ECONOMIC AND ENVIRONMENTAL ANALYSIS OF PENNYSLVANIA'S COAL REFUSE INDUSTRY

FINAL REPORT
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Overview

Pennsylvania's historic coal industry, which played a critical role in the development of the United States into a global economic and military power, has left the current citizens of the Commonwealth with a legacy of environmental degradation, in the form of hundreds of thousands of acres of abandoned mine lands, hundreds of millions of tons of abandoned coal refuse, and attendant environmental problems, including uncontrolled burning of the piles with uncontrolled emissions and contamination of the Commonwealth's water resources with acid runoff and sedimentation. The Commonwealth's inventory (which is acknowledged to be non-comprehensive) has identified 840 piles of coal refuse, low quality coal and other material discarded by original mining operations, scattered across the Commonwealth's anthracite and bituminous regions. The Commonwealth possesses neither the fiscal capacity nor the capability to address these piles and their attendant environmental and safety hazards in a complete and holistic fashion.

In the 1980s, a new technology allowed for the emergence of an industry that addresses this legacy environmental challenge by utilizing this coal refuse to produce and sell energy. A byproduct of this energy generation process, "beneficial use ash," is then used to remediate mining sites. This fuel cycle approach changed the economic structure of coal refuse pile reclamation by generating revenue to offset removal and transportation costs, generating a byproduct for use in remediation, and alleviating the need for the costly removal and disposal of unused coal refuse. This model has allowed Pennsylvania's coal-refuse-to-energy plants to remove and use more than 200 million tons of coal refuse, improve or restore more than 1,200 miles of polluted streams, and reclaim more than 7,000 acres of land over more than two decades of operations.[1] In addition to their environmental benefits, and the millions they have saved the Commonwealth in cleanup costs, these plants are also major economic engines and employment hubs within the Commonwealth, and serve as anchors in the rural communities where they are located.

Today, however, marketplace and regulatory challenges impair the ability of the coal-refuse-to-energy plants to continue to deliver these benefits to the Commonwealth. Dramatic increases in the development and production of low cost natural gas in the Marcellus Shale region, along with annual reductions in electrical usage in the PJM region, have contributed to a steep decline in wholesale energy prices, which fell 73% from Q1 2014 to Q1 2016. At these levels, revenues no longer cover costs for coal refuse plants, forcing dramatic cutbacks in coal refuse consumption and energy production levels. Coal-refuse-to-energy plants are projected to remove and use about 5 million tons of coal refuse in 2016, approximately half of the annual amount removed and used during 2010 – 2014. The current economics of electricity production using coal refuse as

[1] Historical activity levels are provided by industry trade association ARIPPA (Anthracite Region Independent Power Producers Association)

fuel are unsustainable over the long-term, and will ultimately lead to layoffs and plant closures absent any change.

These economic realities threaten the ability of coal refuse-fired plants to continue to deliver the range of economic and environmental benefits to the Commonwealth. However, the coal-refuse-to-energy cycle remains the most cost-effective environmental reclamation and remediation program, particularly relative to publicly financed options, with significant positive externalities for the state. The report that follows quantifies and details the environmental, economic, fiscal and community benefits associated with the coal refuse industry and its activities.

Environmental and Public Benefits

The inventory of refuse piles kept by the Commonwealth's Bureau of Abandoned Mine Reclamation, which is acknowledged to be non-comprehensive, identifies 840 piles throughout the Commonwealth, which are estimated to consist of nearly 300 million tons of coal refuse and to cover nearly 10,000 acres. These coal refuse piles cause numerous environmental and public safety hazards, depress property values, and prevent land from being returned to productive use.

The environmental activities of the coal-refuse-to-energy industry deliver benefits and reduce costs to the Commonwealth and its residents across a number of categories. At historic operating levels, the industry removes and uses 10 million tons of coal refuse and reclaims and remediates 200 acres per year, improving numerous waterways and groundwater resources in the process. Further, many of these benefits compound over time, with remediated areas continuing to deliver benefits in terms of increased safety and avoided costs to state and local government on an ongoing basis.

- These activities would yield quantifiable benefits in terms of air and water quality, public safety, and land value estimated to total nearly $6 million in year one.
- Benefits are estimated to grow to nearly $47 million in year 20, totaling more than $520 million and averaging $26 million annually over that twenty year period.

The valuation framework utilized in this analysis includes a mix of avoided costs, societal benefits, and land value impacts attributable to industry at historic activity levels. This framework recognizes that simply "doing nothing" in the absence of the industry efforts does not eliminate the costs or impacts of Pennsylvania's legacy coal refuse problem.

Economic and Employment Benefits

The coal refuse industry provides significant economic activity and employment within the Commonwealth. The activities of the industry generate jobs across the fuel cycle, including remining, transportation, plant operations and management, and environmental remediation. Wages are family-sustaining, averaging more than $70,000 for direct plant employees. Further, these direct expenditures have indirect and induced "multiplier" effects within the Commonwealth economy, as suppliers and employees of the industry re-spend dollars that rippled through a variety of sectors.

- At historic operating levels, the industry generates an annual economic impact of nearly $740 million.
- This activity directly and indirectly supports 3,600 jobs, with total annual earnings of more than $220 million.

Fiscal Benefits

Increases in economic activity are associated with significant increases in the tax base for the Commonwealth of Pennsylvania, as well as for local municipalities and jurisdictions. Further, employment supported by the industry reduces the need for state expenditures such as social services and public safety.

- At historic operating levels, this activity is estimated to generate nearly $20 million in annual taxes and fees for the Commonwealth of Pennsylvania through sales, income and business taxes and environmental taxes and fees.

Contribution to Rural Communities

The environmental and economic benefits are particularly salient given their concentration in the rural communities of Pennsylvania's coal regions. Many of the areas containing the greatest concentrations of abandoned mine lands and coal refuse piles not only face the environmental legacy of decades of coal production, but have struggled to provide economic opportunities to residents as the state and national economy have shifted away from the industries concentrated in those regions. The coal refuse industry provides community anchors for small towns in these areas in several ways:

- Plants provide a major hub of employment activity, with their activities directly and indirectly supporting a range of employment at a variety of skill levels;
- Their environmental reclamation and remediation activities improve quality of life for local residents by reducing blight, improving public health and safety and restoring recreational and scenic value;
- They serve as major contributors to the local tax base to support government services, through the direct value of their properties and through the economic stimulus and quality of life improvements they engender;
- They make significant investments in the community through public-serving infrastructure improvements, as well as contributions through scholarships, educational services and donations.

1.0 INDUSTRY OVERVIEW

Pennsylvania's coal industry played a formative role in the development of the United States into a global economic and military power in the 19th and 20th centuries, powering the factories, railroads, and ships of the industrial revolution. The Commonwealth was the nation's leading coal producer from the 1870s to the 1930s and its coal resources played an integral role in both World Wars.[2] The legacy of this essential national resource has been left to the current citizens of Pennsylvania, in the form of hundreds of thousands of acres of abandoned mine lands, millions of tons of abandoned coal refuse, and attendant environmental problems.

In the 1980s, new technology allowed for the emergence of an industry that addresses this legacy environmental challenge by utilizing the discarded coal refuse to generate energy, and generating "beneficial use" ash to remediate the mining sites. Over the past three decades, the 14 plants that currently make up Pennsylvania's coal refuse industry have turned thousands of acres of dangerous coal refuse piles into rehabilitated land, while providing employment opportunities and economic impact in Pennsylvania's rural communities through their operations. These activities have saved the state millions in cleanup costs while generating privately supported employment and tax revenues. Today, however, regulatory and marketplace changes threaten the viability of these plants, and their ability to remain positive environmental and economic contributors to the Commonwealth. The regulatory and marketplace challenges facing the industry have already led to the closure of two plants – the Piney Creek Power Plant in Clarion, PA the Archbald Power Plant in Archbald, PA.

1.1 PUBLIC BENEFITS OF THE COAL REFUSE INDUSTRY

This report identifies the broad types of benefits delivered by the coal refuse industry – for the environment, public health and safety, economic impact, and the communities where plants are located. In addition, it details the costs that the Commonwealth avoids – both economically and environmentally – by having mine reclamation carried out by private industry, rather than through public funds. It is organized in six sections:

- Section 1: Industry Overview reviews the genesis of Pennsylvania's coal refuse industry, describes categorically its benefits to the state, and discusses the current state of the industry and the regulatory and marketplace challenges that it faces.

- Section 2: Environmental and Public Benefits describes the major categories of economic benefits that the remediation of coal refuse sites undertaken by the industry creates.

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[2] Wartime coal powered the production and transportation of weaponry, supplies, and equipment. Coal production declined during the 1930s, as the Great Depression stalled industrial development, but it again played a vital role during World War II. In 1944, almost 209 million tons of Pennsylvania coal were mined and used to the War effort (source: Commonwealth of Pennsylvania: Department of Conservation and Natural Resources. *Educational Series)*

- Section 3: Valuation of Environmental Benefits quantifies the value of these environmental benefits in terms of the cost to the state to undertake similar remediation efforts itself, and alternately in terms of the costs to the state of doing nothing and the fiscal and environmental costs of the attendant negative impacts.

- Section 4: Economic Benefits measures the direct economic footprint of the industry, and the indirect and induced economic impacts resulting from its activity, including employment and fiscal impacts

- Section 5: Community Benefits describes the central role of industry in rural communities, including the range of employment opportunities it provides and its contributions to the local tax base, supporting schools, as well as the local environmental, recreation, safety and property value benefits resulting from remediation activities.

- Section 6: Summary of Benefits aggregates and reports the major benefits calculated and described throughout the report.

1.2 PENNSYLVANIA'S COAL MINING LEGACY

Decades of teeming coal production and the industry's subsequent decline have left a hazardous legacy in the state. In 1918, at the peak of World War I, Pennsylvania's 330,000 miners produced more than 227 million tons of coal. The industry shrank considerably following World War II, and by the 1960s, annual coal production in the Commonwealth dropped to 80 million tons. By 2014, the total had fallen to 61 million tons – less than a quarter of the peak production volume.[3]

As coal mining productivity decreased, more than 5,000 mines in Pennsylvania were closed and abandoned. When these mines were abandoned, they left 184,000 acres of abandoned mine lands behind, including more than 9,500 acres of coal refuse piles. Coal refuse, also known as waste coal, is low-energy coal. In the early decades of coal mining, mines sorted high- and low-energy coal, selling the usable high-energy coal and leaving the low-energy coal in piles on mine sites.

The sheer volume of coal refuse piles in Pennsylvania is due to the fact that the state's most productive mining decades occurred prior to the era of comprehensive environmental regulations. Since the Surface Mine Control and Reclamation Act (SMCRA) of 1977 was passed, active mine companies have been required to reclaim the sites they mine, but these regulations were put in place too late to assign legal responsibility for the already-abandoned mines.[4]

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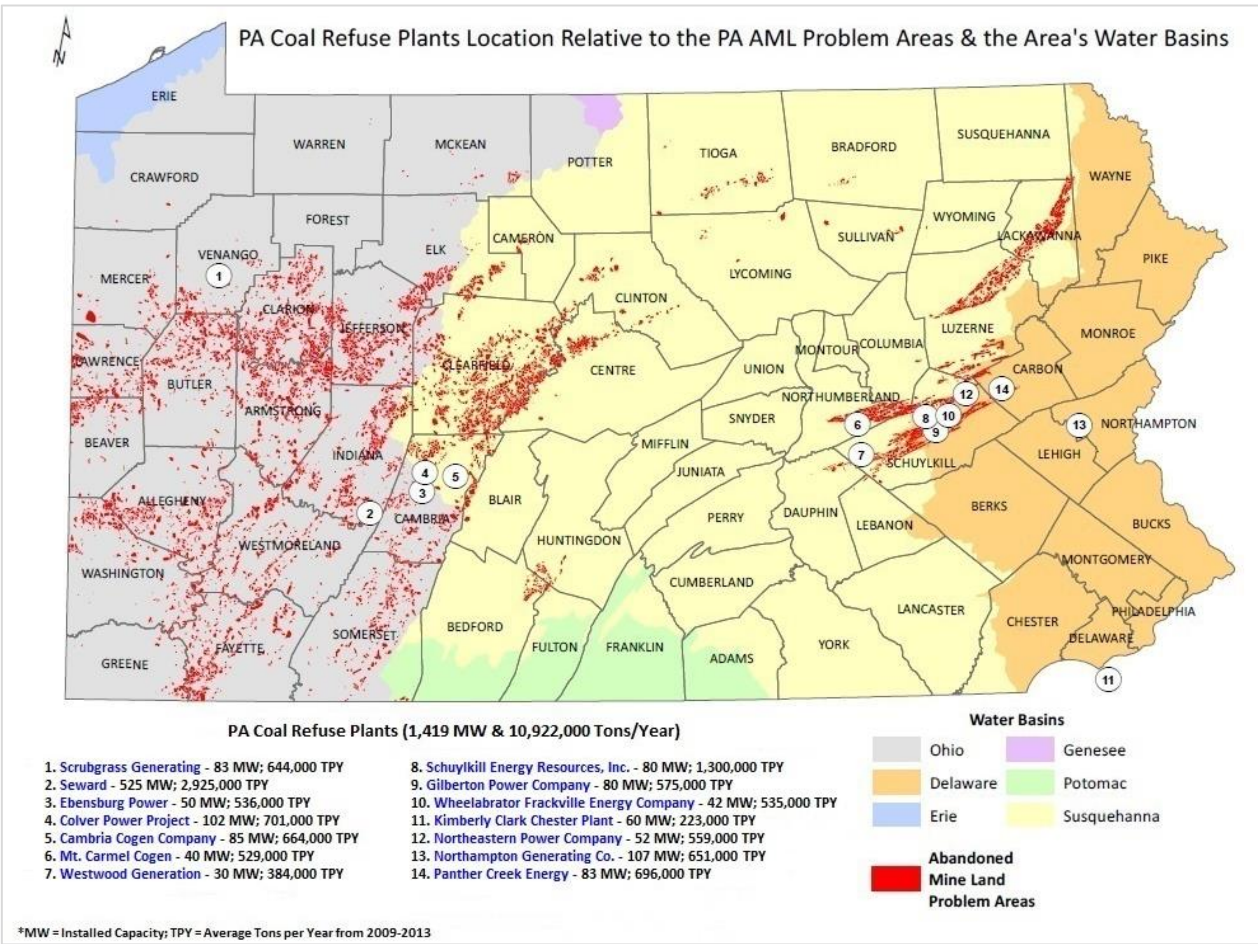
[3] Commonwealth of Pennsylvania: Department of Conservation and Natural Resources. *Educational Series*.

[4] It should be noted that under Pennsylvania's Surface Mining Conservation and Reclamation Act, which predates the federal SMCRA, Pennsylvania was considered a leader in the regulation of coal mines. Many components of the federal SMCRA were

Pennsylvania, in particular, was impacted by the timing of SMCRA. Prior to 1977, the Commonwealth had produced a third of all coal mined in the United States – leaving refuse piles scattered across Western and Northeastern Pennsylvania. Despite remediation efforts by the Commonwealth and in particular the coal refuse industry over the past three decades, the most recent estimates from Pennsylvania's Bureau of Abandoned Mine Reclamation (BAMR) (which are acknowledged to be non-comprehensive) identify 840 coal refuse piles across the Commonwealth. These coal refuse piles generate a range of environmental and safety hazards, directly affecting residents in at least 44 of the Commonwealth's 67 counties (see Figure 1.1). Coal refuse piles are scattered throughout both the bituminous coal area in Western Pennsylvania, and the anthracite region in Northeast Pennsylvania. Figure 1 also shows how the fourteen coal refuse plants are strategically located in close proximity to the state's coal refuse piles so as to efficiently reclaim these sites with nearby fuel sources.

FIGURE 1.1 – MAP OF ABANDONED MINE LAND (AML) AND COAL REFUSE PLANTS IN PENNSYLVANIA



Source: ARIPPA (2016)

modeled off of the Pennsylvania statute, and therefore in many respects the Pennsylvania coal industry was operating under similar regulatory guidelines prior to 1977.

