Regulatory Impact Analysis
For EPA's Proposed RCRA Regulation
Of Coal Combustion Residues (CCR)
Generated by the Electric Utility Industry

Prepared by:

US Environmental Protection Agency
Office of Resource Conservation & Recovery (ORCR)
(formerly Office of Solid Waste)
1200 Pennsylvania Avenue NW (Mailstop 5305P)
Washington DC, 20460 USA

30 April 2010

Acknowledgements

EPA Contractor Support & EPA Staff Assistance for this RIA

In 2009 under EPA contract EP-W-07-0011, work assignment 2-33, Industrial Economics Inc. (Cambridge MA) and its sub-contractor DPRA Inc (Minneapolis MN) provided data analysis support for identifying affected entities and estimating baseline CCR disposal practices and costs (**Chapter 3**), and for estimating costs of regulatory engineering control requirements (**Chapter 4)** in this RIA.

EPA ORCR staff contributing to this RIA: Rachel Alford, Richard Benware, Mark Eads, Christina Kager, and Scott Palmer.

Table of Contents

Table of Appendices

Note: Because of its large number of pages (>400 pages), the Appendix is provided as a separate companion document to this RIA.

Executive Summary

This RIA evaluates the expected regulatory compliance costs, economic and environmental benefits, and potential impact on CCR beneficial use, of EPA's proposed regulation of coal combustion residual (CCR) disposal by coal-fired electric utility plants. The CCR disposal regulatory options evaluated in this RIA are based on EPA's statutory authority contained in the 1976 Resource Conservation and Recovery Act (RCRA). The main findings of this RIA are summarized below according to six sections:

ES-1: Regulatory Options Evaluated in this RIA
ES-2: Benefits of Avoided Future Groundwater Contamination (Human Health Protection & Avoided Remediation Costs)
ES-3: Benefits of Avoided Future CCR Impoundment Structural Failures (Avoided Cleanup Costs)
ES-4: Economic and Environmental Benefits from Future Increase in CCR Beneficial Uses by Other Industries
ES-5: Regulatory Compliance Costs
ES-6: Comparison of Regulatory Benefits to Costs

ES-1: Regulatory Options Evaluated in this RIA

This RIA evaluates three options for RCRA regulation of CCR disposal at coal-fired electric utility plants. All options (a) maintain the existing Bevill regulatory exclusion for CCR beneficial uses, and (b) propose the same set of 10 custom-tailored engineering controls (i.e., technical design and operating standards) for CCR disposal units:

1. Subtitle C "Special Waste" Option: Regulate CCR landfills and impoundments as a "*special waste*" under Subtitle C requirements, and would require phase out of impoundments within five years.

2. Subtitle D Option (version 2): Composite liners required for all (i.e., existing and future new) CCR impoundments but only for new landfills. For any CCR landfills and impoundments that closed before the effective date, there would be no regulatory controls over those units, unless the states choose to adopt controls over such units. Also, all surface impoundments (existing and new) would need to have composite liners within 5-years of the effective date.

3. Subtitle "D prime" Option: Composite liners required only for new impoundments and landfills; unlined units could continue to operate. This approach would be the same as the Subtitle D option above, except that existing impoundments would not be required to retrofit and install a composite liner, or close.

ES-2: Benefits of Avoided Future Groundwater Contamination (Human Health & Avoided Remediation Costs)

By establishing management and permit standards for CCR disposal units under RCRA, the proposed regulatory options will reduce uncontrolled releases and cancer risks, and improve detection and, if necessary, response to future groundwater contamination. This RIA quantifies two components of groundwater protection benefits: (a) human cancer risks avoided from drinking contaminated groundwater, and (b) groundwater contamination remediation costs avoided. **Summary Exhibit 1** below presents the monetized results of this evaluation.

- Estimate of avoided human cancer risks from avoided future groundwater contamination by CCR disposal units:
    - Individual skin cancer risks avoided (by eliminating the groundwater pathway for arsenic at CCR impoundments) are estimated up to 2 x 10^{-2} (i.e., a probability equal to 2 individual human skin cancer incidence risks for every 100 persons exposed) using the current IRIS skin cancer slope factor for arsenic.
    - 30,400 people use drinking water wells within one mile of coal-fired electric utility plants; of which 8,150 (27%) are children.
    - Taking into account current CCR disposal unit designs, an estimated **145** (using the IRIS cancer slope factor) to **2,509** (using the NRC lung and bladder cancer slope factor[1]) future human cancer risks are expected to occur in absence of the proposed RCRA regulation, based on drinking water exposure to arsenic in CCR.
- Other human health risks from CCR disposal units not quantified in this RIA:
    - Human non-cancer risks, including from selenium, cobalt, nitrate/nitrite, and molybdenum, which may be released to groundwater at levels above the MCL or 3 times the human hazard quotient (HQ).
    - Cancer and non-cancer risks from arsenic and other metals released in effluent from CCR impoundments to surface waters.

Summary Exhibit 1
Future Avoided Human Cancer Risks & Avoided Groundwater Remediation Cost Benefits
($millions present value @7% discount rate over 50-years)

Groundwater Protection Benefit Category	Subtitle C special waste	Subtitle D (version 2)	Subtitle "D prime"
Groundwater Remediation Costs Avoided	$466	$168	$84
Monetized Value of Cancer Risks Avoided	$504	$207	$104
Total =	$970	$375	$188

ES-3: Benefits of Avoided Future CCR Impoundment Structural Failures (Avoided Cleanup Costs)

This RIA estimated future avoided cleanup costs from catastrophic impoundment failures, like the one that occurred at TVA's Kingston TN coal-fired electricity plant in December 2008, which would be prevented under the proposed rule. Given the increasing age of CCR

[1] EPA calculated a new cancer slope factor for arsenic from data in the National Research Council report "Arsenic in Drinking Water: 2001 Update" at http://www.nap.edu/openbook.php?isbn=0309076293

impoundments, the relative number that present high or significant hazard potential, and the history of CCR impoundment failures to date, this RIA presents three alternative scenarios of future catastrophic failures, the result for which are displayed in **Summary Exhibit 2** below:

- Failure Scenario #1: Extrapolation of future CCR impoundment failure probability based on the relative (a) recent historical occurrence frequency, (b) CCR quantity release magnitude, and (c) cleanup costs, associated with three recent (2005, 2008, 2009) CCR impoundment failures which exceeded 1 million gallons in release quantity each.
- Failure Scenario #2: Assumes 10% of CCR impoundments in the high failure risk group (i.e., above 40 feet tall and over 25 years old) fail over the next 20 years in absence of RCRA regulation.[2]
- Failure Scenario #3: Assumes 20% of CCR impoundments in the high failure risk group (i.e., above 40 feet tall and over 25 years old) fail over the next 20 years in absence of RCRA regulation.

Summary Exhibit 2
Avoided Future CCR Impoundment Catastrophic Failure Cleanup Costs
($millions present value @7% discount rate)

Impoundment Failure Scenarios	Subtitle C special waste	Subtitle D (version 2)	Subtitle "D prime"
Failure Scenario #1: Extrapolation of three recent (2005, 2008, 2009) CCR impoundment failure events	$5,285	$2,378	$1,216
Failure scenario #2: Assuming 10% of 96 high-risk impoundments fail	$8,366	$3,795	$1,897
Failure Scenario #3: Assuming 20% of 96 high-risk impoundments fail	$16,732	$7,590	$3,795

The proposed regulation has categories of other benefits from avoiding future CCR impoundment structural failures which this RIA did not quantify and monetize, including potential avoided costs associated with a few possible benefit categories:

1. Litigation costs: Avoided litigation and related costs associated with such damage events.
2. Riparian damages: Reduction of toxic chemical contaminated effluent discharges from CCR impoundments to surface waters (i.e., rivers and lakes) through future phase-out of surface impoundments.[3]
3. Non-cancer health risks: Reduction in human health risks from future reduction in human exposure to non-carcinogenic but otherwise toxic chemicals contained in CCR, such as selenium, cobalt, nitrate/nitrite, and molybdenum, which, as currently managed in CCR

[2] Based on the responses to our CERCLA 104(e) information requests to utilities with impoundments, there are 96 impoundments that meet these criteria. However, this RIA estimates that 16 of these impoundments have closed or are expected to close before the CCR rule is finalized and goes into effect. Therefore, this analysis removed these 16 impoundments and based the estimated future impoundment failure cleanup costs on a subset of 80 CCR impoundments meeting the 'at risk' criterion.

[3] EPA is developing a regulatory proposal under the Clean Water Act to revise the current effluent guidelines for steam electric utilities. Current guidelines only control pH, total chlorine, and total suspended solids (TSS). EPA's proposed CCR rule would eliminate CCR surface impoundments, eliminating much of the risk that would be addressed under revisions to the effluent guidelines, including risks posed by arsenic, selenium, mercury, cadmium, copper, chromium, and nickel.

disposal units, can exceed the human health hazard quotient (HQ) or Maximum Contaminant Limit (MCL). **Chapter 5** of this RIA provides a list of contaminants of concern in CCR surface impoundment effluent and potential human health and environmental effects.

4. Dry CCR disposal risks: Human health effects from improperly managed dry disposal, which are based on ongoing research by EPA's Office of Research & Development (ORD), may pose greater risks than previously estimated by EPA in 2000 and 2007.

ES-4: Economic & Environmental Benefits from Future Increase in CCR Beneficial Uses by Other Industries

This RIA evaluated the potential impact that the CCR proposed rule may have on beneficial uses of CCR by other industries. Baseline CCR beneficial use at the current 62 million tons per year rate (2009) is estimated in this RIA to provide $26 billion per year in nationwide social benefits consisting of: (a) materials cost savings, plus (b) lifecycle avoided pollution benefits, plus (c) avoided CCR disposal costs to the electric utility industry. On a present value basis over the 50-year future period-of-analysis (2012-2061) applied in this RIA, the present value of CCR beneficial use amounts to $778 billion (@7% discount). Although the industries which use CCR for beneficial uses are not subject to the requirements of the CCR proposed rule, this RIA presents three alternative scenarios of potential induced effect of the CCR rule on future CCR beneficial use, consisting of increased use (scenario #1), decreased use (scenario #2), and no change (scenario #3). This RIA quanfities both scenario #1 and scenario #2 incrementally in relation to the "no change" scenario #3. EPA believes the increasing beneficial use scenario #1 is most likely because (a) the proposed CCR regulation is targeted at CCR disposal not at CCR beneficial uses, (b) all CCR regulatory options retain the existing RCRA Bevill exemption for CCR beneficial uses, and (c) the added cost of regulatory compliance will make beneficial use relatively more cost-effective and represent an "*avoided disposal cost incentive*"[4] to electric utility plants to increase their supply of CCR to industrial markets for CCR as a raw or intermediate input into industrial manufacturing and construction activities. Furthermore, EPA does not believe that market "stigma" of CCR regulation under RCRA Subtitle C --- as alleged in numerous stakeholder letters to the EPA in 2009 --- will result in a reduction in future annual CCR beneficial use, because the proposed rule designates the Subtitle C option as a "*special waste*" rather than as a "*hazardous waste*." **Summary Exhibit 3** below presents the results for both the increase scenario #1 and the decrease scenario #2.

[4] The concept of "*avoided disposal cost incentive*" is recognized and defined by the American Coal Ash Association (ACAA) on its website as follows:

"*If a [coal-fired electric utility] plant markets its [CCR] into commercial applications, then disposal of this [CCR] is not required. Not only is a revenue stream created for the [coal-fired electricity plant] but also the need to dispose of the [CCR] is avoided. As discussed above, disposal is not just the transportation and placement of [CCR] in a disposal site. The need for future space is a concern. If [CCR is] marketed, then the need to develop future [CCR disposal] sites (including land acquisition, permitting, design and construction costs) is avoided …. It is not uncommon for a company to help offset the costs of transportation or placement at construction sites by providing the contractor or trucking firm a payment of some sort. For example, if the cost of disposal at a plant is normally four dollars a ton, then the company may arrange a payment of four dollars or less to the contractors to cover transportation and placement costs. The difference between the amount of this payment and the cost of disposal is also referred to as "avoided disposal costs*." Source: ACAA Frequently Asked Question nr. 14 webpage at: http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=5#Q14

Summary Exhibit 3 Induced Effect of RCRA Regulation of CCR Disposal on Future Annual CCR Beneficial Use ($millions present value @7%)			
Scenarios	Subtitle C special waste	Subtitle D (version 2)	Subtitle "D prime"
Scenario #1: Induced Increase in CCR Beneficial Use			
Percentage increase relative to baseline CCR beneficial use	+11%	+4%	+2%
Economic market value	+$5,560	+$2,224	+$890
Lifecycle social value	+$84,489	+$33,796	+$13,518
Scenario #2: Induced Decrease in CCR Beneficial Use			
Percentage decrease relative to baseline CCR beneficial use	-18%	No impact	No impact
Economic market value	-$18,744	No impact	No impact
Lifecycle social value	-$233,549	No impact	No impact

ES-5: Regulatory Compliance Costs

Chapter 4 of the RIA presents the estimated costs for industry compliance (and for government implementation) of each regulatory option. **Summary Exhibit 4** below presents the estimated costs on a present value basis. The RIA presents three categories of regulatory compliance cost. These regulatory costs are incremental to an estimated $5,556 million per year average annual baseline (i.e., current) cost to the electric utility industry for CCR disposal, which represents a baseline cost of $76,678 million in present value on a 7% and 50-year discounting basis.

Summary Exhibit 4 Estimate of Regulatory Implementation & Compliance Cost ($millions present value @7% over 50-years)			
Cost Category	Subtitle C special waste	Subtitle D (version 2)	Subtitle "D prime"
1. Engineering controls	$6,780	$3,254	$3,254
2. Ancillary costs	$1,480	$5	$5
3. Dry conversion cost	$12,089	4,836	$0
Total Cost (1+2+3) =	$20,349	$8,095	$3,259
Increase over baseline CCR disposal cost =	+27%	+11%	+4%

The dry conversion cost estimate incorporates projection of the recent (1995-2009) electric utility industry trend converting away from wet CCR disposal to dry CCR disposal. In fact, there are several upcoming EPA regulations which could accelerate this trend but are not reflected in the cost estimate of this RIA. These are anticipated rules under the Clean Air Act which will increase the installation of air pollution scrubbers and other air emission control technology at coal-fired power plants, as well as new wastewater effluent guidelines under the Clean Water Act which will require installation of treatment technology for wastewater discharges from CCR impoundments to surface waters.

ES-6: Comparison of Regulatory Benefits to Industry Compliance Costs

The set of three **Summary Exhibits 5, 6 and 7** below compare the estimated regulatory costs to estimated regulatory benefits, using "net benefits" and "benefit-cost ratio" comparison indicators. The three Exhibits are based on the three alternative scenarios about the potential induced impact of the CCR rule on future annual CCR beneficial use as presented in Section 5C of this RIA (i.e., increase, decrease, and no change, respectively). All three Summary Exhibits below present costs, benefits, and net benefits on both a present value and average annualized equivalent basis, based on a 7% discount rate. A set of exhibits in **Chapter 6** of this RIA present these values based on a 3% rate.

Summary Exhibit 5
Comparison of Regulatory Benefits to Costs
Scenario #1 – Induced Increase in Future Annual CCR Beneficial Use
($Millions @2009$ Prices and @7% Discount Rate over 50-Year Future Period-of-Analysis 2012 to 2061)

Impact Element	Subtitle C "Special Waste"	Subtitle D (version 2)	Subtitle "D prime"
A. Present Values:			
1. Regulatory Costs (1A+1B+1C):	$20,349	$8,095	$3,259
1A. Engineering Controls	$6,780	$3,254	$3,254
1B. Ancillary Regulatory Requirements	$1,480	$5	$5
1C. Conversion to Dry CCR Disposal	$12,089	$4,836	$0
2. Regulatory Benefits (2A+2B+2C+2D):	$87,221 to $102,191	$34,964 to $41,761	$14,111 to $17,501
2A. Monetized Value of Human Cancer Risks Avoided	$504 (726 cancer risks)	$207 (296 cancer risks)	$104 (148 cancer risks)
2B.Groundwater Remediation Costs Avoided	$466	$168	$84
2C. CCR Impoundment Failure Costs Avoided	$1,762 to $16,732	$793 to $7,590	$405 to $3,795
2D. Induced Impact on Future CCR Beneficial Use	$84,489	$33,796	$13,518
3. Net Benefits (2 - 1)	$66,872 to $81,842	$26,869 to $33,666	$10,852 to $14,242
4. Benefit/Cost Ratio (2 / 1)	4.286 to 5.022	4.319 to 5.159	4.330 to 5.370
B. Average Annualized Equivalent Values:*			
1. Regulatory Costs (1A+1B+1C)	$1,474	$587	$236
1A. Engineering Controls	$491	$236	$236
1B. Ancillary Regulatory Requirements	$107	<$1	<$1
1C. Conversion to Dry CCR Disposal	$876	$350	$0
2. Regulatory Benefits (2A+2B+2C+2D):	$6,320 to $7,405	$2,533 to $3,026	$1,023 to $1,268
2A.Monetized Value of Human Cancer Risks Avoided	$37	$15	$8
2B. Groundwater Remediation Costs Avoided	$34	$12	$6
2C. CCR Impoundment Failure Cleanup Costs Avoided	$128 to $1,212	$58 to $550	$29 to $275
2D. Induced Impact on Future CCR Beneficial Use	$6,122	$2,450	$980
3. Net Benefits (2 - 1)	$4,845 to $5,930	$1,947 to $2,439	$786 to $1,032
4. Benefit/Cost Ratio (2 / 1)	4.286 to 5.022	4.319 to 5.159	4.330 to 5.370

* Note: Average annualized equivalent values calculated by multiplying 50-year present values by a 50-year 7% discount rate "capital recovery factor" of 0.07246.

Summary Exhibit 6 Comparison of Regulatory Benefits to Costs Scenario #2 – Induced Decrease in Future Annual CCR Beneficial Use ($Millions @2009$ Prices and @7% Discount Rate over 50-Year Future Period-of-Analysis 2012 to 2061)			
Impact Element	Subtitle C "Special Waste"	Subtitle D (version 2)	Subtitle "D prime"
A. Present Values:			
1. Regulatory Costs (1A+1B+1C)	$20,349	$8,095	$3,259
1A. Engineering Controls	$6,780	$3,254	$3,254
1B. Ancillary Costs	$1,480	$5	$5
1C. Conversion to Dry CCR Disposal	$12,089	4,836	$0
2. Regulatory Benefits (2A+2B+2C+2D):	($230,817) to ($215,847)	$1168 to $7,965	$593 to $3,983
2A. Monetized Value of Human Cancer Risks Avoided	$504 (726 cancer risks)	$207 (296 cancer risks)	$104 (148 cancer risks)
2B. Groundwater Remediation Costs Avoided	$466	$168	$84
2C. CCR Impoundment Failure Costs Avoided	$1,762 to $16,732	$793 to $7,590	$405 to 3,795
2D. Induced Impact on CCR Beneficial Use	($233,549)	$0 (no impact)	$0 (no impact)
3. Net Benefits (2-1)	($251,166) to ($236,196)	($6,927) to ($130)	($2,666) to $724
4. Benefit/Cost Ration (2/1)	(11.343) to (10.607)	0.144 to 0.984	0.182 to 1.222
B. Average Annualized Equivalent Values:*			
1. Regulatory Costs (1A+1B+1C)	$1,474	$587	$236
1A. Engineering Controls	$491	$236	$236
1B. Ancillary Costs	$107	$0.36	$0.36
1C. Dry Conversion	$876	$350	$0
2. Regulatory Benefits (2A+2B+2C+2D):	($16,725) to ($15,640)	$85 to $577	$43 to $289
2.A Monetized Value of Human Cancer Risks Avoided	$37	$15	$8
2.B Groundwater Remediation Costs Avoided	$34	$12	$6
2.C CCR Impoundment Failure Cleanup Costs Avoided	$128 to $1,212	$57 to $550	$29 to $275
2.D Induced Impact on CCR Beneficial Use	($16,923)	NA	NA
3. Net Benefits (2-1)	($18,199) to ($17,115)	($502) to ($9)	($193) to $52
4. Benefit/Cost Ration (2/1)	(11,347) to (10.610)	0.145 to 0.983	0.182 to 1.225
* Note: Average annualized equivalent values calculated by multiplying 50-year present values by a 50-year 7% discount rate "capital recovery factor" of 0.07246.			

Summary Exhibit 7 Comparison of Regulatory Benefits to Costs Scenario #3 – No Impact on Future Annual CCR Beneficial Use ($Millions @2009$ Prices and @7% Discount Rate over 50-Year Future Period-of-Analysis 2012 to 2061)			
Impact Element	Subtitle C “Special Waste”	Subtitle D (version 2)	Subtitle “D prime”
A. Present Values:			
1. Regulatory Costs (1A+1B+1C)	$20,349	$8,095	$3,259
1A. Engineering Controls	$6,780	$3,254	$3,254
1B. Ancillary Costs	$1,480	$5	$5
1C. Conversion to Dry CCR Disposal	$12,089	4,836	$0
2. Regulatory Benefits (2A+2B+2C+2D):	$2,732 to $17,702	$1168 to $7,965	$593 to $3,983
2A. Monetized Value of Human Cancer Risks Avoided	$504 (726 cancer risks)	$207 (296 cancer risks)	$104 (148 cancer risks)
2B. Groundwater Remediation Costs Avoided	$466	$168	$84
2C. CCR Impoundment Failure Costs Avoided	$1,762 to $16,732	$793 to $7,590	$405 to $3,795
2D. Induced Impact on CCR Beneficial Use	$0 (no change)	$0 (no change)	$0 (no change)
3. Net Benefits (2-1)	($17,617) to ($2,647)	($6,927) to ($130)	($2,666) to $724
4. Benefit/Cost Ration (2/1)	0.134 to 0.870	0.144 to 0.984	0.182 to 1.222
B. Average Annualized Equivalent Values:*			
1. Regulatory Costs (1A+1B+1C)	$1,474	$587	$236
1A. Engineering Controls	$491	$236	$236
1B. Ancillary Costs	$107	$0.36	$0.36
1C. Dry Conversion	$876	$350	$0
2. Regulatory Benefits (2A+2B+2C+2D):	$198 to $1,283	$85 to $577	$43 to $289
2.A Monetized Value of Human Cancer Risks Avoided	$37	$15	$8
2.B Groundwater Remediation Costs Avoided	$34	$12	$6
2.C CCR Impoundment Failure Cleanup Costs Avoided	$128 to $1,212	$57 to $550	$29 to $275
2D. Induced Impact on CCR Beneficial Use	$0	$0	$0
3. Net Benefits (2-1)	($1,277) to ($192)	($502) to ($9)	($193) to $52
4. Benefit/Cost Ration (2/1)	0.134 to 0.870	0.145 to 0.983	0.182 to 1.225
* Note: Average annualized equivalent values calculated by multiplying 50-year present values by a 50-year 7% discount rate “capital recovery factor” of 0.07246.			

Chapter 1
Problem Statement: The Need for RCRA Regulation of CCR Disposal

1A. Institutional Context

For purpose of evaluating Federal regulations, the 1993 Executive Order 12866 "Regulatory Planning and Review" (Section 1(b)(1)) requires each Federal regulatory agency to identify the problem that it intends to address, including where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of the problem. In line with this requirement, this Chapter provides a problem statement consisting of the institutional context (i.e., prior EPA actions), significance of the problem (i.e., evidence of environmental damages), and characterization of market failure.

In September 2003, the White House Office of Management and Budget (OMB) updated its guidance to federal agencies on the development of regulatory analysis required under Section 6(a)(3)(c) of the 1993 Executive Order 12866[5] "Regulatory Planning and Review." The updated guidance is OMB's September 17, 2003 "Circular A-4 Regulatory Analysis."[6] Section A (Introduction) of Circular A-4 defines three key elements of good regulatory analysis:

1. Statement of the need for the proposed regulation.
2. Examination of alternative approaches.
3. Evaluation of the benefits and costs (quantitative and qualitative) of the proposed regulation and the main alternatives.

Concerning the first basic element listed above (i.e., statement of the need for regulation), Section B of Circular A-4 requires federal agencies to demonstrate that the proposed regulation is necessary. The Circular defines four categories of possible regulatory need:

1. Required by law: If the need results from statutory or judicial directive, agencies should describe the:
    a. specific authority for the proposed regulation
    b. extent of discretion available to the agency
    c. regulatory instruments available
2. Necessary to interpret law.
3. Market failure: Three examples cited in Circular A-4 (pages 4 & 5) are:
    a. externality, common property resources and public goods
    b. non-competitive market power
    c. inadequate or asymmetric information
4. Other social purposes: Six examples cited in Circular A-4 (page 5) are:
    a. make government operate more efficiently

[5] 1993 Executive Order 12866 (11 pages) is available at: http://www.whitehouse.gov/OMB/inforeg/eo12866.pdf
[6] 2003 OMB Circular A-4 (48 pages) is available at: http://www.whitehouse.gov/OMB/Circulars/a004/a-4.pdf

b. redistribute resources to select groups
c. prohibit discrimination
d. protect privacy
e. permit more personal freedom
f. promote other democratic aspirations

As explained below, EPA's proposed RCRA[7] regulation of coal combustion residual (CCR) disposal at coal-fired electricity plants is both **required by law** and will **correct market failure**.

1B. EPA's Proposed Regulation of CCR Disposal Is Required by Law

In 1976, Congress amended the 1965 Solid Waste Disposal Act (the first federal statute that specifically focused on improving solid waste disposal methods) by adding industrial hazardous waste management requirements as Subtitle C, among other new requirements. This amendment is the 1976 Resource Conservation & Recovery Act (RCRA). The EPA's regulatory evaluation of coal combustion residues (CCR) dates back to 1978, two years after enactment of RCRA. In December 1978, the EPA proposed the first industrial hazardous waste regulations to implement Subtitle C (i.e., Sections 3001 to 3020 of RCRA). At that time, the EPA recognized that certain large-volume industrial wastes, including wastes from the combustion of fossil fuels (aka "CCR" as named in this RIA), might warrant special treatment under RCRA regulation. On 18 December 1978, EPA proposed but deferred and never finalized a relatively limited set of ten RCRA Subtitle C industrial hazardous waste regulations for the management of CCR.[8] Included in this deferral of hazardous waste requirements were six categories of industrial wastes --- which EPA termed "special wastes"[9] --- until further study and assessment could be completed by EPA to determine their risk to human health and the environment. The six categories of special wastes included:

1. Cement kiln dust
2. Mining waste
3. Oil and gas drilling muds and oil production brines
4. Phosphate rock mining, beneficiation, and processing waste
5. Uranium waste
6. Utility waste (i.e., fossil fuel combustion waste by electric utility plants)

These wastes typically are generated in large volumes and, at the time, were believed to possess less risk to human health and the environment than the wastes being identified for regulation as RCRA hazardous waste. On 12 October 1980, Congress enacted the Solid Waste Disposal Act Amendments of 1980 (Public Law 96-482) which amended RCRA in several ways. Pertinent to "special wastes" were the Bentsen and

[7] RCRA = Resource Conservation & Recovery Act of 1976: http://www.epa.gov/waste/laws-regs/rcrahistory.htm
[8] Federal Register, Vol. 43, No. 243, 18 December 1978, page 59015, section 250.46-2 "Utility Waste" of "Hazardous Waste Guidelines and Regulations." This action proposed the following ten regulatory conditions: (a) waste analysis standards, (b) waste site selection standards, (c) waste site security, (d) waste shipment manifesting, (e) recordkeeping, (f) reporting, (g) waste site visual inspections, (h) waste site closure, (i) waste site post-closure care, and (j) groundwater monitoring.
[9] To learn more about these six "special wastes" see EPA's special waste website at http://www.epa.gov/osw/nonhaz/industrial/special/index.htm

Bevill Amendments[10] which exempted “special wastes” from regulation under Subtitle C of RCRA until further study and assessment of risk could be performed:

- 1980 Bentsen Amendment (RCRA 3001(b)(2)(A)): Exempted drilling fluids, produced waters, and other wastes associated with the exploration, development, and production of crude oil or natural gas or geothermal energy.
- 1980 Bevill Amendment (RCRA 3001(b)(3)(A)(i-iii)): Exempted **fossil fuel combustion waste**; waste from the extraction, beneficiation, and processing of ores and minerals (including phosphate rock and overburden from uranium ore mining); and cement kiln dust.

The Bevill and Bentsen Amendments required EPA to complete full assessments of each exempted waste and submit a formal report to Congress on its findings. As itemized in **Appendix A** to this RIA, since 1978, EPA continued to evaluate CCR (as well as the other five waste categories) for different possible RCRA hazardous and non-hazardous waste regulatory approaches. The proposed RCRA regulation this RIA supports is a continuation of those prior evaluations.

1C. EPA’s Proposed Regulation of CCR Disposal Will Correct Market Failure

OMB’s 2003 Circular A-4 “Regulatory Analysis” guidance (pages 4 to 5) to Federal agencies for implementation of Executive Order 12866 identifies three major types of market failure:

1. Externality, common property resource, and public good
2. Market power (i.e., lack of market competition from monopolies)
3. Inadequate or asymmetric information

The CCR proposed rule which this RIA supports may be characterized as addressing the “negative externality” of environmental pollution and damages from CCR disposal landfills and impoundments. As summarized in the “Benefits” **Chapter 5** of this RIA, there are a number of historical and recent environmental damage cases which represent externalities, in that some or all of the (a) human health damages (i.e., human cancer cases from contaminated groundwater near CCR disposal sites) and (b) environmental damages (i.e., ecological damages, natural resource damages, and socio-economic damages from CCR spills/releases from structural failures in CCR disposal impoundments) may be external to the capital and operating costs of the electric utility plants. If implemented, the CCR proposed rule may be expected to reduce this market failure externality, by internalizing into the capital and operating costs of the electric utility plants, the added costs of installing engineering controls and oversight of the physical integrity of CCR disposal units.

Firms are sometimes held accountable for some of the external costs through lawsuits brought by affected citizens. However, the system of accountability can be imperfect. The primary human bearers of the external costs from CCR disposal are households residing disposal units. When an unorganized group of households suffer external costs, they face a host of obstacles to having their costs recuperated. They must

[10] These 1980 RCRA “special waste” amendments are named after US Senator Lloyd Bentsen (D-TX; Senate service years 1971-1993) and US House Congressman Tom Bevill (D-AL; House service years 1967-1997). Source: Biographical Directory of the US Congress at http://bioguide.congress.gov/biosearch/biosearch.asp

form a coherent organization and they must have enough funding to launch and maintain a lawsuit. On the other side of such litigation, households usually face a single firm often with greater legal funding resources. This imbalance suggests that external costs of leachate contamination from industrial waste disposal sites (such as CCR landfills and impoundments) may not be recuperated.

The CCR proposed rule also addresses a second source of market failure – inadequate or asymmetric information. Citizens residing near CCR disposal sites may be unaware of exposure to chemical contaminants contained in CCR leaching from disposal units. Thus, while nearby citizens may have the right to legal lawsuits to recuperate health and property damages, citizens may not be aware of the need to do so until health risks (and health costs) have already been incurred.

A very recent example of negative externalities associated with structural failures is the ecological and socio-economic damages and costs associated with a large environmental disaster involving the collapse of a CCR impoundment in 2008. On 22 December 2008, over a billion gallons (i.e., 5.4 million cubic yards) of CCR was unintentional environmental released over 300 acres from the collapse of a Tennessee Valley Authority (TVA) coal-fired electric utility surface impoundment in Kingston TN. This event caused significant damage to 40 homes, the Emory River, a nearby recreational lake, community roadways, a gas pipeline, and a railroad. As indicated in **Exhibit 5B-2** of this RIA, the estimated cleanup costs to the TVA --- not including social costs of ecological damages and community socio-economic damages --- are estimated at $933 million to $1.2 billion. This event attracted major citizen, national press, and Congressional interest in the subject of CCR management and the urgent need for prevention of such future environmental and community damages. In the wake of this disaster, during her 14 January 2009 Senate confirmation hearing, EPA Administrator-designate Lisa P. Jackson, testified[11]:

> "*I think that you've put your finger on a very important thing that EPA must do right away, which is to assess the hundreds of other sites that are out there. Many of them … are … up hill from schools or from areas where just the physical hazard of having this mountain of wet coal ash, if there's a break, can endanger lives immediately. So I would think that EPA needs to first and foremost assess the current state of what's out here and where there might be another horrible accident waiting to happen … EPA currently has and has in the past, assessed its regulatory options with respect to coal ash, and I think it's time to re-ask those questions and re-look at the state of regulation of them from an EPA perspective*."

According to a 23 January 2009 news report,[12] there was growing Congressional interest for either the EPA with its existing RCRA regulatory authorities, or the Congress with potential new legislation, to regulate CCR disposal units:

> "*Several lawmakers have introduced, or announced plans to introduce, competing legislation to regulate CCR. For example, Senate Environment & Public Works Committee Chairwoman Barbara Boxer (D-CA) said she would introduce legislation compelling EPA to regulate CCR in the event the Obama EPA fails to act soon. "If we are not satisfied with action we may move legislatively," Boxer told EPA Administrator-designate Lisa Jackson at a January 14 [2009] confirmation hearing. "I don't want to get to that point because I think you have the authority to regulate this. It needs to be done*.""

[11] Lisa Jackson's 14 January 2009 Senate confirmation hearing testimony and webcast is available from the US Senate Committee on Environment and Public Works' website at: http://epw.senate.gov/public/index.cfm?FuseAction=Hearings.Hearing&Hearing_ID=ae2c3342-802a-23ad-4788-d1962403eb76

[12] Source: Waste Business Journal, "EPA Vows to Act on Coal Waste," 23 January 2009, http://www.wastebusinessjournal.com/news/wbj20090127B.htm

Just three weeks after the TVA's Kingston TN CCR impoundment disaster, House Natural Resources Committee Chairman Nick Rahall (D-WV) introduced legislation requiring federal standards to regulate the engineering of CCR impoundments.[13] Introduced on 14 January 2009, the Coal Ash Reclamation and Environmental Safety Act of 2009 (H.R. 493) directs the Department of Interior to impose uniform federal design, engineering, and performance standards on CCR impoundments to avoid a repeat of the damage done in Kingston TN. The legislation, which requires minimum design and stability standards for all surface impoundments constructed to hold coal ash, draws on the regulatory model for impoundments that is used for coal slurry management under the Surface Mining Control and Reclamation Act of 1977 (SMCRA).

In a letter dated 02 March 2009, the Environmental Integrity Project and Earthjustice, joined by the National Resources Defense Council, the Sierra Club, Environmental Defense, and 104 other environmental groups requested EPA Administrator Lisa Jackson "*to act as soon as possible*" to regulate CCR. A letter signed by the groups and delivered to EPA on 03 March 2009 identified 12 principles to guide the development of EPA standards. These include the phase-out of CCR surface impoundments, locating CCR disposal sites away from groundwater or surface water, requiring liners, leachate collection systems and adequate monitoring, and requiring industry to assume long term liability for cleanup:

> "*The recent disaster at TVA's Kingston Plant stands as a startling reminder that federal standards for CCR are long overdue. For too long, power companies have been able to dump CCR, laden with a host of toxic metals like arsenic, selenium, lead, mercury, and boron, in unlined mines, quarries, landfills, and surface impoundments. Without federal standards governing disposal practices, contaminants can leak or spill from these dump sites, threatening human health, natural resources and wildlife.*"[14]

On 04 March 2009, US Senators Barbara Boxer (D-CA) and Tom Carper (D-DE) submitted Senate Resolution 64 to the Senate Committee on Environment and Public Works. This resolution calls on the EPA to "immediately" inspect all CCR impoundments and landfills operating at coal-fired electricity plants, and to propose and finalize "as quickly as possible" rules to regulate CCR under RCRA.[15]

---

[13] The text of the 14 January 2009 H.R. 493 bill is available at: http://www.govtrack.us/congress/billtext.xpd?bill=h111-493
[14] Source: http://www.environmentalintegrity.org/pub608.cfm
[15] US Senate Resolution 64 is available at: http://www.govtrack.us/congress/bill.xpd?bill=sr111-64&tab=committees

Chapter 2
Potentially Affected Industries & RCRA Regulatory Options

2A. Identity of Potentially Affected Industries

There are two categories of industries which may be directly affected by the CCR regulatory options. "Directly affected entities" are entities potentially subject to any of the rule's requirements.[16] In addition, there are 14 or more industries which beneficially use CCR.

1. Coal-Fired Electric Utility Industry

The scope of industrial plants directly affected by the regulatory options is classifiable according to at least two different glossary systems:

- Classification #1 of 2: The scope of industrial plants is classifiable as "**coal-fired electric utility plants**" under the US Census Bureau's North American Industrial Classification System" NAICS code 22 "Utilities" economic sector, and in that sector, as a subgroup of the 1,245 establishments within the NAICS 221112 "Fossil Fuel Electric Power Generation" industry:[17]

  NAICS 221112: *This industry comprises establishments primarily engaged in operating fossil fuel powered electric power generation facilities. These facilities use fossil fuels, such as coal, oil, or gas, in internal combustion or combustion turbine conventional steam process to produce electric energy. The electric energy produced in these establishments is provided to electric power transmission systems or to electric power distribution systems.*

- Classification #2 of 2: The scope of industrial plants is classifiable as "**electric utilities plus independent power producers**" under the Energy Information Administration (EIA) categorization system for its coal combustion electric power sector statistics:[18]

  Electric utility: *Any entity that generates, transmits, or distributes electricity and recovers the cost of its generation, transmission or distribution assets and operations, either directly or indirectly, through cost-based rates set by a separate regulatory authority (e.g., State Public Service Commission), or is owned by a governmental unit or the consumers that the entity serves. Examples of these entities include: investor-owned entities, public power districts, public utility districts, municipalities, rural electric cooperatives, and State and Federal agencies.*

  Independent power producer: *A corporation, person, agency, authority, or other legal entity or instrumentality that owns or operates facilities for the generation of electricity for use primarily by the public, and that is not an electric utility.*

[16] Source: "EPA's Action Development Process: Final Guidance for EPA Rulewriters: Regulatory Flexibility Act", OPEI Regulatory Development Series, Nov 2006, see footnote 14 at http://www.epa.gov/sbrefa/documents/rfafinalguidance06.pdf
[17] Source: NAICS codes are defined at http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2007
[18] Source: EIA glossary of terms at http://www.eia.doe.gov/glossary/index.html

2. Waste & Environmental Management Services Industries

In addition, because some electric utility plants transport their CCR to either company-owned or to commercial offsite landfills, and because some regulatory options may trigger RCRA facility-wide corrective action, the regulatory options of the proposed rule may also affect:

NAICS 562211:	Hazardous waste treatment and disposal industry (may be affected under the RCRA Subtitle C regulatory options evaluated in this RIA).
NAICS 562212:	Solid waste landfill industry (may represent baseline offsite CCR landfills to which the estimated 149 of the 495 electric utility plants may transport some or all of the 15 million tons per year CCR for offsite disposal).
NAICS 562219:	Other non-hazardous waste treatment and disposal industry (may represent baseline offsite CCR landfills to which some or all of 149 of the 495 electric utility plants may transport some or all of the 15 million tons per year CCR for offsite disposal).
NAICS 562910:	Environmental cleanup/remediation services industry.

3. Industries Which "Beneficially Use" CCR

According to the American Coal Ash Association (ACAA)[19] as of 2007 there are over 15 industries which "beneficially use" CCR for industrial applications. These industrial applications are listed below with corresponding NAICS[20] codes estimated by EPA ORCR. Because the regulatory options evaluated in this RIA establish CCR disposal requirements, industries which beneficially use CCR are characterized in this RIA as potentially "indirectly" affected by the proposed rule rather than "directly" affected (i.e., subject to the rule's requirements).

1. Concrete/concrete products/grout	NAICS 3273 Cement & Concrete Product Manufacturing
2. Blended cement/raw feed for clinker	NAICS 3273 Cement & Concrete Product Manufacturing
3. Flowable fill	NAICS 23 Construction
4. Structural fills/embankments	NAICS 23 Construction
5. Road base/sub-base	NAICS 237310 Highway, Street & Bridge Construction
6. Soil modification/stabilization	NAICS 23 Construction
7. Mineral filler in asphalt	NAICS 324121 Asphalt Paving Mixture & Block Manufacturing
8. Snow and ice control	NAICS 488490 Other Support Activities for Road Transportation
9. Blasting grit/	NAICS 212319 Other Crushed & Broken Stone Mining & Quarrying
Roofing granules	NAICS 324122 Asphalt Shingle & Coating Materials Manufacturing
10. Mining applications	NAICS 212 Mining

---

[19] Source: American Coal Ash Association (ACAA) "2007 Coal Combustion Product (CCP) Production & Use Survey Results (Revised)" at http://www.acaa-usa.org/associations/8003/files/2007_ACAA_CCP_Survey_Report_Form%2809-15-08%29.pdf

[20] NAICS = North American Industrial Classification System; NAICS codes definitions are available at http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2007

- 2-digit codes represent economic sectors
- 3-digit codes represent economic sub-sectors
- 4-digit codes represent industry groups
- 5-digit and 6-digit codes represent single industries

11. Gypsum panel products (e.g., wallboard)	NAICS 327420 Gypsum Product Manufacturing
12. Waste stabilization/solidification	NAICS 5622 Waste Treatment & Disposal
13. Agriculture	NAICS 111 Crop Production
14. Aggregate	NAICS 23 Construction
15. Miscellaneous/other (unidentified industries)	NAICS not identified

2B. Other Industries with CCR Disposal Units Not Covered by the Proposed Rule

The scope of the proposed rule excludes two other categories of CCR disposal units from the regulatory options. These other two categories are identified here to provide a rough estimate of potential additional cost for regulation if they were added to the scope of the rulemaking or addressed in a separate but similar rulemaking.

- **Inactive/Abandoned CCR Disposal Units Excluded from Scope**

The scope of the proposed rule only covers active (i.e., operating) CCR disposal units used by electric utility plants. There are two other operating status categories consisting of an estimated count of at least 197 additional CCR disposal units excluded from the scope of the rule:[21]

- Inactive units: CCR impoundments and landfills not in operation or not receiving CCR. Inactive impoundments may receive CCR in the future, becoming active again, and therefore have not been closed permanently.
- Abandoned units: CCR impoundments and landfills not in operation and closed. These impoundments usually have been filled to capacity and have been permanently closed.

In absence of inventory data on inactive units, the nationwide count of such inactive and abandoned units is indirectly and roughly estimated in this RIA based on known data for large volume coal mining slurry waste impoundments. There are an estimated 1,600 coal waste impoundments in operation across the US in coal-related industries (i.e., coal mining industry plus industries which burn coal). In addition, there are another 670 coal waste impoundments which are no longer in operation but still contain coal waste slurry (i.e., inactive or abandoned).[22] These two counts represent a ratio of 0.42 inactive/abandoned:to:active (i.e., 670:to:1,600).

In absence of national survey data, multiplying the 0.42 inactive:to:active coal waste impoundments ratio by the 158 coal-fired electric utility plants estimated in this RIA using CCR impoundments, yields an estimate of at least 66 inactive/abandoned CCR impoundments may be located at electric utility plants (i.e., (158 impoundment using electric utility plants) x (0.42 ratio) = 66).

[21] Source: Definitions of "inactive" and "abandoned" coal waste impoundments from page 23 of the National Research Council book Coal Waste Impoundments: Risks, Responses and Alternatives, National Academy Press, 2002 at http://www.nap.edu/openbook.php?isbn=030908251X
[22] Source: Counts of 1,600 active coal waste impoundments and 670 inactive or abandoned coal waste impoundments from the prior footnoted source.

This RIA did not discover similar data for coal waste landfills in active and inactive/abandoned status. For purpose of a rough estimate in this RIA, multiplying the 0.42 inactive/abandoned:to:active ratio by the 311 electric utility plants which use landfills, indicates there may be at least 131 inactive or abandoned CCR landfills at or near electric utility plants (i.e., (311 landfill using electric utility plants) x (0.42 ratio) = 131).

As of 2004, the Mine Safety & Health Administration (MSHA) oversees 646 active coal mining slurry impoundments in the US, which implies 954 remainder active coal slurry impoundments (i.e., 1,600 – 646 = 954).[23] Of these, this RIA estimates at least 158 active impoundments at 158 electric utility plants, which implies that a fraction of 796 other active coal waste impoundments (i.e., 954 – 158 = 796) may be located at electric power plants in non-utility industries (see the next sub-section below "Other Industries Excluded from Scope").

- **Other Industries Excluded from Scope**

The scope of the proposed rule only includes NAICS code 22 coal-fired electric utility plants (495 plants). However, there is a range of 139 to 759 non-utility facilities which currently, or have the capacity to, burn coal and thus generate CCR. Adding these facilities to the scope of the proposed rule could increase the cost estimates by 2% to 28%. This range is based on the following two data sources:

Source #1: As displayed below in **Exhibit 2A** based on 2005 data from the DOE-EIA, there are 139 non-utility coal-fired electricity plants owned and operated by 8 other industrial sub-sectors involving 27 industries. **Appendix B** of this RIA contains a list of these other industry plants according to NAICS industry codes. If these other non-utility industries were to be added to the scope of the CCR proposed rule, a rough estimate of potential additional cost and benefit impacts would be between 2% and 28% relative to the impacts estimated in this RIA:

- >2%: Compared to the 369,183 megawatts (MW) nameplate capacity for the coal-fired electricity plants contained in the 2005 DOE-EIA database (which contains data on electricity plants at least 10 MW nameplate capacity in size), the 5,959 MW capacity of the 139 non-utility electricity plants represents about 2% of national coal-fired electricity generation capacity. For purpose of rough estimation – in so far that electricity plant capacity correlates to annual CCR generation and thus to annual CCR disposal costs and to regulatory costs --- this percentage indicates that the additional economic impact of including these additional 139 non-utility plants in the proposed rule might add at least 2% to the cost estimates under each regulatory option.
- <28%: On the other hand, some CCR disposal costs and regulatory costs better correlate to the count and size (footprint) of CCR landfills and impoundments, not to electricity generating capacity. For such costs, adding the 139 non-utility plants to the scope of the proposed rule could increase the cost estimates for each regulatory option by up to 28% (i.e., (495 + 139) / (495)).

[23] Source: MSHA "Supporting Statement" for Information Collection Request (ICR) 1219-0015 "Refuse Piles and Impoundment Structures, Recordkeeping and Reporting Requirements", March 2008: http://www.msha.gov/regs/fedreg/paperwork/2004/04-24046.pdf

Source #2: EPA's 2002 analysis[24] of the results from a 2001 survey of non-utility CCR generation identified 759 non-utility facilities "with the capacity to burn coal, and therefore, generate CCR." The estimated annual CCR generation for these facilities is 7.8 million tons (as of year 2000), which is 5.5% to 6.3% of the 123.1 million to 141.2 million tons CCR generated by electric utility plants in 2005 as estimated in **Exhibit 3D** of this RIA. Allowing for annual growth of the 7.8 million tons since 2000 suggests that adding these 759 facilities to the scope of the proposed rule could increase the cost estimates by 7%.

[24] Source: "Analysis of Non-Utility Coal Combustion Waste Generation and Management Based on the 2001 CIBO Voluntary Survey," prepared for EPA-OSWER by Science Applications International Corp (SAIC) Engineering & Environmental Management Group (Reston VA) under subcontract to Eastern Research Group (Arlington VA), April 2002, EPA contract No. 68-W-02-036, WA 12:.

Exhibit 2A
Identity of Other Industries Operating Coal-Fired Electricity Plants Not Covered by the Proposed Rule or this RIA

2005 Count	NAICS Sector	NAICS Industry	NAICS Industry Code Definition	2005 Boiler count	2005 Plant count
1	21	2122	Ore mining	4	1
2	31	311	Food Manufacturing	63	29
3	31	3122	Tobacco Manufacturing	3	2
4	31	314	Textile Product Mills	11	4
5	32	321	Wood Product Manufacturing	1	1
6	32	322	Paper Manufacturing	9	4
7	32	322122	Newsprint Mills	98	39
8	32	32213	Paperboard Mills	19	9
9	32	325	Chemical Manufacturing	31	6
10	32	325188	All Other Basic Inorganic Chemical Manufacturing	5	3
11	32	325211	Plastics Material and Resin Manufacturing	9	4
12	32	326	Plastics and Rubber Products Manufacturing	4	1
13	32	327	Nonmetallic Mineral Product Manufacturing	8	3
14	32	32731	Cement Manufacturing	2	1
15	33	331	Primary Metal Manufacturing	5	3
16	33	331111	Iron and Steel Mills	1	1
17	33	331312	Primary Aluminum Production	3	1
18	33	333	Machinery Manufacturing	7	2
19	33	3345	Navigational, Measuring, Electromedical, Control Instruments Mfg	10	1
20	33	336	Transportation Equipment Manufacturing	1	1
21	33	337	Furniture and Related Product Manufacturing	1	1
22	33	339	Miscellaneous Manufacturing	1	1
23	48	482	Rail Transportation	2	1
24	48	483	Water Transportation	3	1
25	61	611	Educational Services	37	14
26	62	624	Social Assistance	2	1
27	92	92	Public Administration	14	4
	Count = 8	Count = 27	Column Totals =	354	**139**
			2005 electricity generation nameplate capacity (megawatts) =	5,959	

Notes:
(a) Source: US Dept of Energy, Energy Information Administration (EIA), 2005 Form EIA-860 "Annual Electric Generator Report" "Existing Electric Generating Units in the United States, 2005" at http://www.eia.doe.gov/cneaf/electricity/epa/epat2p2.html
(b) NAICS codes: The first two digits designate the economic sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry. The five-digit NAICS code is the level at which there is comparability in code and definitions for most of the NAICS sectors across the three countries participating in NAICS (the United States, Canada, and Mexico). The six-digit level allows for the United States, Canada, and Mexico each to have country-specific detail. A complete and valid NAICS code contains six digits. Source: http://www.census.gov/eos/www/naics/faqs/faqs.html#q5

2C. RCRA Regulatory Options Evaluated in this RIA

This RIA evaluates three RCRA regulatory options which are defined with reference to the two alternative regulatory authorities --- Subtitle C and Subtitle D --- contained in EPA's 1976 RCRA waste management statutory authority:

Option 1: RCRA Subtitle C "*special waste*":

- Regulate CCR disposed in landfills and surface impoundments as "special wastes" under Subtitle C, and require phase out of surface impoundments within five years. This approach:
- Eliminates health risks from groundwater and surface water contamination for both landfills and surface impoundments, and avoids damages from uncontrolled ground "fill" operations (e.g., Gambrills MD and Chesapeake VA) and attendant environmental remediation costs.
- Eliminates the future threat of catastrophic failures of surface impoundments.
- Provides for corrective action, including at closed units at facilities with surface impoundments or landfills regulated under the rule, and imposes groundwater monitoring requirements.
- Provides for Federal oversight, which EPA experience has shown is necessary for successful implementation of RCRA industrial waste regulations, especially as it relates to ground-water monitoring and corrective action, when needed. Without Federal oversight, it is highly questionable whether CCR will be properly managed, considering EPA's experience with the RCRA program of the last 10 years, which illustrate the limited results that could be expected of a Subtitle D rule.

Option 2: RCRA Subtitle D "*non-hazardous*" industrial waste (version 2):

- Liners required for all (i.e., existing and future new) CCR surface impoundments but only for new landfills. Subtitle D requirements would set national criteria for landfills and surface impoundments that manage CCR after the rule goes into effect. For any CCR landfills and impoundments that closed before the effective date, there would be no regulatory controls over those units, unless the states choose to adopt controls over such units. Also, all surface impoundments (existing and new) would need to have composite liners within 5-years of the effective date. Consistent with the Subtitle C approach, existing landfills would not need to be lined.
- Requirements would not be enforceable by EPA or the states (unless states had similar requirements under state law). Lack of enforcement and Federal oversight may significantly reduce compliance and effective implementation of regulatory requirements.
- Although this option does not require phase-out of existing surface impoundments, it could cause some phase-out because all surface impoundments would need to have composite liners by a certain date, or they would need to close down, assuming the rule is effectively implemented by the states.
- Eliminates some ground-water contamination over the current situation (e.g., because of surface impoundment retrofitting), thus avoiding some damage cases, again assuming effective implementation.

- Require review of surface impoundments for stability by independent experts, but because impoundments could remain in operation (because they are currently lined or owners choose to retrofit line them rather than phase them out), there would still be a risk of future structural failures of impoundments.

Option 3: RCRA Subtitle "D prime":

- Regulation of disposal under subtitle D, with liners required only for new surface impoundments and landfills. This approach would be the same as the subtitle D approach above, except that existing surface impoundments would not be required to retrofit and install a composite liner, or close. Unlined existing impoundments could continue to operate, but new landfills and surface impoundments or expansions of existing landfills must have composite liners.
- Under this approach the potential for catastrophic failure of surface impoundments would remain significant, since phase-out of surface impoundments wouldn't occur.
- Would be less effective than the subtitle C or subtitle D approaches in eliminating groundwater contamination (or in having it be discovered sooner), but would still provide some benefits over no national regulation. (The same caveats on state regulations and enforcement would apply as in the subtitle D option.)
- Would reduce regulatory costs significantly since conversion to dry disposal would not be required, but would also provide fewer benefits.

Evaluation of three regulatory options is consistent with OMB's 2003 "Circular A-4: Regulatory Analysis" best practices guidance for Federal agencies, which requires analysis of at least three regulatory options.[25] All three regulatory options are identical in two ways:

1. Beneficial use: All options propose to replace the 1980 RCRA "Bevill exclusion" under 40 CFR 261.4(b)(4) for CCR disposal with new RCRA waste regulation, but to retain the existing Bevill exclusion for CCR beneficial uses. Beneficial uses of CCR will retain the Bevill exclusion and will not be subject to any regulation, either under Subtitle C or Subtitle D.

2. Engineering controls: All options propose the same set of **10 custom-tailored engineering controls** (i.e., technical design and operating standards) for CCR disposal units. For purpose of launching this RIA in April 2009, the waste disposal "management standards" described in EPA's August 1999 cement kiln dust (CKD) proposed rule[26] were used in absence of uniquely defined controls specific to CCR disposal units. This was a reasonable starting point because the CKD management standards are similar or identical to the technical standards defined in the CCR proposed rule.

[25] OMB's 2003 Circular A-4 (p.16) directs Federal agencies to analyze at least three regulatory options: http://www.whitehouse.gov/omb/assets/omb/circulars/a004/a-4.pdf
[26] EPA's 20 August 1999 CKD proposed rule (Federal Register, 67 pages).

