Such findings were voiced repeatedly in the NRC Report which recommended the following in Chapter 8, Synthesis of Issues for Planning and Regulation of CCR Mine Placement:

*Abandoned Mine Lands and Remining Sites.* A special consideration is the use of CCRs in reclaiming AML and remining sites and in mining coal refuse piles. As noted in Chapter 5, any regulatory standards for CCR use adopted under SMCRA for active coal mining would most likely apply to remining activities but would not apply directly to CCR use in the reclamation of abandoned mine lands. To ensure adequate protection of public health and the environment, **the committee recommends that placement of CCRs in abandoned and remining sites be subject to the same CCR characterization, site characterization, and management planning standards recommended for active coal mines.** However, when developing performance standards, adequate consideration should be given to the significant differences between active mines, abandoned mines, and the remining of previously abandoned mine sites. At such abandoned sites the CCR placement process begins with a degraded site and the same management options available in an active mine site may not always be feasible. The plans should consider the benefits of CCR use for reclamation at these degraded sites but should also factor in the potential adverse impacts of CCRs, accommodating these concerns in the overall plan.<sup>7</sup> (emphasis in original)

### **6.2.4 No water quality or other monitoring is required when CCW is used as a soil amendment or additive**

According to PADEP regulations and guidance, there is no water quality monitoring required for coal ash used as a soil amendment or additive in coal mines.<sup>8</sup> Researchers for this project attempted to examine one permit authorizing as much as 10,000 tons of coal

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<sup>6</sup> See 25 PA Code 287.664(c)(2).

<sup>7</sup> NRC, *Managing Coal Combustion Residues in Mines*, 2006, page 183.

<sup>8</sup> See 25 PA Code 287.662 and PADEP, *Technical Guidance Document for Beneficial Uses of Coal Ash*, Doc. No. 563-2112-225, April 30, 1998 at page 3 and 6.

ash as a soil amendment at the RFI Energy Mine 208 site (Permit #16940103) for water quality impacts from monitoring points near soils where this ash was placed. The only monitoring well within a close enough distance to assess for impacts was drilled to a 35 foot depth and screened in the spoil. Sewage sludge was also being applied to soils at the site. While small trace element rises were measured in this well, (MW4A), there was not enough information to effectively assess whether the ash from the soil amendment was a source for these rises. There were no data from surface water monitoring points or other information on other potential impacts from the ash such as whether trace element uptake by plants was occurring. Thus further assessment of the site was discontinued. Given more than 300 feet of relief from the highest to lowest elevations at the site, which covers several hill tops intersected by small ravines, the authors are concerned about the possibility for surface drainages contaminated with trace elements and other constituents from ash and sewage sludge to flow offsite without being monitored and for uptake of trace elements by plants and plant eaters.

It appears that PADEP policy allows relatively large amounts of ash to be placed close to or on the ground surface in Pennsylvania coal mines as soil amendment where the ash is exposed continually to precipitation without monitoring of drainages from that ash into surface waters or underlying groundwater or plant uptake of ash constituents. The NRC emphasized repeatedly the need to monitor soil applications of ash:

***Topsoil Replacement.*** . . . In some cases, CCR is used as a soil additive to neutralize acidic soil. However, as discussed in Chapter 4 and in the following section, the uptake by vegetation of metals and other contaminants that may be present in CCRs is a concern.

***Revegetation.*** . . . Many post-mining land uses, such as prime farmland, commercial forestry, and wildlife habitat, have specific revegetation requirements with very specialized planting practices. The uptake by vegetation of metals and other contaminants that may be present in CCRs is a concern, especially when the reclaimed land will be used as farmland. Sufficient soil cover, which is appropriate for the type of vegetation, is necessary to minimize plant uptake (see Chapter 4).

### **Reclamation of Abandoned Mine Lands**

. . . Finally, CCRs are used as either a soil amendment or a soil replacement, particularly at abandoned mine sites where topsoil may be totally lacking (see Chapter 2). However, plant uptake of contaminants must be considered when CCRs are used as a soil replacement.<sup>9</sup>

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<sup>9</sup> NRC, Managing Coal Combustion Residues in Mines, 2006, pages 161 & 162.

### **6.2.5 Overview of deficiencies regarding number and location of monitoring points**

One of the principal deficiencies of the Pennsylvania monitoring program is the failure of regulators to require an adequate number of well-placed monitoring points. PADEP often accepts the use of the monitoring points associated with the active mine, such as existing seeps, springs, mine discharges and abandoned mine shafts for monitoring of ash placement areas.<sup>10</sup> The points are generally accepted as appropriate based on their prior use for monitoring mining impacts. PADEP has great discretion in this area; mining regulations require only one downgradient point and do not require an upgradient monitoring point.

The reason for the gross deficiencies in number and location of monitoring points is likely PADEP's failure to acknowledge that CCW placement sites require monitoring consistent with the goals and requirements of RCRA solid waste management programs. By accepting monitoring schemes whose genesis is the guidance and regulations of the state surface mining program developed pursuant to SMCRA, much is lost. The Surface Mining Control and Reclamation Act was enacted to protect society from the adverse effects of strip mining and to ensure proper reclamation of active and abandoned strip mine lands. SMCRA was never intended to be used as a law for managing large quantities of nonmine waste. While SMCRA's framers tried to make the law as proactive as possible by designing it to minimize harm to the neighbors of strip mines, they accepted some harm from the mining process as inevitable and wrote provisions into the law to require compensation for water supplies lost or degraded by mining. The monitoring systems in surface coal mines have evolved to serve this objective. They are designed to measure major changes in water levels that can be attributed to the pumping, dewatering, and excavation that take place during active mining. They collect baseline information for a few common mine drainage parameters (e.g., iron, sulfate, manganese) from neighboring property owners' wells and mine monitoring points and monitor the changes that occur in those parameters in these wells during the mining.

Monitoring systems for SMCRA permits in Pennsylvania and elsewhere are *not* designed to provide the level of detail provided by the monitoring systems at solid waste disposal facilities permitted under federal RCRA and its state counterparts. Mine monitoring systems are based on site characterizations that typically do not include the level of information provided by the standard hydrogeologic investigations required for most solid waste landfill permits. Information such as the potentiometric contour for water in each aquifer layer in, under, and adjacent to the disposal area; the rates of water flow in each of those layers; and detailed knowledge of the interconnections between the aquifers and between those aquifers and surface waters is not assembled in the Module 8 addressing hydrology or in the Module 25 addressing coal ash in PADEP mining permits involving ash placement. Mining permits require monitoring for fewer constituents in the baseline monitoring than are typically required in landfill permits. The frequency of

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<sup>10</sup> PADEP, *Technical Guidance Document for Beneficial Use of Coal Ash*. Document Number 563-2112-225,

monitoring for ash parameters (usually annually) after mining and ash placement is typically less than required for those same parameters at coal ash landfills (usually at least quarterly). The end result is a monitoring system in most Pennsylvania minefill permits that is based on more rudimentary information and is not designed to detect problems and prevent harm to water supplies, as is the goal for RCRA permitted landfills.

Coal ash is a nonmine-generated industrial solid waste that is chemically different from coal or other mine material. Unlike acid-producing spoils and coal refuse, which generally become less active when taken out of contact with air and placed in reduced environments such as under the post-mining water table in a coal mine, coal ash often becomes chemically more active when placed in water. Most cases of contamination from CCW involved its placement close to or below the water table. RCRA was enacted to ensure that any solid waste that could pose harm if mismanaged is treated, stored, and disposed in a manner that *prevents* that harm from occurring. Thus monitoring systems at RCRA permitted landfills are designed to detect contamination before it becomes a problem and to abate its source to prevent environmental degradation. To accomplish this, RCRA requires extensive site information and effective early warning monitoring systems.

#### **6.2.5.a. Failure to require a sufficient number of monitoring wells**

If RCRA's goal is not to be contravened by the minefilling of industrial wastes like CCW, one downgradient ash monitoring point will not suffice as a minimum requirement for the typical mine fills (placing more than 10,000 tons of ash) studied in this report, particularly given the poor site-specific characterizations of the hydrologic systems surrounding these mine fills.

Although all of the permits reviewed in this report had more than one downgradient monitoring point, there is a major difference between the number of monitoring points at large coal ash mine fills and coal ash landfills in Pennsylvania. For example, there are three downgradient ash monitoring points (two monitoring wells and a seep) and no upgradient ash monitoring points at the Ernest Mine to monitor 7-8 million tons of CCW. There are two ash monitoring points (one upgradient and one downgradient well) at the Ellengowan Mine to monitor 9 million tons of CCW. There are two ash monitoring points (both downgradient wells) and no upgradient points at the BD Mine to monitor nearly 4 million tons. There are seven monitoring points, including two upgradient wells, at the Big Gorilla Pit-Silverbrook Refuse Reprocessing site to monitor 4-5 million tons of CCW. This compares to 15 monitoring wells at the Hatfield's Ferry Power Plant Coal Ash Landfill (Greene County) monitoring approximately 2.2 million tons of CCW and approximately 15 points at the Fern Valley Coal Ash Landfill (Jefferson Hills, PA) monitoring 4.8 million tons.

Even if minefill sites of this size are well-characterized hydrologically, two to three monitoring points is not an adequate number given the varied flow paths of groundwater through fractures, faults, underground mines and mine pools; varying flow gradients from steep to shallow; varying materials through which water is flowing from spoil to gob to

coal to less permeable rock layers; frequent disposal below water tables; no requirement for liners; minimal requirements for covers; and the significant size of ash placement areas. Inadequate site characterization plagued the monitoring programs at several sites examined in this report. For example, PADEP concedes that it has not identified any specific groundwater pathways through which groundwater in the water tables in the ash are migrating from the Big Gorilla Pit.<sup>11</sup> Also, PADEP does not know the volume of the water in the mine pool monitored at the Ellengowan and BD Mines, although that water has become contaminated with high levels of lead.<sup>12</sup> Lastly, PADEP asserts that the water in the ash at the Ernest Mine has not reached downgradient monitoring points, even though after eight years of site operation PADEP readily admits that they have never collected information documenting the rate at which groundwater flows from the ash through the site's refuse pile to the monitoring points.<sup>13</sup>

Good characterization of the hydrology and geology at a disposal site gives operators and regulators the knowledge to put monitoring points more reliably in effective locations, thereby establishing cost-effective monitoring systems that can rely on fewer monitoring points to protect water resources. Lack of knowledge about the basic hydrology and geology at a large ash placement or disposal site creates the need to install greater numbers of monitoring wells at the site. The disparity between monitoring at coal ash landfills and mine fills in Pennsylvania turns this basic logic on its head. Landfill operators who have a detailed understanding of the hydrogeologic systems surrounding their facilities are monitoring their ash from many more points than minefill operators who have a very poor understanding of the hydrogeologic systems. The resulting level of protection afforded to water resources by monitoring at mine fills is substantially weaker than at coal ash landfills.

#### **6.2.5.b. Failure to Monitor Leachate or Pore Water**

PADEP does not usually require that leachate from coal ash in the mine placement site or pore water within the coal ash or within the mixtures of ash with refuse or spoil at these sites be monitored. The authors found such monitoring in only five of the 18 permits examined in this report.<sup>14</sup> Collecting data on the concentrations of constituents in site leachate or from the pore spaces within saturated ash, or mixtures of mine material with ash, is one of the most effective ways to ensure that metals and other constituents are mobilizing in safe concentrations predicted by the characterization of the ash and site in the permit. If high levels of metals or other constituents are detected in groundwater near ash placement areas, pore water wells may be able to confirm or rule out ash as the source. Such wells could have determined the degree to which ash was contributing to

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<sup>11</sup> See Permit Review 6.

<sup>12</sup> See Permit Reviews 5 and 7.

<sup>13</sup> See Permit Review 1.

<sup>14</sup> Those sites are the McDermott site (Permit # 11950102, Per. Rev. 2) at monitoring point MD-22, the Big Gorilla Pit (Permit # 54920201, Per. Rev. 6) at MW-5, the McCloskey site (Permit # 17793044) at a number of cores drilled in the ash (although the data for these cores was not in the permit file), the Bloom #1 site (Permit # 17950111, Per. Rev. 10) at MW-3, and the EME Generation site (Permit # 32753702, Per. Rev. 8).

the increased degradation seen at the majority of sites reviewed in this report. The NRC Report spoke to the need for pore water monitoring with this statement among others:

At least one well (or a suction or pan lysimeter for unsaturated conditions), and preferably two wells, should be placed directly in the CCR to monitor local porewater chemistry and assess the field leaching behavior. These data should then be compared to the predicted flux rates in the site conceptual model.<sup>15</sup>

#### **6.2.5.c. Failure to require upgradient monitoring points**

PADEP guidance does not require a monitoring point upgradient from the area where coal ash is placed in a mine.<sup>16</sup> Without an upgradient well, PADEP cannot compare the effects of mining and ash disposal with water quality in an area of the site where those activities did not occur. In addition, the absence of upgradient monitoring points means PADEP cannot compare the effects of mining and ash on water quality detected at one monitoring point with the effects of mining (without ash addition) that might be observed at another point. The authors found that rather than correct this inability, PADEP regulators repeatedly appeared to use this inability to differentiate degradation based on the absence of effective upgradient monitoring points to dismiss ash as the source of any increases in concentrations found at downgradient ash monitoring wells.

At two of the fifteen sites assessed in this report (Buterbaugh and BD Mining), permit materials simply stated that no monitoring points were designated as upgradient to the ash. At three others (Ernest, McDermott and Wildwood), monitoring reports indicate the upgradient wells became dry before or within one year of the start of ash placement. Thus, there was no upgradient monitoring capability openly conceded in five of these sites.

Of the nine other sites studied, permit materials, historical information, and monitoring data at four of the sites explicitly indicate or suggest that ash had been placed upgradient to the “upgradient” monitoring points prior to the start of ash placement under the permit or was allowed to be placed upgradient to those points during ash placement, thus compromising the ability of those points to generate upgradient data. These are the Ellengowan, EP Bender, Hartley, and Sandy Hollow sites. This possibility may also be the case with the upgradient well MW-2 at the Silverbrook site. At the C&K site, the doubling of manganese concentrations and jumps in iron, acidity, and alkalinity from the baseline to mining and ash placement periods, a jump in sulfate from around 500 mg/L to 1,000-1,200 mg/L, an increase in TDS from an average around 700 mg/L to an average of 1700 mg/L, and the doubling to tripling of chloride, calcium and magnesium levels from before to after mining and ash placement started strongly indicate that “upgradient” MW-1A was in fact downgradient of these operations and was seeing their impacts within 2-3 years despite being 4,000 feet from the mining and ash placement area. These are the only upgradient points we found at these sites. Thus only at the Swamp Poodle, EME

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<sup>15</sup> NRC, Managing Coal Combustion Residues in Mines, 2006, page 170

<sup>16</sup> PADEP Technical Guidance No 563-2112-225.

Generation, Bloom #1, and Russelton sites (four of the fifteen sites studied) did not find researchers find upgradient, or, in the case of Russelton, upstream monitoring points that they considered reliably isolated from the influence of ash throughout the duration of monitoring.