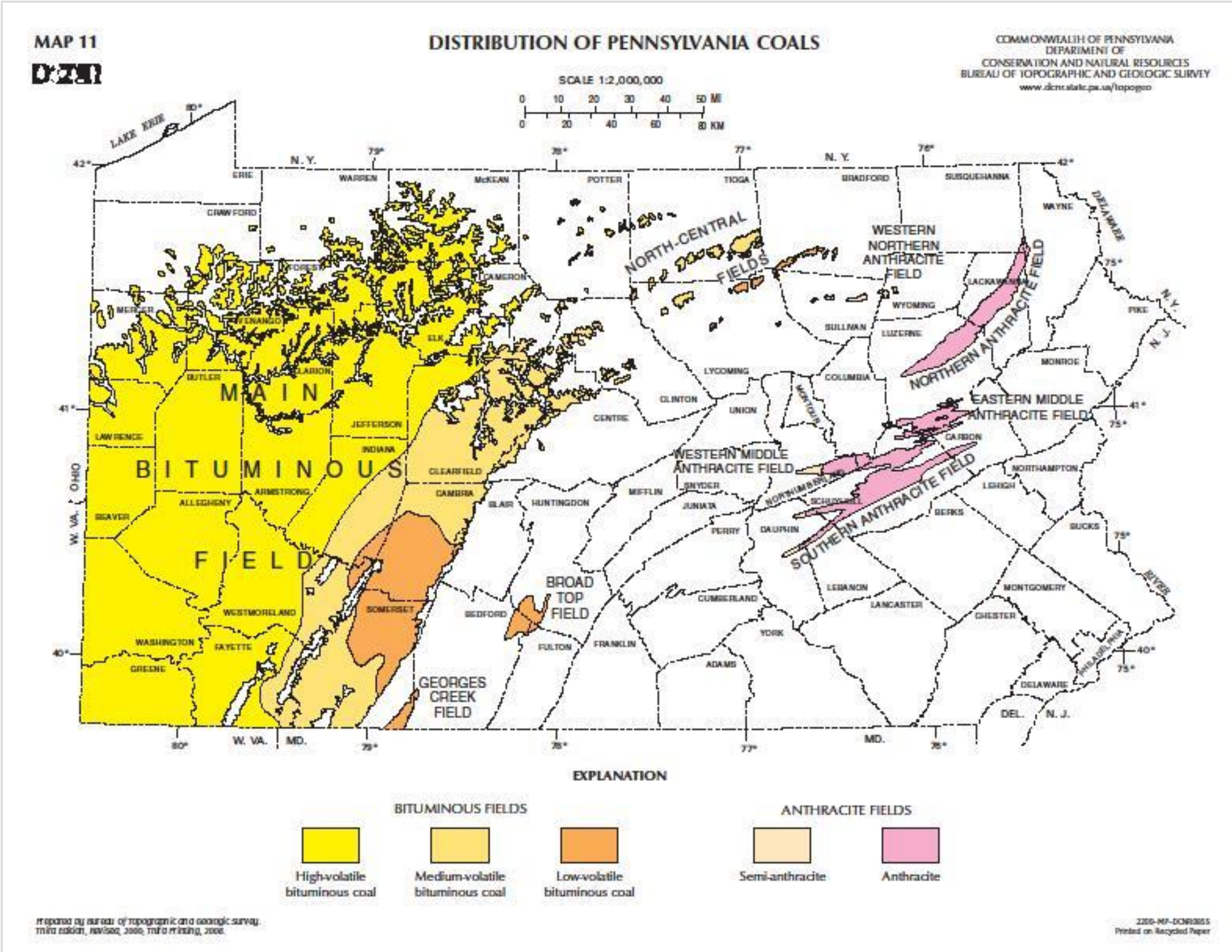
1.3 DEVELOPMENT OF PENNSYLVANIA'S COAL REFUSE INDUSTRY

Technological advancements in the 1970s and 1980s led to the development of a process for the environmental remediation of coal refuse piles through their use as an energy source. Circulating fluidized bed boilers (CFB) are used to burn coal refuse as fuel. CFB units utilize fluidization technology – the burning of solid materials in a low temperature, and turbulent combustion process – to mix coal refuse with pulverized limestone. They also produce an alkaline byproduct (coal ash) that is used to reclaim mine lands and remediate the acidic impact of refuse.

The low-burning temperature minimizes nitrogen formation and the combination of limestone and coal refuse captures sulfur through chemical reactions and collection in the fabric filter collection pollution control devise (baghouse). Finally, the heat generated by the burning process produces steam that fuels electric generators. The revenue from electrical generation made the remediation process (fuel cycle) economically viable at the time the plants were constructed, covering the cost to remove hazardous refuse, remediate soil acidity, and restore mine sites for recreational and commercial use.

The process is effective for both anthracite and bituminous coal refuse. Anthracite, or "hard" coal, is found in the Northeast region of Pennsylvania. Bituminous, or "soft" coal, is found in Western Pennsylvania (Figure 1.2). Both anthracite and bituminous coal mining produce low-energy coal refuse – known as "culm" in the anthracite region and "gob" or "boney" in the bituminous region.

FIGURE 1.2 – DISTRIBUTION OF BITUMINOUS AND ANTHRACITE COAL IN PENNSYLVANIA



Source: Pennsylvania Department of Conservation and Natural Resources (2015)

Prior to the development of CFB technology, which enabled the economical burning of low grade fuel, there was no productive use for coal refuse. Remediation of piles was limited to reprocessing by the coal industry and to reclamation by BAMR of high priority environmental sites.

In response to the oil shortages during the 1970s, U.S. Congress sought to diversify the nation's electric generation mix by promoting the use of alternative fuels (i.e. electricity produced from unconventional fuel sources like coal refuse).

Toward this end, Congress enacted the Public Utility Regulatory Policies Act (PURPA) in 1978. PURPA required that electric utilities buy alternative energy generated by qualified facilities at an "avoided cost" rate. The avoided cost mandate proved instrumental in encouraging developers to invest in what was then "new and risky" business ventures like generating electricity from coal refuse through the use of CFB technology. As a result of fortuitous timing between maturation of the CFB process and passage of PURPA, a new energy technology was born with a strong environmental remediation component.

In addition, strong bipartisan support within Pennsylvania's government for this technology and its application to Pennsylvania's environmental legacy helped foster a regulatory climate that allowed the industry to flourish. This, more than any other reason, is the reason that 14 of the nation's 19 coal refuse generating plants are located in the Commonwealth.

One year after the opening of the first CFB plant in 1987, members of this growing industry formed the Anthracite Region Independent Power Producers Association (ARIPPA) as a non-profit trade association. Over the life of the plants, the activities of ARIPPA members have removed more than 212 million tons of coal refuse, improved or restored more than 1,200 miles of polluted streams, and reclaimed more than 7,000 acres of abandoned mine land.

As testament to its environmental benefits, coal refuse-based generation qualifies as an "alternative energy source" under Pennsylvania's energy portfolio law. Under the PA Alternative Energy Portfolio Standards (AEPS) Act, which was designed to "encourage reliance on more diverse and environmentally friendly sources of energy," coal refuse power plants are categorized as Tier II resources. The Commonwealth has set the benchmark of ensuring that 10 percent of all Pennsylvania energy is produced by Tier II sources by 2020.[5] More recently, the Governor and legislature approved a tax credit proposal to promote the use of coal refuse, acknowledging it as a beneficial way to improve the Commonwealth's scarred and polluted landscape.

1.4 INDUSTRY CHALLENGES

The coal refuse industry is facing a number of regulatory and marketplace challenges, threatening the viability of its work reclaiming and remediating abandoned mine lands in Pennsylvania. New federal pollution regulations account only for the negative environmental externalities of coal refuse plants and not the environmental benefits of their remediation work, subjecting the industry to an asymmetrical regulatory environment. Concurrently, electricity prices have fallen due to an abundant, low-cost supply of natural gas from the Marcellus Shale region and lower demand for electricity, driving prices below the cost of energy generation for coal refuse plants.

The coal refuse plants span both the anthracite and bituminous coal regions and support the local economies of small communities across eight counties. Thirteen of the plants are first generation, with one second generation plant (Seward) built to a larger size and processing a higher volume than the first generation plants. Together, the 14 plants have an operating capacity of 1,419 Megawatts, implying an annual capacity of more than 12 million Megawatt hours (MWh) if running 24 hours a day and 7 days a week. While annual production levels were approximately three-

[5] Pennsylvania Public Utility Commission, "Alternative Energy Portfolio Standards Act (AEPS) Fact Sheet," www.puc.state.pa.us.

quarters of that capacity as recently as 2014, energy production (and attendant environmental benefits) has plummeted in recent years due to market and regulatory changes.

1.4.1 REGULATORY CHALLENGES

Coal refuse plants face challenges from new federal regulations, in particular the Cross-State Air Pollution Rule (CSAPR) and the Mercury and Air Toxic Standards (MATS) Rule. Compliance with the rules' requirements pose impediments to the continued operation of coal refuse power plants and the remediation work that they provide. As examples:

- CSAPR regulates the transport of precursors of fine particulate matter (PM2.5) and ozone, establishing annual emissions budgets and requiring reductions in sulfur dioxide and nitrogen oxide emissions from power plants in 28 states, including Pennsylvania. While coal refuse power plants were allocated sufficient emission credits during Phase I of CSAPR, which took effect in 2015, their credit allowances for Phase II, set to begin in 2017, are insufficient to sustain plant operations. Measures needed to comply with Phase II are expensive and may be uneconomical for coal refuse plants to implement, meaning that several could potentially be forced to cease operations.

- MATS regulates mercury and other emissions. While all coal refuse power plants are able to meet the Mercury standard, most of the bituminous fired plants, because of the higher sulfur content inherent within this type of coal, are unable to meet the rule's acid gas standard for hydrogen chloride. The availability of sufficient allowances at feasible prices (or at all) is in question, again raising the potential closure of plants.

These regulatory challenges are currently being addressed through the introduction of legislation – Satisfying Energy Needs and Saving the Environment (SENSE) Act. The measure, which provides alternatives to the federal requirements recognizing the environmental contributions of the coal refuse industry, passed the U.S. House of Representatives and is now before the U.S. Senate.

At the core of the regulatory challenges for coal refuse plants is the EPA policy that emissions standards consider only the impact of plant emissions, and not the net environmental effects of the plant activity, including the uncontrolled emissions from coal refuse pile fires. Historically, the EPA has acknowledged the environmental benefits of coal refuse-fired plants, noting that the industry combined the production of benefits with the reclamation of land.[6] However, these benefits are not recognized by the current EPA framework, which does not create a subcategory for coal refuse plants, but instead treats these plants within the same category and standards as a conventional coal-fired unit.

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[6] Environmental Protection Agency, "Solid Waste Rule-Identification of Non-Hazardous Secondary Materials That Are Solid Waste," Federal Register 76: 54 (March 21, 2011).

This framework means that Pennsylvania is liable for the emissions related to the controlled burning of coal refuse in CFB plants (where advanced pollution-capture technology mitigates environmental effects), but is not credited for the benefits of avoided emissions from the highly contaminated, dangerous, and uncontrolled burning of untreated coal refuse piles. The Pennsylvania Department of Environmental Protection (DEP) has estimated that 6.6 million tons of coal refuse burn each year in unintended, uncontrolled fires – releasing 9 million tons of carbon dioxide and numerous other air pollutants which are outside the scope of the emissions analysis.[7] The nature of the fuel source creates further complications. Coal refuse is, by definition, low-quality coal, and plants need to burn a larger volume of coal refuse to create electricity relative to the quality of originally-mined coal. The benefit of this activity is the remediation of coal refuse sites, and in fact the higher the quantity of coal refuse burned, the higher the volume of remediation. There is no regulatory compensation for the industry's work in remediating coal refuse sites, and no consideration of the attendant environmental benefits.

1.4.2 MARKETPLACE CHALLENGES

In addition to increased regulatory requirements, which bring with them significant compliance costs, the coal refuse industry faces challenges in the marketplace. The coal refuse plants are part of the PJM interconnection, a Regional Transmission Operator that runs the wholesale electricity market for most of Pennsylvania and all or part of 12 other states and the District of Columbia. New development and extraction techniques have turned the natural gas in the Marcellus Shale formation into an abundant fuel source, significantly lowering the price of natural gas. The decreasing price of natural gas, the most significant variable cost for thermal electricity plants, has translated into falling electricity prices on the PJM Interconnection market into which coal refuse plants sell their electricity. This effect is particularly pronounced in Pennsylvania, where local prices are even lower due to a lack of infrastructure necessary to transport this natural gas to larger markets.

Relative to natural gas producers, coal refuse plants are labor intensive and have an expensive fuel cycle with several components. Both coal refuse and limestone must be transported to plants, and beneficial use ash is then transported for use in environmental remediation. This series of steps and the attendant cost structure relative to increasingly prevalent natural gas producers have created major marketplace challenges for the industry.

Competition from natural gas has driven wholesale electricity prices in PJM down dramatically over the past two years (see Table 1.1). Weighted average prices per Megawatt hour (MWh) fell from $64 in 2014 (when they exceeded $100 in Q1) to $43 in 2015. In 2016, prices for Q1 and Q2 have fallen still further to around $32, half the level of 2014.

[7] See Section 2.2 for a more complete discussion of air quality impacts from uncontrolled coal refuse fires

TABLE 1.1 – PJM QUARTERLY WEIGHTED AVERAGE WHOLESALE ELECTRICITY PRICE $ / MWH, 2014-2016[8]

	2014	2015	2016	2016 % of 2014 Price
Q1 (January – March)	$114.87	$60.18	$31.20	27%
Q2 (April – June)	$52.54	$41.58	$32.25	61%
Q3 (July – September)	$43.86	$38.82	-	
Q4 (October – December)	$42.90	$32.61	-	
Annual	**$63.85**	**$43.31**	**$31.62**	**50%**

Source: U.S. Energy Information Administration, Wholesale Electricity Data

While Table 1.1 reflects average wholesale pricing, the actual price/MWh realized by coal refuse plants can be several dollars lower due to various factors, including congestion, line losses and the location of plants and PJM's price nodes. The gap between the wholesale price of $43.31 for calendar year 2015 and the realized prices reported by member plants of $36.48 was approximately $7 per MWh. This differential indicates that over the most recent four quarters (July 2015 – June 2016), when reported prices have averaged approximately $34 MWh, revenues realized by plants are approximately $27 per MWh from energy generation.

This drop in price translates to a steep drop in revenue for Pennsylvania's coal refuse plants, resulting in an unsustainable business proposition. As reviewed in detail in Section 4 of this report, the industry bears a mix of costs associated with production and remediation, including fixed costs that occur regardless of the production level of the plant, labor costs that are largely fixed in the short run (although they can vary over time in response to demand) and variable costs of energy production which are directly responsive to production levels. Data provided by member plants[9] indicates that the variable costs of production total approximately $22 per MWh (see Table 1.2).

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[8] U.S. Energy Information Administration, "Wholesale Electricity and Natural Gas Market Data," www.eia.gov.

[9] See Section 4.2 for more detail on information collected from industry members.

TABLE 1.2 – VARIABLE ENERGY GENERATION COSTS PER MWH

Variable Energy Generation Costs	Cost per MWh (Base Load)
Mining costs	$9.18
Transportation costs	$5.32
Reclamation costs	$2.42
Limestone moving costs	$2.49
Variable Maintenance costs	$1.49
Other	$1.06
Total Variable Costs	**$21.96**

Source: ARIPPA member survey (2016)

Plants also report significant labor costs (with employees earning average salaries in excess of $70,000), and substantial fixed costs, including utilities, administrative costs, regulatory and compliance fees, insurance costs, equipment rentals, supplies and maintenance.[10] Coal refuse plants are, to some extent, victims of their own success with respect to transportation costs. When plants were constructed in the late 1980s and early 1990s, they were located near their original fuel sources. After nearby coal refuse piles were reclaimed and their lands remediated, plants were forced to lengthen the distance from which they obtained suitable fuel. The growing distance between plants and coal refuse piles has increased transportation costs, both for delivering fuel to the plants and for transporting beneficial use ash back to mining-affected sites for remediation activities, increasing transportation costs over a plant's lifetime.

In addition to energy generation revenues, plants receive revenue through PJM's capacity market, in which power providers pay a fee to producers to ensure sufficient energy generation capacity for anticipated usage spikes. While these prices vary by region and time, typical current revenues are approximately $7 per MWh.[11] Translated on a per MWh basis using base load levels of production, fixed costs reported by member plants are approximately $9 per MWh, exceeding these capacity costs. Further, combining fixed, labor and variable costs yields a total cost of production estimated at $39, well in excess of the combined market revenues from energy generation and capacity payments at current market levels, which is estimated at $34 (see Figure 1.4).

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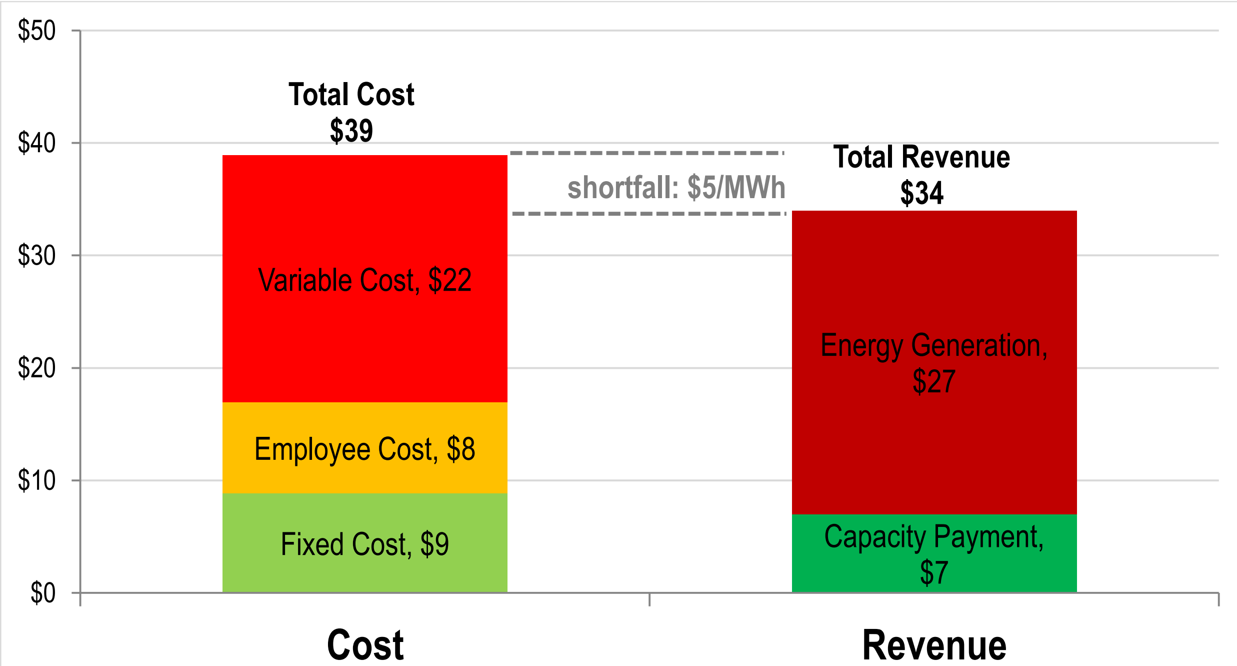
10 Note that maintenance costs are divided between variable maintenance costs (shown in Table 1.2), which vary with the level of production, and fixed maintenance costs, which are constant regardless of the specific level of energy generation provided that the plant is operational. In a sense, these costs are not truly "fixed" because they could be eliminated, but doing so would make the facility non-operational. Therefore, they are effectively fixed for any non-zero level of production. See Section 4.3 for more detail on the classification of industry operating costs.