During EPA's April 2009 launch of this RIA, EPA defined three other RCRA options which are very similar to the above three options. The initial set of options is included in EPA's October, 8 2009 initial draft (165 pages) of this RIA which EPA submitted to OMB for review in mid-October 2009. The regulatory cost estimation in **Chapter 4** and the supplemental analyses in **Chapter 7** of this RIA are based on the initial set of three options, defined as follows:

2009 Option 1: RCRA Subtitle C "*hazardous*" industrial waste:

- Subtitle C provides Federal enforceability.
- RCRA Section 3004(x)[27]custom-tailor engineering controls (i.e., technical standards) for CCR disposal units.
- Subject CCR to Subtitle C land disposal restriction (LDR) treatment standards prior to disposal:
    - Dry CCR (landfills): Moisture conditioning and compaction to attain 95% dry density value.
    - Wet CCR (impoundments): Dewatering and dry disposal within 5 years after rule's effective date.

2009 Option 2: RCRA Subtitle D "*non-hazardous*" industrial waste (version 1):

- This option is different from the 2010 Option 2: Subtitle D option because it does not require liners for existing impoundments as the 2010 Option 2 does, but it only requires liners for new impoundments (and only for new landfills).
- Regulate CCR disposal as RCRA Subtitle D non-hazardous waste based on the same custom-tailored engineering controls as the 2009 Option 1.
- Except under RCRA Section 7003 "*imminent and substantial endangerment*" authority, this option is not Federally enforceable because RCRA Subtitle D directs EPA only to assist state government waste management programs.[28]

2009 Option 3: Hybrid RCRA Subtitle C & Subtitle D:

- Subtitle C regulation of CCR impoundments (same as the 2009 Option 1)
- Subtitle D regulation of CCR landfills (same as the 2009 Option 2)

---

[27] The following excerpt from RCRA Section 3004(x) pertains specifically to CCR, by providing EPA with authority "to modify" the RCRA Subtitle C technical standards for regulation of CCR disposal:

> "*Section 3004(x): If… (2) fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste generated primarily from the combustion of coal or other fossil fuels… is subject to regulation under this subtitle, the [EPA] Administrator is authorized to modify the requirements of subsections (c), (d), (e), (f), (g), (o) and (u) and section 3005(j), in the case of landfills or surface impoundments receiving such solid waste, to take into account the special characteristics of such wastes, the practical difficulties associated with implementation of such requirements, and site-specific characteristics, including but not limited to the climate, geology, hydrology and soil chemistry at the site, so long as such modified requirements assure protection of human health and the environment.*"

[28] Section 4001 of Subtitle D of the 1976 RCRA statute prescribes the Federal role under Subtitle D as assistance to state governments: "*The objectives of this subtitle are to assist in developing and encouraging methods for the disposal of solid waste… Such objectives are to be accomplished through Federal technical and financial assistance to States or regional authorities for comprehensive planning pursuant to Federal guidelines designed to foster cooperation among Federal, State and local governments and private industry.*"

Chapter 3
Baseline CCR Management in the Electric Utility Industry

This Chapter characterizes baseline (i.e., current) CCR management practices within the electric utility industry. This baseline consists of two components described in this Chapter: CCR disposal and CCR beneficial use. This Chapter begins with a description of baseline CCR management quantities (i.e., annual tonnages of CCR) and CCR disposal methods used by the electric utility industry. This Chapter also presents an evaluation of baseline operating conditions (i.e., "engineering controls" and "ancillary costs") of CCR disposal units and an estimate of the associated costs to the electric utility industry. This Chapter concludes with a characterization of baseline CCR "beneficial use" (for CCR which is not disposed) and an estimate of associated net benefits to the environment and the national economy.

3A. Identity of Coal-Fired Electric Utility Plants

This RIA initially identified the sub-group of potentially affected coal-fired electric utility plants using the 2007 US Department of Energy (DOE), Energy Information Agency (EIA) database for electricity power plants from the Form EIA-860 "Annual Electric Generator Report." This data was supplemented with the master list of utility plants from the 2007 EIA-860 database entitled "existingunits2007". [29] This RIA applied three database filters to identify the subset of electricity plants which may potentially be affected by the proposed rule:

- **Database filter #1 of 3**: EPA sorted the 2007 EIA-860 electric plant database by the North American Industry Classification System (NAICS) industrial codes, and deleted all plants not assigned utility sector NAICS code 22 (only 2-digit NAICS codes are provided by the EIA database).

NAICS 22: *The Utilities sector comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal. Within this sector, the specific activities associated with the utility services provided vary by utility: electric power includes generation, transmission, and distribution; natural gas includes distribution; steam supply includes provision and/or distribution; water supply includes treatment and distribution; and sewage removal includes collection, treatment, and disposal of waste through sewer systems and sewage treatment facilities. Excluded from this sector are establishments primarily engaged in waste management services classified in Subsector 562 Waste Management and Remediation Services. These establishments also collect, treat, and dispose of waste*

[29] The EIA-860 database is itemized on an electricity generator unit basis, not on a per-plant basis. It includes specific information about generators at electric power plants owned and operated by electric utilities and non-utility industries (i.e., including independent power producers, combined heat and power producers, and other industrials). The file contains generator-specific information such as initial date of commercial operation, prime movers, generating capacity, energy sources, status of existing and proposed generators, proposed changes to existing generators, county and State location (including power plant address), ownership, and FERC qualifying facility status. Also included are data related to the ability to use multiple fuels; specifically, data on co-firing and fuel switching are included. The DOE spreadsheet "existingunits2007" is available at http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html.

materials; however, they do not use sewer systems or sewage treatment facilities" Source: US Bureau of Census at: http://www.census.gov/eos/www/naics/

- **Database filter #2 of 3**: EPA deleted all of the units that did not use coal as either a primary or secondary energy source using the coal type codes displayed in **Exhibit 3A** below. In addition to these five categories of coal, examples of other primary or secondary energy sources reported by coal burning electric utility plants are agriculture byproducts, distillate fuel oil, natural gas, petroleum coke, propane, and wood & waste solids.

Exhibit 3A
Types of Coal Used by Electric Utility Plants as Coded in the 2007 DOE-EIA Database

Item	Code	Type of Coal
1	BIT	Anthracite Coal, Bituminous Coal
2	LIG	Lignite Coal
3	SUB	Sub-bituminous Coal
4	WC	Waste/Other Coal (Anthracite Culm, Bituminous Gob, Fine Coal, Lignite Waste, Waste Coal)
5	SC	Coal Synfuel. Coal-based solid fuel that has been processed by a coal synfuel plant, and coal-based fuels such as briquettes, pellets, or extrusions, which are formed from fresh or recycled coal and binding materials.

- **Database filter #3 of 3**: The first two filter criteria resulted in a subset of 506 coal-fired electric utility plants. Based on the reported operating status of the generators at these plants (i.e., OP, OS, SB, RE, OA)[30], 11 plants reported that all generators are out-of-service, 2 plants reported that all generators are on standby and all remaining plants reported that at least one of their generators is operating. Removal of the 11 out-of-service plants from the master list resulted in a total affected plant population of **495 coal-fired electric utility plants**.[31] **Appendix C** presents the list of 495 plants.[32]

For purpose of identifying the types and size classifications for owner entities, this RIA initially used the utility code reported in the 2007 EIA-860 database to identify which plants are owned by the same company. Company owner classifications were also checked for many plants using internet searches by plant and company name which sometimes revealed parent company owners. As summarized in **Exhibit 3B** and

---

[30] OP = Operating - in service (commercial operation) and producing electricity. Includes peaking units that are run on an as needed (intermittent or seasonal) basis, OS = Out of service – was not used for some or all of the reporting period and is NOT expected to be returned to service in the next calendar year, SB = Standby/Backup - available for service but not normally used (has little or no generation during the year) for this reporting period, RE = Retired - no longer in service and not expected to be returned to service, and OA = Out of service – was not used for some or all of the reporting period but was either returned to service on Dec 31 or will be returned to service in the next calendar year. Note: Units undergoing maintenance or repair of less than 12 months and are expected to be returned to service are assigned operating status.

[31] This RIA filtered out 11 out-of-service electricity plant identification codes: 508, 511, 996, 1732, 2341, 2468, 2529, 2531, 2908, 3419, and 55612.

[32] In comparison, a 2008 EPA Office of Water (OW) study estimated a nationwide total of 497 coal-fired electric plants using the same 2005 EIA-767 database; the 495 plants estimated in this RIA are less than the 2008 EPA OW estimate because this RIA takes account of more recent plant operating status information (i.e., plants which have converted to other non-coal fuels or are not operating). Source: Table 3-1 (page 3-9) of EPA Office of Waster "Steam Electric Power Generating Point Source Category: 2007/2008 Detailed Study Report," report nr. 821-R-08-011, August 2008; http://www.epa.gov/guide/304m/2008/steam-detailed-200809.pdf

Exhibit 3C below, these 495 coal-fired electric utility plants are owned and operated by 200 entities which are listed in **Appendix D** to this RIA. The 495 plants have a combined electricity generation nameplate capacity of 369,183 MW (megawatts), ranging in individual plant size from 2.3 MW to 3,969 MW, with an average size of 746 MW and a median size of 497 MW. This combined capacity represents 34% of the 1.088 million MW total US electricity generation capacity as of 2007.[33]

Exhibit 3B
Summary Classification of 495 Coal-Fired Electric Utility Plants by Type/Size of Owner Entities (2007)

Item	Type of Owner Entity*	Entity Size Class**	Coal-Fired Electric Utility Plant Count	Owner Entity Count
1	Federal government	Non-small	11	1
2	State government jurisdictions (authorities, districts)	Non-small	13	7
3	Medium & large population municipal government jurisdictions	Non-small	27	19
4	Medium & large companies	Non-small	372	110
5	Medium & large cooperatives (this RIA assumes all privately-owned)	Non-small	20	12
6	Small county government jurisdictions (commission)	Small	1	1
7	Small municipal government jurisdictions (agencies, commissions)	Small	33	33
8	Small companies	Small	12	11
9	Small cooperatives (this RIA assumes all privately-owned)	Small	6	6
Summary:				
		Column totals =	**495**	**200**
		Private sector sub-total (items 4+5+8+9) =	410 (83%)	139 (70%)
		State/local government sub-total (items 2+3+6+7) =	74 (15%)	60 (30%)
		Small entity sub-total (items 6+7+8+9) =	52 (11%)	51 (26%)

Notes:
* Type of owner entity estimated and assigned by EPA ORCR based on owner name or internet research on type of ownership.
** Size class determined according to the following numerical threshold criteria consistent with EPA's Nov 2006 guidance for Regulatory Flexibility Act (RFA) Small Business Regulatory Enforcement Fairness Act (SBREFA) compliance:

- Small non-government = Based on the US Small Business Administration NAICS code 221112 small business size standard of <4 million megawatt hours per year total annual electricity generation by all plants owned by the entity).
- Non-small non-government = entity's total annual electricity generation >4 million megawatt hours per year.
- Small government = Based on the RFA's definition (5 US Code section 601(5)) of "small government jurisdiction" as the government of a city, county, town, township, village, school district, or special district with a population of less than 50,000.
- Non-small government = entity's jurisdiction population >50,000 people.

[33] Source: US Dept of Energy (DOE), Energy Information Administration (EIA) website at http://www.eia.doe.gov/cneaf/electricity/epa/epat2p2.html

Exhibit 3C
State-by-State Electric Utility Plant Counts by Type/Size of Owner Entity (2007)

Item	State	Count of Plants Owned by Non-Small Entities					Count of Plants Owned by Small Entities				Row total plants
		Federal government	State Government	Non-small municipal	Non-small company	Non-small cooperative	County government	Small municipal	Small company	Small cooperative	
1	AK								2		2
2	AL	2			7	1					10
3	AR				3						3
4	AZ		2		3	1					6
5	CA				6						6
6	CO		1	2	11						14
7	CT				2						2
8	DC										0
9	DE				3						3
10	FL			5	9	1					15
11	GA				10		1				11
12	HI				2						2
13	IA			1	13			3		2	19
14	ID										0
15	IL			2	21					2	25
16	IN				21			5			26
17	KS			2	6						8
18	KY	2		1	14	3		1			21
19	LA				4						4
20	MA				4						4
21	MD				8						8
22	ME				1						1
23	MI			2	13			5	2		22
24	MN			1	10			5			16
25	MO			5	10	2		2		1	20
26	MS				3	1		1			5
27	MT				4				1		5
28	NC				19				3		22
29	ND				2	5					7
30	NE		4					3			7
31	NH				2						2
32	NJ			1	6						7
33	NM				3						3
34	NV				2						2
35	NY				11			1	1		13
36	OH			2	20			4			26
37	OK		1		4	1					6
38	OR				1						1

Exhibit 3C State-by-State Electric Utility Plant Counts by Type/Size of Owner Entity (2007)											
		Count of Plants Owned by Non-Small Entities					Count of Plants Owned by Small Entities				
Item	State	Federal government	State Government	Non-small municipal	Non-small company	Non-small cooperative	County government	Small municipal	Small company	Small cooperative	Row total plants
39	PA				32				2		34
40	RI										0
41	SC		4		10						14
42	SD				2						2
43	TN	7									7
44	TX		1	2	14			1		1	19
45	UT			1	4	1					6
46	VA				15				1		16
47	VT										0
48	WA				1						1
49	WI				12	3		2			17
50	WV				16						16
51	WY				8	1					9
Column totals=		11	13	27	372	20	1	33	12	6	**495**

The annual amount of coal burned by these 495 operating plants is 1.036 billion tons per year as reported in the 2007 EIA-923 database, according to the following five types of coal fuel categories:

- Bituminous coal (DOE-EIA data code = BIT): 330 plants (67% of 495 plants)
- Lignite coal (LIG): 21 plants (4%)
- Coal-based synthetic fuel (SC): 19 plants (4%)
- Sub-bituminous coal (SUB): 201 plants (41%)
- Waste/other coal (WC): 33 plants (7%)

Many plants use more than one coal fuel type so the above percentages exceed 100%. **Appendices B & C** present the quantity of coal burned and the types of coal burned for the list of 495 plants. As displayed in the state-by-state **Exhibit 3D** below, 47 states have coal-fired electric utility plants (3 states --- ID, RI, VT --- and DC do not have electric utility plants). The top-5 state coal-fired electric utility plant counts are:

1. PA 34 plants
2. IN & OH 26 plants each
3. IL 25 plants
4. MI & NC 22 plants each
5. KY 21plants

Exhibit 3D
State-by-State Count of NAICS Code 22 Electric Utility Plants and Associated CCR Generation

Item	State	Count of Plants (2007)	% of Plants	CCR Generated (tons as of 2005)	% of CCR Generation
1	AK	2	0.40%	46,179	0.03%
2	AL	10	2.02%	3,210,337	2.27%
3	AR	3	0.61%	744,267	0.53%
4	AZ	6	1.21%	3,334,030	2.36%
5	CA	6	1.21%	159,927	0.11%
6	CO	14	2.83%	1,704,432	1.21%
7	CT	2	0.40%	172,280	0.12%
8	DC	0	0%	0	0%
9	DE	3	0.61%	251,205	0.18%
10	FL	15	3.03%	6,132,345	4.34%
11	GA	11	2.22%	6,077,700	4.30%
12	HI	2	0.40%	58,968	0.04%
13	IA	19	3.84%	1,136,290	0.80%
14	ID	0	0%	0	0%
15	IL	25	5.05%	3,856,748	2.73%
16	IN	26	5.25%	8,798,844	6.23%
17	KS	8	1.62%	1,495,099	1.06%
18	KY	21	4.24%	9,197,567	6.51%
19	LA	4	0.81%	1,614,800	1.14%
20	MA	4	0.81%	363,150	0.26%
21	MD	8	1.62%	1,932,740	1.37%
22	ME	1	0.20%	48,000	0.03%
23	MI	22	4.44%	2,369,673	1.68%
24	MN	16	3.23%	1,525,979	1.08%
25	MO	20	4.04%	2,679,742	1.90%
26	MS	5	1.01%	1,229,400	0.87%
27	MT	5	1.01%	1,830,624	1.30%
28	NC	22	4.44%	5,504,531	3.90%
29	ND	7	1.41%	3,038,100	2.15%

Exhibit 3D
State-by-State Count of NAICS Code 22 Electric Utility Plants and Associated CCR Generation

Item	State	Count of Plants (2007)	% of Plants	CCR Generated (tons as of 2005)	% of CCR Generation
30	NE	7	1.41%	614,473	0.44%
31	NH	2	0.40%	176,900	0.13%
32	NJ	7	1.41%	735,214	0.52%
33	NM	3	0.61%	3,983,300	2.82%
34	NV	2	0.40%	391,500	0.28%
35	NY	13	2.63%	1,479,792	1.05%
36	OH	26	5.25%	10,429,446	7.39%
37	OK	6	1.21%	1,490,800	1.06%
38	OR	1	0.20%	99,900	0.07%
39	PA	34	6.87%	15,359,680	10.88%
40	RI	0	0%	0	0%
41	SC	14	2.83%	2,178,359	1.54%
42	SD	2	0.40%	103,753	0.07%
43	TN	7	1.41%	3,240,120	2.29%
44	TX	19	3.84%	13,165,728	9.32%
45	UT	6	1.21%	2,582,144	1.83%
46	VA	16	3.23%	2,388,527	1.69%
47	VT	0	0%	0	0%
48	WA	1	0.20%	1,405,220	1.00%
49	WI	17	3.43%	1,412,534	1.00%
50	WV	16	3.23%	9,231,718	6.54%
51	WY	9	1.82%	2,224,848	1.58%
	Total	**495**	100%	**141.2 million***	100%

* Note: In comparison to this estimate based on DOE-EIA databases cited in this RIA, the American Coal Ash Association (ACAA) estimated 123.1 million tons CCR generated in 2005 based on its annual voluntary participation survey : http://acaa.affiniscape.com/associations/8003/files/2005%20CCP%20Survey%20%2809-19-06%29Corrected-11-09-07.pdf

3B. Types of CCR Disposal Units

- **Estimated Plant Counts by Type of CCR Disposal Unit**

The scope of CCR disposal units covered by this RIA is active units (i.e., operational units which were receiving CCR as of year 2005). Inactive or abandoned units (i.e., non-operating units) are excluded from the scope of this RIA. The data source used to identify baseline CCR management practices and active units is the 2005 U.S. Department of Energy (DOE) Energy Information Administration (EIA) Form EIA-767 "Steam-Electric Plant Operation and Design Report" database.[34] The EIA-767 database is the primary data source for reporting annual CCR disposition for plants generating greater than 100 MW (megawatts) of electricity. Plants smaller than 100 MW are not required to report CCR tonnage and disposition (i.e., type of disposal and beneficial use) data to the EIA-767 database. Schedule 3 of the EIA-767 database contains the annual disposition of CCR in one or more of the following five forms of CCR management categories, according to annual tons disposed for each plant. EIA-767 does not contain counts of CCR disposal units for each plant:

1. Company-owned landfill
2. Company-owned disposal ponds (i.e., surface impoundments)
3. Onsite use and storage (this RIA assumes all of this quantity eventually goes to beneficial use, not disposal)
4. Sold (for beneficial use)
5. Disposed off site

The 2005 EIA-767 database contained annual CCR disposal data for 363 of the 495 plants identified in the 2007 EIA-860 database. The 363 plants are over 100 MW in size and thus are covered by the EIA-767 database. For the 132 plants which did not report CCR disposal practices in the 2005 EIA-767 database because they are less than 100 MW in size, disposal of CCR is assumed to take place in on-site or off-site landfills (whichever is the lowest-cost method as assigned by the CCR disposal engineering control cost model used for this RIA). For each of the 495 coal-fired utility plants identified in the prior section of this RIA using the 2007 EIA-860 database, baseline CCR disposal practices were assigned using the methodology and data sources presented below. Based on this analysis, **467 of the 495 plants dispose CCR** using the following methods. The 28 remainder of the 495 plants do not dispose because they solely supply their CCR for beneficial uses. A total of 272 of the 495 plants supply CCR for beneficial uses. The total count of disposal methods exceeds the 467 total count of disposing plants because some plants use more than one disposal method. The EIA-767 database does not contain counts of disposal units for each plant so only plant counts are summarized below according to disposal method, not CCR disposal unit counts. Because some plants use more than one disposal unit, the total count of CCR disposal units – although unknown for purpose of this RIA -- exceeds the 467 total count of disposing plants.

---

[34] Source: The EIA-767 database includes annual data from organic-fueled or combustible renewable steam-electric plants with a generator nameplate rating of 10 or more megawatts (MW) regardless of current ownership and/or operation. However, it contains annual tonnage CCR generation, CCR disposal, and CCR beneficial use data only for plants over 100MW in size. The EIA terminated the EIA-767 database after year 2005. Beginning with calendar year 2007 data, two other surveys, the Form EIA-860 and the Form EIA-923, will collect most of the data formerly collected by Form EIA-767. No data will be collected for 2006. The following weblink provides a crosswalk of the data elements previously collected on the Form EIA-767 for 2005 with the corresponding data elements to be collected beginning with calendar year 2007 on the Form EIA-860 or the Form EIA-923: http://www.eia.doe.gov/cneaf/electricity/2008forms/consolidate.html

- Onsite landfills: **311 plants** operate onsite CCR landfills (this RIA refers to these as "onsite" landfills although some may be located off plant property). This estimate consists of two sources (i.e., 212 plants + 99 plants):
  - 212 plants: dentified through actual data reporting of 363 coal-fired electric plants in size >100 MW contained in the 2005 EIA-767 database, out of the total 495 plants identified using the 2007 EIA-860 database (as described in the previous section above).
  - 99 plants: This estimate is based on the remainder 132 electric utility plants (i.e., 495 minus 363 plants = 132 plants) between 1 MW and 100 MW size for which there is no CCR disposal data in the EIA-767 database, and for which the CCR disposal engineering control cost model used in this RIA assigned the lowest-cost of three landfill options: (1) onsite dug landfill, (2) onsite pile landfill, or (3) offsite landfill. The cost model assignment was dependent upon the level of baseline engineering controls assumed required by each plant's state location and annual CCR disposal tonnage. The cost model estimated that 99 of the 132 plants without data dispose CCR in onsite landfills.

- Onsite impoundments: **158 plants** operate onsite CCR surface impoundments (aka "ponds," "embankments," "dams," "dikes," "wet dumps," "constructed wetlands"). This RIA assumes that all impoundments are "onsite" although some may be located off plant property.

  The non-duplicative count of plants using onsite landfills and/or onsite impoundments is **383 plants**.

- Offsite disposal: **149 plants** assigned as sending CCR offsite for disposal to commercial landfills (of which 84 plants solely ship CCR for offsite disposal). Off-site landfills receiving CCR are assumed to already be in compliance with EPA's RCRA Subtitle D guidance. The 149 plants assigned as using offsite landfills consist of the following assignments according to data sources (i.e., 116 plants + 33 plants):
  - <u>116 plants</u>: Electric utility plants >100 MW size (source: 2005 EIA-767 database): Final disposition of wastes is reported as either (a) company-owned landfill, (b) company-owned disposal pond, (c) on-site use & storage, (d) sold, or (e) off-site disposal. This RIA assumes that off-site disposal means offsite commercial landfill. Plants could have reported offsite minefill in this category if it was not "sold" (e.g., they paid to dispose it in a mine or it was used as minefill and no payment was made to the electric utility). However, it is unknown the sub-quantity of "offsite disposal" which includes plants reporting tonnages for non-sold uses as offsite minefill.[35]

[35] In July 2009, ORCR contacted the DOE-EIA Form 767 questionnaire contact person (Natalie Ko, Electric Power Division) to clarify this RIA's assignment of all "offsite disposal" tonnages as commercial landfills. The DOE-EIA contact person responded with additional information from four 2005 Form EIA-767 questionnaires regarding how electricity plant respondents optionally characterized the fly ash and bottom ash reported in the Form EIA-767 survey questionnaire as "Off Site Disposal" :
· "This quantity of fly ash was given away at no cost"
· "The fly ash was sent off site for beneficial use"
· "The fly ash is injected into the nearby mines for recharging the mines"
· "Ash is recycled as a beneficial re-use product for flowable fill in the construction industry"

        - 92 plants Offsite landfill fly ash
        - 76 plants Offsite landfill bottom ash
        - 4 plants   Offsite landfill gypsum
        - 16 plants Offsite landfill FGD
        - 7 plants   Offsite landfill other CCR (i.e., coal combustion by-products)
        - Sub-total = 116 plants (non-duplicative count)
    - 33 plants: This estimate is based on the 132 electric utility plants between 1 MW and 100 MW size for which there is no CCR disposal data in the EIA-767 database, and for which the CCR disposal engineering control cost model used in this RIA assigned the lowest-cost of three landfill options: (1) onsite dug landfill, (2) onsite pile landfill, or (3) offsite landfill. The cost model assignment was dependent upon the level of baseline engineering controls assumed required by each plant's state location and annual CCR disposal tonnage.

- **Estimated Counts of CCR Disposal Units**

The methodology of this RIA does not estimate or use secondary information about the actual count of CCR disposal units (i.e., landfill units and impoundment units) used by these 467 onsite or offsite disposing plants. However, there are two sources of CCR disposal unit counts:

- Source #1 of 2: ASTSWMO: The February-March 2009 ASTSWMO voluntary participation survey[36] of 42 states (which is incomplete coverage of the 47 states identified in this RIA for the 495 coal-fired electric plants) estimates a total of 484 electric utility plant CCR disposal units:

    - 227 electric utility plant CCR landfill units in 41 states
    - 257 electric utility plant CCR impoundment units in 33 states
    - Total electric utility plant CCR disposal units = 484 (i.e., 227 landfills + 257 impoundments)

But it is not clear whether the ASTSWMO CCR disposal unit counts (a) are restricted in the ASTSWMO survey to electric utility plants in NAICS code 221112, (b) may also include counts of CCR disposal units associated with other industries which generate coal-fired electricity in the surveyed states, (c) may include inactive/abandoned as well as active CCR disposal units, or (d) may include landfills or impoundments operated by electric utility plants which contain other types of waste streams (e.g. waste water treatment ponds without co-mingled CCR).

Source #2 of 2: EPA: In March 2009 EPA sent letters[37] to 210 coal-fired electric plant facilities and owner companies in order to identify the location of CCR impoundments and evaluate their structural integrity in the wake of the December 2008 CCR impoundment collapse and

[36] Source: Association of State and Territorial Solid Waste Management Officials (ASTSWMO), 01 April 2009 letter to Matt Hale, Director, EPA Office of Resource Conservation and Recovery: http://www.astswmo.org/files/publications/Positionpapers/ASTSWMO-CCB-letter-attachments.pdf

flooding at the TVA Kingston TN electricity plant. Although not used in this RIA other than for reference here, the responses received to the March 2009 EPA letters resulted in identification of 584 CCR impoundments units at electric utility plants. The letters did not collect information about CCR landfills[38]

3C. Types of CCR and Annual Quantities

As of 2008, coal-fired utilities burn approximately 1.036 billion tons of coal per year using a variety of conventional combustion technologies. NAICS 22 electric utility coal combustion results in the generation of five types of CCR:

1. Fly ash
2. Bottom ash
3. Flue gas desulfurization (FGD) sludge
4. Gypsum
5. Other residues (including boiler slag)

These wastes may be (a) disposed in onsite landfills and surface impoundments (i.e., ponds, dams, embankments, lagoons), or (b) may be applied to beneficial uses, or (c) disposed offsite. At the time of preparing this RIA in 2009, waste generation and disposition data from Schedule 8, Part A of the 2007 DOE EIA database for the Form EIA-932 "Power Plant Operations Report" database had yet to be finalized. Instead, the most currently available waste data was from the 2005 DOE EIA Form 767 "Steam-Electric Plant Operation and Design Report" database. Therefore, the 2005 EIA-767 database is the primary source used in this RIA to quantify CCR generation and identify the ultimate disposition of CCR (i.e., type of disposal or beneficial use). CCR generation and final disposition are reported under the above five CCR type categories in the 2005 EIA 767 database. As estimated in this RIA and displayed below in **Exhibit 3E**, the 495 electric utility plants generated **141.2 million tons per year** of CCR (2005/2007 mixed data).

Interpretive Note: This RIA's CCR generation estimate of 141.2 million tons is 15% and 8% higher, respectively, than the **123.1 million tons (2005)** and the **131.1 million tons (2007)** annual CCR generation estimates published by the American Coal Ash Association (ACAA).[39] The numerical discrepancy between this RIA's estimate and the ACAA estimates may be explained by the fact that both estimates (i.e., this RIA and the ACAA) are based on incomplete CCR tonnage disposition data for less than the "universe" of all known operating

---

[37] Source: Additional information about these March 2009 EPA letters is available at http://www.epa.gov/osw/nonhaz/industrial/special/fossil/coalashletter.htm
[38] Source: EPA's 584 CCR impoundment unit count is documented at http://www.epa.gov/osw/nonhaz/industrial/special/fossil/surveys/faqs.htm#18
[39] As of the date of this RIA, ACAA's "Coal Combustion Products Production & Use Statistics" website contains annual CCR generation and annual CCR beneficial use tonnage estimates for the US electric utility industry for years 2001, 2002, 2003, 2004, 2005, 2006, 2007, and 2008. As reported in footnotes on ACAA's annual survey results data tables, ACAA's CCR generation and CCR beneficial use annual tonnage estimates are based on the following survey coverages: 2001 coverage not indicated on data table; 2002 2/3rd coal burn; 2003 60% coal burn; 2004 60% coal burn; 2005 54% coal burn; 2006 57% coal burn reported by 58 electric utilities; 2007 161 plants; and 2008 274 plants. ACAA's annual CCR tonnage data webpage is at http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3

electric utility plants in the data year, extrapolated to plants for which there is no CCR tonnage data in the EIA database (in the case of this RIA's estimation methodology) and in the case of the ACAA estimates, extrapolated to plants not covered by ACAA's annual utility industry survey by supplementing with EIA data.

The estimate of CCR generation developed in this RIA consists of the following breakout of generation estimates according to two electric utility plant size categories, which correspond to the CCR tonnage disposition data reporting cut-off requirement in the EIA-767 database:

- >100 MW plants: **Exhibit 3E** below presents CCR disposition data for a sub-total of **120.9 million tons** CCR generated per year as reported by plants with annual electricity generation >100 MW from Schedule 3A of the 2005 EIA-767 database for each plant.
  - Ash generation data (fly ash and bottom ash) were available for 385 plants.
  - FGD sludge generation data were available for 72 plants.
  - Gypsum generation data were available for 31 plants.
  - Other byproduct generation data were available for 40 plants.

  If plants > 100 MW reported either company landfill, company disposal ponds, sold for beneficial use, or off-site disposal of CCR in the EIA-767 database, these final disposition practices are assumed in this RIA for the baseline. A total 179 plants with company-owned CCR landfills and 158 plants with company-owned CCR surface impoundments were reported in the 2005 EIA-767 database (i.e., 337 of the 495 electric plants).[40] 112 of the 495 plants reported 8.2 million "on-site use and storage" which this RIA assigned as beneficial use not as disposal. This assumption is supported by (a) DOE's August 2006 report[41] "Coal Combustion Waste Management at Landfills and Surface Impoundments 1994-2004" which interpreted the entire "onsite use & storage" quantity as beneficial use, and (b) the American Coal Ash Association (ACAA) which indicates that 49.6 million tons of coal ash were beneficially used in 2005[42]. However, the beneficial use estimate in **Exhibit 3E** below is much less at 38.8 million tons which is based on the EIA-767 "Sold" (i.e., beneficial use) CCR tonnage category. But adding the 8.2 million tons reported as "onsite use & storage" yields an estimate of 47.0 million tons (**Exhibit 3G**), which nearly matches the ACAA beneficial use estimate of 49.6 million tons. This suggests it is valid to assign the tonnage reported in the EIA-767 database as "onsite use & storage" to beneficial use rather than to disposal.

[40] In the 2005 DPRA Report, an additional step was included after step 1 that identified additional disposal practices using landfill and surface impoundment as reported in the 1995 EPRI Comanagement Survey. This data source was not used to identify CCR management units in this RIA given it dates back to 1995. The data source is only used to identify existing engineering controls for the units identified in the 2005 EIA 767 database. In the 2005 DPRA Report, 14 additional landfills and 10 surface impoundments were identified using this information source.

[41] Source: Footnote c of Table 1 on page 6 of DOE's August 2006 report at http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2008

[42] Source: ACAA's 2005 beneficial use data are available at http://acaa.affiniscape.com/associations/8003/files/2005%20CCP%20Survey%20%2809-19-06%29Corrected-11-09-07.pdf

- 1MW to 100 MW **Exhibit 3F** below presents an additional sub-total of **20.3 million tons** per year of CCR generated by 132 electric utility plants between 1 MW and 100 MW in capacity which had no CCR management information in the EIA767 database, because plants less than 100 MW are not required to report their CCR management annual tonnages in the EIA-767 database. Therefore, this RIA formulated an estimate for this size category of plants based on the following approach. Coal use and percent ash content data from Schedule 4A of the 2005 EIA-767 database were used to estimate ash generation quantities for 102 plants within this smaller size category. For 5 plants for which EIA-767 coal use data were unavailable for 2005, coal use data from Schedule 4A of the 2007 EIA-923 database were used to estimate CCR generation quantities for those 5 plants. FGD sludge generation data obtained from Schedule 8[43] of the 2005 EIA-767 database were used for 115 plants. Landfill (either on-site or off-site whichever is more economical) is the assumed CCR disposal practice. No gypsum or other byproduct generation quantities were estimated. For plants between 1 MW and 10 MW, ash generation quantities estimated using generator nameplate capacity rating data from the 2007 DOE Form 860 database. This 1 MW to 100 MW subtotal of 132 plants consists of two sub-categories:

    - 10 MW to 100 MW: 5.4 million tons of CCR for 110 plants estimated by multiplying the quantity of coal they burned by the percent CCR content of the coal data from Schedule 4A of the 2005 EIA-767 database and 2007 DOE EIA 923 database, or using generator nameplate rating data from the 2007 EIA-860 database and an average percent ash content.
    - 1 MW to 10 MW: 14.9 million tons of FGD sludge reported for 22 plants in Schedule 8 of the 2005 EIA-767 database that did not report any FGD sludge in Schedule 3A of the 2005 EIA-767 database.

[43] In general, data obtained from Schedule 8 of the 2005 EIA-767 database reflects information reported by plants between 10 MW and 100 MW. However, if a plant greater than 100 MW reported no final disposition quantities for FGD sludge in Schedule 3A of the 2005 EIA-767 database, the reported FGD sludge quantity in Schedule 8 is assumed in this RIA to be placed in a landfill for that plant.

Exhibit 3E
Annual CCR Disposition for NAICS 22 Electric Utility Plants >100 MW Capacity (tons per year as of 2005)

Item	CCR Category	A Company-Owned Landfill (Dry Disposal)	B Company-Owned Disposal Ponds (Wet Disposal)	C Onsite Use & Storage (assumed as beneficial use)	D Sold for Beneficial Use	E Offsite Disposal (assumed offsite landfills)	F (A+…+E) Row Totals
1	Fly Ash	21,324,280	15,212,590	3,744,370	20,760,230	9,314,540	70,356,010
2	Bottom Ash	5,707,740	4,311,630	3,487,660	5,453,717	1,907,480	20,868,227
3	Flue Gas Desulfurization Sludge	9,526,400	1,886,200	465,600	408,910	2,506,540	14,793,650
4	Gypsum (salable)	54,620	872,100	372,100	8,437,400	782,800	10,519,020
5	Other CCR	226,510	82,900	108,830	3,729,400	247,680	4,395,320
6	Totals	36.8 million	22.4 million	8.2 million	38.8 million	14.8 million	120.9 million

Exhibit 3F
Annual CCR Disposition for NAICS 22 Electric Utility Plants 1 MW to 100 MW Capacity (tons per year as of 2005)

Item	CCR Category	A Fly Ash Disposed in Off-site Landfill (Plants 1 MW to 100 MW)	B Fly Ash Disposed in Company-owned Landfill (Plants 1 MW to 100 MW)	C FGD Disposed in Company-Owned Landfill (Plants >10 MW)	D (A+B+C) Row Totals
1	Fly Ash	274,917	5,147,468	NA	5,422,385
2	Bottom Ash	Included under Fly Ash	Included under Fly Ash	NA	Included under fly ash
3	Flue Gas Desulfurization Sludge	NA	NA	14,852,300	14,852,300
4	Gypsum (salable)	NA	NA	Included in row 3	Included in FGD
5	Other Byproducts	Included under Fly Ash	Included under Fly Ash	NA	Included under fly ash
6	Totals	0.3 million	5.1 million	14.9 million	20.3 million

Exhibit 3G
Annual CCR Disposition for NAICS 22 Electric Utility Plants All Sizes (tons per year as of 2005)
(Source: **Exhibit 3E** + **Exhibit 3F**)

Item	CCR Category	A Company-Owned Landfill (Dry disposal)	B Company-Owned Disposal Ponds (Wet disposal)	C Beneficial Use (onsite BU + offsite BU + storage for BU)	D Offsite Disposal (assumed offsite commercial landfills)	E (A+B+C+D) Row Totals
1	Fly Ash	26,471,748	15,212,590	24,504,600	9,589,457	70,356,010
2	Bottom Ash	5,707,740	4,311,630	8,941,377	1,907,480	20,868,227
3	Flue Gas Desulfurization Sludge	24,378,700	1,886,200	874,510	2,506,540	14,793,650
4	Gypsum (salable)	54,620	872,100	8,809,500	782,800	10,519,020
5	Other CCR	226,510	82,900	3,838,230	247,680	4,395,320
6	Totals	**56.8 million**	**22.4 million**	**47.0 million**	**15.0 million**	**141.2 million**
	Percentages	40%	16%	33%	11%	100%

Exhibit 3H below summarizes the respective plant counts, annual tonnage CCR disposal, and electricity generation nameplate capacities of the 467 plants which dispose CCR, according to type of CCR disposal method (i.e., CCR landfills and CCR impoundments). Because some plants reported more than one management method, the sum of the plants across each disposal method exceeds the total count of 467 disposing plants.

Exhibit 3H
Summary of Plant Size and CCR Disposal Methods Estimated in this RIA

	A	B	C	D
	Plants Using CCR Landfills (dry disposal)		Plants Using CCR Impoundments*** (wet disposal)	Row Totals (non-duplicative)
Characterizing Metrics	Onsite Landfills	Offsite**		
1. 2007 Count of Coal-Fired Electric Utility Plants which Dispose CCR	311 plants (63% of 495)	149 plants (30% of 495) (84 plants solely use offsite landfills)	158 plants (32% of 495)	**467 plants dispose CCR** (94% of 495) (CCR from the remainder 28 plants is solely for beneficial uses)
2. Annual CCR Disposal (2005) • Minimum per plant = • Maximum per plant = • Mean per plant = • Median per plant =	56.8 million tons (60%) • 400 tons • 1.82 million tons • 205,196 tons • 90,700 tons	15.0 million tons (16%) • 20 tons • 1.28 million tons • 100,899 tons • 33,000 tons	22.4 million tons (24%) • 500 tons • 1.04 million tons • 141,550 tons • 67,300 tons	**94.2 million tons** (100%) • 110 tons • 2.11 million tons • 201,796 tons • 89,300 tons
3. Nameplate capacity* (2007) • Minimum per plant = • Maximum per plant = • Mean per plant = • Median per plant =	213,978 MW (58%) • 11 MW • 3,969 MW • 772 MW • 538 MW	90,547 MW (25%) • 2 MW • 2,911 MW • 608 MW • 350 MW	180,901 MW (49%) • 75.3 MW • 3,564 MW • 1,145 MW • 893 MW	369,183 MW (100%) • 2 MW • 3,969 MW • 746 MW • 497 MW

Notes:
* Nameplate capacity = electricity generation output potential in megawatts (MW).
** This RIA assumes all reported "non-company offsite disposal" in the EIA-767 database involves offsite landfill dry disposal, because it is expensive to transport large volumes of wet (i.e., watery) CCR long distances.
*** Surface impoundments are reported in the EIA-767 database as "company-owned ponds." This RIA assumes all are located onsite.

3D. Size of CCR Disposal Units

The size of CCR disposal units ranges from modest to very large, with some impoundments covering 1,500 acres or more. Sizing of the units is based on the annual tonnage of CCR placed in the unit. CCR disposal unit size assumptions for this RIA are adopted from Section 4.4.1 of the 2005 DPRA Report:

- Landfills sizes:
  Designed as "combination fill landfills"
    - 3.8 million cubic yards capacity
    - 50% of the capacity excavated below grade
    - 40-year capacity (i.e., operating lifespan)[44]
    - Per-unit surface area size ranges from 12 acres for 10,000 tons per year to over 2,000 acres for 2,000,000 tons per year.

  Designed as "pile fill landfills"
    - 3.4 million cubic yards capacity
    - 5% of the capacity excavated below grade
    - 40-year capacity (i.e., operating lifespan)
    - Per-unit surface area ranges from 16 acres for 10,000 tons per year to over 3,000 acres for 2,000,000 tons per year.

- Surface impoundment sizes:
  - 100% of capacity below grade
  - 40-year capacity
  - Per-unit surface area ranges from 30 acres for 10,000 tons per year, 140 acres for 50,000 tons per year, 500 acres for 200,000 tons per year, 1,400 acres for 500,000 tons per year, and 5,500 acres for 2,000,000 tons per year.

---

[44] For the 30 Nov 2005 DPRA report ("Estimation of Costs for Regulating Fossil Fuel Combustion Ash Management at Large Electric Utilities Under Part 258", docket document ID nr. EPA-HQ-RCRA-2006-0796-0469), the EPA asked utility industry representatives for the typical lifespan years of CCR landfills and impoundments. Industry representatives provided a 40-year estimate for both. This estimate is supported by data provided by industry in the 1995 EPRI Comanagement Survey. In the EPRI Survey, data describing six CCR landfills noted the year the unit was opened and the estimated date of closure. The average life expectancy is 34 years and the median life expectancy is 38 years. Similarly, data provided for 18 CCR impoundments indicate an average life expectancy of 45 years and a median life expectancy of 46 years. Therefore, this RIA assumes a 40-year lifespan for both landfills and impoundments.

3E. Cost of Baseline CCR Disposal

This Chapter presents characterizing data and estimates of the costs to the electric utility industry and to government, for baseline (i.e., current) industry engineering controls and other costs associated with CCR disposal. OMB's 2003 Circular A-4 "Regulatory Analysis" (page 15) requires RIAs to measure the benefits and costs of regulations against a baseline defined as:

Baseline = "*[T]he best assessment of the way the world would look absent the proposed rule.*"

The baseline developed here uses the most recent data year available and relies solely on publicly available data used in prior studies and reports, updated using empirically-justifiable factors. For purpose of this RIA, the possible types of baseline costs include:

A. Baseline "engineering control "costs for CCR disposal units:
1. Ground water monitoring
2. Bottom liners
3. Leachate collection system
4. Dust controls – applicable to landfills only
5. Rain and surface water run-on/run-off controls – applicable to landfills only
6. Financial assurance for disposal unit closure and post-closure
7. Disposal unit location restrictions (6 types: water tables, floodplains, wetlands, fault areas, seismic zones, karst terrain)
8. Closure capping to cover unit
9. Post-closure monitoring requirements
10. Storage design and operating standards (tanks, containers, containment buildings) – not evaluated in this RIA

B. Baseline "ancillary costs" directly related to CCR disposal:
11. Offsite disposal
12. Structural integrity inspections – impoundments only
13. RCRA facility-wide investigation (RFI)
14. Corrective action
15. Waste disposal permits
16. Inspection & enforcement
17. Remediation of environmental releases

- **Characterization of Industry Baseline CCR Disposal**

For each of the 467 operating electric utility plants which currently (2007) dispose CCR onsite or offsite (28 of the 495 total plants solely send their CCR for beneficial uses not disposal), this RIA estimated baseline engineering controls at disposal units and associated baseline disposal costs for each type of disposal (note: the sum of plant counts for each disposal category below exceeds 467 because some plants use more than one type of CCR disposal method):

- 311 plants with active onsite CCR landfills
- 158 plants with active onsite CCR surface impoundments
- 149 plants which offsite dispose (assumed all involve offsite landfills)

For this RIA, the "baseline" is defined as existing conditions plus projection of future conditions over the 50-year future period-of-analysis 2012 to 2061 applied in this RIA (this RIA assumes year 2012 represents the first year when the final rule could take effect, if promulgated). Baseline engineering controls were estimated using the following 2-step method which is based on two alternative and complementary sources of information:

- Step 1: If the plant reported controls in the 1995 EPRI Comanagement Survey, 1996 CIBO Survey, or the 1994-2004 DOE-EPA Study, the stricter of these controls or state-specified controls are assumed for the baseline. These studies contained control data for 89 plants with CCR landfills and 50 plants with CCR impoundments (i.e., 139 of the 495 electric utility plants). State regulations added additional controls at 69 of the 89 landfill plants and 43 of the 50 impoundment plants with plant specific information (e.g., the EPRI Survey data may have indicated that the unit had a liner only but state regulations required groundwater monitoring and capping so these additional controls were added).
- Step 2: Controls specified under state regulations for 34 states are assumed for all other plants in those 34 states for the baseline if no 1995 EPRI Comanagement Survey data, 1996 CIBO Survey data, or 1994-2004 DOE-EPA Study data are available for that plant. This step resulted in assigning state-required controls to 201 plants with CCR landfills and 55 plants with CCR impoundments (i.e., 256 of the 495 plants). Overall state regulations were added to 270 plants with CCR landfills and 98 plants with CCR impoundments.

For the 100 plants (i.e., 47 plants with landfills and 53 plants with impoundments) for which there are no data from the three studies, and no state-regulatory data on controls from Step 1, no controls are assumed under baseline for on-site landfills and impoundments; this represents a worst case (i.e., high cost) assumption.

The associated data sources and findings for each baseline characterization step are described below.

- **Step 1: Baseline Installed CCR Disposal Engineering Controls Identified in Prior Industry Surveys (1995, 1996, 2004)**

The controls identified through the Step 1 prior studies were more stringent than the state government requirements discussed in Step 2 for:

- Landfills: Voluntary controls for 25 plants with landfills (9% of 227 plants landfills) receiving 6.4 million tons per year (i.e., 9% of total landfill CCR quantity) in 12 states (some are identified as voluntary because state regulations were not reviewed for the state): AR, AZ, CA, IA, IN, KS, MD, MN, NE, SD, SI, WV.

- o <u>Impoundments</u>: Voluntary controls for 39 plants with impoundments (25% of 158 plants with impoundments) receiving 5.5 million tons per year (i.e., 25% of total CCR impoundment quantity) in 14 states (some are identified as voluntary because state regulations were not reviewed for the state): AL, FL, IA, IL, IN, LA, MN, MS, NM, OH, SC, TX, UT, WY.

- **Step 2: Baseline State Government CCR Disposal Engineering Control Requirements for Landfills & Impoundments (2008)**

Several states have already established certain CCR disposal unit design and operating requirements that are required to be implemented either upon the effective date of the regulation (e.g., groundwater monitoring), upon retirement of the disposal unit (e.g., post-closure monitoring), or for newly constructed units only. **Appendix E** of this RIA provides a summary of the state government requirements for both landfills and impoundments. Current CCR disposal regulations have been reviewed for the top 34 states that utilize coal for producing electricity for required engineering controls at landfills and impoundments. The plants located in these states account for 99% of the annual quantity of CCR managed in company-owned (i.e., onsite) landfills and impoundments. State regulations were reviewed for the following 34 states: AL, AZ, CO, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MS, MO, MT, NV, NM, NY, NC, ND, OH, OK, PA, SC, TN, TX, UT, VA, WA, WV, WI, WY. Below is a synopsis of the baseline state government requirements according to the engineering controls listed above.

1. Groundwater monitoring requirements:

- Point-of Compliance:
  Two options for point-of-compliance groundwater monitoring include installing monitoring wells at the unit boundary or within 150 meters of the unit boundary. Recent changes to state regulations suggest that states typically require unit boundary monitoring.
- Number of Wells:
  Certain states specify a <u>minimum</u> number of monitoring wells: FL (3 wells for impoundments), IA (1 well for landfill), IL (multiple wells for landfills), KY (3 wells for landfills), LA (3 wells for impoundments and landfills), MO (4 wells for impoundments and landfills), ND (3 wells for impoundments), OK (3 wells for impoundments and 4 wells for landfills), TN (3 wells for landfills), UT (3 wells for landfills), WV (3 wells for impoundments and 4 wells for landfills). Well spacing design criteria for landfill boundary detection wells for FL, IA, and KS were reviewed. FL requires a minimum of one down-gradient detection well every 500 feet placed within 50 feet of the unit. Iowa requires a minimum of one detection well every 600 feet placed within 50 feet of the unit. KS recommends a minimum of one-down-gradient detection well every 500 feet.
- Monitoring Parameters:
  Two options for sampling include testing for chemical indicators and testing for RCRA hazardous waste Appendix VIII constituents (i.e., 40 CFR 261 Appendix VIII). Of the 34 state regulations reviewed, three states require chemical indicator monitoring for surface impoundments [CO, PA, WV] and 11 states require chemical indicator monitoring for landfills [IA, FL, KY, MI, OH, OK, PA, TN, UT, WI, WV]. Three states require RCRA Appendix VIII constituent monitoring for impoundments [MO, PA, WV], and 10 states require RCRA Appendix VIII constituent monitoring for landfills [GA, FL, IA, IL, MI, MO, OH, TN, UT, WV].
- Monitoring Frequency:
  Three options for groundwater sampling frequency include quarterly, semi-annual and annual. Of the 34 state regulations reviewed, one state requires quarterly sampling for surface impoundments [CO (depending on the ground-water classification)] and three states require quarterly monitoring for landfills [IA (until baseline conditions are established), IL (first 5 years), MI]. Five states require semi-

annual sampling for surface impoundments [LA, MO, ND, PA (chemical indicators), WV] and 12 states require semi-annual monitoring for landfills [FL, GA, KY, LA, MO, OH (chemical indicators), OK, PA (indicator parameters), TN (chemical indicators), UT, WV, WY]. Three states require annual sampling for surface impoundments [CO (depending on the ground-water classification), PA (metals and VOCs), WV] and five states require annual sampling for landfills [IA (after baseline established), IL (after 5 years), OH (metals, TOC, TDS, chloride, sodium and radionuclides), PA (metals and VOCs), TN (RCRA Appendix VIII constituents)].

- Timing of State Regulation Implementation**:**
  In the baseline, certain states require groundwater monitoring only for newly constructed units. These baseline costs are tracked as future baseline cost streams in the cost model. Of the 34 state regulations reviewed, nine states require immediate compliance with monitoring requirements for impoundments: LA, MN, MO, ND, NV, NY, OK, SC, UT. Eight states that only require groundwater monitoring only at newly constructed surface impoundments: CO, FL, KY, MI, NC, PA, WI, WV. 21 states require immediate compliance with monitoring requirements for landfills: AL, CO, GA, IA, IN, KS, KY, MI, MN, MT, NC, ND, NY, OH, PA, SC, TN, UT, VA, WA, WY. Ten states require groundwater monitoring only at newly constructed landfills: FL, IL, LA, MS, MO, NV, OK, TX, WV, WI.

2. Bottom liner requirements:

- Impoundments:
  Of the 34 state regulations reviewed, 10 states require immediate compliance with liner requirements for surface impoundments: FL (composite), KS (composite), KY (composite), LA (composite), MO (composite), ND (clay or synthetic), NV (composite), NY (composite), OK (composite), and PA (composite). Six states require liners only at newly constructed surface impoundments: CO (clay or soil), MI (clay or composite), NC (composite), WI (composite, synthetic or clay), WV (composite), WY (composite).
- Landfills:
  Of the 34 state regulations reviewed, 19 states require immediate compliance with liner requirements for landfills: AL (composite), CO (clay or synthetic), GA (composite), IN (clay), KS (composite), LA (composite), MI (composite), MN (clay), MT (composite), NC (composite), ND (clay or synthetic), NY (composite), OH (composite), PA (composite), SC (composite or clay), TN (composite), UT (composite), VA (composite), and WA (composite). 10 states require liners only at newly constructed landfills: FL (composite or double), IL (clay or composite), MS composite), MO (composite), NV (composite), OK (composite), TX (composite), WI (composite), WV (composite), WY (composite).

3. Leachate collection/detection system requirements:

- Impoundments:
  Of the 34 state regulations reviewed, nine states require immediate compliance with leachate collection/detection system requirements for surface impoundments: FL, KS, KY, LA, MO, ND, NV, NY, PA. Five states require leachate collection/detection systems only at newly constructed surface impoundments: CO, MI, NC, WV, WI.
- Landfills:
  Of the 34 state regulations reviewed, 18 states require immediate compliance with leachate collection system requirements for landfills: AL, CO, GA, IN (karst areas only), KS, MI, MN, MT, NC, ND, NY, OH, PA, SC, TN, UT, VA, WA. 11 states require leachate collection systems at newly constructed landfills: FL, IL, LA, MS, MO, NV, OK, TX, WI, WV, WY.

4. Dust control requirements: (landfills only)

Of the 34 state regulations reviewed, 16 states require immediate compliance with dust control requirements (wetting and truck covers and/or compaction) for landfills: CO, GA (compaction only), IA, IN, KS, MI, MN (includes compaction), ND (includes compaction), NY, OH, PA, SC, TN, UT, VA, WA. Nine states require dust controls only at newly constructed landfills: FL, IL (includes compaction), LA, MO, NM, OK, WI, WV, WY (includes compaction).

5. Run-on/run-off control requirements: (landfills only)

Of the 34 state regulations reviewed, 18 states require immediate compliance with run-on/run-off control requirements for landfills: AL, CO, GA, IA, IN, KS, MD, MN, MT, NC, NY, OH, PA, SC, TN, UT, VA, WA. 11 states require run-on/run-off only at newly constructed landfills: FL, IL, LA, MS, MO, NV, OK, TX, WI, WV, WY.

6. Financial assurance for CCR disposal unit closure & post-closure care

- Impoundments:
  Of the 34 state regulations reviewed, 11 states require immediate compliance with financial assurance requirements for surface impoundments: AZ, KY, LA, MN, MO, ND, NM, NV, OK, TN, and UT. Four states require financial assurance requirements only at newly constructed surface impoundments: CO, MI, NC, WI.
- Landfills:
  Of the 34 state regulations reviewed, 22 states require immediate compliance with financial assurance requirements for landfills: CO, FL (new construction), GA, IA, IN, KS, KY, MI, MN, MO, MT, NC, ND, NY, OH, SC, TN, UT, TX, VA, WA, WY. Eight states require financial assurance requirements only at newly constructed landfills: FL, IL, LA, MS, NV, OK, WI, WV.

7. Disposal Unit Location Restrictions (6 categories)

State regulations for the top-25 coal usage states (for electricity) were reviewed back in year 2000 for any location restrictions. These regulations were not updated as part of this RIA. The following is a synopsis of state government location restrictions on locating CCR surface impoundments and landfills, according to six categories of location restrictions (water table, floodplains, wetlands, fault areas, seismic zones, unstable karst terrain).

