

A PRELIMINARY REVIEW OF THE FINAL REPORT  
OF THE NATIONAL ACADEMY OF SCIENCES  
“MANAGING COAL COMBUSTION RESIDUES AT MINES”

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**Abstract**

On March 1, 2006, the National Research Council released to the public its final report by the National Academy of Sciences “Managing Coal Combustion Residues at Mines.” Based on the news release of the National Academy of Sciences, putting coal ash back into mines is a viable option for disposal, as long as precautions are taken to protect the environment and public health. The report also acknowledged that CCRs could serve a useful purpose in mine reclamation, lessen the need for new landfills, and potentially neutralize acid mine drainage. The report recommends development of enforceable Federal standards that give the States authority to permit the use of CCRs at mines but allows them to adopt requirements for local conditions. The report, however, is 227 pages long and it is the details of the report that will provide a clear picture of its scientific merit and thus its value to Federal and State regulators. Since the report was not made public until March 1, 2006, it is still too early to provide a definitive evaluation of the merits of its entire contents. As such, the authors will report on the purpose of the NAS study and the recommendations and findings of its committee. The authors will also report on the results of the OSM efforts in technology development and transfer and the benchmarking efforts of the Interstate Mining Compact Commission on this subject. Since neither OSM nor IMCC have had time to prepare a thorough analysis of the report, the observations made in this paper represent the personal observations of the authors only and carry no institutional endorsement.

**Introduction**

On March 1, 2006, the National Research Council released to the public its final report by the National Academy of Sciences “Managing Coal Combustion Residues at Mines.” The study was in response to a request from Congress and was initiated in June of 2004. The National Research Council conducted the study to examine the health, safety, and environmental risks associated with using coal combustion residue in reclamation at active and abandoned coal mines. The study was sponsored by the Environmental Protection Agency (EPA). The committee looked at the placement of coal combustion residue (CCR) in abandoned and active, surface and underground coal mines in all major coal basins. The study also considered coal mines receiving large quantities of coal combustion residue. A profile of the utility industry was taken into consideration in designing the study to focus on the sources producing the greatest quantities of coal combustion wastes. The study was to determine whether CCRs were placed and disposed of

in coal mines with inadequate safeguards and whether this activity is degrading water supplies in coal mines in contravention of SMCRA.

The committee's efforts focused on coal combustion residue from utility power plants and independent power producers, rather than small business, industries, and institutions. The committee examined regulatory structures and the interaction of programs under EPA's jurisdiction and the Surface Mining Control and Reclamation Act (SMCRA) implemented by the Office of Surface Mining (OSM) in partnership with States. The committee held six public meetings around the country between October 2004 and May 2005, and visited field sites related to their inquiry.

### **NAS Statement of Task**

Specifically, the committee addressed the following points:

1. The adequacy of data collection from surface water and ground water monitoring points established at Coal Combustion Waste (CCW) sites in mines.
2. The impacts of aquatic life in streams draining CCW placement areas and the wetlands, lakes, and rivers receiving these drainages
3. The responses of mine operators and regulators to adverse or unintended impacts such as the contamination of ground water and pollution of surface waters
4. Whether CCWs and mine they are being put in are adequately characterized for such placement to ensure that monitoring programs are effective and groundwater and surface waters are not degraded. (This item is not explicitly in the NAS statement of task but is there implicitly.)
5. Whether there are clear performance standards set and regularly assessed for projects that use CCW for "beneficial purposes" in mines.
6. The status of isolation requirements and whether they are needed.
7. The adequacy of monitoring programs including:
  - a. The status of long-term monitoring and the need for this monitoring after CCW is placed in abandoned mines and active mines when placement is completed and bonds released.
  - b. Whether monitoring is occurring from enough locations;
  - c. Whether monitoring occurs for relevant constituents in CCW as determined by characterization of the CCW; and
  - d. Whether there are clear, enforceable corrective actions standards regularly required in the monitoring.
8. The ability of mines receiving large amounts of CCW to achieve economically-productive post mine land uses;
9. The need for upgraded bonding or other mechanisms to assure that adequate resources are available for adequate periods to perform monitoring and address impacts after CCW placement or disposal operations are completed in coalmines;
10. The provisions for public involvement in these questions at the permitting and policy-making levels and any results of that involvement;
11. Evaluate the risks associated with contamination of water supplies and the environment from the disposal or placement of coal combustion wastes in coal mines in the context of

the requirements for protection of those resources by Resource Conservation and Recovery Act (RCRA) and SMCRA.