11 Typical capacity pricing for 2016 and 2017 (which is determined by auctions several years in advanced) is approximately $120 per MW per day. For a plant operating at approximately 75% of annual capacity (similar to the average operating levels reported by member plants from 2010-2014), this capacity payment translates to $6.67 per MWh of production. This figure will vary based on the specific pricing and operating conditions for a given plant in a given year.

FIGURE 1.4 – TOTAL ENERGY GENERATION COSTS AND REVENUES PER MWH



Source: ESI Analysis of ARIPPA Member and U.S. Energy Information Administration Data (2016)

1.4.3 INDUSTRY OUTLOOK

The economic and regulatory challenges put the industry, its employees and all Pennsylvanians benefitting from its environmental activities in a tenuous position. Because market revenues typically exceed variable costs, it is economically sensible in the short run for plants to remain in operation, rather than shutting down operations entirely. However, energy prices vary seasonally (as seen by Table 1.1 and Figure 1.4 above), and plants may be idle for extended periods if market conditions result in prices dropping below economically viable levels. For example, during the March-July time period of this year, 7 of Pennsylvania's 14 coal refuse plants were operating in a "cycling" mode, running only when energy prices were sufficient to recover costs and idling when the cost to operate exceeded pricing. This dynamic is responsible for declines in production levels and economic activity already underway. Over the long term, both labor and fixed costs categories are not truly "fixed," because they depend on an economic incentive for the plant to continue operations. Without a sustainable model with which to yield viable returns, plants will ultimately close, eliminating the significant economic and environmental benefits currently delivered by the industry.

This decline in production incentives is readily apparent in aggregated production data from recent years (see Figure 1.5).

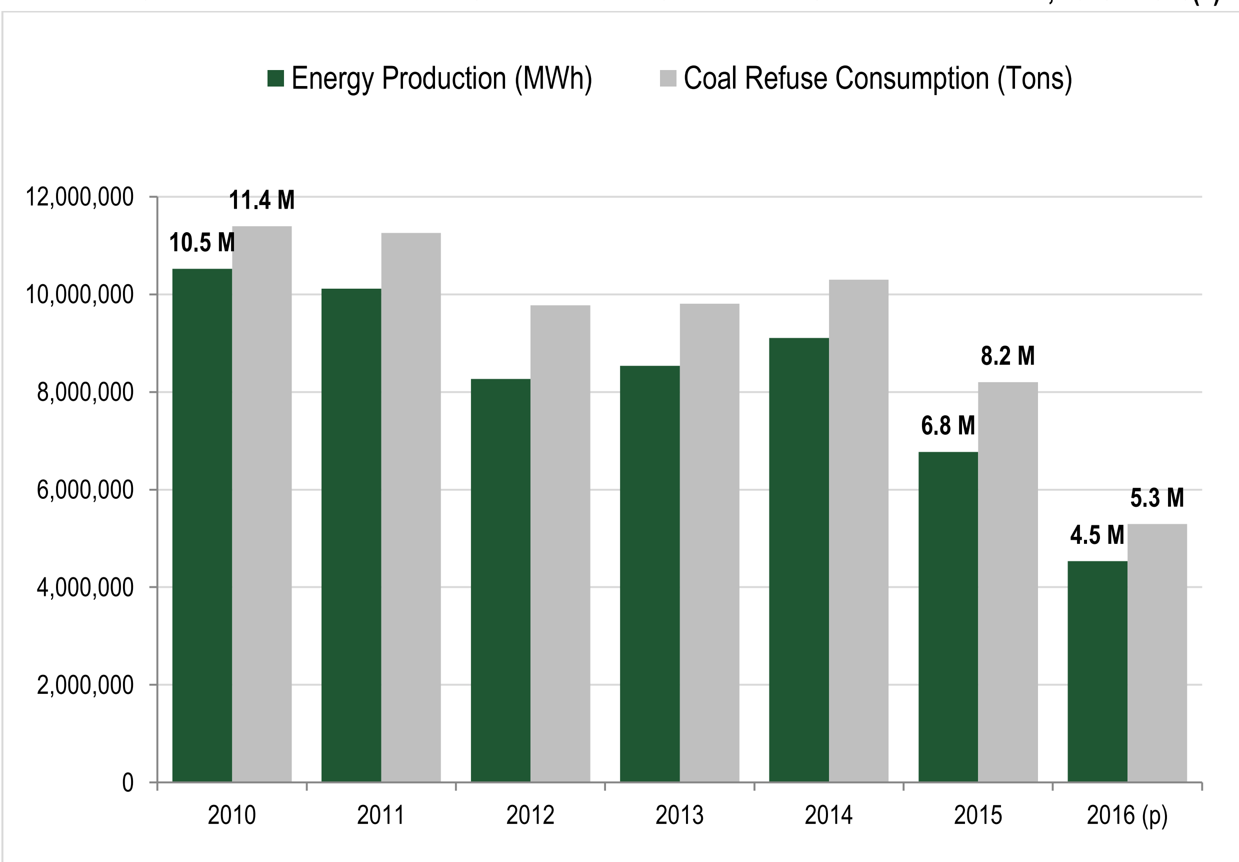
- In 2010, Pennsylvania's 14 coal refuse plants generated 10.5 million MWh of energy and consumed 11.4 million tons of coal refuse.

- Production declined slightly over a five year period, but averaged 9.3 million MWh of energy and 10.5 million tons of coal refuse from 2010 – 2014.

- In 2015, energy production fell an estimated 27% from this five-year average to 6.8 million MWh and coal refuse consumption fell an estimated 22% to 8.2 million tons.

- Projections for 2016 show an even steeper annual decline, (consistent with depressed energy prices observed year to date), with energy production projected to decline 33% to 4.5 million MWh and coal refuse consumption projected to decline 35% to 5.3 million tons. Thus, 2016 activity levels are anticipated to be approximately half of the annual averages observed from 2010 – 2014.

FIGURE 1.5 – ANNUAL INDUSTRY ENERGY GENERATION AND COAL REFUSE CONSUMPTION TRENDS, 2010 – 2016(P)



Source: ESI analysis of ARIPPA member reported data (2016)

Declining energy generation levels reflect the problematic economics of production for coal refuse plants in the current energy price environment. In the short run, revenues at times do not exceed variable production costs, necessitating the idling of plants, and reducing both the economic and environmental impacts of industry activities. Over the long run, it is unsustainable for plants to continue to operate when "all-in" costs far exceed revenues. These economic realities therefore threaten the ability of coal refuse plants to continue to deliver the range of economic and environmental benefits, including the employment of thousands of Pennsylvanians, and the reclamation and remediation of thousands of acres of land, described and quantified throughout this report.

While the economics of coal refuse as an energy source are challenging, the coal refuse cycle they engender remains an extremely cost-effective environmental remediation program. Plants address the hazards caused by abandoned mine lands, including coal refuse piles. The industry has major positive externalities, simultaneously protecting the health of Pennsylvanians and lessening their tax burden. The threat to the economic viability of the plants therefore threatens their ability to deliver these environmental and economic benefits in the future.

2.0 ENVIRONMENTAL AND PUBLIC BENEFITS

The process of coal refuse energy generation and site remediation produces a variety of environmental and public benefits. The reclamation of sites removes the environmental and public health dangers caused by abandoned coal refuse piles. Plant activities improve the quality of local waterways, remove threats to environmental and human health, and restore land to beneficial uses through the components of the fuel cycle.

The federal Environmental Protection Agency (EPA) has historically recognized the environmental benefits of coal refuse plants. In 2011, the EPA reported that "units that burn coal refuse provide multimedia environmental benefits by combining the production of energy with the removal of coal refuse piles and by reclaiming land for productive use."[12] It also acknowledged coal refuse burning facilities equipped with circulating fluidized beds (CFBs) have lower emissions than most existing pulverized boilers and argued that "because of the unique environmental benefits that coal refuse-fired EGU's provide these units warrant special consideration."[13] The coal refuse industry has also received support for its activities from a range of environmental groups.[14]

The section that follows categorically reviews the major environmental and public benefits of the remediation of coal refuse piles. Specifically, it details impacts on water quality (Section 2.1), air quality (2.2), public safety/public health (2.3), reclamation of land (2.4) and the associated improved value of nearby land (Section 2.5). Section 3 of this report extends this analysis to quantify the value of these environmental and public benefits to the Commonwealth.

2.1 WATER QUALITY

Coal refuse piles create acidic runoff, meaning that precipitation picks up pollutants that leach into surface and ground waters. This process is known as Acid Mine Drainage (AMD). Together, coal refuse piles and abandoned mines are the largest source of water pollution in the state and have environmental implications for both local waterways – directly impacting 5,500 miles of streams in

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[12] Environmental Protection Agency, "Solid Waste Rule-Identification of Non-Hazardous Secondary Materials That Are Solid Waste," *Federal Register* 76: 54 (March 21, 2011).

[13] Environmental Protection Agency. "Utility MACT Rule-National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric: Utility Steam Generating Units and Standards of Performance," *Federal Register* 76: 85 (May 3, 2011). Environmental Protection Agency. 2011. "Solid Waste Rule-Identification"

[14] For example, George Jugovic Jr., former President and CEO of leading Pennsylvania environmental group PennFuture stated in 2012: "We recognize that burning waste coal provides substantial environmental benefit. Sometimes you need to be sensible about protecting and cleaning up your environment." Quoted in: Kate Mellot, "Cleanup in Peril: New Standards Threaten Waste Coal Operations," *The Tribune-Democrat* (October 27, 2012).

Pennsylvania – and national watersheds.[15] At the local level, the iron-sulfide minerals found in coal refuse piles are oxidized and discharge iron, manganese, aluminum, and other metals and minerals into water flows. The discharges increase the acid level and silt content of local waterways, causing streams to turn orange in color and harming their ability to sustain marine and plant life (see Figure 2.1).

FIGURE 2.1 – STREAM POLLUTED BY ACID MINE DRAINAGE

Source: EPCAMR (2015)

The local streams impacted by AMD are located within, or extend to, all four of Pennsylvania's major river basins – the Ohio, Susquehanna, Potomac and Delaware. The discharges that originate in Pennsylvania coal refuse piles are then carried from local waterways into the Chesapeake Bay and Delaware River Watersheds to the East, and the Ohio, Mississippi, and Gulf of Mexico Watersheds to the West – creating environmental impacts that are national in scope.

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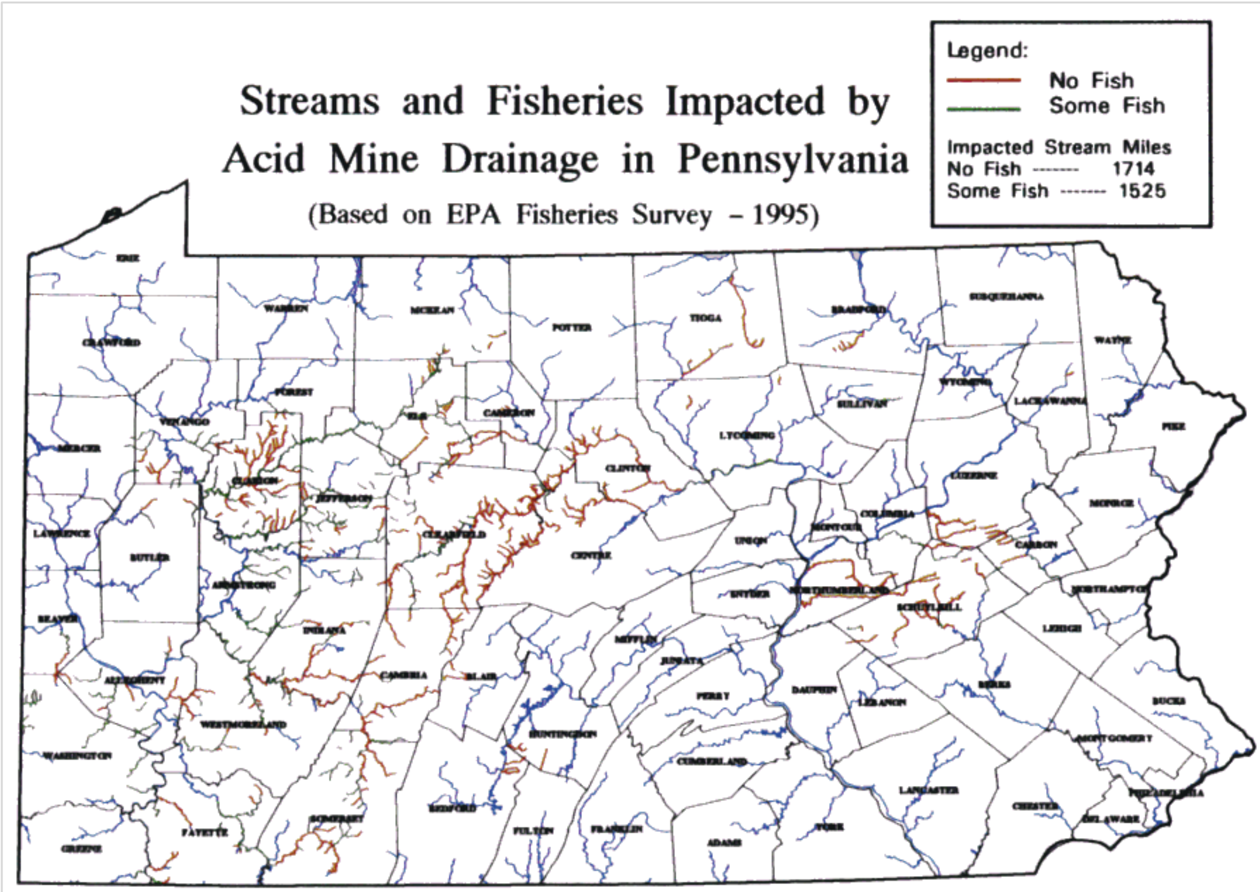
[15] Oversight Hearing on Abandoned Mines in the United States: Hearing Before the Subcommittee on Water Resources and the Environment of the House Transportation and Infrastructure Committee, United States House of Representatives. 114th Congress (2015) (statement of Eric C. Cavazza, Director, BAMR, PA DEP, Washington, DC).

FIGURE 2.2 – MAP OF AMD POLLUTION IN PENNSYLVANIA



Source: Commonwealth of Pennsylvania

There are a broad range of technologies available to treat AMD, falling within the categories of active and passive treatment. Active treatment involves building water treatment plants. Plants can treat a large volume of high-acidity AMD, but are expensive to build and require ongoing operating and maintenance costs.[16] A recent water treatment plant in Cambria County, built to treat AMD from an abandoned mine and co-located coal refuse piles, cost $15 million. The plant helps to restore and has been effective in raising the pH in the Little Conemaugh River from 4.2 in 1993 to 8.0 in 2014. However, there is an ongoing operations and maintenance cost of treating 10,000 gallons of water per minute in perpetuity. For example, in 2007, the active AMD treatment plant in Fox Township, Elk County had an operating cost of $226,000, while passive treatment

[16] Jeff Taylor, Sophie Pape, and Nigel Murphy. "A Summary of Passive and Active Treatment Technologies for Acid and Metalliferous Drainage (AMD)." *Australian Centre for Minerals Extension and Research (ACMER)* (Fremantle, Western Australia: Earth Systems, 2005).

plants in Hampton Township, Allegheny Township and Jones Township, Elk County had annual operating costs of $32,000 and $31,000, respectively.[17]

The second category of AMD treatment technologies is passive treatment systems. Passive systems divert water through alkaline limestone beds or drains, lowering the' pH of the water. These systems are less costly than active treatment. Recent passive treatment projects include a $540,000 treatment system in Cambria County and an $880,000 treatment construction in Clearfield County.[18] However, passive treatment systems are only capable of mitigating pH levels in streams with low flow rates and low acidity loads. In both active and passive systems, the root cause of water pollution is not removed.