- 7-1: Below the natural water table:
  - Of the 25 state regulations reviewed, five states have location restrictions below the natural water table for surface impoundments: NC (4 feet above seasonal water table), ND (within aquifer), OK (if less than 15 feet above ground-water table), WV (5 feet above ground-water table), WY.
  - Of the 25 state regulations reviewed, eight states have location restrictions below the natural water table for landfills: FL, IA (5 feet above ground water), MI (4 feet above ground water), MN (5 feet above ground water), NC (4 feet above seasonal water table), ND (within aquifer), OH (5 feet above water table for wastes with higher leachate concentrations), TN (if less than 5 feet above water table).
- 7-2: Floodplains:

- Of the 25 state regulations reviewed, eight states have location restrictions in floodplains for surface impoundments: KS (under permit), KY, MO (if closed with waste in place), NC, ND, OK (if dike not at least 1 foot above 100-year flood elevation), PA, WV.
- Of the 25 state regulations reviewed, 20 states have location restrictions in floodplains for landfills: AZ, CO, FL, IL, IN, IA, KS, KY, MI, MN, MO, NC, ND, OH, OK, PA, TN, WV, WI, WY.

- 7-3: Wetlands
  - Of the 25 state regulations reviewed, five states have location restrictions in wetlands for surface impoundments: KY, MO (if closed with waste in place), ND, PA, WV.
  - Of the 25 state regulations reviewed, 17 states that have location restrictions in wetlands for landfills include AZ, CO, FL, IL, IN, IA, KY, MI, MN, MO, ND, OK, PA, TN, WV, WI, WY.
- 7-4: Fault areas:
  - Of the 25 state regulations reviewed, two states have location restrictions in fault areas for surface impoundments: MO (if closed with waste in place), WV.
  - Of the 25 state regulations reviewed, seven states have location restrictions in fault areas for landfills: AZ, CO, MO, OH, TN, WV and WI.
- 7-5: Seismic zones:
  - Of the 25 state regulations reviewed, two states have location restrictions in seismic impact areas for surface impoundments: include MO (if closed with waste in place), WV.
  - Of the 25 state regulations reviewed, eight states have location restrictions in seismic impact areas for landfills: AZ, CO, IL, MO, OK (if within 5 miles of epicenter of 4.0 earthquakes), TN, WV, WI.
- 7-6: Karst areas:
  - Of the 25 state regulations reviewed, five states have location restrictions in unstable areas for surface impoundments: KY, MO (if closed with waste in place), ND, PA, WV (1,000 feet away).
  - Of the 25 state regulations reviewed, 12 states have location restrictions in unstable areas for landfills: AZ, CO, IN, IA, KY, MN, MO, ND, PA, TN, WV (1,000 feet away), WI.

8. Closure cap controls

- Of the 34 state regulations reviewed, nine states require immediate compliance with closure control requirements for surface impoundments: AZ (synthetic cap), KY (synthetic cap), LA (clay cap), MO (soil cap), ND (clay or synthetic cap), NM (synthetic cap), OK (clay or synthetic cap), PA (clay or synthetic), TN (synthetic cap). Four states require closure controls only at newly constructed surface impoundments: CO (clay or synthetic cap), MI (clay or synthetic cap), NC (soil cap), WI (synthetic cap).
- Of the 34 state regulations reviewed, 23 states require immediate compliance with closure control requirements for landfills: AL (synthetic cap), CO (clay cap), GA (soil cap), IA (clay cap), IN (clay cap), KS (soil cap), KY, MD (clay cap), MI (clay or synthetic cap), MN (clay cap), MO (soil cap), MT (clay cap), NC (soil cap), ND (clay or synthetic cap), NY (synthetic cap), OH (synthetic cap), PA (synthetic cap), SC (synthetic cap), TN (clay cap), TX (synthetic cap), UT (soil cap), VA (synthetic cap), and WA (synthetic cap). Nine states require closure controls only at newly constructed landfills: FL (synthetic cap), IL (clay or synthetic cap), LA (clay cap), MS (soil cap), NV (soil cap), OK (clay cap), WI (clay cap), WV (soil or clay cap), WY (synthetic cap).

9. Post-closure monitoring requirements

- Of the 34 state regulations reviewed, 11 states require immediate compliance with post-closure groundwater monitoring requirement for surface impoundments: AZ, LA, MO, ND, NM, NV, NY, OK, SC, TN, UT. Seven states require post-closure groundwater monitoring only at newly constructed surface impoundments: CO, KY, MI, NC, PA, WI, WV.
- Of the 34 states reviewed, 22 states require immediate compliance with post-closure groundwater monitoring requirements for landfills: AL, CO, GA, IA, KS, KY, MD, MI, MN, MO, MT, ND, NY, OH, PA, SC, TN, TX, UT, VA, WA, WY. Eight states require post-closure groundwater monitoring at newly constructed landfills: FL, IL, LA, MS, NV, OK, WI, WV.

10. Baseline storage tank/container design and operating standards

The baseline storage tank /container design and operating standards were not evaluated in this RIA because of a lack of data about the baseline count and conditions of CCR storage or treatment tanks, containers, and containment buildings at electric utility plants

- **Industry Baseline CCR Disposal Characterization Findings**

Appendix F of this RIA presents on a plant-by-plant basis the baseline engineering controls assumed for each of the 383 of the 495 electric utility plants which onsite dispose CCR (84 plants solely dispose CCR offsite; this RIA assumes that all offsite CCR disposal units are landfills, and further assumes that all of those offsite landfills currently comply with the engineering controls described in this RIA for the regulatory options). **Exhibits 3I** (for landfills) and **Exhibit 3J** (for impoundments) below summarize the assignment of baseline conditions in this RIA for these 411 plants which dispose CCR onsite.

Exhibit 3I Baseline Compliance with State Government Engineering Control Requirements: CCR Landfills									
		A	B	C	D	E	F	G	H
		Future new CCR landfills				Existing CCR landfills			
Current or State Regulated Engineering control		No. of Plants	Percent of 311 plants with LFs	Volume of CCR diposed in landfills (tons/year)	% of 71.8 million tons onsite + offsite LF	No. of Plants	Percent of 311 plants with LFs	Volume of CCR disposed in landfills (tons/year)	% of 71.8 million tons onsite + offsite LF
1. Groundwater Monitoring		302	97%*	69,706,646	97%*	272	81%	60,623,231	85%
2. Bottom Liner		302	97%*	69,706,646	97%*	238	71%	52,505,314	73%
3. Leachate Collection System		273	81%	62,696,310	88%	222	66%	49,213,424	69%
4. Dust Controls		215	64%	40,634,681	57%	205	61%	42,781,444	60%
5. Run on/Run off Controls		261	77%	60,342,426	84%	209	62%	46,232,440	65%
6. Financial Assurance		266	79%	56,861,231	79%	231	69%	49,487,222	69%
7. Site restrictins	1. Water table	98	29%	18,878,963	26%	ND	ND	ND	ND
	2. Floodplains	232	69%	50,072,235	70%	ND	ND	ND	ND
	3. Wetlands	199	59%	40,227,659	56%	ND	ND	ND	ND
	4. Fault areas	72	21%	18,816,363	26%	ND	ND	ND	ND
	5. Seismic zone	66	20%	13,056,165	18%	ND	ND	ND	ND
	6. Karst areas	152	45%	33,970,045	47%	ND	ND	ND	ND
8. Cap	Synthetic or Clay	245	73%	52,234,482	73%	213	63%	46,031,621	64%
	Soil	48	14%	10,990,166	15%	50	15%	12,094,140	17%
	Clay/Soil	13	4%	5,419,918	8%	5	1%	3,022,219	4%
9. Post Closure Monitoring		271	80%	61,444,140	86%	232	69%	53,249,880	74%
10. Storage design standards		ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = Not determined. Comparisons have not been made comparing the date the state site restriction regulation became effective and the date of existing landfill construction for each plant.
* According to the August 2006 DOE/EPA report "Coal Combustion Waste Management at Landfills and Surface Impoundments, 1994-2004" report nr. DOE/PI-0004, 286 pp; http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2008:

- 97% of newly constructed CCR landfills have groundwater monitoring (Table 14, p.35)
- 97% of newly constructed CCR landfills have liners (Table 13, p.33)

These percentages reflect a mix of state government permit requirements for some surveyed electricity plants, plus industry voluntary actions for other plants.

Exhibit 3J Baseline Compliance with State Government Engineering Control Requirements: CCR Surface Impoundments									
		A	B	C	D	E	F	G	H
		Future new CCR impoundments				Existing CCR impoundments			
Current or State Regulated Engineering control		No. of Plants	Percent of 158 plants with SIs	Volume of CCR disposed in impoundments (tons/year)	% of 22.4 million tons CCR disposed in impoundments	No. of Plants	Percent of 158 plants with SIs	Volume of CCR disposed in impoundments (tons/year)	% of 22.4 million tons CCR disposed in impoundments
1. Groundwater Monitoring		123	78%*	17,472,000	78%*	78	49%	9,216,470	41%
2. Bottom Liner		158	100%*	22,400,000	100%*	62	39%	6,920,820	31%
3. Leachate Collection System		61	39%	7,676,710	34%	48	30%	5,338,110	24%
4. Dust control		NA	NA	NA	NA	NA	NA	NA	NA
5. Runon/runoff control		NA	NA	NA	NA	NA	NA	NA	NA
6. Financial Assurance		63	40%	7,694,010	34%	58	37%	7,327,410	33%
7. Site restrictns	1. Water table	28	18%	3,039,860	14%	ND	ND	ND	ND
	2. Floodplains	51	32%	6,902,610	31%	ND	ND	ND	ND
	3. Wetlands	34	22%	5,347,550	24%	ND	ND	ND	ND
	4. Fault areas	15	9%	1,675,350	7%	ND	ND	ND	ND
	5. Seismic zone	15	9%	1,675,350	7%	ND	ND	ND	ND
	6. Karst areas	34	22%	5,347,550	24%	ND	ND	ND	ND
8. Cap	Synthetic	38	24%	5,911,760	26%	31	20%	4,298,660	19%
	Soil	27	17%	2,490,050	11%	23	15%	2,293,550	10%
	Clay	3	2%	254,800	1%	3	2%	254,800	1%
9. Post Closure Monitoring		78	49%	9,520,360	43%	65	41%	7,181,760	32%
10. Storage design standards		ND	ND	ND	ND	ND	ND	ND	ND

Notes:
NA = Not applicable to surface impoundments.
ND = Not determined. Comparisons have not been made comparing the date the state site restriction regulation became effective and the date of existing surface impoundment construction for each plant.
* According to the August 2006 DOE/EPA report "Coal Combustion Waste Management at Landfills and Surface Impoundments, 1994-2004" report nr. DOE/PI-0004, 286 pages; http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2008:

- 78% of newly constructed CCR impoundments have groundwater monitoring (Table 14, p.35)
- 100% of newly constructed CCR impoundments have liners (Table 13, p.33)

These percentages reflect a mix of state government permit requirements for some surveyed electricity plants, plus industry voluntary actions for other plants.

- **Baseline CCR Disposal Cost Estimation**

This section presents baseline cost estimates for both onsite and offsite CCR disposal units (i.e., landfills and impoundments) for 467 of the 495 electric utility plants which dispose CCR (CCR from the remainder 28 of the 495 plants is solely beneficially used).

- **Cost Estimation Framework**

- Cost calculations: This RIA contains three types of cost estimates (with decreasing relative degrees of expected accuracy):
  - Data-based estimates: Based on a landfill and impoundment engineering controls cost estimation model using relatively robust and recent data inputs (e.g., 2005 or newer) pertaining to CCR quantities and disposal methods for individual electric utility plants. The cost model was first developed by EPA in 1988 to support EPA's 1991 final criteria for municipal solid waste RCRA Subtitle D landfills, and EPA's 1999 proposed rule cement kiln dust landfill requirements.[45] The cost model consists of two software components; **Appendix G** to this RIA provides additional details about the model:
    - 1st of 2 cost model components: Unit Cost Component: The first component is a Fortran computer programmed cost model which dates back to 1988. This model specifies the various steps and physical units (e.g., square footage sizes and associated quantities of labor, equipment and materials for the specified sizes) involved in designing, constructing, operating, and closing a landfill or impoundment. Then it combines the physical component data inputs, with input data on the prices/ costs/ fees for the physical components to estimate as model outputs, the capital and annual O&M costs of specified sizes of landfills and impoundments. The unit prices/ costs/fees used as input data include a wide range of items, such as the per-acre cost of land, clearing, excavation, equipment, labor, bottom liner materials, and cover materials. For this RIA, the model was run multiple times to generate individual cost estimates for a series of five alternatively-sized CCR landfills and impoundments with varying types of engineering controls to represent the range of sizes and engineering controls in the population of 495 electric utility plants. The size categories are defined in tons per day of CCR disposed. Each CCR landfill or

---

[45] The 1988 cost model is documented in the "User's Manual for the Subtitle D Municipal Landfill Cost Model" draft report prepared for EPA's Office of Solid Waste by DPRA Inc, Sept 1988, 129 pages which is available from the Federal docket as document ID nr EPA-HQ-RCRA-2006-0796.

EPA previously publicly referenced this cost model in the following six publications: (a) "Draft Regulatory Impact Analysis for Proposed Revisions to Subtitle D Criteria for Municipal Solid Waste Landfills," prepared for US EPA Office of Solid Waste by Temple, Barker & Sloane, Inc., ICF Incorporated, Pope-Reid Associates (now DPRA Inc.) and American Management Systems, Inc., 05 Aug 1988 (this document includes about a 4-page summary of the cost model); (b) "Regulatory Impact Analysis for the Final Criteria for Municipal Solid Waste Landfills," prepared for US EPA Office of Solid Waste by Temple, Barker & Sloane/Clayton Environmental Consultants, ICF Inc, DPRA Inc, and American Management Systems, Inc., Dec 1990 (this document includes about a 4-page summary of the cost model); (c) "Addendum to the Regulatory Impact Analysis for the Final Criteria for Municipal Solid Waste Landfills," prepared for US EPA, Office of Solid Waste by Temple, Barker & Sloane/Clayton Environmental Consultants and ICF Inc, August 1991; (d) "40 CFR Parts 257 and 258 Solid Waste Disposal Facility Criteria: Proposed Rule," Federal Register, Vol.53, No.168, pp.33314-33422, 30 Aug 1988; (e) "Revised Criteria for Municipal Solid Waste Landfills," Federal Register Volume 56, pp. 50978, 09 Oct 1991; (f) "Technical Background Document: Compliance Cost Estimated for the Proposed Land Management Regulation of Cement Kiln Dust," prepared for the US EPA, Office of Solid Waste by DPRA Inc, 10 April 1998.; and (g) "40 CFR Parts 259, 261, 266, and 270 Standards for the Management of Cement Kiln Dust; Proposed Rule," Federal Register Vol.64, No.161, pp. 45632-45697, 20 Aug 1999.

impoundment is assumed to operate 300 days per year (average number of operating days for coal-fired boilers based on 2005 DOE EIA 767 database). The size categories are 10,000, 50,000, 200,000, 500,000 and 2,000,000 tons of CCR per year. Size is the primary determinant of overall cost; however, landfills and impoundments exhibit increasing returns to scale: the larger the landfill or impoundment, the lower the cost per ton of CCR managed. The cost equations generated by these unit cost model runs are used as inputs in the second component of the cost model to compute landfill and impoundment cost curves (equations) based on size for each combination of engineering controls, so that a unique cost estimate may be assigned to each of the 495 electric utility plants according to each plant's unique annual CCR disposal tonnage.

- 2nd of 2 cost model components: Plant-by-Plant & Aggregate Cost Component: The second component of the model is an Excel spreadsheet with Visual Basic programming used to estimate unique baseline (i.e., current) and regulatory option costs for each electric utility plant. The spreadsheet is populated with plant-by-plant data including plant location, known disposal and beneficial reuse practices, known or estimated baseline engineering controls on CCR disposal units, annual CCR disposal tonnages, and known or estimated CCR landfill and impoundment future closure years. The spreadsheet is also populated with the cost equations generated by the first component of the model for the various engineering controls (e.g., groundwater monitoring and safety inspections) and for off-site landfill disposal costs. The Visual Basic programming is used for this RIA to estimate engineering control costs for both the (a) baseline and (b) regulatory options for each plant over a 50-year future period-of-analysis (i.e., 2012 to 2061). The plant-by-plant estimated costs are then aggregated in this second component of the model on an average annualized basis.

- Assumption-based estimates: These are based on relatively limited data, and/or older data (e.g., older than 2005), or meta-analysis transfer of results from other studies, or data from case studies, or based mostly on professional judgment assumptions rather than data, for some of the major factors used in cost calculations.
- Scenario-based estimates: These are applied in absence of data, case studies, or assumptions for purpose of illustrating potential lower- and upper-bound costs (i.e., bounding estimates). EPA defines "scenarios" as qualitative projections of possible future conditions based on variations in key drivers of change, including social, technological, economic and institutional drivers. Scenario construction is a futures analysis method; as such, scenario-based estimates do not strive to predict the future with absolute certainty, but to explore uncertainties, possible consequences, and possible outcomes.[46]

- 2009 price level: Costs are normalized to beginning-of-year 2009 dollars using inflation factors developed by Engineering News-Record (ENR) Construction Cost Index, and using regional cost adjustment factors applied to each plant cost estimate involving on-site construction. These regional factors account for the variability between states in site work and landscape construction costs. Cost adjustment factors are derived from the Means Building Construction Costs Year 2003 city factors. All the cities for each state were averaged together to derive a state average.

[46] "Source: EPA Office of Science Policy, "Shaping Our Environmental Future: Foresight in the Office of Research & Development," report nr. EPA 600/R-06/150, 2006 at: http://www.epa.gov/osp/futures/FuturesHandbook.pdf

- Before-tax costs: Baseline disposal costs estimated on a before-tax basis to approximate the overall economic cost (i.e., real resource allocation for the economy as a whole, rather than on an after-tax basis which would approximate a relatively narrower financial cost to the electric utility industry because after-tax costs subtract business expense tax deductions and depreciation of capital expenditures for pollution control equipment.

- 50-year period: A 50-year future time horizon (aka period-of-analysis) was applied because new construction for replacement of all CCR disposal units and end of existing lifespan is estimated to have occurred at least once by that time.

- 7% discount rate: A 7% discount rate was applied for calculating both net present value cost and average annualized cost for the engineering control unit costs applied in this RIA. Because both the annualized baseline cost and annualized incremental proposed rule costs estimated in this RIA consist of primarily (i.e., >95%) industry cost rather than government cost, this RIA applies a 7% discount rate rather than a lower (e.g., 3%, 2%, 1% or 0%) discount rate to represent the opportunity cost of business capital investment and business expense financing (i.e., the average rate of return to corporate capital). This is consistent with OMB's 2003 Circular A-4[47] (page 33) and 1992 Circular A-94[48] (page 8) which indicate that a 7% discount rate base-case should be used for regulatory analyses when regulation is expected to primarily and directly affect businesses and industries.

- 0.73% growth: Baseline cost estimates increased 0.73% per year over the 50-year future time horizon to reflect a 0.73% annual growth in coal consumption at electric utility plants (which is a proxy for future annual growth in the annual tonnage of CCR generation needing disposal from those plants). The 0.73% annual growth factor is based on DOE-EIA's January 2009 "Annual Energy Outlook 2009" forecast change in US coal consumption for electricity generation between year 2010 (22.91 quadrillion Btus) and 2030 (26.41 quadrillion Btus), available at: http://www.eia.doe.gov/oiaf/aeo/index.html

- Beneficial use: If reported in the baseline by any particular plant, beneficial use was assumed to continue in the future by that plant under the baseline projection over the 50-year future period-of-analysis. Section 5C in **Chapter 5** of this RIA evaluates potential changes to this beneficial use baseline under alternative regulatory impact scenarios.

- Offsite disposal: If reported in baseline by any particular plant, offsite disposal was assumed to continue in the future by that plant. Offsite disposal landfill cost estimated under both baseline and regulatory options using the engineering control cost model. Truck operating cost estimated separately outside of the model.

- Existing unit closure: One set of years for the opening and closure of disposal units are assumed for each facility. If data for initial year of operation were provided in the 1995 EPRI Comanagement Survey, these data were used. If the plant had more than

[47] 2003 OMB Circular A-4: http://www.whitehouse.gov/omb/circulars_a004_a-4/
[48] 1992 OMB Circular A-94: http://www.whitehouse.gov/omb/circulars_a094/

one disposal unit and more than one reported date for initial year of operation, the years were averaged. For example, if a facility had three disposal units (2 landfills and 1 impoundment) with installation dates of 1970, 1980, and 1990, this RIA assumed the installation date of all the units was 1980. This assumption simplified the cost calculations on a per facility basis instead of a per disposal unit basis. If no disposal unit installation data were available, the installation year is assumed to be equal to the earliest boiler installation year reported in either the 2007 EIA 860 database for that plant or 1998 EIA 767 database, whichever was older. If no disposal unit or boiler installation year data were available, an installation year of 1980 was assumed. If the 1995 EPRI Comanagement Survey provided a forecasted closure year for a unit, new unit installation is assumed to occur in that year. Otherwise, if no closure forecast year is provided, closure is assumed to occur 40 years after the year of installation (assumed average lifespan for CCR landfills and impoundments).

- New unit construction: The timing of when baseline state regulatory requirements for newly constructed units begin to be incurred depends on the installation and closure date for the existing disposal units. Baseline state regulatory cost requirements are incurred at the closure date of the disposal unit when new unit construction occurs. For example, if a plant's disposal unit is assumed in this RIA to close in 2019; new unit construction costs required under state regulations are incurred over its assumed 40-year future lifespan beginning in 2020.
    - New landfills: The most economic of three landfill options – (1) combination landfill with 50% of waste below ground and 50% above ground, (2) pile landfill with 5 % of waste below ground and 95% above ground, or (3) offsite landfill -- is determined within the cost model. The cost for the most economical approach is assigned to that plant unless available data specify otherwise. The choice is dependent upon on estimated engineering control costs and annual CCR disposal tonnage.
    - New impoundments: If currently used as a disposal unit, this RIA assumes a landfill will be constructed as the future new disposal unit as impoundments reach end of lifespan, because the model calculates that new landfills are more economical to construct for two cost reasons: (a) if no pre-existing land depressions for use as a new impoundment, the cost for a larger excavation for a new impoundment rather than a smaller excavation for a landfill is necessary, and (b) the primary determinant of many of the cost for engineering controls is the footprint of the disposal unit such that the same set of engineering controls for a new impoundment would be more expensive than for a new landfill. However, the cost model does not estimate the associated capital and annual O&M costs for future conversion of existing wet ash and wet scrubber boilers and conversion of wet CCR conveyance equipment used for moving CCR to disposal units. These conversion costs are estimated separately outside of the cost model in this RIA.

- **Baseline "Engineering Control" Cost Estimates**

1. Baseline ground water monitoring

Groundwater monitoring costs are based on the Remedial Action Cost Engineering and Requirements (RACER) cost estimating software (2002) with costs based on the R.S. Means, Environmental Cost Handling Options and Solutions (ECHOS), Environmental Remediation Cost Data (2002).

- Assumes same groundwater monitoring requirements for both landfills and impoundments
- Point of compliance:
  Placement at the unit boundary is assumed in the cost estimates. Unit boundary point-of-compliance monitoring complies with the "within 150 meter point-of-compliance" criterion. Plants monitoring at the unit boundary will incur no additional costs under the within 150 meter placement criteria.
- Number of wells:
  EPA's March 1985 "Ground Water Technical Enforcement Guidance" Document (pages 2-8 to 2-16) recommends a maximum of 150 feet spacing between down-gradient wells. EPA's December 1980 SW-611 "Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities" (pages 40 to 43) recommends a maximum of 250 feet spacing between down-gradient wells. Assuming the technical documents are the most stringent and the state regulation minimums are the least stringent, a middle ground within the range is anticipated and used in the cost estimates. This RIA does not evaluate the cost differences between the upper and lower bounds of well spacing.
  Groundwater monitoring well costs in this analysis assume a minimum of 2 down-gradient wells for the first 800 feet of length along two sides of the landfill or impoundment unit, which is assumed to be square, plus additional wells spaced every 400 feet. In addition, one up-gradient well is assumed.
- Constituents:
  The cost estimates include monitoring for the following chemical indicators and metals, which represents a reasonable "likely-case" scenario between indicators only and RCRA 40 CFR 261 Appendix VIII constituent monitoring which includes about 500 chemical substances:
  - Chemical indicators: Based on EPA's 1999 cement kiln dust proposed rule parameters (i.e., pH, conductivity, total dissolved solids, potassium, chloride, sodium, and sulfate) as a cost proxy.
  - Metals: Metals with primary and secondary Maximum Contaminant Levels (MCLs) (i.e., Al, Cu, Fe, Mn, Ag, Zn, Sb, As, Ba, Be, Cd, Cr, Pb, Hg, Se, Tl).
- Frequency:
  The cost estimates only include semi-annual sampling (most-likely case) analogous to EPA's 1999 cement kiln dust proposed rule and to many current state regulations, even if some states require a quarterly or annual basis.
- Unitized cost estimate: Dividing the average annual cost estimate result displayed in **Exhibit 3L** below (row item 1) for baseline ground water monitoring, by the count of electric utility plants estimated in **Exhibit 3I** (row 1, column A) and **Exhibit 3J** (row 1, column A) above to conduct that activity under state government requirements, yields an average annual per-plant (i.e., unitized) cost estimate of $64,000. In comparison, EPA's most recent (2008) Information Collection Request (ICR) No. 0959.13 "Ground-Water Monitoring Requirements" (renewal) for the RCRA Subtitle C 40 CFR 264.92 and 265.92 TSDF "ground-water protection standard" provides an estimate of $28,130

per year.[49] The $64,000 unitized cost for groundwater monitoring generated by the above assumptions applied in the engineering control cost model used for this RIA is 2.3 times larger and more appropriate to this RIA because it reflects a larger number of wells per-plant to monitor the groundwater under the larger sized CCR disposal units compared to the average sizes of other types of industrial waste disposal units.

2. Baseline bottom liners

- Same bottom liner requirements for both new landfills and new impoundments
- The cost estimates include a composite (2-foot compacted clay-synthetic) liner for the more stringent design and a 2-foot compacted clay liner, single-synthetic liner, and a 2-foot compacted ash liner for less stringent baseline designs.

3. Baseline leachate collection system

- No leachate collection is assumed from beneath the impoundment liner
- The cost estimate is comprised of perforated pipes spaced approximately 300 feet apart along the base of the unit. It includes a wet well for leachate collection. Leachate is shipped by truck for off-site treatment.
- Assumes 3-inches of leachate per year collected in landfill leachate collection systems.

4. Baseline dust controls

Cost estimate includes CCR compaction equipment, water trucks for spraying CCR during compaction and for spraying unpaved landfill roads, and covers for landfill trucks:

- Compaction Equipment

  Ash is assumed to be compacted in the waste management area by self-propelled rollers for regulatory scenarios including dust controls. A model cost assumption is that four passes are made by the roller in 6-inch lifts. With these assumptions, the roller can compact approximately 1,300 cy of ash per day. The operating life of purchased compaction equipment is assumed to be five years. The number of sheepsfoot rollers required is estimated as follows:

$$\text{Rollers} = \frac{\text{(tons/yr)(2,000 lb/ton)(16.02 kg/m3 / lb/cf)}}{\text{(1,190 kg/m3)(27 cf/cy)(1,300 cy/day)(300 days/yr)}}$$

  The cost of a sheepsfoot roller is assumed to be $75,000 in 1995 dollars.
  Plants will incur annual costs for equipment operation ($0.63/cy) and maintenance.
  Maintenance costs are assumed to be 5% of capital costs. Annual costs for compaction are estimated as follows:

$$\text{Annual Cost} = \frac{\text{(tons/yr)(2,000 lb/ton)(16.02 kg/m3 / lb/cf)(\$0.63/cy)}}{\text{(1,190 kg/m3)(27 cf/cy)}} + \$75{,}000 \times 0.05 \times \text{Rollers}$$

- Water Truck for Compaction:

Ash is assumed to be wetted in the waste management area by water trucks to facilitate compaction and to control dust. A model assumption is that FFC plants currently use water trucks 50% of the operational day to control dust on roads (see Water Spray on Roads). It is reasonable to

[49] $28,130 per year per-facility average cost derived for purpose of this RIA by dividing the reported $27.818 million annual cost by the reported 989 TSDFs from the EPA ICR 0959.13, Federal Register, Vol.73, No.103, page 30617; 28 May 2008; http://edocket.access.gpo.gov/2008/pdf/E8-11888.pdf

assume that the same water trucks will be used for the roads and the ash management unit. Therefore, it is assumed that an existing water truck is available for compaction 50% of the operational day. Additional water trucks are assumed to be necessary to facilitate compaction for large facilities. The cost of tarps, tarp mechanisms, and installation of the mechanisms, as well as the life of each tarp were estimated by ICF in "Cost Functions for Alternative CKD Control Technologies" (Draft), 19 July 1996. A model assumption is that a water truck will be necessary for compaction 50% of the time required by the compaction equipment. The water truck time for compaction is estimated as follows:

$$\text{Water Truck Time for Compaction} = \frac{(\text{tons/yr})(2{,}000\ \text{lb/ton})(16.02\ \text{kg/m3 / lb/cf})(8\ \text{hr/day})(0.5)}{(1{,}190\ \text{kg/m3})(27\ \text{cf/cy})(1{,}300\ \text{cy/day})}$$

One existing water truck for compaction and water spray on roads is estimated to be sufficient for plants managing less than 391,000 tons per year of ash. Facilities managing between 391,000 and 1,173,000 tons per year are assumed to purchase one additional water truck. Facilities managing between 1,173,000 and 1,955,000 tons per year are assumed to purchase two additional water trucks. Facilities managing more than 1,955,000 tons per year to the maximum facility size modeled of 2,000,000 tons per year are assumed to purchase three additional water trucks. The cost of a water truck is assumed to be $101,000 in 1995 dollars. The water truck operating life is assumed to be five years. The operating costs for water spray for compaction are estimated assuming that the truck travels approximately five miles per day, for each day used, with a fuel consumption of five miles per gallon at a fuel cost of $1.15 per gallon. The truck is assumed to operate 50% of the hours required for compaction. The daily water volume used is assumed to be 10,000 gallons, at a cost of $2 per 1,000 gallons. The annual cost associated with ash management is estimated as follows:

$$\text{Annual Cost} = \frac{(\text{tons/yr})(2{,}000\ \text{lb/MT})(16.02\ \text{kg/m3 / lb/cf})(0.5)}{(1{,}190\ \text{kg/m3})(27\ \text{cf/cy})(1{,}300\ \text{cy/day})} * [(8\text{hr/day})(\$31.50/\text{hr}) + (5\ \text{mi/day})(\$1.15/\text{gal})/(5\ \text{mi/gal}) + (10{,}000\ \text{gal/day})(\$2/1{,}000\ \text{gal})]$$

- Covers on Trucks:

Covers on hauling trucks as a fugitive dust control technology is an option for the compliance scenarios. Capital costs for this dust control technology include the cost of the roll-on tarp mechanism and the installation of this mechanism. Capital costs for covers on trucks are estimated as follows: Capital Cost = [(tons/year) x (2,000 lb/ton) x (16.02 kg/m3 / lb/cf) x (0.65 hr/load)] x ($4,800)
Water truck capacity, refill time, and spray width were estimated by ICF in "Cost Functions for Alternative CKD Control Technologies" (Draft), dated July 19, 1996.
(1,190 kg/m3)(0.80)(27 cf/cy)(9 cy/load)(2,400 hr/yr)
Annual costs for this dust control technology include the cost of the tarps and the cost to replace the tarps. Tarps are estimated to be replaced every 150 loads. Replacement of a tarp is estimated to require 15 minutes. Annual costs for covers on trucks are estimated as follows:

$$\text{Annual Cost} = \frac{(\text{tons/yr})(2{,}000\ \text{lb/ton})(16.02\ \text{kg/m3 / lb/cf})(\$155/\text{tarp} + 0.25\text{hr/tarp}*\$19/\text{hr})}{(1{,}190\ \text{kg/m3})(0.80)(27\ \text{cf/cy})(9\ \text{cy/load})(150\ \text{load/tarp})}$$

- Water Spray on Roads:

Water spray on roads is required as a fugitive dust control technology for the compliance scenarios. A model assumption is that FFC plants currently have water trucks and use water spray on roads as a baseline management practice. A model assumption is that dust control is required for a road length of 1.5 miles (3 miles roundtrip), with a road width of 10 meters. The water truck capacity is assumed to be 5,000 gallons and requires approximately one hour to fill. The water truck can spray a width of five meters at an assumed speed of 10 miles per hour. For the baseline scenario, a model assumption is that the entire water volume (5,000 gallons) will be sprayed on each pass of the truck along one side of the road (i.e., 1.5 miles x 5 meters). The resulting water volume per road area, averaged over the 1.25 hours required to spray the road and refill the truck, is approximately 2.5 times that of the average hourly daytime evaporation rate. Therefore, water spray on roads will be required 3 times per day. The water volume sprayed per road area is estimated as follows:

Water per Area = (1.5 mi)(5,280 ft/mi)(0.3048 m/ft)(10 m)(5,000 gal)(3.785 L/gal) = 0.784 L/m2

The time required for the water truck to be filled, spray along both sides of the road, and return for refilling is estimated as follows:

Time = (1 hour) + (3 miles)/(10 miles/hour) = 1.3 hour

Therefore, the total time for one pass is assumed to be 1 hour and 15 minutes. The average rate of water spray is estimated as follows:

$$\text{Spray Rate} = \frac{(0.784\ \text{L/m2})(1{,}000\ \text{ml/L})(\text{cm3/ml})(1{,}000\ \text{mm/m})}{(100\ \text{cm/m})3(1.25\ \text{hr})} = 0.6272\ \text{mm/hr}$$

The average hourly daytime evaporation rate is approximately 0.25 mm/hr. Therefore, the water spray rate is approximately 2.5 times the evaporation rate. Since the total time required for water spray (1.25 hour) times 2.5 is approximately 3, a model assumption is that water spray on roads is required approximately every 3 hours. In order to coordinate the water truck use for road spray and ash compaction, it is assumed that the truck alternates between these two requirements during the day. Therefore, over a nine-hour day (eight working hours plus one hour for lunch), roads are sprayed 3 times, requiring a total of approximately 4 hours, or 50% of the operational day. Because it is assumed that FFC facilities currently spray water on roads for dust control, the incremental cost from the baseline to the compliance scenarios is zero.

5. Baseline rain and surface water run-on/run-off controls (landfills only)

The cost estimates assume that stormwater run-on/run-off control is comprised of a ditch surrounding active area of landfill and an excavated bermed basin for water collection.

6. Baseline financial assurance for CCR disposal unit closure and post-closure care

Financial assurance helps assure that the owners and operators of CCR landfills and impoundments have adequately planned for the future cost of closure, post-closure care, and corrective action for known releases, and to assure that adequate funds will be available when needed to cover these costs if the owner or operator is unwilling or unable to do so. Financial assurance helps protect future generations from paying for damages caused by or the prevention of damages potentially created from current waste management activities. Requiring provision of financial assurance during operation of landfills and impoundments places the cost burden on the current owner and consumer, and prevents costs from being passed from the current generation to future generations.

The cost estimate includes the costs for selecting a financial mechanism, establishing a financial test, and establishing a letter of credit. The differences between RCRA Subtitle C and Subtitle D financial assurance mechanisms are not assessed. This RIA assumes the same requirements for both landfills and impoundments:

- Capital cost includes selection of financial assurance mechanism, establishment of financial test, and establishment of letter of credit. The letter of credit is assumed to be most available to utilities and will be utilized in most circumstances. This is amortized in the annual cost.
- Annual cost includes maintenance of financial test and maintenance of letter of credit. Establishment and annual maintenance of the letter of credit is estimated to be 1% to 3% of the nominal value of the letter of credit (i.e., total cost of closure and post closure). This RIA applied the 2% midpoint of this range. Implementation costs are estimated on the assumption that an outside consulting firm and legal assistance will assist in obtaining and maintaining the letter of credit ($692 per year in 1995 dollars or $1,051 per year inflated to 2009 dollars). Estimate obtained from Mohammad Iqbal and John Collier, ICF, Inc., “Local Government Financial Test Economic Analysis,”

memorandum to George Garland, EPA, 30 April 1995. Additional supporting information obtained from EPA "Estimating Costs for the Economic Benefits of RCRA Noncompliance," September 1997.

7. Baseline disposal unit location restrictions

Baseline cost not estimated in this RIA.

8. Baseline closure capping to cover unit

The cost estimate for this engineering control does not include the closure plan cost or closure certification costs. Capping costs are a large capital expense. So, if a unit is expected to close in one year the total capping cost is assigned to the last year in the life of the unit. However, businesses are likely to borrow money from a bank for these large capital costs and annualize them over a set period of time, for example, 10 or 20 years. Incremental cost estimates in the cost model are overestimated for large capital expenditures applied to existing units that have been added over short time periods. In addition, owners are likely to close these units prior to the proposed rule coming into effect if promulgated as a final rule. This RIA assumes the same requirements for both landfills and impoundments:

- Synthetic cap with drainage layer is comprised of a 60 mil HDPE synthetic liner, 1 foot sand, filter fabric, 1.5 foot slope and earth fill, 0.5 foot topsoil, and vegetation. It includes a perforated pipe for drainage collection.
- Synthetic cap without drainage layer is comprised of a 60 mil HDPE synthetic liner, 1.5 foot slope and earth fill, 0.5 foot topsoil, and vegetation.
- Clay cap is comprised of 2 feet of off-site clay, 0.5 foot topsoil, and vegetation. Cover costs would be lower if on-site clay is available.
- Soil/clay cover is comprised of 0.5 foot clay, 0.5 foot earthfill, and 0.5 foot topsoil, and vegetation. Cover costs would be lower if on-site clay is available.
- Soil cap is comprised of a 1.5 foot slope and earth fill, 0.5 foot topsoil, and vegetation. The slope of the cap is assumed to be 0.02:1 (rise:run) with a cover toe slope of 4:1 (run:rise).

9. Baseline post-closure groundwater monitoring requirements

- Same requirements for both landfills and impoundments
- Baseline post-closure monitoring is assumed to comprise 30 years of groundwater monitoring and surface water monitoring on a semi-annual basis. The physical parameters (i.e., point of compliance, number of wells, sets of chemical indicators and sets of chemical constituents monitored, and semi-annual frequency) and unit cost are assumed identical as defined in the baseline groundwater monitoring cost item 1 above in this section of the RIA.
- However, post-closure monitoring costs are estimated in this RIA assuming an annual sum is placed in a fund by affected entities (i.e., electric utility owners) during the assumed average 40-year operating life of the CCR disposal unit. At the time of closure sufficient monies will be available in the fund to cover post-closure monitoring for the next 30 years beyond end-of-lifespan, assuming an annual interest rate of 7%.

10. Baseline storage tank/container design and operating standards

Baseline cost not estimated in this RIA

- **Baseline "Ancillary Costs" Estimates**

11. Baseline offsite disposal

The baseline cost for engineering controls at offsite CCR disposal sites (assumed in this RIA to be commercial Subtitle D landfills) is estimated using the same cost model as the engineering controls for onsite disposal units. In addition, the offsite disposal baseline cost includes the cost for truck transport from the electric utility plant to the offsite landfill, calculated as follows:

- Baseline Assumptions:
  - 12% (15 million tons/year) CCR currently trucked offsite to non-haz LFs (2005)
  - 6 miles average one-way trucking distance to offsite LFs[50]
  - $0.10/ton/mile non-haz waste truck operating cost
  - 12 tons CCR per full truckload (source: Gambrills MD case study); (15 million tons/year) / (12 tons/load) = 1.25 million truckloads per year
- Baseline Cost Calculations:
  - Manifest cost: $0
  - Trucking cost: (15 million tons/year) x (6 miles) x ($0.10/ton/mile truck operating cost for non hazmat) = $9.0 million/year

12. Baseline structural integrity inspections

Assumptions:

Baseline assumption is that 82% of CCR disposal units at electric utility plants are inspected (source: page 36 of joint DOE/EPA report "Coal Combustion Waste Management at Landfills and Surface Impoundments, 1994-2004", report nr. DOE/PI-0004, Aug 2006 at: http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2008). Per-plant cost for inspections estimated in **Exhibit 3K** below.

Cost Calculation:

Industry cost: ($10,829/year per facility) x (82% inspected) x (495 plants) = $4.40 million per year

State government cost: ($599/year per facility) x (82% inspected) x (495 plants) = $0.24 million per year

Total (industry + state) = $4.64 million per year

[50] Source: based on actual distance reported for a MD plant at http://www.rachel.org/en/node/445). Note: a broader range of 2.4 miles to 25 miles in one-way offsite landfill distance was reported by an OH plant at http://www.columbusdispatch.com/live/content/local_news/stories/2008/04/14/Powerfills.ART_ART_04-14-08_B1_FF9TI0U.html?sid=101, and a WI plant, respectively at http://www.lacrossetribune.com/articles/2007/09/21/news/03landfill0921.txt

Exhibit 3K Summary of Industry & State Government Labor Costs for MSHA Surface Impoundment Safety Plan & Annual Inspections & Estimate of Annual Costs for Similar Structural Integrity Activities for Electric Utility Plant Surface Impoundments					
Item	Paperwork Burden Element*	Labor hours	Cost (2006)	Cost per facility	Annualized
Industry Costs					
1	Impoundment Safety Plan prepared by mining company engineer >>> Purpose: To evaluate geotechnical, hydrologic, hydraulic & other engineering factors to construct or improve surface impoundment structures to avoid structural failures	1,300	$70.07/hr	$91,091	$9,109
2	Revisions to Impoundment Safety Plan prepared by mining company engineer[2]	40	$70.07/hr	$2,803	$280
3	Fire Extinguishing Plan prepared by mining company engineer or supervisor	20	$70.07/hr	$1,401	$140
4	Annual Status Report & Annual Certification prepared by company engineer >>> Purpose: To determine whether impoundments are operated and maintained according to approved engineering safety plan	2	$70.07/hr	$140	$14
5	Recordkeeping and weekly inspections[3] >>> Purpose: To determine whether any signs of instability have developed	2.5 hrs per inspectn x 17 inspect = 42.5	$30.27/hr	$1,286	$1,286
			Subtotal (Industry costs):	$10,829 per facility per year	
State Government Costs					
6	Review of Impoundment Safety Plans	160 hrs tech review + 2 hrs admin review	$30.57/hr	$4,952	$495
7	Review of revisions to Impoundment Safety Plans	30 hrs tech review + 2 hrs admin review	$30.57/hr	$978	$98
8	Review and prepare responses for impoundment abandonment plans	1	$30.57/hr	$31 per plan	$3
9	Review of annual inspection Status Reports and Certifications	1	$30.57/hr	$31 per report	$3
			Subtotal (State government costs):	$599 per facility per year	
Total Cost					
			Total industry + state government cost:	$11,428 per inspection	

Notes:
* Elements, labor hours, and labor costs are based on the "Supporting Statement" for the March 2008 DOL/MSHA ICR 12-19-0015, "Refuse Piles and Impounding Structures, Recordkeeping, and Reporting Requirements" at: http://www.msha.gov/regs/fedreg/paperwork/2004/04-24046.pdf
1. Assumes plans are valid for 10-years similar to the length of RCRA permits.
2. Assumes one revision to the plan will be made during 10-years.
3. Average labor hours per inspection between inspections at sites with monitoring instruments (3 hours) and at sites without monitoring instruments (2 hours).

13. Baseline RCRA facility-wide investigations (RFI)
Baseline cost assumed to be $0 because this RIA assumes that all baseline CCR disposal units used by electric utility plants are not regulated under RCRA Subtitle C.

14. Baseline facility-wide corrective action
Because CCR is not regulated as Subtitle C hazardous waste, there are no existing facility-wide (i.e., CCR disposal units plus other waste units also located at the same plant) corrective action requirements, although some state governments have the following unit-specific corrective action requirements affecting CCR disposal units.
State regulations for the top 25 coal usage states (for electricity) were reviewed for correction action requirements in 2000. These regulations were not updated as part of this RIA. Corrective action requirements were identified in 21 of the 25 states.

- Surface impoundments: 71% of CCR impoundments representing 67% of CCR impoundment annual tonnage have state government baseline corrective action requirements:
  - AZ, IN, and IA establish a corrective action alert level and response action in site-specific state permits
  - CO requires corrective action for new units
  - 9 states (FL, GA, KY, MI, NC, ND, PA, UT, WI) require corrective action
  - IL, MN, TX, WV, WY do not allow groundwater degradation, but specific enforcement mechanisms are not specified in state regulations
  - MO requires corrective action for units closed with waste in place, otherwise, corrective action may be established under a permit
  - NM requires an abatement plan.
- Landfills: 66% of CCR landfills with 81% of CCR landfill annual tonnage have state government corrective action requirements:
  - AZ establishes corrective action alert level and response action in site-specific state permits
  - 15 states (CO, FL, GA, IL, KY, MI, NC, ND, OH, OK, PA, UT, WV, WI, WY) require corrective action
  - MN, TX do not allow groundwater degradation, but, specific enforcement mechanisms are not specified in state regulations
  - MO, TN require assessment only
  - NM requires an abatement plan

15. Baseline waste disposal permit cost

- Assumptions:
  - 93% of CCR landfills have a state government non-hazardous waste disposal permit and 12% of CCR impoundments have such permits. Source: page 28, Table 9 of "Coal Combustion Waste Management at Landfills and Surface Impoundments, 1994-2004", August 2006 at http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2008
- Industry waste disposal permit cost:
  - ($5,000 RCRA Part A permit) + ($50,000 RCRA general facility permit requirements) + ($25,000 average RCRA Part B for impoundment or landfill) = $80,000 per Subtitle C permit
  - Assume RCRA Subtitle D (40 CFR 257, 258) waste permitting activities are less burdensome than RCRA Subtitle C waste permits. Based on factor of 3.3 times more technical standards listed in RCRA Subtitle C (40 CFR 264/265, 268, 270) compared to Subtitle D (40 CFR 257, 258), assume Subtitle D permitting costs are lower by the 3.3 factor:

($80,000 per year average Subtitle C waste disposal permit cost) / (3.3) = $24,300 per non-haz waste disposal permit
[((93% landfills w/permit) x (337 landfills)) + ((12% impoundments w/permit) x (158 impoundments))] x ($24,300 per permit) = $8.1 million

Amortized industry cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $0.59 million/year

- State government waste disposal permit cost:
  - Build estimate based on the following four RCRA Subtitle C permit-related state government activities associated with RCRA Subtitle C waste disposal permits:[51]
    (1,215 pre-application activities) + ($27,063 application review) + ($26,846 permit issuance) + ($3,110 permit maintenance) = $58,200 average cost per Subtitle C waste disposal permit.
  - Assume RCRA Subtitle D (40 CFR 257, 258) waste permitting activities are less burdensome than RCRA Subtitle C waste permits. Based on factor of 3.3 times more technical standards listed in RCRA Subtitle C (40 CFR 264/265, 268, 270) compared to Subtitle D (40 CFR 257, 258), assume Subtitle D permitting costs are lower by the 3.3 factor:
    ($58,200 per year average Subtitle C waste disposal permit cost) / (3.3) = $17,600 per non-haz waste disposal permit
  - State Cost Calculation:
    [((93% landfills w/permit) x (337 landfills)) + ((12% impoundments w/permit) x (158 impoundments))] x ($17,600 per permit) = $5.85 million
    Amortized state cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $0.42 million/year

Total baseline permit cost (industry + state government) = $1.01 million per year

16. Baseline enforcement inspection

Not estimated in this RIA.

17. Baseline remediation of environmental releases

Not estimated in this RIA.

[51] Source: Based on cost data from page 84 of January 2007 ASTSWMO report “State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report” at: http://www.astswmo.org/files/publications/hazardouswaste/Final%20Report%20-%20RCRA%20Subtitle%20C%20Core%20Project.pdf

- **Baseline CCR Disposal Cost Estimation Results**

Exhibit 3L below displays the average annualized costs for each of the baseline cost components, as well as on an average per-ton and per-plant basis. **Appendix H** provides plant-by-plant and owner entity-by-entity estimates of baseline costs.

Exhibit 3L
Industry Baseline Cost Estimates for CCR Disposal by Electric Utility Plants (Onsite + Offsite)
($millions per year in 2009$ discounted @7% over 50-year period-of-analysis 2012 to 2061)

Baseline Cost Element	CCR Landfills (311 plants)	CCR Impoundments (158 plants)	Row totals (467 of 495 plants)	
A. Engineering controls (onsite disposal):				
1. Ground water monitoring	$19.2	$8.0	$27.2	0.5%
2. Bottom liners	$2,751	$1,219	$3,970	71.5%
3. Leachate collection system	$105.5	$52.2	$157.7	2.8%
4. Dust controls	$24.2	$2.8	$27.1	0.5%
5. Water run-on/run-off controls	$4.8	$0.7	$5.6	0.10%
6..Financial assurance	$61.2	$17.9	$79.2	1.4%
7. Disposal location restrictions	Not estimated	Not estimated	Not estimated	
8. Closure capping to cover unit	$72.7	$15.7	$88.5	1.6%
9. Post-closure groundwater monitoring	$1.3	$0.5	$1.8	0.03%
10. Storage design/operating requirements	Not estimated	Not estimated	Not estimated	
Subtotal Engineering Control costs =	$3,040	$1,317	$4,357	78%
B. Ancillary costs for CCR disposal:				
11. Offsite disposal (commercial landfills)	$1,193	$0	$1,193	21.5%
12. Structural integrity inspections	$2.46	$2.18	$4.64	0.08%
13. RCRA facility-wide investigation (RFI)	$0	$0	$0	0%
14. Corrective action	Not estimated	Not estimated	Not estimated	NE
15. Waste disposal permits	$0.69	$0.32	$1.01	0.02%
16. Enforcement inspection	Not estimated	Not estimated	Not estimated	NE
17. Remediation of environmental releases	Not estimated	Not estimated	Not estimated	NE
Subtotal Ancillary costs =	$1,196	$2.5	$1,199	22%
Cost Summary (A+B)				
Column total annualized cost =	$4,236	$1,320	**$5,556** **(includes $1,193 offsite disposal)** **PV = $76,678 (@7%, 50-years)**	
Average annual cost per plant =	$13.6 million per plant	$8.4 million per plant	$11.9 million per plant	
Average cost per CCR ton disposed =	$59 per ton (71.8 million tons per year)	$59 per ton (22.4 million tons per year)	$59 per ton (94.2 million tons/year disposed)	

- **Validity Check of Baseline Cost Estimate (2 Tests):**
    - **Validity Test #1 of 2: Comparison to ACAA Published Estimate of Average CCR Disposal Cost**

As displayed above in **Exhibit 3L** the estimated baseline (i.e., current) average annualized cost to the 495 coal-fired electric utility plants for disposal of CCR is $5.6 billion per year (2009$). This annualized cost includes amortization of capital investment in construction of disposal units and associated equipment (i.e., in-plant equipment for extracting CCR from boilers, CCR storage equipment, CCR conveyance equipment such as slurry pipelines for wet CCR or trucks and mechanical conveyor belts for dry CCR, and the disposal units themselves), plus annual expenditures for operation, maintenance and replacement/expansion of this equipment and disposal units. On a unitized cost-per-ton basis -- calculated by dividing the annualized baseline cost by the estimated 94.2 million tons per year (as of 2005) CCR disposed in (a) onsite landfills plus (b) offsite landfills plus (c) impoundments annually – the estimated baseline cost represents an average unitized cost of $59 per-ton.

In comparison, the American Coal Ash Association (ACAA) estimates that the average unit cost (per-ton) for baseline disposal of CCR by coal-fired electric utility plants ranges as low as $3 per-ton to higher than $40 per-ton:

> "*As one can see, a variety of factors enter into determining disposal costs. The lowest cost occurs when a disposal site is located near the power plant and the material being disposed can be easily handled. If the material can be piped, rather than trucked, costs are usually lower. In these types of situations, cost may be as low as $3 to $5 per ton. In other areas, when distance is far away and the [CCR] must be handled several times due to its moisture content or volume, costs could range from $20 to $40 per ton. In some areas, the costs are even higher. If new sites are required and extensive permitting processes take place, the total cost of the facility may be increased, resulting in higher disposal costs over time.*"[52]

The reasons the average annualized and unitized baseline CCR disposal cost of $59 per-ton estimated in this RIA, is higher than the baseline cost range of $3 to over $40 per-ton reported by the ACAA, are:

- Low-end unitized cost: The low-end of ACAA's reported cost range is $3 to $5 per-ton. Assuming the cheapest operating surface impoundment does not include a liner and leachate collection costs as estimated in this RIA for impoundments in states with such regulatory requirements, the baseline surface impoundment unitized cost may be as low as $2 per-ton based on the cost elements applied in this RIA. This low-end unitized cost may be derived from the impoundment cost column of **Exhibit 3L** as follows:

    (Column total cost - Row 2 cost - Row 3 cost) / (22.4 million tons per year managed in impoundments) =
    ($1,317 million/year - $1,219 million/year - $52.2 million/year) / (22.4 million tons per year) = **$2.04 per-ton**

- High-end unitized cost: The upper-end of ACAA's reported cost range is $20 to $40 per ton, which applies to offsite disposal. The cost estimation of this RIA incorporates off-site commercial disposal costs on a state-by-state specific basis according to electricity

[52] Source: ACAA webpage containing Frequently Asked Question nr. 13 at http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=5#Q13

power plant location, using commercial landfill tipping fees ($2009) for contaminated soil, which range widely from $11 per-ton to $135 per-ton, with a national average of $50 per-ton. For example, commercial landfill tipping fees for contaminated soil for some of the high coal usage states are: TN = $11.19/ton, IN = $32.73/ton, OH = $35.48/ton, and PA = $57.96/ton. The baseline cost estimation method of this RIA then added a CCR offsite transportation and loading cost of approximately $33 per-ton based on the RACER cost estimation tool. For the estimated 15.0 million tons per-year of CCR disposed in offsite landfills, the estimated baseline cost is $1,193 million per-year, which is equivalent to **$79.53 per-ton** over the 50-year time period of the RIA cost analysis which assumes increasing coal usage (0.73% per-year) by electric utilities and subsequent offsite landfill disposal over the 50 year time period. It is unknown what cost elements are included in the high-end of the ACAA reported cost range (e.g., transportation cost and/or landfill tipping fee cost). In addition, electric utility companies likely have annual or multi-year contracts with offsite landfill operators that offer lower tipping fees than the state-average off-site contaminated soil tipping fees used in this RIA.