At the largest ash placement site studied in this report, the Ellengowan Mine, deep mine fires resulted in many dozens of truckloads of burning coal, culm, and associated rock and the ash from that material being dumped directly into the mine pool at the bottom of the ShennPenn Pit in the 1970s. That minepool for the Indian Ridge deep mine flows east where some of it is sampled by MW-1, the most “upgradient” monitoring point at the Ellengowan site. From this monitoring point, waters flow through the Knickerbocker deep mine under 3 million tons of FBC ash slurried into the Knickerbocker Pit before turning westward into the mine pool in the Maple Hill deep mine where they are eventually sampled by the other designated “upgradient” monitoring point in the Ellengowan Permit, the Maple Hill Shaft. But not before being joined by potentially large amounts of ash leachate entering the Maple Hill minepool through the bottom of the Conveyor Ash pit which has received nearly 3 million tons of FBC ash. Deep mine maps and minepool elevations measured from boreholes by the PADEP’s Wilkesbarre District staff also document that waters under the BD Mining ash pit where nearly 4 million tons of FBC ash have been placed also flow north on occasion into the Maple Hill mine pool. In addition, deep mine water has been withdrawn from the Maple Hill deep mine by pumps at the Maple Hill Shaft for decades to control mine pools in the area and more recently to provide water for the Schuylkill Energy Resources power plant and the Knickerbocker Pit Demonstration Project. Water withdrawal rates at the Maple Hill Shaft can be considerable, exceeding 1100 gallons per minute, meaning that this monitoring point pulls water from many directions. Thus both of the “upgradient” monitoring points for the Ellengowan permit, MW-1 and Maple Hill Shaft, were not even upgradient to coal ash prior to the issuance of the Ellengowan permit in 1986. Furthermore the Maple Hill Shaft has in fact been downgradient to the placement of nearly 10 million tons of FBC ash in three pits starting 19 years ago with the dumping of ash into the BD Mining pit.

The continued pumping of mine pools from the Maple Hill Shaft and at least two other withdrawal points, combined with the absence of data on water elevation data at Ellengowan monitoring points for up to 15 years while most of this ash placement has occurred makes any assumptions about water flow directions problematic at monitoring points. These include the “upgradient” Maple Hill Shaft or the only other point established to monitor three fourths of the ash dumped at the Ellengowan site, the “downgradient” Monitoring Holes South, which also samples the minepool. There are no well logs or diagrams that provide details on the construction and screening, or sample collection depths for these two monitoring points in the permit files. The absence of this information was confirmed at a May 19, 2005 meeting with staff of the PADEP’s Pottsville District Mining Office. However, water elevations from 1989 in the Module 25 and water elevations reported from sampling in 2005 and 2006 at these points and monitoring wells at the Knickerbocker pit document a direction of flow from minepools under the Knickerbocker and Conveyor ash pits past the Maple Hill Shaft to the west,

confirming that Maple Hill Shaft is a downgradient ash monitoring point. Why the PADEP continues to identify Maple Hill Shaft as an “upgradient” ash monitoring point is not clear. Doing so can cause those who examine the monitoring data to falsely conclude that water at the Ellengowan site is not being contaminated by ash given the high pollutant concentrations found at this “upgradient” monitoring point.

#### **6.2.5.d. Monitoring of hydrologic units and large volumes of water**

Subchapter F of Chapter 87 (Pennsylvania’s surface mining law) allows and, in fact, encourages the monitoring of hydrologic units rather than individual monitoring points.<sup>17</sup> The goal of the hydrologic unit is to measure significant impacts to surface waters draining an entire permit area or portion of a permit area. The system does not focus on and often cannot determine impacts at any particular monitoring point. Consequently, there can be no response to degradation of water quality from one or two monitoring points. Substantial groundwater contamination is not detected until those waters reach the surface. Agency responses to rising concentrations of ash contaminants measured at surface monitoring points such as springs, seeps, or other mine discharges are not likely to occur until those rises have been substantial and sustained for a long enough period to cause significant degradation to larger volumes of surface waters outside the mine environment.

The monitoring systems at large anthracite minefills studied in this report rely in significant part on downgradient points that are monitoring large quantities of water in underground mine pools. While information on the actual volumes of water in these mine pools is not usually provided, they are characterized as draining large areas. For example, the mine pool underlying the Ellengowan and BD sites is reportedly draining a series of connected underground mines spanning an area of 8,000 to 10,000 acres. Monitoring Hole South, the sole downgradient ash monitoring point inside the permit area for approximately 9 million tons of coal ash placed at the Ellengowan Mine (aside from the ash in the Knickerbocker Pit), is monitoring this mine pool.<sup>18</sup>

Any detection of high levels of pollution at Monitoring Hole South measures this pollution in a very large quantity of water. Whether this pollution comes from ash in the Ellengowan permit or the more than three million tons of ash placed to date in the neighboring BD permit, monitoring it from one point in the mine pool allows the ash potentially to cause very large amounts of pollution at levels threatening human health and the environment, without any opportunity for early detection and abatement. This approach to managing pollution is the opposite of the preventive approach prescribed by RCRA. Indeed the high levels of lead and cadmium, far over DWS, and high levels of other trace elements measured repeatedly at Monitoring Hole South as well as the downgradient monitoring points in the BD mine raise a distinct possibility that the

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<sup>17</sup> 25 PA Code 87.201 through 87.209. See *Alkaline Addition for Surface Coal Mines* (Document No. 53-2112-217), BMR PGM Section II, Part 2, Subpart 17 and *Permitting Pre-existing Pollutational Discharges under Subchapter F of 25 PA Code Chapter 87, Subchapter G of 25 PA Code Chapter 88* (Document No.

<sup>18</sup> See Ellengowan Surface Mine/Knickerbocker Pit (Permit Review 5) and BD Mining (Permit Review 7).

approximately 16 million tons of ash placed in these two mines is seriously contaminating very large quantities of water in the mine pool underlying these sites.

### **6.2.6 Insufficiency of baseline monitoring**

It is essential to determine adequate baseline water quality prior to placement of coal ash. Without such a determination, it is difficult to identify and quantify the impact of ash placement. Baseline values for both concentration and loading are needed. Legally, enough baseline data to characterize seasonal variations in water quality and quantity (meaning baseline loading values must also to be determined) is required by SMCRA. This applies to any pollutant that might cause a material damage to the hydrologic balance beyond the permit boundaries. If mine permits are modified to allow for the importation of coal ash to sites, the baseline seasonal variation in the quality and quantity of parameters in the coal ash must be as equally characterized in waters at those sites as are the quality and quantity of mining parameters. We know of no provision in SMCRA that implies otherwise. According to a US DOI study of Pennsylvania remining sites, a full 12-month baseline sampling program is recommended to accurately characterize any preexisting discharges.<sup>19</sup> The DOI recommendations apply as fully to remining operations that include ash disposal as those that do not, extending the need for the baseline characterization that applies to traditional mining parameters to coal ash parameters.

No loading values for ash parameters were presented for baseline characterization at any of the sites studied in this report. While there are baseline loading values for aluminum, iron, manganese, and sulfate which are significant ash parameters, loadings were calculated for those constituents as mining parameters from subchapter F monitoring points, not as ash parameters from ash monitoring points.

While there were several permits examined in this report that had more than six months of baseline concentration data for Module 25 ash parameters, there were none that used more than six months of data to characterize baseline quality for those parameters. Those permits with the most data prior to ash placement were for the EME Generation site and Big Gorilla site.<sup>20</sup> The expanded pre-ash placement monitoring data in the EME case come from having at least three years of monitoring data from active gob disposal operations from which to measure the added impact of the ash placement. At the Big Gorilla site, there are water quality data from the Silver Brook discharge and other points monitoring effects of the refuse remining and ash placement occurring for eight years prior to the commencement of ash disposal into the Big Gorilla Pit. However, much of these data at both sites did not include values for many trace elements monitored under the Module 25 provisions for PADEP mine fill permits.

The large majority of sites had only 3 to 6 months of concentration data (monthly samples) collected at ash monitoring points for Module 25 parameters with two

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<sup>19</sup> Hawkins, Jay W. *Characterization and Effectiveness of Remining Abandoned Coal Mines in Pennsylvania*, U.S. Bureau of Mines, U.S. Department of the Interior, 1995.

<sup>20</sup> EME Generation - Permit Review 8, Big Gorilla - Permit Review 6.

exceptions noted for having even less baseline data. One of these is the BD Mining site and the other is the Hartley Strip site.

At the BD Mining site, downgradient monitoring point MP006 (the Gilberton Shaft) had only one measurement for trace elements and other ash parameters. There were no baseline measurements for these or any other Module 25 parameters at the other downgradient well, MP007, which is much closer to the pit where ash was placed.<sup>21</sup> This despite the fact that some 4 million tons of ash have been placed in this first disposal pit at the BD site and another 4 million tons of ash placement are now underway at a second pit. The Hartley Strip had no baseline data for any constituents at the ash monitoring wells that the authors could find in the permit files.<sup>22</sup> Incredibly at the BD Mining site, PADEP also did not require an upgradient monitoring point to be established, and at the Hartley site, designated upgradient well MW-2 was within the ash placement area, calling into question its subsequent performance monitoring results as reliable upgradient data. The failure to collect adequate baseline data seriously hinders assessment of the impact of coal ash at these sites. The NRC report specifically mentioned Pennsylvania when discussing the lack of good upgradient monitoring points as well as the failure to gather sufficient baseline data:

#### **Number and Placement of Wells and Length of Monitoring**

The committee is concerned about the number and placement of monitoring wells at CCR mine placement sites. . . .

Additionally, the committee observed sites at which background or upgradient wells were not situated in appropriate locations to achieve long-term baseline data for comparison. Monitoring well data from mine placement of CCRs is often difficult to interpret due to the influences of the mining process itself and the large volumes of spoil, which can impact water quality in ways similar to CCR. Nearly all sites face the difficulty of siting wells in locations where the background influences of mining operations can be separated from the influence of CCRs, even somewhat simple sites. Substantial pre-CCR-placement monitoring data (or background data) are needed to discern the contributions of CCR from other influences. The problem is particularly severe in densely mined regions, such as the anthracite region of Pennsylvania, where several active or abandoned mines may contribute flow to a single monitoring point.<sup>23</sup>

This discussion reflects two kinds of “baseline” or “background” data used to gauge impacts from ash placement, data from upgradient monitoring points compared to that from downgradient points and data from before to after ash placement starts at

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<sup>21</sup> BD Mining, Permit Review 7.

<sup>22</sup> Hartley Strip Mine, Permit Review 9.

<sup>23</sup> NRC, Managing Coal Combustion Residues in Mines, 2006, pages 167 & 168.

downgradient points. The fact that PADEP failed to require the operator to establish any upgradient monitoring point at the BD Mining ash site makes its failure to require more than one baseline measurement of trace metals and other ash parameters from downgradient monitoring points that much more egregious. The Department approved this permit knowing it was authorizing a massive ash minefilling operation with a monitoring system that lacked either kind of background data assessment capability from which to gauge impacts of the ash.

### **6.2.7 Frequency of monitoring for trace metals and other ash parameters is inadequate**

After ash placement at active coal mine sites, groundwater monitoring must be performed annually for the following parameters: aluminum, arsenic, cadmium, calcium, chloride, chromium, copper, lead, magnesium, mercury, nickel, potassium, selenium, sodium, and zinc.<sup>24</sup> Yet annual monitoring is clearly insufficient. It fails to account for different seasons in the hydrologic cycle when aquifers are recharging or discharging and when water tables are fluctuating and greater precipitation may dilute contaminant concentrations. Depending on when the sampling occurs, the results can understate or overstate trends in concentrations or miss detection of a contaminant entirely. Thus the fundamental requirement of SMCRA for performance monitoring to ensure that material damage to the offsite hydrologic balance is avoided has been simply abrogated in this instance by PADEP guidance for coal ash parameters.

Not all permits studied were requiring only annual monitoring for these parameters. Several of the larger ash application sites were requiring more frequent monitoring although sometimes the frequency of monitoring at these sites was erratic. For example, at the Ernest Mine (Permit # 32950201), monitoring for trace elements and other ash parameters during ash placement has ranged from once every quarter to once every 15 months. At the NEPCO Silverbrook site (Permit # 54920201), monitoring has been similarly erratic. While it has extended for more than 20 years, prior to 2000, there were several gaps including two gaps of three to four years each in which no data for trace elements or other ash parameters can be found. Since 2000, monitoring for ash parameters has varied from quarterly to semi-annual. At the McDermott Mine (Permit # 11950102), monitoring for trace elements and other ash parameters was quarterly on a fairly consistent basis. This has also been the case at the EME Generation site (Permit #32753702) and at the BD Mining site (Permit #54850202). At the EP Bender Mine (Permit # 11930102), a smaller site involving 65 thousand tons of FBC ash, there was also quarterly monitoring for trace metals and other ash parameters.

However, at the other nine sites assessed in the report (Swamp Poodle, Ellengowan, Bloom #1, Hartley, Sandy Hollow, Buterbaugh, C&K, Russelton, and Wildwood), monitoring for trace elements and other readily soluble ash parameters such as calcium and magnesium was performed on the minimal annual basis prescribed in PADEP

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<sup>24</sup> PADEP, *Technical Guidance Document for Beneficial Uses of Coal Ash*, Doc. No. 563-2112-225, April 30, 1998 at page 4.

guidance. This has produced just nine measurements of concentrations of these constituents over nine years at Hartley (after ash placement started), five measurements of these constituents over four and half years at C&K, four measurements over three and a half years at Buterbaugh, four measurements over 6 years at Bloom #1, three measurements over three years at Swamp Poodle, and three measurements over five years at Sandy Hollow at individual monitoring points. There were other ash monitoring points at these sites, but even less measurements of ash parameters were taken at them. While there are other trends that add to evidence that ash is the source of high trace element concentrations at the Hartley, Swamp Poodle, and Bloom #1 sites, clearly too little data on trace elements, calcium and magnesium has been produced at any of these sites to give a definitive picture of the impacts that are occurring from these constituents.

#### **6.2.8 No monitoring for obvious indicator parameters**

The absence of antimony, boron, and molybdenum from PADEP's list of monitoring parameters is a critical deficiency. These three trace metals are not commonly seen in AMD but leach from Eastern and Midwestern coal ash in alkaline pH environments making them useful markers for distinguishing coal ash contamination in the disturbed coal mine setting, particularly when alkaline ashes are being used to abate acidity. PADEP's SPLP leach test has repeatedly documented these three metals leaching above other trace element concentrations from ashes of bituminous and anthracite coals and waste coals authorized for mine placement in the permits studied in this report.

