WHITE PAPER

Generation and Use of Boiler Slag and the Potential Impact of Listing Boiler Slag as a RCRA Subtitle C Hazardous Waste

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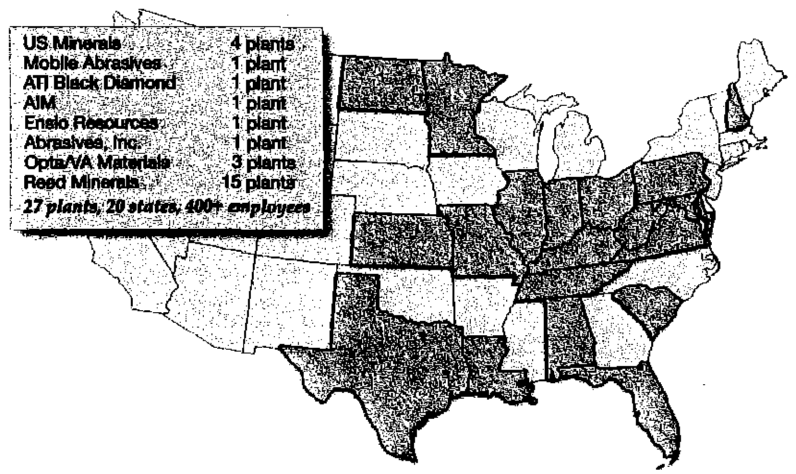
1.0 *INTRODUCTION*

Boiler slag is a coal combustion by-product (CCB) that is in high demand for beneficial uses due to its unique and *environmentally benign* characteristics. Boiler slag is a glassy, vitrified material that is virtually inert in the environment. Industry reports that approximately 90% or more of all boiler slag generated in the US is beneficially used, supporting a $200,000,000 industry that includes 29 plants across 20 states (Figure 1), and affects the lives of thousands of people.[1]

Figure 1
29 Boiler Slag Plants Across 20 States



For more than 70 years, boiler slag has been and continues to be a key component in asphalt roofing shingles. Notably, *eighty percent* (80%) of the roofing shingles across the US contain boiler slag.[1] In an another example of its beneficial use, the use of boiler slag as an industrial abrasive grit is also *protective* of the health of US workers. Naturally occurring abrasives contain crystalline silica, which causes a severely debilitating lung condition known as silicosis. Because it is a vitrified, glassy material, boiler slag is a safer and economical alternative to natural abrasives, eliminating worker exposure to crystalline silica and silicosis.

Boiler slag and all CCBs are non-hazardous wastes. The United States Environmental Protection Agency (EPA) has affirmed this determination on *four* separate occasions over the last 20 years through comprehensive scientific study. EPA's own 1988 report to Congress went so far as to state unequivocally that "*EPA has concluded that coal combustion waste streams generally do not exhibit hazardous characteristics under current RCRA regulations. EPA does not intend to regulate under Subtitle C fly ash, bottom ash, boiler slag, and flue gas desulfurization wastes.*"[2]

EPA's exhaustive studies and rulings demonstrating that boiler slag and the other CCBs, such as fly ash and bottom ash, do not meet either the statutory definition of a hazardous waste (RCRA §10004(5)) or the criteria established by EPA[a] *are* the regulatory drivers behind the success of beneficial use of these valuable resources. EPA's regulatory declaration in 2000, once again affirming the non-hazardous waste designation of CCBs, went as far as stating that the agency did not want "*to place any unnecessary barriers on the beneficial uses of [CCBs], because they conserve natural resources, reduce disposal costs, and reduce the total amount of wastes destined for disposal*."[3] Clearly, EPA has achieved its goal as the American Coal Council reported in 2005 that the direct and indirect annual economic benefits to the US for the collective beneficial use of boiler slag and all CCBs was *$2.2 billion* and *$4.5 billion*, respectively.[4]

Contrary to three decades of scientific research, EPA is yet again considering a proposed ruling that would list CCBs, including boiler slag, as a hazardous waste under RCRA Subtitle C. To be clear, on-going published research on boiler slag and the other CCBs by industry and regulatory agencies shows that the scientific conclusions supporting EPA's four prior rulings continue to demonstrate that these valuable resources do not meet either the statutory definition of a hazardous waste or the criteria established by EPA to list a hazardous waste. Clearly, the scientific findings *have not* changed and continue to show that CCBs are not ignitable, corrosive, reactive or toxic, leaving industry perplexed as to how and why would EPA list CCBs as a hazardous waste even though these materials do not meet any of EPA's own criteria for such a listing.

Since 1999 to 2008, the beneficial use of CCBs has grown from 30 million tons annually to 56 million tons[5]. The designation of CCBs as a hazardous waste *would devastate* and for all intents and purposes destroy this healthy, and environmentally beneficial industry that affects thousands of people across the US, and is an integral part of our nation's sustainability initiative to reduce greenhouse gas emissions and energy consumption. This point is emphasized by the American Coal Ash Association (ACAA) and the Coal Combustion Products Partnership[b] (C^2P^2), documenting that current regulations in states across the country, such as Pennsylvania, Maryland, Virginia, Florida, Delaware, North Carolina, Colorado, Tennessee, Georgia, Michigan, North Dakota, Wyoming, Indiana, Illinois and

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[a] Ignitability (40 CFR 261.21), Corrosivity (40 CFR 261.22), Reactivity (40 CFR 261.23), Toxicity (40 CFR 261.24).

[b] The Coal Combustion Products Partnership is a cooperative effort between EPA and the ACAA, Utility Solid Waste Activities Group (USWAG), Department of Energy (DOE), Federal Highway Administration (FHWA), the Electric Power Research Institute (EPRI), and the United States Department of Agriculture Agricultural Research Service (USDA-ARS) to promote the beneficial use of CCBs and the environmental benefits that result from their use.