### **NAS Findings and Recommendations (NRC, 2006)**

#### **1. Conclusion**

- a. The committee believes that placement of CCR in mines as part of coal mine reclamation may be an appropriate option for the disposal of this material.

#### **2. Value of existing CCR data and information**

- a. The two most common CCR disposal options, surface impoundments and landfills, provide insights into the types of issues that can emerge when the soluble constituents of CCRs are not contained within the waste management system.
- b. Although disposal conditions may differ substantially from mine settings, landfills, and surface impoundments are useful for understanding the specific conditions under which CCRs can potentially impact humans and ecosystems. The EPA has identified numerous cases of water contamination related to CCR landfills and surface impoundments that, in many cases, has caused considerable environmental damage. In some landfill settings, groundwater has been degraded to the point that drinking water standards were exceeded off-site. In other landfills and surface impoundments, contamination of surface waters has resulted in considerable environmental damage; in the most extreme cases, multiple species have experienced local extinctions. Such cases are instructive because these impacts can be clearly related to CCR disposal, and they help guide the selection of mining environments for CCR placement that are most protective of human and ecological health.
- c. ... the committee's review of literature and damage cases recognized by EPA supports the EPA's concerns about proper management of CCRs.
- d. As of 2005, EPA had recognized 24 proven damage cases involving CCR landfills and surface impoundments. One CCR coal minefill is under investigation as a potential damage case by EPA.
- e. ....comparatively little is known about the potential for mine-filling to degrade the quality of groundwater and/or surface waters particularly over longer time periods.
- f. ...there are insufficient data on the contamination of water supplies by placement of CCRs in coal mines, making human risk assessment difficult.
- g. Currently, there are very few data available to directly indicate that placement of CCRs in abandoned or active coal mines is either safe or detrimental.

#### **2. Potential Impacts**

- a. Of the three methods currently available for disposal of CCRs (surface impoundments, landfilling, and minefilling), comparatively little is known about the potential for minefilling to degrade the quality of ground water and/or surface waters particularly over *longer periods (decades to centuries)*. Additionally, there are insufficient data on the contamination of water supplies by placement of CCRs in coal mines, making human risk assessments difficult.
- b. The committee concludes that the presence of high contaminant levels in many CCR leachates may create human health and ecological concerns at or near some mine sites over the long term.

### 3. CCR Disposal and Use Options

- a. The committee recommends that secondary uses of CCRs that pose minimal risks to human health and the environment be strongly encouraged.
- b. With regard to CCR placement in minefills, the committee concludes that while potential advantages (*beneficial use*) should not be ignored, the full characterization of possible risks should not be cut short in the name of beneficial use.

### 4. CCR Characterization

- a. In order to contribute to evaluation of the risk of placing CCRs at mine sites, the committee recommends that CCRs be characterized prior to significant mine placement and with each new source of CCRs. CCR characterization should continue periodically throughout the mine placement process to assess any changes in CCR composition and behavior.
- b. The committee suggests some simple improvements to current leaching protocols. In particular, the CCR characterization methods used should provide contaminant leaching information for the range of geochemical conditions that will occur at the CCR placement site and in the surrounding area, both during and after placement. Samples that exceed pre-determined leaching criteria should be rejected for mine placement, although samples that meet the criteria may still need additional evaluation depending on the potential risks of CCR placement determined from the site characterization.

### 5. Site Characterization

- a. Current site characterization requirements of SMCRA focus on assessing the potential impacts of coal mining and reclamation but do not specifically address the impacts of CCR placement. The committee recommends that comprehensive site characterization specific to CCR placement be conducted at all mine sites prior to substantial placement of CCRs.

### 6. CCR Use in Reclamation

- a. The disposal of CCRs in coal mines occurs under highly variable conditions, ranging from small quantities to massive minefills, from arid to wet regions, from remote to semiurban locations, from surface to underground mines, and from active to abandoned mines. Thus, the committee endorses the concept of site-specific management plans, including site-specific performance standards.
- b. Given the known impacts that can occur when CCRs react with water in surface impoundments and landfills, special attention should be paid in reclamation operations to the interactions of water with CCRs. Specifically, the committee recommends that CCR placement in mines be designed to minimize reactions with water and the flow of water through CCRs. Such methods include:
  - (1) placement well above the water table
  - (2) compaction (*in lifts*)
  - (3) cementation (*cement addition*)
  - (4) use of *impermeable* liners, and
  - (5) use of low-permeability covers.

### 7. Post Reclamation Water Quality Monitoring

- a. Based on its reviews of CCR post-placement monitoring at many sites visited during the course of the study, the committee concludes that the number of monitoring wells, the spatial coverage of wells, and the duration of monitoring at CCR minefills are generally insufficient to accurately assess the migration of contaminants.