Frequent monitoring for antimony, boron, and molybdenum would provide timely information about adverse impacts from coal ash placement that could be differentiated from mining impacts at the same site. Yet only one of the 19 permits studied in this report monitors for any of these constituents on a regular basis. That permit for the Hartley Strip site monitored for antimony and found it in levels exceeding the DWS in both mine monitoring wells assessed and in one case by more than 18 times.<sup>25</sup> There was sporadic monitoring for molybdenum at those wells that found this trace metal at a level 19 times higher than EPA's Removal Action Level and long-term child health advisory. As discussed in Section 6.2.1, boron and molybdenum were also found in two other wells in the Hartley mine that are part of the monitoring system for the Hatfield's Ferry Power Plant's coal ash landfill and found in harmful concentrations in the waters of Little Whitely Creek that drain from the mine and the landfill.

Additional field data demonstrating the leachability of boron and molybdenum are readily available. At the Montour PPL coal ash landfill in Pennsylvania, a study found boron, molybdenum, and selenium to be consistently above detection limits in the generally alkaline pore water in a test cell.<sup>26</sup> Molybdenum and selenium have been repeatedly found in levels well beyond detection (exceeding DWS and health advisories by several times) and boron has been detected, albeit in levels below health advisories, in

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<sup>25</sup> See Permit Review 9.

<sup>26</sup> Fruchter et al. (Fruchter, J.S., D. Rai, J.M. Zachara, and R.L. Schmidt. 1988. *Leachate Chemistry at the Montour Fly Ash Test Cell, Interim Report*. EPRI EA-5922. Electric Power Research Institute, Palo Alto, CA.)

pore water measurements on the waste anthracite coal ash in the Big Gorilla Pit studied in this report.<sup>27</sup>

Additional research confirms the leachability of boron and molybdenum from coal ash. Dressen et al. (1977) found that molybdenum was highly leachable from coal fly ash under alkaline conditions, and Wu and Chen (1987) found that very high percentages of boron (58-88%) were leachable from Illinois Basin bituminous coal ashes under alkaline conditions. Ainsworth and Rai (1987) found molybdenum to be strikingly more concentrated in fly ash from eastern bituminous coal compared to western subbituminous coal and lignite. The inexplicable failure of PADEP mining regulators to monitor for well known signature parameters of contamination from eastern and midwestern CCW such as antimony, boron, and molybdenum raises a basic question about whether the PADEP appreciates the need for its mine monitoring programs to differentiate sources of contamination between mining, coal refuse, and coal ash (a waste that has nothing to do with mining or cleaning coal) and thus whether the agency is genuinely committed to protecting the mine environment from the adverse effects of coal ash.

In addition, PADEP also fails to analyze for hexavalent chromium in leach tests or monitor for it at ash placement sites. There is, nevertheless, research from within Pennsylvania showing that much, if not most, of the chromium in coal ash is the more toxic and water-soluble chromium (VI).<sup>28</sup> PADEP should require monitoring for all of these trace metals at coal ash mine placement sites.

Lastly, it should be noted that despite the requirement to monitor for potassium annually (at a minimum) at coal ash placement sites, the authors did not find consistent monitoring for this parameter in the permits examined in this report. This is a significant omission because potassium is another important indicator parameter often found in large quantities in the eastern coal ashes and waste coal ashes being placed in the mines studied in this report and is readily soluble in the SPLP tests performed on those ashes.

### **6.2.9 Monitoring at detection limits that are too high**

PADEP is allowing mine operators to routinely submit monitoring reports that analyze for trace metals only down to detection limits that are above DWS and water quality standards as well as the highest baseline concentrations reported for those metals, sometimes by many times. As a result, researchers found many instances, in at least eight of the fifteen permits studied in this report, in which regulators and the public are left not knowing from monitoring reports whether harmful levels of these metals are leaching from deposits past monitoring points. For example, some 56 of 174 samples, nearly one third of all samples from monitoring points in the adjoining Ellengowan and BD Mining sites (Permit Review 5 and Permit Review 7 respectively), that were analyzed for lead

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<sup>27</sup> See Permit Review 6.

<sup>28</sup> Cain, Randy D. Dengwei Huo, and H.M. “Skip” Kingston. *Treating Hexavalent Chromium In Fly Ash Leachate Using Acid Mine Drainage*, 1999, Allegheny Energy, Generation Division, 800 Cabin Hill Drive, Greensburg, PA 15601, Department of Chemistry and Biochemistry and Environmental Science and Management Program. Duquesne University, Pittsburgh, PA 15282-15230.

from 1994 to 2006, reported results as being less than a detection limit that exceeded the DWS for lead (0.015 mg/L). The operators reported one sample with a result of <0.50 mg/L, more than 33 times the DWS and 26 other samples with a result of <0.10 mg/L, 6.7 times the DWS. Thus at these adjoining sites where 16 million tons of FBC culm ash has been dumped and there have been many actual concentrations of lead exceeding the DWS at downgradient ash monitoring points, this constant use of high detection levels has hampered understanding of what appears to be a very serious lead problem in large mine pools downgradient from the ash. It is worth noting that the permit-required SPLP tests on both sources of the FBC culm ash dumped here have revealed to PADEP for many years that both ashes readily leach high levels of lead in the laboratory (10-32 times the DWS).

At the EME Generation site (a.k.a. Homer City Coal Refuse Disposal site, Permit # 32753702), every one of 113 samples analyzed for lead at the three designated ash monitoring points reported a result of <0.05 mg/L, more than 3 times the DWS. Thus in nine years of monitoring, PADEP failed to establish whether there was a harmful concentration of lead in the water before this permit was issued or whether lead was rising from below the DWS to up to up to 3.3 times beyond the DWS after the permit was issued.

At the Hartley site, high detection limits crippled analysis of trace elements at the mine's ash monitoring wells because there were so few results reported to begin with, given the annual frequency of monitoring. For example, of seven samples analyzed for antimony at MW-1 from 1989 to 1998, four reported results at detection limits exceeding the DWS (0.006 mg/L). Two of those results were <0.10 mg/L, 16.67 times the DWS. Two of the seven results for cadmium at MW-1 were reported less than a detection limit that was twice as high as the DWS (0.005 mg/L) and one of the seven results for mercury was less than a detection limit twice the DWS (0.002 mg/L). At MW-2, five of nine samples analyzed for antimony reported results less than detection limits that were greater than the DWS and four of those were below detection limits 16.67 times the DWS. Three of nine samples reported cadmium at less than a detection limit twice the DWS.

At the Bloom #1 site, detection limits for arsenic and cadmium were raised in monitoring from before to after the commencement of operations, leaving observers less able to tell if problems were occurring once ash placement started. Virtually all values reported for these two trace elements were below detection limits throughout monitoring. Furthermore, at all ash monitoring points, cadmium concentrations were recorded in monitoring reports in the first two samples in the baseline period at <0.005 mg/L, (equal to the DWS). In the subsequent four samples to the end of the baseline period, cadmium was reported at <0.020 mg/L, four times the DWS at all monitoring points. Then, after ash placement started, cadmium was reported at <0.030 mg/L, six times the DWS through the duration of monitoring at all monitoring points. Arsenic was reported at <0.010 mg/L (equal to the DWS) during the baseline period and then at <0.015 mg/L throughout the duration of monitoring after ash placement started at all monitoring

points<sup>29</sup>. At monitoring well FA-32, this problem occurred for selenium as well, with values reported at detection limits that rose from <0.010 throughout baseline monitoring to a limit eventually five times as high, <0.050 mg/L, equal to the DWS during ash placement.

The same problem occurred in results from both of the shallow ash monitoring wells assessed at the C&K site, with selenium values reported below detection limits that rose by more than thirteen times from baseline monitoring (at <0.0023 mg/L) to ash placement monitoring (up to <0.031 mg/L). While these higher detection limits are not exceeding the DWS for selenium, they are well beyond the federal recommended water quality standard that prevents chronic toxicity to aquatic life in surface waters of 0.005 mg/L (Continuous Chronic Criterion), and thus are not protective analytical levels for monitoring shallow groundwater whose discharges to surface waters can often increase through the broken earth of reclaimed surface mines.

High detection limits have been frequently allowed in monitoring for trace elements in the Ernest Mine (Permit # 32950201). Some 37 results for arsenic, cadmium, lead, and selenium have been reported at less than detection limits that exceeded DWS. The worse examples were results of <0.4 mg/L for lead, 26.7 times the DWS, reported in September 1999 and June 2000 at all three downgradient ash monitoring points. These two results preceded actual lead concentrations at MW1 of 0.170 mg/L in September 2000 and 0.131 mg/L in June 2001 that exceeded the highest baseline (before ash placement) concentration (0.012 mg/L) by more than 10 times and the DWS (federal action level) by more than 8.7 times. Similar high lead levels exceeding all baseline concentrations and the DWS were measured at the other two downgradient ash points in the two samplings after those two with the results at <0.4 mg/L. PADEP's acceptance of such high detection limits in this instance may have presented a picture substantially more benign than it actually was, given the high actual values subsequently reported at all points. Cadmium values were reported at <0.04 mg/L, eight times the DWS in those samples with the high lead detection limits. Selenium values were reported at less than detection limits up to <0.2 mg/L, four times the DWS at all three monitoring points. These detection limit values were much farther above water quality standards particularly for cadmium (CCC of 0.00025 mg/L) and selenium (CCC of 0.005 mg/L) which are the more relevant standards of concern at one of those ash monitoring points, E-5 a surface seep into McKee Run, a major stream draining the area.

Similar high detection limits may have masked cadmium, arsenic, and selenium exceedances of DWS and WQS at ash monitoring points in the McDermott Mine (Permit #11950102). Detection limits for cadmium, set at <0.010 mg/L were reported for the large majority of results at all monitoring points and thus kept reviewers of data from knowing how many exceedances of the DWS took place for this element. This hindered understanding of the scope of a problem that is documented by multiple measurements of actual cadmium above twice the DWS in latter samples at several of the monitoring

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<sup>29</sup> An exception was an actual concentration of 0.017 mg/L of arsenic reported in the last baseline sample (April, 1996) at monitoring point FA-19. See Permit Review 10, Figure 10.28.

points, while not a single result was reported above  $<0.010$  mg/L before ash placement started at any monitoring point.

### **6.2.10 Lapses in data collection**

The authors of this report encountered gaps in monitoring data in every permit examined. Sometimes the gaps occurred because monitoring points were dry or disabled but other times there was no documentation explaining why the gaps occurred. In several cases, these gaps were filled by asking PADEP staff for data not found in the permit files.

The most notable gaps in data occurred for trace elements and other more exclusive readily soluble ash parameters such as calcium, magnesium, potassium, sodium, and chloride. Ironically, trace elements, particularly the heavy metals, are the constituents that generate the greatest concerns in controversies concerning coal ash management. In several cases these gaps exacerbated an existing paucity of data for trace elements given that only annual monitoring was required for them to begin with. The gaps also occurred at times after high trace element concentrations had been recently reported or when major operations began. Thus regulators are left with no data, precisely when they need more data to look for the source of any potential problem suggested by the high concentration, or whether adverse impacts are readily occurring from the advent of the operation.

An example of the first situation occurred at the Bloom #1 site, where there were only four measurements for trace elements (and calcium, magnesium, and other annual ash parameters) over a six year period of monitoring at four ash monitoring points. Worse, however, is that three of the measurements were grouped in a two year period from April 1997 to March 1999 which was then followed by a four year gap of any data before the last measurement occurred in March 2003. Adding to the concern over this gap was the fact that the sole measurement for trace elements obtained a year later from a fifth ash monitoring point, MW-3 installed directly in the ash/spoil backfill, recorded arsenic at 21.5 mg/L, 2150 times the DWS.

Another example of this situation occurred at the Russelton site (Permit # 02930201), where there were just four measurements of trace metals taken at what PADEP considered the best downgradient ash monitoring point, D-8, in five years of monitoring (from beginning of 1997 through end of 2001). Adding to this paucity of data and short duration of monitoring was a one year and ten month gap between the December 1998 and October 2000 measurements. This level of monitoring occurred at a site where 1.5 million tons of ash had been placed. Of further note is that the highest arsenic (0.0876 mg/L nearly nine times the DWS) and highest cadmium (0.053 mg/L, more than 10 times the DWS) concentrations found at Russelton were measured at D-8 in October 1997, nearly a year after ash placement was underway.

An example of the second situation occurred at the Silverbrook Mine (Permit # 54920201). After high levels of selenium were reported in the May 1994 sampling at

upgradient MW-2 (0.0960 mg/L) and the downgradient Silverbrook Discharge (0.260 mg/L), there were no data for selenium, other trace elements, or other ash parameters such as calcium, magnesium, aluminum, and sodium for more than a three year period (from June 1995 to August 1998) at either MW-2 or the Silverbrook Discharge in the PADEP monitoring records. This absence of data reporting occurred during ongoing placement of ash over a 250 acre area at the site. Many of these other parameters had also been rising gradually at both monitoring points previous to June 1995. Furthermore in the middle of this gap, in July/August of 1997, ash placement started in the Big Gorilla Pit making the data from the Silverbrook Discharge, the primary monitoring point downgradient of this Pit, that much more important.

At the Swamp Poodle site there were only three measurements of trace elements and other ash parameters at ash monitoring points and the first measurement did not take place until a year and one month after ash placement had been underway. Chloride measurements stopped in March 1998 even though ash placement continued for another year.

At the Hartley site, assessment of data from two mine ash monitoring wells was seriously hampered by the lack of baseline data in the permit files. There was a six and half year gap in data for major and minor elements from both of the mine ash monitoring wells examined, a four year gap in trace element data at the downgradient well and a nearly two year gap in trace element data at the upgradient well. These gaps occurred amidst measurements of antimony and lead several times over the DWS. Rising levels of boron and molybdenum at two additional wells installed in this mine, as part of a monitoring network for an adjacent coal ash landfill, document that ash in the Hartley Mine is contaminating water as even the generator of the ash has conceded, making these gaps in data from the mine monitoring wells that much more egregious.

At the McDermott site, assessment of high levels of lead, cadmium, and selenium revealed from quarterly monitoring for trace elements was hampered by a gap in data ranging from one year and three months to one year and ten months in 2000 and 2001 at all monitoring points.

Data gaps hindered our assessment of the impacts of ash at all sites and made any effective assessment at a number of other sites impossible, resulting in their removal from this study. These data gaps, on top of the standard termination of monitoring within a few years if not months of the completion of ash placement, the small numbers of monitoring points, annual frequency of monitoring for trace elements and other ash parameters, failure to monitor for well-known ash indicator parameters such as boron and molybdenum, inadequate collection of baseline data and frequent use of high detection limits in analysis of samples leave those seeking to definitively assess impacts at most Pennsylvania mine fills with more questions than answers. Indeed it would seem difficult to design monitoring programs less capable of characterizing impacts than the ones accepted by PADEP for several of the sites studied in this report.

