

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

This report provides an in depth analysis of impacts to groundwater and surface water at 15 coal ash placement sites in mines in the bituminous and anthracite coalfields of Pennsylvania. The goal of this report is to test the assertion of the Pennsylvania Department of Environmental Protection that the use of CCW in coal mine reclamation, as permitted under this Agency's Coal Ash Beneficial Use Program, does not result in the pollution of groundwater or surface water. *This report concludes that degradation has occurred from coal ash placement at the majority (two-thirds) of the permit sites examined, based on rising trends in concentrations of CCW contaminants at relevant ash monitoring points.* In addition, our analysis reveals serious deficiencies in the PADEP beneficial use program that could potentially lead to degradation and the contamination of water supplies at many more ash placement sites. Below is a summary of the findings of this report and a list of recommendations that addresses these findings.

Findings:

- ***At 10 of the 15 coal ash minefills examined, monitoring data indicate CCW degraded water quality.*** Increased levels of contaminants including sulfate, total dissolved solids, manganese, iron, aluminum, calcium, magnesium, potassium, sodium, chloride, fluoride, and trace elements such as arsenic, cadmium, lead, selenium, chromium, nickel, zinc and copper were detected in monitoring wells and/or surface water downgradient of CCW placement areas after ash placement occurred at levels substantially exceeding concentrations of any of these constituents before ash placement. Often the level of these contaminants greatly exceeded safe drinking water standards and water quality standards. The following conclusions were reached for the other five sites:
 - For three of the minefills, degradation occurred but data do not provide compelling evidence to differentiate ash from mining or coal refuse as a source contributing to the deterioration of water quality.
 - At one of the minefills, data indicate that water quality improvement appeared to have occurred as a result of remining and reclamation with ash placement for some parameters, but degradation has occurred in other water quality parameters that appears to be from the ash. Serious gaps in monitoring for trace metals and the absence of monitoring data after the conclusion of ash placement render it impossible to determine long-term impacts from the ash.
 - At one of the minefills, water quality improvement appeared to have occurred as a result of remining and reclamation with ash placement. However, the absence of monitoring after the conclusion of ash placement renders it impossible to determine long-term impacts from the ash.
- ***At sites where monitoring data indicated ash degraded water quality, the increases in contaminants commonly found in ash leachate (such as arsenic, selenium, lead, cadmium, chromium, nickel, calcium, magnesium, potassium, sodium and chloride and antimony, boron and molybdenum at the one site in which these three contaminants were monitored) often corresponded with drops in acidity and rises in***

alkalinity and/or pH. Thus a correlation was usually found between the decline in acidity and rise in alkalinity during active mining caused by the coal ash and the level of coal ash contaminants in the water.

- ***At all 15 coal ash minefill sites, serious deficiencies in monitoring occurred.*** These deficiencies included: (1) inadequate number of groundwater and surface water monitoring points including no monitoring points located in the ash and no upgradient monitoring points in at least half the placement sites; (2) insufficient frequency of data collection including only annual sampling for trace elements at most sites; (3) significant lapses in data collection particularly for trace elements after ash placement; (4) absence of monitoring for key ash indicator parameters including antimony, boron, and molybdenum; (5) analyzing samples at detection limits above or far above drinking water standards; (6) inadequate records indicating water elevations at groundwater monitoring points and dates, quantities, and locations of ash placement; and (7) the termination of monitoring after the completion of ash placement, even when the most recent monitoring data indicated worsening degradation of water quality. A standard release of the mine operator from water monitoring usually at the completion of Phase II of reclamation, when ground surfaces have been recontoured and revegetated, occurs in most cases one to three years after coal ash placement and backfilling at mine sites is completed. This is far shorter than the time normally required at coal ash landfills for post closure monitoring (one to three decades) and not enough time to ascertain that adverse impacts to water quality from coal ash placement will not occur.