Montana, *would not permit the beneficial use of CCBs* if EPA were to list CCBs as a hazardous waste.[5]

The ACAA and C^2P^2 stated that the designation of CCBs as a hazardous waste "*would have significant and long lasting effect upon society's willingness to beneficially re-use fly ash and other [CCBs] by destabilizing their markets*[5]." Industry relying on the beneficial use of boiler slag would be at a significant competitive disadvantage to other less safe and more costly alternatives, resulting in the significant contraction if not total shutdown of the 29 plants in 20 states across the US (Figure 1) that beneficially use boiler slag to produce commercial and residential products.

Industry understands that EPA is not overly concerned with the likely effects Subtitle C regulations would have the beneficial use of boiler slag and other CCBs, citing that hazardous wastes such as solvents are recycled. However, there is a significant difference. Hazardous waste solvents, for example, do not require landfilling as they are recycled for their energy value by burning in boilers and cement kilns. Boiler slag on the other hand, is different because it is recycled into consumer products. Discarded products, including those generated by homeowners in the case of roofing shingles, would have to be managed as a hazardous waste, and disposed most likely by landfilling.

The roofing industry for example, which has relied on asphalt shingles with boiler slag roofing granules for more than 70 years of commercial and residential roofing, would be faced with a major and costly overhaul of its business, most likely resulting in the shutdown of the smaller, local roofing contractors that would not have the knowledge or resources to comply with RCRA Subtitle C regulations regarding the disposal of roofing shingles, which would be a hazardous waste since they contain boiler slag. The industry would need to identify a suitable and economic replacement for these shingles, as well as re-tool its practice to deal with the millions of tons of discarded shingles annually from roof replacements and repairs that would have to be managed as a hazardous waste if EPA were to list boiler slag as a RCRA Subtitle C waste.

The utility industry supports the development by EPA of non-hazardous regulations under RCRA Subtitle D that would be applicable to the operations of coal ash storage facilities, including the design and construction standards. As noted above, on-going published research on boiler slag and the other CCBs by industry and regulatory agencies shows that the scientific conclusions supporting EPA's four prior rulings continue to demonstrate that these valuable resources do not meet either the statutory definition of a hazardous waste or the criteria established by EPA to list a hazardous waste. Therefore, it can be concluded that subjecting these materials to hazardous waste regulations *would not* be any more protective to human health or the environment than regulating them under Subtitle D.

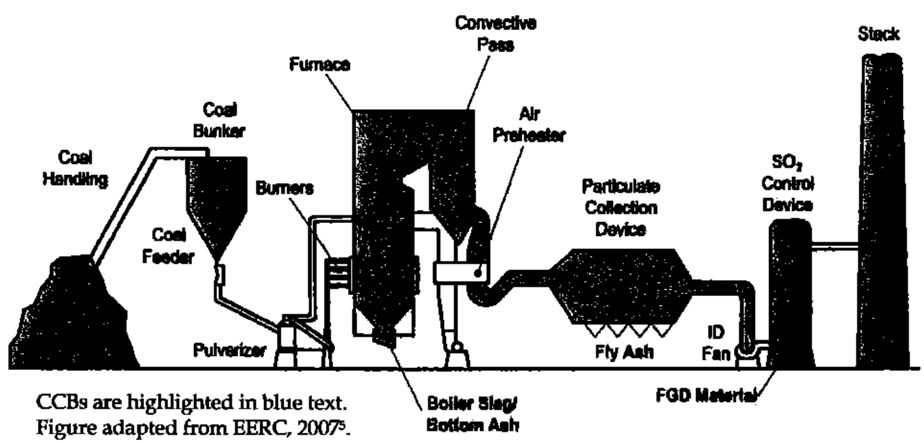
This document has been prepared to provide an understanding of the generation and beneficial uses of CCBs, in particular boiler slag. Building upon this foundation, the paper concludes by identifying the potentially devastating effects and barriers to the beneficial uses of CCBs that would result if EPA's proposed ruling becomes codified.

2.0 CCB GENERATION AND BENEFICIAL USE

2.1 CCB Generation

Coal-fired power plants provide approximately one-half of the electricity generated in the United States[6]. These plants burn coal to produce energy to convert water into steam in a boiler. The steam rotates a turbine to produce electricity. The burning of coal to produce electricity results in the production of various residues that are referred to collectively as CCBs.

Figure 2
Generation of CCBs

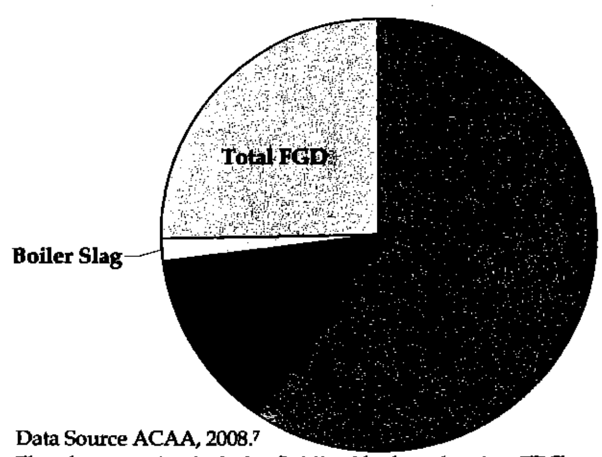


CCBs are highlighted in blue text.
Figure adapted from EERC, 2007[5].

As shown in Figure 2, CCBs consist of boiler slag, fly ash, and bottom ash, which represent the non-combustible mineral matter present within the coal. CCBs also include the solid products produced during the "scrubbing" of the flue gas to remove sulfur, which is an atmospheric pollutant. In 2007 approximately 131 million tons of CCBs were produced.[7]

Figure 3 illustrates that fly ash makes up the bulk of CCBs generated by coal-fired boilers. Conversely, boiler slag represents the smallest volume of CCBs generated. The different types of CCBs have different physical and chemical properties as follows:

Figure 3
Types of CCBs Produced



Data Source ACAA, 2008.[7]
Fly ash proportion includes fluidized bed combustion (FBC) ash.