#### **6.2.11 No monitoring of ecological impacts**

Given the numerous basic deficiencies in monitoring, it is not surprising that researchers for this report found no evidence that PADEP is attempting to monitor let alone assess the ecological impacts of mine placement of coal ash. In numerous cases, the operations sanctioned in permits issued by the PADEP suggest the Department is oblivious to the ecological threats posed by large volumes of coal ash in the open environment. The temporary placement of CCW in large mine sites left uncovered for long periods (as is occurring at all large minefilling operations examined in the report), the construction of wetlands partially from coal ash or evaporation ponds and impoundments where ash leachate is directed and its constituents left to concentrate in sediments to be taken up in microorganisms, plants, benthic life, fish and higher organisms (as is occurring at the EME and Ernest sites) or the filling of end-cut lakes, silt ponds or water filled pits with ash (as was done in the Big Gorilla Demonstration project and the BD Mining site) are examples of this lax regard for the potential harm that CCW poses to ecosystems. In many instances the deficiencies in basic monitoring reduce the likelihood that mine operators or the Department would discern problems that may be developing. With only annual monitoring at many sites for trace elements that have toxic repercussions in extremely small amounts, regular detection limits accepted in monitoring results that are hundreds of times over those amounts, small numbers of monitoring points, and short durations of monitoring, the failure to detect ecological problems should be an expected result. Researchers note that when mine placement permits had concentration “triggers” for trace elements in ash, they were usually set at drinking water standards and in some cases 25 times the DWS, which levels are hundreds of times over the levels of selenium, cadmium, silver, copper, mercury and other trace elements that cause adverse impacts to aquatic life. Unfortunately the exceedance of even those concentrations did not “trigger” actions by the Department to investigate or remediate contamination from ash. The examination of these permits provided much data of trace element concentrations well above the federal recommended water quality standards (more often the chronic Criterion Continuous Concentrations and but even the higher acute Criterion Maximum Concentrations) being discharged from springs, seeps and other surface discharges from coal ash sites into low flow streams in comparatively large flow volumes. The selenium and cadmium discharges from the MD3 mine discharge and other seeps at the McDermott Site into tributaries of Hinckton Run at McDermott site, cadmium, chromium, lead, and nickel discharges from the Ernest E5 seep into McKee Run at the Ernest site, and silver, nickel, and zinc discharges from MP-19 down downhill to Cherry Run at the EME Generation site are examples.

The NRC summarized the need for better surface water and ecological monitoring in the following statement:

Surface-water and ecological monitoring are key components of any monitoring program to protect the ecosystem from potential adverse impacts. It is important to note that chemical levels adequate to protect environmental health can be significantly lower than those prescribed to protect human health. For surface-water, the frequency of sampling should adequately capture

temporal variations in the background conditions as well as variations in any point- and/or non-point-source loading. Tissue residue monitoring provides valuable insights into the bioavailability of certain contaminants that can be present at low concentrations in water but accumulate in living organisms (e.g., selenium). The duration of surface-water monitoring should be consistent with the duration of groundwater monitoring. In the event that surface water quality impacts are detected, appropriate ecological monitoring may need to be implemented.<sup>30</sup>

### **6.3 FAILURE TO ADEQUATELY CHARACTERIZE COAL ASH PRIOR TO PLACEMENT**

#### **6.3.1 The PADEP certification criteria for coal ash is clearly inadequate**

PADEP's certification criteria for coal ash, as set forth in the Certification Guidelines,<sup>31</sup> fails to require a waste characterization that predicts the potential of the ash to leach harmful constituents after placement. Certification of coal ash for mine placement requires the use of the Synthetic Precipitation Leaching Procedure (SPLP)<sup>32</sup> to determine the mobility of trace heavy metals and other metal oxides, as well as more prevalent inorganic constituents such as sulfate, chloride, and sodium. For a coal ash to be certified for placement in a Pennsylvania coal mine, the concentrations of constituents in the leachate cannot exceed maximum acceptable leachate concentrations set by PADEP. Those concentrations are normally 25 times the "groundwater parameter," equivalent to Pennsylvania's drinking water standard, for metals and 10 times the groundwater parameter for nonmetals.

While this test determines the quantity of inorganic constituents that readily leach out of a coal ash sample under controlled laboratory conditions for short periods, it is *not* designed to simulate actual conditions in the coal mines where CCW is placed. The actual conditions in mines are more geochemically complex. Placements usually involve large volumes of coal ash in much more concentrated environments for leaching, a variety of overburden materials, and changing chemistries of groundwaters and leachates moving through the coal ash. Also missing from the SPLP is the ability to predict coal ash leaching behavior over time. Coal ash placements will produce leachate over decades, not hours. Different constituents in CCW and the surrounding overburden will become more or less soluble as these factors change. Not surprisingly, researchers at US EPA, US DOE, and at numerous universities have found standard leaching tests, such as the SPLP, in and of themselves, should simply not be relied upon to predict the leaching

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<sup>30</sup> NRC, *Managing Coal Combustion Residues in Mines*, page 175, 2006.

<sup>31</sup> PADEP, *Certification Guidelines for Beneficial Uses of Coal Ash*, 563-2112-224, BMR PGM Section II, Part 2, Subpart 24.

<sup>32</sup> A description of the SPLP can be found in Chapter 1, Section 1.4.3.

behavior of numerous contaminants in coal ash at CCW disposal sites.<sup>33</sup> Concentrations of metals and other constituents in groundwater affected by CCW are often markedly different from concentrations generated in tests such as the SPLP.

A study of a bituminous fly ash disposal site revealed that several different leaching tests, both column and shake extraction, failed to predict the contaminants found in the monitoring wells.<sup>34</sup> The study found that leaching tests both over predict and under predict concentrations of pollutants and that results should be field tested until the leaching characteristics of the particular ash in the site in question are fully known. The study found that leach tests are unreliable field indicators "primarily because these tests are not designed, and should not be used, to predict exactly the concentrations of leachate components that will be found in the field."<sup>35</sup>

### **6.3.2. Why waste characterization of coal ash is essential**

Prior to the “beneficial use” of any CCW, the waste must be characterized to determine if it is an appropriate material for the specific use and site in question. This means that both its elemental and its mineralogical composition (different oxidation states of elements and the compounds in which they are found) must be determined. It means that the probable reactions of the ash with water and minerals at the site must be predicted to understand how the waste and the water leaching through it will evolve chemically over time. The fate of mineral phases of major and minor constituents of the ash such as iron, manganese, calcium, aluminum, and sulfate and the constituents of site materials must be calculated to understand when potentially harmful metals might leach from the ash or from site materials as a result of chemical reactions with the ash.

This degree of characterization is analogous to the characterization routinely required for overburden spoils and coal wastes in mining permits. It is as fundamental to the safety and success of beneficial use of CCW at a mine as the overburden analysis is to preventing AMD in contemporary mining. Nothing close to this degree of characterization is required in PADEP’s Certification Guidelines. PADEP’s limited waste characterization for the placement of coal ash is indefensible. In Pennsylvania, it would be unacceptable for a mine operator to submit a mining permit application with a random index leaching test of overburden for each 20 acres to be mined, along with a paste pH. Such tests are grossly inadequate to characterize natural materials for their toxic forming potential. Yet, in spite of PADEP’s need to understand the complexity of

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<sup>33</sup> From testimony of Greg Helms, USEPA Office of Solid Waste and Emergency Response, Washington D.C.; Ann Kim, US Department of Energy, National Energy Technology Laboratory, Pittsburgh PA; David Kosson, Ph.D., Chairman, Department of Civil and Environmental Engineering, Vanderbilt University, Nashville TN; and Rick Holbrook, US Office of Surface Mining, Western Region, at the December 6, 2004 Meeting of the National Research Council’s Committee on Mine Placement of Coal Combustion Wastes in Farmington, New Mexico.

<sup>34</sup> Dodd, D.J.R., A. Golomb, H.T.Chan and D. Chartier. “A Comparative Field and Laboratory Study of Fly Ash Leaching Characteristics,” Ontario Hydro Research Division, Toronto, Ontario, Canada, in *Hazardous Solid Waste Testing: First Conference, ASTM STP 760*, American Society for Testing and Materials, 1981, pp. 164-185.

<sup>35</sup> *Ibid.*

spoil chemistry and its reactions during mining, PADEP shows no similar intent to understand the complexity of CCW chemistry and its reactions at mine sites.

The National Research Council discussed the shortcomings of leach tests used by states in minefill permits like the TCLP and the SPLP extensively and among other points, concluded the following:

These tests do not use leaching solutions that are representative of the large range of geochemical conditions likely to be encountered in mines, and they may greatly underestimate the actual leaching that will occur. It is recommended that leaching procedures be continually improved to encompass the range of pH and oxidation-reduction conditions that might be encountered in pore-water close to the CCR placement area over an extended time (many decades to centuries). Leaching tests should also assess slower dissolution reactions.

Until some recently proposed leaching protocols are evaluated more thoroughly, some simple improvements to currently applied leaching protocols can be made. As a first step, a wider range of leaching conditions should be applied in static leach tests. These leaching conditions should include low-pH leaching solutions to represent the aggressive leaching that may occur in the most reactive areas of the unsaturated zone. The composition of the leaching solution should be monitored both before and after leaching is complete to ensure that the final leaching solution is representative of expected conditions at the mine site. Leaching tests should be conducted over longer periods (e.g. several weeks) and a few solid-to-solution ratios should be evaluated to assess whether precipitation controls are limiting leaching characteristics. Samples that do not pass a predetermined criterion should be rejected for mine placement. Samples that do pass the criterion may still have to be evaluated in greater detail, depending on the potential risks of CCR placement determined from site characterization, including column leaching tests and longer-term evaluations of leaching as CCR materials age.<sup>36</sup>

The authors of this report found that none of these steps are being considered, let alone employed, at the sites studied. There is no range of leaching conditions being applied in the SPLP test. There is always only one pH of the leaching solution, 4.2 standard units, which may be more acidic than some mine environments and is definitely not as acidic as the low-pH of acid mine drainage found in the most aggressive leaching environments of mines. The composition of the leaching solution is not monitored at the end of the test to ensure that the final leaching solution is representative of expected conditions at the mine site. Usually the pH of the final test leachate is several units higher than the field pH

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<sup>36</sup> NRC, Managing Coal Combustion Residues in Mines, pages 151 & 152, 2006.

measured at downgradient points close to the ash deposits. Leaching tests are only conducted for 18 hours and only with one solid to solution ratio that is typically far more dilute (with much more solution to solid) than that found in the mine disposal environment. Whether “precipitation controls are limiting leaching characteristics” is not assessed. Even samples whose metals concentrations pass the limit on leaching allowed under PADEP’s guidance, are sometimes disposed in the mines without explanation as will be discussed. Samples that do pass the test are never “evaluated in greater detail, depending on the potential risks of CCR placement determined from site characterization.”

### **6.3.3 Acid base accounting is insufficient at coal ash placement mine sites**

In fact, unlike the overburden analysis required by SMCRA, PADEP only requires acid base accounting procedures for CCW at a mine site when it is used officially as an “alkaline addition” to address acid mine drainage. And those procedures fail to take into account the impact of the kinetic potential for the alkalinity in the ash to buffer acidity. For example, much of the alkalinity in FBC ash is not available to react with acidity, because it is bound up inside cementaceous clumps of the ash. Concerns have also been raised that PADEP’s standard acid base accounting procedure fails to analyze for the different oxidation states of major elements in the ash such as iron, manganese, and sulfur. This can result in the failure to account for the acid-generating potential of an ash and the resulting overestimation of the net neutralization potential or buffering capacity.

Given that alkaline addition is one of the primary “beneficial purposes” claimed for ash placement in the sites studied in this report, the authors were surprised to find that a sustained decline in acidity and increase in pH appeared to occur at only three out of the 12 sites where ash was used for this purpose. At the other nine sites, the abatement of AMD was at best temporary and was never uniformly achieved. Indeed, at six alkaline addition ash sites in western Pennsylvania, the McDermott, Ernest, EP Bender, Bloom #1, Swamp Poodle and Hartley Mines,<sup>37</sup> average acidity at most downgradient ash monitoring points steadily increased and the average pH decreased as a result of the mining operation, without readily apparent sustained buffering effects from large quantities of ash. This occurred despite the fact that the ash placed in five of the six mines was the more alkaline FBC ash rather than the less alkaline Type F bituminous coal ash from conventional pulverized coal plants.

Thus, it appears that PADEP’s procedures for acid base accounting and estimating the neutralization potential of coal ash for AMD treatment need to be reexamined. Without an effective acid base accounting procedure for a given coal ash that can be used to determine the quantity of the ash needed to address AMD in a given mine, the ash’s buffering capacity can be exhausted. As a result, the ash can acidify and be stripped of that portion of its metals that mobilize in lower pH conditions. (Stewart, 1996) The

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<sup>37</sup> See McDermott Mine (Permit Review 2), Ernest Mine (Permit Review 1), EP Bender Mine (Permit Review 3), Bloom #1 Mine (Permit Review 10), Swamp Poodle Mine (Permit Review 4), and Hartley Mine (Permit Review 9).

concentrations of those metals in the mine waters can then increase to levels higher than their levels in the AMD before the ash was put in the mine.

#### **6.3.4 Failure to recognize the leaching potential of metals in an alkaline environment**

In addition, PADEP's focus on lowering acidity in coal mines overlooks the increased leaching potential of metals such as arsenic and selenium when acidity is decisively buffered at these mines by alkaline ashes. Monitoring at the Ernest, McDermott, C&K Coal, Swamp Poodle, Bloom #1, Penn State, and Big Gorilla operations, detected arsenic and/or selenium during periods of reduced acidity, elevated alkalinity and/or rising pH.

In several cases, very high levels of these metals were detected. For example, at the Swamp Poodle Mine, while arsenic was found at high levels in a downgradient monitoring well located in strongly acidic drainages, the level skyrocketed from 0.180 mg/L to 3.890 mg/L as acidity (which was as high as 18,500 mg/L) dropped from 4,000 mg/L to 0.0 mg/L at this monitoring point.<sup>38</sup> Likewise at the Ernest Mine, when acidity dropped by approximately 4,000 mg/L at a downgradient ash monitoring point four years after ash placement began, arsenic climbed to 0.513 mg/L, its highest recorded level at this monitoring point.<sup>39</sup>

Similarly at the Bloom #1 Mine, when a well was installed in the area of the mine where spoils were mixed with FBC ash to measure alkalinity effects, the concentration of arsenic measured in the only sample taken from the well in which trace elements were measured was 21.5 mg/L, 430 times the current DWS, and 2150 times the new DWS for arsenic (effective January 23, 2006).<sup>40</sup> The pH (field-6.9, lab-6.6) in this sampling, as with other samplings from this well, was also higher than at the other monitoring points in the mine, and alkalinity (151 mg/L) was dominating acidity (20 mg/L).<sup>41</sup>

Metals often exist in solution as cations. Some metals can also complex with oxygen to form oxyanions. In other words, they can mobilize as positively charged cations or negatively charged anions and migrate in water under a wide range of different pH and

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<sup>38</sup> See Swamp Poodle Mine, Permit Review 4.

<sup>39</sup> See Ernest Mine, Permit Review 1.

<sup>40</sup> See Bloom #1 Mine, Permit Review 10.