- **Validity Test #2 of 2: Comparison to CCR Disposal Costs Contained in the EIA Form 767 Database**

The 2005 Energy Information Administration (EIA) Form 767 database (Schedule 3, Part B) indicates $5,890 million in annual capital and O&M cost reported by steam electric plants with nameplate capacity of 100 MW or greater, including (a) $0.314 million per year for water pollution controls, (b) $0.193 million per year for solid waste disposal, (c) $0.185 million per year for other pollution controls, (d) $3,627 million per year capital expense for air pollution abatement, and (e) $1,546 million per year for collection and disposal O&M costs for fly ash, bottom ash, and FGD. This last cost element --- $1,546 million per year for CCR disposal --- is only 28% of the $5,556 million per year estimate displayed in **Exhibit 3L** above. However, the 2005 EIA Form 767 cost data are associated with only 179 coal-fired electric utility plants, which represent only 36% of the 495 coal-fired electric utility plants addressed by this RIA. Therefore, to facilitate a direct comparison, the $1,546 million per year cost from the data in EIA Form 767 may be extrapolated to all 495 plants by multiplying by the factor 2.765 (i.e., 495 / 179), which produces an estimated extrapolated cost for all 495 plants of $4,275 million per year (i.e., 2.765 x $1,546 million per year). This extrapolated cost is 23% lower than the $5,556 million per year baseline cost estimated in this RIA. This comparison suggests the baseline cost estimated in this RIA may be an over-estimate, but it is not clear whether the cost data in the EIA Form 767 database include baseline costs to the electric utility plants for compliance with existing state government regulations concerning CCR disposal (e.g., the annualized cost for obtaining and maintaining state government disposal permits and the annualized cost for impoundment structural integrity inspections), as does this RIA.

Chapter 4
Estimated Cost for RCRA Regulation of CCR Disposal

<u>Note</u>: EPA formulated cost estimates in this Chapter based on the October 2009 draft RIA regulatory options. Because the high-end cost of those options (i.e., for the Subtitle C "hazardous waste" option) is larger than the high-end cost for the 2010 regulatory options (i.e., for the Subtitle C "special waste" option), the costs in this Chapter are proportionately over-estimated. However, Section 6B of this RIA applies scaling factors to adjust the costs estimated in this Chapter to the 2010 options.

4A. EPA's Prior Cost Estimates for Possible RCRA Regulation of CCR Disposal at Electric Utility Plants

In prior studies, EPA's Office of Solid Waste (which EPA renamed as the ORCR effective 18 January 2009), formulated the following industry compliance cost estimates for different RCRA-based regulatory approaches to CCR disposal by the electric utility industry:

1988: OSW's 1988 Report to Congress on CCR estimated **$2.4 billion to $4.7 billion** per year (1986$) in potential average annualized industry cost (514 plants in 1984) for compliance with technical standards contained in 40 CFR 264 RCRA **Subtitle C** hazardous waste regulations. The range reflects different liner assumptions (i.e., single versus double liners) and whether only unlined CCR units close or all existing units close requiring construction of new units. This cost includes closure costs but not a cost for corrective action excavating and removing CCR to Subtitle C facilities for closure of existing units. This report separately estimated that corrective action "at a cost of about $2.0 billion per plant, industry-wide costs would exceed $1.0 trillion" lump-sum cost, which is equivalent to $43 billion annualized cost (discounted @3% over 40-years). Source: EPA-OSWER report nr. EPA/530-SW-88-002, Feb 1988.

1999: OSW's 1999 Report to Congress focused on the "co-management" (i.e., low-volume mixed with high-volume) subset of CCR units (i.e., 206 units at 353 plants in 1994), constituting 53 million tons (50%) of the 105 million total high-volume electric utility CCR generation in 1997. This report estimated a range of **$800 million to $900 million** per year (1998$) in potential average annualized compliance cost to the electric utility industry to comply with technical standards similar to 40 CFR 258 RCRA **Subtitle D** non-hazardous waste regulations. This cost estimate includes opening new CCR units to replace existing units that do not meet Subtitle D standards, including the following itemized costs: land purchase, site development, liner installation, leachate collection, groundwater wells & monitoring, closure costs, and post-closure costs. This estimate accounted for state CCR management requirements as of 1997. Source: EPA OSWER report nr. EPA 530-R-99-010, March 1999.

2005: In a November 2005 report, an OSW contractor (DPRA Inc) estimated **$304 million to $521 million** per year (2005$) in potential average annualized cost for the electric utility industry (i.e., 470 units at 452 plants in 2003) to comply with regulatory options developed with reference to the "tailored standards" of EPA's 1999 cement kiln dust proposed rule which based many elements on 40 CFR 258 RCRA **Subtitle D** non-hazardous waste regulations. Cost elements in this report included (a) location standards, (b) operating criteria such as cover material, dust control, run-on/run-off control, (c) design criteria such as liner and leachate collection, (d) groundwater monitoring, (e) closure and post-closure standards, and (f) financial assurance for closure, post-closure and corrective action. This estimate accounted for state CCR management requirements as of 2004, but did not include costs for corrective action. Source: EPA-OSWER document ID nr. EPA-HQ-RCRA-2006-0796-0469 at http://www.regulations.gov.

These three prior RCRA regulatory cost estimates range from **$304 million to $4.7 billion** per year. Even without updating these prior cost estimates to the current 2009 price level, all three prior cost estimates exceed the 1993 Executive Order 12866 Section 3(f)(1) "economically significant" $100 million annual effect threshold for Federal rulemakings.

4B. Regulatory Cost Estimation Algorithms & Results

This section presents **incremental cost estimates** for each regulatory option, for both existing active (i.e., operating) and future new CCR landfills and impoundments, and by size/type of affected electric utility plant owner entity. Incremental comparison of the estimated cost of each regulatory option to the baseline (as estimated in **Chapter 3** of this RIA) is consistent with OMB's 2003 "Circular A-4: Regulatory Analysis" best practices guidance to Federal agencies:

> "*Identify a baseline. Benefits and costs are defined in comparison with a clearly stated alternative. This normally will be a "no action" baseline: what the world will be like if the proposed rule is not adopted*."

As listed below, this RIA estimates 18 potential regulatory costs and the land disposal restriction (LDR) dewatering treatment standard, based on many of the same unit cost data sources and the same framework (i.e., 2009 price level, 50-year period of analysis, etc.), identified in the prior chapter of this RIA for baseline cost estimation. According to three methodological groupings, this RIA estimates three categories of regulatory costs:

A. **Engineering controls** for CCR disposal units – estimated using the cost model described in the prior chapter of this RIA:

1. Ground water monitoring
2. Bottom liners – for future new units only
3. Leachate collection system – for future new units only
4. Dust controls – applicable to landfills only
5. Rain and surface water run-on/run-off controls – applicable to landfills only
6. Financial assurance for disposal unit closure and post-closure
7. Disposal unit location restrictions (6 types: water tables, floodplains, wetlands, fault areas, seismic zones, karst terrain)
8. Closure capping to cover unit
9. Post-closure monitoring requirements
10. Temporary storage requirements – not estimated in this RIA because do not have information on the baseline counts or physical conditions of CCR storage tanks and storage buildings at electric utility plants.

B. **Ancillary costs** for CCR disposal – estimated outside of the engineering control cost model:

11. Offsite disposal (hazmat trucking, RCRA manifesting, offsite RCRA TSDF permits)
12. Structural integrity inspections – impoundments only
13. RCRA facility-wide investigation (RFI)
14. RCRA facility-wide corrective action
15. RCRA TSDF hazardous waste disposal permits for onsite disposal
16. RCRA enforcement inspection
17. Cleanup remediation of future CCR impoundment failures as RCRA hazardous waste
18. EPA administrative reporting & recordkeeping

C. **LDR cost** for land disposal restriction dewatering treatment – Sections 3004(d) and (m) of the RCRA statute require treatment prior to land disposal for Subtitle C hazardous waste listings, but not for Subtitle D non-hazardous waste regulation. The purpose of the treatment is to "substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized" (source: section 3004(m)):

- Dry CCR disposal (landfills): Moisture conditioning and compaction included in engineering control cost item 4.
- Wet CCR disposal (impoundments): Estimated outside and separately of the engineering controls cost model in this RIA.

This RIA does not include either qualitative or quantitative estimation of the potential effects of the proposed rule on economic productivity, economic growth, employment, job creation, or international economic competitiveness. These potential effects are identified as factors in both the 1993 Executive Order "Regulatory Planning and Review" (section 3(f)(1)) and in the 1995 Unfunded Mandates Reform Act (section 202(a)(4)). These other potential economic effects are excluded from this RIA because the upper-end of the range in average annualized regulatory cost across all regulatory options as estimated in this chapter below, does not exceed the 0.25% to 0.5% of Gross Domestic Product (GDP) threshold identified in OMB's 1995 guidance[53] for attempting to measure such other economic effects for purpose of UMRA economic analysis compliance. Based on the 2008 US GDP of $14.42 trillion,[54] the 0.25% to 0.5% threshold is equal to $36 billion to $72 billion.

4B.1 Regulatory Cost to Industry for RCRA "Engineering Controls"

This RIA assumes that that same set of RCRA 3004(x) custom-tailored engineering controls is required under each of the regulatory options, so the costs for engineering controls for all regulatory options are mostly, but not entirely, based on the same cost estimation formulae described above in **Chapter 3** for estimation of baseline engineering control costs. Furthermore, this RIA assumes that the engineering control costs are

---

[53] Source: Section 4.B(3) of OMB's 31 March 1995 guidance for implementing the UMRA state that "*We would note that such macro-economic effects tend to be measurable, in nation-wide econometric models, only if the economic impact of the regulation reaches 0.25 percent to 0.5 percent of Gross Domestic Product. A regulation with a smaller aggregate effect is highly unlikely to have any measurable impact in macro-economic terms unless it is highly focuses on a particular geographic region or economic sector.*"

[54] Source: 2008 3rd quarter estimate of 2008 US GDP as reported in "TABLE B–8.—Gross domestic product by major type of product, 1959–2008" of the 2009 Economic Report of the President at http://www.gpoaccess.gov/eop/tables09.html

similarly specified in EPA's cement kiln dust 20 August 1999 proposed rule.[55] This assumption was required to launch this RIA in April 2009 prior to the initial draft of the CCR proposed rule and its regulatory options. This RIA assumes that liners and leachate collection systems requirements apply only to future new CCR landfills and impoundments. Offsite disposal costs are assumed unaffected under all regulatory options because offsite CCR disposal units are assumed to be commercially-owned units (i.e., owned by the waste management industry) and assumed currently in compliance with the custom-tailored engineering controls. For engineering controls added to existing units the costs are added to the remaining years of the lifespan of the landfill or impoundment.

1. Regulatory groundwater monitoring cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

2. Regulatory bottom liner cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

3. Regulatory leachate collection cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

4. Regulatory fugitive dust control cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

5. Regulatory financial assurance cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

6. Regulatory closure costs
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

7. Regulatory disposal unit location restriction costs
This cost element is estimated outside of the engineering controls cost model, using the factors, data and calculations below.

- Count of Existing Electric Plants Which May be Affected by Location Restrictions

To estimate the potential cost of location restrictions, this RIA conducted a GIS analysis to determine which facilities may be affected by location restrictions. As summarized below, the GIS analysis was conducted for three of the six possible site restrictions (i.e., using three GIS-based datasets pertaining to fault areas, seismic zones, and karst zones readily available to EPA-ORCR at the 2009 launch of this RIA). This limitation potentially results in under-estimation in this RIA of the number or electric utility plants which may be affected and thus under-estimation of regulatory location restriction costs. On the other hand, the average per-plant cost of $4.1 million applied below for estimating the potential cost of this regulatory element is over five-times higher than the $0.75 million[56] cost per-plant cost estimated by another study for

[55] Federal Register, Vol.64, No.161, 20 Aug 1999, pp.45632-45697.
[56] Source: $0.75 million disposal unit location restriction mitigation cost for a single electric utility plant is from page 10 (slide number TVA-00007496) of "Kingston Fossil Plant Decision Matrix: Pond or Peninsula?," 27 Jan 2005 Plant Managers Conference Room at http://www.tva.gov/kingston/tdec/pdf/TVA-00007487.pdf

location restriction mitigation involving karst mitigation and floodplain/wetland mitigation; this probably overly offsets the possible cost underestimation in this RIA for this regulatory element.

The GIS was based on the DOE-EIA eGRID database to identify the geographic coordinates for 491 of the 495 electric utility plants (disregarding four plants not present in the eGRID database). **Appendix I** of this RIA presents site location data for each electric utility plant used in the GIS analysis. In order to geographically capture both the facilities and their waste units, and to compensate for the fact that there exists uncertainty as to the exact facility location versus the reported geographic coordinates (i.e., depending on whether location was measured by plant centroid, street address, smokestack, etc.), this GIS analysis used both a 1-mile and a 3-mile buffer around the reported facility coordinates. This RIA presumes these buffers are likely to ensure inclusion of the facility's onsite CCR disposal units, and account for uncertainty in the location data. The 1-mile buffer should capture all impoundments; the 3-mile buffer represents an upper-bound to capture all landfills that could reasonably be considered on-site.

1. Water table restrictions: GIS analysis not conducted for this site restriction
2. Floodplain restrictions: GIS analysis not conducted for this site restriction
3. Wetlands restrictions: GIS analysis not conducted for this site restriction
4. Fault area restrictions

To identify fault zones, used the USGS database, "Quarternary Fault and Fold Database for the United States," which contains national scale location data on faults and associated folds.[57] This analysis identified plants including their buffers which fall within 200 feet of fault lines that have exhibited movement in the Holocene era. The USGS dataset includes fault lines that are believed to have been a source of earthquakes greater than magnitude 6 during the Quarternary (the past 1,600,000 years) and it defines "Holocene" as the past 15 thousand years.[58,59]

- 1-mile buffer: 1 plant falls within 200 feet of a fault line.
- 3-mile buffer: 3 plants fall within 200 feet of a fault line. (these three plants are located in NV and UT).

It is important to note that this preliminary analysis has certain limitations and may not capture facilities in other areas of seismic risk. According to the USGS fault line database, no relevant faults are located in the central and eastern US. The USGS states in its database description that this absence of identified faults with movement in the central and eastern US is partly a real phenomena, because the western US has more tectonic activity, but that it is partly a detection problem caused by geological characteristics present in the central and eastern US, such as glacial sediments, that conceal evidence of movement along faults. For this reason, the analysis of seismic zones below, which are defined based on the likelihood of future seismic activity, may represent a more reliable estimate of the number of facilities potentially affected by fault area restrictions.[60]

---

[57] US Geological Survey, 2006, "Quarternary Fault and Fold Database for the United States" at: http//earthquakes.usgs.gov/regional/qfaults. File used: fitarc.shp

[58] RCRA defines "Holocene" as "the most recent epoch of the Quarternary period, extending from the end of the Pleistocene to the present" (40 CFR 264.18(a)(2)(iii)).

[59] Faults designated by the dataset as showing movement during the Holocene are not necessarily believed to have produced an earthquake of magnitude 6 or greater during the Holocene. Rather, they are believed to have produced an earthquake of magnitude 6 or greater during the Quarternary, but their most recent suspected movement of any degree was during the Holocene.

[60] The USGS data layer used for this analysis indicates that faults with Holocene movement are located only in states in the West and Southwest regions of the US. This appears generally consistent with a separate analysis in *the RCRA Practice Manual* (Garrett, Theodore L., 2004, published by American Bar Association), and the small number of plants affected is not unexpected given the relatively small number of plants in these regions. However, the *RCRA Practice Manual* also notes that virtually all plants in CA and NV, and in parts of AK, AZ, CO, HI, ID, MT, NM, UT, WA, WY would be located within 200 feet of relevant faults. This suggests an upper bound of 54 plants (out of the 491 plants analyzed), if all facilities in the identified states may be affected by fault area restrictions.

5. Seismic zone restrictions:
To identify seismic zones, USGS National Seismic Hazard Maps provide peak horizontal acceleration at different probabilities of exceedance in 50 years.[61] Identified those facilities, including their buffers, which overlap with the seismic impact zones that have a 10% or greater probability of exceeding a maximum horizontal acceleration of 10% the force of gravity (i.e., 0.10 g) in 250 years.[62] The USGS data gives probabilities of exceedance over 50 years; thus used a data layer presenting 2% probability of exceedance, and assumed that this equates to a 10% probability of exceedance in 250 years.

- 1-mile buffer: 151 plants fall within seismic zones
- 3-mile buffer: 152 plants fall within seismic zones

6. Karst zone restrictions:
This analysis used two databases: (1) DOE-EIA's eGRID database to identify the geographic coordinates of 491 of the 495 plants analyzed (disregarding four plants that were not present in the eGRID database), and (2) the USGS's GIS database "Engineering Aspects of Karst," which provides national-scale data on karst coverage.[63] Four types of karst areas are identified in the dataset: (a) long karst features (fissures, tubes, and caves over 1000 feet long and 250 feet deep); (b) short karst (fissures, tubes, and caves less than 1000 feet long and 50 feet deep), (c) areas where karst features are generally absent but present in small isolated areas, and (d) pseudo-karst areas, which have features analogous to karst.

- 1-mile buffer: 138 plants fall within karst zones
- 3-mile buffer: 177 plants fall within karst zones

These counts do not distinguish between the four different types of karst terrain identified in the data set; this analysis represents an initial upper bound of potentially affected facilities.

- Potential Cost for Existing & New Electric Plants to Meet Disposal Unit Location Restrictions

According to the above findings for the three location criteria evaluated in this RIA (i.e., fault areas, seismic zones, karst zones), a maximum count of 177 plants could be affected (this is the upper-end of the affected plant counts across the three location evaluations). The potential cost to these plants of the location restrictions is estimated in this RIA using the cost to retro-fit existing CCR disposal units and to protect new CCR disposal units with a berm (aka levee). A berm is a type of engineering measure which may serve to demonstrate that engineering measures have been incorporated into disposal unit design to mitigate the potential adverse impacts disposal units may have on, or be caused by, these six location considerations.

The cost to construct a berm is based on the cost to construct a 10-foot tall flood berm using US Army Corps of Engineers' publication "Flood Proofing – How to Evaluate Your Options," (July 1993), which provides unit costs in 1993 dollars to construct clay core flood control levees that are two, four, and six-feet high. This RIA inflated these unit costs to 2009 dollars using the ENR Construction Cost Index, and conducted a regression analysis on the unit costs (i.e., extrapolated the cost based on the implied cost curve of the smaller berms) to estimate the cost to construct a 10-foot tall berm. The estimated cost per linear foot to construct a 10-foot tall berm is $375. It is assumed that this unit cost could apply to both existing and new units, and that the berm would be constructed physically separate from the disposal unit, not integral as "freeboard" to the disposal unit's structure.

---

[61] U.S. Geological Survey, 2008, "National Seismic Hazard Maps," from USGS website: http://gldims.cr.usgs.gov/nshmp2008/viewer.htm. Data file used: pga2pct_p.shp.
[62] This threshold for seismic impact zones is consistent with RCRA's municipal solid waste landfill location restrictions (40 CFR 258.14(a)(b)(1)).
[63] U.S. Geological Survey, 1984, "Engineering aspects of karst," from USGS website: http://pubs.usgs.gov/of/2004/1352. File used: karst.shp.

- Impoundment berms: The average surface impoundment size for existing units in the cost model is 343 acres. Assuming a square impoundment and that the berm would be constructed on three sides of the impoundment the average berm length is 11,594 feet. Therefore, the cost to construct a berm around an average-size impoundment is $4.3 million.[64]
- Landfill berms: Similarly, the average landfill size for existing units in the cost model is 278 acres. Assuming a square landfill and that the berm would be constructed on three sides of the landfill (leaving one side open for truck access), the average berm length is 10,447 feet, and the cost to construct a berm surrounding an average-size landfill is $3.9 million.

Using the 3-mile buffer karst zone finding of 177 plants, the potential cost for constructing berms at those plants plus future plants is:

- Existing units: ($4.1 million average berm cost) x (177 disposal units) = $726 million total cost
  Amortized with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $53 million/year equivalent
- New units: Apply 0.73% average annual growth rate in future CCR generation (cited elsewhere in this RIA) to estimate the count of future new or expanded disposal units over 50-years, and assume 36% (i.e., 177/495) will need berms:
  (495 existing disposal units) x (1.0073% growth rate)^(50 years) = 712 existing plus new units over 50-years
  (712 units over 50-years) – (495 existing units) = 217 future new disposal units
  (217 future new units) x (36% needing berms) x ($4.1 million average berm cost) = $318 million total cost
  Amortized with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $23 million/year equivalent
  Average annualized berm cost for existing + new units = $76 million/year equivalent

8. Regulatory closure cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

9. Regulatory post-closure monitoring cost
Same cost estimation formula applied above in **Chapter 3** for baseline cost estimation.

10. Storage design and operating standards for tanks, containers, and containment buildings
Not estimated in this RIA due to lack of baseline information about the count and condition of these units at electric utility plants

4B.2 Ancillary Regulatory Requirement Costs

For estimating most of the "Other Ancillary Costs" in this section, this RIA distinguishes between RCRA Subtitle C and RCRA Subtitle D requirements according to the respective basis of each regulatory option, as well as between costs to electric utility plants and costs to state government RCRA-authorized regulatory programs.

---

[64] For purpose of comparison to the $4.3 million (per impoundment) and $3.9 million (per landfill) location restriction mitigation cost estimates above, in 2005 the TVA estimated an "assumed" cost of $500,000 for karst mitigation and $250,000 for floodplain mitigation for a potential new CCR disposal site involving 1,300 linear feet for mitigation. Extrapolation of TVA's $750,000 cost estimate to 11,594 feet (impoundment) yields $6.7 million (i.e., (11,594 feet / 1,300 feet) x ($750,000)), and to 10,447 feet (landfill) yields $6.0 million (i.e., 10,447 feet / 1,300 feet) x ($750,000)). Source for TVA cost estimate: page 10 of "Kingston Fossil Plant Decision Matrix: Pond or Peninsula?", 27 January 2005 Plant Managers Conference, http://www.tva.gov/kingston/tdec/pdf/TVA-00007487.pdf

11. Regulatory offsite disposal costs (hazmat trucking, RCRA manifests, RCRA TSDF permits for offsite)
EPA assumed that Subtitle C options add extra cost to (a) truck hauling to offsite disposal, and (b) all offsite landfills must become RCRA Subtitle C permitted. This cost estimate does not include taxes/trans-state government fees associated with off-site disposal.

11a & 11b. Added truck hauling cost (Subtitle C options)

Assumptions:

- Affects the 12% (15 million tons per year) annual CCR generation currently trucked offsite to non-haz LFs (2005)
- 6 miles average one-way trucking distance to offsite LFs[65]
- $0.19/ton/mile hazardous waste truck operating cost
- 12 tons CCR per full truckload (source: Gambrills MD case study); (15 million tons/year) / (12 tons/load) = 1.25 million truckloads per year

Cost Calculations:

- 11a. RCRA manifest cost: (1.25 million truckloads) x ($53 per manifest per load average cost from EPA 2007 ICR 801.15) = $66 million per year
- 11b. Trucking cost (distance + operating cost): (15 million tons/year) x (6 miles) x ($0.09/ton/mile added truck operating cost for hazardous waste loads) = $8.1 million per year
- Subtotal (11a manifest + 11b trucking): $74.1 million per year

11c. Added cost for RCRA Subtitle C permits for all offsite CCR landfills under Subtitle C

Assumptions:

- Added operating cost to offsite CCR landfills for meeting engineering control requirements under each of the regulatory options evaluated in this RIA are included in the "Engineering Control Costs" section above, so are not again calculated here to avoid double-counting. Only the paperwork burden cost for obtaining a RCRA permit is estimated here.
- Industry average cost per waste disposal permit:

  ($440[66] average RCRA Part A permit application cost per-plant per-year) + ($68,960[67] average RCRA Part B application cost per-facility per-year) = $69,400 per Subtitle C permit per year

  ($69,400 per permit per year) x (3 years ICR annualization period) = $208,200 per permit

  (149 offsite CCR landfills) x ($208,200 per permit) = $31.02 million

  Amortized industry cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $2.25 million/year

---

[65] Source: based on actual distance reported for a MD plant at http://www.rachel.org/en/node/445). Note: a broader range of 2.4 miles to 25 miles in one-way offsite landfill distance was reported by an OH plant at http://www.columbusdispatch.com/live/content/local_news/stories/2008/04/14/Powerfills.ART_ART_04-14-08_B1_FF9TI0U.html?sid=101, and a WI plant, respectively at http://www.lacrossetribune.com/articles/2007/09/21/news/03landfill0921.txt

[66] $440 unitized cost derived for this RIA from EPA Information Collection Request (ICR) No. 0262.12 "RCRA Hazardous Waste Permit Application and Modification Part A", Federal Register, Vol.74, No.17, 28 Jan 2009, page 4958; http://edocket.access.gpo.gov/2009/pdf/E9-1804.pdf

[67] $68,960 unitized cost derived for this RIA from EPA Information Collection Request (ICR) No. 1573.12 "Part B Permit Application", Federal Register, Vol.74, No.100, page 25237, 27 May 2009; http://edocket.access.gpo.gov/2009/pdf/E9-12285.pdf

- State government average cost per waste disposal permit:
  - Average cost for state government review of RCRA Subtitle C permits consists of four activities:[68]
  - (1,215 pre-application activities) + ($27,063 application review) + ($26,846 permit issuance) + ($3,110 permit maintenance) = $58,200 per permit
  - (149 offsite CCR landfills) x ($58,200 per Subtitle C permit) = $8.67 million
  - Amortized state cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $0.63 million/year
- Total Subtitle C permit cost (industry + state government) = $2.9 million per year

Total cost for item 11 (11a + 11b + 11c):

- Industry share of cost = $76.35 million per year
- State government share of cost = $0.63 million per year
- Total (industry + states) = $76.98 million per year

12. Regulatory structural integrity inspection cost

- Assumptions:

  EPA assumed that the residual 18% of the non-inspected plants require inspection over the 82% baseline inspection coverage. The per-plant cost for inspections is estimated in the **Chapter 3** baseline above.
- Cost Calculation:

  Industry cost: ($10,829/year per facility) x (18% not inspected) x (495 plants) = $0.96 million per year

  State government cost: ($599/year per facility) x (18% not inspected) x (495 plants) = $0.054 million per year

Total (industry + state) = $1.01 million per year

13. Regulatory RCRA facility-wide investigation (RFI) cost

- Industry RFI cost:
- As of 2008, state government corrective action covers 64% of electric utility industry impoundments and 78% of landfills. Thus, assume that 57 plants with impoundments (i.e., 36% x 158 plants with impoundments) plus 74 plants with landfills (i.e., 22% x 337 plants with landfills) may require RFIs, for a total of 131 RFIs.
- The purpose of an RFI is to obtain information to fully characterize the nature, extent and rate of migration of releases of hazardous waste or constituents to determine whether interim corrective measures and/or a Corrective Measures Study may be necessary for other waste units at the facility (source: EPA 530/SW-89-031, May 1989, Vol.I). RFIs may include: rapid field screening using portable field instruments, drilling in soils, excavating test pits, ground-water monitoring, waste testing, biomonitoring, and site surveying, site photography, site mapping.
- RFI average cost:

  $0.75 million average cost for RFIs involving captive industrial landfills

[68] Source: Based on cost data from page 84 of January 2007 ASTSWMO report “State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report” at: http://www.astswmo.org/files/publications/hazardouswaste/Final%20Report%20-%20RCRA%20Subtitle%20C%20Core%20Project.pdf

$0.69 million average cost for RFIs involving captive industrial waste management (assume applies to impoundments)
Source: EPA OSRE memorandum "Transmittal of Average Cost of Investigation Derived from Fund-Lead Superfund Costs, Interim Measures Cost Compendium, and Compendium of Related Guidance Documents", 01 Nov 2004. This memo indicates that Superfund remedial investigation costs can be used as a proxy for RCRA RFI costs.
Industry RFI cost calculations:
  - Landfills: (74 landfills) x ($0.75 million average cost per RFI) = $55.5 million total cost
  - Impoundments: (57 impoundments) x ($0.69 million average cost per RFI) = $39.3 million total cost

Total = $94.8 million total cost to industry
Amortized industry RFI cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $6.9 million/year equivalent

- State government RFI cost:

State government RFI review, approval, oversight average cost per RFI = $76,000[69]
(131 RFIs) x ($76,000 review, approval, oversight average cost per RFI to state governments) = $10 million total cost
Amortized state government RFI cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $0.7 million/year equivalent

- RFI total cost (industry + state governments) = $7.6 million per year

14. Regulatory RCRA facility-wide corrective action cost
Average annualized future potential cost was not estimated in this RIA because of a high degree of uncertainty. Through a process called corrective action, RCRA Subtitle C requires RCRA-regulated facilities to investigate and clean-up releases of hazardous wastes or constituents to the environment identified in the RCRA facility-wide investigation (RFI). After the RFI, if the need for cleanup is discovered, the RCRA-regulated facility must perform a "Corrective Measures Study" (CMS) which may range in cost from $100,000 to $800,000 for such a study.[70] State government cost for corrective measures study & corrective action review, approval, oversight is $117,300 per case.[71] The purpose of a CMS is to develop and evaluate the corrective action alternative(s) and to recommend the corrective measure(s) be taken at the facility.[72]

As of 2008 the RCRA corrective action universe is about 3,800 sites nationwide.[73] Relative to the RCRA-regulated universe of 217,500 facilities (consisting of about 16,000 hazardous waste LQG "large quantity generators" plus about 200,000 hazardous waste SQG "small quantity generators" plus about 1,500 hazardous waste TSDF "treatment, storage, disposal facilities" as of 2008), the 3,800 corrective action universe implies a 1.75% relative incidence of occurrence (i.e., 3,800 / 217,500 = 1.75%). Corrective action costs vary from facility-to-facility depending on the number and types of waste management units and other industrial equipment/processes and wastes involved. The

69 Source: Divided the $2,200,600 annual RFI cost to 10 state governments by the 29 annual RFIs from page 82 of the January 2007 ASTSWMO report "State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report" at: http://www.astswmo.org/files/publications/hazardouswaste/Final%20Report%20-%20RCRA%20Subtitle%20C%20Core%20Project.pdf
70 Source: RACER unit cost reported on p.38 of EPA's 2000 "Unit Cost Compendium" , document ID nr. EPA-HQ-RCRA-2002-0031-0429 at : http://www.regulations.gov
71 Source: derived from cost data contained on page 83 of the ASTSWMO "State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report", January 2007 at: http://www.astswmo.org/files/publications/hazardouswaste/Final%20Report%20-%20RCRA%20Subtitle%20C%20Core%20Project.pdf
72 Source: "Corrective Measures Study Scope of Work", EPA Region 3 at: http://www.epa.gov/reg3wcmd/ca/pdf/CMSATTC.pdf
73 Source: 3,800 corrective action cases represents EPA's "2020 Corrective Action Universe" as identified on EPA Hazardous Waste Corrective Action Facility Information website at: http://www.epa.gov/waste/hazard/correctiveaction/facility/index.htm#2020

corrective action remedies usually involve mitigating damages to surface water and groundwater. The General Accountability Office (GAO) reported[74] that RCRA corrective action could cost 3,698 non-Federal hazardous waste treatment, storage, or disposal facilities a total of about $16 billion (1996$) to clean up their properties contaminated by hazardous substances, representing an average $4.327 million corrective action cost per-facility. Updated[75] to 2009$ implies an average of $5.365 million RCRA corrective action cost per facility.

15. Regulatory RCRA TSDF waste disposal permit cost for onsite disposal

RCRA Subtitle C hazardous waste regulations require hazardous waste treatment, storage, disposal facilities (TSDFs) to obtain RCRA permits as described in 40 CFR 270 consisting of a two-part (i.e., Part A and Part B) application process. The paperwork burden cost of this requirement is estimated below. Furthermore, but not included in the cost estimate below, are separate, additional RCRA regulations containing "technical requirements" used by permit issuing authorities (e.g., RCRA-authorized state government waste programs or EPA Regional offices) to determine what technical requirements must be placed in permits. The separate cost of technical requirements is estimated in the "Engineering Controls" regulatory cost section of this RIA above.

- Assumptions:
    - Although 93% of CCR landfills have a state government non-hazardous waste disposal permit and 12% of CCR impoundments have such state permits, assume CCR disposal units will need new RCRA disposal permits under Subtitle C options.
    - 383 of the 495 total electric utility plants currently dispose onsite (i.e., 84 of the 495 plants solely dispose CCR offsite, plus 28 plants solely supply CCR for beneficial uses).
- Industry average cost per waste disposal permit:
    - ($440[76] average RCRA Part A permit application cost per-plant per-year) + ($68,960[77] average RCRA Part B application cost per-facility per-year) = $69,400 per Subtitle C permit per year
      ($69,400 per permit per year) x (3 years ICR annualization period) = $208,200 per permit
      (383 plants) x ($208,200 per permit) = $79.74 million
      Amortized industry cost with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $5.8 million/year
- State government average cost per waste disposal permit:
    - Build estimate based on the following four RCRA Subtitle C permit-related state government activities associated with RCRA Subtitle C waste disposal permits:[78]
      (1,215 pre-application activities) + ($27,063 application review) + ($26,846 permit issuance) + ($3,110 permit maintenance) = $58,200 average cost per Subtitle C waste disposal permit per year.

---

[74] Source: page 1 of US General Accountability Office (GAO), "Hazardous Waste: Progress Under the Corrective Action Program is Limited, But New Initiatives May Accelerate Cleanups," report nr. GAO/RCED-98-3, October 1997; http://www.gao.gov/archive/1998/rc98003.pdf

[75] Updated from 1996$ to 2009$ using the NASA "Gross Domestic Product Deflator Inflation Calculator" at http://cost.jsc.nasa.gov/inflateGDP.html

[76] $440 unitized cost derived for this RIA from EPA Information Collection Request (ICR) No. 0262.12 "RCRA Hazardous Waste Permit Application and Modification Part A", Federal Register, Vol.74, No.17, 28 Jan 2009, page 4958; http://edocket.access.gpo.gov/2009/pdf/E9-1804.pdf

[77] $68,960 unitized cost derived for this RIA from EPA Information Collection Request (ICR) No. 1573.12 "Part B Permit Application", Federal Register, Vol.74, No.100, page 25237, 27 May 2009; http://edocket.access.gpo.gov/2009/pdf/E9-12285.pdf

[78] Source: Based on cost data from page 84 of January 2007 ASTSWMO report "State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report" at: http://www.astswmo.org/files/publications/hazardouswaste/Final%20Report%20-%20RCRA%20Subtitle%20C%20Core%20Project.pdf

- State Cost Calculation:
  (383 electricity plants dispose CCR onsite) x ($58,200 per Subtitle C permit per year) = $22.3 million per year
- Total Subtitle C permit cost (industry + state government) = $28.1 million per year

16. Regulatory RCRA enforcement inspection cost

- Assumptions:
  - State government average cost = $7,900 per Subtitle C inspection (source: hazardous waste LQG large quantity generator average calculated by dividing the $1,517,357 annual enforcement inspection cost to 10 surveyed state governments by 192 annual enforcement cases, from page 87 of the January 2007 ASTSWMO report "State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report"
  - 1.6% average annual enforcement inspection frequency based on dividing the 11,965 LQG "large quantity generator" universe reported by 10 survey states by the 192 hazardous waste LQG enforcement cases reported in the January 2007 ASTSWMO report "State RCRA Subtitle C Core Hazardous Waste Management Program Implementation Costs Final Report"
- Cost calculation:
  ($7,900 per LQG enforcement) x (495 electric utility plants) x (1.6% LQG enforcements annually) = $0.063 million per year

17. Regulatory future remediation added cost

Potential $18.5 million to $376 million per case in added cleanup cost for future surface impoundment failures, if regulated under RCRA Subtitle C rather than Subtitle D, is based on the two example case studies summarized in **Exhibit 4A** below.

Exhibit 4A
Two Case Studies:
Possible Added Cost Under RCRA Subtitle C Regulation of CCR Cleanup at Electricity Plants from CCR Impoundment Failures
(Note: Assumptions or numerical factors unique to each case study are applied in the cost calculations below rather than the national average assumptions and numerical factors applied elsewhere in this RIA)

Case Study #1: **TVA Kingston TN (2008)**	**Case Study #2:** **Constellation Energy Gambrills MD (2008)**
If cleanup as non-hazardous waste: Baseline Assumptions: • 3.32 million tons released • $0.10/ton/mile truck operating cost (source: OSW-EMRAD) • 45 miles to Subtitle D LF (source: OSW-EMRAD) • $35/ton tipping fee (source: 2005 Chartwell) • 154,000 truckloads (source: TVA assumes 21.6 tons ash per load) Baseline Cost Calculations: • Trucking cost: (3.32 million tons) x (45 miles) x ($0.10/ton /mile) = $15 million • LF tipping fee: ($35/ton) x (3.32 million tons) = $116 million • Manifest: $0 • Case #1 total = $131 million for event	**If cleanup as non-hazardous waste:** Baseline Assumptions: • 0.25 million tons released • $0.10/ton/mile truck operating cost (source: OSW-EMRAD) • 193 miles to Subtitle D LF (Constellation Energy's mileage estimate to existing VA fly ash LF) • $35/ton tipping fee (source: 2005 Chartwell) • 20,833 truckloads (source: Constellation Energy assumes 12 tons ash per load) Baseline Cost Calculations: • Trucking cost: (0.25 million tons released) x (193 miles) x ($0.10/ton /mile) = $5 million • LF tipping fee: ($35/ton) x (0.25 million.tons) = $9 million • Manifest: $0 Case #2 total = $14 million for event
If cleanup as RCRA Subtitle C hazardous waste Assumptions: • 3.32 million tons released • $0.19/ton/mile truck operating cost (source: TVA) • 370 miles to Subtitle C LF (source: TVA) • $80/ton Subtitle C tipping fee (source: TVA) • 154,000 truckloads (source: TVA assumes 21.6 tons ash per load) Cost Calculations: • Trucking cost: (3.32 million tons) x (370 miles) x ($0.19/ton/mile truck operating cost) = $233 million • LF tipping fee: ($80/ton) x (3.32 million tons) = $266 million • Manifest: (154,000 truckloads) x ($53 manifest cost per load) = $8 million • Case #1 total = $507 million for event	**If cleanup as RCRA Subtitle C hazardous waste** Assumptions: • 0.25 million tons released • $0.19/ton/mile truck operating cost (from TVA) • 179 miles to Subtitle C LF (closest is Envirosafe OH with 0.9 million tons permitted capacity) • $90/ton tipping fee (2004 ETC national median fee) • 20,833 truckloads (source: Constellation Energy assumes 12 tons ash per load) Cost Calculations: • Trucking cost: (0.25 million tons) x (179 miles) x ($0.19/ton/mile truck operating cost) = $8.5 million • LF tipping fee: ($90/ton) x (0.25 million tons) = $23 million • Manifest: (20,833 truckloads) x ($53 manifest cost per load) = $1 million • Case #2 total = $32.5 million for event
Case #1 incremental cost over non-hazardous: **$376 million for cleanup event**	**Case #2 incremental cost over non-hazardous:** **$18.5 million for cleanup event**

18. EPA administrative reporting and recordkeeping costs

Three of the regulatory costs itemized above -- item 11 offsite disposal truck manifesting and offsite disposal hazardous waste permits, item 12 structural integrity inspections, and item 13 RCRA facility-wide investigation (RFI) – include the cost of paperwork burden for those items. In addition, certain features of the Subtitle C options of the proposed rule require four other paperwork burden activities:

18a. Notice of Regulated Waste Activity & EPA ID Number

RCRA Subtitle C regulations for hazardous waste "generators" require generators to notify their facilities as such and obtain EPA identification numbers (40 CFR 262.12). According to EPA's most recent (2009) estimate, the average per-facility response burden is $162 per facility.[79] Applied to the 495 electric utility plants yields an estimated one-time notification cost of $80,190 (i.e., (495 electric utility plants) x ($162 per notification)). Amortized with a capital recovery factor of 0.07246 (@7% discount rate & 50-years) = $5,800 per year average annual equivalent.

- Industry share of cost: (86%) x ($5,800/year) = $5,000/year
- State government share of cost: (14%) x ($5,800/year) = $800/year

18b. General Facility Standards for Hazardous Waste TSDFs

This cost item represents a set of paperwork burden activities grouped under 40 CFR 264/265 Subpart B (i.e., 264.10 to 264.19 and 265.10 to 265.19) and includes (1) maintaining records for hazardous waste that is stored, treated, and/or disposed onsite, (2) descriptions of location, design, construction, operating methods, techniques, and practices for onsite hazardous waste storage, treatment, and/or disposal, (3) contingency plans for unanticipated damages from hazardous waste onsite storage, treatment and/or disposal, (4) maintaining qualifications of facility ownership, (5) maintaining continuity and financial responsibility of facility operation, and (6) employee hazardous waste training. According to EPA's most recent (2009) estimate the average per-facility paperwork burden is $27,350 per facility per year.[80] Applied to the 383 electric utility plants which currently dispose onsite (i.e., 84 of the 495 plants solely dispose CCR offsite with other companies, plus 28 plants solely provide CCR for beneficial uses) yields an estimated cost of ($27,350 per facility pre year) x (383 plants which dispose CCR) = $10.48 million/year:

- Industry share of cost: (86%) x ($10.48 million/year) = $9.01 million/year
- State government share of cost: (14%) x ($10.48 million/year) = $1.47 million/year

18c. RCRA Hazardous Waste Biennial Report

RCRA Subtitle C requires hazardous waste LQG large quantity generators (40 CFR 262.41) and hazardous waste TSDF treatment, storage, and disposal facilities (40 CFR 264.75 and 265.75) to submit "Hazardous Waste Report" information on a 2-year repeating cycle (aka "RCRA

---

[79] $162 per year notification cost derived from EPA Information Collection Request (ICR) No. 0261.16 "Notification of Regulated Waste Activity (Renewal)", Federal Register, Vol.74, No.123, pages 31028-31029, 29 June 2009; http://edocket.access.gpo.gov/2009/pdf/E9-15310.pdf

[80] $27,350 per facility per year average cost derived from EPA Information Collection Request (ICR) No. 1571.09 "General Hazardous Waste Facility Standards", Federal Register, Vol.74, No.23, pages 6152-6154, 05 Feb 2009.

Biennial Report"). According to EPA's most recent (2009) estimate, the average annualized per-facility response burden is $3,410 per year.[81] Extrapolated to 495 electric utility plants produces a cost estimate of $1.69 million per year.

- Industry share of cost: (86%) x ($1.69 million/year) = $1.45 million/year
- State government share of cost: (14%) x ($1.69 million/year) = $0.24 million/year

18d. CERCLA Reportable Quantity (RQ) Spill/Leak Reporting

Section 103(a) of CERCLA requires facilities and vessels to immediately notify the National Response Center (NRC) of a hazardous substance release (e.g., spill, leak) into the environment if the amount of the release equals or exceeds the substance's reportable quantity (RQ) limit. In general there are five RQ categories (1, 10, 100, 1,000 or 5,000 pounds). Subtitle C options may add CCR to the CERCLA list of hazardous substances and assign an RQ of one-pound, as well as allowing the use of concentrations to determine RQ thus resulting in a range of 1,294 pounds to 10,000,000 pounds for 12 chemicals. Using the total count of facilities (i.e., establishments) in the US manufacturing sector (NAICS 31, 32, 33) plus the US waste management sector (NAICS 562) as rough indicators, there are 315,000 industrial facilities in the US which may handle RQ-listed hazardous substances.[82] According to EPA's most recent (2007) estimate, the average per-facility response burden is $122 (i.e., 4.1 burden hours) per facility per response, based on an average annual 25,861 facilities at an annual paperwork burden cost of $3.161 million.[83] Relative to this 300,000 industrial facility universe, this annual count of RQ-reporting facilities represents an 8% fraction. Extrapolated to the 495 electric utility plants yields a rough estimate of 40 possible RQ reports per year, at a cost of $4,900 per year (i.e., (495 electric utility plants) x (8% RQ reports per year) x ($122 per RQ report)).

- Industry share of cost: (86%) x ($4,900/year) = $4,200/year
- State government share of cost: (14%) x ($4,900/year) = $700/year

Sub-total cost item 17 (17a + 17b + 17c + 17d) = $12.94 million per year.

- Industry share of cost: (86%) x ($12.94 million/year) = $11.13 million/year
- State government share of cost: (14%) x ($12.94 million/year) = $1.81 million/year

Exhibit 4B below presents a summary of these "Ancillary Cost" elements numbered from 11 to 18.

---

[81] $3,410 per facility per year average cost derived from EPA Information Collection Request (ICR) No. 0976.14 "2009 Hazardous Waste Report", Federal Register, Vol.74, No.93, pages 22922-22924, 15 May 2009; http://edocket.access.gpo.gov/2009/pdf/E9-11410.pdf

[82] 315,000 industrial facilities based on "Number of Establishments" published for NAICS codes 31-33 Manufacturing (293,919 establishments) plus NAICS code 562 Waste management and remediation services (21,254 establishments) from the US Census Bureau in its "2007 Economic Census." Not all manufacturing or waste management facilities necessarily handle hazardous substances so this is an over-estimate, but there are also other economic sectors (e.g., mining, construction, utilities, transporters, and wholesalers), which handle hazardous substances not included in this facility count which offsets this over-estimate.

[83] $122 per facility average cost derived from EPA Information Collection Request (ICR) No. 1049.11 "Notification of Episodic Releases of Oil and Hazardous Substances (Renewal); Federal Register, Vol.72, No.205, 24 Oct 2007, pp.60357-60358; http://edocket.access.gpo.gov/2007/pdf/E7-20934.pdf

Exhibit 4B **Summary of "Ancillary Cost" Estimates Associated with RCRA Regulation of CCR Disposal** ($millions average annualized; 2009$)				
Ancillary Cost Element	Applicability to CCR Regulatory Options	Electric Utility Industry Cost	State Government RCRA-Authorized Program Cost	Row Total Cost
11. Ancillary offsite disposal costs	Subtitle C	$76.35	$0.63	$76.98
12. Impoundment structural integrity inspections	Subtitle C and Subtitle D	$0.96	$0.054	$1.01
13. RCRA facility-wide investigations (RFIs)	Subtitle C	$6.9	$0.7	$7.6
14. RCRA facility-wide corrective action	Subtitle C	Not estimated – historical average cost = $5.4 million per facility	Not estimated	Not est.
15. RCRA TSDF waste disposal permits	Subtitle C	$5.8	$22.3	$28.1
16. RCRA enforcement inspections	Subtitle C	$0	$0.063	$0.063
17. Future disposal unit failure cleanup remediation as RCRA hazardous waste	Subtitle C	Not est. – case study example	Not est. – case study example	Not est.
18. EPA administrative reporting & recordkeeping 18a. EPA regulated waste notification 18b. RCRA TSDF general facility standards 18c. RCRA haz waste biennial report 18d. CERCLA RQ reporting	Subtitle C	Subtotal= $11.13 $0.005 $9.01 $1.45 $0.0042	Subtotal= $1.81 $0.0008 $1.47 $0.24 $0.0007	$12.94 $0.0058 $10.48 $1.69 $0.0049
Column Totals for the three options of the October 2009 draft RIA :				
	Subtitle C hazardous waste	$100.4	$25.6	**$126.7**
	Subtitle D (version 1)	$0.96	$0.05	**$1.0**
	Hybrid C&D*	$7.9	$7.7	**$15.6**
* Hybrid C&D costs for ancillary cost items 13, 14, 15, 16, 17, 18 are proportioned only to the 158 plants with impoundments that would be regulated under Subtitle C for this option, by the proportionate multiplier: (158 plants w/impoundments) / (495 total plants) = 0.319				

4B.3 Land Disposal Restriction Cost (for dewatering treatment of CCR)

This element consists of two components:

- Dry CCR disposal (landfills): Moisture conditioning and compaction to 95% maximum dry density value according to ASTM D 698 or ASTM D 1557 test methods prior to disposal in landfills.
- Wet CCR disposal (impoundments): Dewatering to remove solids prior to disposal in impoundments within 5-years of rule's effective date. The potential cost for this treatment standard is estimated below.

However, only the potential cost for the wet CCR disposal dewatering treatment standard is estimated in this section of the RIA because the potential cost for meeting the dry CCR moisture conditioning and compaction requirements are already estimated in item 4 of the "engineering controls" in this chapter above:

- **Examples of CCR Dewatering Methods**

Based on the following recent (1997-2009) example descriptions of dry CCR disposal practices at existing or planned coal-fired electric utility plants, dry CCR disposal may involve different methods for any given plant:

1. Tanks & chain drag: As described in March 2009 by the Basin Electric Power Cooperative.[84] Bottom ash will be dewatered in tanks and the water will be re-circulated to transport additional bottom ash. Bottom ash will be removed using a chain drag. The ash will then be hauled by truck to a lined landfill offsite. The fly ash will be conveyed in a dry state. Both ashes will be disposed in a landfill close to the plant site.
2. Pressure squeeze conveyor: Another tank-based example apparently similar to the Basin Cooperative method is reported for dry disposal conversion by the coal mining industry, involving the Phoenix Process Equipment company supplier of alternative slurry processing equipment. This second example involves a thickening tank, porous conveyor belt and pressure to squeeze water out of the coal washings, producing a semi-solid, 75% dewatered cake which is scraped off the conveyor belt and stacked like a pile of sand. The cost for this process is reported at $0.50 per ton of coal waste processed.[85]
3. Horizontal belt filters: According to a May 2009 technical paper[86], dewatering gypsum using horizontal belt filters is common in the electric utility industry, and a new modified horizontal belt filter method involving two feedboxes allows fly ash and FGD (gypsum) to be dewatered simultaneously.
4. Storage silos & rail system: As described June 2009[87] for a $10 million conversion project located at Detroit Edison's Monroe Michigan Power Plant -- a four boiler unit, 3,200-megawatt power station originally constructed in 1974. Installation of equipment to collect the coal ash in a dry state, plus dry ash storage facilities (storage silos), and truck/rail loading equipment for distribution of the dry ash to concrete producers in the Midwest United States and Eastern Canada.

---

[84] Source: March 2009 Basin Electric Power Cooperative examples at http://www.basinelectric.com/News_Center/Feature_Articles/Coal_ash_handling.html

[85] Source: Dave Cooper, "Better, Safer Ways to Handle Coal Slurry Do Exist", page 14 of the Nov 2001 "E"-Notes Newsletter of the Ohio Valley Environmental Coalition at http://www.ohvec.org/newsletters/enotes_97-01_pdf/enotes_2001_11.pdf

[86] Source: May 2009 horizontal belt filter technical paper by Alex Hohne at http://www.flyash.info/2009/036-hohne2009.pdf

[87] Source: June 2009 Detroit Edison Monroe Power Plant example at http://www.headwaters.com/data/upimages/press/6.30.09MonroeAshRelease.pdf

5. Integrated silo system: Integrated with precipitators, vacuum pumps and bag filter/receivers, as described in an engineering report[88] about the 1997 dry fly ash system conversion of Northern Indiana Public Service Company's Michigan City Plant.

For this RIA, EPA ORCR identified four alternative existing studies with cost estimates (dated 1981, 1985, 2005, and 2009) comparing dry and wet CCR disposal at coal-fired electric utility plants. The first three studies provided cost estimates on a per-plant basis, whereas the 2009 study provided an extrapolated nationwide cost estimate. However, only the 2005 study is used in this RIA as a basis for deriving a cost estimate for the wet CCR dewatering land disposal treatment, because the first two studies are over 25-years old (1981 and 1985), and the 2009 study does not provide sufficient details for verification of data and calculations. These three other studies are summarized below in this chapter to illustrate the magnitude of cost estimation uncertainty implied by the other studies, compared to the estimate derived below in this section of the RIA.

- **Summary of 2005 TVA CCR Dry Disposal Cost Study**

- In August 2009 TVA announced a proposed plan to convert its wet CCR disposal to dry disposal. TVA's CEO Tom Kilgore said before a 28 July 2009 US Congressional subcommittee hearing that TVA has developed a 5-year plan to shift CCR disposal from wet impoundments to dry landfills. TVA estimated it will cost between $1.5 billion to $2 billion over 8 to 10 years for its 11 coal-fired electric utility plants.[89] Detailed or semi-detailed calculations of TVA's 2009 cost estimate are not available for this RIA to use for extrapolation nationwide.
- However, a 2005 TVA cost estimate titled "Kingston Fossil Plant Decision Matrix: Pond or Peninsula?" provides detailed cost estimates for dry conversion of the TVA Kingston TN plant.[90] The TVA cost study involves conversion of an existing impoundment currently used to dispose wet fly ash and wet bottom ash at the TVA Kingston TN electric utility plant, for future dry fly ash and dry bottom ash disposal. The FGD stream remains wet-sluiced before and after this hypothetical conversion in the cost study. In addition to the cost of converting the electric plant boilers and the impoundment for dry ash disposal, the cost study also includes the cost for construction of a new storm water runoff management pond (Source: row item 68 of TVA's "Appendix C Detailed Cost Sheets", slide nr. TVA-00007403).
- TVA cost study involves conversion of 475,600 cubic yards of fly ash plus bottom ash per year; this RIA estimates this quantity is equivalent to 880,000 tons per year, assuming 1.85 tons per cubic yard multiplier.[91]

---

[88] Source: Dec 1997 NIPSC conversion report at http://www.babcockpower.com/pdf/rst-145.pdf

[89] Source: TVA news release "TVA Coal Combustion Products Remediation Plan Proposed", 20 Aug 2009 http://www.tva.gov/news/releases/julsep09/ccprp_other.htm

[90] Source: TVA 27 January 2005 plant managers conference slide presentation (25 pages).. Wet disposal is presented as "Option 1" and dry disposal is presented as "Option 2" in the TVA cost presentation. Additional details for the TVA cost estimates are available at http://www.tva.gov/kingston/tdec/pdf/TVA-00007402.pdf

[91] "Source: 1.85 tons per cubic yard multiplier represents the midpoint from the following 1.2 to 2.5 range: According to EPA's 1988 Report to Congress ("Wastes from the Combustion of Coal by Electric Utility Power Plants," page 3-14), the dry density of fly ash is 80-90 lbs/cubic ft which translates to a specific density of 1.4. The Federal Highway Administration studied fly ash for use in highway construction and reported its specific gravity may be as low as 1.7 to as high as 3.0. Conversion of this implied 1.4 to 3.0 range in fly ash specific gravities to tons-per-cubic-yard as follows:

- Low-end: (1.4 g/cm3) / (0.000001 m3/cm3) x (0.764 m3/yd3) / (1000 g/kg) x (2.204 lbs/kg) / (2000 lbs/short ton) = 1.2 short tons per cubic yard.
- High-end: (3.0 g/cm3) / (0.000001 m3/cm3) x (0.764 m3/yd3) / (1000 g/kg) x (2.204 lbs/kg) / (2000 lbs/short ton) = 2.5 short tons per cubic yard.