- b. The committee found quality assurance and control and information management procedures for water quality data at CCR mine placement sites to be inadequate.
  - c. The committee believes that a more robust and consistent monitoring program is needed in situations involving CCR mine placement. The committee recommends that the number and location of monitoring wells, the frequency and duration of sampling, and the water quality parameters selected for analysis be carefully determined for each site, in order to accurately assess the present and potential movement of CCR-associated contaminants.
  - d. Although monitoring plans should be site-specific, downgradient wells should be sited with an understanding of the travel times for contaminants to reach these monitoring points.
  - e. Depending on the individual site characteristics and the distances to downgradient wells, a longer duration of groundwater monitoring may be necessary at some sites to adequately assess the temporal release of contaminants, which can occur over several decades. To address these concerns, several monitoring points should be established along predicted flow paths that will yield early (prior to bond release) information that can be used to confirm predicted CCR leachate transport.
  - f. At least one well or lysimeter, and preferably two, should be placed directly in the CCR to assess the field leaching behavior and confirm predicted contaminant flux.
  - g. As part of the monitoring plan, quality assurance and control plans should be developed prior to CCR placement with clearly defined protocols for sampling and analysis, for data validation, and for managing systematic errors in analytical procedures.
8. Performance Assessment
- a. The committee recommends that the disposal of CCRs in coal mines be subject to reasonable site-specific performance standards that are tailored to address potential environmental problems associated with CCR disposal.
  - b. In areas where CCR leachate may interact with surface waters (directly or through groundwater interaction), more stringent requirements may be necessary to protect aquatic life.
  - c. Where violations of permit requirements or exceedences of performance standards occur, authority for appropriate penalties or corrective actions must be available to mitigate the damage and prevent future violations.
9. CCR Use in Abandoned Mine Lands and Re-mining Sites
- a. In order to assure adequate protection of ecological and human health, the committee recommends that placement of CCRs in abandoned and re-mining sites be subject to the same CCR characterization, site characterization, and management planning standards recommended for active coal mines.
10. Research
- a. The committee recommends that research be conducted to provide more information on the potential ecological and human health effects of placing CCRs in coal mines.
    - (1) Environmental behavior of CCRs placed at coal mines for protracted time scales over a range of climates, hydrogeologic settings, CCR types, and mining and reclamation techniques.
    - (2) Fate and transport of contaminants from CCRs placed at coal mines and the potential for exposure by humans and biological communities for protracted time scales.

- (3) Improvement and field validation of leaching tests to better predict the mobilization of constituents from CCRs in the mine settings for comparison with post reclamation water monitoring results.

11. Public Participation

- a. Government agencies responsible for regulating CCRs should ensure that the public receives adequate advance notice of any proposals to dispose of CCRs in mine sites.
- b. The committee recommends that any proposal to dispose of substantial quantities of CCRs in coal mines be treated as a “significant alteration of the reclamation plan” under SMCRA.

12. Alternatives for Regulatory Authority

- a. Neither SMCRA nor its implementing regulations currently address the use or placement of CCRs in an explicit manner. As a consequence, States vary in their approach and in the rigor with which they address CCR use in mines.
- b. The committee concludes that although SMCRA does not specifically regulate CCR placement at mine sites, its scope is broad enough to encompass such regulation during reclamation activities.
- c. Some States have expressed concern that they do not have the authority to impose performance standards specific to CCRs. Therefore, the committee recommends that enforceable federal standards be established for the disposal of CCRs in minefills.
- d. The committee believes that OSM and its SMCRA State partners should take the lead in developing new national standards for CCR use in mines because the framework is in place to deal with mine related issues.
- d. Regardless of the regulatory mechanism selected, coordination between OSM and EPA efforts is needed and would foster regulatory consistency with EPA’s intended rulemaking proposals for CCR disposal in landfills and impoundments.
- e. In all cases, guidance documents will also be necessary to help States implement their responsibility for managing CCR.

**Results of five national OSM technical interactive forums  
on CCB placement at SMCRA mines.**

**(Based on excerpts from an article in *Energeia* Vol 15, No. 5 2004. by K.C. Vories)**

Based on a survey (Murarka, 2000) concerning the location of CCB placement at coal mine sites, about 1 percent, or 100 out of the approximately 9650 coal mine sites, were using CCB placement in 17 of the 26 coal mining States. Most of the uses to date have been extensively researched and indicate that the placement of these materials on the mine site usually results in a beneficial impact to human health and the environment when it is used to mitigate other existing potential mining hazards and secondarily as non-toxic fill within the spoil area prior to grading and final reclamation.