<sup>41</sup> PADEP stated (phone conversation June 15, 2005 with John Varner, Phillipsburg Office, PADEP) that the high level of total suspended solids in this sample, 418 mg/L, indicates the sample probably was not handled correctly resulting in high levels of arsenic being acidified into the sample. Levels of total versus dissolved arsenic were not provided in the monitoring report. However, even if PADEP believes virtually all of the 21.5 mg/L of arsenic was an undissolved portion of the 418 mg/L of TSS that was measured in this sample, that would mean approximately 5 percent of those solids were arsenic, a matter that should be of concern. Furthermore, the much higher levels of other ash indicator parameters in this sample such as calcium (632 mg/L), chloride (153 mg/L), magnesium (254 mg/L) and potassium (70.30 mg/L) than were found in most waters measured at other monitoring points, along with the higher alkalinity and pH and lower acidity in this sample, all suggest that the arsenic if not mostly solubilized, is moving with the groundwater in this ash-influenced environment.

oxidizing/reducing conditions. Metals having this characteristic include arsenic, antimony, boron, chromium (VI), molybdenum, selenium, and vanadium.<sup>42</sup>

The tendency for oxyanions to leach in oxidized and reduced environments or when acidic pHs are elevated raises questions about whether the objective of improving water quality is being served by reming permits that place large volumes of FBC ash into acid mine environments. Does the disruption of gob piles in abandoned mine sites and their replacement with large volumes of alkaline FBC ash, with the objective to rapidly raise pH, create more problems by mobilizing high levels of oxyanionic toxic metals that would otherwise remain immobile if these sites were not excavated and the acidity was allowed to abate gradually? There is a growing body of data indicating that over time acidity levels decline significantly in abandoned surface and underground mines as the pyrites near the surface of gob piles and acid-producing rock and spoils are oxidized, the piles settle and their inner geochemical environments become less exposed to the atmosphere and oxygen. (See Chapter 1, Section 1.5.1.)

### **6.3.5 Failure to adhere to standards in the Certification Guidelines for acceptable coal ash**

In the course of this report's permit reviews, the authors found that PADEP failed numerous times to enforce the requirement in the Certification Guidelines that prohibits an ash from being placed in a mine if one of the heavy metals in the ash leaches more than 25 times the state drinking water standard in the leach test.

For example, SPLP leach test results indicated that antimony regularly leached at levels more than 25 times the drinking water standard from FBC ashes disposed in several mines examined in this report. The drinking water standard for antimony, a potentially toxic heavy metal, is 0.006 mg/L. Thus the "Maximum Acceptable Leachate Concentration" for antimony in the leachate is 0.150 mg/L.<sup>43</sup> Nevertheless, PADEP approved large volumes of ash for placement that leached higher levels:

- The concentration of antimony that leached from "fly/bottom ash" in a January 1994 test reported to PADEP in the February 1994 biannual analysis of FBC ash (from waste anthracite coal) placed at the Ellengowan Mine was 0.71 mg/L, almost 5 times the acceptable level
- Permit-approved test results show the antimony that leached from a sample of FBC bottom ash (from waste bituminous coal) approved for disposal at the Ernest Mine in August 1994 was 0.250 mg/L.
- Permit-approved test results show that antimony leached from an April 1995 composite sample of bottom ash and fly ash at 0.200 mg/L, but was approved for disposal at the McDermott Mine.
- The above test result was used to approve the ash for disposal at the E.P. Bender Mine in 1996.

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<sup>42</sup> PADEP, Report, Coal Ash Beneficial Use in Mine Reclamation and Mine Drainage Remediation in Pennsylvania at pg 284, December 2004.

<sup>43</sup> PADEP, Certification Guidelines.

- Antimony leached at 0.260 mg/L in March 1997 from another composite sample of ash from the same source, and this resulted in approval to dispose of that ash at the Colver #2 Mine “Rail Yard Site” (Permit # 11970201 – initially examined but not studied in this report).

This low level of concern for adhering to the standards was not exclusive to antimony. A detailed examination of the Penn State site is illustrative.<sup>44</sup> Ash from the Carlson Generating Station in Jamestown, New York was placed at the Penn State site apparently without interruption even though the ash surpassed several Maximum Acceptable Leachate Concentrations in the first two quarters of 2004. A fly ash sample collected in February 2004 leached an arsenic concentration of 5.0075 mg/L in the required SPLP test, 4 times the acceptable limit. The sample also leached 0.2141 mg/L of antimony exceeding the previously stated acceptable limit, 7.98 mg/L of aluminum exceeding the acceptable limit for this element (5.00 mg/L), and 0.192 mg/L of cadmium exceeding the acceptable limit for this element (0.130 mg/L).

We found no documentation in the permit files of a PADEP response to these leaching levels, much less any indication of a temporary halting of ash shipments. Instead there were only test results for a second sample of fly ash collected in mid March 2004. Aside from pH, this sample was tested and apparently only analyzed for arsenic, antimony, aluminum, and cadmium. It leached 2.90 mg/L of arsenic, over twice the acceptable limit, but leached within acceptable limits for antimony, aluminum and cadmium, although both antimony and aluminum levels were elevated (0.032 mg/L and 2.28 mg/L, respectively).

There is no documentation of concern over this second test in the permit file, only documentation of a test result for a third sample of fly ash collected in mid April 2004. Leachate from this test was analyzed only for arsenic, which measured 1.132 mg/L, a high level but within “acceptable limits.”

Selenium and molybdenum leached at high levels, 0.1864 and 0.520 mg/L from the first sample in the test. The pH of the first sample’s leachate climbed in 18 hours to 10.19 units from 4.20 units in the extraction fluid at the start of this test and the second sample’s leachate climbed from 4.20 units to 8.15 units over the same short duration, indicating that substantial chemical changes were occurring. This raises questions of whether the trace metals, which were not tested in the second and third tests, would have been elevated and why PADEP would not want to determine their concentrations.

Indeed it appears that PADEP accords little priority to checking the toxic potential of ashes placed in Pennsylvania coal mines from the information available in permit files. In this case, there was no indication that the PADEP knew about unacceptable levels of arsenic, aluminum, antimony, and cadmium leaching from the Carlson ash until it received the “Six-Month Submittal For Coal Ash Beneficial Use Certification” on June 26, 2004 from Geotech Engineering, Inc., who managed the collection and testing of ash

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<sup>44</sup> The Penn State Site, Permit # 17820104, was one of four sites in the study for which final work could not be completed.

on behalf of the mine operator. This report was the only document in the permit file that informed PADEP that the Carlson ash violated these leaching limits. Absent another document dated before this report indicating otherwise, it is reasonable to assume that much of this ash was placed in the mine for at least several months before PADEP even became aware of the unacceptable levels of arsenic, aluminum, antimony and cadmium that readily leached from it.

Perhaps even more troubling is the absence of any indication that PADEP was concerned about those levels after it received the information. The next communication between Geotech Engineering and PADEP available in the permit file was a January 19, 2005, “Six-Month Submittal For Coal Ash Beneficial Use” which included test results for an August 2004 sample of Carlson ash to cover ash placed in the Penn State #1 Mine during the second half of 2004. The measured arsenic was again high at 0.865 mg/L. But there was no comment from Geotech to the agency about the unacceptable leaching levels of the previous report’s samples and no comments from the agency in the file indicating any concern about these levels, much less any evidence of a PADEP response action.

Based on letters in the permit file from PADEP to the operator for the Penn State #1 Mine approving continued use of different ashes at this mine that met “the Department’s guidelines,” it is clear that PADEP was not even aware of the leaching results of these tests until long after they occurred. The following statement from a letter dated October 8, 1997 from PADEP to the mine operator concerning use of BUA (Beneficial Use Ash) from the Scrubbgrass Power Plant represents a typical timeframe for PADEP approval of leach test results submitted by the mine operator:

We have reviewed Synthetic Precipitate Leaching Procedure (SPLP) analytical data submitted for the month of **February 1997** which we received on **September 29, 1997**. We have found the quality of the BUA to be in compliance with the Department’s guidelines. Based on the **SPLP** analysis the project may continue in accordance with the approved permit. (From file for Surface Mining Permit # 17820104 – emphasis in original document)

The guidelines emphasize that the SPLP test be on ash in the exact condition it will be in when it is placed in the mine. This letter is to the mine operator, not the generator. It is approving leach test data produced eight months earlier for coal ash that is generally not to be stockpiled in large quantities at the mine site. Regarding the ashes from the Carlson Station placed in the first half of 2004, the report from the laboratory to the operator of Carlson Station, for the first sample stated, “SAMPLE MARKED: Fly Ash / 2-5-04 / 2:00PM/SAMPLE FROM FRONT, MIDDLE, AND BACK OF ASH TRUCK” on the page giving the results of the bulk analysis of the ash. The reports for the second and third sample were also labeled “from the ash truck.” This suggests that the ash was sampled enroute from the power station to the mine. Clearly it appears that, regardless of the quality of the ashes involved, PADEP’s approval of their use at the Penn State #1 Mine was largely an after-the-fact exercise that often occurs many months after the ash has actually been placed in the mine and after large volumes have accumulated and are interacting with the environment.

This failure to enforce the restriction on placing ash at mine sites that exceed the PADEP standard for acceptable leaching is particularly of concern given the high level of leaching that must occur quickly from the ash in a dilute leaching test to surpass this standard and the lax requirements for isolating the ash from water in the state's mines. This concern is exacerbated by PADEP's failure to require that metals such as antimony be monitored at mine ash placement sites. The bottom line is that even if the SPLP were a reliable indicator of what trace metals in ash will do in placement environments, there is ample opportunity in the permits examined in this report for large volumes of coal ash that readily leach metals in toxic amounts to be placed into Pennsylvania coal mines and cause considerable water quality degradation before PADEP would even know that there was a problem. What is needed are regulatory requirements that PADEP adhere to certification guidelines, evaluate leach test results and respond to exceedances of leach tests in a timely matter before large amounts of the ash are deposited in the mines.

## **6.4 FAILURE TO ADEQUATELY CHARACTERIZE THE MINE SITE PRIOR TO PLACEMENT**

### **6.4.1 Failure to determine pre-placement water flow**

In general, Pennsylvania permits show little in the way of detailed pre-placement site characterization. Most remaining sites presume that the pre-existing mining characterization is still adequate. However, the characterization deemed adequate for mining purposes often does not contain the detail needed to effectively abate AMD, much less establish monitoring systems to measure adequately the impacts of coal ash placement at previously mined sites.

Pre-placement characterization of mine sites is absolutely critical to preventing degradation from coal ash placement. One important aspect of site characterization is understanding pre-placement groundwater and surface water flow. One scientist explained:

An understanding of the groundwater flow regime is essential to the design of site-specific monitoring plans to determine the impact of mining on groundwater quality and the hydrologic balance. The more thorough the understanding of this system, the more efficient this plan can be, maximizing the information which can be obtained and minimizing the cost of monitoring. This knowledge also gives the groundwater chemistry of the site meaning by providing a frame of reference regarding a given monitoring point's location and relative importance within the groundwater flow system. Absent this understanding, considerable time and money can be wasted by the poor placement of groundwater monitoring wells and the subsequent collection of meaningless water quality data. Although groundwater chemistry can be used to help

characterize the flow system, it must be integrated within a broader effort intended to define groundwater potential and hydraulic gradient.<sup>45</sup>

Placement of CCW in mines will change the pre-placement hydrology. Such changes may be deliberate, such as the plugging of holes to stop or divert mine drainage, or the changes may be inadvertent. Pre-placement monitoring locations may become meaningless because of mining operations. Points unnecessary to monitor before placement may become important in evaluating the post-placement conditions. For all site elements, the pre-placement conditions should be described, and the conditions post-operations should be projected. The post-operations conditions should be measured against projections, and the site characterization should be updated as needed. Then, the performance should again be projected into the future. Because coal ash placement creates an inherently transient system, site characterization is a dynamic process that should continue indefinitely.<sup>46</sup>

Examples of the need for ongoing effort to update the characterization of these sites occurred at the Ernest and McDermott sites when the sole upgradient wells designated by these permits became dry before and right after operations started, and at the Wildwood site where the sole upgradient well became dry one year into mining and ash placement. A fourth example already described would be that at the C&K Site where the data from upgradient monitoring well M-1A showed decisive deterioration in water quality after mining and ash placement started. Yet in none of these cases was there any record of any effort by PADEP to require the operators to install functional upgradient wells or update the characterizations of these sites. While PADEP did respond to sharp increases in AMD and related mining parameters controlled by NPDES permits and subchapter F limits, we could find no effort to actually gain any updated understanding of the hydrogeology at sites that would explain how the unforeseen pollution was occurring to effectively address it. An example of a PADEP response occurred at the McDermott site, where the operator was ordered to double the volume of ash placement to provide more acid buffering capability, which effort completely failed to stop the sharp increase in acidity at the site.

The National Research Council voiced a fairly strong, unambiguous, and detailed opinion in support of the need for adequate pre- and post-site characterization that involved continuing efforts to reevaluate and update understanding of sites as mining and ash operations proceed and to integrate information from waste characterization measures with information from site characterization to improve monitoring and better protect site waters from contamination.

## **SITE CHARACTERIZATION**

Site characterization is a dynamic process of developing and continually refining a site conceptual model, which captures

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<sup>45</sup> Norris, Charles H. *Minefill Practices for Power Plant Wastes: An Initial Review and Assessment of the Pennsylvania System*, August 29, 2003 at page 16.

<sup>46</sup> *Ibid.*

relevant aspects of the site that affect the behavior and potential impacts of CCRs in the mine environment. According to the National Research Council (NRC, 2001), a site conceptual model is “an evolving hypothesis identifying the important features, processes, and events controlling fluid flow and contaminant transport of consequence at a specific field site in the context of a recognized problem.” It can also serve as a valuable tool to link potential sources to receptors through environmental fate and transport pathways and exposure routes (ASTM, 2003) The site conceptual model supports CCR management decisions, such as whether to place CCRs at a particular mine site. ....

A site conceptual model can only represent an approximation of the real world because of the complexity of the mine setting and the inherent scarcity of field data. Nevertheless, the conceptual model serves as the basis for identifying critical information gaps, so that additional characterization data can be gathered to evaluate risk. This additional characterization data is then used to further refine, or, if necessary, to completely revise the site conceptual model (Bredehoeft, 2005) to capture site-specific complexities in groundwater flow, CCR leaching, and contaminant transport. Although site characterization and CCR characterization are initially discussed separately in this chapter, CCR characterization information is an integral part of the site conceptual model because the total mass and leachability of contaminants in the CCRs affect the extent of natural (or engineered) isolation necessary to prevent downgradient ecological or human health impacts.

The extent of pre-placement site characterization needed will depend on the aforementioned assessment of the risk of CCR mine placement as well as a consideration of the uncertainty in the site conceptual model. As uncertainty in the site characteristics and behavior of CCR increases, more effort should be placed on characterization. As discussed in Chapter 5, although the potential benefits of CCR mine placement are important to consider in CCR management decisions, these benefits do not reduce the need to characterize potential risks. Managers and regulators cannot make sound decisions about CCR placement unless both the benefits and the potential risks are well understood. Inadequate investment in the site characterization up front may lead to an erroneous assessment of potential CCR impacts and improper placement or engineering design. The costs of adequate site characterization are likely to be far lower than the costs of remediating groundwater and surface water contamination from a mine site with improperly sited CCRs.