- ***Water quality is threatened by the systematic failure to require adequate site characterization, particularly for groundwater systems prior to approval of permits for ash placement.*** Such characterizations would provide substantive site-specific information identifying the natural and man-made groundwater flow paths at ash placement sites and locate the connections of shallow groundwater flow in mine placement sites to deeper groundwater aquifers and minepools underneath sites. It would document the directions and rates of flow of groundwater in shallow systems directly affected by ash placement and the flow rates and directions in aquifers underneath ash placement areas. It would identify flow directions, rates and volumes of water being sampled in minepools underneath ash sites. Thus regulators would understand when monitoring points should see the effects of ash placement with a reasonable degree of confidence. The failure to assemble this site information, integrate it with information about the waste, and update the characterizations of sites as new information becomes available results in the placement of ash at sites where monitoring systems allow contamination of groundwater and surface water from the ash without knowledge or response from mining operators or PADEP.

- ***The failure to require adequate waste characterization is a systemic deficiency of the PADEP Coal Ash Beneficial Use Program.*** There is no attempt in the PADEP program to field validate the results of the SPLP test on ashes at mine sites or otherwise predict what particular ashes may do at particular sites given the specific geochemistries of those sites. The reliance on the SPLP test as the sole safeguard for protecting groundwater and surface water in coal mines results in the placement of CCW that is capable of leaching

dangerous quantities of hazardous constituents without understanding that potential toxicity and without engineered safeguards in place to prevent the contamination of groundwater and surface water.

- ***PADEP's failure to require corrective action standards in CCW placement permits is a critical program-wide deficiency.*** Because of PADEP's failure to establish these standards at ash monitoring points for ash parameters in permits, contamination of water from ash at a mine site fails to trigger a response from PADEP in most instances. Thus the operator makes no attempt to assess the contamination, much less engage in steps to stop further contamination or remediate damages. Dangerous degradation of water quality from ash is not being recognized or addressed.

- ***NPDES permits at coal ash placement minesites fail to regulate constituents of concern for coal ash.*** The Clean Water Act water pollution discharge permits granted for Pennsylvania coal mines accepting coal ash make no attempt to limit or even monitor coal ash contaminants in those discharges to surface waters. Leachate from ash should be characterized and monitoring requirements and limits for ash contaminants set in these permits. Combined with the absence of corrective action standards, this deficiency means there are no limits on the concentrations of coal ash contaminants that can migrate from minefills into groundwater or surface water.

- ***Coal mine bonds are grossly insufficient in amount and duration to serve as financial assurance for correcting adverse impacts to surface water or groundwater caused by coal ash placement.*** Unlike the substantial financial assurance 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. As a result, mine bonds typically cover substantially smaller expenditures of resources. One surface mine examined in this report had 12 million tons of coal ash placed on 144-acres with a bond of \$930,000, while PADEP required a 64-acre coal ash landfill holding 4.9 million tons of ash to post a surety bond of \$20 million.

- ***PADEP regulations do not require sufficient isolation of the coal ash placed in coal mines from groundwater.*** For some beneficial applications, Pennsylvania regulations prohibit placement of coal ash within 8 feet of the "regional water table." However, this prohibition does not apply to all coal ash placement projects nor does it afford sufficient protection when it does apply. A narrow definition of "regional water table" exempts the perched and seasonal high water tables from this prohibition. Consequently, the researchers of this report found that of the permits 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 also authorized ash placement under the water tables of the spoil aquifers that will emerge at these sites in the post-mining environment. Because this report also finds that PADEP is lax in enforcement of its Certification Guidelines (allowing ash that leached harmful amounts of contaminants to be placed in coal mines) and is lax in its groundwater monitoring and corrective action

requirements, the failure to isolate large quantities of waste from groundwater creates a significant potential hazard at ash placement sites.