- **Boiler Slag** is a specific type of CCB that is a vitrified, i.e., glassy, material that renders it virtually inert in the environment. In fact, vitrification is a process endorsed by EPA as a Best Alternative Developed Technology (BADT) used to "trap" harmful chemicals and metals in a solid, glassy block. The vitrified block that is left in place is permanent and not harmful to people.[8] Boiler slag is produced when temperatures are sufficiently high during coal combustion to melt coal ash. When quenched with water, the molten ash vitrifies and becomes boiler slag. Boiler slag is composed of granular, angular particles with smooth, glassy surfaces. Boiler slag is sometimes referred to as "wet-bottom boiler slag" or by a brand name, such as Black Beauty, Black Magnum or Black Diamond.[9, 10, 11] Its unique characteristic of being vitrified during combustion makes boiler slag environmentally benign so it is not surprising that there have been *no* documented cases where the proper management or beneficial use of boiler slag has resulted in an adverse environmental impact.

- **Fly Ash**, which comprises the vast majority of CCBs, consists of very fine particles that are removed from flue gasses by electrostatic precipitators, baghouses, or scrubber systems. Fly ash is generally powdery in texture and made up of glassy, clay-sized spherical particles that are composed mostly of silica, which is the principal mineral in beach sand and glass.[9]

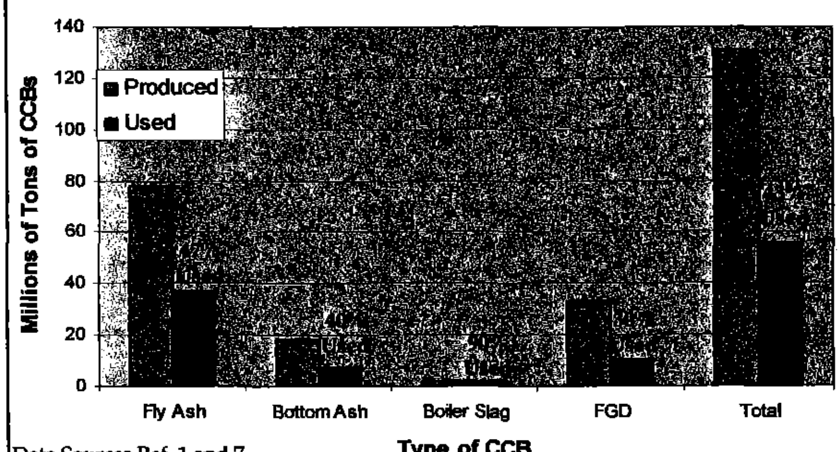
- **Bottom Ash** is made up of larger particles of unburned material that are too large and heavy to be carried by flue gasses. Bottom ash is composed of granular, angular particles with porous surfaces. The principal difference between bottom ash and fly ash is the large particle size of bottom ash.[9]

- **Flue Gas Desulfurization (FGD) Product** results from scrubbers designed to remove sulfur from flue gases by allowing them to react with lime or limestone. The physical nature of the FGD product may vary depending upon the type of scrubber from a wet sludge to a dry powder, but is chemically composed of predominantly calcium sulfate (gypsum/anhydrite used to make wallboard) or calcium sulfite.[9]

2.2 Beneficial Uses

The physical and chemical properties of CCBs make them ideal for a variety of beneficial uses. As illustrated in Figure 4, 40% to 50% of all CCBs produced in the US are beneficially used, while the remaining 60% are disposed in landfills, surface impoundments, and ponds. The most common uses for different types of CCBs are listed below.

Figure 4
2007 CCB Production and Use



Data Sources Ref. 1 and 7.

- Boiler slag is commonly used as an abrasive grit and roof shingle granules. Other uses include concrete manufacture, asphalt filler, and snow and ice control. The high demand for boiler slag is evidenced by the fact that industry reports that approximately 90% of all boiler slag produced in the United States is beneficially used.[1]

- Fly ash and bottom ash are often used as components in concrete. Some of these ashes contain free lime; they are, therefore self-cementing when combined with water and can be used to replace Portland cement. Structural fill, road base, and mine reclamation are other common uses for fly ash and bottom ash. The tiny, spherical particles that make up fly ash can improve the consistency and flowability of flowable fills and grouts. The granular, angular shape of bottom ash make it useful for snow and ice control on roads.[9, 10]

- FGD product is most commonly used in the production of wallboard. Agricultural applications and components in concrete products are also common uses.[9]

As footnoted previously, the C^2P^2 program[b] is a cooperative effort between EPA and other federal agencies, and EPRI. The program's goal is to promote the beneficial use of CCBs and the environmental benefits that result from their use. C^2P^2 reports the following benefits from the beneficial uses of CCBs:

1. **Environmental benefits** can include reduced greenhouse gas emissions, reduced land disposal requirements, and reduced utilization of virgin resources.

2. **Economic benefits** can include reduced costs associated with coal ash and slag disposal, increased revenue from the sale of CCBs, and savings from using CCPs in place of other, more costly materials;

3. **Performance benefits** can result from the physical and chemical characteristics of CCBs and include greater resistance to chemical attack, increased strength, and improved workability. For instance, high fly ash-content concrete can be used for high performance, long-life pavements which are designed to last 50 years—twice the lifetime of conventional pavements.[12]

Particularly noteworthy is the significant role that beneficially using CCBs can have on reducing greenhouse gas emissions. Globally, the production of Portland cement is estimated to generate more than *2.4 billion tons per year* of carbon dioxide (CO_2). In the US, cement manufacturing is estimated to produce more than 100 million tons of CO_2 each year. A very effective beneficial use of CCBs to reduce CO_2 emissions is to use less cement and replace it with more fly ash, which results in a more durable and reliable building material. Fly ash is used to replace about 15% of the Portland cement in concrete, which since 1990 has reduced CO_2 by about 200 million tons. For every ton of Portland cement replaced by CCBs the release of one ton of CO_2 to the atmosphere is *avoided.*[12, 13]

3.0 BOILER SLAG

3.1 Generation of Boiler Slag

Boiler slag is a special class of bottom ash and is only produced in slag-tap and cyclone boilers. In these types of boilers, the combustion chamber reaches temperatures that melt the bottom ash. When the molten ash is quenched with water, it immediately vitrifies into an amorphous solid (glass) and fractures into granular, angular particles.[10] As indicated in Figures 3 and 4, boiler slag represents a very small fraction of the total CCBs produced in the United States (about 2%), yet a disproportionately high percentage of the total beneficial use of CCBs.