### Information Needed for CCR Placement

The Surface Mining Control and Reclamation Act (SMCRA) outlines general site characterization requirements to obtain a mining permit and to develop the reclamation and operation plan (30 CFR 779.25, 780.22 (2004) (see Sidebar 6.1). However, these site characterization requirements were intended to assess the potential impacts from coal mining and do not specifically consider the impacts of CCR placement. In most cases, additional site characterization data are needed to guide CCR placement, both to evaluate the potential for contaminant transport and to support the engineering plan for the placement and design of an effective groundwater monitoring network (see Chapter 7).<sup>47</sup> (emphasis in original)

Beyond the drying up of a few wells, research of the sites in this Report found that pre-permit characterizations of large ash placement sites in remining operations have had more fundamental deficiencies because they have been based on the limited level of information necessary for mining permits. But rather than putting more effort into characterization to address the uncertainties confronting them, the PADEP's response has been to ignore the deficiencies. For example, at the Ernest remining operation in Indiana County, PADEP asserted, four years after the initiation of ash placement after more than a million tons had been placed at the site and toxic concentrations of lead, arsenic, chromium, and cadmium were showing up at the downgradient ash monitoring points, that NONE of the designated downgradient ash monitoring points were capable of seeing impacts from the ash because the waste was still 2400 feet away from the ash monitoring points.<sup>48</sup> Yet it appears that PADEP never measured the permeability or hydraulic conductivity of the 94-acre waste coal pile separating the ash from the monitoring points.<sup>49</sup> Furthermore, the single upgradient point required to be installed in the permit went dry and was never replaced. Thus, despite the substantial degradation of groundwater and surface water that has occurred at this site since ash placement began, PADEP maintains that its monitoring system is not capable of measuring impacts from the ash on the shallow groundwater moving through the refuse pile. Since this is the only water being monitored for ash placement impacts, it is unfathomable that analysis of water flow in this critical area of the site was not required.

Another example of the failure to perform adequate site characterization involves the Big Gorilla Pit Demonstration Permit.<sup>50</sup> In this case, beyond ignoring the obvious

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<sup>47</sup> NRC Managing Coal Combustion Residues in Mines, pages 129-130 & 132, 2006.

<sup>48</sup> See Ernest Mine, Permit Review 1.

<sup>49</sup> PADEP Ebensberg Office staff stated to this report's authors in a February 2005 meeting that they never collected such data and did not know how fast water was moving from the uncovered ash through the refuse and downhill to these monitoring points although they believed the pile had the consistency of sand and gravel.

<sup>50</sup> Solid Waste Management Permit #301304. The site is within the Silverbrook Refuse Project (Permit #54920201, see Permit Review 6).

deficiencies in the site characterization, PADEP has chosen to promote the site nationally as a success story involving the elimination of an acid lake. This Demonstration Project deposited 3 million tons of highly alkaline FBC ash into the 17-acre “Big Gorilla” acidic pit lake, in part to reduce AMD by eliminating the flow of water from the pit lake into the underlying deep mine pool. The pit lake is recharged by precipitation, and it discharges as groundwater. Yet according to the permit and PADEP, the specific groundwater flow path from the pit was never determined. PADEP acknowledges that the underlying earth has interconnected deep mines and is crossed with several faults and fractures, but the extent or direction of water movement through these conduits was not ascertained. Furthermore, the PADEP report on beneficial use of coal ash in mines stated that neither the groundwater monitoring wells in the most likely positions to be downgradient from the pit nor the monitoring of mine pool water discharging from the nearby Silverbrook outfall saw noticeable influence from the ash.<sup>51</sup> And while PADEP maintained that the ash blocked the flow of water from the pit into the mine pool, PADEP also asserted that water levels in nearby monitoring wells and in the mine pool continued to fluctuate seasonally at the same levels as before the filling of the pit (indicating that a hydraulic connection remains between the pit and the mine pool). A monitoring well and two cores installed in the ash in the Big Gorilla Pit also ran readily into water and sampling of these points always found a water table. Thus the effectiveness of the ash in preventing water movement and infiltration has not been demonstrated.

Furthermore levels of selenium and molybdenum in the Big Gorilla ash pore water have measured at several times drinking water standards and health advisories (in multiple samples in the case of selenium) and lead levels have also started to rise over the DWS. And once ash placement started in the lake, selenium, chromium, arsenic, and copper climbed to levels never before seen in the acid lake before the ash was dumped into it. Thus PADEP is unable to measure the effect the project is having on acidity in the underlying hydrologic system or to determine where high metal concentrations from the ash may be draining. Yet the Department continues to promote the Big Gorilla Demonstration Project as a success, making no apparent effort to fill obvious gaps in its understanding of what is occurring with the underlying hydrogeologic system.

The degree of information needed for effective site characterization was outlined in great detail by the NRC. The following are details relating to some of the information needed to characterize groundwater flow and its pathways to surface waters.

***Subsurface Water Flow.*** To understand the potential for contaminant transport from CCR placement sites, three dimensional flow processes should be included in the site conceptual model based on current theories of unsaturated and saturated flow in heterogeneous systems. The placement of CCR calls for thorough characterization of pre-mining groundwater flow and predictions of post-reclamation flow through the entire mine area, including disturbed area such as the mine spoil and the emplaced CCR. Site data to characterize groundwater flow would include seasonal fluctuations of the water table with respect to the CCR

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<sup>51</sup> PADEP, Report, Coal Ash Beneficial Use in Mine Reclamation and Mine Drainage Remediation in Pennsylvania. Chapter 9, December 2004

placement zone and hydraulic conductivities, rates, and directions of groundwater flow in all aquifers potentially influenced by the CCR. Predictions of post-reclamation groundwater flow would require an understanding of the material properties of the spoil and CCR, including the hydraulic conductivities of the material upon emplacement, and an approximation of the placement geometry. As described in Chapter 3, water flow paths can change dramatically because of CCR emplacement. Groundwater flow through fractured rock, including coal, is difficult to quantify, and adequate site characterization information about fractures is costly to obtain, because prediction of flow requires knowledge of the number, size and thickness, and continuity of the fractures (NRC, 1990, 1996; Domenico and Schwartz, 1998). Similarly, groundwater flow through heterogeneous coal spoils, which may contain both matrix and conduit (or pseudokarstic) flow (Hawkins and Aljoe, 1991; Smith and Beckie, 2003) is difficult to quantify.

Information on unsaturated flow characteristics is required to define the rate of contaminant migration into the groundwater zone, especially when CCRs are placed above but in close proximity to the water table. Prediction of water movement in the unsaturated zone requires information on values of hydraulic conductivity for CCR, spoil, and other materials as a function of water content and wetting and drying histories. Information on surficial topography relative to hydraulic conductivity variations may provide additional information about local infiltration at the land surface.

Sufficient data should be collected to estimate travel times for contaminants to the habitats of sensitive receptors and to the nearest monitoring wells. A thorough groundwater flow characterization will also inform the design of an effective groundwater monitoring network that will intercept any contaminant plume from the CCR placement site.

***Surface water flow.*** Large amounts of surface water flow data are typically collected in the standard mine permit application. However, the addition of CCR placement at a mine site necessitates that there be a clear understanding of the interconnections between groundwater and surface water flow under pre-mining, mining, and post-reclamation conditions.<sup>52</sup> (emphasis in original)

Not a single one of the permits studied in this report came close to providing this level of information about groundwater or its interconnections to surface water at the sites. The NRC report also stressed the importance of integrating the characterizations of the ash with the characterizations of the mine sites into which the ash was proposed to be placed to make intelligent decisions about the suitability of ash for sites and the safeguards, including monitoring systems, needed at those sites.

## INTEGRATION OF CCR AND SITE CHARACTERIZATION DATA

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<sup>52</sup> NRC., Managing Coal Combustion Residues in Mines, pages 134 & 135, 2006

Current site characterization is usually conducted independently of CCR characterization. In practice, site characterization and CCR characterization should be carried out in an integrated fashion to provide the information needed to develop a site conceptual model that adequately informs CCR management decision making in a way that is protective of the environment. For example, site characterization data are needed to inform the design of relevant leaching tests, by providing the range of geochemical conditions that might be encountered over long periods of time (decades to centuries) at the mine site. Likewise, an understanding of the total mass and leach ability of the contaminants in CCRs to be disposed at a mine site is needed to evaluate the potential for attenuation through reaction with geological materials. Given the complex hydrology and geochemistry of mine sites, the site conceptual model should be reevaluated as additional site data are obtained (at least annually during active placement).<sup>53</sup> (emphasis in original)

There are no annual reevaluations of site conceptual models at any of the ash placement sites studied in this report. And there is no attempt to integrate waste characterizations with site characterizations at the sites, even though the need for such integration became obvious to the authors of this report in a number of cases. An example of the failure to integrate these characterizations occurred at the McDermott site, where high levels of lead (exceeding the DWS by up to 9 times) were documented to be a problem in baseline water quality at the site at many of the monitoring points. Despite this fact, the McDermott permit was amended in 1997 to allow for a different ash to be brought to this site. The new ash, FBC ash from the Cambria Power Plant, had leached lead at 0.180 mg/L, 12 times the DWS in the SPLP test performed on it for its disposal at the Ernest site in August 1994. More recent samples of Cambria ash have leached even higher concentrations of lead in the SPLP test including one sample of bottom ash that leached 0.350 mg/L, 23 times the DWS. Lead concentrations have continued to be a problem throughout mining and ash placement at the McDermott site. Some 90 percent of the 316,000 tons of ash dumped there is from the Cambria cogen plant. Yet rather than concern over the prospect of exacerbating what appeared to already be a “natural” problem of high lead at this site, PADEP has repeatedly asserted that the high lead in the baseline proves that the ash dumped at this site could not have been the source of the problem. The concept that ash known for leaching high lead levels might not be a good ash to dump at McDermott does not appear to have entered the Department’s thinking.

#### **6.4.2 Failure to predict post-placement conditions**

As a rule, there is no attempt to predict post-placement site conditions. Under Subchapter F, which is intended to remediate the pre-existing water pollution from mine sites through re-mining and various acidity abatement measures such as alkaline addition in mining permits, the only required projection by the permit is for the type and success of post-mining vegetative cover. Without performance projections, there is no way to measure performance and determine the need for additional, new characterization. There is also no process institutionalized to account for the success or failure of mining and

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<sup>53</sup> *Ibid.* at page 152.

reclamation and acid abatement methods such as alkaline addition through ash placement so that any needed changes in these activities are more assuredly made.

## **6.5 FAILURE OF THE PENNSYLVANIA PROGRAM TO IMPROVE WATER QUALITY OR PREVENT DEGRADATION OF SURFACE WATER AND GROUNDWATER**

### **6.5.1. No requirement for the “beneficial use of ash” to improve water quality**

There is no requirement in Pennsylvania law that ash placement projects actually improve water quality, only a requirement that they not cause deterioration in water quality.<sup>54</sup> Regardless of whether coal ash is being used ostensibly to clean up water pollution in a mine, Pennsylvania surface mining regulations allow the release of reclamation bonds to a mine operator upon a demonstration that surface and ground water quality simply has not been degraded.<sup>55</sup> This is in sharp contrast to the original intent of Pennsylvania’s coal ash beneficial use program as set forth in the state’s 1992 regulations. Those regulations required that “placement of coal ash as part of a mining or reclamation activity shall achieve an overall improvement in water quality.”<sup>56</sup> Although Pennsylvania regulations require that ash placement projects in active mines where acid mine drainage is evident be *designed* to improve overall water quality, there is no requirement that this be accomplished prior to bond release.<sup>57</sup> Given that monitoring of groundwater and surface water ceases upon bond release, the legal and practical ability of PADEP to assure that the operator achieves the overall improvement intended by the permit’s design is questionable.

In the case of CCW placement in abandoned mines, the requirement is the same, only that the ash not degrade water quality. No specific or overall improvement in water quality is required.<sup>58</sup> Nor is post-project monitoring to assure that degradation does not occur later from the ash.

Indeed, there were no specific goals of improvement in water quality set in any of the 18 ash minefill permits examined in this report. For example, there were no objectives to reduce high aluminum, iron, or manganese in acid-degraded waters to levels complying with water quality standards or at least to levels in nearby streams less impacted by AMD. There were no objectives to raise pH specifically to levels in compliance with water quality standards. There were no objectives to reduce pollution to any specific degree.

### **6.5.2. Subchapter F regulatory prohibition against “degradation” does not address contamination from most coal ash parameters**

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<sup>54</sup> 25 PA Code 287.663 and 664.

<sup>55</sup> See 25 Pa Code 87.209(b)(3)(ii).

<sup>56</sup> See 25 PA Code 287.664(a) in Pennsylvania Bulletin, Vol. 22, No. 27, July 4, 1992.

<sup>57</sup> See 25 Pa Code 287.663(d)(5)(iv).

<sup>58</sup> See 25 Pa Code 287.644(c).

While regulations require that coal ash placement at Subchapter F remining sites not “degrade water quality,” this nondegradation specifically applies only to four major constituents: acidity, iron, manganese, and aluminum.<sup>59</sup> Nondegradation also applies only to surface water discharges and not to site groundwater, and only to contaminant loadings (the total amount of contaminant flowing into a surface water in units of pounds per day) not contaminant concentrations (the amount of contaminants in a given volume of water or milligrams per liter). Finally contaminant loadings can be noticeably increasing at ash monitoring points that are surface discharges, but PADEP does not consider this to be a problem unless those increased loadings are great enough to cause a significant increase in loadings over a “hydrologic unit,” which can often include many discharge points.<sup>60</sup>

It is concentration that determines toxicity to biota, not load. Furthermore, there are many constituents concentrated in ash, from sulfates to chlorides, fluorides, sodium, and a myriad of trace elements and metals that leach in concentrations harmful to life beyond just acidity, iron, manganese and aluminum. When groundwater polluted with high concentrations of those constituents reaches small streams as baseflow, the effects can be devastating on aquatic life regardless of whether the loadings are rising significantly further downstream. The result of confining the “nondegradation” requirement to just loadings of four pollutants in surface waters with large volumes of flow (often greater than 1000 gallons per minute) is that under state laws and regulations, actions to place coal ash in coal mines to “clean up acid mine drainage” can legally contaminate groundwater to an unpalatable, toxic quality or pollute surface waters in seeps, springs and small streams to concentrations that are fatal to aquatic life, while PADEP maintains that no degradation or harm is occurring.