Beneficial uses at SMCRA mine sites are as: (1) a seal to contain acid forming materials and prevent the formation of acid mine drainage; (2) an agricultural supplement to create productive artificial soils on abandoned mine lands where native soils are not available; (3) a flowable fill that seals and stabilizes abandoned underground mines to prevent subsidence and the production of acid mine drainage; (4) a construction material for dams or other earth like materials where

such materials are needed as a compact and durable base; and (5) a non-toxic, earthlike fill material for final pits and within the spoil area .

Research (Kim *et al.*, 2001) has shown that less than 1 percent of these materials have the potential to leach hazardous constituents (According to Nationwide Analysis by the U.S. Department of Energy with only 2 out of 288 sources, or 0.7 percent, of the CCBs tested demonstrated the potential to leach trace elements at levels that would be classified as hazardous). All of the SMCRA water monitoring data I am aware of to date, indicate that placement of these materials at SMCRA mine sites does not produce ground water that has hazardous constituents and in most cases is environmentally beneficial.

SMCRA is based on performance standards rather than design standards. By using performance standards, which are minimum levels of environmental protection, SMCRA allows for each State Regulatory Authority to develop methods and techniques that are most appropriate for the climate, geology, geography, and other site conditions that occur locally. It also allows the operator to design the site-specific mining and reclamation techniques that maximize the operator's efficiency and still insure the appropriate level of environmental protection. The result is that each State is allowed to develop a program specifically suited to its needs to protect the environment based on local conditions while maintaining a uniform national level of environmental protection.

There is no exemption for any coal combustion by-product placed at a SMCRA mine site from any of the permitting requirements and environmental performance standards contained in SMCRA. When the use or disposal of coal combustion by-products happens at surface coal mines, State and Federal coal mining regulators are involved to the extent that SMCRA requires the mine operator to: (1) ensure that all toxic materials are treated, buried, and compacted, or otherwise disposed of, in a manner designed to prevent contamination of the ground or surface water; (2) make sure the proposed land use does not present any actual or probable threat of water pollution; (3) ensure the permit application contains a detailed description of the measures to be taken during mining and reclamation; (4) assure the protection of the quality and quantity of surface and ground water systems, both on and off the mine site, from adverse effects of the mining and reclamation process; and (5) assure that rights of present users of such water are protected.

This result is supported by all existing scientific research and water monitoring which finds: (1) no evidence of damage to public health or the environment due to the placement of these materials at SMCRA mine sites; (2) in most cases, actual improvement of ground or surface water quality; and, (3) in the cases where they are used as soil amendments, improved plant growth on the surface.

SMCRA became law on August 3, 1977. In the 28 plus years since its passage, there has not been a single CCB related damage case at a SMCRA mine. To date, the author is unaware of any scientific evidence of any damage to public health or the environment due to placement of CCBs at SMCRA mine sites. Based on a side-by-side comparison of the regulatory protections provided by SMCRA in comparison to RCRA, when SMCRA is properly applied and enforced it is adequate to protect the public health and the environment.

## **State Perspective on the Management and Regulation of Coal Combustion Residues**

In May of 2000, the U.S. Environmental Protection Agency (EPA) published a Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels. Among other things, and of particular concern to the states, EPA found that, although coal combustion by-products (CCBs) (or coal combustion residues (CCRs)) did not warrant regulation under subtitle C of the Resource Conservation and Recovery Act (RCRA) as “hazardous waste”, the agency had determined that national regulations under subtitle D of RCRA are warranted when these wastes are disposed in landfills or surface impoundments, and that regulations under subtitle D and/or possible modifications to existing regulations established under the Surface Mining Control and Reclamation Act (SMCRA) are warranted when these materials are used as fill in surface or underground mines. IMCC was especially concerned about the “mine placement” aspects of the determination given the significant interplay between approved state regulatory programs under SMCRA and any potential adjustments to the national SMCRA regulations (which serve as a template for state regulatory programs).

Following publication of EPA’s notice, IMCC suggested to both EPA and the Office of Surface Mining (OSM) that an intergovernmental forum would serve as a valuable mechanism to initiate discussions between state and federal governments concerning next steps pursuant to the regulatory determination. This suggestion followed on the heels of a resolution adopted by IMCC in May of 2000 affirming the appropriateness and effectiveness of state regulations and policies for the safe handling, recycling, beneficial use and placement of coal combustion by-products and supporting the management of CCBs without the application of federal RCRA subtitle C requirements.