Unlike active and passive treatment systems, the elimination of coal refuse piles and proper reclamation of sites removes the source of AMD and its associated environmental consequences originating from that site. The remediation process stabilizes mine sites and removes negative water quality effects in two ways. First, the coal refuse is moved off site to be used as fuel in the alternative energy plant. This directly reduces the main source of water pollution. Second, the abatement process reduces the acidity of the site and neutralizes any remaining unusable coal refuse. The ash produced by a CFB boiler that burns coal refuse with limestone is alkaline, and thus neutralizes acidic materials when returned to the site. In addition, the reclamation process diverts water runoff from reclaimed areas, further eliminating acid mine drainage and reducing the concentration of metals in local waterways.

The permitting requirements for obtaining a surface mining permit (a precondition to removing coal refuse piles) require companies to develop abatement plans for discharges of surface and ground waters, including the remediation of AMD. Companies are required to take baseline measurements of water conditions and are liable for worsening conditions, which creates an economic incentive for the improvement of local water quality and allows improvements to be scientifically quantified.

The effectiveness of the coal refuse reclamation in improving local water quality is evidenced in the long-term stability and environmental quality of remediated waterways. For example, at the coal refuse site in Revloc, PA, the nearby coal refuse plant Ebensburg Power Company removed three million tons of coal refuse as part of the fuel cycle process (including remediation through the use of beneficial ash) resulting in the reclamation of 56 acres of land. The reclamation process resulted in the restoration of aquatic life, including trout stockings, to six miles of the south branch of Blacklick Creek. Through reclamation, surface water discharge at the site saw reductions of 93% acidity, 92% iron, 71% manganese and 95% aluminum.

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[17] "Mining Company Invests Big to Treat Acid Mine Trainage," *The Allegheny Front*, June, 13, 2014. Pennsylvania Department of Environmental Protection, "The History of Acid Mine Drainage Abatement Facilities Constructed in Pennsylvania under 'Operation Scarlift,'" www.portal.state.pa.us

[18] Pennsylvania Department of Environmental Protection, "Wolf Administration Investing $25.1 Million in Projects to Protect and Improve Pennsylvania Water Resources," May, 18, 2016, wwww.ahs.dep.pa.gov.

If left untreated, coal refuse piles have direct, negative impacts on local waterways and are carried into national watersheds. The reclamation process restores the environmental health of local streams and eliminates the future contamination of surface and ground waters through the removal and de-acidification of coal refuse piles.

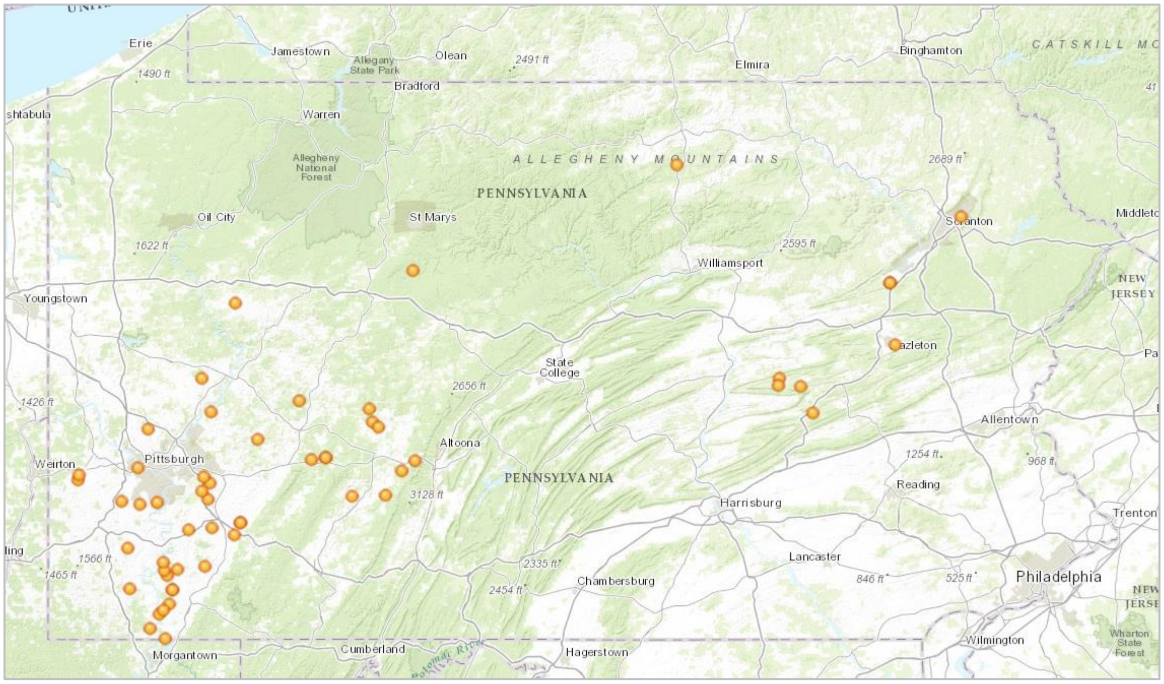
2.2 AIR QUALITY

Coal refuse piles also have negative consequences for air quality for surrounding communities. Coal dust from piles can be swept up by the wind and deposited elsewhere, creating adverse effects for downwind residents. Further, unattended coal refuse piles can be ignited by spontaneous combustion and the burning of piles creates major air quality issues for surrounding communities (DEP has identified 42 coal refuse piles currently burning in Pennsylvania).

The EPA has identified spontaneous combustion as a common cause of coal refuse fires.[19] The flow of air through untreated piles oxidizes combustible coal refuse materials. The oxidation process generates heat which ultimately ignites the combustible components of piles. Burning piles create a range of uncontrolled negative atmospheric impacts, including smoke, minute dust particles, and the release of poisonous and noxious gases. The poisonous and noxious gases released by burning piles – including carbon monoxide, carbon dioxide, hydrogen sulfide, sulfur dioxide, ammonia, sulfur trioxide, sulfuric acid, and oxides of nitrogen – can be fatal to vegetative life and negatively impact human health. In addition to spontaneous combustion, untreated refuse piles are also susceptible to ignition from the burning of trash and garbage on coal refuse dumps, forest fires, and lightning.

[19] United States Department of the Interior, *Coal Refuse Fires, an Environmental Hazard* (Washington, DC: United States Department of the Interior, 1971).

FIGURE 2.3 – LOCATION OF BURNING COAL REFUSE PILES IN PENNSYLVANIA



Source: BAMR (2005)

When a coal refuse pile ignites, either through spontaneous combustion or garbage burning, emissions from the burning piles hang in localized areas. Coal refuse piles are often located in valleys and surrounding hills trap contaminated air. When the concentration of noxious gases from coal refuse pile fires hangs in valleys, it affects public health in near-by communities. Concentrations of sulfur dioxide can increase illness rates and hospital admissions for older persons with respiratory disease, increase absenteeism from work, accentuate the system of patients with chronic lung disease, and increase daily death rates.[20] Once ignited, fires will continue to burn for decades if left un-remediated, since the coal refuse provides a continuous fuel source until the pile is exhausted.

[20] Industrial Research Laboratory, *Source Assessment: Coal Refuse Piles, Abandoned Mines and Outcrops, State of the Art* (Cincinnati, OH: United States Environmental Protection Agency, 1978).

FIGURE 2.4 – FIREFIGHTERS WORK TO EXTINGUISH A COAL REFUSE FIRE IN FELL TOWNSHIP, PA

Source: The Times Tribune (2014)

When abandoned mine lands are remediated, coal refuse piles are removed before they ignite through spontaneous combustion. During the reclamation process, coal refuse is burned in a highly controlled and regulated manner, using limestone injections to control acid gas and fabric filter systems to reduce filterable particulate matter (FPM) emissions. The emissions of these units can be considered an offset of the eventual in-place burning of coal refuse piles due to spontaneous combustion. In addition, the emissions of spontaneous fires are uncontrolled, whereas refuse-fired units are able to capture and remove the same pollutants – mitigating the total air quality impact of the coal refuse piles. These piles can also burn for years or decades, since the coal refuse supplies a continuous fuel source until the pile is exhausted. The remediation and reclamation of coal refuse piles removes the ongoing negative impacts of stable (non-burning) piles and prevents new fires caused by spontaneous combustion.

2.3 PUBLIC SAFETY AND PUBLIC HEALTH

In addition to their environmental impacts on water and air quality, abandoned coal refuse piles pose public safety and public health threats. Piles are unstable and can collapse, threatening the safety of nearby communities. Such collapses have led to landslides and mud slides that affected public and private lands, including highways, homes, crops, and forests. Some coal refuse piles are located just hundreds of feet from homes and businesses, compounding this danger. In total, an estimated 1.6 million Pennsylvanians live less than one mile from an abandoned mine – and the threats they pose.[21]

Abandoned mine sites are unsupervised and often close to private property. As a result, they are sometimes used for the dumping of illegal waste. The burning of trash and garbage on mine sites is another cause of coal refuse fires. Emergency response efforts to contain fires and minimize their impact on communities and public health are dangerous, disruptive, and costly. There are currently 52 known coal refuse piles burning in Pennsylvania, a number that does not include underground mine fires. In 2014, the Commonwealth spent $2.2 million in PADEP Abandoned Mile Land Program emergency funds to extinguish a single coal refuse fire in Lackawanna County. Absent the remediation of unattended piles, new fires continue to ignite, posing significantly public safety risks.

Coal refuse piles also pose a danger to public health because they are frequently used for recreation activities, particularly all-terrain vehicle (ATV) and bike riding. Piles are unstable and can shift underneath riders, leading to bike crashes and ATVs overturning, which cause serious injuries and even death.[22] At least four Pennsylvanians have died from ATV accidents on coal refuse piles since 2005. When coal refuse is reclaimed, previously dangerous areas are turned into safe parks and recreational sites.

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[21] Jessica D. Matthews, "Region Waiting to Reclaim Scarred Land: Too Many Mines, Too Little Money," *The Sunday Times* (January 1, 2005).

[22] United States Department of Labor: Mine Safety and Health Administration, "Stay Out – Stay Alive Fatal Accident Summaries, 1999-2014," www.arlweb.msha.gov.

2.4 RECLAMATION OF LAND

Beyond the air, water, public health, and safety hazards eliminated through the reclamation and remediation of coal refuse piles, the process creates substantial areas for productive use. Reclamation turns the physical blight of a coal refuse pile into healthy, productive land that improves the quality of life for residents in surrounding communities through aesthetic, recreation and in some cases commercial use value. This is achieved through removal, remediation, and restoration, sometimes referred to as "The Three Rs" of the coal refuse fuel cycle.

First, coal refuse is removed from a mine site to the project, where it is fused with imported limestone and ammonia through the combustion process. The removal of coal refuse eliminates the presence of the unstable piles from the mine site. Land is further reclaimed through remediation, where alkaline ash from the energy generation process is used to attack the acidity in the site's soil, minimizing Acid Mine Drainage. Finally, the land is restored and revegetated. Under surface mining regulations, the reclamation of a site must include: installation of hydraulic controls, installation of wetland treatment systems for small volume discharges, grading and compacting, covering the site with 1 to 4 feet of soil or best vegetative supporting material, adjusting soil acidity with alkaline materials, the addition of fertilizers, and planting vegetation consistent with local flora. Water in the area must also be monitored for 10 years after the final placement of beneficial use ash.

After areas are stabilized and restored, the land is available for other uses. The return of vegetation and the improved environmental health of local streams enable the land to be used for commercial and recreational purposes. Reclaimed lands have become industrial parks, shopping centers, housing developments, soccer fields, and pastures. One example, the Revloc Reclamation Project in Revloc, PA resulted in the reclamation of 56 acres, 20 of which were then available for industrial development.

FIGURE 2.5 – ERNST, PA BEFORE AND AFTER COAL REFUSE RECLAMATION

2.5 IMPROVED VALUE OF NEARBY LAND

In addition to the value of land directly reclaimed, the removal and remediation of coal refuse piles have beneficial impacts on nearby properties. The blight, physical danger and environmental impacts associated with coal refuse piles all have negative impacts on the desirability of nearby property. Reclamation of this land for a productive use, such as open space, has beneficial impacts on nearby properties, which are reflected economically in improved property values for adjacent land holders. This benefit accrues both to the private land holders who capture the value increase, and to local jurisdictions which see attendant increases in their property tax base.

Research on the presence of physical blight in communities has clearly demonstrated that they negatively impact property values. Landfills, like coal refuse piles, are a disamenity and a physical blight on communities. Econometric analysis of three Pennsylvania landfills found their presence decreased adjacent property values by an average of 2.7 to 13.7 percent, depending on their size.[23] Conversely, productive land uses have been demonstrated to have a positive impact on nearby property. For example, a hedonic regression analysis of residential property values in Southeastern Pennsylvania found that proximity to protected open space added more than $16 billion in residential property value in the five-county region, or approximately $10,000 per household.[24] The remediation of coal refuse piles not only removes the blighting disamenity, but in many cases replaces it with the positive amenity of open space, increasing the net benefit to nearby landholders. This effect is augmented by the environmental benefits of remediation, which can restore the scenic and recreational benefits of streams and wilderness areas for nearby residents.

These benefits are particularly relevant in areas where coal refuse piles are directly adjacent to residential properties. As shown in Figures 2.7 and 2.8, coal refuse piles are not confined to uninhabited areas, but in many cases loom directly over residential properties and communities. The greater the density of the surrounding community, the greater the benefit that can be realized through the removal and remediation of coal refuse piles.

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[23] Richard C. Ready, "Do Landfills Always Depress Nearby Property Values?" *Journal of Real Estate Research* 32: 3 (2010), 321-339.

[24] Economy League of Greater Philadelphia, Econsult Corporation and Keystone Conservation Trust. "The Economic Value of Protected Open Space in Southeastern Pennsylvania." November 2010.

FIGURE 2.7 – COAL REFUSE PILE ABOVE EHRENFELD, PA

Source: Democrat Tribune (2015)

FIGURE 2.8 – COAL REFUSE PILE OVER HOMES IN FREDERICKTOWN, PA

Source: Allegheny Front (2016)

3.0 VALUATION OF ENVIRONMENTAL AND PUBLIC BENEFITS

The environmental and public benefits described in Section 2 accrue in different forms to a number of different beneficiaries, including private landholders, citizens at large, and the Commonwealth as a government entity. A number of analytical techniques can be used to quantify these benefits in economic terms on an annual basis.

- Water and air quality benefits are approached through an avoided cost framework, which estimates the amount that the Commonwealth would otherwise need to spend, absent the remediation activities of the coal refuse industry.

- Public safety benefits are estimated using a societal benefit framework, using standard statistical measures for the value of avoided injuries and fatalities.

- Land impacts, including both direct reclamation and impacts on adjacent properties, are estimated through their impact on land values, which accrue to the property holders and reflect a market-driven determination of added value.

Importantly, the Commonwealth is not positioned to replicate the cycle of coal refuse consumption, energy generation, and remediation undertaken by the industry. Mainly due to financial constraints and other spending priorities, the Commonwealth has historically approached the problems associated with coal refuse sites reactively rather than proactively, addressing public safety and environmental liabilities after they occur. The valuation framework therefore must consider costs to the Commonwealth of failing to remediate coal refuse piles, recognizing that simply "doing nothing" in the absence of the industry efforts does not eliminate the costs or impacts of Pennsylvania's legacy coal refuse problem.

3.1 SCOPE OF COAL REFUSE PROBLEM

Coal refuse piles are part of the extensive environmental liability within the Commonwealth associated with abandoned mine lands (AML). The Pennsylvania Department of Environmental Protection (DEP) has previously estimated that addressing all AML issues throughout the Commonwealth would carry a cost as high as $15 billion.

In Pennsylvania, public coal refuse remediation efforts are administered by the Bureau of Abandoned Mine Reclamation (BAMR). BAMR is responsible for resolving abandoned mine land problems, including mine fires, mine subsidence, dangerous highwalls, open shafts and portals, and mining impacted water supplies in accordance with requirements established by the federal Office of Surface Mining Reclamation and Enforcement (OSMRE) under authority of the Surface Mining Control and Reclamation Act (SMCRA). Any lands and waters affected by mines that were abandoned or left in an inadequate reclamation status prior to August 3, 1977 are eligible for reclamation by BAMR or may qualify for federal funds under Title IV of SMCRA.

Estimates of the scale of un-remediated coal refuse in Pennsylvania utilized for the purpose of developing industry benefit estimates are based on an inventory first developed by BAMR. This inventory is acknowledged by the Commonwealth to be non-comprehensive, with accompanying documentation stating that the inventory is "by no means complete as many AML problems and features exist that have never been added to the inventory."[25] Further, alternative studies of specific counties or regions have yielded larger estimates than those represented in the BAMR inventory for the same geographic area, suggesting that the inventory is perhaps best considered to be a lower bound estimate of the potential scope of the problem.[26] Nonetheless, the inventory is the most comprehensive and documented available source on the extent of un-remediated coal refuse statewide, and therefore, is used as the basis point for calculation in this analysis.