PADEP agreed with the importance of monitoring in-stream concentrations of contaminants in its Final Project Agreement (FPA) for a joint US EPA/PADEP project that was to evaluate the environmental impacts of remining in Pennsylvania. In the FPA describing the proposed 2000 study, PADEP wrote:

In certain circumstances, in-stream water quality monitoring is the most effective way to measure the performance of AMD remediation activities within the watershed, as the water quality impact of all remining, reclamation, and abatement activities are manifest there. The XL Project will use concentration, rather than loading data, because: 1) in-stream concentration data are more stable than load data; 2) concentration data are much easier and less costly to collect than load data (however for this test load data will also be collected); 3) pollution loads from individual discharges are manifested in the in-stream concentration; and 4) loading data, particularly in large streams, tend to be dominated by flow, which makes it difficult and impractical to monitor actual changes in in-stream quality. Accordingly, when using in-stream monitoring as a measure of environmental performance, concentration data are much more practical and sensitive than loading data. This would not be an appropriate method of

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<sup>59</sup> See 25 PA Code 87.201-209.

<sup>60</sup> See, for example, hydrologic units for the Ernest Permit, Permit Review 1.

monitoring if a stream were so large that massive dilution was taking place that would mask the effect of the re-mining. As stated previously, the testing required by the project will provide for the collection of both in-stream concentration and individual discharge loading data in order to assess the BMP approach to re-mining permits.<sup>61</sup>

Yet PADEP routinely relies solely on loading data for a few mining parameters to assess environmental impact at mine sites where ash has been placed. Concentrations of ash parameters at ash monitoring points appear to have no bearing on whether the agency considers water quality problems to be occurring.

### **6.5.3 Absence of corrective action requirements and failure to address rising concentrations**

Trigger levels are essential to the detection and timely remediation of water quality degradation. Such “triggers” are concentrations of pollution that, if exceeded, generate a requirement to undertake a response action so that the source of the contamination is found and further contamination is avoided. Monitoring groundwater in the absence of trigger levels or similar enforceable corrective action standards confers no protection. Environmental protection only exists if the regulations define an unacceptable condition, and agencies require by law corrective action when that unacceptable condition occurs. While there are trigger levels established at Subchapter F mines for loads of the aforementioned four mining parameters,<sup>62</sup> there are no trigger levels similar to those used in solid waste disposal programs for ash parameters at monitoring points around Pennsylvania’s minefills. The NRC recognized that triggers for ash parameters are needed at ash monitoring points in coal mines:

#### **Performance Standards for Monitoring**

Performance standards should be established for the aforementioned groundwater and surface water monitoring points to ensure adequate protection of groundwater and surface water quality. . . . These performance standards could be based on best available data, model predictions, and relevant water quality standards (including tissue-based standards developed for elements such as selenium), considering pre-placement water quality conditions. Indications that the established performance standards have not been met, should trigger more intensive monitoring and, if warranted, the development of a remediation plan.<sup>63</sup>  
(emphasis in original)

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<sup>61</sup> PADEP. Coal Mining and Reclamation XL Project, Final Project Agreement, September 22, 2000. [www.dep.state.pa.us/dep/deputate/minres/districts/ProjectXL/FPA-Final-9-22-00.htm](http://www.dep.state.pa.us/dep/deputate/minres/districts/ProjectXL/FPA-Final-9-22-00.htm).

<sup>62</sup> These triggers have been exceeded and prompted corrective responses from PADEP at the McDermott, Bloom #1 and EP Bender Mines.

<sup>63</sup> NRC., Managing Coal Combustion Residues in Mines, page 173, 2006

And in the final chapter of its Report, the NRC recommended the following:

**Disposal of CCR's in coal mines should be subject to reasonable site specific performance standards that are tailored to address potential environmental problems associated with CCR disposal.** These requirements may be in addition to any permitting requirements associated with mine-site and CCR characterization. For example, the maximum contaminant levels established under the Safe Drinking Water Act might be used as a benchmark for determining unacceptable contamination levels for groundwater at some appropriate, designated monitoring site. In some mined areas, however, the natural groundwater is of poor quality, and some relative non-degradation approach may be needed. In areas where CCR leachate may interact with surface water (directly or through groundwater interactions) more stringent requirements may be necessary to protect aquatic life (see Chapter 4, Sidebar 4.5). Where violations of permit requirements or performance standards occur, authority for appropriate penalties or corrective actions must be available to mitigate the damage and prevent future violations.<sup>64</sup> (emphasis in original)

Regulations promulgated in Pennsylvania in 1992 did require minefill permits to incorporate corrective action triggers at ash monitoring points.<sup>65</sup> *Operators placing coal ash in mines were required to conduct groundwater monitoring and abide by the corrective action requirements set forth for the state's residual waste landfills.*<sup>66</sup> Accordingly, before 1997, PADEP's mining permits authorizing ash placement incorporated trigger levels at ash monitoring points for concentrations of trace metals and several major constituents. These triggers were equal to the state drinking water standard or the highest background concentration measured during the baseline period (prior to ash placement), whichever was higher.<sup>67</sup> In April 1998, however, Pennsylvania amended these regulations to remove these requirements for permits involving ash placement in coal mines.

Thus explicit corrective action standards for ash placement do not exist in the Pennsylvania mine ash placement program. This means that contamination, even when detected, does not necessarily trigger a response let alone any effort to abate damage that may be occurring. In fact, when monitoring data documented significant increases in contaminant concentrations in the permits examined in this report, the contamination was almost never acknowledged officially, or even informally, by PADEP.

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<sup>64</sup> *Ibid.*, page 181, 2006

<sup>65</sup> See Pennsylvania Bulletin, Vol. 22, No. 27, July 4, 1992.

<sup>66</sup> See 25 PA Code 288.251-258 (Water Quality Monitoring).

<sup>67</sup> See 25 PA Code 288.257.

As a result serious pollution at downgradient ash monitoring points is occurring and is not being recognized, let alone addressed. For example, at the Ernest Mine, triggers at monitoring points for ash contaminants (approved in the original 1995 permit) were exceeded some 370 times by June 2003.<sup>68</sup> Triggers for the trace metals, arsenic, cadmium, chromium, lead, nickel, and zinc, were exceeded cumulatively 94 times. Aluminum triggers were exceeded 62 times, and the exceedances occurred at all three downgradient ash monitoring points. Triggers for other major/minor constituents such as iron, manganese, sulfate, fluoride, chloride, and TDS were exceeded 214 times. Many of these exceedances involved concentrations that were several times to hundreds of times higher than the highest concentrations measured before ash placement and, in some cases, the exceedances were thousands of times drinking water standards. Many exceedances did not start until ash placement had been underway for at least one year and in the case of sulfate, aluminum, cadmium, nickel, and zinc, the exceedances had worsened with time through the period studied in this report. Many of these exceedances occurred as ash indicator parameters such as calcium and chloride were rising and as acidity was dropping significantly from 1999-2001, further implicating ash as the source.

Regardless of any debate about its cause, substantial water quality degradation beyond trigger levels set in the permit occurred at the Ernest Mine and is continuing to occur at all three downgradient ash monitoring points. Yet this report’s researchers could find no documentation of any response from PADEP to these exceedances during the 8-year period in which they occurred. The only recognition of the rising pollution at these monitoring points appeared to be a report issued by PADEP in June 2002 that responded to concerns voiced by the Clean Air Task Force about this water quality degradation by dismissing it as the inevitable result of mine drainage. As of the end of 2005, there were no inspection reports, hydrologic investigations, or other evidence in the permit file that indicated PADEP has ever discussed mitigating steps with the operator. These could have included increasing the frequency of monitoring, installing additional monitoring points, monitoring for additional ash constituents, isolating or diverting ash and refuse leachate, capping the ash and removing ash or at least halting ash placement temporarily. Yet there was no evidence that PADEP staff even asked the operator about the exceedances during the near decade of monitoring examined in this report.

The exceedances of concentration triggers were also documented at several other permit sites in this report.<sup>69</sup> The following exceedances of pre-1998 triggers at ash monitoring points were found:

	<u>Major/Minor Elements</u>	<u>Trace Elements</u>
McDermott	543	37
Buterbaugh	41	3
Swamp Poodle	51	20
C&K Coal	68	3
EME Generation	231	6
Bloom #1	20	

<sup>68</sup> See Permit Review 1.

<sup>69</sup> See McDermott, Permit Review 2; Buterbaugh, Permit Review 13; Swamp Poodle, Permit Review 4; C&K Coal, Permit Review 12; EME Generation, Permit Review 8; Bloom #1, Permit Review 10.

Researchers could find no information indicating the degradation of water quality at ash monitoring points at the sites above had abated as of the end of 2005. Yet with the exception of the McDermott site, project researchers could find no recognition of these exceedances of concentration triggers or any evidence of PADEP actions to address the pollutant concentrations involved.

Despite PADEP's failure to address the exceedances of these triggers, the agency continued to issue permits that established triggers, although in at least one case at far higher concentrations. For example, rather than using drinking water standards or baseline concentrations (as was required in the 1992 regulations), PADEP in July 1998 set trigger levels at ash monitoring points in the Maple Coal Company's "Rail Yard Site" at concentrations generally equal to the Maximum Acceptable Leachate Concentrations for metals under the Coal Ash Certification Guidelines.<sup>70</sup> For some constituents, the triggers were set at even higher levels. In other words, most triggers were 25 times the drinking water standard for metals and 10 times the standard for nonmetals. Because baseline levels at the two downgradient monitoring points for most ash parameters were well below DWS, these trigger levels allowed concentrations of pollutants in the water from ash to reach levels many times higher than concentrations in the water prior to ash placement before any response would be expected of the operator or PADEP. For example, the trigger for arsenic of 1.25 mg/L at ash monitoring point SW-23 was 962 times higher than the highest level of baseline arsenic measured in the water at that point. The trigger for barium at 50.00 mg/L was 1000 times higher than the highest baseline barium. The trigger for selenium at 1.25 mg/L was 1250 times higher than the highest baseline selenium. The trigger for fluoride at 100 mg/L was 1000 times higher than the highest baseline fluoride, and the trigger for chloride at 6250 mg/L was 255 times higher than the highest baseline chloride.

The discussion in the Module 25 of this permit stated that concentrations of chromium, cadmium, and lead were one to two orders of magnitude higher in the leachate generated from the leach test on the ash to be placed at the Rail Yard Site than in the mine drainage, making these three metals "good indicators of groundwater degradation (from the ash) if it occurs." Yet the triggers for these metals were twice the highest baseline concentration for chromium, 72 times the highest baseline concentration for lead and 260 times the highest baseline concentration for cadmium at this monitoring point (SW-23).

The same discrepancies were found at the other downgradient ash monitoring point at the Rail Yard Site, with trigger levels several times to several thousand times over the highest baseline concentrations measured for the ash trace elements at SW-4A. The most egregious difference was in the trigger established for mercury, which at 4.38 mg/L was 3,982 times higher than the highest baseline level for mercury at SW-23 and 4,380 times higher than the highest baseline level for mercury at SW-4A.

The failure to enforce corrective action triggers at ash monitoring points in coal mines when the regulations required such enforcement, the removal of these triggers from the

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<sup>70</sup> Permit # 11970201.

regulations in 1998, and the extremely lax setting of triggers by administrative discretion in the Rail Yard permit suggest that PADEP discounts the potential for pollution to occur from ash at minefill sites. More importantly, monitoring without standards for responding to contamination or without the consistent intention to respond if it occurs defeats the purpose of monitoring and confers none of the protection that the public assumes is being afforded to water supplies by PADEP's minefilling program.

#### **6.5.4 No control of pollution from coal ash in mine NPDES Permits**

The National Pollution Discharge Elimination System (NPDES) Permits issued as Part A of the mining permits studied in this report do not attempt to control point or nonpoint sources of water pollution that could occur from the coal ash in these mines. Researchers found virtually identical technology-based limits for average monthly, maximum daily and instantaneous maximum concentrations of iron, manganese, and Total Suspended Solids for NPDES permits outfalls at all mines examined in this report.<sup>71</sup> Additionally alkalinity must always exceed acidity and pH must stay within the 6-9 units range.

Notwithstanding the fact that iron, manganese and TSS can come from ash, there are no limits or monitoring requirements in these NPDES permits for any of the myriad other potentially dangerous parameters in Pennsylvania coal ashes. These include Total Dissolved Solids, sulfate, chloride, sodium or trace elements such as lead, cadmium, arsenic, selenium, chromium, antimony, boron, molybdenum, nickel, copper, zinc, and other constituents. Most of these are concentrated in the ashes being placed in these mines, have regularly leached at toxic levels from those ashes in 18 hour leach tests and have the potential to leach in more unpredictable and lethal concentrations from large ash deposits in mines than indicated by those tests. Aside from bulk analysis and leach test data, there is baseline data gathered for most of these constituents as part of the Module 25 in these permits. Monitoring has shown sustained rises in concentrations of at least several of these constituents after ash placement commenced at the large majority of sites examined in the report. Research documents the propensity of trace elements in Pennsylvania coal ash such as arsenic, selenium and antimony to leach in alkaline drainages and neutral to higher pHes<sup>72</sup> that are the objectives of "alkaline additions" to mine sites and the purpose of the pH and alkalinity standards in these NPDES permits. On the other hand, acidic conditions which may prevail at these mines are ideal for the leaching of other cations and trace elements concentrated in Pennsylvania coal ash, such as aluminum, cobalt, chromium, copper, manganese, nickel and zinc due to the enhanced dissolution of the ash particles.<sup>73</sup> Yet there is no attempt to use any of this information to set water quality-based effluent limits or monitoring requirements at permit outfalls for potentially dangerous parameters in ash. Thus the following statement in these NPDES permits boiler-plated from permit to permit presents a false premise,

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<sup>71</sup> There were some differences noted. For example total iron allowed in the monthly average concentration limit in the Ernest NPDES Permit No. PA0213004, Mine Drainage Treatment Facilities was 2.8 mg/L while other permits were uniformly enforcing 3.0 mg/L as this limit.

<sup>72</sup> NRC citing Kim, A.G., G.Kazonich, and M. Dahlberg. 2003. "Relative solubility of cations in class F fly ash." *Environ. Sci. Technol.* 37:4507-4511.

<sup>73</sup> *Ibid.*

Based on the hydrologic data and anticipated characteristics and flows described in the permit application and its supporting documents and/or revisions, the following effluent limitations and monitoring requirements apply to the above listed outfall numbers.

The uniform limits in these NPDES permits infers a single characterization for all coal mines in the state that is oblivious to any drainage that might be produced by ash being placed in the mines regardless of the ash's location, amount or toxicity.

Indeed there is long-established precedent in other state mining regulatory programs for conducting effluent characterization and monitoring, if not setting additional limits to address ash constituents in NPDES permits for coal mines being used as dumping grounds or placement sites for coal ash. For example, the Guidance Policy Memorandum for the West Virginia Office of Mining and Reclamation concerning "Disposal and Utilization of Coal Ash on Surface Mining Operations," dated January 3, 1994, states:

Permits, Revisions, and Modifications

The OMR may approve the utilization of coal ash in a beneficial use application as described in an application for a surface mining permit, an NPDES permit, and revisions or modifications to existing permits. . . .

Coal ash utilization as a beneficial use on surface mining operations will be evaluated by OMR in accordance with plans, design specifications, testing procedures, and monitoring requirements as set forth and submitted on the attached form (MR-36). The attached form will serve as an element to both the surface mining and NPDES permit application or application for a revision or modification of an existing permit.