3.2 Characteristics of Boiler Slag

Figure 5
Boiler Slag Photo

Photo from ACAA.[7]

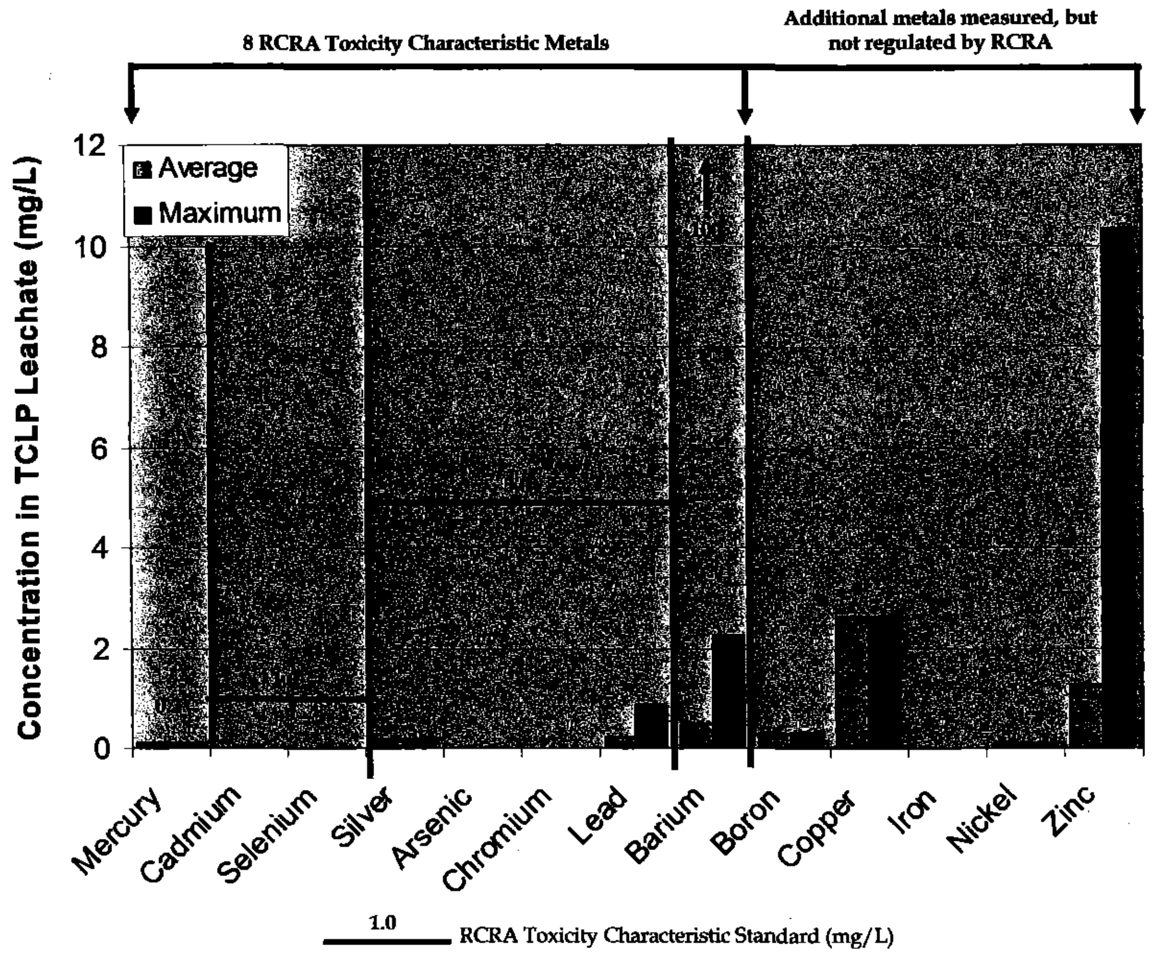
The physical appearance of boiler slag is black angular particles that have a smooth, glassy surface and are about the size of medium to coarse sand {Figure 5). The large particle size (relative to fly ash) and vitrified nature means that boiler slag is much less susceptible and virtually inert to leaching when in contact with water.[11]

The precise chemical composition of boiler slag depends upon the composition of the coal burned. The three primary components of boiler slag are: silica, aluminum, and iron. These components make up 60% to 90% of the total composition of boiler slag. Calcium, magnesium, sodium, potassium and titanium make up the majority of the remaining composition along with small amounts of sulfate and other metals.[10, 11]

Hazardous wastes, as defined by EPA, fall under two large groupings: characteristically hazardous wastes and listed hazardous wastes. Characteristically hazardous wastes test positive for ignitability, corrosivity, reactivity, or toxicity.[14] The Toxicity Characteristic Leaching Procedure (TCLP) test is the threshold test used by EPA to determine whether solid materials must be managed as a hazardous waste due to the presence of toxic metals or chemicals.

TCLP tests of boiler slag have repeatedly shown that boiler slag *is not* characteristically hazardous. This is illustrated by Figure 6, which shows the TCLP results for representative samples of boiler slag. None of the boiler slag samples tested exceeds the TCLP regulatory limit. In fact, of the regulated metals, cadmium, arsenic, and chromium did not leach at all. Using EPA's own regulated threshold to determine if a waste is to be managed as hazardous or non-hazardous, the TCLP tests demonstrate that boiler slag is *not* characteristically hazardous.