• ***Poor organization of PADEP permit files and inaccurate information in the files hampers evaluation of ash placement sites.*** The hallmarks of a modern and efficient information system are transparency, accuracy, and accessibility. The permits lacked transparency because information was not well organized or consistently assembled. The permits lacked a general information section explaining where pertinent data, such as the date operations commenced and ceased, could be found. Information was also often missing, including inspection reports, monitoring data and maps. Researchers of this report also found inaccurate information, including the location and characterization of wells. Lastly, the permits were difficult to access because information was not available electronically.

• ***A major program deficiency is the failure of PADEP to require that ash placement projects improve water quality, which is ostensibly asserted as their purpose.*** The operative standard in PADEP laws and regulations of “no degradation” from projects using ash in coal mines is not even protecting, much less cleaning up, Pennsylvania’s waters. One of the most publicized objectives of placing coal ash in coal mines is to clean up acid mine drainage from past mining practices. Yet there are no general or specific levels of reduction in acidity, increase in pH, or reduction in other mine drainage parameters from baseline concentrations set as objectives in permits that use coal ash for “alkaline addition” to treat AMD, only a calculation of the amount of ash that should be applied to avoid generating AMD from new mining or re-mining. Thus there is no standard against which to measure the results of these permits and make needed improvements when permits are not successful in meeting the standard. Indeed, in 6 of the nine of permits examined for which ash was specifically used as an “alkaline addition” to treat acid mine drainage, acidity increased and pH decreased at all or the majority of downgradient monitoring points. The adage of ‘the best defense is a strong offense’ applies here. Without regulatory requirements for ash placement permits to set and achieve specific goals of improvement in water quality, this program is in essence permitting disposal sites without the basic safeguards imposed by the state’s solid waste regulations such as long term monitoring for ash parameters, and corrective action standards. The result is contamination of water.

• ***PADEP’s permitting program fails to require ecological monitoring of streams or other surface waters in the vicinity of ash disposal sites.*** PADEP does not require ecological monitoring of streams or other surface waters or terrestrial life that may be affected by ash disposal sites.

• ***PADEP fails to promote the safe reuse of coal ash in Pennsylvania.*** Rather than promoting safer beneficial reuses of coal ash in lieu of mine placement as recommended in the NRC report, PADEP actively promotes mine placement which maximizes the potential for future harm from CCW.

Recommendations

It is essential that Pennsylvania's coal ash beneficial use program require sufficient safeguards in the following areas to address the above findings of deficiencies. These recommendations are consistent with the recommendations of the National Research Council of the National Academies of Science set forth in their March 2006 report:

1. Waste Characterization: Sufficient testing of CCW must better determine the propensity of the ash to leach constituents in harmful amounts at mine placement sites. PADEP must use effective field validation techniques such as monitoring of water quality directly within the placed ash to ascertain the actual behavior of the ash in the mines and adjust leach tests accordingly. PADEP must end its total reliance on one short-term laboratory leaching test, that uses the same conditions on every coal ash to be placed in every mine regardless of the differences between ashes and mines. Most experts agree that this test does not reflect how CCW actually behaves in the mine.

2. Site Characterization: Baseline water quality, rates and directions of flow, and interconnections between all surface water and groundwater potentially affected by ash placement must be identified and documented with site specific data at every ash placement site before decisions are made to approve ash placement permits. The locations of all connections to deeper groundwater systems and minepools underneath ash placement sites must be identified with site specific detail. Efforts must be made to identify volumes of water in minepools underneath ash placement sites so that monitoring systems can be calibrated to detect changes in the water quality in those minepools before ash has contaminated substantial volumes of water. Site characterization must be integrated with waste characterization and updated regularly as new information from sites and the wastes becomes available so that placement of CCW with clearly dangerous leaching potentials in specific sites is avoided, evolving hydrology at sites is understood and monitoring systems are adjusted to account for changes in water movement.