The database, available from the Commonwealth's Department of Environmental Protection (DEP) includes a total of 840 coal refuse piles, 52 of which are identified as currently burning. Piles are quantified in terms of both acreage covered and cubic yards of refuse, which is translated into tonnage of coal refuse using a ratio of 1.1 tons per cubic yard. Acreage data is available for 810 of the 840 piles, totaling 9,500 acres of land covered by coal refuse piles. Cubic yardage data is available for 718 piles, totaling 224 million cubic yards. For the 92 piles for which acreage but not cubic yardage is available, acreage and tons are estimated using the established ratios between acreage, cubic yardage and tons for the majority of piles for which all three metrics are available. This method yields an estimate of 263 million cubic yards and 290 million tons for the 810 piles for which acreage is available (see Table 3.1).[27]

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[25] "History of Pennsylvania's Abandoned Mine Land Inventory," published by the Commonwealth Department of Environmental Protection July 2013. For example, in addition to pre-existing sites that may not have been identified, coal refuse sites that were abandoned or went into forfeiture after 1977 have not been added to the inventory.

[26] For example, when the Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR) carried out a survey of the refuse piles in Westmoreland County, it identified 103 piles, 36% greater than the 76 listed for the county in the original BAMR report. In addition, surveys of the anthracite region conducted prior to the development of the inventory identified approximately 800 banks and 1 billion tons of coal refuse in the anthracite region alone.

[27] No yardage or tons is estimated for the 30 piles for which no acreage is provided.

TABLE 3.1 – BAMR INVENTORY OF COAL REFUSE PILES

Metric	Value
Total Piles	840
Burning Piles	52
Non-Burning Piles	788
Piles with available acreage	810
Est. Total Acreage covered by refuse	**9,500**
Est. Total Cubic Yards of refuse	**263 mil**
Est. Total Tonnage of refuse	**290 mil**

Source: ESI Analysis of Bureau of Abandoned Mine Reclamation and Office of Surface Mining Reclamation and Enforcement data

3.2 COMMONWEALTH REMEDIATION EFFORTS

Coal refuse pile remediation is addressed by BAMR as a subset of the broader set of environmental efforts related to abandoned mine lands (AML). Funding sources for these efforts identified by the Pennsylvania DEP primarily include federal and state revenue streams based on dedicated fees.

Most notable among funding sources are federal Title IV funds, which are generated through a fee on active coal production. Under Title IV, SMCRA requires that active coal mining companies pay an AML fee on each ton of coal mined. OSMRE then returns collected fees to the state through AML grants. Since 1980, Pennsylvania has received more than $1.1 billion in AML funds. However, the amount collected and distributed through this program has diminished considerably in the past few years due to declines in coal production and the uncertainties of the federal appropriations process. In 2016, Pennsylvania received an AML grant of $42.9 million, down from $67.2 million in 2012. Current environmental regulations also make the construction of new coal plants in the future very unlikely. Accordingly, future funding for AML reclamation efforts is in jeopardy, both in Pennsylvania and nationally. Further, statutory parameters governing project distribution of these funds rarely provide a priority ranking for the removal of abandoned coal refuse piles.

Another major source of funding for AML issues is the state's Growing Greener program, which receives its funding from landfill tipping fees, and is used for watershed restoration and protection, abandoned mine reclamation, and abandoned oil and gas well plugging projects. This program has invested a total of more than $1.3 billion since its inception in 1999, including $548 million allocated by DEP.[28] However, a limited amount of this funding is conveyed directly to acid mine drainage and coal refuse pile issues.

Under SMCRA, BAMR is required to focus on high-priority sites that pose the highest human and environmental health threats. However, BAMR does not have sufficient resources to address most abandoned mine related problems in the Commonwealth. From 2012-2014, for example, only 10 percent of requests for investigation into AML problems resulted in accelerated response projects. Further, DEP is resource-constrained in its ability to address coal refuse piles that do not pose an imminent fire risk. From 2012-2014, for example, annual program accomplishment reports from BAMR identify only one awarded project for the remediation of such a coal refuse pile. That reclamation effort involved the re-organization, or re-grading, of a 4 acre pile to remove the threat of landslides, but it did not eliminate the other negative environmental impacts of piles, including air pollution and water contamination.

In March 2016, the Commonwealth awarded a $13.5 million contract through federal AML funds for the removal of a 62 acre, 3.2 million ton coal refuse pile in Ehrenfield (Cambia County). This project represents the largest state awarded coal refuse pile remediation project in several years. DEP's announcement of the award notes that previous bids (originally solicited in July 2013) were cost-prohibitive, until the project was reworked by identifying a nearby facility in which the coal refuse could be placed at a reduced cost, which "resulted in a cost reduction to allow the contract to proceed."[29] This unique circumstance created a favorable outcome for the Commonwealth and the community, but is not replicable on a large scale across the state.

In general, remediation activities undertaken by the Commonwealth are qualitatively different from those undertaken by the coal refuse industry. Commonwealth efforts are generally reactive, mitigating immediate risk through stabilization activities but failing to address the core environmental problems and reclaim sites in a sustainable way. Without full-scale remediation, sites remain a liability to the Commonwealth and public health and safety concern over the long-run.

Fundamental differences between the Commonwealth and the industry drive differing cost structures for remediation of abandoned coal refuse sites. The removal of coal refuse from existing sites is an expensive task, requiring the re-mining, transportation and ultimate disposal of the coal refuse. This task can be performed far more cost-effectively by the coal refuse industry than by the Commonwealth for several structural reasons:

- First, the industry uses the coal refuse as a fuel source, and therefore generates revenue through the sale of electricity to offset the cost of the fuel cycle, including mining and

[28] Additional funds are allocated by the Department of Agriculture for farmland preservation projects, the Department of Conservation and Natural Resources for state park renovations and improvements, and by the Pennsylvania Infrastructure Investment Authority for water and sewer system upgrades.
[29] Former DEP Secretary John Quigley, quoted in: PR Newswire. "Pennsylvania DEP Awards Contract to Reclaim Long-Abandonded Ehrenfeld Mine Site in Cambia County. March 8, 2016.

transportation of the coal refuse. The Commonwealth is not in a position to establish such a program (which would require the capital costs and expertise necessary to set up a plant) and therefore cannot generate similar offsetting revenue.

- Second, the energy production process undertaken by the industry generates beneficial use ash, by mixing coal refuse with limestone to remove its acidity. This means that a byproduct of the energy generation process can be utilized to remediate the sites from which the coal refuse is removed, addressing environmental problems in a sustainable way. State remediation efforts would have to purchase this beneficial ash or another similar substance, adding to the cost of remediation for the Commonwealth compared to the coal refuse industry.

- Finally, if coal refuse is not used as an energy source, it must be disposed of in a safe and sustainable manner. From the perspective of the state, this would involve storing coal at a permitted coal refuse disposal site or landfill with proper environmental controls to prevent the acid seepage issues present at the original coal refuse sites. The economics of this step are highly cost-prohibitive on the scale required to address the abandoned coal refuse problem in a comprehensive way.

These storage costs alone generally make the economics of the level of remediation undertaken by the industry untenable for the Commonwealth. Landfilling the 290 million tons of coal refuse at the municipal tipping fee rate of $75 per ton, [30] for instance, would yield a price tag of more than $20 billion in landfill costs alone, higher than the DEP's estimated cost for all AML issues. While permitted disposal facilities are more cost-effective, bids to DEP involving the storage of coal at these facilities for the Ehrenfield project were deemed cost prohibitive.[31] These costs would be on top of mining and transportation costs for the removal of refuse from its current sites, and remediation costs for the restoration of sites and treatment of AMD.[32]

In 2001-2007, the Commonwealth undertook a $4.6M project to reclaim the 40-acre Mather Coal Refuse Site in Waynesburg, PA. At this site, a screening process was used to separate the usable coal refuse from the coal refuse pile and it was sold to a nearby coal refuse plant. Disposal of the remaining materials was addressed through a combination of re-shaping, re-grading, and burial, to reduce the elevation of the pile by almost 100 feet. Finally, top soil and

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[30] See: The Morning Call. "Trash Talk? Two Lehigh Valley Landfills Say they are Fast Running out of Space." November 26, 2015, and CleanEnergyProjects.com. "Landfill Tipping Fees in USA in 2013 (http://www.cleanenergyprojects.com/Landfill-Tipping-Fees-in-USA-2013.html)

[31] Disposal costs for Ehrenfeld are unique due not only to the proximity of the disposal facility to the refuse pile site, but the fact that the facility is a former permitted surface mine site with no coal left to mine, and therefore sufficient storage space. Nonetheless, DEP still reports anticipated disposal costs of $12.7 million above and beyond the $13.5 million award for removal (see: DEP Presentation at 2016 Pennsylvania Abandoned Mine Reclamation Conference, June 2016).

[32] Historically, site restoration of abandoned mine lands has been undertaken by the state under "Operation Scarlift," with typical remediation costs of $40,000 to $100,000 an acre. Note that even at these costs, environmental damage is not addressed to the standard of the coal refuse industry, because beneficial use ash is not used.

vegetation were planted over the site. However, the cost of the project was limited to $4.6 million because there was a market in place to purchase much of the coal refuse at the site, greatly reducing the amount that needed to be dealt with through burial and re-grading.[33]

In sum, it is simply economically infeasible for the Commonwealth to remediate coal refuse sites to the degree undertaken by the industry. The environmental cycle developed by the industry, where the removal of coal refuse is financed by revenues from energy generation, and a byproduct of the energy generation process is used to remediate coal refuse sites, represents a sustainable model for environmental remediation that cannot be replicated by the Commonwealth. Therefore, it is important to understand the costs that the Commonwealth would bear in the likely event that the Commonwealth fails to replace the activity undertaken by the industry.

3.3 VALUING ENVIRONMENTAL AND PUBLIC BENEFITS

The environmental and public benefits derived from the remediation of coal refuse piles accrue in a variety of ways to a variety of beneficiaries. Therefore, a mix of analytical approaches is required to quantify these values on an annualized basis. Table 3.2 below shows quantifiable benefits attributable to the remediation of piles undertaken by the industry. Quantifiable benefits vary in value type, in beneficiary type, and in duration (see Table 3.2).

TABLE 3.2 – CLASSIFICATION OF ENVIRONMENTAL AND PUBLIC USE BENEFITS

Category	Quantification of Benefits	One-Time Beneficiaries	Ongoing Beneficiaries
Water	Avoided cost for remediation of waterways related to sites	Avoided cost for state and local government	Cumulative avoided cost benefit
Fire/Air	Avoided cost for response to fires	Avoided cost for state and local government	Cumulative avoided cost benefit
Public Safety	Reduction in fatalities and injuries	Societal health benefit	Cumulative societal health benefit
Land Reclamation	Land value of remediated sites	Increased value to property holders	Increased local tax base
Nearby Property Value	Increase in value of nearby properties	Increased value to property holders	Increased local tax base

[33] Observer Reporter, "Work on Mather Coal Refuse Pile Nearly Done After 4 Years," October 7, 2005. Observer-Reporter, "Company Resumes Work at Mather Coal Refuse Site," August 17, 2006.

This framework is utilized to model the environmental and public benefits provided by the coal refuse industry at historic operational levels relative to no action being taken, and the state assuming responsibility for the attendant liabilities. Benefits are modeled over a 20 year time horizon, which is representative of the approximate remaining life cycle of the first generation coal refuse plants, which came online in the late 1980s and early 1990s. Historic operating levels are defined in more detail below as they relate to each component of the calculation, but generally refer to industry activities at established levels prior to the recent reductions in activity due to falling energy prices. As such, they represent the "steady state" benefits that the industry can produce through the successful resolution of its profitability concerns.

- Water benefits represent an avoided cost to state and local government, which absent remediation will have to engage in water treatment activities of various types to address pollutants seeping into water from coal refuse piles. Fire and air quality represent an avoided cost to the extent that remediation of the piles prevents future pile fires. Finally, public safety benefits represent a societal health benefit from reductions in fatalities and injuries of various degrees of severity associated with coal refuse piles.
    - In each of these cases, benefits are cumulative, in that the remediation of piles not only generates benefits (through avoided costs for water treatment, reduction in the likelihood of fires, or reduction in the probability of fatalities and injuries) in a given year, but once remediation of a site has taken place, the benefits from that site remain in future years. Therefore, the benefits in future years in these categories include the benefits from all piles remediated from year one on, not simply those piles remediated in a given year.[34]
- Land value, including both the reclaimed sites and increases in nearby property values, accrue as one-time increases in property value for property holders. On an ongoing basis, these increases in property value increase the local tax base, delivering annual revenue increases to local municipalities.[35]

Water

Remediation of coal refuse piles has important demonstrated effects on the quality of nearby waterways by reducing or eliminating the seeping of acidic pollutants. As discussed in Section 2, remining activities undertaken to extract coal refuse requires permit issuance that establishes an

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[34] Note that the quantification of benefits in this report is entirely forward-looking, in that future activity is designated as "year one" and activity undertaken by the industry to date is excluded. This framework makes clear, however, that the remediation already undertaken by the industry over more than two decades of activity continues to generate significant financial and societal benefit to Pennsylvania into the future.

[35] It should be noted that in some cases, reclaimed land may result in a public rather than a private use. From an analytical standpoint, land valuations effectively capitalize this recreational value into a monetary value, making land value an appropriate representation of the societal benefit derived from land reclamation.

environmental baseline for nearby waterways, which are then retested on a regular basis subsequent to remediation. This "before and after" measurement framework demonstrates conclusively the benefits of remediation of coal refuse piles on water quality. Evidence from these analyses can also be used to quantify the benefits by using an avoided cost framework. This approach estimates the volume of pollutants averted on an annual basis due to industry reclamation efforts at historic levels, and then values the reduction in pollutants based on the cost of water treatment to remove those pollutants on an ongoing basis.

In 1999, members of the Pennsylvania DEP undertook a comprehensive study of 110 remining sites in the bituminous area in Western Pennsylvania where mining operations had been completed and "before and after" water quality impacts could be evaluated.[36] This study found a 61% overall reduction in acid loading from these discharge sites, a decrease of nearly 16,000 pounds per day across the 110 sites evaluated. Treatment costs for this volume of acid loading, were it to take place at a single treatment site, were estimated at $3 million annually, a ratio of $187 per pound of daily acid loading. It should be noted that this approach to valuation is highly conservative, since economies of scale suggest that the treatment costs of a given volume of pollution at one site are likely to be far lower than treatment costs for the same total volume scattered across hundreds of disparate sites. This calculation also excludes reductions in the presence of various metals (iron, manganese and aluminum) also observed in the data set.

These ratios can be applied to historic activity levels of the coal refuse industry to quantify the future potential benefits of remediation of coal refuse piles on water quality. Estimating historic activities levels involves an extrapolation from the subsample of sites analyzed by the study to the broader universe of remediated sites statewide. At the time of the study in 1999, more than 300 remining permits had been issued for which preexisting water quality measures were available, with activity yet to be completed on many of the sites. This sample represented only the western bituminous coal region. Further, at that time, the thirteen plants in existence had been operating for an average of approximately 8 years. Extrapolating this sample to include all projects statewide yields an estimate of approximately 50 projects per year.[37]

Acid loadings and treatment value can then be extrapolated from this annualized activity estimate. Applying the per site reductions in acid loadings observed in the 110 sites included in the study yields an estimate of nearly 8,000 pounds of daily acid loading reduction attributable to the remediation undertaken by the industry at historic levels. Applying the ratio of $187 per pound

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[36] M.W Smith (District Mining Manager, Pennsylvania DEP), K.B.C. Brady (Hydrogeologist, Pennsylvania DEP), J.W. Hawkins (Hydrogeologist, OSMRE), "Effectiveness of Pennsylvania's remining program in abating abandoned mine drainage: water quality impact." Presented at Society of Mining, Metallurgy and Exploration (SME) Annual Meetings, February 2002.

[37] This estimate is calculated using the assumption that the 110 completed remining sites studied represent 50% of projects from that time ultimately completed, that the projects in the bituminous region represented 50% of statewide sites. These assumption yield an estimate of more than 400 statewide sites, which annualized over a period of 8 years represents approximately 50 remining sites per year. This is in line with historic data from DEP fact sheets available online, which indicate an average of 62 remining permits per year from 1998-2000.

yields an estimate of approximately $1.5 million in avoided cost for water treatment in year one.[38] As noted above, the benefits of remediation undertaken in a given year are retained in future years, since water treatment costs must be born each year absent remediation, and are therefore additive with remediation activity that takes place in subsequent years. Estimated water treatment value increases from $1.5 million in year one to $29 million in year twenty, totaling $306 million in nominal dollars over the twenty years modeled.

Fire/Air

Removal of coal refuse from the site reduces the number of coal refuse piles that could catch fire in the future. The value of this reduction can be quantified by estimating the avoided cost to the Commonwealth associated with responding to and addressing fewer burning piles.[39]

Currently, there are 52 known actively burning coal refuse piles around the Commonwealth. As reviewed in Section 2, these uncontrolled fires have a number of negative environmental consequences, producing noxious gasses[40] that can be fatal to vegetative life and harm human health. In addition, fires have the possibility of spreading beyond the refuse pile to adjacent areas, potentially including forests. These problems are compounded by the fact that the coal refuse is an energy source, and fires have the potential to burn for decades or even centuries before they are exhausted barring any intervention.