Figure 6
TCLP Analysis of Representative Boiler Slag Samples



Listed hazardous wastes are specifically categorized as hazardous wastes, often based upon the processes by which they are generated or used. The following criteria are used by EPA to determine if wastes should be listed hazardous wastes:

- Wastes that typically contain harmful chemicals or other factors that could pose a risk to human health or the environment without special regulation (toxic listed wastes);

- Wastes that contain chemicals that could pose a threat to human health or the environment even if properly managed (acutely hazardous wastes);
- Wastes that typically exhibit one of the four characteristic hazardous waste characteristics;
- Wastes that EPA believes for some other reason fits within the statutory definition of hazardous waste developed by Congress.[14]

A determination by EPA that boiler slag is a hazardous waste would effectively lump and stigmatize this valuable resource with wastes that are clearly hazardous and have been vetted thoroughly through EPA's listing process before final ruling. For example, electroplating and metal finishing wastes are listed as hazardous wastes. These wastes can typically consist of more than 90% of the heavy metals chromium, nickel and zinc. In contrast, 85% to 99% of the composition of boiler slag is made up of amorphous silica and oxides of aluminum, iron, calcium, potassium, and magnesium, which are not heavy metals.[15]

Table 1 illustrates the stark difference in chemical makeup between these industrial wastes and boiler slag. Table 1 lists some typical metals concentrations found in electroplating and metal finishing wastes as compared with typical concentrations of the same metals in boiler slag. Clearly, although metals may be present within boiler slag, they are present at negligible levels compared to these listed hazardous wastes. Just as importantly, exhaustive testing of boiler slag has shown that its vitrified state renders it virtually *inert and non-hazardous* as indicated by the TCLP leaching results shown in Figure 6.

Table 1
Bulk Analysis of Boiler Slag vs Bulk Analysis of Electroplating and Metal Finishing Hazardous Wastes

Metal	Range of Concentrations reported for Electroplating/Metal Finishing Waste[16, 17]	Range of Concentrations Reported for Boiler Slag[18]
Arsenic	No data available	ND – 2.1 ppm
Beryllium	No data available	0.28 ppm – 6.30 ppm
Cadmium	No data available	ND – 0.06 ppm
Chromium	300 ppm – 254,000 ppm	ND – 55 ppm
Lead	27.6 ppm – 766 ppm	0.53 ppm – 6.80 ppm
Nickel	100 ppm – 224,000 ppm	ND – 44 ppm
Zinc	100 ppm – 474,000 ppm	ND – 137 ppm

ND – not detected in materials analyzed.

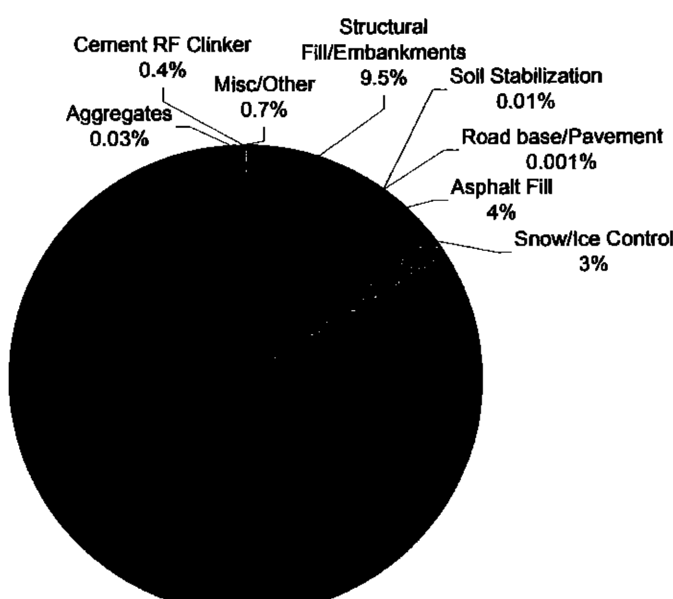
3.3 Beneficial Uses of Boiler Slag

The inert physical and chemical characteristics of boiler slag make it an ideal material for certain uses that are in wide demand throughout the US. Of all the types of CCBs produced, boiler slag has the highest percentage of use reported by industry at greater than 90%.[1] The ACAA notes that the most significant barrier to boiler slag use is availability, because not all types of coal-fired boilers produce this material. In fact, the slag-tap and cyclone boilers are being phased out of operation because of the cost to comply with existing air emissions standards for nitrous oxides (NO_x). As a result, the percentage of boiler slag beneficially used compared to its generated volume will increase because future production will decreases as cyclone boilers are phased out of operation.[11]

The reuse of boiler slag conserves natural resources, reduces the need to use more expensive raw materials, reduces the generation of greenhouse gasses, and provides tremendous economic benefit to the respective industries and cost savings to local jurisdictions. By far, the largest use of boiler slag is the production of blasting grit and roofing granules (Figure 7).[7] Boiler slag is very durable when exposed to the weather, making it excellent for use as granules in roofing shingles as it protects the shingles, and gives them weight and strength. As noted previously, *80%* of the commercial and roofing shingles in the US contain boiler slag.[1] Roof repairs or replacements that generate roofing shingles would have to manage these "waste shingles" as hazardous waste if EPA ruled that CCBs are subject to Subtitle C regulations. This would create a tremendous economic cost to the industry, and homeowners faced with replacing or repairing roofs.

Boiler slag is also an ideal material for blasting grit because of its amorphous silica composition. The hard angular shape of the boiler slag particles makes for very good cutting surfaces.[9] Notably, natural abrasive materials generally contain crystalline silica, which has been shown to cause silicosis. The use of boiler slag in lieu of other crystalline sand-based abrasives is protective of workers as it eliminates exposure to respirable crystalline silica dust and silicosis.