- The TVA cost study did not estimate the cost for dewatering FGD (gypsum) because FGD is already dewatered by most electric utility plants for beneficial uses, thus only four of the 495 electric utility plants (i.e., TVA Widows Creek plant, TVA Paradise plant, Louisville Gas & Electric Co Trimble County plant, and Northern Indiana Public Service Company R.M. Schafer plant) wet dispose 1.9 million tons FGD per year in impoundments as of 2005 (source: column B of **Exhibit 3G** of this RIA).
- Unit cost (i.e., average cost per ton) of conversion from wet to dry disposal estimated from the 2005 TVA cost analysis which provides cost estimates for converting from wet ash disposal to dry ash disposal:

	TVA wet disposal	TVA dry disposal	Added cost for dry	Unitized dry cost
o Capital cost	$13.12 million PV	$38.45 million PV	Cost not incremental	$43.7/ton per year (@20 years)
o Annual O&M cost	$10.63 million PV	$17.51 million PV	$6.88 million PV	$0.60/ton (@13 years)

(Note: PV = present value for TVA's 25-year period of analysis 2005-2029; TVA costs are in 2005$ prices)

- Cost estimate calculation under conversion to dry disposal scenario, calculated based on TVA's per-ton cost extrapolation to 22.4 million tons per year baseline wet CCR (i.e., wet fly ash, wet bottom ash, wet FGD, wet gypsum, wet other CCR) disposal in impoundments at 158 of the 495 electric utility plants:
  - Capital cost: (22.4 million tons per year wet CCR disposal for conversion at 158 plants) x ($43.7/ton per year conversion capital cost) x (20 years capitalization period) x (1.174 price update multiplier[92] to 2009$ price level) = $22,984 million undiscounted capital cost
    Annual equivalent capital: ($22,984 million) x (0.07246 capital recovery factor @7% & 50-years) = $1,665 million per year
  - O&M cost: ($0.60/ton conversion O&M cost) x (22.4 million tons/year wet CCR disposal for conversion at 158 plants) x (45 years future operational period 2017-2061 which assumed to begin 5 years after 2012 final rule promulgation) x (1.174 price update multiplier to 2009$ price level) = $710 million undiscounted total O&M
    PV present value discounted @7% over 50-years = $153 million PV present value O&M
    Annual equivalent O&M: ($153 million) x (0.07246 capital recovery factor @7% & 50-years) = $11 million per year
  - Total annualized cost (capital + O&M) = ($1,665 million/year capital) + ($11 million/year O&M) = $1,676 million/year

- **Uncertainty in Land Disposal Treatment Cost Estimate**

In addition to the 2005 Tennessee Valley Authority (TVA) cost study referenced above, there are three other related cost studies (1981, 1985, and 2009) which are summarized below. The first two studies provide cost estimates on a per-plant basis for a few plant sizes, and the 2009 study provides a nationwide cost estimate. This RIA did not apply these other studies because the first two are over 25-years old (i.e., 1981 and 1985) and the third study does not provide sufficient details for verification of data and calculations. These studies are summarized below and used as a basis for formulating alternative nationwide cost estimates for land disposal treatment, for the purpose of illustrating the potential magnitude of uncertainty in this RIA's cost estimate in relation to these other studies.

[92] 1.174 price update multiplier represents 2009:to:2005 ratio in the Engineering-News Record Construction Cost Index: (8566 CCI for July 2009) / (7297 CCI for 2005).

- **Study #1 of 3: 1981 TVA/EPA**

- In January 1981, TVA's Energy Demonstrations and Technology Office (Chattanooga TN) co-authored with EPA's Industrial Environmental Research Laboratory (Research Triangle Park NC) a study titled "Economic Analysis of Wet Versus Dry Ash Disposal Systems," Interagency Energy/Environment R&D Program Report, report no. TVA/OP/EDT-81/30 and EPA-600-7-81-013, 126 pages.[93]
- The study compares the relative costs of wet and dry methods of coal ash disposal for five electric plant power size categories (300 MW, 600 MW, 900 MW, 1,300 MW, 2,600 MW) with annual coal ash generation ranging from 0.2 million to 1.7 million per year per plant.
- Per-plant capital and O&M costs estimated based on 35-year assumed plant lifespan in 1980$. Capital costs for (a) in-plant coal ash handling systems, (b) conveyance/transport, and disposal units, were obtained from equipment suppliers.
- The study found (page 67) there is not a significant difference in ash system economics based on the method of analysis. Present worth analysis "*indicates that wet disposal is typically the least cost alternative. However, various dry disposal options are within a 15 percent range of those costs. The costs are, in fact, sensitive to spreading the dry disposal area capital costs over the life of the power station and the in-plant handling system cost. Use of either the lower dilute phase transport system cost or the dense phase collection system cost results in the dry disposal system alternative become the least cost alternative*."
- The study also noted that staged construction may provide 30% saving in system total cost: "*[T]he above analyses assumed construction of all the required facilities upon start-up. In the case of dry disposal, this is a reasonable assumption although site preparation costs would proceed during the development of the site. In the case of wet disposal, it may be economically sound to construct the embankment in stages, even if the amount of material to be placed or the engineering estimate is higher for staged construction. This is due to the high cost of the dam or levee and the cost of money over the life of the project. As an example… wet disposal area was analyzed for all construction occurring in 1980 and by a staged construction sequence (3 stages). In this case, staged construction provided a 30 percent savings in the total cost of the system.*"
- The 1981 study used two cost methods. The "Present Worth" (aka present value PV) cost method findings (page 62) indicated the following comparative ranges in wet dry versus wet disposal costs:

Disposal method	1980$ cost ($/ton)	2009$ update ($/ton)[94]
Dry disposal	$2.19 to $4.50	$4.81 to $9.87
Wet disposal	$1.86 to $5.68	$4.08 to $12.46

[93] Source: 1981 TVA/EPA report at http://nepis.epa.gov/Exe/ZyNET.exe/20006ORT.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1981+Thru+1985&Docs=&Query=tva+wet+dry+disposal&Time=&EndTime=&SearchMethod=3&TocRestrict=n&Toc=&TocEntry=&QField=pubnumber%5E%22600781013%22&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=pubnumber&IntQFieldOp=1&ExtQFieldOp=1&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C81thru85%5CTxt%5C00000000%5C20006ORT.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=10&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x

[94] 1980$ costs from the 1981 TVA/EPA study updated by EPA ORCR to 2009$ using the GDP calculator at http://cost.jsc.nasa.gov/inflateGDP.html

- Using the EPA ORCR 2009$ updated unit cost midpoints displayed above yields the following rough cost estimate for the 158 electric utility plants with CCR impoundments:
    - Capital cost: (22.4 million tons per year wet CCR disposal for conversion at 158 plants) x ($4.81 to $9.87 per ton dry disposal unitized present value cost) x (40.6% capital cost fraction) x (50 years period-of-analysis for this RIA) = $2,187 million to $4,488 million present value capital cost
    Annualized capital cost: ($2,187 million to $4,488 million) x (0.07246 capital recovery factor @7% & 50-years) = $158.5 million to $325.2 million per year
    - O&M cost[95]: (22.4 million tons per year wet CCR disposal for conversion at 158 plants) x [(($4.81 to $9.87 per ton dry disposal unitized present value cost) x (59.4% dry O&M fraction)) – (($4.08 to $12.46 per ton wet disposal unitized present value cost) x (31.6% wet O&M fraction))] x (45 years dry disposal operational period 2017-2061 which assumed to begin 5 years after 2012 final rule promulgation) = $1,580.5 million to $1,941.4 million present value O&M
    Annualized O&M cost: ($1,580.5 million to $1,941.4 million) x (0.07246 capital recovery factor @7% & 50-years) = $114.5 million to $140.7 million per year
    - Total annualized cost (capital + O&M) = ($158.5 million to $325.2 million per year capital) + ($114.5 million to $140.7 million per year O&M) = $273 million to $466 million per year

- **Study #2 of 3: 1985 EPA**

- EPA's Air and Energy Engineering Research Laboratory (Research Triangle Park NC) published cost estimates for both wet and dry CCR disposal at coal-fired electric utility plants in the report "Full-Scale Field Evaluation of Waste Disposal from Coal-Fired Electric Generating Plants", document nr. EPA/600/S7-85/028, August 1985, 12 pages.[96]
- This is a 3-year study of waste characterization, environmental data, engineering, and cost evaluations associated with disposal of coal ash and FGD waste by six coal-fired electricity plants ranging in nameplate capacity between 310 to 1,786 megawatts and located in FL, IL, MN, NC, PA, and WY. EPA used this study to assist preparation of EPA's 1988 "Report to Congress on Wastes from the Combustion of Coal by Electric Utility Power Plants" (report no. EPA530-SW-88-002, Feb 1988).
- This study developed "generic" capital and annual O&M costs for both wet CCR pond disposal and dry CCR landfill disposal methods involving fly ash, bottom ash, and FGD, based on specific costs for the six sites combined with cost estimates from other studies by TVA,

[95] O&M cost extrapolation calculation in this RIA for the 1981 study applies two different O&M cost percentages based on the study's 59.4% dry disposal O&M cost percentage derived from page B-10, and on the study's 31.6% wet disposal O&M cost percentage derived from page C-11.
[96] Source: 1985 EPA AEERL report at http://nepis.epa.gov/Exe/ZyNET.exe/2000TNFC.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1981+Thru+1985&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=pubnumber%5E%22600S785028%22&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=pubnumber&IntQFieldOp=1&ExtQFieldOp=1&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C81thru85%5CTxt%5C00000010%5C2000TNFC.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=10&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x

EPRI, and other organizations. **Exhibit 4C** below displays the unitized capital costs and **Exhibit 4D** below displays the unitized O&M costs from the study updated for this RIA to 2009 price level.

- Using the 2009-updated mean unit capital and O&M cost estimates displayed in **Exhibit 4C** and **Exhibit 4D**, provides the following cost estimates for conversion to dry disposal, based on extrapolation to 22.4 million tons per year baseline wet CCR (i.e., wet fly ash, wet bottom ash, wet FGD, wet gypsum, wet other CCR) disposal in impoundments at 158 of the 495 electric utility plants which have a subtotal of 180,901 MW nameplate total capacity:
  - o <u>Capital cost:</u> (180,901,000 kilowatt capacity for 158 electric utility plants with surface impoundments) x ($37.60 dry conversion capital cost per kilowatt capacity from **Exhibit 4C**) = $6,810 million capital cost

    Annual equivalent cost: ($6,810 million) x (0.07246 capital recovery factor @7% & 50-years) = $494 million/year
  - o <u>O&M cost</u>: (22.4 million tons per year wet CCR disposed in impoundments) x (-$17.40 cost savings per ton to manage for dry disposal from **Exhibit 4D**) = -$389 million per year O&M cost savings.
  - o <u>Total average annualized cost</u> (capital + O&M) = ($494 million/year capital cost) – ($389 million/year O&M cost savings) = $105 million per year dry conversion cost.

Exhibit 4C
Comparison of Unitized Capital Costs for Wet and Dry CCR Disposal (Source: 1985 EPA Study; $/kW)

Item	Disposal Operation	Wet or Dry CCR	Plant Size Categories (MW = megawatts) 250 Min	250 Max	500 Min	500 Max	1000 Min	1000 Max	2000 Min	2000 Max	Row Summary Across Four Size Categories Min	Max	Midpnt	Mean
1A	Fly ash handling/processing	Wet	$2.3	$6.8	$1.9	$5.5	$1.5	$6.4	$1.3	$3.6	$1.3	$6.8	$4.1	$3.7
1B		Dry	$2.2	$4.1	$1.8	$3.3	$1.4	$2.7	$1.2	$2.2	$1.2	$4.1	$2.7	$2.4
2	Fly ash storage	Dry	$4.7	$8.8	$4.2	$7.7	$3.7	$6.8	$3.2	$5.9	$3.2	$8.8	$6.0	$5.6
3A	Fly ash transport	Wet	$3.5	$6.4	$2.7	$5.1	$2.2	$4.0	$1.7	$3.2	$1.7	$6.4	$4.1	$3.6
3B		Dry	$0.3	$0.5	$0.3	$0.6	$0.3	$0.5	$0.2	$0.5	$0.2	$0.6	$0.4	$0.4
4A	Fly ash placement/disposal	Wet	$15.1	$27.8	$12.9	$23.9	$11.0	$20.5	$9.4	$17.5	$9.4	$27.8	$18.6	$17.3
4B		Dry	$4.3	$8.1	$3.3	$6.1	$2.5	$4.7	$1.9	$3.6	$1.9	$8.1	$5.0	$4.3
5	Bottom ash handling/processing	Wet/Dry	$2.2	$4.6	$1.7	$3.7	$1.3	$3.0	$1.0	$2.4	$1.0	$4.6	$2.8	$2.5
6A	Bottom ash transport	Wet	$3.0	$5.6	$2.4	$4.5	$1.9	$3.6	$1.5	$2.8	$1.5	$5.6	$3.6	$3.2
6B		Dry	$0.2	$0.4	$0.2	$0.3	$0.1	$0.2	$0.1	$0.2	$0.1	$0.4	$0.3	$0.2
7A	Bottom ash placement/disposal	Wet	$6.4	$11.8	$5.1	$9.6	$4.2	$7.7	$3.4	$6.2	$3.4	$11.8	$7.6	$6.8
7B		Dry	$1.3	$2.4	$1.1	$2.0	$0.9	$1.6	$0.7	$1.3	$0.7	$2.4	$1.6	$1.4
Summary:														
Wet Subtotal (1A+3A+4A+5+6A+7A)		Wet (1982$)	$32.5	$63.0	$26.7	$52.3	$22.1	$45.2	$18.3	$35.7	$18.3	$63.0	$40.7	$37.0
Dry Subtotal (1B+2+3B+4B+6B)		Dry (1982$)	$15.2	$28.9	$12.6	$23.7	$10.2	$19.5	$8.3	$16.1	$8.3	$29.0	$18.7	$16.8
2009 Updated Wet Subtotal*		Wet (2009$)	$72.8	$141.1	$59.8	$117.1	$49.5	$101.2	$41.0	$79.9	$41.0	$141.1	$91.0	$82.8
2009 Updated Dry Subtotal*		Dry (2009$)	$34.0	$64.7	$28.2	$53.1	$22.8	$43.7	$18.6	$36.0	$18.6	$64.9	$41.8	**$37.6**
* Note: 2009 price update multiplier (source: ENR Construction Cost Index ratio 2009:to:1982 = 8564/3825) = 2.239														

Exhibit 4D

Comparison of Annual O&M Costs for Wet and Dry CCR Disposal (Source: 1985 EPA Study; $/dry metric ton)

			Plant Size Categories (MW = megawatts)								Row Summary Across Four Size Categories			
		Wet or Dry	250		500		1000		2000					
Item	Disposal Operation	CCR	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Midpnt	Mean
Fly Ash:														
1A	Fly ash handling/processing	Wet	$2.5	$6.8	$1.0	$5.4	$1.6	$4.3	$1.3	$3.6	$1.0	$6.8	$3.9	$3.3
1B		Dry	$2.5	$4.7	$2.1	$3.9	$1.7	$3.2	$1.5	$2.7	$1.5	$4.7	$3.1	$2.8
2	Fly ash storage	Dry	$3.3	$6.1	$3.0	$5.6	$2.8	$5.2	$2.5	$4.7	$2.5	$6.1	$4.3	$4.2
3A	Fly ash transport	Wet	$4.2	$7.6	$3.2	$5.9	$2.5	$4.7	$2.0	$3.7	$2.0	$7.6	$4.8	$4.2
3B		Dry	$1.7	$3.1	$1.5	$2.8	$1.3	$2.5	$1.2	$2.2	$1.2	$3.1	$2.2	$2.0
4A	Fly ash placement/disposal	Wet	$11.5	$21.3	$9.1	$16.8	$7.2	$13.5	$5.7	$10.5	$5.7	$21.3	$13.5	$12.0
4B		Dry	$7.0	$13.0	$5.6	$10.5	$4.6	$8.5	$3.7	$6.9	$3.7	$13.0	$8.4	$7.5
	Subtotal fly ash	Wet (1982$)	$18.2	$35.7	$13.3	$28.1	$11.3	$22.5	$9.0	$17.8	$8.7	$35.7	$22.2	$19.5
		Dry (1982$)	$11.2	$20.8	$9.2	$17.2	$7.6	$14.2	$6.4	$11.8	$6.4	$20.8	$13.6	$12.3
Bottom Ash:														
5	Bottom ash handling/processing	Wet/Dry	$11.3	$22.8	$9.0	$19.1	$6.9	$15.7	$5.3	$12.8	$5.3	$22.8	$14.1	$12.9
6A	Bottom ash transport	Wet	$9.2	$17.1	$7.3	$13.5	$5.6	$10.3	$4.3	$7.9	$4.3	$17.1	$10.7	$9.4
6B		Dry	$3.4	$6.3	$2.8	$5.2	$2.2	$4.1	$1.8	$3.3	$1.8	$6.3	$4.1	$3.6
7A	Bottom ash placement/disposal	Wet	$9.2	$17.1	$7.9	$14.6	$6.5	$12.1	$5.4	$10.0	$5.4	$17.1	$11.3	$10.4
7B		Dry	$5.4	$10.0	$4.7	$8.8	$4.1	$7.6	$3.5	$6.5	$3.5	$10.0	$6.8	$6.3
	Subtotal bottom ash	Wet (1982$)	$29.7	$57.0	$24.2	$47.2	$19.0	$38.1	$15.0	$30.7	$15.0	$57.0	$36.0	$32.6
		Dry (1982$)	$20.1	$39.1	$16.5	$33.1	$13.2	$27.4	$10.6	$22.6	$10.6	$39.1	$24.9	$22.8
Summary (Fly Ash & Bottom Ash):														
	Weighted average*	Wet (1982$)	$20.7	$40.4	$15.7	$32.3	$13.0	$25.9	$10.3	$20.6	$10.1	$40.4	$25.2	$22.4
		Dry (1982$)	$13.2	$24.8	$10.8	$20.7	$8.8	$17.1	$7.3	$14.2	$7.3	$24.8	$16.1	$14.6
	2009 updated weighted average**	Wet (2009$)	$46.4	$90.4	$35.2	$72.3	$29.1	$58.1	$23.1	$46.2	$22.6	$90.4	$56.5	$50.1
		Dry (2009$)	$29.5	$55.6	$24.2	$46.4	$19.8	$38.3	$16.4	$31.8	$16.4	$55.6	$36.0	$32.7
											Incremental cost from conversion to dry disposal =			**-$17.4**

Notes:
* Fly:to:ash weighted average based on 2005 relative annual tonnages evaluated in the RIA: Fly ash tons/year = 15,200,000; Bottom ash tons/year = 4,300,000
** 2009 price update multiplier (source: ENR Construction Cost Index ratio 2009:to:1982 = 8564/3825) = 2.239

- **Study #3 of 3: 2009 USWAG**

- On 11 June 2009 the Utility Solid Waste Action Group (Jim Roewer, Executive Director) provided to EPA a 14-page cost study USWAG sponsored by the EOP Group Inc., containing an estimate of $39,000 million present value (PV) for conversion to dry disposal: "Cost Estimates for Closure of Ash Ponds at Fossil Fuel Power Generation Facilities", prepared in 2009 by EOP Group Inc. USWAG/EOP's $39,000 million PV estimate uses a 3% discount rate over 20 years with a 10-year implementation period, and consists of:
  - $12,900 million PV (33%) for fly ash and bottom ash conversion to dry disposal
  - $2,500 million PV (6%) for foregone sunk cost in ponds
  - $23,700 million PV (61%) for construction of new wastewater plants for other non-ash ancillary wastewaters (e.g., stormwater) which are currently co-mingled with the wet ash.
- For purpose of comparing this estimate with the other two cost studies above, the following rough calculations extend the O&M costs from the 20-year period from the USWAG/EOP study, to the 50-year period applied in this RIA:
  - Dry management O&M cost = ($2.00 per ton higher cost than wet management) x (20.6 million tons per year in impoundments) x (40-years after 10-year impoundment phase-out) = $1,648 million (undiscounted).
    PV discounted @7% over 50-years = $279 million PV present value
  - Waste water treatment plant (WWTP) O&M cost = ($525 million per year) x (40-years after 10-year impoundment phase-out) = $21,000 million (undiscounted).
    PV discounted @7% over 50-years = $3,558 million PV present value
  - Substituting these 50-year based PV O&M cost estimates for the 20-year based PV O&M cost estimates into the USWAG/EOP $39,000 million 20-year PV total cost estimate produces the following 50-year based average annualized cost:
    - <u>Capital cost</u>:($39,000 million PV total cost) – ($400 million 20-year PV dry management O&M) – ($5,200 million 20-year PV WWTP O&M) = $33,400 million PV capital cost
      Annual equivalent capital cost: ($33,400 million PV) x (0.07246 capital recovery factor @7% & 50-years) = $2,420 million per year annualized capital cost
    - <u>O&M cost</u>: ($279 million 50-year PV dry management O&M) + ($3,558 million 50-year PV WWTP O&M) = $3,837 million PV present value O&M
      Annualized O&M cost: ($3,837 million PV) x (0.07246 capital recovery factor @7% & 50-years) = $278 million per year O&M
    - <u>Total annualized cost</u> (capital + O&M) = $2,698 million per year

Exhibit 4E below presents a summary of the extrapolated cost estimates based on the per-plant cost findings from these three alternative cost studies, compared to the cost estimate based on the 2005 TVA cost study applied in this RIA.

Exhibit 4E **Summary of Wet Conversion Cost Estimates Based on Four Alternative Studies 1981, 1985, 2005, 2009** ($millions updated to 2009$)					
	A	B	C	D	E (A to D)
Type of Dry Conversion Cost Element	**Cost Study #1** EPA 1981	**Cost Study #2** EPA 1985	**Selected for Basis of the Estimate Applied in this RIA** **Cost Study #3** TVA 2005	**Cost Study #4** USWAG/EOP 2009	Implied Range
1. Capital cost:					
1a. Present value (PV) =	$2,187 to $4,488	$6,810	$22,984	$33,400	$2,187 to $33,400
1b. Annualized equivalent* =	$158 to $325	$494	$1,665	$2,420	$158 to $2,420
2. Average annual O&M cost	$115 to $141	-$389 savings	$11	$278	-$389 savings to $278
3. Total annualized cost (1b+2)	$273 to $466	$105	**$1,676** **(PV** = $23,137)**	$2,698	$105 to $2,698
Row 3 implied uncertainty range compared to estimate based on 2005 TVA study =					**-94% to +61%**
Notes: * Annualized over a 50-year period @7% discount rate. ** Present value computed by multiplying the annualized value by a 13.801 present value multiplier, which represents 7% discount over 50-years.					

- **Update of Cost Estimate for Converting from Wet to Dry CCR Disposal**
  - **Purpose of Dry Conversion Cost Estimate Update**

The purpose of this section is to update the initial estimate above in this RIA, of the cost of converting CCR disposal impoundments to dry disposal (i.e., landfills). The initial **$23.137 billion** estimate (present value discounted at 7% over 50-years) presented in above in this section of the RIA is based on the 2005 universe of 158 coal-fired electric utility plants (classified in NAICS code 22) with active CCR impoundments addressed in EPA's October 2009 draft RIA for the proposed rule. **Exhibit 4F** below provides a summary of this initial cost estimate.[97] As of February 2010, the 2005 universe is the latest available data from the U.S. Department of Energy's Energy Information Administration (EIA) Form 767 database, because the EIA temporarily suspended its electric utility industry data collection survey questionnaire to revise it.

[97] EPA's 2009 draft RIA cost estimate was based on an extrapolation of a cost estimate developed in 2005 by the Tennessee Valley Authority (TVA) for converting its Kingston TN coal-fired electric plant to dry disposal of fly ash and bottom ash. In the RIA, EPA (a) unitized TVA's cost estimate on a cost-per-ton basis for both the capital cost and annual O&M cost components, and then (b) extrapolated the unit costs to the 2005 national universe of 22.4 million tons wet disposed CCR associated with the 158 electric utility plants with active CCR impoundments as of 2005. **Exhibit 4F** below displays how the draft RIA timed the capital and O&M costs over the 50-year period of analysis applied in the RIA (2012 to 2061), and the result of discounting the 50-year cost stream at a 7% annual rate.

Exhibit 4F

PROPOSED RULE OCT 2009 RIA "OPTION 1" (RCRA Subtile C 3004x)				
All Impoundments Must Convert to Dry Ash System in 5-Years				
Capital cost for conversion to dry (non-discounted lump-sum) =				$22,984,000,000
Added annual O&M for dry compared to wet (non-discounted) =				$15,800,000
			A	B
	Row	Year	Count of existing electric utility plants with impoundments	5-Year phase-out 08 Oct 2009 draft RIA simple estimate if lump-sum capital cost in 1st year of final rule
	1	**2012**	158	$22,984,000,000
	2	2013	158	$0
	3	2014	158	$0
	4	2015	158	$0
	5	2016	158	$0
	6	2017	158	$15,800,000
	7	2018	158	$15,800,000
	8	2019	158	$15,800,000
	9	2020	158	$15,800,000
	10	2021	158	$15,800,000
	11	2022	158	$15,800,000
	12	2023	158	$15,800,000
	13	2024	158	$15,800,000
	14	2025	158	$15,800,000
	15	2026	158	$15,800,000
	16	2027	158	$15,800,000
	17	2028	158	$15,800,000
	18	2029	158	$15,800,000
	19	2030	158	$15,800,000
	20	2031	158	$15,800,000
	21	2032	158	$15,800,000
	22	2033	158	$15,800,000
	23	2034	158	$15,800,000
	24	2035	158	$15,800,000
	25	2036	158	$15,800,000
	26	2037	158	$15,800,000
	27	2038	158	$15,800,000
	28	2039	158	$15,800,000
	29	2040	158	$15,800,000
	30	2041	158	$15,800,000
	31	2042	158	$15,800,000
	32	2043	158	$15,800,000
	33	2044	158	$15,800,000
	34	2045	158	$15,800,000
	35	2046	158	$15,800,000
	36	2047	158	$15,800,000
	37	2048	158	$15,800,000
	38	2049	158	$15,800,000
	39	2050	158	$15,800,000
	40	2051	158	$22,984,000,000
	41	2052	158	$15,800,000
	42	2053	158	$15,800,000
	43	2054	158	$15,800,000
	44	2055	158	$15,800,000
	45	2056	158	$15,800,000
	46	2057	158	$15,800,000
	47	2058	158	$15,800,000
	48	2059	158	$15,800,000
	49	2060	158	$15,800,000
	50	2061	158	$15,800,000
Non-discounted total cost =				$46,663,000,000
Non-discounted average cost =				$933,000,000
Present value cost (@ 7% disc.rate) =				**$23,167,000,000**
Average annualized cost (@ 7% disc.rate) =				**$1,679,000,000**
Discount rate =		**7%**		
nnual engineering + ancillary costs for RIA "Option 1" Subtitle C =				$595,000,000
Total annualized cost for RIA "Option 1" Subtitle C =				**$2,274,000,000**
		Present value cost (@ 7% disc.rate) =		**$31,383,000,000**

PROPOSED RULE OCT 2009 RIA "OPTION 1" (RCRA Subtile C 3004x)				
All Impoundments Must Convert to Dry Ash System in 5-Years				
Capital cost for conversion to dry (non-discounted lump-sum) =				$22,984,000,000
Added annual O&M for dry compared to wet (non-discounted) =				$15,800,000
			A	B
	Row	Year	Count of existing electric utility plants with impoundments	5-Year phase-out 08 Oct 2009 draft RIA simple estimate if lump-sum capital cost in 1st year of final rule
	1	**2012**	158	$22,984,000,000
	2	2013	158	$0
	3	2014	158	$0
	4	2015	158	$0
	5	2016	158	$0
	6	2017	158	$15,800,000
	7	2018	158	$15,800,000
	8	2019	158	$15,800,000
	9	2020	158	$15,800,000
	10	2021	158	$15,800,000
	11	2022	158	$15,800,000
	12	2023	158	$15,800,000
	13	2024	158	$15,800,000
	14	2025	158	$15,800,000
	15	2026	158	$15,800,000
	16	2027	158	$15,800,000
	17	2028	158	$15,800,000
	18	2029	158	$15,800,000
	19	2030	158	$15,800,000
	20	2031	158	$15,800,000
	21	2032	158	$15,800,000
	22	2033	158	$15,800,000
	23	2034	158	$15,800,000
	24	2035	158	$15,800,000
	25	2036	158	$15,800,000
	26	2037	158	$15,800,000
	27	2038	158	$15,800,000
	28	2039	158	$15,800,000
	29	2040	158	$15,800,000
	30	2041	158	$15,800,000
	31	2042	158	$15,800,000
	32	2043	158	$15,800,000
	33	2044	158	$15,800,000
	34	2045	158	$15,800,000
	35	2046	158	$15,800,000
	36	2047	158	$15,800,000
	37	2048	158	$15,800,000
	38	2049	158	$15,800,000
	39	2050	158	$15,800,000
	40	2051	158	$22,984,000,000
	41	2052	158	$15,800,000
	42	2053	158	$15,800,000
	43	2054	158	$15,800,000
	44	2055	158	$15,800,000
	45	2056	158	$15,800,000
	46	2057	158	$15,800,000
	47	2058	158	$15,800,000
	48	2059	158	$15,800,000
	49	2060	158	$15,800,000
	50	2061	158	$15,800,000
Non-discounted total cost =				$46,663,000,000
Non-discounted average cost =				$933,000,000
Present value cost (@ 7% disc.rate) =				**$23,167,000,000**
Average annualized cost (@ 7% disc.rate) =				**$1,679,000,000**
Discount rate =		**7%**		
nnual engineering + ancillary costs for RIA "Option 1" Subtitle C =				$595,000,000
Total annualized cost for RIA "Option 1" Subtitle C =				**$2,274,000,000**
		Present value cost (@ 7% disc.rate) =		**$31,383,000,000**

- **Recent Trend in CCR Impoundment Phase-Outs**

Since formulating the initial cost estimate above, EPA obtained new information which indicates that many electric utility plants have already closed or are planning to close CCR impoundments and convert to dry disposal (i.e., landfill disposal and/or sell and transport dry CCR offsite for beneficial use by other industries) for reasons independent of the CCR proposed rule. As displayed below in **Exhibit 4G**, EIA's historical data[98] for the electric utility industry indicate that between 1996 and 2005, the tonnage of CCR disposed in impoundments has decreased by 10% from 25.2 to 22.5 million tons despite total CCR generation at electric utility plants increasing 24% over that same period from 102.0 million tons (1996) to 126.3 million tons (2005). This represents an average annual CCR impoundment **phase-out rate of 1.1% per year**.

	1996	2005	10-year decrease
Tonnage wet disposal	25.188 million	22.537 million	10%
Percentage of generation	25% of CCR	18% of CCR	7%

Exhibit 4G
Documentation of Recent Trend (1996-2005) In Switching From Wet to Dry CCR Disposal in the US Electric Utility Industry

Coal Ash, FGD Waste - EIA Data

Thousand Short Tons

	1996							2005						
	Utility Landfill (Dry)	Utility Disposal Ponds (Wet)	On Site Use and Storage	Sold	Off Site Disposal	Total	%	Utility Landfill (Dry)	Utility Disposal Ponds (Wet)	On Site Use and Storage	Sold	Off Site Disposal	Total	%
Fly Ash	21,450	15,710	2,446	12,091	8,110	59,806	59%	22,557	15,322	4,645	21,211	10,626	74,360	59%
Bottom Ash	5,340	4,973	1,968	4,322	2,537	19,140	19%	6,109	4,374	3,553	5,767	2,177	21,981	17%
Sludge	12,938	3,484	1,011	236	987	18,655	18%	9,592	1,886	467	409	2,507	14,861	12%
Gypsum	502	987	379	1,190	88	3,146	3%	55	872	372	8,513	783	10,595	8%
Other	171	35	0	691	305	1,202	1%	227	83	116	3,749	315	4,490	4%
Total	40,401	25,188	5,804	18,529	12,028	101,950	100%	38,539	22,537	9,153	39,650	16,407	126,286	100%

% Share of Total

	1996							2005						
	Utility Landfill (Dry)	Utility Disposal Ponds (Wet)	On Site Use and Storage	Sold	Off Site Disposal	Total		Utility Landfill (Dry)	Utility Disposal Ponds (Wet)	On Site Use and Storage	Sold	Off Site Disposal	Total	
Fly Ash	36%	26%	4%	20%	14%	100%		30%	21%	6%	29%	14%	100%	
Bottom Ash	28%	26%	10%	23%	13%	100%		28%	20%	16%	26%	10%	100%	
Sludge	69%	19%	5%	1%	5%	100%		65%	13%	3%	3%	17%	100%	
Gypsum	16%	31%	12%	38%	3%	100%		1%	8%	4%	80%	7%	100%	
Other	14%	3%	0%	57%	25%	100%		5%	2%	3%	84%	7%	100%	
Total	40%	25%	6%	18%	12%	100%		31%	18%	7%	31%	13%	100%	

[98] Source: US Department of Energy EIA F767_PLANT database at: http://www.eia.doe.gov/cneaf/electricity/page/eia767.html

One important reason for this change is that dry systems allow plants more flexibility in the type of coal they use as fuel. For example, as plants switched from bituminous to sub-bituminous coal, they also converted to dry fly ash handling systems because the ash from some sub-bituminous coals has cementitious properties that can cause plugging and high maintenance costs for some wet ash disposal systems, thus necessitating dry ash systems. Also, some types of sub-bituminous coal fly ash are in economic demand by the cement industry because of their low carbon content and need to be stored dry for transport. EIA's historical data for coal-fired electric plant fly ash disposal confirms this same trend away from wet disposal to dry disposal (and to beneficial reuse). In 1996, 26% of fly ash was disposed of in ponds (aka "impoundments"). This fly ash disposal method dropped to 21% in 2005.

- **Possible Factors Behind this CCR Dry Disposal Conversion Trend**

In the next few years, there will be a number of factors that may affect the way coal-fired plants in the electric utility industry operate that may further encourage CCR dry disposal rather than wet disposal. Five example factors are:

1. Federal regulations: EPA plans to issue a number of regulations that will affect electric utility plants under the Clean Air Act and the Clean Water Act. For example anticipated Clean Air Act regulations will likely lead to increased use of SO2 controls on existing electric utility plants that will increase the tonnage of flue gas desulfurization (FGD) solids that must be processed (i.e., beneficially used or disposed) and is some cases add calcium derivatives to the existing fly ash (through use of dry scrubbers). While the incremental costs of handling such additional materials are site specific, there are a number of factors that are likely to drive electric utility companies to give more consideration to dry CCR disposal. While wet disposal was common on earlier generations of wet scrubbers, in recent cases, some electric utility companies have focused much more strongly on options to reduce costs by finding beneficial uses for CCR. Furthermore, given the magnitude of the upcoming projects and growing public interest in how CCR are handled and disposed, expediting approval of the project may also drive towards consideration of dry disposal methods.
2. State regulations: A number of state governments are considering programs that may affect their respective state-wide economic demand for electricity.
3. Technology: New technologies for generation, transmission, and use of electricity are being introduced into the market.
4. Fuel cost: Spot markets for coal make it easy for plants to fuel switch or mix coal fuel types. This means, among other things that wet CCR disposal systems, because they limit the types of coal that these plants can use, are likely to be further reduced.
5. Plant property: As land availability constraints becomes more important to electric utility plants (e.g., some electric utility plants are located in riparian settings), on-site wet disposal areas become less important in favor of smaller footprint on-site dry disposal landfills and sending CCR off-site for disposal or beneficial use.

As electric utility companies face this myriad of changes, they are likely to be reconsidering at a very detailed level how they are operating their plants. In fact, this is evident in the fact that some electric utility companies have already announced actual or planned closures of a number of coal-fired electric generator units, while other companies have announced plans to switch some units or plants from coal to other fuels such as natural gas. This consideration of the way electric utility plants will operate is likely to include a reconsideration of how the plants will handle and disposal CCR. Furthermore, since future air pollution regulations are likely to cause more reassessment at electricity plants with older and less efficient air emission particulate control devices and air pollution scrubbers, air regulations themselves are likely to provide further inducement to reconsider CCR disposal practices at plants that are currently using wet disposal. These actions in the near future also mean that the market and regulatory environment in which these plants operate will continue to be in flux and the ability to operate in a way that will make them able to respond quickly to changes will be important.

Corroborating continuation of this historical phase-out trend are recent (2009) announcements by five electric utility companies (i.e., Tennessee Valley Authority (TVA), Duke Energy Company, Hoosier Energy REC Inc, Vectren Southern Indiana Gas & Electric Company, and Westar Energy Company)[99] that they plan to convert all or a significant portion of their CCR impoundments to dry management within the next 10 years corroborates continuation of this recent impoundment phase-out trend. These 18 plants alone comprise 17% of the annual 22.4 million tons CCR disposed annually in impoundments (as of 2005). In addition, three companies have announced planned coal-fired electricity plant closures or planned switching from coal to other fuels. These three plants comprise 3% of the annual CCR impoundment disposal tonnage. See **Exhibit 4H** below for a list of these companies, their plant names, and associated CCR impoundment disposal annual tonnages. Future developments in the electric utility industry, including compliance with upcoming Clean Air Act and Clean Water Act regulations under development at EPA, will increase the dry disposal conversion trend. It is inappropriate to assign the costs of these conversions to the CCR proposed rule, because they would happen anyway, in absence of the rule.

[99] TVA's 20 August 2009 news release "TVA Coal Combustion Products Remediation Plan Proposed" announced that TVA plans "to convert all TVA wet ash and gypsum storage to dry…over eight to 10 years." . Recent plans to convert from wet CCR impoundment disposal to dry landfill disposal for electric utility plants operated by the Duke Energy Company, the Hoosier Electric Cooperative, and Vectren Southern Indiana Gas & Electric Company were reported 24 October 2009 by Mark Wilson of the Courier Press "Coal Ash Disposal Varies From Company to Company" at http://btop.courierpress.com/news/2009/oct/24/coal-ash-disposal-varies-from-company-to-company/?print=1
Westar Energy apparently converted to dry fly ash management by December 2006 according to "Coal Plant O&M: Retrofit Flyash-Handling System Pays Dividends," Douglas J. Smith, Contributing Editor, Coal Power magazine, 01 Nov 2007: http://www.coalpowermag.com/transportation/Coal-Plant-O-and-M-Retrofit-Flyash-Handling-System-Pays-Dividends_79.html

Exhibit 4H
Lists of Coal-Fired Electric Utility Plants With Active CCR Impoundments (as of 2005)
Which are Either Voluntarily Planning to Convert to Dry Disposal
or Voluntarily Planning to Close or Switch Away from Coal to Another Fuel Source (e.g., Natural Gas)

Plants With CCR Impoundments Soon Converting to Dry Disposal*				Coal-Fired Electric Utility Plants Closing or Switching Away From Coal Fuel with CCR Impoundments**			
A Company Name	B Plant Name	C State	D 2005 CCR Pond Tons (1,000s)***	E Company Name	F Plant Name	G State	H 2005 CCR Pond Tons (1,000s)***
1. PSI Energy Inc (Duke Energy)	Cayuga	IN	210.9	1. Progress Energy	Cape Fear	NC	101.3
2. PSI Energy Inc (Duke Energy)	Edwardsport	IN	11.5	2. Progress Energy	Lee	NC	106.1
3. PSI Energy Inc (Duke Energy)	R Gallagher	IN	125.6	3. Progress Energy	L V Sutton	NC	166.0
4. PSI Energy Inc (Duke Energy)	Wabash River	IN	192.1	4. Progress Energy	W H Weatherspoon	NC	47.0
5. PSI Energy Inc (Duke Energy)	Gibson	IN	897.8	5. Duke Energy Company	Buck	NC	121.9
6. Tennessee Valley Authority	Colbert	TN	29.2	6. Duke Energy Company	Dan River	NC	28.5
7. Tennessee Valley Authority	Widows Creek	TN	852.8	7. Northern States (Xcel Energy)	High Bridge	MN	0.01
8. Tennessee Valley Authority	Paradise	TN	517.9	8. Northern States (Xcel Energy)	Riverside	MN	6.7
9. Tennessee Valley Authority	Shawnee	TN	61.1				
10. Tennessee Valley Authority	Bull Run	TN	22.4				
11. Tennessee Valley Authority	Gallatin	TN	180.5				
12. Tennessee Valley Authority	John Sevier	TN	10.0				
13. Tennessee Valley Authority	Johnsonville	TN	53.7				
14. Tennessee Valley Authority	Kingston	TN	325.9				
15. Southern Indiana Gas & Electric Company (Vectren)	F B Culley	IN	35.6				
16. Southern Indiana Gas & Electric Company (Vectren)	A B Brown	IN	165.8				
17. Hoosier Energy R E C Inc	Frank E Ratts	IN	39.8				
18. Westar Energy	Jeffrey Energy Center	KS	184.1				
Subtotal impoundment tons for 18 plants listed above =			3,916.7	Subtotal for 8 plants listed above =			577.51
% of 22.4 million tons 2005 wet disposal tonnage by 158 plants =			**17%**	% of 22.4 million tons 2005 wet disposal tonnage by 158 plants =			**3%**

Notes:
* EPA-ORCR identified the 18 plants with recent plans to convert from wet to dry CCR landfill disposal for electric utility plants operated by the Duke Energy Company, the Vectren Company, and the Hoosier Electric Cooperative, from the 24 October 2009 news report by Mark Wilson of the Courier Press "Coal Ash Disposal Varies From Company to Company." . The Westar Energy plant was identified by an EPA-ORCR staff person based on knowledge of that specific plant or company.
** EPA identified the 8 plants switching from coal from SourceWatch websites: http://www.sourcewatch.org/index.php?title=Coal_plant_conversion_projects and http://www.sourcewatch.org/index.php?title=Existing_U.S._Coal_Plants
*** Source: Based on the 2005 DOE-EIA data.

- **Result of Dry Conversion Cost Update**

The result of this dry conversion cost update is displayed below in comparison to the initial conversion cost estimate. The adjusted cost incorporates the **average annual 1.1% decrease** in CCR impoundment disposal tonnage calculated based on the 1996-2005 EIA data trend as presented in **Exhibit 4G** above, relative to the 2005 base year impoundment disposal tonnage of 22.4 million tons over the same 50-year period (i.e., 2012 to 2061) applied in the RIA. This adjustment provides a declining future CCR impoundment tonnage trend which would be impacted by the CCR proposed rule when it is implemented, rather than simply assigning to the rule a dry conversion cost for the entire 2005 impoundment tonnage (i.e., 22.4 million tons) as was done in the initial cost estimate. The cost adjustment using this trend involved two steps:

> <u>Step 1</u>: Assign a dry conversion cost to the extrapolation phase-out trend (i.e., 2006 to 2061) representing what the electric utility industry could be expected to incur in the future in absence of the CCR rule. The results of this 1st step are displayed in columns A1 to A4 of **Exhibit 4I** below.
>
> <u>Step 2</u>: Re-estimate the phase-out cost under this same industry trend but by adding the requirement under the CCR rule that all remaining CCR impoundment tonnage that is not projected to be voluntarily phased-out within 5-years of the final rule's adoption must be phased-out. This step incorporates three assumptions: (a) EPA promulgates the final rule at the start of 2012, (b) state governments adopt the final rule 2-years later at end of 2013, and (c) the final rule allows a 5-year phase-out period which spans 2014 to 2018. The results of this 2nd step are displayed in columns B1 to B4 of **Exhibit 4I** below.

Exhibit 4I

Adjustment of Dry Conversion Cost Estimate to Account for Utility Industry's Voluntary Impoundment Phase-Out Trend										
			A1	A2	A3	A4	B1	B2	B3	B4
			A. Cost of Dry Conversion Trend Without CCR Rule				B. Dry Conversion Cost if Mandated by CCR Rule			
Projected trendline year count	RIA 50-year period of analysis	End of year	Regression trendline wet disposal phaseout (million tons/year)	Year-by-year incremental conversion to dry (million tons/year)	Incremental added cost year-by-year ---- regression trendline dry conversion cost projection without CCR rule	Regression trendline dry conversion cumulative cost without CCR rule	Mandatory wet phaseout within 5-years of rule	Mandatory year-by-year incremental conversion to dry (million tons/year)	Incremental added cost year-by-year ---- mandatory dry conversion cost projection with CCR rule	Mandatory dry conversion cumulative cost with CCR rule
1		**2005**	**22.5**	**Base year**	**Base year**	**Base year**	**22.5**	**Base year**	**Base year**	**Base year**
2		2006	22.2	0.3	$22,122,377	$22,122,377	22.2	0.3	$22,122,377	$22,122,377
3		2007	21.9	0.3	$22,122,377	$44,244,754	21.9	0.3	$22,122,377	$44,244,754
4		2008	21.7	0.3	$22,122,377	$66,367,131	21.7	0.3	$22,122,377	$66,367,131
5		2009	21.4	0.3	$22,122,377	$88,489,508	21.4	0.3	$22,122,377	$88,489,508
6		2010	21.1	0.3	$22,122,377	$110,611,885	21.1	0.3	$22,122,377	$110,611,885
7		2011	20.8	0.3	$22,122,377	$132,734,262	20.8	0.3	$22,122,377	$132,734,262
8	1	**2012**	20.5	0.3	$22,122,377	$154,856,640	20.5	0.3	$22,122,377	$154,856,640
9	2	2013	20.2	0.3	$22,122,377	$176,979,017	20.2	0.3	$22,122,377	$176,979,017
10	3	2014	19.9	0.3	$22,122,377	$199,101,394	19.9	4.0	$298,704,663	$475,683,680
11	4	2015	19.6	0.3	$22,122,377	$221,223,771	19.6	4.0	$298,704,663	$774,388,344
12	5	2016	19.3	0.3	$22,122,377	$243,346,148	19.3	4.0	$298,704,663	$1,073,093,007
13	6	2017	19.0	0.3	$22,122,377	$265,468,525	19.0	4.0	$298,704,663	$1,371,797,671
14	7	2018	18.7	0.3	$22,122,377	$287,590,902	18.7	4.0	$298,704,663	$1,670,502,334
15	8	**2019**	**18.4**	0.3	$22,122,377	$309,713,279	0	0	$0	$1,670,502,334
16	9	2020	18.1	0.3	$22,122,377	$331,835,656	0	0	$0	$1,670,502,334
17	10	2021	17.8	0.3	$22,122,377	$353,958,033	0	0	$0	$1,670,502,334
18	11	2022	17.5	0.3	$22,122,377	$376,080,410	0	0	$0	$1,670,502,334
19	12	2023	17.2	0.3	$22,122,377	$398,202,787	0	0	$0	$1,670,502,334
20	13	2024	16.9	0.3	$22,122,377	$420,325,164	0	0	$0	$1,670,502,334
21	14	2025	16.6	0.3	$22,122,377	$442,447,541	0	0	$0	$1,670,502,334
22	15	2026	16.4	0.3	$22,122,377	$464,569,919	0	0	$0	$1,670,502,334
23	16	2027	16.1	0.3	$22,122,377	$486,692,296	0	0	$0	$1,670,502,334
24	17	2028	15.8	0.3	$22,122,377	$508,814,673	0	0	$0	$1,670,502,334
25	18	2029	15.5	0.3	$22,122,377	$530,937,050	0	0	$0	$1,670,502,334
26	19	2030	15.2	0.3	$22,122,377	$553,059,427	0	0	$0	$1,670,502,334
27	20	2031	14.9	0.3	$22,122,377	$575,181,804	0	0	$0	$1,670,502,334
28	21	2032	14.6	0.3	$22,122,377	$597,304,181	0	0	$0	$1,670,502,334
29	22	2033	14.3	0.3	$22,122,377	$619,426,558	0	0	$0	$1,670,502,334
30	23	2034	14.0	0.3	$22,122,377	$641,548,935	0	0	$0	$1,670,502,334
31	24	2035	13.7	0.3	$22,122,377	$663,671,312	0	0	$0	$1,670,502,334
32	25	2036	13.4	0.3	$22,122,377	$685,793,689	0	0	$0	$1,670,502,334
33	26	2037	13.1	0.3	$22,122,377	$707,916,066	0	0	$0	$1,670,502,334
34	27	2038	12.8	0.3	$22,122,377	$730,038,443	0	0	$0	$1,670,502,334
35	28	2039	12.5	0.3	$22,122,377	$752,160,821	0	0	$0	$1,670,502,334
36	29	2040	12.2	0.3	$22,122,377	$774,283,198	0	0	$0	$1,670,502,334
37	30	2041	11.9	0.3	$22,122,377	$796,405,575	0	0	$0	$1,670,502,334
38	31	2042	11.6	0.3	$22,122,377	$818,527,952	0	0	$0	$1,670,502,334
39	32	2043	11.3	0.3	$22,122,377	$840,650,329	0	0	$0	$1,670,502,334
40	33	2044	11.0	0.3	$22,122,377	$862,772,706	0	0	$0	$1,670,502,334
41	34	2045	10.8	0.3	$22,122,377	$884,895,083	0	0	$0	$1,670,502,334
42	35	2046	10.5	0.3	$22,122,377	$907,017,460	0	0	$0	$1,670,502,334
43	36	2047	10.2	0.3	$22,122,377	$929,139,837	0	0	$0	$1,670,502,334
44	37	2048	9.9	0.3	$22,122,377	$951,262,214	0	0	$0	$1,670,502,334
45	38	2049	9.6	0.3	$22,122,377	$973,384,591	0	0	$0	$1,670,502,334
46	39	2050	9.3	0.3	$22,122,377	$995,506,968	0	0	$0	$1,670,502,334
47	40	2051	9.0	0.3	$22,122,377	$1,017,629,345	0	0	$0	$1,670,502,334
48	41	2052	8.7	0.3	$22,122,377	$1,039,751,722	0	0	$0	$1,670,502,334
49	42	2053	8.4	0.3	$22,122,377	$1,061,874,100	0	0	$0	$1,670,502,334
50	43	2054	8.1	0.3	$22,122,377	$1,083,996,477	0	0	$0	$1,670,502,334
51	44	2055	7.8	0.3	$22,122,377	$1,106,118,854	0	0	$0	$1,670,502,334
52	45	2056	7.5	0.3	$22,122,377	$1,128,241,231	0	0	$0	$1,670,502,334
53	46	2057	7.2	0.3	$22,122,377	$1,150,363,608	0	0	$0	$1,670,502,334
54	47	2058	6.9	0.3	$22,122,377	$1,172,485,985	0	0	$0	$1,670,502,334
55	48	2059	6.6	0.3	$22,122,377	$1,194,608,362	0	0	$0	$1,670,502,334
56	49	2060	6.3	0.3	$22,122,377	$1,216,730,739	0	0	$0	$1,670,502,334
57	50	2061	6.0	0.3	$22,122,377	$1,238,853,116	0	0	$0	$1,670,502,334
Summary Relative to 2005			Column total =	16.5	$1,238,853,116	$35,307,313,810		22.2	$1,670,502,334	$77,993,470,971
(56 years after base year)			Average annual =			$630,487,747				$1,392,740,553
			Present value (PV) =			$4,321,186,852				$12,375,281,254
			Annualized PV value =			$309,483,860				$886,318,954
Summary Relative to 2010			Column total =	15.3	$1,150,363,608	$35,086,090,039		21.1	$1,582,012,826	$77,772,247,201
(52 years after update)			Average annual =			$674,732,501				$1,495,620,138
			Present value (PV) =			$5,426,935,463				$15,984,210,270
			Annualized PV value =			$391,493,777				$1,153,085,179
Summary Relative to 2012			Column total =	14.7	$1,106,118,854	$34,842,743,891		20.5	$1,537,768,072	$77,528,901,053
(50 years same as RIA)			Average annual =			$696,854,878				$1,550,578,021
			Present value (PV) =			**$5,962,000,000**				**$18,049,000,000**
			Annualized PV value =			$432,005,623				$1,307,827,824
Discount rate =		7%	**Added Cost for Conversion to Dry Disposal Under the CCR Proposed Rule Compared to Conversion Trend Without Rule:**							
									Present value (PV) =	**$12,087,000,000**
									Annualized PV value =	$875,822,201
					Percent reduction compared to October 2009 draft RIA dry conversion cost estimate:					
									October 2009 draft RIA cost estimate =	$23,200,000,000
									Reduction in cost estimate compared to RIA =	**-48%**

As summarized below in comparison to the initial cost estimate, the updated conversion cost is the difference in the step-1 cost to the electric utility industry for continuation of the phase-out trend without the CCR rule, compared to the step-2 cost for mandatory phase-out with the rule.

Dry conversion cost:	Initial cost estimate	Updated cost estimate	
Average annualized cost	$1.676 billion/year	$0.876 billion/year	(48% reduction)
Present value (PV) cost	$23.2 billion PV	$12.1 billion PV	(48% reduction)

The updated cost is also presented below after integrating the updated dry conversion cost back into the overall cost of the CCR proposed rule which contains two other cost categories as estimated for the Subtitle C option (i.e., $491 million/year for engineering control costs + $107 million/year for ancillary regulatory costs).

Rule total cost: (i.e., updated dry conversion cost + engineering control cost + ancillary cost)

	Initial cost estimate	Updated estimate	
Average annualized cost	$2.27 billion/year	$1.47 billion/year	(35% reduction)
Present value (PV) cost	$31.4 billion PV	$20.3 billion PV	(35% reduction)

As shown above, the composite effect of the two cost update factors is they reduce the initial dry conversion cost estimate by **48%**, and reduce by **35%** the overall compliance cost estimate (i.e., dry conversion cost plus engineering control costs plus ancillary costs).

- **Factors Which May Accelerate the CCR Impoundment Phase-Out Trend**

For the reasons described above, it is clear that there is a significant past and continuing trend toward CCR impoundment phase-out at electric utility plants, regardless of the CCR rule, and that this trend will continue. Described below, EPA has identified **seven factors** which corroborate continuation of this impoundment phase-out trend, some of which have been quantified in the cost adjustment:

1. Industry conversions to dry CCR disposal: This factor corroborates the phase-out trend applied in the cost update. As discussed above, there is a documented over **two-decade long trend 1996 to 2019** away from wet CCR disposal in the electric utility industry. This trend consists of two parts: (a) the 1996-2005 historical data period, plus (b) the more recent (2009) announcements of actual conversions which occurred between 2005 and 2009, and planned conversions to occur within the next 10 years (i.e., by 2019). According to one company (United Conveyor Corporation) who has been supplying dry disposal equipment and conversion services to the electric utility industry, the main historical drivers for this voluntary shift have been (1) generating dry fly ash as a saleable co-product to other industries for beneficial uses, and (2) decreasing the volume of fly ash going to impoundments to provide greater capacity for bottom ash. Since then, concern over possible future environmental release liabilities associated with CCR impoundments, and pressure from individual state governments, has led electric utility companies to consider dry conversion. TVA is the most prominent example of this trend which publicly announced[100] in 2009 it plans to convert its wet fly ash and wet bottom ash systems to

[100] TVA's 20 August 2009 news release is at http://www.tva.gov/news/releases/julsep09/ccprp_other.htm

dry disposal within the next eight to 10 years (i.e. by 2019). Conversions of this sort are a current trend, and they will definitely continue, even in the absence of the CCR proposed rule. As summarized in **Exhibit 4H** above (columns A to D), EPA identified 18 such plants constituting **17%** of the industry-wide wet CCR disposal tonnage as of 2005. It is inappropriate to attribute the wet disposal phase-out cost of the CCR proposed rule to plants independently moving to dry CCR disposal. At this point, EPA expects that most plants will choose to move to dry disposal given the additional factors presented below.