Water Quality

Surface and ground water monitoring stations for the purpose of monitoring coal ash leachates shall be established at appropriate locations so as to satisfy the requirements of both the Surface Mining Act and the NPDES program. Likewise, the analysis of water samples shall include the same chemical parameters for both permits. In the event that discharge points are established at different locations than the designated monitoring stations, analysis of water at the discharge point will include the same chemical parameters as for the monitoring station.

The absence of provisions in NPDES permits for coal ash parameters combined with the failure of the Subchapter F program to address ash parameters and the elimination of corrective action triggers leaves those living next to Pennsylvania coal mines unprotected by any discernable regulatory limits on contamination coming from coal ash placed in those mines.

## 6.6 INADEQUACY OF BONDING TO GUARANTEE ENVIRONMENTAL REMEDIATION

Coal mine bonds are fundamentally inadequate in amount and duration to serve as financial assurance for correcting adverse impacts to surface water or groundwater and other problems created by coal ash placement. Bonds at coal ash placement sites must be set at levels that include costs for maintaining ash disposal sites and for long term water quality monitoring to ensure that failures will be detected and adverse impacts remediated. However, according to PADEP’s 1998 guidance document, *Beneficial Use of Coal Ash at Active Coal Mine Sites*, “The beneficial use of coal ash will require no additional bonding associated with the mining of the site.”<sup>74</sup> Given that bonds are the primary means for assuring that natural resources are restored and post-mine land uses achieved, it is critical that this inadequacy be addressed.

A comparison of the bonds required for coal ash residual waste landfills and those required for coal ash minefills in Pennsylvania illustrates the inadequacy of the bonds required for minefills. According to 25 PA Code 287.331(a), the total bond liability for a coal ash landfill must be based on the total estimated cost to the Commonwealth for the following: (1) To complete final closure of the facility according to all the regulatory and permit requirements; and (2) To take measures necessary to prevent adverse effects upon public health and safety, public welfare and the environment, during operation and after closure, until the bond is released. Accordingly, Section 287.331(c) requires that the amount of the landfill bond be based on the following factors:

- 1) The costs to the Commonwealth to conduct closure and post closure care activities, as well as costs of monitoring, sampling and analysis, and soil and leachate analysis, facility security measures, remedial abatement measures, and postclosure restoration and maintenance measures.
- (2) The nature and size of the facility and type of operation.
- (3) The quantity, type and nature of the waste to be managed at the facility.
- (4) The costs related to size of the surface area, the topography and geology of the area and the land uses around the facility.
- (5) The additional estimated costs to PADEP that may arise from applicable public contracting requirements or the need to bring personnel and equipment to the permit area after its abandonment by the operator to perform restoration and abatement work.
- (6) The additional estimated costs incident to or necessary and proper for the satisfactory completion of the requirements of the state environmental protection acts, title 25 of the PA code, the terms and conditions of the landfill permit and orders of PADEP.
- (7) The additional estimated cost for at least the next three years which is anticipated to be caused by inflation, determined by averaging the annual Implicit Price Deflator for Gross National Product published by the United States Commerce Department, or a superseding standard, for at least the prior 3 years.

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<sup>74</sup> PADEP, *Beneficial Use of Coal Ash at Active Mine Sites*, Document No. 563-2112-206 at page 6.

- (8) The compliance history of the operator, applicant, permittee and related parties.

Consideration of the above factors can raise significantly the amount of a residual waste landfill bond. For example, the surety bond posted for the Montour Coal Ash Disposal Area at the PPL Montour Power Station in Washingtonville, PA is \$20,741,700. The total permitted capacity of this residual waste landfill is 4,992,221 tons and the size of the landfill is 64 acres. For the Fern Valley Residual Waste Landfill in Jefferson Hills, PA, the surety bond was \$3,150,865. At the time of closure of this facility in 2003, 4,850,152 tons of coal ash were placed in the landfill. At the Hatfield's Ferry coal ash landfill, the surety bond is \$3,463,000. The capacity of this landfill is 2.2 million tons, and it covers 187 acres.

In comparison, bonds required at surface mines are woefully inadequate. Unlike the substantial surety bonds required by PADEP at coal ash residual waste landfills, mining bonds in Pennsylvania are calculated only to cover the costs of reclaiming the original contour of a surface mine and revegetating its ground to certain standards and do not include resources for monitoring or remediating contamination of groundwaters or surface waters resulting from coal ash placed at the surface mine. Consider the following bonds for several surface mines where ash has been placed. The total bond value for the Knickerbocker-Ellengowan site is \$932,698. This site has 12 million tons of coal ash placed on 144 acres. The total bond value for the Silverbrook-Big Gorilla surface mine is \$465,982. That site now contains over 4.1 million tons of ash and is slated to receive more ash. The total value of the bond for the BD Mining surface mine is \$1,402,953, and the mine has 3.7 million tons of coal ash placed over 125 acres. This site is also slated to receive significantly more ash. The EME Generation Refuse Disposal Site is authorized to accept 2-2.8 million tons of coal ash, and the total value of its bond is \$1,040,713. Lastly, the total value of the bond for the Ernest surface mine is \$511,109, and the amount of coal ash expected to be placed on that site is 7-9 million tons.

Based on this small sample of surface mines and landfills, the amount of the bond per ton of coal ash at a residual waste landfill is more than 15 times the amount per ton of coal ash at a surface mine. While millions of dollars are routinely required as financial assurance at coal ash landfills, the addition of millions of tons of ash to a surface mine engenders no responsibility on the mine operator to set aside any funds to address potential adverse impacts from the waste. Yet at all of the aforementioned surface mines, this report found evidence of substantial water quality degradation from the coal ash.

Bonds for coal ash residual waste landfills and for coal ash minefills also differ in their duration. Pursuant to 25 PA Code 287.314, the duration of bond liability for a residual waste landfill is 10 years after final closure certification. In contrast, the period of liability for bonds posted for a coal surface mining activity extends only five additional years after completion of permanent revegetation of the permit area, and PADEP routinely uses its discretion to release the majority of the bond amount much earlier.<sup>75</sup> At

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<sup>75</sup> See 25 PA Code Sec. 86.151.

surface mining sites, Phase I bond release (60% of the total bond) is permitted when backfilling is complete. Phase II bond release (85% of the total bond) occurs upon revegetation. Thus only 15% of the bond is retained during Phase III, which terminates when vegetation has been established for five years.

In fact, PADEP usually releases the mine operator from the requirement to monitor water quality at the Phase II release of the bond (when revegetation is initially established), frequently 2-3 years after mining and ash placement occurs, far too short a period for monitoring to ascertain with any assurance that contamination of groundwater and/or surface water will not occur from the ash at the mine site. In fact, while the criteria for bond release for surface mining permits includes the consideration of environmental factors, the authors of this report found at several sites that PADEP released the Phase II portion of the bond and the operator from the monitoring requirement despite the fact that the latest publicly available monitoring data indicated that water quality degradation was continuing if not worsening at the relevant ash monitoring point(s).

For example, at the Sandy Hollow Mine, monitoring for ash monitoring wells was terminated even before the Phase II bond was released, despite rising sulfates and TDS levels above DWS at the downgradient ash monitoring well that were well under DWS during the baseline monitoring period. At the Swamp Poodle Mine, PADEP released all bonds and terminated the monitoring requirement despite the latest publicly available data for trace elements at a downgradient well that revealed by far the highest levels measured for arsenic (78 times the 2005 DWS) and cadmium (46 times the DWS) observed at that well. The latest data for manganese, sulfates, and TDS at another downgradient well also revealed contamination at 320 times, 8.8 times, and over 6 times DWS respectively, and 2 to 3 times higher than the highest baseline levels for these constituents.

## **6.7 ISOLATION REQUIREMENTS INADEQUATE FOR COAL ASH PLACEMENT IN MINES**

Placement of coal ash directly in contact with groundwater at mine sites heightens the risk of contamination of groundwater by ash. The guiding principle of solid waste disposal under RCRA is isolation from water. The National Research Council also placed great emphasis on the need to isolate coal ash from water in mines:

Given the known impacts that can occur when CCRs react with water in surface impoundments and landfills, CCR placement in mines should be designed to minimize reactions with water and the flow of water through CCRs. Regardless of whether the CCR is placed in an active or an abandoned coal mine, the issue of limiting the interactions of CCRs with groundwater should be a priority.<sup>76</sup>

In the case of coal ash placement in Pennsylvania's mines, however, contact with groundwater is frequently tolerated and, in some cases, intentional. Pennsylvania regulations do prohibit placement of coal ash within 8 feet of the regional water table for

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<sup>76</sup> NRC., Managing Coal Combustion Residues in Mines, page 162, 2006

some beneficial uses. This prohibition applies to the use of coal ash at coal refuse disposal sites (25 PA Code 287.663(f)(1)(v)), use of coal ash as a soil substitute or additive (25 PA Code 287.662(d)(7)), and use of coal ash in abandoned mines (25 PA Code 287.664(c)(3)). According to 25 PA Code 287.663(d)(6), however, the prohibition against placement in groundwater does *not* apply when PADEP approves the use of coal ash “as part of a mine drainage project” at active mine sites and coal refuse reprocessing sites. It is arguable that this vaguely drafted exemption would not be applicable to any placement project at an active mine or coal refuse reprocessing site whose purpose was to address AMD. Furthermore, PADEP’s regulations, as well as its technical guidance, indicates that PADEP has the discretion to approve placement within 8 feet of the regional water table at all sites “upon a demonstration that groundwater contamination will not occur.”<sup>77</sup> The technical guidance requires a study demonstrating there will be improvement or at least no degradation to water quality prior to placement within 8 feet of the regional groundwater table.<sup>78</sup>

The problem with Pennsylvania’s regulatory prohibition is not only in the loopholes mentioned above, but in the narrow definition of its terms. Section 25 PA Code 287.1 defines the regional groundwater table as “the fluctuating upper water level surface of an unconfined or confined aquifer, where the hydrostatic pressure is equal to the ambient atmospheric pressure. *The term does not include the perched water table or the seasonal high water table.*” (Emphasis added.) The seasonal high water table is defined as the minimum depth from the soil surface at which redoximorphic features are present in the soil.

Thus the prohibition against deposition in the water table explicitly fails to include the perched and seasonal high water tables. This was not always the case. When PADEP enacted its coal ash beneficial use program in 1992, the regulations originally included a prohibition against placement in the perched and seasonal high water tables. The requirement found at 25 PA Code 287.664(c)(12), (13) and in the Module 25, Table 25-1 (1993) stated: “Ash placement shall be at least 4 feet above the premining seasonal high water table or perched water table, and at least 8 feet above the regional groundwater table. The regional groundwater table may not be artificially manipulated to achieve the above.” PADEP removed this requirement in 1997 when the department amended its coal ash beneficial use regulations. One major problem with allowing placement of ash in contact with a perched zone is that perched water does not mean isolated water; in most cases perched water is in fact an integral part of the regional groundwater and surface water system.

The impact of relaxing the isolation requirement is significant. Of the 15 permits examined thus far, the eight that authorized the mining of coal seams all authorized placement of coal ash into the elevations of perched water tables that existed at these sites prior to mining and thus presumably also authorized ash placement under the water tables of the spoil aquifers that will emerge at these sites in the post-mining environment. Essentially, the permits allowed operators to place large quantities of coal ash into the

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<sup>77</sup> See 25 PA Code 287.663(d)(6) and (f)(1)(v). See also PADEP, Technical Guidance Document for Beneficial Uses of Coal Ash, Doc. No. 563-2112-225 at page 4.

<sup>78</sup> *Ibid.*

space originally occupied by the coal seams, which were aquifers and any limestone, sandstone, or other aquifer layers above or in between those seams.

Furthermore, the permits in this report did not identify the location of the relevant “regional groundwater table.” Thus it was very difficult if not impossible for the reviewers to determine whether the mine operator was even in compliance with the current less stringent requirement.

Lastly, PADEP authorizes placement of coal ash in groundwater at selected “demonstration projects” pursuant to the residual waste regulations.<sup>79</sup> These sites are permitted on the basis that they demonstrate a “new or unique technology for the processing or disposal of residual waste.”<sup>80</sup> Ash can be placed within 8 feet of the regional groundwater table if a study is submitted to the Department that demonstrates that there will be an improvement to water quality or at least demonstrates that there will be no groundwater pollution. In the Big Gorilla demonstration project that placed dry ash into a wet environment, the authors of this report can find no such study even though the ash in this project was placed into the mine pool at the bottom of the Big Gorilla Pit, which is presumed to be part of the regional water table. However, from information in PADEP’s permit files, they also cannot conclude definitively whether this mine pool is considered to be groundwater or surface water. Assuming mine pools are considered to be groundwater, there is no indication in the permit materials of what elevations in this mine pool are considered to be “the fluctuating upper water level surface,” which would define the upper limit of the “regional water table” on which a study of impacts to water quality in this case presumably would be required. The absence of water elevation data from groundwater and mine pool monitoring points at several of the sites in this report marginalizes considerations about protecting the regional water table. The characterizations of most mine sites and monitoring systems studied in this report do not readily identify the location of the regional water table.

## 6.8 SUMMARY

The water quality problems identified at numerous mine sites in this report can be traced directly to the above-described deficiencies in the guidance, regulations, and implementation of the Pennsylvania coal ash minefill program. In its zeal to reclaim mines and provide an affordable means of ash disposal, PADEP has created a program that lacks many critically important and basic safeguards. Among the most critical deficiencies are the lack of long term monitoring, monitoring from too few points, failure to characterize waste and waste sites, failure to isolate the waste from water and the absence of corrective action standards. Also critical is the failure to enforce program requirements such as responding to the exceedance of concentration triggers at monitoring points and the placement of ash that exceeds prohibited leaching levels for toxic metals, the inadequacy of bonds and their release before protection of water supplies is assured, indeed even when monitoring indicates harm to those supplies is occurring, and the illusory protection afforded to groundwater aquifers. These

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<sup>79</sup> 25 PA Code 287.501-506.

<sup>80</sup> See 25 PA code 287.501 The Big Gorilla Pit Site, Permit Review 6, was permitted as a residual waste demonstration project.

deficiencies can be cured by several means. These include programs to establish safer uses for ash before minefilling it, regulatory reform, amendment of guidance documents, and effective enforcement by PADEP of program requirements. Regulations should establish common sense safeguards regarding the characterization of wastes and sites, and monitoring and corrective action requirements. These regulations should be enforceable by those who live in the vicinity of ash placement sites should PADEP fail to enforce them. Without such changes, it is certain that significant water degradation from ash placement in coal mines will continue.



CAPTION - AC Fuels Co Site, SMP # 54980201 in Schuylkill County, a mile west of McAdoo, is the site for major refuse remining and disposal of FBC ash from the Panther Creek Cogen Plant. PADEP staff says the ash put in the site equals 50 % of the volume of coal refuse taken out (Aug. 2007 communication). Photo by Steven Dreyer, McAdoo, PA.