Figure 7
2007 Boiler Slag Use



Data Source: ACAA, 2008.[6]

Boiler slag is also commonly used as mineral filler in asphalt because its resistance to high temperatures make it resistant to degradation; also the angular particle shape reduces vehicle skidding on roads. Boiler slag's load bearing and compaction characteristics, combined with its relatively large particle size also make it an excellent material for drainage layers in embankments. Finally, the dark color and angular shape of the particles make boiler slag a useful addition to snow and ice road treatments to increase traction for vehicles and melting of ice in sunlight.[10, 11] Unlike salt and other road treatment chemicals that melt completely, boiler slag is essentially inert and does not adversely affect the quality of storm water runoff that can result from other road chemicals. The use of boiler slag for road treatments is particularly important to the small townships and boroughs across the US as it provides a significant cost savings to these jurisdictions compared to having to purchase, store and apply salt. Listing boiler slag as a hazardous waste would dramatically increase costs for these jurisdictions, requiring the need to raise more revenue to off set the costs, for example, by raising property taxes.

4.0 REGULATORY CONSIDERATIONS

Public awareness of CCB management across the Country has been heightened recently as a result of the release of 3.1 million cubic feet of fly ash and water from a surface impoundment in Kingston, Tennessee in December 2008. This catastrophic event, however, was caused not by the inherent characteristics of the ash but by the failure of the surface impoundment dike that contained the CCBs and water. There has never been any such incident related to the management of boiler slag reported in the literature or by regulatory agencies, or evidence that the management or beneficial use of boiler slag has resulted in adverse impacts to ground water.

Nonetheless, there is an acknowledged need within industry to protect human health and the environment from the improper management and handling of CCBs. A review of cases in which CCBs have caused damage to ground and surface water quality reveals that the majority of these cases can be attributed to poor management practices including placement of fill materials below the water table and the lack of appropriate liners.[19] In recent years, a number of states have begun to voluntarily regulate CCB fill activities under non-hazardous RCRA Subtitle D type regulations.[20] The experiences of these states shows that Subtitle D disposal criteria, when applied to CCBs and enforced, are fully protective of human health and the environment. Subjecting CCB management to Subtitle C regulations would not be any more protective of human health and the environment than Subtitle D regulations.

4.1 Background

The 1980 Bevill Amendment to RCRA excluded CCBs from classification as hazardous waste but required that EPA research the potential risks posed by these materials. Since then, the EPA on *four* separate occasions declared that CCBs do not warrant regulation as a hazardous waste. Most recently, in 2000 EPA published a regulatory determination that CCBs (and other fossil fuel combustion by-products) should not be regulated as hazardous wastes. The 2000 determination also stated that non-hazardous (Subtitle D) standards should be followed for CCB surface impoundments, landfills and mine fills but that no further regulations were required for beneficial uses of CCBs (other than mine filling).[3]

In a 2006 survey, the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) found that the majority of states have some form of permitting and regulation program for CCB landfills and surface impoundments. The majority of these states with permitting programs regulate CCBs under general solid waste or industrial (i.e. non-hazardous) waste guidelines and many have regulations for CCB fills and surface impoundments that are consistent with federal Subtitle D requirements (Table 2).[19]

This survey while only a few years old, still does not reflect all of the recent changes that have occurred at the State level. Maryland, for example, has published new CCB regulations, effective 1 December 2008 that provide the regulatory framework for CCB disposal and use in mine reclamation.[21] Although Maryland *does not* support regulation of CCBs as hazardous waste, these new regulations provide a regulatory framework for the disposal of CCBs and the use of CCBs for mine reclamation.[22] Specifically, Maryland now requires that all CCB disposal facilities need to meet the same standards required for industrial solid waste landfills. Under Maryland's new regulations, disposal facilities are required to address leachate collection, perform ground water monitoring, use liners, and perform routine analysis of CCBs. A CCB disposal facility will need to be sited in conformance with all local zoning and land-use requirements as well as the respective county's ten-year solid waste management plan.[21]

Table 2
Percentage of States With CCB Landfills and Surface Impoundments With Specific Regulatory Requirements

Regulatory Requirement	Required for Landfills	Required for Surface Impoundments
Bottom Liner	64%	33%
Ground Water Monitoring	81%	39%
Leachate Collection	52%	14%
Final Cover System	79%	36%
Post Closure Care	79%	39%
Siting Controls	83%	42%
Corrective Action	86%	42%
Structural Stability	69%	36%
Financial Assurance	69%	31%

Data Source: ASTSWMO, 2009.[20]

Maryland's new regulations also address coal and non-coal mine reclamation sites. The use of CCBs in non-coal mines will need to meet standards similar to those required for industrial solid waste landfills. The new standards for coal mine reclamation stipulate that only alkaline CCBs are used. For both disposal and mine reclamation sites, dust control measures must be implemented and post closure monitoring and maintenance must be performed.[21]