2. Plants switching to other fuels: EPA assumes this factor is reflected in the phase-out trend applied to the cost update. Some coal-fired electricity plants have since 2005 switched, or are planning to switch, some or all of their coal-fired boilers at certain plants, from coal to other fuels (e.g. natural gas) for reasons unrelated to the CCR proposed rule. In such cases, the cost of closure of their CCR disposal impoundments should not be attributed to the cost of the proposed rule. This factor decreases the estimated cost of the rule, and particularly EPA's estimated future cost of phasing-out wet disposal attributable to the proposed rule. For example, based on EPA's recent internet search, as also displayed in **Exhibit 4H** above (columns E to H), EPA identified 8 coal-fired electric utility plants using impoundments (as of 2005) representing **3%** of wet CCR disposal by the 158 plants, which have or plan to switch fuels at one or more of their coal-fired electricity generation boilers within one or more plants, or to close one or more of their coal-fired boilers or entire coal-fired plants.

3. Lifespan expiration of existing CCR impoundments: This factor suggests a faster future phase-out trend than applied in the cost update, but is not applied in the cost update. Another factor which corroborates the future continuation of the electric utility industry's voluntary phase-out of CCR impoundments, is the fact that existing (i.e., active, operational) CCR impoundments have distinct operational lifespans. When an impoundment reaches its end-of-lifespan, the electric utility plant must in that future year either add new impoundment capacity by installing another impoundment, or convert to dry disposal by installing a landfill (or providing their annual CCR for beneficial uses). For purpose of estimating the "engineering cost" component (in **Chapter 4** of this RIA), EPA assigned impoundment lifespan start years (i.e., year in which impoundment construction was completed and began receiving CCR), and future expected impoundment operational lifespan closure years, to each of the 158 coal-fired plants with operational CCR impoundments (as of 2005) identified in this RIA. For the most part, the impoundment start years were based on actual industry-reported data from the references cited in this RIA. However, expected closure years were provided by industry for 78 of the 158 plants; thus, EPA assigned expected closure years to the remainder 80 plants assuming a 40-year lifespan. **Exhibit 4J** below presents a summary of the expected future closure years in relation to the remaining lifespan years and associated impoundment tonnages which are expected to reach end of operational lifespan in absence of the CCR rule. This summary indicates that all existing CCR impoundments could be expected to reach end-of-lifespan by year 2051, and that **20%** of impoundments will have reached end-of-lifespan by year 2018. According to the cost update assumptions discussed in the 2nd update steps of prior section above, year 2018 represents the 5th year of the CCR final rule's assumed 5-year phase-out period spanning 2014 to 2018, which also assumes the CCR final rule is promulgated by EPA at the start of 2012 and that state governments will adopt the rule 2-years later by the end of 2013. This lifespan expiration trend corroborates the assumed continuation of the phase-out trend depicted in **Exhibit 4I** (column A1) which indicates that **17%** of CCR impoundment tonnage may be expected to have phased-out by year 2018 (i.e., 18.7 million tons remaining by 2018 compared to 22.5 million tons in the analysis base year 2005) in absence of the CCR rule. In fact, given that end-of-lifespan provides companies with a low-cost opportunity to convert to dry disposal, the higher 20% end-of-lifespan percentage compared to the

17% phase-out trend suggest the future phase-out trend may be accelerated compared to the 1.1% annual phase-out assumed based on the 1996-2005 trend. For example, this result suggests that by 2018 the annual phase-out rate in that year could be **1.3%** (i.e., (20%/17%) x 1.1%)).

4. EPA's Clean Air Act emissions standards: This factor is not quantified in the cost update. Where existing coal-fired electric utility plants put in new air emission scrubbing systems, EPA believes they will overwhelmingly rely on CCR management systems that do not require wet disposal impoundments. Two of EPA's upcoming Clean Air Act (CAA) air pollution regulations may lead some coal plants to begin using large amounts of reagent to capture SO2 from boiler flue gas:

- EPA's Clean Air Mercury Rule (CAMR) which was vacated by the DC Circuit Court in 2007 compels EPA under the CAA Section 112 to issue maximum achievable control technology (MACT) regulations for coal- and oil-fired electric utility units: http://www.epa.gov/ttn/atw/utility/utilitypg.html
- EPA's remanded Clean Air Interstate Rule (CAIR) was also vacated by the DC Circuit Court in 2007 but was later reinstated and remanded back to the Agency for further review/clarification: http://www.epa.gov/cair

Such plants would likely experience a significant increase in the amount of fly ash or wet FGD waste tonnage to be disposed, because the reactants are either captured with the fly ash or with the wet FGD waste. If these plants currently dispose of bottom ash, fly ash, or wet FGD waste in wet impoundments, the likelihood of significantly increased future disposal tonnages may prompt them to consider a switch to dry disposal. Therefore, new CCR generated as a result of new Clean Air Act emissions requirements are very likely to cause plants to switch away from wet disposal independent from the CCR proposed rule. EPA has not quantified this factor for purpose of updating the 2009 RIA regulatory cost estimate in this RIA.

5. EPA's Clean Water Act effluent standards: This factor is not quantified in the cost update. EPA is currently developing new industrial wastewater effluent regulations for coal-fired electricity plants. These new regulations are likely to tighten significantly existing effluent limits. These new regulations will be one more factor likely to influence plants to switch to dry disposal systems.

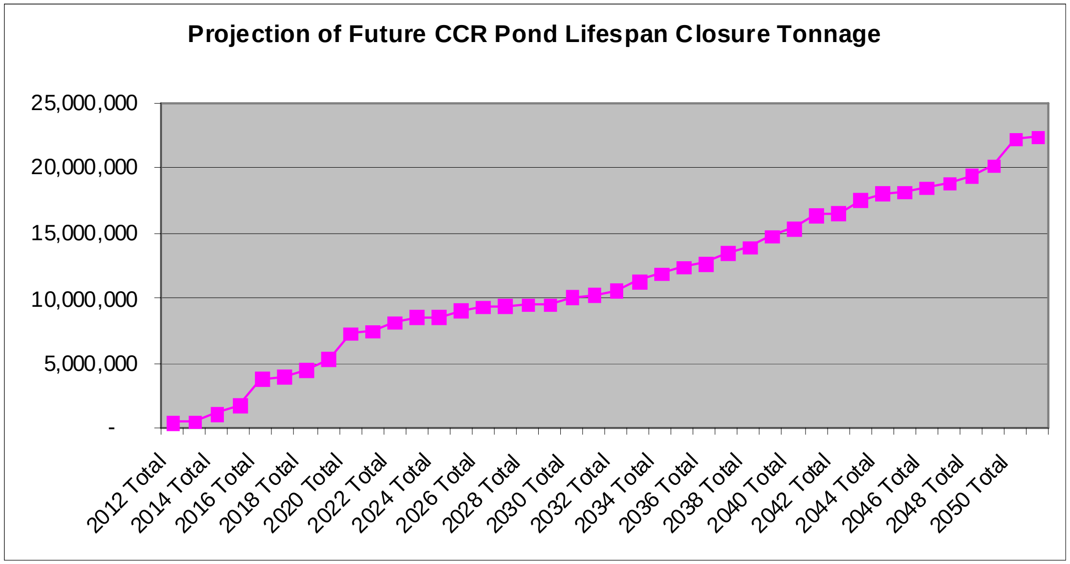
6. State government implementation of rule: This factor is quantified in the cost update. It recognizes that states require two years for their state legislatures or environmental regulatory programs to adopt new RCRA regulations such as the CCR final rule, which is necessary for the rule to become federally enforceable. In the initial cost estimate, EPA assumed that the CCR final rule would become effective (i.e., adopted by states) in year 2012 and that dry conversion capital costs would all be incurred in that single year. In contrast to that simple cost estimation framework, this cost update factor pushes the dry conversion cost 2-years out into the future beginning in 2014. The 5-year allowed dry conversion (i.e., impoundment phase-out) period is thus 2014 to 2018. In reality, there is a further distinction to be made. For states which operate EPA-authorized RCRA regulatory programs (as of 2005, EPA-authorized states comprise 97% of the 22.4 million tons annual CCR impoundment disposal tonnage), they could have 2-years adoption period. However, in non-authorized states (i.e., AK, IA), territories, and Indian country, the CCR rule becomes effective in 2012 by fact that EPA will implement it directly. According to the 2005 EIA data, in this 2nd group there are four plants with impoundments in IA plus one plant with impoundment(s) on tribal land totaling 3% of the 22.4 million tons impoundment disposal in 2005.[101] Because this 2nd group only comprises a very small 3% fraction of the annual CCR impoundment disposal tonnage, and to avoid adding another layer of complexity to the cost update which would only result in a very small (i.e., <5%) difference in updated estimate, the cost update does not separately calculate costs for both groups addressing under this factor, but applies implementation year to the entire 22.4 million tonnage. This 2-year final rule adoption cost-timing adjustment factor is highlighted in **Exhibit 4I** above.

7. 5-year impoundment phase-out period: This factor is quantified in the cost update. It recognizes that electric utility plants are likely to incur dry conversion capital costs spread across each of the years in the CCR rule's 5-year mandated phase-out period, rather than incurring all dry conversion capital cost in one year as was simply assumed in the initial cost estimate. This cost-timing adjustment factor is highlighted in **Exhibit 4I** above.

[101] As of 2005, the four IA plants are the George Neal North plant (50,200 tons/year CCR impoundment disposal), the Lansing plant (24,000 tons/year), the Louisa plant (23,000 tons/year), and the Walter Scott Jr Energy Center plant (104,000 tons/year). The one plant located on tribal land is the Four Corners plant in NM (501,400 tons/year).

Exhibit 4J

RIA 50-year period	Actual company planned or EPA estimated pond closure year	CCR pond end of lifespan (tons/year)	Cumulative pond lifespan end (tons/year)	% pond tonnage phaseout
	2009 Total	0	0	0%
	2010 Total	0	0	0%
	2011 Total	0	0	0%
1	**2012 Total**	481,300	481,300	2.1%
2	2013 Total	40,400	521,700	2.3%
3	2014 Total	634,700	1,156,400	5.2%
4	2015 Total	599,450	1,755,850	7.8%
5	2016 Total	2,021,700	3,777,550	16.9%
6	2017 Total	189,300	3,966,850	17.7%
7	**2018 Total**	513,400	4,480,250	**20%**
8	2019 Total	838,400	5,318,650	23.7%
9	2020 Total	1,969,160	7,287,810	32.5%
10	2021 Total	183,100	7,470,910	33.4%
11	2022 Total	661,700	8,132,610	36.3%
12	2023 Total	410,800	8,543,410	38.1%
13	2024 Total	39,000	8,582,410	38.3%
14	2025 Total	477,700	9,060,110	40.4%
15	2026 Total	280,900	9,341,010	41.7%
16	2027 Total	27,600	9,368,610	41.8%
17	2028 Total	134,000	9,502,610	42.4%
18	2029 Total	36,200	9,538,810	42.6%
19	2030 Total	527,100	10,065,910	44.9%
20	2031 Total	170,350	10,236,260	45.7%
21	2032 Total	327,400	10,563,660	47.2%
22	2033 Total	746,500	11,310,160	50.5%
23	2034 Total	594,100	11,904,260	53.1%
24	2035 Total	473,000	12,377,260	55.3%
25	2036 Total	322,000	12,699,260	56.7%
26	2037 Total	742,800	13,442,060	60.0%
27	2038 Total	476,100	13,918,160	62.1%
28	2039 Total	825,900	14,744,060	65.8%
29	2040 Total	642,050	15,386,110	68.7%
30	2041 Total	1,009,100	16,395,210	73.2%
31	2042 Total	141,600	16,536,810	73.8%
32	2043 Total	992,010	17,528,820	78.3%
33	2044 Total	505,700	18,034,520	80.5%
34	2045 Total	104,400	18,138,920	81.0%
35	2046 Total	338,000	18,476,920	82.5%
36	2047 Total	326,800	18,803,720	83.9%
37	2048 Total	575,800	19,379,520	86.5%
38	2049 Total	788,300	20,167,820	90.0%
39	2050 Total	2,075,700	22,243,520	99.3%
40	2051 Total	121,900	**22,400,000**	100.0%
Column total (2005 base) =		**22,400,000**		



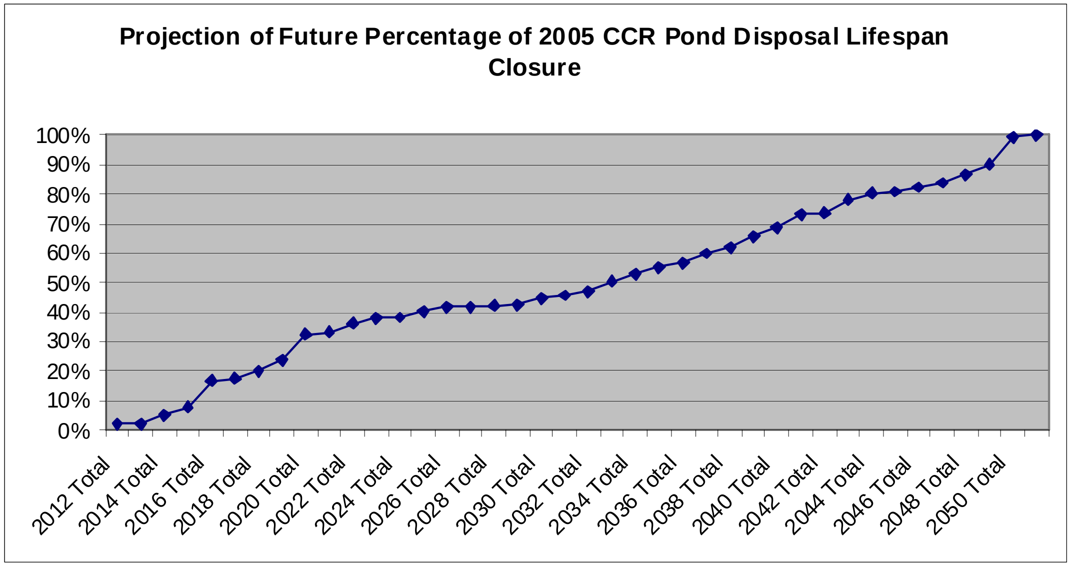


Exhibit 4K below summarizes the above regulatory cost estimates on an incremental basis (i.e., without including the "Baseline Costs" estimated in **Chapter 3** of this RIA). **Appendix J** presents regulatory costs estimates for each of the 495 electric utility plants.

Exhibit 4K
Summary of Cost Estimates for the October 2009 Draft RIA Regulatory Options
($millions in 2009 price level; average annual amortized @7% discount rate over 50-year period 2012 to 2061)

RCRA Regulatory Cost Element	Subtitle C Hazardous waste	Subtitle D (version 1)	Hybrid C&D
A. Engineering Controls (onsite):	**$491**	**$491**	**$491**
1. Groundwater monitoring	$13	$13	$13
2. Bottom liners	$95	$95	$95
3. Leachate collection	$8	$8	$8
4. Fugitive dust controls	$5	$5	$5
5. Water runon/runoff controls	$2	$2	$2
6. Financial assurance	$30	$30	$30
7. Disposal unit location restrictions	$76	$76	$76
8. Closure capping to cover unit	$255	$255	$255
9. Post-closure groundwater monitoring	$2	$2	$2
10. Storage design & operating standards	Not estimated in this RIA	Not estimated in this RIA	Not estimated in this RIA
B. Other Ancillary Costs:	**$107**	**$1**	**$9**
11. For offsite disposal (11a+11b+11c) = 11a. RCRA manifest cost 11b. Added operation for hazmat truck 11c. Offsite LF RCRA Subtitle C permit	$77 $66 $8 $3	$0 Not relevant Not relevant Not relevant	$0 (offsite applies only to LFs so no incremental cost over baseline)
12. Structural integrity inspections	$1	$1	$1
13. RCRA facility-wide investigation	$7.6	Not relevant	$2.4
14. RCRA facility-wide corrective action	Not estimated in this RIA; historical average = $5.4 million per case	Not relevant	Not estimated in this RIA; historical average = $5.4 million per case
15. RCRA TSDF haz waste disposal permit	$7	Not relevant	$2
16. RCRA enforcement inspection	$0.06	$0	$0.02
17. Future added cleanup cost as "hazardous waste"	Not estimated in this RIA: case studies indicate possible $18 to $376 million per case	Not relevant	Not estimated in this RIA; case studies indicate possible $18 to $376 million per case
18. EPA paperwork reporting/recordkeeping	$13	Not relevant	$4
C. Land Disposal Restriction Dewatering Treatment	**$876 (updated)**	**$876 (updated)**	**$876 (updated)**
TOTAL ANNUALIZED COSTS (A+B+C) = Average cost per-ton (94.2 million tons disposed) = Average cost per-plant (467 disposing plants) =	**$1,474 per year (updated)** ($15.65 per ton) ($3.16 million per plant)	**$1,368 per year (updated)** ($14.52 per ton) ($2.93 million per plant)	**$1,376 per year (updated)** ($14.61 per ton) ($2.95 million per plant)

Note: **Chapter 6** of this RIA scales these cost estimates based on the October 2009 draft RIA options, to the 2010 regulatory options.

4C. State-by-State Distribution of Incremental CCR Regulatory Costs

Exhibit 4L below summarizes the distribution of estimated regulatory costs on a state-by-state basis and by option. This state-by-state summary is based on apportionment of nationwide average annualized cost estimated for each regulatory option, according to state-by-state annual CCR tonnage generated by the 495 coal-fired electric utility plants.

Exhibit 4L
State-by-State Distribution of Estimated Incremental Costs for the October 2009 Draft RIA Regulatory Options
($million average annualized cost in 2009$ over 50-year period of analysis 2012 to 2061)

A	B	C	D	E	F	G	H
Item	State	# of coal-fired electricity plants	2005 CCR generation by coal-fired electric utility plants (tons/year)	State % of nationwide CCR generation (based on Column D)	Subtitle C Hazardous waste	Subtitle D (version 1)	Hybrid C&D: Subtitle C impoundments Subtitle D landfills
1	AK	2	46,179	0.03%	$0.4	$0.4	$0.4
2	AL	16	3,210,337	2.27%	$33.5	$31.1	$31.2
3	AR	4	744,267	0.53%	$7.8	$7.3	$7.3
4	AZ	8	3,334,030	2.36%	$34.8	$32.3	$32.5
5	CA	6	159,927	0.11%	$1.6	$1.5	$1.5
6	CO	12	1,704,433	1.21%	$17.8	$16.6	$16.6
7	CT	0	172,280	0.12%	$1.8	$1.6	$1.7
8	DC	0	0	0.00%	$0.0	$0.0	$0.0
9	DE	2	251,205	0.18%	$2.7	$2.5	$2.5
10	FL	15	6,132,345	4.34%	$64.0	$59.4	$59.7
11	GA	13	6,077,700	4.30%	$63.4	$58.9	$59.2
12	HI	1	58,968	0.04%	$0.6	$0.5	$0.6
13	IA	15	1,136,289	0.80%	$11.8	$11.0	$11.0
14	ID	0	0	0.00%	$0.0	$0.0	$0.0
15	IL	17	3,856,748	2.73%	$40.2	$37.4	$37.6
16	IN	33	8,798,845	6.23%	$91.8	$85.3	$85.7
17	KS	8	1,495,099	1.06%	$15.6	$14.5	$14.6
18	KY	31	9,197,567	6.51%	$96.0	$89.1	$89.6
19	LA	3	1,614,800	1.14%	$16.8	$15.6	$15.7
20	MA	0	363,150	0.26%	$3.8	$3.6	$3.6
21	MD	4	1,932,740	1.37%	$20.2	$18.8	$18.9
22	ME	1	48,000	0.03%	$0.4	$0.4	$0.4
23	MI	24	2,369,673	1.68%	$24.8	$23.0	$23.1
24	MN	20	1,525,979	1.08%	$15.9	$14.8	$14.9
25	MO	20	2,679,742	1.90%	$28.0	$26.0	$26.1
26	MS	6	1,229,400	0.87%	$12.8	$11.9	$12.0

Exhibit 4L **State-by-State Distribution of Estimated Incremental Costs for the October 2009 Draft RIA Regulatory Options** ($million average annualized cost in 2009$ over 50-year period of analysis 2012 to 2061)							
A	B	C	D	E	F	G	H
Item	State	# of coal-fired electricity plants	2005 CCR generation by coal-fired electric utility plants (tons/year)	State % of nationwide CCR generation (based on Column D)	Subtitle C Hazardous waste	Subtitle D (version 1)	Hybrid C&D: Subtitle C impoundments Subtitle D landfills
27	MT	5	1,830,624	1.30%	$19.2	$17.8	$17.9
28	NC	27	5,504,531	3.90%	$57.5	$53.4	$53.7
29	ND	9	3,038,100	2.15%	$31.7	$29.4	$29.6
30	NE	6	614,473	0.44%	$6.5	$6.0	$6.1
31	NH	1	176,900	0.13%	$1.9	$1.8	$1.8
32	NJ	2	735,214	0.52%	$7.7	$7.1	$7.2
33	NM	4	3,983,300	2.82%	$41.6	$38.6	$38.8
34	NV	2	391,500	0.28%	$4.1	$3.8	$3.9
35	NY	11	1,479,792	1.05%	$15.5	$14.4	$14.4
36	OH	24	10,429,446	7.39%	$108.9	$101.2	$101.7
37	OK	3	1,490,800	1.06%	$15.6	$14.5	$14.6
38	OR	1	99,900	0.07%	$1.0	$1.0	$1.0
39	PA	28	15,359,680	10.88%	$160.4	$148.9	$149.7
40	RI	0	0	0.00%	$0.0	$0.0	$0.0
41	SC	14	2,178,360	1.54%	$22.7	$21.1	$21.2
42	SD	2	103,753	0.07%	$1.0	$1.0	$1.0
43	TN	12	3,240,120	2.29%	$33.8	$31.4	$31.5
44	TX	18	13,165,728	9.32%	$137.4	$127.6	$128.2
45	UT	7	2,582,144	1.83%	$27.0	$25.1	$25.2
46	VA	13	2,388,526	1.69%	$24.9	$23.1	$23.3
47	VT	0	0	0.00%	$0.0	$0.0	$0.0
48	WA	1	1,405,220	1.00%	$14.7	$13.7	$13.8
49	WI	12	1,412,534	1.00%	$14.7	$13.7	$13.8
50	WV	20	9,231,718	6.54%	$96.4	$89.5	$90.0
51	WY	12	2,224,848	1.58%	$23.3	$21.6	$21.7
	Totals =	**495**	**141.2 million**	100%	**$1,474/year**	**$1,368/year**	**$1,376/year**

4D. Cost Estimation Uncertainty

This section addresses OMB's 2003 Circular A-4 "Regulatory Analysis" guidance (page 40) requirement for RIAs involving rules with expected annual economic effects of $1 billion or more, to present a formal quantitative analysis of the uncertainties about benefit and cost estimates. This section only addresses uncertainties with respect to cost estimates for both baseline cost and incremental costs for the regulatory options. This section first presents **three specific examples** of data quality uncertainty factors in this RIA, followed by an **overall uncertainty factor** to represent all such specific data quality uncertainty factors combined (the three factors below are not additive across their low- and high-end percentage range endpoints because such simple addition would represent unlikely compounding of these factors):

- **Specific Examples of Data Quality Uncertainty Factors in This RIA**

1. CCR tonnage data: The baseline and regulatory cost estimates in this RIA are based on the annual CCR disposal and beneficial use tonnages reported by electric utility plants to the 2005 DOE-EIA Form 767 database. However, the DOE-EIA 767 data reporting form[102] does not provide respondents with a definition for the "tons" collected in Schedule 3 of the data reporting form. Because there are three numerical definitions of "ton" commonly used in the US (i.e., short-ton = 2,000 pounds, long-ton = 2,200 pounds; and metric ton = 2,205 pounds), this factor potentially introduces **-20% to +20%** uncertainty range. For purpose of consistency with the use of short-tons in most EPA RCRA program reports,[103] this RIA interprets CCR "tons" as short-tons.
2. Data sources: Also with respect to CCR tonnage data, this RIA cites multiple possible sources of data based on different published sources. For example, as displayed in **Exhibit 4D** of this RIA, one source (American Coal Ash Association) provides an industry survey-based estimate of CCR generation by electric utility plants in 2005 of 123.1 million tons. Whereas this RIA estimates 141.2 million tons CCR generation in 2005 based on data from the 2005 DOE-EIA Form 767 database for plants >100 MW in size and based on supplemental estimates made in this RIA for <100 MW size plants. This data source inconsistency factor represents **-13% to +15%** uncertainty range.
3. Data years: Information and data used to evaluate and estimate the cost of baseline CCR disposal practices are from various published sources dated 1995, 1996, and 2006. Furthermore, unit costs for CCR disposal unit engineering controls applied in this RIA are from different published data years such as 2000, 2004, and 2007. This RIA updated historical data to 2009 price levels using various indexes, some of which were specific to a particular type of unit cost, and other indexes were general (e.g., GDP Price Deflator). The uncertainty in accuracy of unit costs introduced by use of historical data is **not quantified**.

- **Overall Data Quality Uncertainty Range**

---

[102] Instructions to the 2005 DOE-EIA Form 767 data reporting questionnaire (24 pages) are available at http://www.eia.doe.gov/cneaf/electricity/forms/eia767/eia767instr.pdf
A copy of the 2005 DOE-EIA 767 data reporting questionnaire (16 pages) is available at http://www.eia.doe.gov/cneaf/electricity/forms/eia767/eia767.pdf
[103] One example of the standardized use of "short-tons" in EPA RCRA program reports is the RCRA Biennial Hazardous Waste Reports which are archived at http://www.epa.gov/waste/inforesources/data/biennialreport/index.htm

The method applied to characterize the overall level of quantitative uncertainty in the cost estimates of this RIA, is based on the 02 February 2005 "Recommended Practice No. 18R-97: Cost Estimate Classification System as Applied in Engineering, Procurement, and Construction for the Process Industries"[104]. This method is specifically applicable to cost estimates developed for mechanical and chemical process equipment used for engineering, procurement and construction across a wide variety of industries including the electric utility industry sector (i.e., NAICS code 22). As summarized in **Exhibit 4M** below, this cost estimate classification system involves five estimation categories (i.e., Class 1, Class 2, Class 3, Class 4, Class 5) reflecting different relative (a) levels of cost definition, (b) purposes and uses of cost estimates, (c) cost estimation methodologies, (d) expected accuracy ranges, and (e) degrees of cost estimate preparation effort.

Exhibit 4M
Summary of Cost Estimation Classification System for Characterizing Data Quality Uncertainty in this RIA

Estimate Category	Level of Detail (Quantity of Input Information & Data)	Level of Effort (Time Required to Complete the Cost Estimate)	Expected Accuracy Range
Class 5	Very limited information (e.g., little more than proposed project type, location, and capacity).	Very limited amount of time and with little effort, sometimes requiring less than one hour FTE to prepare the cost estimate.	-50% to +100%
Class 4	1% to 5% complete, limited information (e.g., preliminary engineered process and equipment lists) for purpose of alternatives analysis, screening analysis, or demonstration of economic feasibility.	Sometimes requiring up to two months FTE for preparing the cost estimate.	-30% to +50%
Data quality uncertainty range applied in this RIA (i.e., between Class 3 and Class 4) =			**-25% to +40%**
Class 3	10% to 40% complete, semi-detailed information (e.g., process flow diagrams, equipment diagrams, layout drawings, engineered process and equipment lists).	May require up to nine months FTE to prepare the cost estimate.	-20% to +30%
Class 2	30% to 70% complete, detailed information	May require up to 1.5 years FTE to prepare the cost estimate.	-15% to +20%
Class 1	50% to 100% complete and full project definition (e.g., virtually all engineering and design documentation/plans)	May require up to or over three years FTE to prepare the cost estimate.	-10% to +15%

Because the bulk of the data collection and analysis presented in this RIA was executed in a relatively short time (i.e., five months) using semi-detailed information for baseline CCR disposal conditions, disposal unit costs, and engineering control and ancillary costs for the regulatory options, the level of numerical uncertainty for the baseline cost and incremental costs for each of the regulatory options estimated in this RIA may be classified between a Class 3 and Class 4 type of estimate (i.e., -25% to +40%), as displayed below in **Exhibit 4N.** These uncertainty ranges represent a probability distribution about the cost estimates, and may be interpreted as the expected values (i.e., best estimates) and low-end and high-end ranges about each cost estimate. Such quantitative indicators of uncertainty are identified in OMB's Circular A-4 (pages 40, 41) as acceptable for characterizing probability distributions for cost estimates involving major rules with possible annual economic effects of $1 billion or more for one or more regulatory options.

[104] Recommended Practice No. 18R-97 (10 pages) published by the Association for the Advancement of Cost Engineering at: http://www.aacei.org/technical/rps/18r-97.pdf

Exhibit 4N **Cost Estimation Uncertainty with Overall Data Quality Uncertainty Factor Applied to the October 2009 Draft RIA Options** ($millions in 2009$)			
Cost Estimate Uncertainty Indicator	Subtitle C Hazardous waste	Subtitle D (version 1)	Hybrid C&D: Subtitle C for impoundments Subtitle D for landfills
Best estimate (w/updated LDR cost):	**$1,474/year (updated) $20,343 PV**	**$1,368/year (updated) $18,880 PV**	**$1,376/year (updated) $18,990 PV**
-25% uncertainty low-end	$1,106/year $15,264 PV	$1,026/year $14,160 PV	$1,032/year $14,243 PV
+40% uncertainty high-end	$2,064/year $28,485 PV	$1,915/year $26,429 PV	$1,926/year $26,581 PV
Note: PV = present value of average annualized cost over 50-years @7% discount rate, calculated by multiplying the average annualized cost by the present value factor = 13.801.			

Note: **Chapter 6** of this RIA scales these estimated costs based on the October 2009 draft RIA, to the 2010 regulatory options.

Chapter 5
Potential Benefits of RCRA Regulation of CCR Disposal in the Electric Utility Industry

Exhibit 5A below displays social benefits associated with EPA's RCRA regulatory program, a few or many of which may be associated with any particular RCRA regulation. To a lesser or greater degree, a range of these benefit elements may be associated with future benefits from RCRA regulation of CCR disposal, according to the unique physical and environmental attributes at any particular CCR disposal site.

Exhibit 5A **Human Health, Environmental, & Economic Benefits of the EPA RCRA Regulatory Program***		
Benefit Category (n = 6)	Benefit Sub-Element Examples (n = 36)	
1. Human Health Protection Benefits	1A. Mortality Reduction-Examples 1) Reduced risk of cancer fatality 2) Reduced risk of acute fatality	1B. Morbidity reduction-Examples 1) Reduced risk of cancer 2) Reduced risk of morbidity (e.g., asthma, nausea)
2. Ecological Protection Benefits	2A. Market Ecological Values: 1) Commercial fisheries 2) Market recreational benefits (e.g., involving fees) 3) Food	4) Fuel 5) Fiber 6) Timber 7) Fur/leather
	2B. Non-Market Ecological Values & Amenities (examples): 1) Non-market recreational benefits (e.g., w/out fees)	2) Non-use values: existence, bequest, and quasi-option values
3. Indirect Ecosystem & Resource Conservation Benefits	1) Climate moderation 2) Flood moderation 3) Groundwater recharge 4) Sediment trapping 5) Soil retention 6) Nutrient cycling	7) Pollination by wild species 8) Biodiversity 9) Water filtration 10) Soil fertilization 11) Pest control 12) Reduced pressure on endangered species 13) Avoided habitat destruction
4. Avoided Economic Costs	1) Avoided costs of providing government mandated alternate drinking water supplies	2) Avoided costs associated with government mandated cleanups of industrial waste accidents or spills
5. Avoided Materials Damages, Improved Aesthetics, & Historical Preservation	1) Aesthetic pleasure 2) Improved taste, order, visibility	3) Protection of resources with cultural and historic value 4) Protection of constructed resources (e.g., buildings, infrastructure)
6. Potential Long-Term Benefits (Sustainability)	1) Avoided increases in damages related to changes in affected populations 2) Benefits associated with resource conservation	3) Benefits associated with the precautionary principle, protection from unforeseen issues 4) Benefits from long-term increases in the value of environmental quality
* Source: Exhibit 1-1 of EPA Office of Solid Waste, "Approaches to Assessing the Benefits, Costs, and Impacts of the RCRA Subtitle C Program," prepared by Industrial Economics Inc., October 2000,		

In contrast to the **Exhibit 5A** list of RCRA regulatory program benefits, because of time, data, and methodological limitations, the regulatory benefits estimated in this RIA do not represent a complete list of expected benefits of the CCR proposed rule. For example, the benefits analysis in this Chapter of the RIA does not estimate benefits of (a) reducing cancer risks associated with preventing direct effluent discharges of CCR to surface waters, (b) ecological and ecosystem benefits, (c) off-site CCR disposal regulatory benefits, or (d) non-cancer human health protection benefits. In contrast to this large number of possible benefit elements, this RIA monetizes only three benefit categories consisting of five sub-elements.

1. Groundwater Protection Benefits at CCR Disposal Sites
    a. Human health protection benefits (i.e., benefit of preventing cancer from arsenic exposure)
    b. Groundwater remediation costs avoided
2. CCR Impoundment Catastrophic Failure Benefits
    a. Future cleanup costs avoided
3. Benefits from Increase in Future CCR Beneficial Uses
    a. Direct market benefits (economic benefits)
    b. Lifecycle social benefits (economic + environmental benefits)

These monetized benefits are based on EPA's initial analysis using existing information and analytical techniques. EPA requests public comment on all data sources and analytical approaches used in estimating the benefits presented in this Chapter.

5A. Groundwater Protection Benefits (Avoided Future Cancer Risks & Groundwater Remediation Costs)

This section estimates the potential future benefits of reduced human cancer risks and avoided groundwater contamination remediation costs associated with controlling arsenic from onsite CCR landfills and surface impoundments. The estimates are based on EPA's risk assessment, which predicts leaching behavior using SPLP and TCLP data. Recent research and damage cases indicate that these leaching tests under-estimate risks from dry disposal.[105] Human cancer risks avoided are based on the individual "excess" lifetime cancer probabilities estimated below. This estimation follows an 8-step method which begins by characterizing the cancer risks and expected number of future cancer risks from arsenic releases to groundwater from CCR landfills and surface impoundments in the absence of EPA or state action. It then proceeds to monetize these cancers using accepted economic practices. Next, a baseline is established for the operation of state regulatory and remedial

[105] Recent EPA research demonstrates that CCR can leach significantly more aggressively under different pH conditions potentially present in disposal units. In a 2009 EPA study of 34 electric utility plants, CCR from 19 facilities exceeded at least one of the 40 CFR Toxicity Characteristic regulatory values for at least one type of CCR (e.g., fly ash or FGD residue) at the self-generated pH of the material (source: EPA Office of Research & Development, "Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data," EPA-600/R-09/151. Office of Research and Development, Air Pollution Control Division. Research Triangle Park, NC. December 2009). This behavior likely explains the rapid migration of chemical constituents from CCR disposal sites like Chesapeake, VA and Gambrills, MD. See also EPA "Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control," EPA 600/R-06/008. Office of Research and Development. Research Triangle Park, NC. January 2006; and EPA "Characterization of Coal Combustion Residues from Electric Utilities Using Wet Scrubbers for Multi-Pollutant Control," EPA/600/R-08/077. Office of Research and Development, Air Pollution Control Division. Research Triangle Park, NC. July 2008.

programs. Groundwater remediation costs and cancer costs under the baseline and each regulatory option are then estimated. Finally, the aggregate benefits from each regulatory option (incremental to the baseline) are estimated.

Step 1. Categorize CCR Disposal Units by Type

This step begins with the baseline data on CCR disposal (i.e., disposal unit liner types, annual CCR disposal tonnages) contained in **Appendix F** of this RIA for the 495 coal-fired electric utility plants. A subtotal 84 of the 495 plants dispose CCR offsite only, and thus, no liner type is assigned to these facilities in this benefits analysis.[106] Some of the plants have multiple data entries because they were known to have multiple CCR disposal units on-site. This estimation step assigned only the riskiest disposal unit type and liner type combinations of those listed for each such plant, which resulted in the six combinations displayed below in **Exhibit 5A-1**.[107] This hierarchy was based on the 90th percentile, trivalent arsenic cancer risks in the EPA-ORCR 2009 CCR risk report as follows, with those units posing the greatest risk appearing first. **Appendix K1** presents further information on CCR disposal unit liner types and associated data.

These plants were then further divided by the type of waste disposed in the units; CCR only or co-managed wastes. The ratio of facilities that only dispose CCR compared to facilities that co-manage CCR with coal refuse is displayed below in **Exhibit 5A-1**. These ratios allowed EPA to model a single number of potential cancer cases as a best estimate. The data used in the 2009 risk assessment[108] were from a 1995 EPRI survey. Thus, there is some uncertainty regarding the current accuracy of these ratios. To account for this uncertainty, EPA also calculated a bounding range of cancers based on the assumption that all facilities would dispose of CCR only, and that all facilities would co-manage CCR with coal refuse only.

Exhibit 5A-1
Categorization of CCR Disposal Unit Types

CCR Disposal Unit Type	CCR Only	Co-managed
1. Unlined Landfill	66%	34%
2. Clay-Lined Landfill	74%	26%
3. Composite-Lined Landfill	53%	47%
4. Unlined Surface Impoundment	32%	68%
5. Clay-Lined Surface Impoundment	48%	52%
6. Composite-Lined Surface Impoundment	71%	29%

[106] Note: 83 facilities in Exhibits E2 and E4 of the 2009 risk assessment are not assigned WMUs or liner types, 5 fewer than indicated in this RIA.
[107] Multiple CCR disposal units at a single industrial facility will all affect the same surrounding population. To avoid duplication of population risks, the analysis used the simplifying assumption that the human health risks will be driven by the riskiest single WMU, when multiple waste management units are present, but populations around all WMUs are accounted for in **Appendix K2** of this RIA.
[108] Source: EPA "Human and Ecological Risk Assessment of Coal Combustion Wastes," Office of Resource Conservation and Recovery, December 7, 2009.

Step 2. Determine Potentially Affected Populations of Groundwater Drinkers

With information on the universe of facilities, WMUs, and liners nearby groundwater-drinking populations were assigned. To accomplish this, EPA first assigned latitude and longitude coordinates to the 495 sites based on its 2007 eGRID database. Only a few sites were not in eGRID, and it is assumed that these sites were constructed since the 2007 eGRID data collection. Once latitude and longitude data were assigned, EPA used GIS data to ascertain the location of private groundwater wells within a one-mile radius from the latitude and longitude coordinates, and then the number of individuals drinking from those wells.[109,110] The data divide populations into adults (18 and older) and children, the same two populations examined in the 2009 risk assessment. Once these data were attached to specific sites, they were aggregated based on the liner/WMU categories above.

Aggregated data were then scaled to account for the missing population information and population growth. First, the data was scaled up to account for the missing population data in the sites not identified in eGRID. There were 5 unlined landfills, 1 clay-lined landfill, and 7 composite-lined landfills that had onsite disposal but no eGRID data from which to determine the population. All surface impoundments had the necessary eGRID data. To account for these individuals, EPA made the assumption that these plants had populations similar to the plants EPA had data for, since EPA had no data to suggest otherwise.[111] Thus, the population was scaled up by a scaling factor equal to the total number of plants divided by the number of plants for which EPA had population data as follows:

1) Unlined Landfills = 76/71 (~1.07)
2) Clay-Lined Landfills = 28/27 (~1.04)
3) Composite-Lined Landfills = 150/143 (~1.05)

The populations were then scaled up to current population levels based on Census data, resulting in a scaling factor of 1.093.

Once these preliminary population estimates were produced, it was also necessary to account for the size of the waste management unit. In the 2009 risk assessment, WMUs were assumed to be square as a requirement of the model. Using the same assumption here, the actual 1-mile radius around the square area of a WMU could be estimated by scaling the population density of the original 1-mile radius up to the area 1-mile around a square WMU of average size. This led to scaling factors of 1.81 and 2.56 for landfills and surface impoundments, respectively. Further discussion of this area-based scaling can be found in **Appendix K2**.

In addition to accounting for the increased area in the 1-mile radius, EPA assumed that half of the receptors would be up-gradient and half would be down-gradient of the WMU. For the purposes of this assessment, populations were assumed to be equally distributed within the

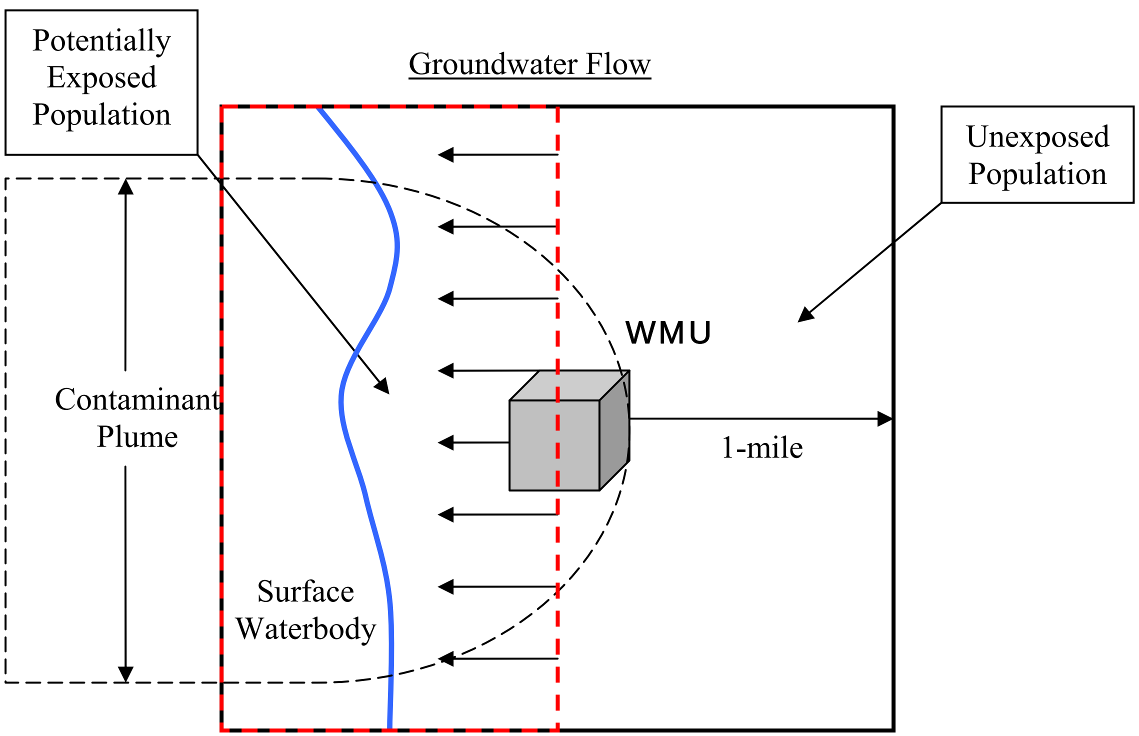
[109] This data was developed through the use of the 2000 census block data in combination with the 1990 census drinking water source data. For a further discussion of population development, see **Appendix K3** of this RIA.

[110] Municipal water systems using groundwater often rely on deeper aquifers, in which case they would be less susceptible to contamination from CCR releases. Therefore, these systems were not included in the 2009 Risk Assessment or in this analysis. However, exposure through this pathway is possible, which means that these population estimates could underestimate the population that is exposed to these wastes.

[111] EPA does not account for CCR disposed off-site as in the Gambrills MD and Chesapeake VA damage cases.

square whose center was the facility WMU. This is illustrated in **Exhibit 5A-2** below. It was also assumed that only down-gradient populations would be affected (red rectangle), and no up-gradient populations would be affected. This was accounted for by dividing the one-mile population by two. The issue of surface waterbodies is addressed below. **Appendix K3** provides a detailed explanation of the derivation of the exposed population by plant. Overall, 715,855 individuals are potentially exposed to CCR. Of this total, 34,533 use private drinking water wells.

Exhibit 5A-2
Conceptual Model for Exposed Well-Drinking Population



Step 3. Apply EPA-ORCR 2009 Arsenic Groundwater Risk Results

This step involved determining the most appropriate individual risk factors for use in estimating arsenic cancer population risk for the estimated populations residing near the CCR disposal sites. There are two sources of information on individual risks associated with arsenic exposure:

IRIS 1998: Based on skin cancer incidence, as data on skin cancer risks were available prior to the availability of quantitative data for internal cancers. Skin cancer is a health endpoint associated with lower fatality risk than the internal cancers induced by arsenic. The skin cancer based risk assessments no longer represent the current state of the science for health risk assessment for arsenic. This RIA presents these estimates below for informational purposes only. This source describes a distribution of risks to a hypothetical individual who drinks water from a well located at a randomly selected point one mile down-gradient from the waste management unit edge. The probabilistic risk estimates were "site-based" (that is, not site-specific, but based roughly on 181 actual coal-fired power plants that were operating in 1995). EPA has only the "peak" risks (i.e., those corresponding generally to the highest groundwater concentrations that are modeled to occur) available for analysis because computer modeling of peak risks contain gigabytes worth of information, and while EPA attempted to keep track of risks up to 10,000 years of the computer model run, the data in these large files became corrupted and are now unusable. However, below in this RIA EPA does extrapolate population risks in other years. These other years are the years between the cessation of operation of the landfill, or the years after the beginning of operation of the surface impoundment, leading up to the years in which the "peak" risks occur at half of the modeled facilities.

NRC 2001: The latest science on health risks associated with arsenic exposure is from the National Research Council (NRC) report "Arsenic in Drinking Water: 2001 Update"[112] which reviewed the available toxicological, epidemiological, and risk assessment literature on the health effects of inorganic arsenic, building upon the NRC's prior report, "Arsenic in Drinking Water" (1999). The 2001 report, developed by an eminent committee of scientists with expertise in arsenic toxicology and risk assessment provides a scientifically sound and transparent assessment of cancer risks from inorganic arsenic. EPA's Science Advisory Board endorses these estimates and the IRIS estimates are currently being updated to reflect this latest science. Therefore, while IRIS estimates exist, because the more recent NRC scientific information is available, this RIA relies on the NRC information for analysis of the cancer risks associated with CCR. **Appendix K4** provides more detailed information on how this NRC research was used.

For the purposes of initially estimating the expected number of cancers (i.e., cancer risks) in Steps 3 and 4, this RIA applied risk results obtained with the latest (i.e., 1998) IRIS value. However, in Step 5 below, the 2001 NRC research was used to update these cancer estimates. It should be noted that the 1998 IRIS skin cancer value does not examine bladder and lung cancer incidence, and therefore is not a substitute for the 2001 NRC cancer risk research in this area. To the extent that the skin cancers estimated by the IRIS value are not accounted for, this RIA may underestimate total cancer incidence.

---

[112] National Research Council, Arsenic in Drinking Water: 2001 Update, National Academy Press, 2001 at http://www.nap.edu/openbook.php?isbn=0309076293

This RIA extracted only those results from the EPA 2009 risk assessment to either represent (a) conventional CCR (i.e., fly ash, bottom ash, boiler slag, and flue gas desulphurization waste managed in the landfill or impoundment without mixing with other materials), or (b) CCR co-managed with coal refuse.[113] Of these results, only those for trivalent arsenic were used.[114] For the primary analysis, it was assumed that all arsenic was speciated in this manner. As noted in the EPA source data, arsenic III and arsenic V cancer risk results for unlined surface impoundments that co-dispose CCR with coal refuse were not statistically different at the 90th percentile, and these risks are likely to drive the population risk estimates. A sensitivity analysis was conducted where all arsenic was assumed to be speciated in the arsenic V state. This analysis is presented in **Appendix K5**. Finally, risks for both adult and child receptors were included so that each group would be accurately represented. Once all of these data were collected they were sorted by CCR disposal unit and liner type.

This analysis reflects possible groundwater and surface water interactions that could affect the population risk estimates. In situations in which the modeled distance to a surface water body was less than the modeled distance to a drinking water well EPA assumed that the groundwater plume is fully intercepted by a surface waterbody.[115] To this end, EPA extracted the model inputs for the distance to groundwater wells and the distance to surface waterbodies used in the EPA source, randomly selected from input distributions.[116] These two were then compared using a logical test in Microsoft Excel. This test returned a 0 if the surface waterbody was closer than the drinking water well and 1 if it was not. Thus, a 1 was a positive indication that the contaminant plume in that model run reached the groundwater well.

Finally, EPA extracted the exposure durations used in each model run from the EPA-ORCR 2009 CCR risk report to capture the fraction of the individual's lifetime risk that was experienced in a one-year period. EPA accomplished this by matching the probabilistic exposure duration inputs, to their corresponding age category. Then, each probabilistic run was sorted to return the exposure duration of the adult and child age category. These Monte Carlo data constituted a weighted approach for estimating individual human cancer risks. Population risk is typically calculated by multiplying risk results by the affected population. Since there were thousands of equally valid model iterations, this RIA assigned each of these risks an equal weight in its final population risks by using the average of these individual risks.

Individual risk estimation took into account the fact that the contaminant plumes might be intercepted by surface waterbodies by multiplying by either 0 or 1 as identified above. Each of these risks was then divided by exposure duration to estimate the yearly cancer risk.[117] Once all of these risks were calculated for a given WMU/liner type they were summed and divided by the number of iterations to give the average one year increment of risk for that WMU/liner type at the peak risk. Thus, the final equation that was used for calculating average risks can be stated as:

---

[113] Fluidized Bed Combustion waste results were not deemed appropriate for use for the reasons discussed in EPA "Human and Ecological Risk Assessment of Coal Combustion Wastes," Office of Resource Conservation & Recovery, August 2009.

[114] A 1981 Oak Ridge National Laboratory study states "As (III) is likely to be the predominant arsenic species in ash pore water and groundwater." Source: Turner, Ralph R. "Oxidation State of Arsenic in Coal Ash Leachate," Environmental Science & Technology, Vol.15, Number 9, September 2001.

[115] Full interception will not occur in instances where the waterbody is shallow, the waterbody is man-made, or the facility is oriented perpendicular to the waterbody. This simplifying assumption serves to minimize the influence of the model runs in which interception may have occurred, but was not reflected in EPA "Human and Ecological Risk Assessment of Coal Combustion Wastes," Office of Resource Conservation & Recovery, August 2009.

[116] For further discussion of how these distributions were developed, see Appendix C of EPA "Human and Ecological Risk Assessment of Coal Combustion Wastes" Office of Resource Conservation and Recovery, Washington, DC, August 2009.

[117] For further discussion of cancer risks and exposure durations, see **Appendix K4** of this RIA.

$$iRISK = \frac{\sum \frac{RISKn \times WELLREACH}{EDn}}{N}$$

Where:

iRISK	=	Average increment of lifetime cancer risk from a 1-year exposure
RISKn	=	Risk result for the nth model run
WELLREACH	=	0 if plume is intercepted by a surface water body, 1 otherwise
EDn	=	Exposure duration for the nth model run
n	=	Iteration number
N	=	Number of iterations

The results are presented in **Exhibit 5A-3** below. For each, the results are presented for both adults and children under each of the WMU/liner scenarios. For full distributions of individual risks before averaging, see **Appendix K6** – Distributions.

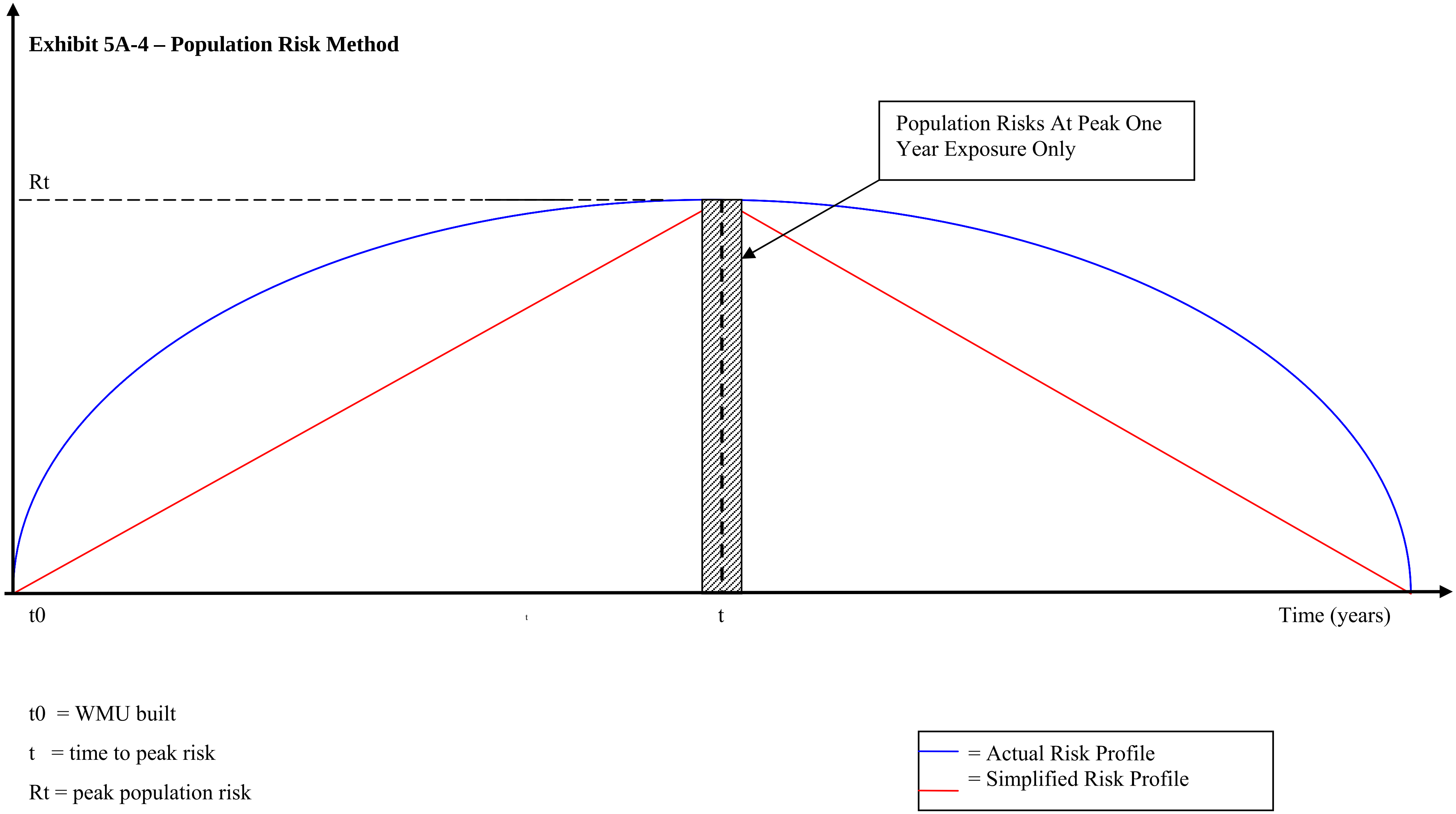
Exhibit 5A-3
Peak One Year Risks For CCR Cancer

	Conventional CCR		CCR Co-managed With Coal Refuse	
Liner - Receptor	Landfills	Impoundments	Landfills	Impoundments
Unlined - Adult	6E-06	4E-05	5E-06	2E-04
Unlined - Child	1E-05	1E-04	1E-05	4E-04
Clay-Lined - Adult	3E-06	3E-05	2E-06	1E-04
Clay-Lined - Child	7E-06	6E-05	4E-06	2E-04

Step 4. Extrapolate Annual Cancer Risks from Peak Cancer Risks

The peak risks that were calculated occur well after cancers can first materialize. Thus, constraining the benefits to only the peak population risks significantly underestimates total cancers avoided. To compensate for this shortfall, this RIA formulated an approach illustrated in **Exhibit 5A-4** below. The blue parabolic curve for population risk is based on the well concentrations over time in the results. While EPA cannot reconstruct the exact curve due to data availability issues, a parabolic curve represents groundwater contamination. From this shape it is clear that the peak population risks only capture a fraction of total population risks. Using an assumption of linear increases to the peak and linear decreases from the peak, produced the simplified risk profile seen as a red line in **Exhibit 5A-4**.