The extent of future coal refuse pile fires is unknown, and it is unclear if all existing fires have been reported. Coal refuse piles often catch fire through spontaneous combustion[41] but can also ignite due to a forest fire, lightning strike, or the nearby burning of garbage. While each of these factors is unpredictable, it is clear that each existing non-burning coal refuse pile contains some risk of ignition each year, and that risk is reduced by removal of the coal refuse pile and remediation of the site. Over the past three fiscal years, the BAMR has commissioned the extinguishing of two coal refuse fires, one at Simpson Northeast (completed May 2014) and one

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[38] Note that as referenced in Section 2.1, passive water treatment costs for projects awarded under the Commonwealth's Growing Greener program typically number in the hundreds of thousands of dollars per site, while capital costs for active water treatment facilities are often in the tens of millions in initial investment, which is then supplemented by ongoing treatment costs.

[39] From an economic cost-benefit standpoint, there may be instances in which the financial value of environmental benefits does not exceed the cost of addressing the fire. In those cases, absent a public safety threat, it may be rational for the Commonwealth to bear the environmental costs rather than address the fire. In these cases, the quantification of the costs of remediation may be overstated. Conversely, however, this approach does not consider the environmental costs prior to a fire being extinguished, which results in an understatement of "all-in" societal costs for addressing a new fire.

[40] Including: carbon monoxide, carbon dioxide, hydrogen sulfide, sulfur dioxide, ammonia, sulfur trioxide, sulfuric acid, and oxides of nitrogen

[41] Combustion is caused by the flow of air through the pile, which oxidizes the remaining material

at Staback Park (completed May 2015), both in Lackawanna County. The cost to the Commonwealth for extinguishing these fires averaged approximately $120,000 per acre. [42]

For the purpose of the quantification of benefits, it is assumed that at current levels, one additional un-remediated pile per year will ignite or one ongoing fire will worsen in condition, resulting in a public safety hazard requiring remediation. The reduction in this probability achieved through remediation activities is estimated based on the proportion of known statewide coal refuse tonnage consumed by the industry at historic levels of operation (10 million of 290 million tons). The value of this proportionate reduction in likelihood is calculated as an avoided cost based on response costs to the Commonwealth from the Simpson Northeast and Staback Park fires. This value is applied to the average coal refuse pile size statewide of approximately 12 acres to estimate the average cost to extinguish a coal refuse pile fire. This calculation yields an avoided cost to the Commonwealth of approximately $50,000 in year one. These benefits accumulate over time because once a coal refuse pile is remediated, the reduction in its potential to ignite is permanent rather than temporary, and therefore additive with benefits accrued from remediation in subsequent years. Therefore, the proportional reduction in the likelihood of a fire requiring intervention in year 20 is calculated as the reduction in fire probability attributable to the reclamation of all coal refuse piles over the full 20 year period. Estimated value therefore increases to $950,000 in year 20, totaling $10 million in nominal dollars over the twenty year period.

Public Safety

Remediation of coal refuse piles addresses a significant public safety hazard. As discussed in Section 2, abandoned mines and coal refuse piles pose a range of public safety hazards, including risks of catastrophes, such as mine explosions or floods and ongoing public health consequences related to fires or degraded water quality. This quantification focuses more narrowly on the social value of averting injuries related to the coal refuse piles themselves.

As noted in Section 2, coal refuse piles are frequently used for recreational purposes, particularly all-terrain vehicle (ATV) and bike riding. This activity can lead to serious injury and death due to the instability of the piles. Since 2005, there have been four documented deaths from ATV accidents on coal refuse piles in Pennsylvania, a rate of approximately 0.4 deaths per year.[43] In addition, there are likely many injuries of varying severity for each death associated with ATV activity on coal refuse piles. National data analyzed by the U.S. Consumer Product Safety Commission indicates that for every ATV fatality, there are approximately 160 ATV-related

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[42] Total contracted costs for Simpson and Staback, as reported by BAMR, was $2.46 million ($2.18 million for Simpson and $280,000 for Staback) to extinguish a total of 20.9 acres (17.6 for Simpson and 3.3 for Staback).

[43] United States Department of Labor: Mine Safety and Health Administration, "Stay Out – Stay Alive Fatal Accident Summaries, 1999-2014," www.arlweb.msha.gov.

injuries treated by the emergency department.[44] For the purpose of the quantification of benefits, this injury to fatality ratio is applied to the observed annual fatality level. As piles are removed, the number of injuries and deaths is expected to decline.

Valuation of fatalities and injuries averted is based on the framework established by the U.S. Department of Transportation (DOT) for the statistical value of a life and varying degrees of injury severity that are frequently used to evaluate the financial benefits of transportation initiatives. The latest guidance from DOT, issued in summer 2015, sets the value of a statistical life (VSL) at $9.4 million in 2013.[45] Further, DOT provides guidance on the fraction of a VSL attributable to categories of injuries (ranging from "Minor to Critical") for the purpose of cost-benefit analysis, and the relative frequency of such injury types as observed in National Highway Traffic Safety Administration data published in July 2011.[46] These relationships are used to distribute and valuate the estimated 160 injuries associated with each ATV-related fatality related coal refuse piles.

These benefits are then multiplied by the proportional reduction in injury likelihood represented by the remediation of 10 million tons of coal refuse per year (out of 290 million total) undertaken by the industry at historic levels of operation. This yields an injury value savings of approximately $640,000 in year one (of which $130,000 is attributable to the reduced probably of a fatality and $510,000 is attributable to the reduced probability of injuries). Importantly, these benefits compound as time goes on because once a coal refuse pile is remediated, public safety benefits remain in subsequent years. Therefore, averted injury value in year 20 is calculated as the reduction in the probability of injuries and fatalities due to the elimination of coal refuse piles over the full 20 year period. This value is estimated at $12.75 million in nominal dollars in year 20.

Land Reclamation

One of the most direct benefits accrues from the reclamation of land previously occupied by coal refuse piles, which can be put to a productive commercial, residential, or recreational use. These benefits accrue directly to property holders in the year they occur.

These increases also trigger long-term increases in the property tax base for local governments. The scale of this revenue increase is difficult to estimate since local tax structures vary significantly. In addition, the increased tax revenue does not represent a true added benefit from a societal perspective, since it is in practice a transfer from private land holders to government.

[44] United States Consumer Product Safety Commission. "2014 Annual Report of ATV-Related Deaths and Injuries." November 2015.

[45] United States Department of Transportation. "Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses – 2015 Adjustment." June 17, 2015.

[46] United States Department of Transportation. "TIGER Benefit-Cost Analysis (BCA) Resource Guide. Updated 3/27/15.

Therefore, quantification of this benefit is excluded from this analysis, which focuses on the one-time land value associated with the reclamation of land.

Historical data from ARIPPA indicates that member plants have remediated approximately 7,200 acres of land previously occupied by coal refuse piles over the life of the plants. This suggests a long-term average of approximately 300 acres reclaimed per year. Data provided by the Commonwealth DEP indicates that in fiscal years 2012, 2013, and 2014, 393 acres were reclaimed by the industry, an average of 131 acres per year. Annual reclamation levels for the purpose of the quantification of benefits were conservatively assumed to be 200 acres per year, in between recent and long-term annualized averages.

Further, the DEP has quantified reclamation value for abandoned mine lands reclaimed in recent years both by the coal refuse industry and through Government-Financed Construction Contracts (GFCCs). Total land value for fiscal years 2012-2015 for reclamation undertaken through these two methods was estimated at approximately $10,000 per acre. Notably, this DEP valuation quantifies not the cost of reclamation (which varies significantly by site based on the extent of environmental damage and the type of remediation activity undertaken), but rather per acre land value post-remediation. While GFCC and industry reclamation efforts differ significantly in their cost structure, resulting land values are similar, suggesting that this average valuation represents an appropriate proxy value for the land value of future reclamation work performed by the industry. Annual benefits are therefore estimated at 200 acres at approximately $10,000 per acre, or $2 million per year.

Nearby Property Value

Remediation of coal refuse piles also benefits nearby properties through the replacement of a significant disamenity with remediated land. These benefits accrue on a one-time basis to nearby property holders.[47]

Considerable econometric research exists on the positive effect of nearby amenities, and conversely the negative effect of nearby disamenities, on property value. In the case of the remediation of coal refuse piles, a significant disamenity (the coal refuse pile) is replaced with a productive use, either as open space or through commercial or residential development. For example, an analysis of three Pennsylvania landfills found that their presence decreased adjacent property values by an average of 2.7 to 13.7 percent.[48] In the case of the remediation of coal refuse piles, a negative amenity (the coal refuse pile) is often replaced with a positive amenity, in

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[47] As with the direct value of reclaimed land, increases in property value also generate increases in local tax revenue through increases in the property tax base. As above, this value is excluded from the calculation, as it represents a transfer rather than a new societal benefit, and can vary significant based on the local tax structure.

[48] Richard C. Ready, "Do Landfills Always Depress Nearby Property Values?" *Journal of Real Estate Research* 32: 3 (2010), 321-339.

the form of open space created through remediation. Therefore, the "net change" in nearby values may be even greater.

For the purpose of the quantification of benefits, a 5% increase in property values was assumed for property within one-quarter mile of the remediated site, consistent with the economic literature. Initial nearby property values are conservatively assumed to be equivalent to the value of remediated sites, at approximately $10,000 per acre.[49]

Estimating the acreage within one-quarter mile of remediated sites requires spatial analysis of piles of various sizes. Coal refuse piles for which total acreage were assumed to be circular, and pile diameter was calculated from reported acreage. This diameter was extended out one-quarter of a mile and the net difference between acreage for the larger area and the initial pile acreage was calculated for each pile. This net difference represents the impacted nearby property. This approach yields an estimate that on average, there are approximately 16 acres of property within one-quarter mile for each acre of a coal refuse pile. This estimate is applied to the assumption of 200 acres a year of remediation due to industry activities, yielding an estimate of approximately 3,200 acres of nearby property positively impacted by remediation efforts. Applying a 5% increment in property value to the a value of approximately $10,000 per acre yields an annual benefit due to remediation of approximately $1.6 million in increased nearby property value.

Summation of Quantified Benefits

The five categories of benefits described above are calculated on an annual basis in years 1 through 20 and aggregated to estimate the total value of environmental and public use benefits attributable to industry activity at historic operating levels. As described above, these benefits represent a combination of avoided costs and positive benefits attributable to the activity of the industry relative to that activity not taking place.[50] Results of this calculation are shown in Table 3.3 below.

Year 1 benefits total $5.8 million, with more than half derived from direct land reclamation and increases in nearby property value associated with land reclamation. Over time, environmental and public safety benefits, which compound over time as a greater portion of the remaining coal refuse piles are remediated, begin to supply to majority of the benefits. Water remediation is the largest category, generating $306 million in nominal terms over the 20 year time horizon.

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[49] Note that this value is conservative because nearby properties may have significant residential or commercial development already in place. For example, a residential area may have several homes within one-quarter mile of a site, with aggregate value of improvements (i.e. homes) in the hundreds of thousands or millions.

[50] Total benefits are expressed as the net difference between societal benefits accumulated (a positive number) and costs avoided (a negative number).

In total, benefits accelerate from nearly $6 million in year 1 to nearly $47 million in year 20, and total more than $520 million in nominal terms, averaging $26 million per year over the 20 year time period (see Table 3.3). [51]

TABLE 3.3 – QUANTIFICATION OF ENVIRONMENTAL AND PUBLIC USE BENEFITS OVER 20 YEAR TIME SPAN ($M)

Category	Benefit Type	Year 1	Year 10	Year 20	Total	20 Year Avg
Water	Cumulative	$1.5	$14.6	$29.2	$306.2	$15.3
Fire/Air	Cumulative	$0.1	$0.5	$1.0	$10.0	$0.5
Public Safety	Cumulative	$0.6	$6.4	$12.8	$133.9	$6.7
Land Reclamation	One-Time	$2.0	$2.0	$2.0	$40.4	$2.0
Nearby Property Value	One-Time	$1.6	$1.6	$1.6	$32.6	$1.6
Total		**$5.8**	**$25.1**	**$46.5**	**$523.1**	**$26.2**

Source: ESI Calculation

[51] It is worth repeating that the quantification of benefits in this analysis is entirely forward-looking, in that future activity is designated as "year one" and activity undertaken by the industry to date is excluded. This framework makes clear, however, that the remediation already undertaken by the industry over more than two decades of activity continues to generate significant financial and societal benefit to Pennsylvania into the future.

4.0 ECONOMIC IMPACT

The coal refuse industry is a major economic generator and a major employer within the Commonwealth. The activities of the industry extend well beyond the 14 plants themselves, encompassing the full fuel cycle of mining, transportation, energy generation and environmental remediation. Each of these expenditures, which represent the direct footprint of the industry, in turn create indirect and induced "multiplier" effects within the Pennsylvania economy. This section describes and quantifies those effects in terms of economic output (Section 4.4), job creation (Section 4.5) and tax revenue generation (Section 4.6).

4.1 METHODOLOGY

Direct economic activity generated by the coal refuse industry translates into additional economic activity within Pennsylvania in multiple ways:

- First, some proportion of the direct expenditures that goes to the purchase of goods and services gets circulated back into an economy when those goods and services are purchased from local vendors. This represents what is called the "indirect effect," and reflects the fact that local purchases of goods and services support local vendors, who in turn require additional purchasing with their own set of vendors.

- Second, the ARIPPA member plants and the associated businesses pay annual salaries to their employees. That labor income gets circulated back into an economy when those employees spend some of their earnings on various goods and services. This represents what is called the "induced effect," and reflects the fact that some of those goods and services will be purchased from local vendors, further stimulating a local economy.

The total economic impact is the sum of its own direct economic footprint plus the indirect and induced effects generated by that direct footprint. As described in Section 4.2 below, estimates of the direct economic footprint of the industry are derived primarily from information provided by member plants through a survey completed in April and May 2016. As described below, the "coal refuse industry" is not limited to operations conducted directly by the plants, but also includes services related to the coal refuse fuel cycle (including remining, transportation, and environmental remediation) that may, in some cases, be contracted by plants to other firms, but would not take place if not for the existence of the industry.

Direct inputs are modeled using IMPLAN, an input/output modeling software used to assess the economic and job creation impacts of economic development projects, the creation of new businesses, and public policy changes. IMPLAN modeling translates an initial amount of direct economic activity into the total amount of economic activity that it supports, which includes multiple waves of spillover impacts generated by spending on goods and services and by spending of labor income by employees. These increases in economic activity are then translated into attendant fiscal impacts using a custom fiscal model for the Commonwealth of Pennsylvania, which is developed by comparing observed levels of economic activity with observed revenue collections (i.e. effective tax rates). [52]

4.2 MEMBER SURVEY

To model the economic impact of the coal refuse industry in Pennsylvania, information was requested from ARIPPA's 14 member plants on various operational and budgetary metrics via a confidential online survey. The survey responses were used to determine the aggregate operating profile for Pennsylvania's coal refuse industry.[53]

Member plants vary in capacity, annual production, employment, average salaries, and total operating costs. They also vary as to which components of the energy generation and environmental remediation cycle are performed by the entity operating the plant, and which are contracted out to other providers. This study seeks to quantify the economic impact of the coal refuse industry rather than simply the operational impact of member plants. Therefore, services integral to the production of the industry (such as mining, transportation, etc.) are included as direct expenditures associated with the industry, regardless of whether services are contracted out or performed directly by member plants.

As reviewed in Section 1 of this report, energy market pricing has declined significantly in recent years, changing production incentives for producers. Therefore, while the cost structure has been relatively fixed, energy generation levels and thus total costs have declined significantly. This has led to reductions in employment and economic impact. In order to illustrate this change in operations overtime, survey responses were collected for two operating years: 2015 and the most recent year for which the plant was operating at base load. Base load refers to a plant that is operating consistently to meet a continuous energy demand.

Energy production for the industry in 2015 was reported to be 33% lower than base loaded levels.[54] Although a few plants were not negatively impacted during the 2015 calendar year, the

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[52] See Appendix A for a more complete description of ESI's economic and fiscal impact modeling approach.

[53] While the survey was sent to all 14 plants, four member plants were unable to disclose full operating details for confidentiality purposes. The 10 completed responses, which accounted for 80 percent of electricity generation, were used to determine industry standards on operating costs and energy output. These industry standards allowed ESI to build a full model of the entire coal refuse industry in Pennsylvania, including all 14 ARIPPA member plants. ESI received confirmation from some non-reporting plants that their operational and cost structure conformed with industry averages given their production capacity.

[54] It is important to note that the most recent year of base loaded operations varies by plant. The base load metrics therefore represent a hypothetical operating year which would only occur if all plants were operating at baseload in the same calendar year. However, it should be noted that total energy production as recently as 2010 was 10.52 million Mwh, or 97.5% of the base load level reported below. Therefore, this base loaded level is not inconsistent with historic operation levels for the industry under power purchase agreements.

majority of plants generated significantly less energy in 2015 than they produced during their most recent year operating at base load (see Table 4.1).