4.2 EPA's Current Proposal

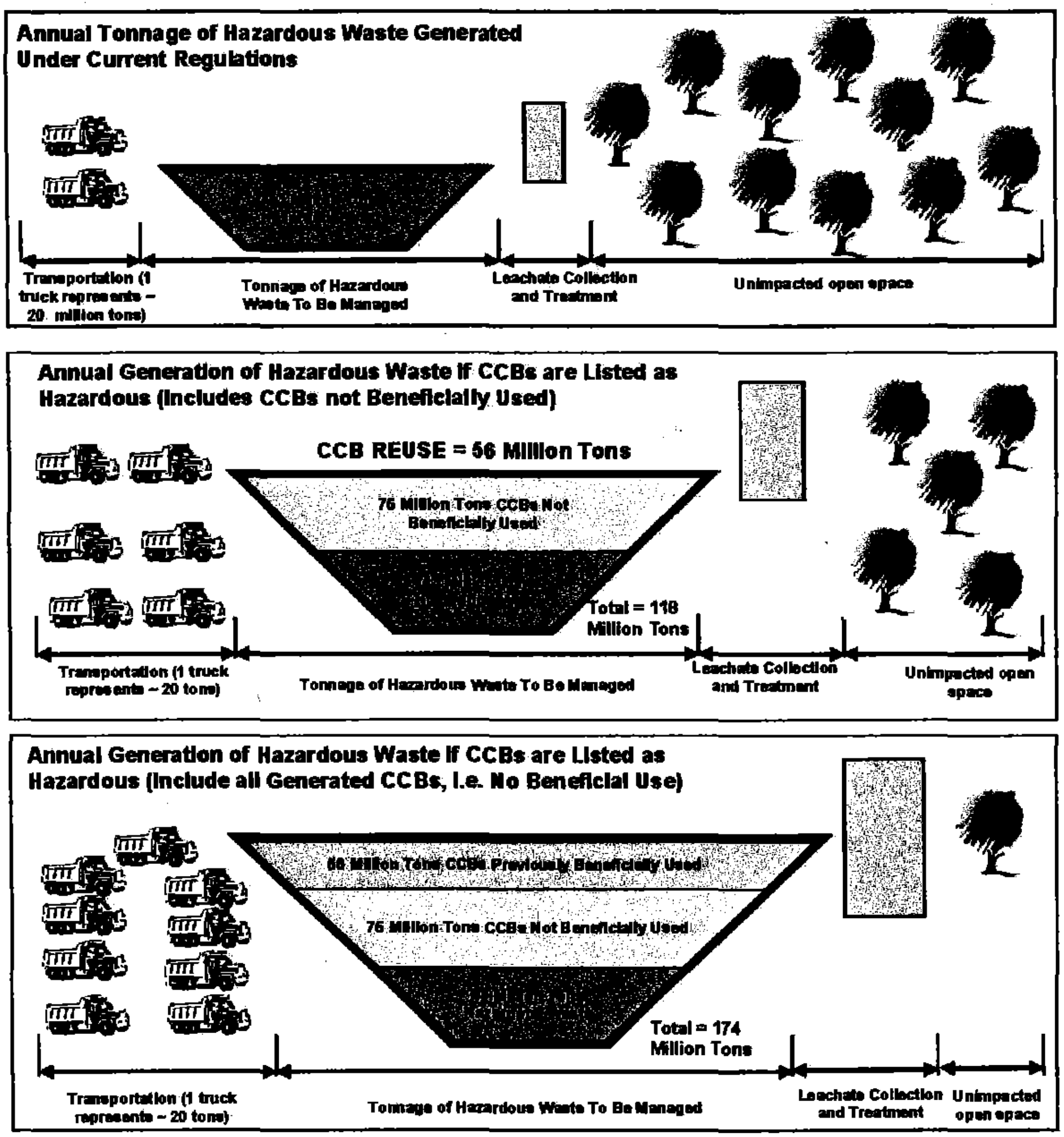
EPA is considering specifically listing CCBs as hazardous wastes, subject to RCRA Subtitle C, in spite of the fact that boiler slag and CCBs do not meet the hazardous waste characteristics of toxicity, corrosivity, reactivity, or ignitibility.[2, 3] Although it is likely that that certain beneficial uses of CCBs would be excluded from Subtitle C regulation, this arrangement still poses significant problems:

- CCB generators and users will both be subject to additional, financial burdens related to transportation, licensing, manifesting, containment, and monitoring of these materials;
- A new (and voluminous) waste stream will be added to state hazardous waste management programs that are already struggling to manage existing waste streams;
- Extensive re-permitting and retrofitting will be necessary for existing and in-use CCB storage and fill facilities (some of which are already Subtitle D compliant);
- Beneficial use of CCBs will decrease dramatically, further increasing the volume of the new hazardous waste stream because of the following:
    - Many state regulations strictly regulate or prohibit the beneficial use of materials classified as hazardous waste;
    - A hazardous waste label on CCBs as a raw material will make them less attractive to manufacturers and potential users;
- The drop in beneficial use will have the secondary impacts of increasing demand for landfill space and mineral natural resources. In addition, an opportunity for reducing CO_2 emissions from the production of Portland cement will be lost;
- The inability of manufacturers to use CCBs as raw materials may lead to the use of materials that are inferior in performance or safety (i.e. the use of natural abrasives containing crystalline silica which can cause silicosis rather than amorphous silica-containing boiler slag);
- CCB-containing products (i.e. shingles, used abrasives, wallboard, and concrete blocks) may also fall under the hazardous waste classification when being discarded;

- The costs of electrical generation will increase as power generators must spend additional dollars in their handling and disposal of CCBs; these increased electric generation costs will almost certainly be passed on to consumers in higher electricity rates. The disposal of boiler slag alone as a hazardous waste would increase costs to rate payers by approximately $520,000,000 annually at an estimated disposal cost of $200 per ton[23].

Figure 8 illustrates the potentially detrimental effect of regulating CCBs as RCRA

Figure 8
Impacts to Subtitle C Waste Management System and Natural Resources if CCBs are Regulated as a Hazardous Waste



Data Sources: ACAA, 2008[7] and EPA,2008[24]

Subtitle C hazardous waste. Currently, 43 million tons of materials are managed annually as a hazardous waste.[24] Under EPA's proposed ruling, this would increase substantially as that proportion of CCBs not currently beneficially used would require landfilling. This would increase the amount of materials to be managed as hazardous waste by *75 million tons annually.* As a point of reference, this is equivalent to 3,750,000 20-ton trucks on the Country's roads transporting CCBs from coal fired powered plants to Subtitle C landfills. The incremental increase in disposal cost is estimated as $150 per ton as a hazardous waste compared to disposal as a non-hazardous waste (approximately $200 per ton disposal cost for hazardous waste in a Subtitle C facility versus an estimated $50 per ton disposal of non-hazardous waste in a Subtitle D facility). This would equate to an incremental cost increase to the utility industry, and ultimately customers and rate payers, of more than *$11 billion annually* (75 million tons times $150 per ton).