3. Water Quality Monitoring: At all sites, monitoring for ash parameters should occur on no less than a quarterly frequency and from sufficient points based on competent site specific characterization of placement areas to assure that contaminant plumes are not migrating from ash. Monitoring results must be analyzed by laboratories and reported at concentrations low enough to assure that exceedances of Drinking Water Standards and other relevant standards are documented. Monitoring should never stop if contaminant concentrations are increasing. Decisions to terminate monitoring should be supported by ample data revealing safe and stable concentrations of ash parameters in pore water within the ash on the site, rates and directions of water movement from ash placement areas and concentrations at downgradient and downstream points that demonstrate consistent attenuation and dispersion of contaminants to levels well below safe standards. The duration of the monitoring period should be no less protective than for nonmine coal ash landfills using RCRA based standards. The required monitoring must include ash indicator parameters such as boron, molybdenum and other indicators and baseline monitoring for those parameters at ash and nonash monitoring points in order to differentiate contamination caused by coal ash from mining impacts.

4. Corrective Action: Permits must contain enforceable corrective action standards that provide “trigger levels” for all coal ash parameters being monitored. To ensure that water quality is not degraded to conditions worse than existed prior to ash disposal, these trigger levels should not be set above levels measured for coal ash parameters during baseline monitoring periods. Exceedance of these standards must “trigger” enhanced monitoring at greater frequencies and at additional monitoring points to verify the existence of the contamination, locate its sources and implement any remedial steps necessary to clean up the contamination.

5. NPDES permits: The federal Clean Water Act water pollution discharge permits granted for Pennsylvania coal mines accepting coal ash (Part A of the mining permits) must regularly characterize leachate from the ash, monitor for ash contaminants and set limits for ash contaminants that pose the potential for harm in surface discharges from ash placement areas.

6. Financial Assurance: Just as PADEP requires for operators of coal ash landfills, PADEP must establish a program to require operators of coal mines that serve as ash placement sites to calculate the costs to monitor water quality and address potential long term water quality problems at coal ash placement sites. PADEP must require operators to purchase financial assurance instruments sufficient to accomplish these steps should the operator become unable to do so.

7. Isolation of Coal Ash from Groundwater: PADEP must include a prohibition against placement of coal ash in the perched and seasonal high water tables. Placement of coal ash directly in contact with groundwater at mine sites significantly heightens the risk of contamination of the groundwater by the waste.

8. Permit Organization: Information pertaining to coal ash placement at mine sites must be better organized, more accurate and much more accessible. The present system essentially precludes anyone but the most tenacious researcher from understanding the impacts of an ash placement operation. Consistent organization, closing of information gaps, and review of permits for accuracy is needed. Ultimately, the permits should be updated with the use of a modern database system that could be readily accessible by the public via the internet.

9. Requiring a Beneficial Result from the Coal Ash Beneficial Use Program: Coal ash is a nonmine-generated industrial solid waste. If Pennsylvania’s “beneficial use” of coal ash in coal mines is not a disposal program, there must be a measurable benefit achieved by placement of coal ash in Pennsylvania coal mines. Accordingly at coal mine sites with water quality degraded from past mining practices, PADEP should require permits authorizing the “beneficial use” of ash to meet specific demonstrable improvements in water quality within the effective dates of the permits. These permits should outline the specific changes in parameters of degraded water quality to be addressed and the timeframes for achieving the changes. Examples could include specific, sustained decreases in acidity, increases in pH, and decreases in mine drainage parameters at

downgradient or downstream ash monitoring points. At regular intervals, progress in achieving the improvements in water quality should be assessed so that modifications can be made to ensure the improvements are achieved. Permits that propose to use coal ash for another beneficial purpose, such as for a soil amendment or cap, should also include specific performance objectives to which they are held accountable. The overall performance of PADEP's programs for the beneficial use of coal ash in mines should be periodically assessed as well.