Exhibit 5A-4 – Population Risk Method



The constant slope allowed estimation of the population risks from each year's exposure by assembling the model iteration times to peak.[118] Dividing peak risks (y-value) by the time to peak (x-value), the slope of the time line was determined for each WMU/liner type as displayed in **Exhibit 5A-5** below.

Exhibit 5A-5 Human Cancer Time Slope Factors For CCR				
	Slopes For Conventional CCR		Slopes For CCR Co-managed With Coal Refuse	
Liner - Receptor	Landfills	Impoundments	Landfills	Impoundments
Unlined - Adult	1E-08	6E-07	8E-09	3E-06
Unlined - Child	2E-08	1E-06	2E-08	6E-06
Clay-Lined - Adult	5E-09	4E-07	3E-09	1E-06
Clay-Lined - Child	1E-08	7E-07	6E-09	3E-06

Multiplying this slope by the number of years elapsed yields the yearly increment of individual risk for that year. Multiplying this average incremental individual risk by the population exposed in each year[119] EPA estimated the number of cancers in each year. While this under-estimates cancer incidence by the difference between the blue and red profiles it is the best estimate based on currently available data.

As displayed in **Exhibit 5A-6** below, this approach results in an estimate between 45 and 196 potential cancer cases over 75 years[120] as a result of arsenic consumed through contaminated groundwater using EPA's 1995 cancer slope factor (1.5 $mg/kg/d^{-1}$) for arsenic based on skin cancers. Using the ratios of conventional CCR co-managed with coal refuse a best estimate within this range is **145 cancers**.

[118] Since these iterations were performed in later model runs they could not be tied to the specific model iterations used above. 67% of the model runs had the nearest groundwater well occurring beyond the nearest surface waterbody. Since the longer arrival times occur with longer travel distances, and these iterations tended to be the iterations that were intercepted, assumed that the 33% of model runs that were not intercepted are also the 33% of model runs with the shortest arrival times (i.e., shortest distances). Taking the midpoint of these arrival times yielded the 16.5th percentile.

[119] This RIA inflated the future population each year based on the future projections made by the US Census Bureau. From that point on, this RIA assumed a constant annual growth rate equal to the growth rate in year 2050.

[120] Seventy-five years were used for the analysis based on the 78 year time to peak period, less two years states are allowed to adopt the rule's provisions, and less an additional year for installing groundwater monitoring. Seventy-eight years are the time at which the risks for typical unlined and clay-lined surface impoundments that are not intercepted by surface water will peak. Cancers occurring after year 78, though potentially significant, are unlikely to play a significant role when monetized because under a 3% discount rate, benefits fall to ten percent of their value at year 78, and at a 7% discount rate, benefits fall to 0.5% of their value at year 78. These future cancers will be further reduced by state regulations, detection of contamination, and a general trend away from wet handling.

Exhibit 5A-6 **Potential Future Human Cancer Cases from the Disposal of CCR Based on Arsenic Cancer-Slope Factor from EPA/IRIS**						
	Disposal of Conventional CCR			Disposal of CCR Co-Managed with Coal Refuse		
WMU	Adult	Child	Totals	Adult	Child	Totals
Unlined Landfills	0.1	0.1	0.2	0.1	0.1	0.2
Clay-Lined Landfills	0.1	0.1	0.2	0.0	0.0	0.0
Unlined Surface Impoundments	20.1	16.3	36.4	98.1	67.6	166.7
Clay-Lined Surface Impoundments	4.8	3.5	8.3	17.6	12.6	309.2
Totals	25.1	20.0	**45**	115.8	80.3	**196**

Step 5. Estimate Arsenic Cancer Risks Using Recent NRC Science for Arsenic

Based on the NRC data source, lifetime exposure to 10 ug/L arsenic in drinking water would lead to 23 excess male bladder cancers and 14 excess male lung cancers per 10,000 people. Under the exposure factor assumptions used by the NRC the equivalent cancer slope factor (CSF) is 26 mg/kg/d^{-1}. For details of how this cancer slope factor was calculated, see **Appendix K4** – Cancer Calculations.[121] **Exhibit 5A-7** below displays the population risk estimates for CCR disposal base on the NRC source.[122] Using the NRC (2001) cancer slope factor one would expect between approximately 778 and 3,392 cancer cases over 75 years as a result of arsenic consumed through contaminated groundwater. Using the ratios of conventional CCR co-managed with coal refuse produces a best estimate within this range of **2,509 cancers**.

Exhibit 5A-7 **Potential Future Human Cancer Cases from CCR Disposal Based on Arsenic Cancer-Slope Factor from NRC**						
	Disposal of Conventional CCR			Disposal of CCR Co-Managed with Coal Refuse		
WMU	Adult	Child	Totals	Adult	Child	Totals
Unlined Landfills	2	2	4	1	1	2
Clay-Lined Landfills	1	1	2	1	1	2
Unlined Surface Impoundments	348	281	629	1,696	1,169	2,865
Clay-Lined Surface Impoundments	82	61	144	305	218	523
Totals	433	345	**778**	2,003	1,389	**3,392**

[121] EPA is currently in the process of revising the arsenic cancer slope factor in EPA's Integrated Risk Information System (IRIS).
[122] EPA also conducted a sensitivity analysis assuming the female cancer slope factor in **Appendix K5** of this RIA.

Step 6. Monetize Future Avoided Cancer Risk Benefits

Reflecting the best science available, EPA used a point estimate of cancer cases avoided to monetize cancer risks. **Appendix K4** provides further explanation as to why the NRC science is considered more appropriate than the older skin cancer research that the current IRIS value was derived from. Because EPA has greater confidence in the NRC estimates, it chose to use the 2,509 cancers calculated above as the best estimate. EPA also used the NRC ratio of 23 male bladder cancers to 14 male lung cancers to estimate how many of each type were likely to occur in each year. That is, 62%, or 1,556 cancers, are assumed to be bladder cancers and 38% or 953 are assumed to be lung cancers. **Appendix K7** shows the best estimate number of lung and bladder cancers in each year that was used in the remaining portions of this analysis.

Since cancers are not all fatal, the next step was to estimate the number of cancers that are fatal and non-fatal. This was done separately for each type of cancer using 5-year survival rates from the EPA-ORCR 2009 CCR risk report. The 5-year survival rate used for bladder cancer is 82% and the 5-year survival rate used for lung cancer is 14%. Thus, 1,276 (82%) of bladder cancers are non-fatal and 280 (18%) are fatal. For lung cancer, 133 (14%) are non-fatal and 820 (86%) are fatal. Again, these cancers are spread over the 75 years of the analysis. In order to monetize avoided cancer risks, this RIA applied the value of a statistical life (VSL) plus the cost of terminal cancer treatments displayed in **Exhibit 5A-8** below. To monetize avoided non-fatal cancer risks, this RIA used an estimate from Magat et al. (1996).[123] This study shows that a typical individual's assessment of a non-fatal lymphoma risk reduction was the equivalent of 58.3% of a fatal lymphoma risk reduction.[124] Therefore, this RIA assumed individuals value non-fatal bladder and lung cancer risk reduction in a similar manner.

Exhibit 5A-8
Unitized Monetary Values for Human Cancer Risks Applied in this RIA

Monetized Value	2008$
Fatal cancers: value of statistical life (VSL)*	$8,800,000
Non-fatal cancers: 58.3% of VSL*	$5,130,400
Medical costs associated with fatal bladder cancer**	$149,863
Medical costs associated with fatal lung cancer**	$87,703

Notes:
*Median VSL of $4.65 million (1997$) from Exhibit 7-3 (page 89) of EPA "Guidelines for Preparing Economic Analyses," EPA 240-R-00-003, Sept 2000; converted for this RIA to 2008 dollars using the Consumer Price Index. In addition, projections of benefits in future years are subject to income elasticity adjustments. These represent changes in valuation in relation to changes in real income. For example, if, for every 1% increase in real income, a particular consumer's willingness-to-pay for a particular item increases by 1%, this would be represented by an income elasticity of 1.0. For most items, income elasticity values are actually less than 1, indicating that valuation of most items does not increase as fast as real income levels. To do so, applied the change in Gross Domestic Product per-capita between the original dollar year of the estimates and 2008, and an income elasticity of 0.5 based on estimates from Viscusi, W. K. and Aldy, J. E. "The Value of a Statistical Life: A Critical Review of Market Estimates throughout the World," Journal of Risk and Uncertainty, Vol.27, 2003, pp. 15–76.
** These costs reflect the inpatient hospital stays, skilled nursing facility stays, home health agency charges, physicians' services, and outpatient and other medical services - in other words the treatment and maintenance costs. Costs are assumed to occur during initial

[123] Magat, Wesley A., V. Kip Viscusi and Joel Huber "A Reference Lottery Metric for Valuing Health," Management Science, Vol.42, Issue 8, 1996, pp.1118 - 1130.
[124] EPA acknowledges that alternative approaches to valuing non-fatal cancers are available. One such alternative is presented in **Appendix K5** of this RIA.

Exhibit 5A-8 Unitized Monetary Values for Human Cancer Risks Applied in this RIA
treatment, maintenance care between initial and terminal treatment and terminal treatment during the final six months prior to death: • Bladder cancer costs are based on survival and death rates each year for 20 years which captures most deaths from bladder cancer among those who are diagnosed with the disease. • Lung cancer costs are based on a 10 year time horizon during which most deaths are assumed to occur. The original figures in the 2001 EPA report are in 1996 dollars (source: EPA "The Cost of Illness Handbook," Office of Pollution Prevention & Toxics, October 2001). These costs are updated for this RIA to 2008 dollars using the Medical Care Component of the Consumer Price Index.

These values are further adjusted for cessation lag and income as described in **Appendix K8**. EPA used the cessation data of bladder cancers from arsenic in Chen and Gibb (2003)[125] to construct a Weibull curve approximating the lag time between reduced arsenic exposure and reduced cancer outcomes. Because this lag will reduce willingness to pay compared to an immediate risk reduction, the value of reduced statistical cancers are 83% and 67% of what they would be using an unadjusted VSL (at a 3% and 7% discount rate, respectively.) This is described in more detail in **Appendix K8**. For income, EPA projected per capita GDP, and used this combined with an income elasticity of 0.5 income elasticity of 0.5 from Viscusi and Aldy (2003) to estimate the growth in VSL until the exposure year. There has been economic debate over whether VSL should be adjusted to the year of exposure or the year of the cancer. However, typically, it is not possible to know when the exposure occurred. Because of the model used here, this RIA applied the VSL adjustment at the time of exposure. The full table of VSL adjustment factors, as well as their derivation, is presented in more detail in **Appendix K8**.

Applying these nominal dollar values to the number of fatal and non-fatal bladder and lung cancers in each year, a current year value for avoiding cancer risk was calculated for each of the 75 years. These values can be seen in **Appendix K7**. The present value (PV) of these values is approximately $4,696 million at a 3% discount rate and $885 million at a 7% discount rate. This would reflect the value of avoiding future cancer risks assuming that no steps were taken to prevent contamination and the resulting cancers. However, as discussed below, this is not realistic under baseline state regulatory controls.

Step 7. Account for Groundwater Remediation under the Baseline and Regulatory Options

The results above assume that arsenic is released from existing impoundments and landfills, without any controls (beyond the liners taken into account in the model). The benefits of regulatory options would be reflected by lower rates of cancer, resulting from the rule's controls (including ground-water monitoring, permitting, corrective action, phase-out of surface impoundments, financial assurance, etc.).[126] The rule will also have the benefits of reducing or eliminating groundwater remediation cost, because groundwater releases are eliminated through

[125] Source: Chen, C.W. & Gibb, H. "Procedures for Calculating Cessation Lag." Regulatory Toxicology and Pharmacology," Vol.38, Issue 2, 2003, pp.:157-65.
[126] The two Subtitle D Options evaluated were: (1) Subtitle D — regulation of landfills and surface impoundments, with liners required for existing and new surface impoundments, and new landfills and (2) Subtitle "D Prime" — regulation of landfills and surface impoundments, with liners required only for new surface impoundments and landfills.

controls like surface-impoundment phase-out, or reduced because releases are caught earlier. These benefits, and how they relate, are described in the section below.

First, even in the absence of federal regulations, CCR disposal units will not leach and cause cancers in all cases estimated through the evaluation above. Even without federal regulation, there will be facilities that discover contamination and clean the contamination up before cancers occur, either due to state regulations or good practice. Where exposures are identified, this RIA assumed that the pathway will be cut off (e.g., through provision of alternative water sources). Even facilities that fail to prevent contamination may detect that contamination and clean it up at a later time, although after exposure has occurred. This Step of the estimation attempted to account for these practices.

To estimate the different speed and cost of groundwater remediation likely under the baseline and under the three regulatory scenarios (i.e., Subtitle C, Subtitle D and Subtitle D Prime), this RIA began by examining the differences across states in groundwater monitoring requirements pertaining to CCR disposal units, and focused on groundwater monitoring requirements because adequate monitoring is needed to determine whether a release has occurred. This RIA assumes that, where releases of concern have been identified, and particularly where people may be at risk, drinking water pathways will be cut off and alternative drinking water will be provided. Then calculated the percentage of CCR disposed by each state, and noted which of three levels of groundwater monitoring were required:

1. No monitoring requirements
2. Monitoring requirements for only future newly constructed CCR disposal units
3. Monitoring requirements for both future new and existing CCR disposal units

Then EPA tracked the percentage of total waste that was discarded by facilities in states requiring each of these three monitoring scenarios. **Exhibit 5A-9** below presents these percentages for states requiring at least some monitoring (categories 2 and 3 above) and states requiring monitoring at exiting facilities (category 3 above). The first value in the table, 91%, is the percentage of CCR discarded in landfills that impose some form of monitoring requirements, whether for new landfills only, or for both new and existing landfills. 62% is the percent of CCR discarded in landfills that impose monitoring requirements on both new and existing CCR disposal units (a subset of the 91%).[127] Percentages are also provided for CCR that are managed in surface impoundments. **Appendix K9** provides these data for each individual state.

[127] Some states may require monitoring only for off-site units; however, in the absence of a specific breakdown, EPA made the assumption that on-site units would be monitored in all states that require monitoring.

Exhibit 5A-9 **State Government Groundwater Monitoring Requirements Assumed in this RIA**				
	Landfills		Surface Impoundments	
	Any Monitoring Requirements (categories 2&3)	Required at New and Existing Units (category 3)	Any Monitoring Requirements (categories 2&3)	Required at New and Existing Units (category 3)
Percent of Facilities	91%	62%	48%	12%

These percentages helped to determine when releases will be identified, and the likely cost of cleanups or other remedies, when releases are identified, under the baseline and three regulatory scenarios. Since all but 4 of the 2,509 cancers projected above result from surface impoundments, only surface impoundment monitoring data were used in the calculations.[128] For the baseline scenario, it was assumed that states with the highest level of monitoring requirements (those requiring groundwater monitoring at both new and existing units) would generally find groundwater contamination relatively early and would require preventive measures that would avoid cancers (e.g., intercept the plume and/or put residents on municipal or bottled water). Thus, 12% of contamination that could occur would have already been detected, and the resulting cancers prevented. To the extent that cleanups and/or alternative water are required, that was considered part of the baseline.

To model the Subtitle D option, EPA assumed that states with groundwater monitoring requirements at new units, or with some coverage of the units in question, would upgrade their existing programs to provide fuller coverage – because they already have a regulatory infrastructure – but other states with no program would not. While states that do not currently regulate units would not change their practices simply because EPA issued national rules, EPA recognizes that facilities in these latter states will to a certain extent comply, to avoid citizens' suits. However, EPA's and states' experience in implementing the RCRA program demonstrates that self-implementing ground-water monitoring programs are of limited reliability. Given these factors, the percentage of waste disposed of in states with some level of groundwater monitoring programs is a reasonable estimate of benefits for the subtitle D approach. Under these assumptions, contamination in states with monitoring requirements for only new units, as well as contamination in states with monitoring requirements for new and existing units would be detected promptly. This leads to 48% of surface impoundment groundwater contamination being detected before extensive damage has occurred, and therefore 48% of cancers being prevented.

Since the Subtitle "D Prime" option does not require the retrofitting of existing units, unlined surface impoundments would remain a continuing source of release. However, the presence of a new national rule accompanied by EPA support would lead at least some states to make such updates. Since the potential risks will fall somewhere between the Subtitle D option and the baseline, the midpoint between baseline and the Subtitle D option (30%) was chosen as a best estimate. This leads to 30% of contamination being immediately detected, and thus 30% of cancers being prevented.

[128] Note, however, that considerable evidence indicates that releases from dry disposal can present significant risk as well, as demonstrated by EPA research on CCR leach rates at different pHs and the damage cases.

Finally, for Subtitle C, there would be federal oversight of the groundwater monitoring requirement, and therefore this RIA assumes 100% of facilities would have contamination detected early. Looking forward, this would effectively prevent all cancers.[129] In addition, the technical standards of the subtitle C rule would largely prevent future releases because surface impoundments would be phased-out, and because new landfills would require composite liners. Similarly, closure requirements would largely prevent releases after closure of both types of units.

Where releases of arsenic from disposal units occur in the future, they will be detected promptly after they occur under the proposed option, as well as under the other options where good monitoring programs are in place. In these cases, there may be response costs, but no cancer risks. On the other hand, if facilities do not have adequate detection systems in place (and other adequate controls, e.g., liners, adequate closure, etc.), then detection will be delayed. This RIA assumes that releases will eventually be discovered, but that detection may be on a delayed basis. To quantify this assumed that contamination would be discovered consistently until it was all discovered. Since the rate of discovery is unpredictable, further assumed detection would be at a constant rate, reaching 100% detection by the final year of the analysis.[130] These discoveries were assumed not to start for six years because the first percentile of time duration until peak risks for unlined surface impoundments occurred. Restated, this profile assumes that facilities in states that require groundwater monitoring for existing units would generally find contamination in the future soon after it occurred, reducing response costs, and preventing cancer risks. But where monitoring and other controls were not adequate, releases would potentially go undetected for lengthy periods, causing cancers until the contamination was eventually detected and those residents switched to municipal or bottled drinking water. In addition, response costs would be significantly increased. The present value of avoiding all of the risks in the baseline case is the upper-bound on benefits, and this upper bound is reduced by detection and groundwater remediation as described in this section. The risk reduction benefit for each regulatory option is the difference between baseline risks and remaining risks under that option. These benefits, accounting for the detection and remediation, are presented in **Exhibit 5A-10** below. Baseline expected cancer risks are accounting for detection and remediation, compared to without taking these factor into account. Further discussion of the cancer profile can be found in **Appendix K7**.

This RIA projects a trend towards decreased management of CCR in surface impoundments. Facilities with surface impoundments have been slowly moving from wet handling in impoundments to dry handling in landfills or to beneficial uses. While this trend could affect the profile discussed above, it is unlikely to have a significant effect on risks for two reasons. First, surface impoundments, to the extent they are closed, are typically closed with waste in place. Thus, they are likely to continue to leach beyond the 75-year period modeled in the 2009 risk assessment; this is particularly true in situations where they are not lined (which are overwhelmingly the case) and where they are located in states without strong regulation. In the latter case, closures are likely to be inadequate, leading to continued infiltration. Second, the releases that occurred before the surface impoundments are closed will continue to migrate until they reach the groundwater wells or until they are intercepted by a surface waterbody (again particularly in states without strong programs). Given the relatively very large size of the CCR impoundments, and the presence of a hydraulic head at least before closure, these historic releases have the potential to be significant. Given these considerations, the closure of surface impoundments in states without regulations (e.g., corrective action, groundwater monitoring, etc.) would behave very similarly to active surface impoundments in terms of their risks to human health and the environment. For this reason, the regulatory oversight in the options above was not modified for closed CCR disposal units.

[129] Cancers from historic releases would not be affected, but the releases would be promptly identified and future exposures avoided.

[130] Some releases are likely to go entirely undetected in the absence of groundwater monitoring and other controls. However, to put a reasonable limit around the analysis, this RIA assumed 100% detection.

Exhibit 5A-10 **Present Value of Avoided Human Cancer Risks Associated with CCR Disposal** ($millions present value over 50-years)			
Discount rate	Subtitle C	Subtitle D	Subtitle D'
@ 3%	$1,825	$750	$375
@ 7%	$504	$207	$104

The other major cost associated with groundwater contamination is that of remediation or other response. To estimate that cost, EPA began by estimating the number of coal-fired electric utility plants that would require responses under various state environmental programs, based on the 2009 risk assessment. In any particular situation, a state could require remediation of a site involving potential drinking water to 10^{-4}, 10^{-5}, or 10^{-6} levels. In addition, states may choose to require groundwater remediation for groundwater that is not a likely drinking water source, because of ecological concerns. **Exhibit 5A-11** below shows the number of facilities potentially requiring cleanup. Since each estimate is equally acceptable under current state programs, the average is believed to be a best estimate for how many electric utility plants will ultimately need groundwater remediation so as not to overestimate the number of remediation events.

Exhibit 5A-11 **Proportion of CCR Sites Requiring Remediation Based on State Cleanup Levels**							
State Cleanup Levels	Clean All Groundwater			Clean Only Drinkable Groundwater			Average
	10^{-4}	10^{-5}	10^{-6}	10^{-4}	10^{-5}	10^{-6}	
Total LF	22	50	72	7	16	24	32
Total SI	93	132	150	31	44	50	83

These plant counts are based on the probabilistic model iterations from the 2009 risk assessment which were used to estimate what fraction of sites would leach at above various clean up levels. Typically, solid waste cleanups can be conducted at either 10^{-4}, 10^{-5}, or 10^{-6} individual cancer risk levels. **Exhibit 5A-12** uses the PERCENTRANK function in Excel to estimate what percent of risk results fall at or below each clean up level. For example, in the first cell of **Exhibit 5A-12**, the 78% means that 10^{-4} is higher than 78% of the probabilistic results for unlined landfills with conventional ash.

UL	=	Unlined
CL	=	Clay-Lined
A	=	Conventionally Managed Ash
C	=	Co-managed Ash
LF	=	Landfill
SI	=	Surface Impoundment

Exhibit 5A-12 Percentile of Cleanup Levels in the EPA-ORCR 2009 CCR Risk Study								
Clean Up Level	UL A LF	CL A LF	UL C LF	CL C LF	UL A SI	CL A SI	UL C SI	CL C SI
1.00E-04	78%	83%	74%	85%	46%	59%	30%	43%
1.00E-05	55%	59%	42%	57%	15%	24%	12%	21%
1.00E-06	36%	35%	18%	28%	5%	7%	3%	8%

Model results equal to or above these percentiles would require a state or federal cleanup. In other words, the percentage of sites above the cleanup level displayed in **Exhibit 5A-13** can be derived by subtracting the percents in **Exhibit 5A-12** above from 100%. However, while states may require remediation of all groundwater, whether or not it is potable, they may also choose not to on a site by site basis. As discussed in the EPA-ORCR 2009 CCR risk report, it is estimated that two-thirds of sites are located closer to a surface waterbody than to the nearest groundwater well. Therefore, sites located on surface waterbodies may not be cleaned in some states. This 2/3 decrease is accounted for in the second set of values in **Exhibit 5A-13**.

Exhibit 5A-13 Percent of Electric Utility Plants Requiring Future Groundwater Remediation								
Clean Up Level	UL A LF	CL A LF	UL C LF	CL C LF	UL A SI	CL A SI	UL C SI	CL C SI
Assuming All Groundwater is Remediated								
1.00E-04	22%	17%	26%	15%	54%	41%	70%	58%
1.00E-05	45%	41%	58%	43%	85%	76%	89%	79%
1.00E-06	65%	65%	82%	72%	96%	93%	97%	93%
Assuming Only Potable Groundwater is Remediated								
1.00E-04	7%	6%	8%	5%	18%	13%	23%	19%
1.00E-05	15%	14%	19%	14%	28%	25%	29%	26%
1.00E-06	21%	21%	27%	24%	32%	31%	32%	31%

The number of utility plants with each type of CCR disposal, liner type, and management combination was calculated by taking the **Appendix F** plant data from this RIA and combining it with the conventional versus co-managed rates.

Exhibit 5A-14 Estimated Number of Electric Utility Plants by CCR Disposal Unit Type							
UL A LF	CL A LF	UL C LF	CL C LF	UL A SI	CL A SI	UL C SI	CL C SI
50	21	26	7	31	28	68	31

Multiplying the number of facilities in each category from **Exhibit 5A-14** above by the percent of facilities requiring remediation in **Exhibit 5A-13** above yields the estimated number of facilities that would lead to state or federal clean ups in **Exhibit 5A-15** below. These estimates of the number of facilities requiring cleanup does not account for any cleanups resulting from other constituents exceeding a hazard quotient of 1. Thus, this estimate may under-estimate the total number of cleanups.

Exhibit 5A-15 Number of Electric Utility Plants Requiring Future Groundwater Remediation								
Clean Up Level	UL A LF	CL A LF	UL C LF	CL C LF	UL A SI	CL A SI	UL C SI	CL C SI
Assuming All Groundwater Is Remediated								
1.00E-04	11	4	7	1	17	11	47	18
1.00E-05	23	9	15	3	26	21	60	24
1.00E-06	32	14	21	5	30	26	66	29
Assuming Only Potable Groundwater Is Remediated								
1.00E-04	4	1	2	0	6	4	16	6
1.00E-05	7	3	5	1	9	7	20	8
1.00E-06	11	5	7	2	10	9	22	9

With the number of units requiring remediation, EPA estimated the cost of groundwater remediation under the baseline and each regulatory option presented above. Groundwater remediation costs were estimated in two steps. First, EPA assumed contamination that might occur at sites in states with more stringent monitoring requirements, would be discovered promptly. This suggests that there is likely to be less remediation required than at the typical site. Thus, EPA assigned these sites the 25th percentile remediation costs displayed in **Exhibit 5A-16** below as the midpoint of the bottom half of costs. These future remediation events were spread evenly across all 75 years of the analysis.

Exhibit 5A-16 Per-Site Groundwater Contamination Remediation Costs*		
Cost element category	25th percentile "early costs"	75th percentile "later costs"
Capital Costs	$6,075,900	$21,195,000
Annual O&M	$98,910	$1,413,000
O&M at 3% discount rate**	$1,978,242	$28,260,605
O&M at 7% discount rate**	$1,239,522	$17,707,453
Total cost at 3%	$8,054,142	$49,455,605
Total cost at 7%	$7,315,422	$38,902,453

Notes:
*Cost data from Exhibits 3 and 4 in EPA "Cost Analyses for Selected Groundwater Cleanup Projects: Pump and Treat Systems and Permeable Reactive Barriers," Office of Solid Waste & Emergency Response, EPA-542-R-00-013. February 2001 at: http://www.epa.gov/tio/download/remed/542r00013.pdf
**O&M costs were capitalized over 30 years at both a 3% and 7% discount rate for use in the two estimates. This was done to simplify spreadsheet calculations.

For the remaining sites expected to require remediation, but lacking groundwater monitoring requirements, EPA assumed discovery of contamination would take longer. That is, CCR contamination would have migrated for some number of years, resulting in a larger groundwater plume to remediate, or more extensive remediation. EPA assigned these sites the 75th percentile remediation costs as the midpoint of the top half of costs. Since the first percentile time to peak results for unlined surface impoundments is six years, it is assumed that no discoveries and cleanups will be made in the first six years for these sites (three years once the two years for state adoption and one year for groundwater monitoring are considered). The costs are thus spread evenly over the remaining 72 years. The present value of these remediations, accounting for the slow, but continued discovery of contaminated sites, is presented in **Exhibit 5A-17** below. Further discussion of the discounted remediation costs for each year is presented in **Appendix K10**.

Exhibit 5A-17 Present Value of Future Groundwater Remediation Costs from CCR Contamination ($ millions present value over 50-years)				
Discount Rate	Subtitle C	Subtitle D	Subtitle D'	Baseline
@ 3%	$96	$1,016	$1,302	$1,587
@ 7%	$39	$336	$420	$504

Aggregate benefits from cancer risk reductions and avoided remediation costs are summarized in **Exhibit 5A-18** below. These benefits are calculated by subtracting the costs resulting under that option from the costs resulting under the baseline (i.e., cost avoided).

Exhibit 5A-18
Present Value of Future Avoided Human Cancer Risks
& Avoided Groundwater Remediation Cost Benefits
($millions present value over 50-years)

	Subtitle C	Subtitle D	Subtitle D'
@ 3% discount			
Groundwater Remediation Costs Avoided*	$1,491	$571	$286
Human Cancer Risks Avoided	$1,825	$750	$375
Total	$3,316	$1,321	$661
@ 7% discount			
Groundwater Remediation Costs Avoided*	$466	$168	$84
Human Cancer Risks Avoided	$504	$207	$104
Total	$970	$375	$188

Note:
* Calculated by subtracting the present value future groundwater remediation cost estimated in **Exhibit 5A-17** for each regulatory option, from the estimated baseline present value in that same Exhibit.

Step 8. Characterize Cancer Risk Estimation Uncertainties

There are a number of uncertainties associated with the annualized cancer estimates calculated in this RIA which are likely to under-estimate groundwater protection benefits:

- Estimates do not account for historic releases at operating plants. These releases could lead to further migration and future cancer risks without proper regulatory actions like groundwater monitoring.
- A linear slope for individual cancer risk was used to approximate the increase in cancer risks instead of the parabolic curve.
- Approximately 18% of plants dispose of CCR off-site only. Since these facilities were not accounted for, additional populations would be exposed to arsenic cancer risks from disposal as recently illustrated by the Gambrills, MD and Chesapeake, VA damage cases.
- Three new research studies[131] (2006, 2008, 2009) from EPA's Office of Research and Development, indicates that landfills may leach toxic metals much faster than originally believed. The damage cases at Gambrills MD and Chesapeake VA resulted in groundwater contamination much more quickly than would be expected, and are therefore consistent with this research.

[131] The three new EPA studies are:

1. "Characterization of Mercury-Enriched Coal Combustion Residues from Electric Utilities Using Enhanced Sorbents for Mercury Control," EPA 600/R-06/008. Office of Research and Development. Research Triangle Park, NC. January 2006.

- Multiple CCR disposal units at a single electric utility plant will all affect the same population. The risk estimates do not account for any additive risks from multiple units. However, the populations around these units are accounted for as described in **Appendix K2**.
- Multiple landfills could exist at some facilities. While the area of multiple surface impoundments was considered, the area of multiple landfills was not considered because EPA did not have survey results for dry handling even though some facilities are known to have more than one CCR landfill onsite.
- Residents on municipal water systems were not included in the 2009 risk assessment or in this analysis. However, exposure through this pathway is possible, which means this RIA likely under-estimated the human population that may be exposed to CCR.
- Populations that are farther than 1-mile that may be within the plume were not included.
- Some surface water bodies that this analysis assumes fully intercept the groundwater plume may in fact only partially intercept the plume, or not intercept it at all. This situation would be more likely to occur when surface water bodies are small or shallow with low flow rates, relative to the size of the aquifer underneath the CCR disposal unit, or are oriented such that they would not likely intercept the groundwater plume.
- Potential cancer cases resulting from consumption of recreationally-caught fish (contaminated by direct surface impoundment discharges and leaching from groundwater to surface water) are not included in the calculations.
- According to the EPA-ORCR 2009 CCR risk study, cancers can continue well after the analysis ends, but these cancers were not calculated in the population risk estimates.
- The use of a 5-year survival rate does not take into account those who may die from the cancer after year 5. Since some of the projected 5-year cancer survivors would have died in later years, they are undervalued in this assessment.
- The estimated number of cleanups is based only on modeled arsenic contamination. It does not account for cleanups based on hazard quotients over 1 for toxic constituents with non-cancer endpoints.

The following are some uncertainties that are likely to cause over-estimation of groundwater protection benefits:

- Cancer risk estimates might include some individuals who are down-gradient, but are outside the plume.
- All arsenic was assumed to be present in the arsenic III state. **Appendix K5** contains an analysis in which all arsenic was assumed to be speciated in the arsenic V state, and EPA concluded that even if some portion of arsenic was speciated in the arsenic V state, the final results would not significantly change.
- The male CSF estimate from NRC (2001) was used instead of the female CSF. **Appendix K5** contains an analysis in which this female CSF was applied.
- It is possible that some states would choose not to remediate CCR contamination above cleanup levels once local residents were placed on municipal or bottled water.

---

2. "Characterization of Coal Combustion Residues from Electric Utilities Using Wet Scrubbers for Multi-Pollutant Control," EPA/600/R-08/077. Office of Research and Development, Air Pollution Control Division. Research Triangle Park, NC. July 2008.
3. "Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data," EPA-600/R-09/151. Office of Research and Development, Air Pollution Control Division. Research Triangle Park, NC. December 2009.

- Willingness to pay estimates for non-fatal cancers has been assigned lower values in some research. An alternative valuation for these cancers is presented in **Appendix K5**.
- Medical treatment costs for those dying of cancer would not occur until the cancer was first discovered.

The following are some uncertainties that have an unknown effect on the benefits:

- This RIA assumed an evenly distributed population for establishing up-gradient and down-gradient populations, as well as for adjusting population for the WMU area.
- The latitude and longitude data of the WMU are uncertain.
- State programs serve as a proxy for units managed well and units managed poorly. However, there could be some WMUs managed well in states without any program. Conversely, there could be some WMUs managed poorly in states with an existing program.
- State regulatory programs affecting CCR disposal may be different than summarized in **Appendix E** of this RIA.
- Remediation costs are very site-specific, and the 25th and 75th percentile costs used here may overestimate or underestimate the true remediation costs of any particular cleanup. For example, the cost of responses to new releases caught early will sometimes be below the estimated costs. In other cases, even if contamination is identified early, those costs can exceed the 75th percentile estimates above. Responses at Gambrills MD and Chesapeake VA, two sites where CCR contamination was identified relatively early, are examples of sites where actual groundwater remediation responses will far exceed the cost estimates.
- This RIA assumed that discovery of CCR groundwater contamination and the resulting remediation costs would be incurred evenly over the 75 year period for regulated facilities and evenly over the 72 years for unregulated facilities. However, experience under the municipal solid waste program indicates that the incorporation of lined units could reduce contamination over time.

5B. Benefit of Preventing Future CCR Impoundment Structural Failures (Avoided Cleanup Costs)

In December 2008, a failure of a CCR impoundment at the Tennessee Valley Authority (TVA) Kingston Fossil Fuel Plant TN resulted in the environmental release of 5.4 million cubic yards of CCR. This impoundment failure event illustrated the potential environmental damage severity of structural failures involving CCR impoundments. This section of the RIA estimates future avoided impoundment failure cleanup costs as a potential benefit of the CCR proposed rule, according to the following 5-step method.

Step 1. Characterize CCR Impoundment Release Data

EPA began by examining the CCR impoundment survey data collected in March and April 2009 by EPA under the authority of Section 104(e) of the Comprehensive Emergency Response, Compensation and Liability Act (CERCLA), from 162 individual electric utility plants and from 61 electric utility corporate headquarters offices. EPA obtained its list of facilities from a 2005 Department of Energy (DOE) Survey of coal burning electric utility facilities. EPA used DOE's 2005 Energy Information Agency F767 database, which provides information on the disposition of coal ash from coal burning electricity producers. The database included "steam-electric plants with a generator nameplate rating of 10 or more megawatts." The term "generator," means the actual electric generator, not the whole plant. A plant typically will have one or more generators. EPA also sent the letters to corporate offices of the electric utilities to make sure that all of their facilities were accounted for due to limitations in the DOE survey. Based on information received in response to the initial letter to the utility corporate headquarters offices, on April 27, 2009, EPA sent information request letters to an additional 48 plants that had been identified by the corporate offices.

Based EPA's initial collation of the mail survey data, 42 CCR releases from impoundments were reported, all of which occurred within the last 15 years (1995-2009), in response to Question 8 of the survey questionnaire which asked for electric power plants to report all CCR impoundment releases which occurred within the last 10 years (i.e., 1999 to 2008). **Exhibit 5B-1** below presents a summary of these 42 CCR impoundments release cases. **Appendix K11** provides additional information about these 42 release cases.

Exhibit 5B-1

2009 EPA Mail Survey Data for 42 Historical Release Events Involving CCR Impoundments at Coal-Fired Electric Utility Plants

Item	Owner Company	Name of Coal-Fired Electric Plant	Name of CCR Impoundment	Capacity (acre feet)	Height (feet)	Year Installed	CCR Release (gallons)	Release year	Age at release
1	Allete Inc	Clay Boswell Power Station	Coal Pile Sump	1	20	1972	Unknown	2008	36
2	Ameren Energy Generating Co	Meredosia Power Station	Fly Ash Pond	650	24	1968	500	2006	38
3	American Electric Power	Cardinal Power Station	Fly Ash Reservoir 2	11350	237	1987	Unknown	2004	17
4	City of Springfield	Lakeside	Metal Cleaning Waste Basin		4	1982	Unknown	1998	16
5	City of Springfield	Lakeside	Metal Cleaning Waste Basin		4	1982	Unknown	2009	27
6	Dominion	Chesterfield Power Station	Lower (Old) Ash Pond	740	19	1964	Unknown	2005	41
7	Duke Energy Corp	Walter C. Beckjord Power Station	Ash Pond C	1400	50	1966	Unknown	1999	33
8	East Kentucky Power Coop Inc	Dale Power Station	Dale Ash Pond #4	112	26	1977	Unknown	2008	31
9	First Energy Generation Corp	Bruce Mansfield Power Station	Lakeside Ash Pond		20	1957	Unknown		
10	Georgia Power Co	Harllee Branch Power Station	C	1240	83	1971	Unknown	2000	29
11	Georgia Power Co	Bowen Power Station	Ash Pond	3719	45	1968	Unknown	2002	34
12	Georgia Power Co	Bowen Power Station	Ash Pond	3719	45	1968	Unknown	2008	40
13	Indianapolis Power & Light Co	Eagle Valley Generating Station	A/B/C Pond			1949	30,000,000	2007	58
14	Indianapolis Power & Light Co	Eagle Valley Generating Station	A/B/C Pond			1949	30,000,000	2008	59
15	Kansas City Power & Light Co	LaCygne Generating Station	Scrubber Sludge Ponds	6818	45	1971	Unknown	2007	36
16	Kansas City Power & Light Co	LaCygne Generating Station	Scrubber Sludge Ponds	6818	45	1971	Unknown	2007	36
17	Kansas City Power & Light Co	LaCygne Generating Station	Scrubber Sludge Ponds	6818	45	1971	Unknown	2009	38
18	MidAmerican Energy Co	Riverside Generating Station	South Surface Impoundment	109	10	1967	Unknown	2002	35
19	Northern Indiana Pub Serv Co	R. M. Schahfer Power Station	Little Blue Run Dam	84300	388	1975	Unknown		
20	Northern States Power Co	Sherburne County Power Station	Pond No. 2		57	1984	600	2007	23
21	PacifiCorp	Naughton Power Station	FGD Pond #2	382	25	1999	Unknown	2006	7
22	PacifiCorp	Naughton Power Station	North Ash Pond	2100	61	1973	11,100,000	2007	34
23	PacifiCorp	Dave Johnston Power Station	Blowdown Canal	1	0	1972	14,400	2009	37
24	PacifiCorp	Jim Bridger Power Station	FGD Pond #1	1340	32	1979	Unknown		
25	PacifiCorp	Jim Bridger Power Station	FGD Pond #2	11534	42	1990	Unknown		
26	PPL Generation, LLC	PPL Montour Power Station	Detention Basin	53	8	1968	Unknown	2004	36
27	PPL Generation, LLC	PPL Martins Creek Power Station	Ash Basin 4	40	43	1989	100,000,000	2005	16
28	PPL Generation, LLC	PPL Montour Power Station	Ash Basin No. 1		40	1968	Unknown	2007	39
29	PPL Montana LLC	Colstrip Steam Electric Station	Units 1 & 2 Stage Evaporation Ponds	4370	88	1992	100	1995	3
30	PPL Montana LLC	Colstrip Steam Electric Station	Units 3 & 4 Effluent Holding Pond	17000	138	1983	Unknown	1999	16
31	PPL Montana LLC	Colstrip Steam Electric Station	Units 1 & 2 Stage Evaporation Ponds	4370	88	1992	50	2000	8
32	PPL Montana LLC	Colstrip Steam Electric Station	Units 1 & 2 A Pond	245	25	1975	2,700	2003	28
33	PPL Montana LLC	Colstrip Steam Electric Station	Units 3 & 4 Effluent Holding Pond	17000	138	1983	Unknown	2004	21
34	PPL Montana LLC	Colstrip Steam Electric Station	Units 3 & 4 Effluent Holding Pond	17000	138	1983	Unknown	2005	22
35	PPL Montana LLC	Colstrip Steam Electric Station	Units 1 & 2 Stage Evaporation Ponds	4370	88	1992	2,000	2006	14
36	Progress Energy Carolinas Inc	W. H. Weatherspoon Power Station	1979 Pond		28	1979	Unknown	2001	22
37	Progress Energy Carolinas Inc	Roxboro Power Station	FGD Flush Pond		33	2008	Unknown	2008	0
38	Santee Cooper	Winyah Power Station	Unit 3 & 4 Slurry Pond	1190	30	1980	Unknown	2008	28
39	Tennessee Valley Authority	Kingston Power Station	Dredge Pond			1955	1,100,000,000	2008	53
40	Tennessee Valley Authority	Widows Creek Power Station	Gypsum Stack (Wet Stacking Area)	11157	75	1986	6,100,000	2009	23
41	Xcel Energy	PSCo Comanche Station	Polishing Pond (#4)	12	0	1972	3,000	2007	35
42	Xcel Energy	PSCo Valmont Station	West Ash Settling Pond	16	0	1964	5,050	2008	44
			Minimum =	1	0	1949	50	1995	0
			Maximum =	84,300	388	2008	1,100,000,000	2009	59
			Mean (average) =	6,874	59	1976	85,148,560	2005	29
			Median =	1,750	42	1974	5,050	2007	32
			Column total (based on gallons released data for 15 of the 42 events) =				1.277 billion		

As displayed below in **Exhibit 5B-2**, EPA was able to collect cost data on three of the most significant and recent release cases (i.e., cases resulting in the most gallons released):

Exhibit 5B-2
Cleanup Costs for Three Recent Environmental Releases Involving CCR Impoundments

Item	Owner company name	Coal-fired electric utility Plant name & location	Impoundment release year	Release volume (gallons)	EPA-assigned cost for this RIA*
1	PPL Generation LLC	PPL Martins Creek Power Station PA (“Ash basin 4”)	2005	100 million	$37 million
2	Tennessee Valley Authority (TVA)	Kingston TN (“Dredge cell dike”)	2008	1.1 billion (5.4 million cubic yards)	$3.0 billion
3	Tennessee Valley Authority (TVA)	Widows Creek Power Station TN (“Gypsum stack”)	2009	6.1 million	$9.2 million
			Column totals =	1.2061 billion	$3.0462 billion

* Data sources:

- Item 1: Page 29 of “Public Health Issues Surrounding Coal as an Energy Source,” Brian Schwartz, MD, MS, Department of Environmental Health Sciences, February 2009 at http://www.jhsph.edu/bin/g/f/Coal_and_public_health_Mar_2009.pdf
- Item 2: $3.0 billion is EPA’s initial “social cost” estimate assigned in this RIA to the December 2008 TVA Kingston TN impoundment release event. Social cost represents the opportunity costs incurred by society, not just the monetary costs for cleanup. OMB's 2003 "Circular A-4: Regulatory Analysis" (page 18) instructs Federal agencies to estimate "opportunity costs" for purpose of valuing benefits and costs in RIAs. This $3.0 billion social cost estimate is larger than TVA’s $933 million to $1.2 billion cleanup cost estimate (i.e., TVA’s estimate as of 03 Feb 2010), because EPA’s social cost estimate consists of three other social cost elements in addition to TVA’s cleanup cost estimate: (a) TVA cleanup cost, (b) response, oversight and ancillary costs associated with local, state, and other Federal agencies, (c) ecological damages, and (d) local (community) socio-economic damages. **Appendix Q** to this RIA provides EPA's documentation and calculation of these four cost elements, which total $3.0 billion in social cost. **Appendix Q** to this RIA also provides an alternative, lower estimate of social costs, based on different modeling assumptions for capturing such costs. This alternative analysis suggests that TVA’s cleanup costs alone may be close to the social costs associated with the Kingston impoundment failure. EPA specifically requests comment on this social cost estimate, and will continue to develop this estimate for the final rule.
- Item 3: 25 January 2010 e-mail entitled “TVA Widow’s Creek Clean Up Info” from Anda Ray, Sr. Vice President of TVA Environment & Technology and TVA Sustainablity Officer, to Jim Kohler, EPA-ORCR Environmental Engineer.

Given this limited data, this RIA attempted to quantify the likelihood and costs of future releases using a historical methodology. First, distinguished between three types of historical CCR impoundment structural failures (i.e., releases):

1. Catastrophic failures: Involving a billion gallons or more. These releases would have the potential to cause as much or more damage than occurred in December 2008 at TVA's Kingston TN plant.
2. Significant failures: Involving between a million and a billion gallons. These would be less than a complete failure, but still costly. TVA Widow's Creek (6,100,000 gallons) and PPL Martin's Creek (100,000,000 gallons) are the lowest and highest known releases in this category, respectively. As an approximation, EPA assumes their costs should also bracket the costs of other significant releases.[132] Thus, EPA estimates that the typical costs of a significant failure will be \$23.1 million (the average of TVA Widow's Creek and PPL Martin's Creek).
3. Seepage failures: Involving releases below one million gallons. While these releases can still be significant and present risks to human health and the environment, this RIA does not include these in this analysis, which under-estimates total costs using this historical methodology. These smaller seeps are common to earthen dams and are not necessarily a problem unless the seepage volume is increasing or the seepage becomes cloudy - indicating the possible transport of CCR through the embankment.

Step 2. Fit a Distribution of Future Releases.

For the two categories consisting of catastrophic and significant releases, this RIA estimates not only the cleanup costs of these events, but also their frequency. Since relatively little data are available, this RIA applies a Poisson distribution. The Poisson distribution is used when rare discrete events, and not continuous functions, are being modeled. To be a Poisson process, the arrival of events must satisfy stationarity, non-multiplicity, and independence. Here, the events (releases) satisfy non-multiplicity because the probability of two or more events in a short period of time is very small. They also satisfy independence because releases occurring in one time period are independent of releases in any other time period. However, as these impoundments increase in age, it is quite likely that releases might increase over time, which would violate the stationarity requirement. This potential problem is dealt with in Step 4 below. For the present, it will be assumed that releases occur at a constant rate in the future. In general, a Poisson distribution can be represented by the equation:

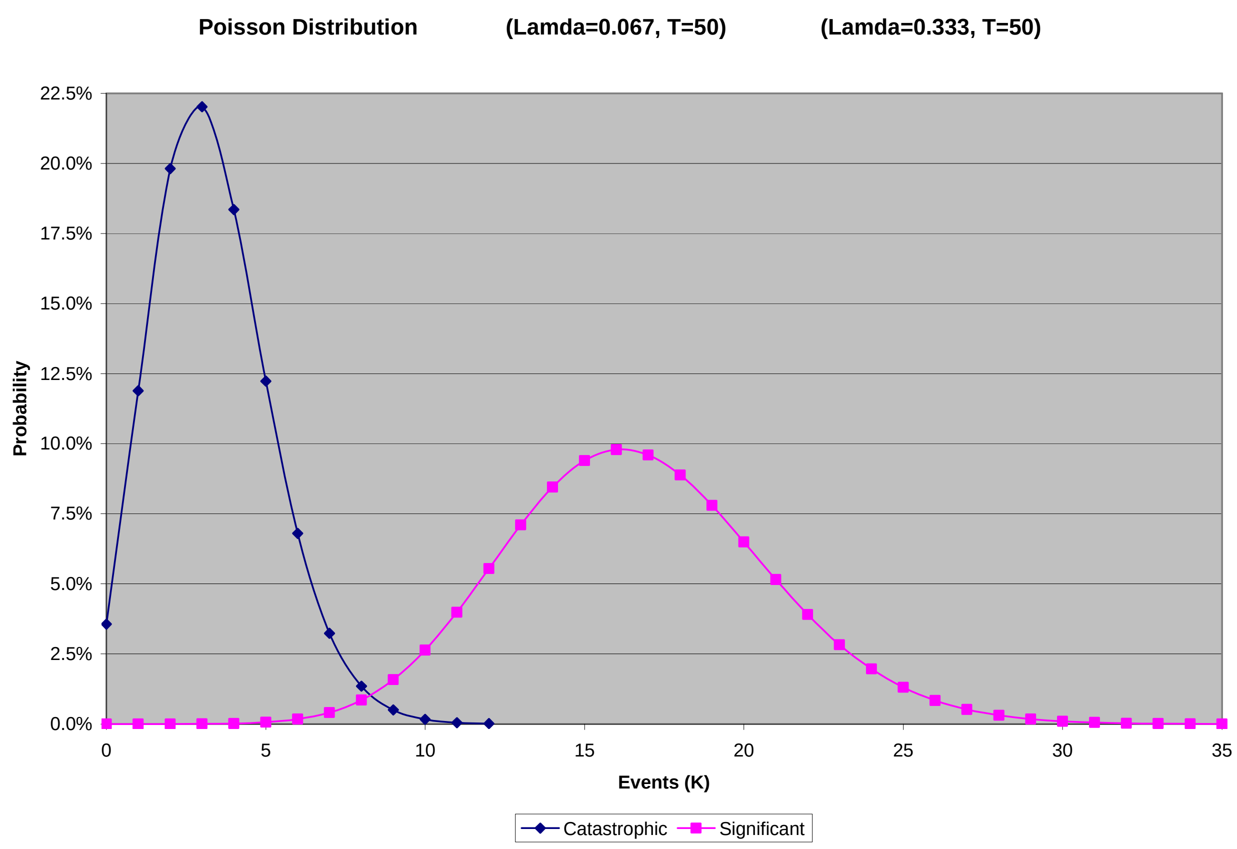
$$\frac{(\lambda t)^k e^{-(\lambda t)}}{k!}$$

[132] This is a valid assumption if cleanup costs are closely correlated to tonnage released. Since cost modeling software typically requires an input of gallons released, the correlation is likely strong.

Where:
λ = Observed arrival rate (0.067 for catastrophic, 0.333 for significant);[133]
t = Time period being projected (50 years)
e = Constant (2.71828183)
k = Number of impoundment release events projected

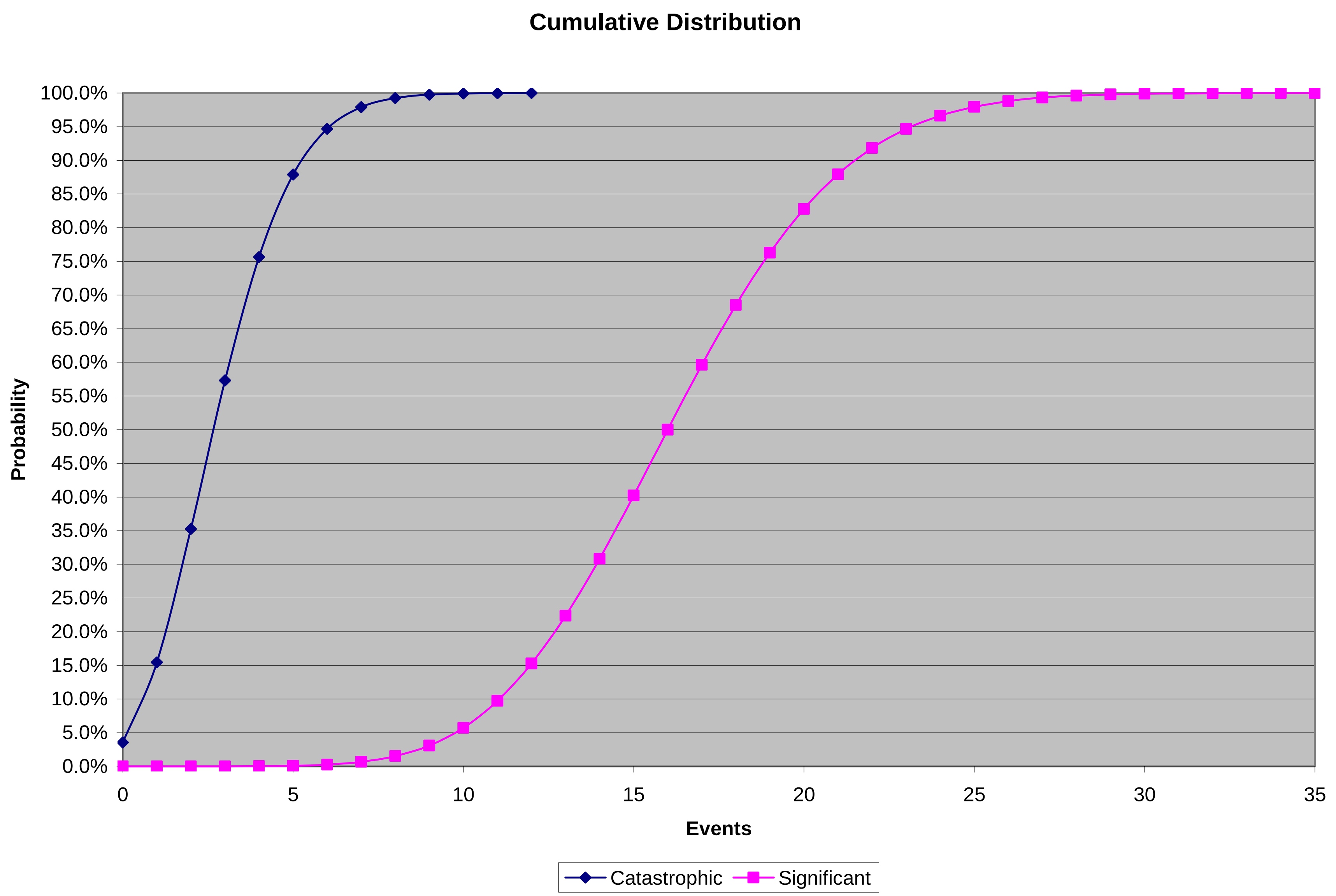
The probabilities of a specific number of future CCR impoundment catastrophic or significant releases are illustrated in **Exhibit 5B-2** and **Exhibit 5B-3** (cumulative distribution) below.