TABLE 4.1 – ARIPPA MEMBER PLANT ENERGY GENERATION AT BASE LOAD AND IN 2015

Plant	Capacity (MW)	Energy Generation at base load (Mwh)	Energy Generation 2015 (Mwh)	% Change
Seward	525	3,724,944	1,600,000	-57%
Northampton Generating Co	107	926,535	452,512	-51%
Colver Power Project	102	829,280	829,280	0%
Cambria Cogen Company	85	748,615	602,336	-20%
Panther Creek Energy	83	579,413	479,531	-17%
Scrubgrass Generating	83	696,692	615,627	-12%
Schuylkill Energy Resources Inc.	80	706,609	686,034	-3%
Gilberton Power Company	80	585,516	584,648	0%
Kimberly Clark Chester Plant	60	302,863	167,557	-45%
Northeastern Power Company	52	401,455	188,753	-53%
Ebensburg Power	50	429,747	196,979	-54%
Wheelabrator Frackville Energy Company	42	350,000	350,000	0%
Mt. Carmel Cogen	40	285,052	285,052	0%
Westwood Generation	30	219,873	202,844	-8%
Total	**1,419**	**10,786,594**	**7,241,154**	**-33%**

Source: ARIPPA (2015), ARIPPA member survey (2016)

4.3 DIRECT INDUSTRY OPERATING EXPENDITURES AND EMPLOYMENT

There are a variety of distinct costs associated with the operations of the coal refuse industry. Broadly, these include

- Fixed costs (including utilities, administration, insurance, regulatory and compliance fees, equipment and supplies) that occur regardless of the production level of the plant;
- Labor costs, which are largely fixed in the short-run but will vary over time to respond to production demand; and
- Variable costs which are directly responsive to production levels.

Plants have fixed operating costs such as utilities, administrative costs, regulatory and compliance fees, insurance costs, equipment rentals, supplies, and some forms of maintenance.[55] These costs do not fluctuate significantly with an increase or decrease in energy generation but instead stay relatively constant each year. In aggregate, it is estimated that plant fixed costs total nearly $100 million on an annual basis.

Direct labor costs make up a significant portion of the operating costs for coal refuse plants. ARIPPA member plants reported annual salaries of more than $70,000 for their employees. It is estimated, in aggregate, the 14 plants directly employ 540-570 workers with nearly $40 million in employee compensation. There are additional direct labor costs associated with mining activities if mining services are performed in-house. For many plants, all mining activities are performed by direct employees. In other cases, mining services are contracted out to local businesses.

In addition to salaries directly paid to the employees and other fixed costs at each of the 14 plants, operating a coal refuse plant requires significant variable costs. These expenditures include the fuel cycle costs (mining costs, transportation costs, land reclamation costs), limestone moving costs, and maintenance costs. It is important to note, however, that only some of these services are performed by plant employees. In many cases, these additional services are contracted out to specific trucking, mining, or maintenance businesses. For each megawatt-hour of energy generated, it is estimated that variable costs equate to $22 and $23 (see Table 4.2).

TABLE 4.2 – VARIABLE ENERGY GENERATION COSTS PER MWH

Variable Energy Generation Costs	Cost per MWh (base load)	Cost per MWh (2015)
Mining costs	$9.18	$9.39
Transportation costs	$5.32	$5.44
Reclamation costs	$2.42	$2.67
Limestone moving costs	$2.49	$2.59
Variable Maintenance costs	$1.49	$1.77
Other	$1.06	$1.07
Total Variable Costs	**$21.96**	**$22.94**

Source: ARIPPA member survey (2016)

To capture the entire impact of the coal refuse industry, the model includes direct fixed and variable expenditures made by each of the plants in addition to the expenditures associated with all the trucking, mining, and limestone moving businesses supported by the plant operations.

55 Note that maintenance costs are divided between variable maintenance costs (shown in Table 4.2), which vary with the level of production, and fixed maintenance costs, which are constant regardless of the specific level of energy generation provided that the plant is operational. In a sense, these costs are not truly "fixed" because they could be eliminated, but doing so would make the facility non-operational. Therefore, they are effectively fixed for any non-zero level of production.

Without the ARIPPA member plants, the businesses which support the plants (trucking, mining, limestone moving, etc.) would likely not exist. The direct output therefore includes all expenditures and labor supported by the coal refuse industry in Pennsylvania, both within and outside of the 14 ARIPPA member plants. In total, it estimated that the industry directly supports 1,820 full-time equivalent employees. However, in 2015, the industry directly supported 1,450 jobs, a 26 percent decline in employment from operations at base load.

Table 4.3 below shows annual fixed costs, labor costs, and variable costs for the industry. At base load levels, industry expenditures total more than $430 million, $250 million of which (58%) is variable energy generation costs. In 2015, industry expenditures were $347 million, with variable expenditures falling to approximately 50% of total expenditures.

TABLE 4.3 – ANNUAL INDUSTRY OPERATING EXPENDITURES

	Annual Expenditures (base load)	Annual Expenditures (2015)
Fixed Costs ($M)	$95.6	$90.9
Labor Costs ($M)	$87.0	$83.3
Variable Costs ($M)	$249.5	$173.0
Total Expenditures ($M)	**$432.1**	**$347.1**

Source: ARIPPA member survey (2016)

As detailed in Section 1.4.3, member survey data indicates that these expenditures are projected to continue to fall in 2016, with production anticipated to drop by approximately one-third from already depressed 2015 levels due to the significant decline in energy prices. Since variable energy generation costs make up such a significant component of industry expenditures, this decline will have immediate contractionary effects on the economic impact of the industry. Further, these forces will ultimately reduce labor expenditures and fixed expenditures through layoffs and plant closures absent a change in the economics of the industry.

In addition to annual operating expenditures, a significant investment of capital was made by plant owners during the initial plan construction process. Initial development costs for plants total in the hundreds of millions. These investments have been supplemented with periodic upgrades in major components such as boilers and turbines. These investments are frequently in the millions of dollars, and are above and beyond the routine maintenance costs reflected in the annual operations above and included in the annualized economic impact reflected in this report.

4.4 ANNUAL ECONOMIC IMPACTS FROM INDUSTRY OPERATIONS

Direct industry expenditures generate indirect and induced impacts, which sum to the total economic output associated with the industry. Further, these direct, indirect, and induced expenditures support significant employment and earnings within the Commonwealth.

In a calendar year in which all plants were operating at base load, direct operating expenditures of $432 million from Pennsylvania's coal refuse industry would be estimated to generate $736 million in economic impact and support 3,600 jobs with $223 million in earnings.[56]

In 2015, direct output of the coal refuse industry, which includes all operating expenditures and labor income totaled approximately $347 million each year, down 20 percent from plant operations at base load. The operations of the coal refuse plants in Pennsylvania generated an estimated economic impact of $589 million and supported approximately 2,800 jobs and $186 million in earnings in the Commonwealth (see Table 4.4).

TABLE 4.4 – ANNUAL ECONOMIC IMPACT OF THE COAL REFUSE INDUSTRY IN PENNSYLVANIA

	Base load	2015	% Change
Direct Jobs (FTE)	1,820	1,450	-26%
Direct Output ($M)	$432	$347	-20%
Indirect & Induced Output ($M)	$304	$241	-21%
Total Output ($M)	**$736**	**$589**	**-20%**
Total Employment (FTE)	**3,600**	**2,800**	**-20%**
Total Earnings ($M)	**$223**	**$186**	**-17%**

Source: ARIPPA (2016), ESI (2016), IMPLAN (2013)

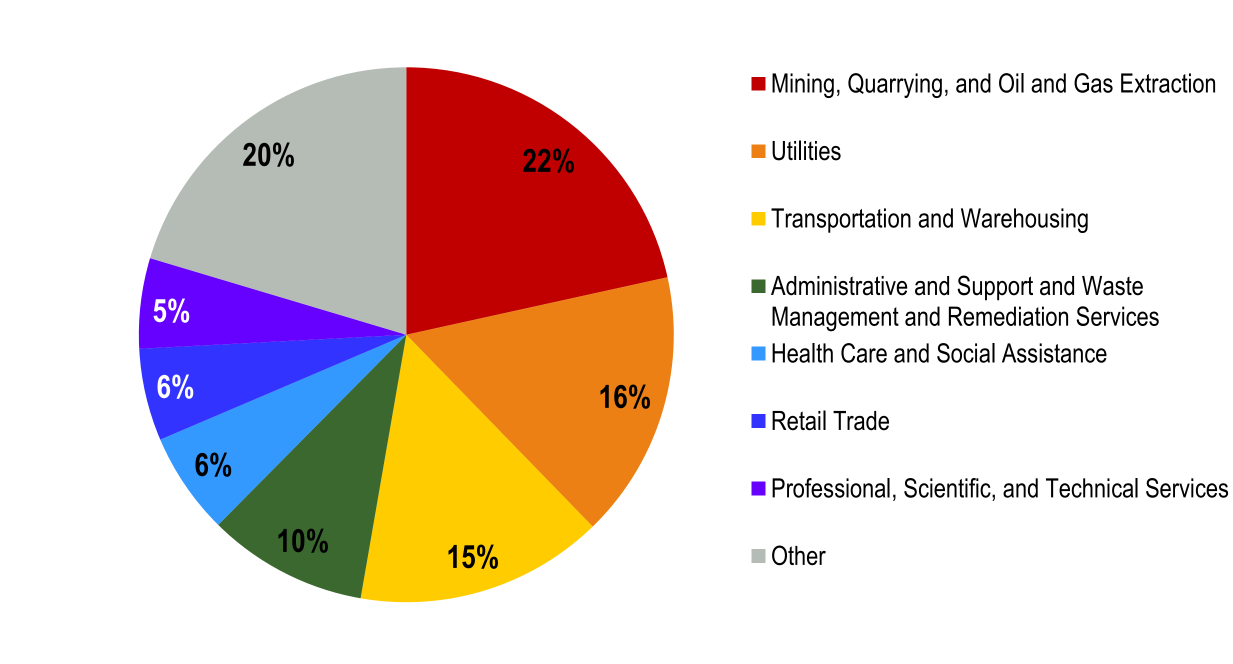
4.5 EMPLOYMENT IMPACTS FROM INDUSTRY OPERATIONS

In an interconnected economy, the economic footprint of the coal refuse industry has impacts well beyond the energy sector. Supply chain impacts ripple through industries providing a variety of goods and services that support the activities of the industry. Moreover, the wages generated by the industry circulate through the economy as they are re-spent in a variety of sectors.

Figure 4.1 below shows the distribution of total (direct, indirect and induced) employment supported by coal refuse industry operations by sector. While energy and mining sectors represent the largest impact, nearly half of all jobs supported by the industry occur outside of the mining, utilities, and transportation sectors. Other industries outside of those listed below, which include industrial machinery and equipment repair, environmental services, and other service sector, make up about 20% of total employment impact, indicating that a "long tail" of sectors benefits from the activities of the industry.

[56] Note that this analysis conservatively applies no inflation adjustment to base load levels, despite the fact that base load levels for most plants last occurred between 2010 and 2014.

FIGURE 4.1 – EMPLOYMENT IMPACT OF THE COAL REFUSE INDUSTRY IN PENNSYLVANIA IN CALENDAR YEAR 2015



Source: ARIPPA (2016), ESI (2016), IMPLAN (2013)

4.6 FISCAL IMPACT FROM INDUSTRY OPERATIONS

The increases in economic output and employment associated with industry operations also yield significant increases in state and local tax bases. Fiscal impacts result both from the set of direct taxes and fees paid by plants and from increases in tax revenue (notably income and sales taxes) associated with the additional income generated by industry operations. These revenues result not only from the direct operations and employment of the industry, but from the impacts of the indirect and induced impacts estimated above on various state and local tax bases.

Table 4.5 below quantifies fiscal impacts to the Commonwealth of Pennsylvania from the direct, indirect, and induced impact of annual operations of the industry in four broad categories.[57]

- Income tax revenue from the increased labor income associated with the industry is estimated to be $6.3 million per year at base load, and $5.4 million in 2015.
- Sales tax revenue from the increased output in the Commonwealth economy associated with the industry is estimated to be $6.7 million per year at base load, and $5.7 million in 2015.

[57] See Appendix A-5 for a more complete description of ESI's fiscal modeling approach.

- Business tax revenue associated with profits accruing both within the industry and in other industries benefiting from the increased economic activity attributable to the industry is estimated to be $1.6 million at base load and $1.4 million in 2015.

- Environmental taxes and fees paid directly by industry plants, including emittance fees, permit fees, and reclamation bonding, total $4.4 million at base load and $4.7 million in 2015.[58]

In sum, estimated fiscal impacts associated with the industry for the Commonwealth of Pennsylvania total $19.7 million at base load and $17.3 million for 2015 (see Table 4.5).

TABLE 4.5 – FISCAL IMPACT OF THE COAL REFUSE INDUSTRY TO THE COMMONWEALTH OF PENNSYLVANIA ($M)

Tax Type	Operations (at base load)	Operations (2015)
Income	$6.6	$5.5
Sales	$7.0	$5.7
Business	$1.7	$1.4
Environmental Taxes and Fees	$4.4	$4.7
Total	**$19.7**	**$17.3**

Source: IMPLAN (2013), State of Pennsylvania Tax Compendium (2013), ESI (2016), ARIPPA (2016)

In addition to taxes accruing to the Commonwealth, the industry generates significant tax revenue for local counties, municipalities, and school districts, most notably through property taxes as well as other local service fees. These impacts are difficult to quantify on a statewide basis, due to the varying tax structures of local municipalities. However, as discussed in the section that follows, they represent essential revenue streams in small communities across Pennsylvania's coal country.

It should also be noted that the employment supported by the industry not only generates revenue for the Commonwealth, but reduces government expenditures associated with increased levels of unemployment, including social services and public safety.

58 Note that this calculation conservatively excludes 3rd party taxes and fees that are not borne directly by the plants but likely would not take place absent the operations of the industry.

5.0 IMPORTANCE OF INDUSTRY TO RURAL COMMUNITIES

The coal refuse industry plays a prominent role in rural and disadvantaged communities across Pennsylvania's two legacy coal regions, revitalizing both economic and environmental conditions. Plants are economic and community anchors for their host jurisdictions, serving as employment hubs and large components of the local tax base, both directly and indirectly. Local residents are also the largest beneficiaries of the environmental impacts of remediation undertaken by the industry, which improves quality of life and property values. In addition, plants have undertaken significant community investments, including infrastructure improvements and recreational upgrades that benefit the entire community.

5.1 ECONOMIC AND PUBLIC BENEFITS

Coal refuse plants are linchpins of the rural communities in which they are located. This role is particularly vital in light of the economic challenges of Pennsylvania's legacy coal counties.

Range of Employment Supported

The broader coal industry, like the coal refuse industry, faces a new set of environmental and market-driven challenges. EPA regulations and the falling price of natural gas have led power plants to turn from coal to natural gas and renewable energy sources. Since 2008, Pennsylvania has lost approximately 1,100 coal power jobs – more than 25 percent of total employment in the industry.

As the demand for new coal mining and production drops, the continued operation of coal refuse-fired plants offers stability in the face of economic insecurity and hardship faced by most coal communities in Pennsylvania. In 2015, the seven legacy coal counties in which plants are located each had an unemployment rate in excess of the Pennsylvania state annual average, and an average annual wage below the state average (see Table 5.1). The activities of coal refuse plants not only sustain direct employment within these counties, but create a ripple-effect of economic opportunity through the economic stimulus and spending power they generate.

TABLE 5.1 – UNEMPLOYMENT RATE IN LEGACY COAL COUNTIES WITH COAL REFUSE PLANTS, 2015

County	Unemployment Rate	Average Wage
Cambria	6.4%	$36,800
Carbon	5.8%	$34,700
Indiana	6.1%	$43,600
Northampton	5.1%	$45,500
Northumberland	5.9%	$37,300
Schuylkill	6.1%	$38,900
Venango	5.8%	$37,000
State of PA	**4.7%**	**$52,200**

Source: Bureau of Labor Statistics Local Area Unemployment Statistics (2015 Annual Average)
Bureau of Labor Statistics Quarterly Census of Employment and Wages (2015)

The coal refuse industry provides and supports a variety of family-sustaining jobs, from entry level (manual) to technical (engineering) up to management and finance positions. Average wages for plant employees are greater than $70,000 per year which is nearly double the average annual wage in the surrounding counties (see Table 5.1 above). Annually, total direct labor income associated with the industry is in excess of $100 million.

The industry generates direct and spin-off jobs in a variety of areas including operations and management, maintenance, trucking, mining, remediation and reclamation. These sectors represent stable career options that allow families to put down roots within communities. The industry is also employment intensive relative to newer energy technologies, which increases its impact on its host communities. The labor income generated by this activity has significant ripple implications within small communities. Stable employment opportunities increase consumer spending on housing and goods and services, and support jobs in the service-provision sector.

Tax Revenue Generation

Plants are also major contributors to the tax base of local communities and counties. For most local jurisdictions, property taxes are the primary revenue stream supporting local services and school districts. With assessed values in the millions of dollars, plants are typically among the largest property taxpayers in local communities.

Beyond direct property ownership, plant activities contribute to local real estate values in a number of ways:

- As a major employment center, plants are a key driver of residential demand within surrounding communities.