10. *Ecological monitoring:* As a condition of permitting, PADEP should require ecological monitoring of streams or other surface waters that may be affected by ash disposal sites. PADEP should require monitoring to determine ash impacts on aquatic biota (i.e., studying aquatic biota's uptake of ash contaminants). Such monitoring must include collection of baseline data as well as long-term monitoring after ash placement has ceased to determine impacts to water quality and aquatic biota. Plant uptake of CCW contaminants and the effects of CCW on plant life at CCW sites should also be monitored.

11. *Enforceable Regulations:* Central to the failures of the Pennsylvania program discussed throughout this report is the absence of explicit, enforceable regulations requiring minimum safeguards at coal ash placement sites. Enforceable safeguards, required by regulations and explicit permit conditions, are necessary elements of any program permitting the deposition of industrial solid waste in mines. When PADEP amended its coal ash beneficial use program in 1998, most of the requirements for groundwater monitoring, corrective action, waste characterization, and other safeguards were removed from regulations and placed in several guidance documents. Consequently, PADEP gained great discretion in these critical areas, while the public has no standards to enforce. For example, PADEP can and does accept ash for placement that exceeds maximum allowable leachate concentrations. However, the certification standards are set forth in unenforceable guidance. Clearly PADEP has the discretion to certify ash that exceeds these guidelines, is doing so without establishing that the ash will not harm water and the public has no recourse. Similarly, monitoring results indicate at many ash placement sites that contamination is occurring, but since there are no longer any "trigger" levels in the regulations or permits, a response is wholly within the discretion of PADEP. In most instances PADEP fails to take any response action and makes no attempt to document or explain its inaction. This degree of discretion is entirely inappropriate in view of the millions of tons of coal ash placed each year in mines in Pennsylvania and in view of the known toxicity of this waste. Considering the rapidly increasing generation of waste coal ash in Pennsylvania, which is primarily disposed in mines, the absence of regulatory standards becomes even more problematic.

12. *Statewide Programmatic Review of Pennsylvania Coal Ash Placement Sites:* PADEP should conduct a statewide review of all ash placement in mines conducted under its beneficial use program given (1) the failure of permitted ash minefills, as documented in this report, to achieve their intended purpose; (2) the propensity of permitted ash minefills, as documented in this report, to contaminate groundwater and surface water; (2) the increasing public concern about minefilling in Pennsylvania; (3)

the National Academies of Science's recommendations that call into question many critical aspects of the Pennsylvania Coal Ash Beneficial Use Program; and (4) the pending national rulemaking on mine placement. This review should include the imposition of long-term monitoring at older, finished mine placement sites where such monitoring is not currently underway. This monitoring must be designed to determine whether adverse impacts from coal ash disposal are occurring.

13. *Promotion of Safe Reuse of Coal Ash:* PADEP must heed the primary recommendation of the NRC Report to promote safe and beneficial reuse of CCW in lieu of mine disposal. PADEP should approve CCW disposal in mines only when safer reuse alternatives are not feasible. PADEP should require all applicants, prior to receiving permits or the renewal of permits for ash placement in mines, to demonstrate that reasonable efforts have been made by the CCW generators to market the CCW for beneficial reuses, such as in the manufacture of concrete, pavement or other aggregates. PADEP should encourage CCW generators to continue these efforts to divert the CCW from mine placement after minefill permits for their CCW are issued.

In summary, the Pennsylvania Coal Ash Beneficial Use Program in mines is far from a model program. In principle, the safe and beneficial reuse of an abundant industrial waste is a sound goal. However, the authors of this report have observed practices that defeat this laudable goal by damaging water supplies and leaving large unmonitored waste deposits not isolated and posing longterm potential risks to local communities. The authors look forward to working with the Commonwealth of Pennsylvania to create a safer coal ash placement program and to conducting additional research to better define the risks and benefits of coal ash placement in mines.



CAPTION - AC Fuels Co Minefill in Schuylkill County where FBC ash from Panther Creek Cogen Station is used for reclamation according to PADEP and dumped without standards according to nearby residents. Photo by Steven Dreyer, McAdoo, PA.

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