The first of the state/federal dialogues occurred in May of 2001 and over the course of the next three years, the parties shared and discussed information and analyses of their respective regulatory programs under SMCRA and RCRA. The states also provided data and information from state approved permits where mine placement was predominant to demonstrate the types of environmental controls applicable in these situations and the environmental protection afforded by exiting regulatory standards. Copies of the various documents and notes generated at the four state/federal dialogues are available at [www.epa.gov/epaoswer/other/fossil/index.htm](http://www.epa.gov/epaoswer/other/fossil/index.htm).

Throughout the state/federal discussions, the states have consistently articulated the following concerns to EPA and OSM, several of which were addressed in the NAS report:

1. SMCRA appears to serve as an adequate and effective baseline for any type of regulatory analysis concerning mine placement of CCRs. In this regard, the states see the SMCRA permit serving as the platform for CCR mine placement at coal mines. For non-coal mines, the states believe that the existing state permitting framework, which is often RCRA-based, is adequate.
2. it is essential to examine the effectiveness and comprehensiveness of existing state programs before adding additional regulatory requirements. Experience at the state level in implementing existing state and federal laws substantiates the adequacy of the existing regulatory structure.
3. there is a need to coordinate among all applicable statutes/regulations that impact the



regulation of mine placement of CCRs, including SMCRA, RCRA, the Clean Water Act and the Safe Drinking Water Act. There is a belief that many of the necessary regulatory requirements are already in place in the context of these statutes and their respective regulatory programs.

4. there is an absolute need for flexibility to accommodate differences among the states related to geology, climate, ash characterization and agency operation. Comprehensive federal regulation will be difficult to implement on a nationwide basis due to these differences.
5. there needs to be consideration given to both coal and noncoal sites and the differences between them. In this regard, heavy-handed federal efforts to achieve some sort of uniformity will only undermine effective and efficient regulation at the state level.

As an overall objective in the area of regulating mine placement of CCRs, the states have strived to strike a balance between existing state regulatory program requirements and any gaps that may be defined and justified. Although there are differences among the states in the way they regulate mine placement of CCRs (for instance, in terms of sharing jurisdiction among several state agencies; relying primarily on the SMCRA program for mine placement at coal mines; and differentiating between beneficial use and classic disposal), there has been limited evidence of major gaps that require filling through new national regulations under either SMCRA or RCRA. And in those states that do not have well defined programs for mine placement of CCRs, it is usually because they have not had to deal with its beneficial use or disposal within their borders. Even in those states, a comparison of their programs with states who actively regulate mine placement of CCRs demonstrates that most, if not all, of the program elements are in place and would likely operate effectively when needed.

The few areas within state programs that have been shown to need some degree of shoring up, as suggested in the NAS report, can best be addressed through intergovernmental discussions, such as have occurred over the past several years. Also, through a benchmarking type of approach, states can identify areas in their programs that would benefit from fine-tuning and this can be accomplished by patterning these areas after other state programs. If and when specific regulatory gaps are confirmed to exist in a significant majority of state programs, then it would be appropriate to consider national guidance from OSM (the agency recommended by the NAS to take the lead in this area). However, all of the analyses of state programs undertaken to date by OSM and EPA do not justify the need for such guidance, and OSM has stated on numerous occasions that it believes state programs are adequate or structured in such a way as to address any gaps (at least as far as SMCRA programs for CCR mine placement at coal mines are concerned).

From the states' perspective, now that the NAS has completed its work and issued its report, we are hopeful that OSM, in coordination with EPA, will move forward expeditiously with its position on the need for additional federal regulation of minefill practices for coal combustion residues. We believe that all of the information required by the agency to make this decision is now in hand and that it is well poised to render that decision. We fully expect, however, that OSM and EPA will need additional time to review and consider the findings and recommendations of the NAS before taking final action. In the end, we anticipate that OSM, in coordination with EPA, can appropriately recommend that the states continue their on-going

efforts to work cooperatively with both agencies to assess the effectiveness of their respective regulatory programs and make appropriate adjustments, given the flexibility and discretion afforded the states under SMCRA's state primacy design. Furthermore, we anticipate that the states will continue their benchmarking initiatives, which provide for the analysis and comparison of state program elements with the overall objective of enhancing their respective programs through the adoption of lessons learned during program implementation and the incorporation of innovative approaches. In the final analysis, we believe that our citizenry and the environment will be well served by state regulatory programs that fully comply with applicable federal laws and that reflect the results of the laboratories of invention inherent in state primacy. We also believe that an effective regulatory regime for the mine placement of coal combustion residues will insure that there are effective and safe alternatives to classic land disposal while enhancing the reclamation of both active and abandoned mined lands.

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