- This residential demand and the associated household income translates to commercial demand within a range of sectors.

- The environmental remediation activities of coal refuse plants generate direct land value, and increase adjacent property values by converting a disamenity (coal refuse piles) into a productive use.

These property value increases are beneficial both to local jurisdictions and their citizens. Homes typically represent the largest element of personal financial net worth, meaning that growth in these assets has significant implications for residents. Meanwhile, jurisdictions are able to provide needed services without increases in property tax rates.

Industry supported economic activity can also impact a range of other local taxes and fees. Earned income taxes, often assessed at the county level, are generated through the employment income supported by the industry. Plants are also a significant contributor to municipal service fee revenues.

5.2 COMMUNITY INVESTMENTS

In addition to the coal refuse industry's role in improving the economic and environmental health of local communities by their economic, fiscal and environmental impacts, plants make numerous investments that benefit communities. These include infrastructure investments, scholarships, charitable contributions, community service, and environmental stewardship.

Infrastructure

Plants contribute to their community immensely by investing in infrastructure and community spaces that benefit the general public. Many plants assist communities with the maintenance of reservoirs while allowing recreational access. In addition, many have built public roads, highways, and bridges in their respective local communities that serve the general public, in addition to improving access to plant facilities. Prominent examples include:

- Panther Creek removed and reclaimed the coal refuse banks along the Nesquehoning Creek and stocked the creek with trout. Additionally, Panther Creek helped to repair the 4th Hollow Reservoir in Nesquehoning by granting the Borough an interest-free loan.

- Colver invested $7 million in new construction and reconstruction of 3.5 miles of state road – that includes a dedicated truck route -- from the power station to U.S. Route 422. This provides quick access to the Route and zero trucking impact on the community. The Colver Power Project also invested $20 million dollars in order to reconstruct the Vetera Dam and the Colver Reservoir.

- Cambria Cogen Company built a community park, which includes a playground, ball fields, basketball courts, pavilions, etc. and allows their reservoir to be used by the community for fishing, kayaking, and accessing public drinking water.

- Mount Carmel Cogeneration, Inc. donated land for a little league field for local children.

- In order to promote traffic safety, Seward Power Plant used $30 million to build a new bridge over a state road and nearby Norfolk Southern rail line. The company also purchased new traffic signals along the roads most frequently used for trucks bringing shipments to the plant.

- Ebensburg Power Company and Cambria Cogen currently provide funding to the local water authority to help maintain and manage the Wilmore Dam.

- The Wheelabrator Frackville cogeneration facility supports their town of Morea by maintaining local parks and supplying funds for water tank repairs.

Contributions and Community Service

In addition to providing the community with public parks and infrastructure, the plants also serve the local residents financially and through programming. Each plant's survey response provided a variety of details on ways in which they have served and continue to serve the local community.[59]

- *Educational services:* The ARIPPA member plants serve local schools by organizing tours of their plant for local elementary and high school students attending career days at neighborhood schools, and awarding education scholarships for nearby students. To date, the Colver Power Project in Cambria County has awarded 74 continuing education scholarships to graduates of four local high schools. Additionally, some plants offer internship programs for state university students in engineering, technology, chemistry, safety science, and mathematic fields.

- *Employment services:* These coal refuse plants are committed to hiring full and part-time workers from the community. Panther Creek and Westwood Generation, LLC both report hiring summer help locally. When 16 coal miners were displaced in Cambria County, the Colver Power Project enrolled them in "power plant school" through the PA Customized Job program and, upon completion of the program, hired all 16 as full-time employees.

- *Event services:* Some plants host and support specific events such as Earth Day presentations, plant tours, charity golf tournaments, and county fairs.

[59] The list is in no way inclusive of all significant contributions made to the community as the following examples merely provide a representation of each plant's contribution to the area.

- *Additional financial support:* Additional services to the community include financially supporting community events and associations such as local bike-a-thons, Adopt-A-Highway programs, volunteer fire companies, anti-drug awareness programs, the Make-A-Wish Foundation, local libraries, food banks, community parks, head start programs, and church groups.

<u>ARIPPA Investments</u>

ARIPPA, the industry trade group, also partners with environmental groups, community organizations, and conservation districts to improve the landscape and environmental health of Pennsylvania coal regions. Each year, ARIPPA partners with the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) and the Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR) and awards up to $20,000 in grants to watershed organizations working on Abandoned Mine Land (AML) and Acid Mine Drainage (AMD) remediation projects. Recent grant winners included the Elk and Huntingdon County Conservation Districts, the Allegheny Land Trust, the Mehoopany Creek Watershed Association, and Centralia Illegal Dump Site Cleanup. Funded projects include: the limestone dosing of creeks, AML analysis, the purchase and installation of a new AMD treatment system, and repairing eroded stream banks.

Beyond environmental clean-ups, ARIPPA grants also support community development projects and provide opportunities for vulnerable populations. One such project was an ARIPPA-funded grant for the McGlynn Learning Center in Wilkes-Barre, which provides after-school tutoring, recreational, and cultural activities for low-income children. With funding from ARIPPA, children at the Center built bluebird boxes for AML and AMD sites throughout the Wyoming Valley and for their own community housing developments. Through its community investments, ARIPPA partners with organizations that share its commitment to improving the environmental health and quality of life in rural communities throughout Pennsylvania.

6.0 SUMMARY OF BENEFITS

As reviewed throughout this report, the activities of Pennsylvania's coal refuse industry deliver a range of environmental, economic and community benefits to the Commonwealth and its citizens. Plants remove coal refuse piles left behind by Pennsylvania's mining industry, thereby addressing environmental and public safety hazards and reclaiming land for productive use. Their operations generate significant economic stimulus in the rural communities of Pennsylvania's coal country, and directly and indirectly support thousands of jobs with family-sustaining wages. Plants are also anchors in their communities, both as economic and employment hubs and as community partners.

As described within this report, marketplace and regulatory challenges, including steep declines in energy prices driven in part by growth in natural gas production, have forced cutbacks in activity levels for the coal refuse industry, and threaten to lead to further layoffs and plant closure. Given these challenges, it is useful to consider the annual environmental, economic, fiscal and community contributions of the industry when operating at historic activity levels. This section summarizes the range of benefits described and quantified throughout this report.

6.1 ENVIRONMENTAL BENEFITS AND PUBLIC BENEFITS

The coal refuse industry is historically the most prolific actor in the remediation of coal refuse piles across the Commonwealth. Industry trade group ARIPPA reports that over more than two decades of operation, member plants have consumed more than 200 million tons of coal refuse, improved or restored more than 1,200 miles of polluted streams, and reclaimed more than 7,000 of acres of land.

Despite these efforts, the volume of remaining coal refuse across the Commonwealth is daunting. The inventory of refuse piles kept by the Commonwealth's Bureau of Abandoned Mine Reclamation (which is acknowledged to be non-comprehensive) identifies 840 piles throughout the Commonwealth, which are estimated to be nearly 300 million tons of coal refuse and to cover nearly 10,000 acres. These coal refuse piles cause numerous environmental and public safety hazards, depress property values, and prevent land from being returned to productive use.

Due to budgetary constraints, the Commonwealth is typically forced to address the negative impacts of coal refuse piles on a reactive, rather than proactive basis, due in part to the cost structure of remediation for the Commonwealth relative to the coal refuse industry. The industry has developed a comprehensive fuel cycle, in which coal refuse is used to produce energy, offsetting mining and transportation costs, and beneficial use ash returned to mining sites for reclamation. The Commonwealth, by contrast, cannot generate energy and attendant revenue with refuse, does not have beneficial ash available for reclamation, and most crucially, must pay to dispose safely of coal refuse that it removes. As a result, the remediation activities of the industry are far more cost-effective than those of the Commonwealth, and result in a greater level of environmental remediation.

The environmental activities of the coal refuse industry deliver benefits to the Commonwealth and its residents across a number of categories. At historic operating levels, the industry is estimated to consume 10 million tons of coal refuse and remediate 200 acres per year, improving numerous waterways in the process. These activities yield quantifiable benefits in terms of air and water quality, public safety, and land value estimated to total nearly $6 million in year one. Further, many of these benefits compound over time, with remediated areas continuing to deliver benefits in terms of avoided costs to state and local government on an ongoing basis. Benefits are estimated to grow to nearly $47 million by year 20, totaling more than $520 million and averaging $26 million over a twenty year period (see Table 6.1).

TABLE 6.1 – QUANTIFICATION OF ENVIRONMENTAL AND PUBLIC USE BENEFITS OVER 20 YEAR TIME SPAN ($M)

Category	Benefit Type	Year 1	Year 10	Year 20	Total	20 Year Avg
Water	Cumulative	$1.5	$14.6	$29.2	$306.2	$15.3
Fire/Air	Cumulative	$0.1	$0.5	$1.0	$10.0	$0.5
Public Safety	Cumulative	$0.6	$6.4	$12.8	$133.9	$6.7
Land Reclamation	One-Time	$2.0	$2.0	$2.0	$40.4	$2.0
Nearby Property Value	One-Time	$1.6	$1.6	$1.6	$32.6	$1.6
Total		**$5.8**	**$25.1**	**$46.5**	**$523.1**	**$26.2**

6.2 ECONOMIC BENEFITS

The coal refuse industry also provides a major source of economic activity and employment within the Commonwealth. The activities of the industry generate jobs across the fuel cycle, including mining, transportation, plant operations and management, and environmental remediation activities. Wages are family-sustaining, averaging more than $70,000 for direct plant employees. Further, these direct expenditures have indirect and induced "multiplier" effects within the Commonwealth economy, as suppliers and employees of the industry re-spend dollars that rippled through a variety of sectors.

At historic operating levels, the industry generates an annual economic impact of nearly $740 million. This activity directly and indirectly supports 3,600 jobs, with total earnings of more than $220 million (see Table 6.2).

Further, these increases in economic activity are associated with significant increases in the tax base for the Commonwealth of Pennsylvania. At historic operating levels, this activity is estimated to generate nearly $20 million in annual taxes and fees for the Commonwealth of Pennsylvania through sales, income and business taxes and environmental taxes and fees (see Table 6.3).

TABLE 6.2 – ANNUAL ECONOMIC IMPACT OF THE COAL REFUSE INDUSTRY IN PENNSYLVANIA AT BASE LOAD LEVELS

	Base load
Direct Output ($M)	$432
Indirect & Induced Output ($M)	$304
Total Output ($M)	**$736**
Total Employment (FTE)	**3,600**
Total Earnings ($M)	**$223**

TABLE 6.3 – ANNUAL FISCAL IMPACT OF THE COAL REFUSE INDUSTRY TO THE COMMONWEALTH OF PENNSYLVANIA AT BASE LOAD LEVELS ($M)

Tax Type	Base Load
Income	$6.6
Sales	$7.0
Business	$1.7
Environmental Taxes and Fees	$4.4
Total	**$19.7**

6.3 COMMUNITY BENEFITS

These environmental and economic benefits are particularly salient given their concentration in the rural communities of Pennsylvania's coal regions. Many of the areas containing the greatest concentrations of abandoned mine lands and coal refuse piles not only face the environmental legacy of decades of coal production, but have struggled to provide economic opportunities to residents as the state and national economy have shifted away from the industries concentrated there. The coal refuse industry provides community anchors for small towns in these areas in several ways:

- Plants provide a major hub of employment activity, with their activities directly and indirectly supporting a range of employment at a variety of skill levels;

- Their environmental remediation activities improve quality of life for local residents by reducing blight, improving public health and safety and restoring recreational and scenic value;

- They serve as major contributors to the local tax base to support government services, through the direct value of their properties and through the economic stimulus and quality of life improvements they engender;

- They make significant investments in the community through public-serving infrastructure improvements, as well as contributions through scholarships, educational services and donations.

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APPENDIX A – ECONOMIC AND FISCAL IMPACT METHODOLOGY

A.1 OVERVIEW

Economic impact estimates are generated by utilizing **input-output models** to translate an initial amount of direct economic activity into the total amount of economic activity that it supports, which includes multiple waves of spillover impacts generated by spending on goods and services and by spending of labor income by employees. This section summarizes the methodologies and tools used to construct, use, and interpret the input-output models needed to estimate the coal refuse industry's economic and fiscal impact.

A.2 INPUT-OUTPUT MODEL THEORY

In an inter-connected economy, every dollar spent generates two spillover impacts:

- First, some amount of the proportion of that expenditure that goes to the purchase of goods and services gets circulated back into an economy when those goods and services are purchased from local vendors. This represents what is called the "**indirect effect**," and reflects the fact that local purchases of goods and services support local vendors, who in turn require additional purchasing with their own set of vendors.

- Second, some amount of the proportion of that expenditure that goes to labor income gets circulated back into an economy when those employees spend some of their earnings on various goods and services. This represents what is called the "**induced effect**," and reflects the fact that some of those goods and services will be purchased from local vendors, further stimulating a local economy.

The role of input-output models is to determine the linkages across industries in order to model out the magnitude and composition of spillover impact to all industries of a dollar spent in any one industry. Thus, the total economic impact is the sum of the direct economic footprint plus the indirect and induced effects generated by that direct footprint.

A.3 INPUT-OUTPUT MODEL MECHANICS

To model the impacts resulting from the direct expenditures generated by Pennsylvania's coal refuse industry, Econsult Solutions, Inc. developed a customized economic impact model using the **IMPLAN** input/output modeling system. IMPLAN represents an industry standard approach to assess the economic and job creation impacts of economic development projects, the creation of new businesses, and public policy changes.

IMPLAN is one of several popular choices for regional input-output modeling. Each system has its own nuances in establishing proper location coefficients. IMPLAN uses a location quotient to determine its regional purchase coefficient (RPC). This represents the proportion of demand for a good that is filled locally; this assessment helps determine the multiplier for the localized region. Additionally, IMPLAN also accounts for inter-institutional transfers (e.g. firms to households, households to the government) through its Social Account Matrix (SAM) multipliers. IMPLAN takes the multipliers and divides them into 440 industry categories in accordance to the North American Industrial Classification System (NAICS) codes.

These economic impacts in turn produce one-time or ongoing increases in various tax bases, which yield temporary or permanent increases in various tax revenues. To estimate these increases, Econsult Solutions, Inc. created a **fiscal impact model** to translate total economic impacts into their commensurate tax revenue gains for the Commonwealth.

A.4 EMPLOYMENT AND WAGES SUPPORTED

IMPLAN estimates the direct jobs employed by the project or activity being modeled. These estimated direct jobs will be displayed in the report unless the number of jobs is known beforehand by the project's owner, and if provided, will be noted in the body of the report. The project/activity expenditures also support induced and indirect jobs. These are jobs not directly employed by the project, but instead are employees who work for the project's vendors and employees who work at businesses frequented by those employees directly employed by the project. We report the total jobs supported by the project, therefore all direct, indirect, and induced jobs. These jobs are a mix of full-time and part-time jobs.

IMPLAN generates job estimates based on the term job-years, or how many jobs will be supported each year. For instance, if a construction project takes two years, and IMPLAN estimates there are 100 employees, or more correctly "job-years" supported, over two years, that represents 50 jobs each year. The 50 jobs represent the annualized number of jobs supported by the construction project. The job can be the same each year such as the coffee barista serving the directly employed construction workers or different if in the first year of the project a welder is needed and in the second year of the project an electrician is required.

The total income is for all direct, indirect and induced jobs. It includes proprietor income, wages, and all benefits. Since many projects/events require the employment sourced from multiple industries, the average wages paid will be different per industry. Therefore, it is not correct to divide the total labor income and divide it by the total job-years to derive an average employee compensation estimate.

A.5 FISCAL IMPACT MODEL

The IMPLAN model provides estimates of the economic impact of a project, program or industry on the regional or state economy. However, it provides an imprecise estimate of the combined fiscal impact of the increased economic activity on state and local governments. Consequently, ESI has constructed a custom fiscal model to estimate impacts for the Commonwealth of Pennsylvania, using established ratios between economic activity and tax revenues to establish effective tax rates for the Commonwealth.

The IMPLAN model provides estimates of direct, indirect, and induced expenditures, labor income, and employment within the defined region. The ESI fiscal impact model combines the IMPLAN output with the relevant tax types and tax bases associated with the jurisdiction or jurisdictions for which fiscal impact is being modeled. Specifically, the estimated labor income supported by the direct, indirect, and induced expenditures generated by the model are used to apportion the net increase in the relevant tax bases and therefore in those tax revenue categories. The resulting estimates represent the projected tax revenue gains to the jurisdiction or jurisdictions as a result of the increased business activity and its attendant indirect and induced effects.

A.6 ABOUT ECONSULT SOLUTIONS, INC.

This report was produced by Econsult Solutions, Inc. ("ESI"). ESI is a Philadelphia-based economic consulting firm that provides businesses and public policy makers with economic consulting services in urban economics, real estate economics, transportation, public infrastructure, development, public policy and finance, community and neighborhood development, planning, as well as expert witness services for litigation support. Its principals are nationally recognized experts in urban development, real estate, government and public policy, planning, transportation, non-profit management, business strategy and administration, as well as litigation and commercial damages. Staff members have outstanding professional and academic credentials, including active positions at the university level, wide experience at the highest levels of the public policy process and extensive consulting experience.