However, as noted previously, the increase in landfilling due to CCBs being listed as a hazardous waste would most likely be far greater than 75 million tons annually, as the demand for beneficial uses will dramatically decrease in face of the issues bulleted above. Taking this projection to its extreme, if all CCBs were landfilled in Subtitle C landfills, the tonnage of hazardous waste would increase by approximately 131 million tons per year at an incremental annual cost increase of almost *$20 billion.*

5.0 CONCLUSIONS

The beneficial use of CCBs, including boiler slag, is a healthy, environmentally beneficial industry that results in reduced volumes of material being landfilled, reduced consumption of natural resources, reduced CO_2 emissions, and increases green jobs. The beneficial use of boiler slag is protective of US workers as it eliminates worker exposure to crystalline silica and potential silicosis when used as an abrasive grit.

The nationwide beneficial use of CCBs is approximately 40% (52 million tons), and use of boiler slag is even higher at 90% reuse. Regulation of these materials as hazardous waste will *dramatically reduce* the demand for beneficial using these materials and will at the same time *dramatically increase* the volume of materials that will have to be handled by Subtitle C landfill facilities. As noted above, if all CCBs were landfilled in Subtitle C landfills, the tonnage of hazardous waste would increase by approximately 131 million tons per year at an incremental annual cost increase of almost *$20 billion.*

Notably, approximately 20 states throughout he Country *and* the ASTSWMO have notified EPA of their belief that the best management option for regulating CCBs is pursuant to RCRA Subtitle D non-hazardous regulations *and not* Subtitle C hazardous waste regulations.[20] This view was reflected most recently by Shari Wilson, Secretary of the Maryland Department of the Environment (MDE), responsible for developing Maryland's new CCB regulations. Appearing in front of Congress, Ms. Wilson told the subcommittee that Maryland would prefer to have CCBs regulated under RCRA Subtitle D, adding that Maryland fears that Subtitle C regulations would discourage the beneficial use of CCBs.[22] Just as importantly, regulating CCBs as a Subtitle C hazardous waste would not be any more protective of human health or the environment than regulating these materials under Subtitle D as a non-hazardous waste. Subtitle D regulations provide the added benefit of not representing a barrier to industry and end users for the beneficial use of these resources.

6.0 REFERENCES

1. Personal Communication. Michael Carpinello to Leonard Rafalko. 7 August 2009.

2. United States Environmental Protection Agency (EPA). Report to Congress: Wastes from the Combustion of Coal by Electric Utility Power Plants. EPA/530SW88002. 1988.

3. EPA. Regulatory Determination on Wastes from the Combustion of Fossil Fuels; Final Rule. May 2000.

4. American Coal Council. The Value of Coal Combustion Products: An Economic Assessment of CCP Utilization for the US Economy, prepared by Power Products Engineering, Eden Prairie Minnesota, 2006.

5. American Coal Ash Association (ACAA) and the Coal Combustion Products Partnership (C^2P^2). Letter to Mr. Matt Hale, Director, Office of Resource Conservation and Recovery, USEPA, from Mr. Thomas H. Adams, Executive Director of the Coal Combustion Products Partnership, 25 March 2009.

6. Energy Information Administration (EIA). Official Energy Statistics from the U.S. Government: Net Generation by Energy Source: Total (All Sectors). EIA, July 2009.

7. ACAA. 2007 Coal Combustion Product (CCP) Production and Use (Revised). ACAA 2008.

8. EPA. Handbook: Vitrification Technologies for Treatment of Hazardous and Radioactive Waste. EPA/625/R-92/002. May 1992

9. United States Geological Survey (USGS) and ACAA. Coal Combustion Products Factsheet. FS-076-01. August 2001.

10. Recycled Materials Resource Center (RMRC). User Guidelines for Byproducts and Secondary Use Materials in Pavement Construction. www.rmrc.unh.edu/tools/uguidelines/cbabs1.asp RMRC, last updated July 2008.

11. ACAA. Resource Bulletin: RB-23: Boiler Slag. ACAA, 2004.

12. EPA. http://www.epa.gov/waste/partnerships/c2p2/use/benefits.htm USEPA, Last updated May 2009.

13. CalStar Products. Open Letter to Matt Hale, EPA Director of Solid Waste. 31 March 2009.

14. EPA. Introduction to Hazardous Waste Identification. EPA530-K-05-012. USEPA, 2005

15. National Institute for Occupational Safety and Health (NIOSH). Nomination of Abrasive Blasting Agents for Chronic Inhalation Studies in Rats. NIOSH, 2001.

16. Magalhaes, J.M., Silva, J.E., Castro, F.P., and Labrincha, J.A. Physical and Chemical Characterisation of Metal Finishing Industrial Wastes. Journal of Environmental Management, Vol. 75, pp. 157-166. 2005.

17. Venkateswaran, P., Vellaichamy, S., and Palanivelu, K. Speciation of Heavy Metals in Electroplating Industry Sludge and Wastewater Residue Using Inductively Coupled Plasma. International Journal of Science and Technology. Vol. 4, pp. 497-504. 2007.

18. KTA-Tator, Inc. Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting. Prepared for NIOSH by KTA-Tator. March 1999.

19. EPA. Coal Combustion Waste Damage Case Assessments. USEPA, July 2007.

20. Association of State and Territorial Solid Waste Management Officials (ASTSWMO). Letter to Matt Hale, EPA. 1 April 2009.

21. Maryland Department of the Environment (MDE) November 2008. Facts About Regulations on Coal Combustion By-Products. MDE,

22. Rickman, Jonathan. EPA Preparing Regulations for Coal Plant Ash. Coal Power Magazine. 29 May 2009.

23. Wiley's Remediation Technologies Handbook: Major Contaminant Chemicals and Chemical Groups by Jay H. Lehr, John Wiley & Sons, Inc. - 2004 - Technology & Engineering - 1271 pages.

24. EPA. National Analysis: The National Biennial RCRA Hazardous Waste Report (Based on 2007 Data). EPA, 2008.