Exhibit 5B-2



[133] λ was calculated by dividing the number of events observed between 1995 and 2009 by the 15-year time period.

Exhibit 5B-3



Cumulative Distribution
100.0%
95.0%
90.0%
85.0%
80.0%
75.0%
70.0%
65.0%
60.0%
55.0%
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Probability
0
5
10
15
20
25
30
35
Events
Catastrophic
Significant

Step 3. Calculate Future Impoundment Failure Avoided Cleanup Cost Benefits

After fitting a distribution of the number of releases likely to occur, EPA proceeded to combine these with the cost data presented in Step 1 above. This was done for the average case and three high-end cases (90^{th}, 95^{th}, and 99^{th} percentiles). For each case, the number of expected releases seen in **Exhibit 5B-4** below was divided by 50 to get the expected number of releases per year. These events were then multiplied by their respective costs, and the catastrophic and significant release values were summed in each year.

Exhibit 5B-4
Projected Future CCR Impoundment Releases
Based on 15-Year (1995-2009) Period of Historical CCR Impoundment Structural Failure Cases

Type of CCR Impoundment Release	Expected Number of Release Events				Assigned Cost Per Failure Event
	99^{th} %-ile	95^{th} %-ile	90^{th} %-ile	Average	
Catastrophic	8	7	6	3	$3.0 billion*
Significant	27	24	22	17	$23.1 million

* Note: $3.0 billion is EPA's initial "social cost" estimate assigned in this RIA to the December 2008 TVA Kingston TN impoundment release event. Social cost represents the opportunity costs incurred by society, not just the monetary costs for cleanup. OMB's 2003 "Circular A-4: Regulatory Analysis" (page 18) instructs Federal agencies to estimate "opportunity costs" for purpose of valuing benefits and costs in RIAs. This $3.0 billion social cost estimate is larger than TVA's $933 million to $1.2 billion cleanup cost estimate (i.e., TVA's estimate as of 03 Feb 2010), because EPA's social cost estimate consists of three other social cost elements in addition to TVA's cleanup cost estimate: (a) TVA cleanup cost, (b) response, oversight and ancillary costs associated with local, state, and other Federal agencies, (c) ecological damages, and (d) local (community) socio-economic damages. **Appendix Q** to this RIA provides EPA's documentation and calculation of these four cost elements, which total $3.0 billion in social cost. **Appendix Q** to this RIA also provides an alternative, lower estimate of social costs, based on different modeling assumptions for capturing such costs. This alternative analysis suggests that TVA's cleanup costs alone may be close to the social costs associated with the Kingston impoundment failure. EPA specifically requests comment on this social cost estimate, and will continue to develop this estimate for the final rule.

However, EIA data indicate that there is a current trend among coal-fired power plants to switch from wet handling to dry handling. As seen below in **Exhibit 5B-5**, this will lead to a decrease of approximately 300,000 tons being disposed of in surface impoundments per year, or approximately 1.3% of the initial 22.5 million tons in 2005. Since the tons disposed of (and similarly, the number of surface impoundments) likely relate to the number of releases, these decreases are accounted for by using 2005 wet tonnage as a benchmark and assuming the quantity of wet tonnage declines 300,000 tons per year. The cost for each year is multiplied by the remaining percent still handled wet.

Exhibit 5B-5 Decreasing CCR Wet Disposal Trend					
Year	% CCR Still Disposed Wet	Year	% CCR Still Disposed Wet	Year	% CCR Still Disposed Wet
2005	100.0%	2024	75.2%	2043	50.3%
2006	98.7%	2025	73.9%	2044	49.0%
2007	97.4%	2026	72.6%	2045	47.7%
2008	96.1%	2027	71.2%	2046	46.4%
2009	94.8%	2028	69.9%	2047	45.1%
2010	93.5%	2029	68.6%	2048	43.8%
2011	92.2%	2030	67.3%	2049	42.5%
2012	90.9%	2031	66.0%	2050	41.2%
2013	89.5%	2032	64.7%	2051	39.9%
2014	88.2%	2033	63.4%	2052	38.6%
2015	86.9%	2034	62.1%	2053	37.3%
2016	85.6%	2035	60.8%	2054	36.0%
2017	84.3%	2036	59.5%	2055	34.7%
2018	83.0%	2037	58.2%	2056	33.3%
2019	81.7%	2038	56.9%	2057	32.0%
2020	80.4%	2039	55.6%	2058	30.7%
2021	79.1%	2040	54.3%	2059	29.4%
2022	77.8%	2041	52.9%	2060	28.1%
2023	76.5%	2042	51.6%	2061	26.8%

The final step in the calculation was to take the adjusted costs in each year and discount them by 3% and 7% to calculate the present value (PV) as displayed in **Exhibit 5B-6** below. A full table of year-by-year costs can be found in **Appendix K11**. Approximately 97% of these costs result from catastrophic releases, and the remaining 3% result from significant releases. It is important to note that no costs are attributed to 2012-2014 as the rule will not be adopted and implemented until 2015. However, all costs beginning in 2015 are assumed to be avoided under subtitle C. Although facilities are given 5 years to phase out CCR impoundments under one of the proposed regulatory options, the other options require regular inspections of CCR impoundments to prevent catastrophic or significant releases.

For a subtitle D approach, expect delayed compliance with the requirement that surface impoundments be lined and that existing unlined surface impoundments be closed if they aren't lined when compared to compliance with the surface impoundment phaseout under subtitle C. Compliance will largely depend on the uncertainties of state regulations, the implementation of those regulations, and citizen suits. Also, since some facilities will line their surface impoundments instead of converting to dry handling, these facilities will continue to pose risks for catastrophic failure even though they may no longer require cleanup costs for groundwater contamination. The percent of states with at least some surface impoundment regulations, 48% as described in **Appendix K9**, is used as a proxy for the phase-out of existing impoundments. However, the 5.5% of those 48% that would retrofit with composite liners could still pose release risks. This results in 45% of the subtitle C benefits being realized in subtitle D.

For the subtitle D prime approach, existing impoundments will not need to be lined, but can continue to operate until they close. Third-party inspections of surface impoundments would be required under this option, but it is difficult to predict the extent to which these inspections would actually occur and would decrease catastrophic failures. In any case, the benefits of subtitle D prime would be less than those of subtitle D and greater than the baseline in terms of costs of catastrophic failures avoided. Thus, EPA used the midpoint as a best-estimate of the effectiveness that these inspections would have, which results in 23% of the subtitle C benefits being realized in a subtitle D prime approach.

Exhibit 5B-6
Estimate of Future CCR Impoundment Structural Failure Cleanup Costs Avoided As Benefits Under Three RCRA Regulatory Options
(present value in $millions)

Discount Rate	99th %-ile	95th %-ile	90th %-ile	Average
Subtitle C special waste				
3%	$7,407	$6,483	$5,567	$3,124
7%	$4,177	$3,656	$3,140	$1,762
Subtitle D (version 2)				
3%	$3,333	$2,917	$2,505	$1,406
7%	$1,880	$1,645	$1,413	$793
Subtitle “D Prime”				
3%	$1,704	$1,491	$1,280	$719
7%	$961	$841	$722	$405

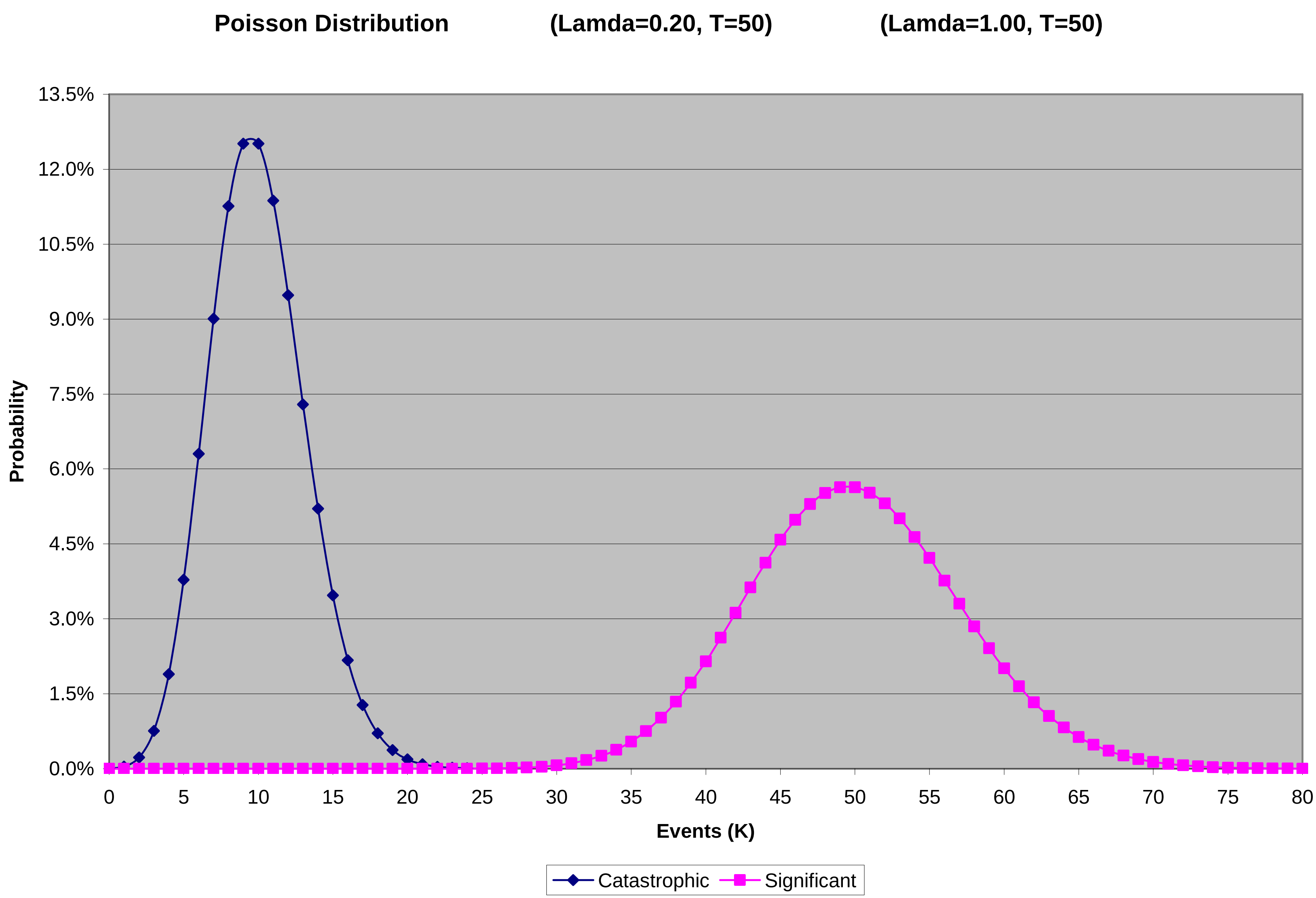
Step 4. Account for Increasing CCR Impoundment Release Trend

In Step 2 above, it was noted that the arrival rate of releases might violate the stationarity requirement for Poisson distributions. This is due to the trend of increasing release frequency based on the aging structure of the earthen impoundments. EPA attempted to discern whether a time trend was likely between releases and the average age of the surface impoundments. First, EPA limited the universe to the 38 releases that had reported release dates within the past 15 years. Next, the number of releases in 2009 was scaled up to account for the fact that the EPA mail survey questionnaires were returned by June of 2009. Thus, the four releases in 2009 were scaled up by 12 months/6 months, or a factor of 2. Using commission age and only those releases for which a release year was known, EPA constructed the profile of releases in the years ranging from 1995 to 2009 displayed in **Exhibit 5B-7** below.

Exhibit 5B-7 Summary of 15-Year (1995-2009) Period of Historical CCR Impoundment Structural Failures			
Year	CCR impoundment average age	Count of impoundment release events	% of all CCR impoundments releasing
1995	21.1	1	0.20%
1996	21.5	0	0.00%
1997	22.5	0	0.00%
1998	23.5	1	0.19%
1999	24.5	2	0.38%
2000	25.3	2	0.38%
2001	26.1	1	0.19%
2002	27.0	2	0.37%
2003	27.9	1	0.19%
2004	28.7	3	0.55%
2005	29.7	3	0.55%
2006	30.5	3	0.55%
2007	31.3	7	1.27%
2008	32.3	8	1.45%
2009	33.0	8	1.44%

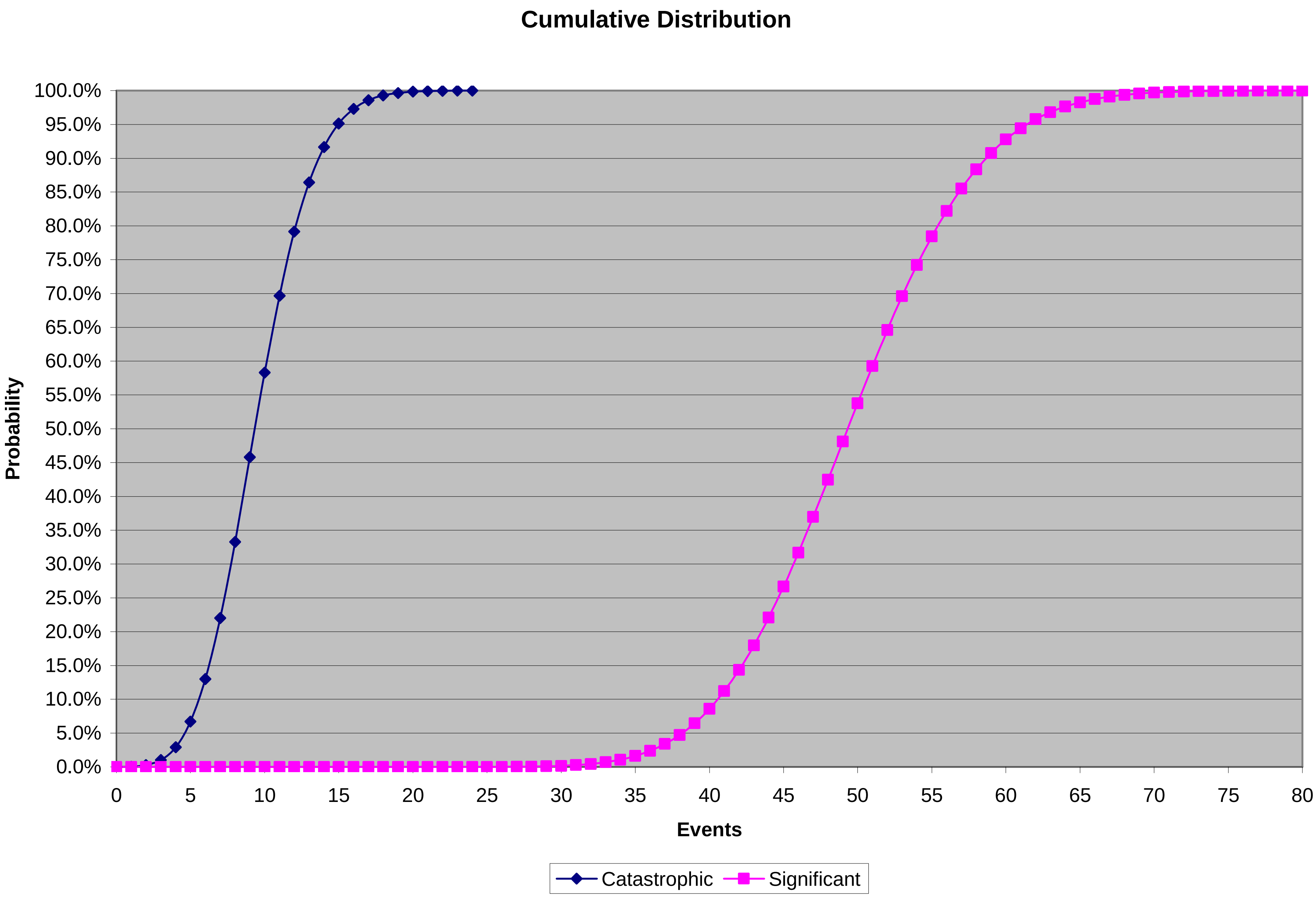
As can be seen in the table above, both the absolute number of releases and the percent of units with releases have increased over the past 15 years. All five significant releases and the catastrophic release at TVA Kingston TN have happened since 2005. To account for this potential lack of stationarity, EPA conducted a sensitivity analysis with alternate values of λ. Instead of looking at the last 15 years, EPA assumed that the previous 5-year period best reflects impoundment releases. Thus, in place of the earlier calculated lambda values (0.067 and 0.333) derived by dividing the number of catastrophic and significant failures between 1995 and 2009 by 15, EPA calculated higher lambdas (0.2 and 1) by dividing the catastrophic and significant failures between 2005 and 2009 by 5. Using these new lambda values, but keeping the same 50-year forecast period, EPA derived the Poisson distribution seen in the two figures below. The probability of a specific number of catastrophic or significant releases is illustrated in **Exhibit 5B-8** and **Exhibit 5B-9** (cumulative distribution) below.

Exhibit 5B-8



Poisson Distribution
(Lamda=0.20, T=50)
(Lamda=1.00, T=50)
Probability
13.5%
12.0%
10.5%
9.0%
7.5%
6.0%
4.5%
3.0%
1.5%
0.0%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Events (K)
Catastrophic
Significant

Exhibit 5B-9



Cumulative Distribution
100.0%
95.0%
90.0%
85.0%
80.0%
75.0%
70.0%
65.0%
60.0%
55.0%
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Probability
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Events
Catastrophic
Significant

With these new distributions, EPA performed the same calculations as described in Step 3. The expected number of releases in **Exhibit 5B-10** below was divided by 50 to get releases per year; these releases were multiplied by the cost per release; an adjustment was made to account for voluntary switching to dry handling; and yearly values were discounted. A full exhibit of year-by-year costs can be found in **Appendix K11**.

Exhibit 5B-10
Projection of Future CCR Impoundment Releases
Based on 5-Year (2005-2009) Historical CCR Impoundment Release Cases

Type of CCR impoundment release event	Expected Number of Release Events				Cost per CCR impoundment release event
	99th %-ile	95th %-ile	90th %-ile	Average	
Catastrophic	18	15	14	10	$3.0 billion*
Significant	67	62	59	50	$23.1 million

* Note: $3.0 billion is EPA's initial "social cost" estimate assigned in this RIA to the December 2008 TVA Kingston TN impoundment release event. Social cost represents the opportunity costs incurred by society, not just the monetary costs for cleanup. OMB's 2003 "Circular A-4: Regulatory Analysis" (page 18) instructs Federal agencies to estimate "opportunity costs" for purpose of valuing benefits and costs in RIAs. This $3.0 billion social cost estimate is larger than TVA's $933 million to $1.2 billion cleanup cost estimate (i.e., TVA's estimate as of 03 Feb 2010), because EPA's social cost estimate consists of three other social cost elements in addition to TVA's cleanup cost estimate: (a) TVA cleanup cost, (b) response, oversight and ancillary costs associated with local, state, and other Federal agencies, (c) ecological damages, and (d) local (community) socio-economic damages. **Appendix Q** to this RIA provides EPA's documentation and calculation of these four cost elements, which total $3.0 billion in social cost. **Appendix Q** to this RIA also provides an alternative, lower estimate of social costs, based on different modeling assumptions for capturing such costs. This alternative analysis suggests that TVA's cleanup costs alone may be close to the social costs associated with the Kingston impoundment failure. EPA specifically requests comment on this social cost estimate, and will continue to develop this estimate for the final rule.

EPA estimated subtitle C (special waste) costs avoided that were between two and three times the costs predicted in Step 3. This difference helps to explain how significant the assumption of lambda, and the potential non-stationarity of the data, can have on the final results. Sensitivity results were also calculated for subtitle D (version 2) and subtitle "D prime" approaches. As assumed above for the subtitle D (version 2) option, EPA expects delayed compliance with the requirement that surface impoundments be lined and that existing unlined surface impoundments be closed if they are not lined when compared to compliance with the surface impoundment phaseout under subtitle C. Compliance will largely depend on the uncertainties of state regulations, the implementation of those regulations, and citizen suits. Also, since some facilities will line their surface impoundments instead of converting to dry handling, these facilities will continue to pose risks for catastrophic failure even though they may no longer require cleanup costs for groundwater contamination. The percent of states with at least some surface impoundment regulations, 48% as described in **Appendix K9,** is used as a proxy for the phase-out of existing impoundments. However, the 5.5% of those 48% that would retrofit with composite liners could still pose release risks. This results in 45% of the subtitle C (special waste) benefits being realized in Subtitle D (version 2).

For the subtitle "D prime" approach, existing impoundments will not need to be lined, but can continue to operate until they close. Third-party inspections of surface impoundments would be required under this option, but it is difficult to predict the extent to which these inspections would actually occur and would decrease catastrophic failures. In any case, the benefits of subtitle "D prime" would be less than those of subtitle D (version 2) and greater than the baseline in terms of costs of catastrophic failures avoided. Thus, this RIA used the midpoint as a best-estimate of the effectiveness that these inspections would have. This results in 23% of the subtitle C (special waste) benefits being realized in a subtitle "D prime" approach. **Exhibit 5B-11** below presents the avoided cleanup cost estimates for the three regulatory options (i.e., Subtitle C special waste, Subtitle D version 2, and Subtitle "D prime").

Exhibit 5B-11
Future CCR Impoundment Structural Failure Cleanup Costs Avoided
($millions present value over 50-years)

Discount Rate	99th %-ile	95th %-ile	90th %-ile	Average
Subtitle C (special waste)				
3%	$16,708	$13,966	$13,043	$9,371
7%	$9,423	$7,876	$7,356	$5,285
Subtitle D (version 2)				
3%	$7,519	$6,285	$5,869	$4,217
7%	$4,240	$3,544	$3,310	$2,378
Subtitle "D Prime"				
3%	$3,843	$3,212	$3,000	$2,155
7%	$2,167	$1,811	$1,692	$1,216

Step 5. Estimate Future Avoided Cleanup Costs for Two Alternative Impoundment Failure Scenarios (Scenario #2 & #3)

Not all of these releases are likely to pose the type of catastrophic risks that were seen at TVA's Kingston, TN plant. Catastrophic releases are more likely where there is a high potential for impoundment materials to disperse over large areas. This is most likely to occur at tall impoundments. Thus, this RIA presents an alternative assumption that the Kinston-like catastrophic releases would only occur at these tall impoundments. In addition, as age appears to be a driving factor in releases, this analysis also assumed that Kingston-like catastrophic releases would occur at older impoundments. Particularly, 96 impoundments of the 584 covered in the 2009 EPA mail survey were at least 40 feet tall and at least 25 years old. The analysis below assumes that 10% - 20% of these impoundments could fail within the next 20 years. This is equivalent to the upper percentiles of failures predicted in Steps 3 and 4 above; however it moves the costs forward in time, to show the sensitivity of the benefits with respect to time.

Exhibit 5B-12 Scenario #2: Cleanup Cost Estimates for CCR Impoundment Catastrophic Failures @ 10% Failures						
% of Tons Baseline	Year	Costs @3% (in millions)	Costs @7% (in millions)	% of Tons Subtitle C	Costs @3% (in millions)	Costs @7% (in millions)
88.2%	2014	-	-	88.2%	-	-
86.9%	2015	$1,146	$1,022	70.6%	$930	$830
85.6%	2016	$1,095	$941	52.9%	$677	$582
84.3%	2017	$1,047	$866	35.3%	$438	$362
83.0%	2018	$1,001	$797	17.6%	$213	$169
81.7%	2019	$956	$733	0.0%	$0	$0
80.4%	2020	$914	$674			
79.1%	2021	$873	$619			
77.8%	2022	$833	$569			
76.5%	2023	$796	$523			
75.2%	2024	$759	$481			
73.9%	2025	$724	$441			
72.6%	2026	$691	$405			
71.2%	2027	$659	$372			
69.9%	2028	$628	$341			
68.6%	2029	$598	$313			
67.3%	2030	$569	$287			
66.0%	2031	$542	$263			
64.7%	2032	$516	$241			
63.4%	2033	$491	$221			
62.1%	2034	$467	$202			
Baseline Total		$15,305	$10,309	C Total	$2,259	$1,943

Given the costs above, the total benefits of a Subtitle C phase out over 5 years would be the difference between the potential catastrophic failure costs under C and the catastrophic failure costs under the baseline. For the 20% "Scenario #3", this figure is double, as displayed below in **Exhibit 5B-13**. For Subtitle D, it is assumed that the 48% of states (by tonnage, as described in **Appendix K9**) that have at least some regulatory oversight currently, would enforce the retrofitting requirement. However, since 5.5% of impoundments already have composite liners, these units would not be expected to close. Thus 94.5% times 48% leads to an approximately 45% of the Subtitle C benefits. For Subtitle D prime, the requirement of dam safety inspections would be likely to result in some amount catastrophic failure reduction between the baseline and the Subtitle D approach. This RIA uses the midpoint, a 23% reduction, as a best estimate. While these estimates are likely much higher than the actual benefits from preventing catastrophic failures, they do help to define the upper bound of what is possible under current practices of mismanagement.

Exhibit 5B-13 Avoided Future CCR Impoundment Catastrophic Failure Cleanup Costs ($millions present value)			
Scenarios	Subtitle C Special waste	Subtitle D (version 2)	Subtitle "D Prime"
Scenario #2: Assuming 10% of the 96 Impoundments Fail			
at 3%	$13,046	$5,918	$2,959
at 7%	$8,366	$3,795	$1,897
Scenario #3: Assuming 20% of the 96 Impoundments Fail			
at 3%	$26,092	$11,836	$5,918
at 7%	$16,732	$7,590	$3,795
Note: These future CCR impoundment failure cleanup costs avoided do not account for avoided costs from releases that are less than "catastrophic."			

5C. Induced Effect of RCRA Regulation on CCR Beneficial Use

This section assesses the potential effects of the different regulatory options for disposal of CCR on the future annual quantities of CCR beneficially used. It also estimates the values of social and economic impacts associated with baseline and different levels of beneficial use. It estimates the expected increase in beneficial use from increased cost of disposal of CCR and evaluates future changes in the beneficial use of coal combustion residuals (CCR) as a result of a potential "*stigma*" effect.

5C1. Baseline Environmental & Economic Benefits of CCR Beneficial Use by Other Industries

According to CCR beneficial use market data compiled for year 2005 as displayed below in **Exhibit 5C-1**, and extrapolated in this RIA to 2009 as displayed in **Exhibit 5C-2** below, 62 million tons of annual CCR generated by **272** of the 495 electric utility plants is not disposed, but is beneficially used as material substitutes in at least **14 industrial applications**. The purpose of this section is to provide estimates of two categories of baseline benefits associated with baseline CCR beneficial use, consisting of five sub-elements (i.e., 1a, 1b, 2a, 2b, 2c):

1. Economic benefits: Economic benefits estimated in this section are based on recent market prices and include:
   a. Annual cost savings to over 14 CCR beneficial use industries in the form of reduced industrial raw and intermediate materials purchase prices relative to purchasing higher-priced substitute materials, compared to paying electric utility plants lower prices for buying and using CCR as an industrial material.
   b. Cost savings to electric utility plants for avoiding the cost of disposing CCR which is beneficially used.

2. Lifecycle benefits: Lifecycle benefits as quantified in this RIA are based on market or social values assigned to the relative physical consequences of using CCR compared to substitute industrial materials, through the entire "materials flow" chain of the national economy which consists of five basic stages (1. raw materials extraction, 2. materials processing, 3. industrial manufacturing, 4. product use, 5. product end-of-lifespan disposal/recycling). Three lifecycle physical consequences are quantified in this RIA but not all monetized:
   a. Lifecycle resource consumption savings (water & energy consumption)
   b. Lifecycle air pollution emissions (GHG, CO, NOx, SOx, PM, Hg, Pb)
   c. Lifecycle wastes (wastewaters and solid wastes)

   Lifecycle benefits in this RIA are only based on three categories of CCR beneficial uses (i.e., concrete, cement, and wallboard representing a sub-total of 58% of all CCR beneficial uses) which were addressed in the prior 2008 study[134] used as a reference for this section of the RIA.

---

[134] Source: EPA Office of Solid Waste "Waste and Materials-Flow Benchmark Sector Report: Beneficial Use of Secondary Materials – Coal Combustion Products," Final Report, EPA report nr. 530-R-08-003, prepared by Industrial Economics Inc., 95 pages, 12 Feb 2008 at: http://www.epa.gov/osw/partnerships/c2p2/pubs/benuse07.pdf. The beneficial use market data cited in this source is summarized from the American Coal Ash Association (ACAA) 2005 national survey of the electric utility industry.

Lifecycle benefits encompass economic benefits so these two categories are not additive but duplicative. Lifecycle benefits in this RIA are based on "lifecycle analysis" (LCA), a method which involves estimating both internalized (e.g., market priced) and externalized (e.g., costs not captured in market prices) material flow consequences:

> "*Life cycle analysis depicts the production of materials in a system of complex physical outcomes, and can predict the incremental physical consequences of a change in material inputs, technology, waste management practices, or price incentives. In LCA, as in reality, one change in the physical system, such as the substitution of fly ash for virgin Portland cement, leads to a corresponding cascade of economy-wide impacts and shifts. As inputs are substituted, technologies, physical outputs, and exposure pathways change. Using a range of modeling platforms and life cycle inventories to calculate the outputs associated with each incremental change, LCA calculates the net result of all of these interactions, capturing the total incremental effect of a change in operations on physical environmental impacts such as air emissions, and energy and water use.*"

- **Economic Benefits of CCR Beneficial Use**

As estimated in **Exhibit 5C-1** below (Column F), CCR used for beneficial use applications has an estimated annual US market value of **$177 million** per-year based on annual CCR sales revenue data supplied by 233 electric utility plants to the 2005 EIA-767 database, updated in this RIA to 2009. Based on comparison with the average higher prices for substitute industrial materials, using lower-priced CCR provides the US national economy with **$2,300 million** in annual net cost savings compared to the higher $2,477 million annual cost of substitute materials in these 14 industrial applications (see Column I of **Exhibit 5C-1**).

Exhibit 5C-1

Estimate of Annual Materials Cost Savings Benefit of CCR Generated by the Electric Utility Industry for Beneficial Use in Industrial Applications

A Item	B Industry Application	C 2005 CCR beneficial use (million tons)	D % of CCR beneficial use market	E 2005 average market price paid electric plants* ($/ton)	F (C x E) Implied annual CCR sales revenues to electric utility plants	G 2005 avg price for substitute material ($/ton)	H (C x G) 2005 implied annual alternative materials cost	I (H – F) Implied annual US national cost savings w/CCR beneficial uses
1	Construction concrete ingredient NAICS code 3273	See 1A + 1B	See 1A + 1B	See 1A + 1B	See 1A + 1B	See 1A + 1B	See 1A + 1B	See 1A + 1B
1A	Direct ingredient: substitute for portion of Portland cement ingredient in concrete mfg NAICS code 3273	16.35	33.0%	$0 to $45	$0 to $735.8 million	$80	$1,308 million	$572.2 to $1,308 million
1B	Indirect ingredient: raw feed blended with limestone or shale to make cement clinker to be ground into cement for concrete mfg NAICS code 3273	4.22	8.5%	$0 to $45	$0 to $189.9 million	$80	$337.6 million	$147.7 to $337.6 million
2	Construction structural fill for building foundations and embankments NAICS code 238910	8.35	16.8%	$1	$8.35 million	$3	$25.05 million	$16.7 million
3	Construction wall board NAICS code 327420	8.18	16.5%	$0 to $8	$0 to $65.4 million	$4.5 to $12	$36.8 to $98.2 million	$32.8 to $36.8 million
4	Waste stabilization (substitute for lime) NAICS code 5622	2.84	5.7%	$15 to $25	$42.6 to $71.0 million	$66	$187.4 million	$116.4 to $144.8 million
5	Blasting grit NAICS code 212322	1.63	3.3%	Not reported	Not reported	Not reported	Not estimated	Not estimated
6	Roofing granules NAICS code 324122	Included with grit (row 5)	Included with grit (row 5)	Not reported	Not estimated	Not reported	Not estimated	Not estimated
7	Minor uses (n=7)**	8.04	16.2%	$3 to $20	$24.1 to $160.8 million	$5 to $83	$40.2 to $667.3 million	$16.1 to $506.5 million
	Column totals (2005) =	49.61	100%	Implied average (F/C) = $3	$75 to $1,231 million (best estimate**** = $149 million)	Implied average (H/C) = $40	$1,935 to $2,624 million (best est.**** = $1,979 million)	$1,830
	2008 updated estimates =	**62*** **			**$177 million**		$2,477 million	**$2,300 million ($37 per ton)**

Explanatory notes:

Source: Data in columns C, E, and G are from "Waste and Materials-Flow Benchmark Sector Report: Beneficial Use of Secondary Materials – Coal Combustion Products," EPA report nr. 530-R-08-003, prepared by Industrial Economics Inc., 95 pages, 12 Feb 2008 at http://www.epa.gov/osw/partnerships/c2p2/pubs/benuse07.pdf

* Average price includes "free on board" (FOB) shipping and insurance costs paid by the supplier from the point of manufacture to a specified destination.

** Minor uses include: (1) agricultural soil amendment for flue gas desulfurization gypsum, (2) road base foundation layer underlying pavements for bottom ash, (3) mine reclamation material as substitute for soil, (4) mineral filler in asphalt, (5) soil stabilizer, (6) snow and ice control substitute for sand, and (7) mining.

*** 2009 update estimated tonnage (Column C above) derived in **Exhibit 5C-2** of this RIA; 2009:to2005 multiplier = 62.09/49.61 = 1.25.

**** "Best estimate" in Column F based on sum of coal-fired electric plant CCR "byproduct sales revenues" from the DOE-EIA F767_PLANT database for 233 plants.
"Best estimate" in Columns H and I derived by numerical interpolation of the ranges displayed based on the proportionate best estimate and range of Column F.

Exhibit 5C-2
2001-2008 Historical Trend in CCR Beneficial Use Quantity (Short Tons*)

A. Actual Data:	Year	CCR Beneficial Use** (tons per year)	% change	% Use	Linear Regression Output	
Actual =	2001	37,119,321			R-Squared	0.943
Actual =	2002	45,523,256	+22.6%	35%	Standard Error	1,859,123
Actual =	2003	46,384,405	+1.9%	38%	Observations	8
Actual =	2004	49,089,818	+5.8%	40%		*Coefficients*
Actual =	2005	49,612,541	+1.1%	40%	Intercept	39,784,058
Actual =	2006	54,203,170	+9.3%	43%	X Variable	2,867,597
Actual =	2007	56,039,005	+3.4%	43%		
Actual =	2008	60,593,660	+8.1%	46%		

Notes:
* Tons source: Amer. Coal Ash Assoc http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3
** "Beneficial use" data in this Exhibit correspond to the 15 categories defined in the ACAA dataset which do not match the definition (examples) of CCR beneficial uses in EPA-ORCR's CCR proposed rule.

B. Trendline:	Year	Regression best fit	% change
Trendline =	2001	39,784,100	
Trendline =	2002	42,651,700	7.2%
Trendline =	2003	45,519,300	6.7%
Trendline =	2004	48,386,800	6.3%
Trendline =	2005	51,254,400	5.9%
Trendline =	2006	54,122,000	5.6%
Trendline =	2007	56,989,600	5.3%
Trendline =	2008	59,857,200	5.0%
Projection =	2009	62,724,800	4.8%
	Annual average growth rate =		5.2%

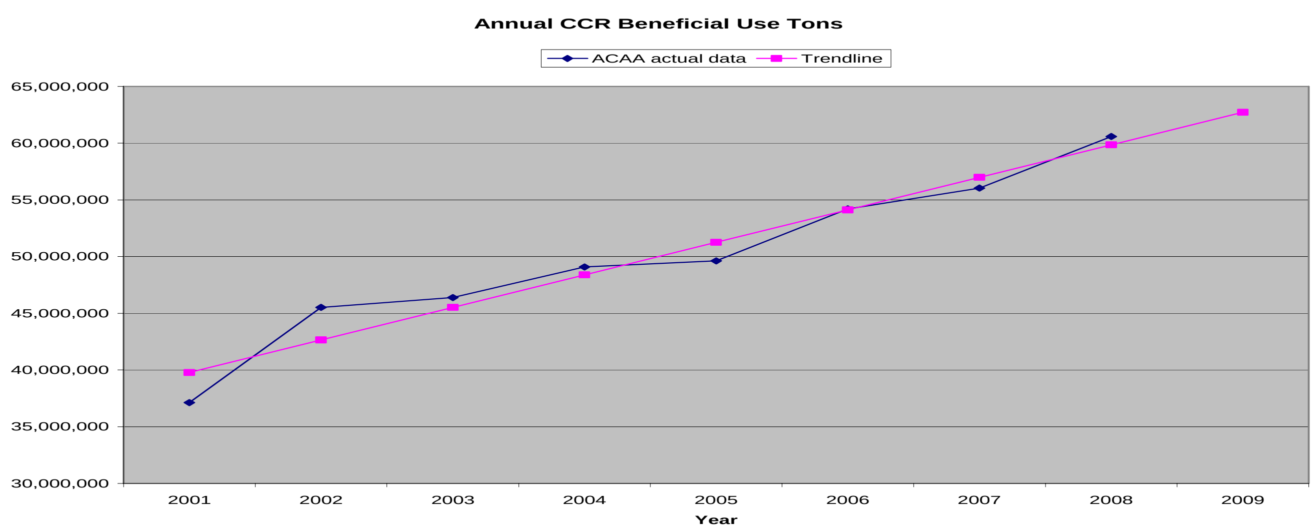


Exhibit 5C-3 below presents a 2004 state-by-state summary of annual quantity of CCR beneficially used.

Exhibit 5C-3
State-by-State Summary of CCR Beneficial Use (2004*)

A	B	C	D	E
Item	State	2004 CCR generation (short tons)	2004 CCR beneficial use (short tons)	% CCR used beneficially
1	AK	43,000	Not reported	NR
2	AL	3,408,000	663,000	19%
3	AR	688,000	324,000	47%
4	AZ	2,764,000	1,161,000	42%
5	CA	50,000	0	0%
6	CO	1,548,000	252,000	16%
7	CT	181,000	0	0%
8	DC	0	0	NA
9	DE	121,000	24,000	20%
10	FL	5,092,000	3,171,000	62%
11	GA	3,141,000	1,022,000	33%
12	HI	48,000	0	0%
13	IA	1,260,000	750,000	60%
14	1D	0	0	0%
15	IL	4,419,000	1,968,000	45%
16	IN	9,549,000	3,023,000	32%
17	KS	1,399,000	575,000	41%
18	KY	14,537,000	2,521,000	17%
19	LA	1,588,000	716,000	45%
20	MA	310,000	130,000	42%
21	MD	1,983,000	646,000	33%
22	ME	36,000	0	0%
23	MI	2,145,000	614,000	29%
24	MN	1,561,000	387,000	25%
25	MO	2,348,000	1,070,000	46%
26	MS	1,758,000	681,000	39%
27	MT	952,000	51,000	5%
28	NC	3,545,000	1,641,000	46%
29	ND	2,757,000	731,000	27%
30	NE	469,000	299,000	64%
31	NH	141,000	57,000	40%
32	NJ	600,000	112,000	19%
33	NM	3,668,000	864,000	24%
34	NV	825,000	314,000	38%
35	NY	1,379,000	368,000	27%
36	OH	6,980,000	2,290,000	33%
37	OK	1,277,000	625,000	49%
38	OR	95,000	81,000	85%
39	PA	9,545,000	2,941,000	31%
40	RI	0	0	NA
41	SC	2,172,000	1,169,000	54%
42	SD	105,000	28,000	27%
43	TN	3,803,000	2,163,000	57%
44	TX	12,943,000	4,395,000	34%
45	UT	2,341,000	812,000	35%
46	VA	2,442,000	203,000	8%
47	VT	0	0	NA
48	WA	2,301,000	1,683,000	73%
49	WI	1,437,000	1,219,000	85%
50	WV	7,220,000	2,401,000	33%
51	WY	2,106,000	508,000	24%
	Totals =	129,001,000	44,653,000	35%

Notes:
* Source: DOE & EPA, "Coal Combustion Waste Management at Landfills and Surface Impoundments 1994-2004," DOE/PI-0004, Aug 2006, page 5 (Table 1) at: http://www.ead.anl.gov/pub/doc/coal_waste_report.pdf
In comparison, the ACAA reports that a 5% smaller amount of 122,465,119 tons CCR was generated in 2004

- **Lifecycle Benefits Associated with CCR Beneficial Use**

The baseline (2005) material cost savings estimate displayed in **Exhibit 5C-1** above is adjusted below to exclude the mining applications use, because mine-filling is not covered in the proposed rule.[135] As displayed in **Exhibit 5C-4** below, subtracting 2.3% of the mining applications beneficial use category decreased the baseline CCR beneficial use from 49.6 million tons to 48.5 million tons (relative to 2005).

Exhibit 5C-4
Subtraction of Mining Application Minor Use from the Minor Use Category of the Material Cost Savings for CCR Beneficial Use

CCR Beneficial Use Category (Minor Uses)	CCR beneficial use tons (2005)	% of all CCR uses	Materials price cost savings (million 2009$)
1. Flowable fill	259,907	0.5%	$10.7
2. Road base/sub-base	1,461,992	2.9%	$60.0
3. Soil modification/stabilization	1,139,640	2.3%	$46.8
4. Mineral filler in asphalt	140,838	0.3%	$5.8
5. Snow & ice control	547,541	1.1%	$22.5
6. Mining applications	1,132,945	2.3%	$46.5
7. Agriculture	415,741	0.8%	$17.1
8. Aggregate	872,776	1.8%	$35.8
9. Miscellaneous minor uses	2,071,157	4.2%	$85.1
Sub-total Minor Uses =	8,042,537	16.2%	$330.3
Total All Uses (Major + Minor) =	49,612,541	100.0%	$1,830
Total Excluding Mining =	48,479,596	97.7%	**$1,783.5 ($37 per ton)**

From a materials lifecycle analysis perspective, CCR beneficial use generates net environmental benefits. Based on a 2008 life cycle study[136] of two of the 14 CCR beneficial use industrial applications (i.e., concrete and wallboard) there are 12 environmental benefit categories with the annual magnitudes estimated below in **Exhibit 5C-5**. This estimate of environmental benefits is based on only 47% (i.e., 23.2 million tons) of the 49.62 million tons for the 2005 CCR beneficial use market as reported in that 2008 study. Thus, these estimates may understate annual environmental benefits of CCR beneficial uses. These net benefits are not additive to the economic benefits, but encompass them.

[135] As noted in the Federal Register notice of EPA's proposed CCR rule, minefilling will be addressed in an alternate rulemaking.
[136] Source: Exhibit 5-3 of "Waste and Materials-Flow Benchmark Sector Report: Beneficial Use of Secondary Materials – Coal Combustion Products," prepared by Industrial Economics Inc for the EPA Office of Solid Waste, 12 Feb 2008, 95 pages at http://www.epa.gov/osw/partnerships/c2p2/pubs/benuse07.pdf

To avoid double-counting of economic and social benefits, EPA evaluated the monetization of the energy, water, and air pollution-related impacts for any such double counting. Based on this evaluation, this RIA concludes that each of the individual monetized estimates for these impacts are fully additive and do not double count benefits, with one exception regarding partial overlap between energy cost savings and the value of avoided SOx air emissions. For SOx, where there exists a cap and trade permit program, firms must pay to emit SOx. A portion of the SOx emissions avoided from beneficially using CCR is from the energy sector. Under the presumption that the marginal costs of abatement equal the value of marginal damages, the value of the portion of SOx emissions from the energy sector will be reflected in the energy cost savings. The portion of avoided SOx emissions that comes from sectors other than energy is not reflected in energy cost savings and thus should be retained. However, separately adding a value for reduced SOx emissions likely represents some amount of double counting.

Unlike the SOx permit program, most regulation of NOx and particulate matter (PM) does not require firms to purchase permits to pollute. Thus there is little to no overlap between the external costs of these air pollutants and energy costs. In addition, aside from limited state programs, GHG damages are not currently regulated and would not be reflected in the market price for energy. Thus, the benefits from NOx, particulates and GHG reductions are fully additive to private energy cost savings. Furthermore, for water use, the only benefits included are the direct cost savings, and because the water savings in these cases are not associated with energy production, these savings are not being captured elsewhere. Reduced water use in the production process is a real cost savings that should be a component of total benefits.

Therefore, this RIA concludes that there is only a partial double counting between energy cost savings and the savings associated with reduced SOx emissions. No other beneficial use benefits categories are affected by this double counting issue. Thus, **Exhibit 5C-5** below has subtracted the $1,491 million benefits attributable to SOx reductions from the environmental benefits estimate, resulting in an environmental estimate of **$22,980 million per year**, or **$474 per ton** average lifecycle benefit, assigning zero values to tonnage other than concrete and wallboard. In addition to baseline lifecycle benefits, there are an estimated **$2,927 million per year** in baseline avoided disposal cost benefits to the electric utility industry (i.e., (49.61 million tons CCR beneficial use in 2005) x ($59 per ton average baseline disposal cost estimated in **Exhibit 3L** of this RIA)), which constitutes a total of **$25,907 million per year** (relative to 2005 CCR beneficial use tonnage), which is an average of **$533 per ton** nationwide baseline social benefits from CCR beneficial use.

Exhibit 5C-5
Estimate of Annual Baseline Lifecycle Benefits from CCR Beneficial Use
(Based on 2005 CCR beneficial use tonnage)

Benefit category	Physical quantity of environmental benefits for 48.5 million tons annual CCR beneficial use w/out mining application*	Unit monetization values (2009$)**	Estimated benefits ($millions per year)
A. Resource Consumption Savings			
1. Energy consumption	158 trillion BTU energy savings	$0.00003093 per BTU	$4,888
2. Water consumption	32.1 billion gallons water savings	$0.0025259 per gallon	$81
		Subtotal (1+2) =	$4,969
B. Air Pollution Savings			
3. GHG - greenhouse gases	11.5 million metric tons CO2 equivalent emissions avoided	$20.76 per metric ton	$239
4. CO – carbon monoxide	9,200 metric tons emissions avoided	Not estimated	Not estimated
5. NOx – nitrous oxides	30,400 metric tons emissions avoided	$10,255 per metric ton	$312

Exhibit 5C-5 **Estimate of Annual Baseline Lifecycle Benefits from CCR Beneficial Use** (Based on 2005 CCR beneficial use tonnage)			
Benefit category	Physical quantity of environmental benefits for 48.5 million tons annual CCR beneficial use w/out mining application*	Unit monetization values (2009$)**	Estimated benefits ($millions per year)
6. SOx – sulfur oxides	*23,900 metric tons emissions avoided*	*$62,375 per metric ton*	*$1,491*
7. PM – particulate matter	9,704 metric tons emissions avoided	$486,312 per metric ton	$4,719
8. Particles non-specified	26,200 metric tons emissions avoided	$486,312 per metric ton	$12,741
9. Hg - mercury	0.584 metric tons emissions avoided	Not estimated	Not estimated
10. Pb - lead	0.656 metric tons emissions avoided	Not estimated	Not estimated
		Subtotal (3 to 10) =	$19,502
		Subtotal air pollution savings excluding SOx & excluding mine-filling use =	$18,011
C. Other Environmental Savings			
11. Waterborne wastes	2,446 short tons waste generation avoided (SM + BOD + COD + Cu + Hg + Pb + Se)	Not estimated	Not estimated
12. Solid waste	27,991 short tons waste generation avoided	Not estimated	Not estimated
		Total (1 to 12) =	$24,471
		Total annual lifecycle benefits (excluding SOx & excluding mine-filling use) =	**$22,980 ($474/ton)**

Notes:
* Physical quantity of environmental benefits are based on only two of the 14 beneficial use industrial applications (i.e., 15.0 million tons per year fly ash CCR used in concrete, plus 8.2 million tons per year FGD CCR used in wallboard). These estimates are from Exhibit 5-3 (page 5-6) of "Waste and Materials-Flow Benchmark Sector Report: Beneficial Use of Secondary Materials – Coal Combustion Products," prepared by Industrial Economics Inc for the EPA Office of Solid Waste, 12 Feb 2008; available at http://www.epa.gov/osw/partnerships/c2p2/pubs/benuse07.pdf. This 2008 reference report does not provide environmental impact estimates for the other 12 beneficial use industrial applications.
** Unit monetary values applied for monetization are from the following sources:

- Row 1 & Row 2: 2007 values from Exhibit 5-3 (page 5-6) of the Industrial Economics Inc reference report. Unit values updated for this RIA from 2007 to 2009 using NASA's Gross Domestic Product Deflator Inflation Calculator at http://cost.jsc.nasa.gov/inflateGDP.html
- Row 3: Based on the September 2009 interim social cost of carbon (i.e., interim SCC) from Table III.H.6-3, page 29617 of the joint EPA and DOT-NHTSA "Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards," Federal Register, Volume 74, No. 186, 28 Sept 2009. The value applied in this RIA is the $19.50 per ton median value from the $5 to $56 per ton range displayed in the 2007 column in that source. Furthermore, this RIA updated the 2007$ median value from 2007 to 2009 dollars using the NASA Gross Domestic Product Deflator Inflation Calculator at http://cost.jsc.nasa.gov/inflateGDP.html. EPA is aware that final SCC values were published on March 9, 2010 in conjunction with a Department of Energy final rule. EPA intends to use the final SCC values for the CCR final rule RIA. The final SCC values are published in the Department of Energy, Energy Efficiency & Renewable Energy Building Technologies Program, "Small Electric Motors Final Rule Technical Support Document: Chapter 16 - Regulatory Impact Analysis", March 9, 2010 at http://www1.eere.energy.gov/buildings/appliance_standards/commercial/sem_finalrule_tsd.html).
- Rows 4-10: Unit values from the report "The Influence of Location, Source, and Emission Type in Estimates of the Human Health Benefits of Reducing a Ton of Air Pollution" by Neal Fann, Charles Fulcher and Bryan Hubbell, in Air Quality, Atmosphere & Health, Volume 2, No.3, Sept 2009, pages 169-176. The dollar values from this report were updated from 2006 to 2009 using NASA's Gross Domestic Product Deflator Inflation Calculator at http://cost.jsc.nasa.gov/inflateGDP.html
- Rows 12-13: Waterborne waste and solid waste generation avoided benefits were not monetized in the 2008 Industrial Economics Inc. reference study cited above.

5C2. Potential Effect of RCRA Regulation of CCR Disposal on CCR Beneficial Use

Under the proposed regulation, the Bevill exemption still applies to quantities of CCR directed to certain beneficial uses so that these quantities do not face increased disposal costs associated with Subtitle C or D regulation of disposed CCR. The increased costs of disposal of CCR as a result of their regulation under RCRA subtitle C will create a strong economic and regulatory incentive for increased beneficial uses of CCR. In fact, EPA concludes that the increased costs of disposal of CCR under subtitle C of RCRA, but not the beneficial use of CCR, will actually increase their usage in non-regulated beneficial uses, simply as a result of the economics of supply and demand. The economic driver - availability of a low-cost, functionally equivalent or often superior substitute for other raw materials - will continue to make CCR an increasingly desirable product. Furthermore, it has been EPA's experience in the RCRA hazardous waste regulations and elsewhere that material inevitably flows to less regulated applications.

On the other hand, industry and state government stakeholders have asserted in letters to EPA, that regulation of CCR as a RCRA "hazardous waste" will impose a "stigma" on CCR beneficial use which will significantly curtail these uses. In their view, even an action that regulates only the disposal of CCR in landfills or surface impoundments as hazardous waste, but retains the Bevill exemption for beneficial uses, would have this effect. Also, the states particularly have argued that, by operation of state law, the beneficial use of CCR would be prohibited under many states' beneficial use programs, if EPA were to designate CCR as a hazardous waste when disposed.

The purpose of this section of the RIA is to quantify both possibilities – i.e., an induced increase (Scenario #1) and an induced decrease (Scenario #2) -- in future CCR beneficial use, and to explain the basis for this RIA selecting the former (Scenario #1) as the "base case."

- **Examples of Hazardous Waste Recycling Success Not "*Stigma*"**

EPA's past experiences with the impacts of RCRA regulation, and with how RCRA industrial hazardous wastes and other hazardous materials are used and recycled, suggests that a "hazardous waste" designation of industrial secondary materials and wastes, does not impose a significant barrier to its beneficial use (e.g., recycling), and that non-regulated uses generally increase as the costs of regulated disposal increase. As summarized below, EPA's experience has shown that the economic incentive of a high disposal cost has outweighed any hypothetical stigma effect in case after case of hazardous waste recycling. Six examples listed below illustrate the point that a RCRA "hazardous waste" designation does not stand in the way of a material's (or waste's) subsequent industrial recycling or reuse as a raw or intermediate material:

1. <u>Electric arc furnace dust:</u> RCRA hazardous waste (waste code = K061), and yet it is a highly recycled material. Specifically, between 2001 and 2007, approximately 42% to 51% of K061 was recycled as evidenced by Biennial Reporting System (BRS) data. Both currently and historically, K061 has been used as an ingredient in fertilizer, an input in making steel, and in the production of zinc products, including pharmaceutical materials. Slag from the smelting of K061 is in high demand for use in road construction. The use of slag is regulated under Pennsylvania's beneficial use program, despite the fact that it is derived from a listed hazardous waste. In fact, there is little doubt that, without its regulation as a hazardous waste, a significantly greater amount of K061 would be diverted from recycling to disposal in non-hazardous landfills.

2. Electroplating wastewater sludge: Listed hazardous waste (F006) that is recycled for its copper, zinc, and nickel content for use in the commercial market. In 2007, approximately 35% of F006 material was recycled according to BRS data. These materials are clearly in no way stigmatized in the marketplace.
3. Chat: Superfund cleanup waste with lead contamination is used in road construction in Oklahoma and the surrounding areas. In this case, the very waste that has triggered an expensive Superfund cleanup is successfully offered in the marketplace as a raw material in road building. The alternative costs of disposal in this case are a significant driver in the beneficial use of this material, and the Superfund origin of the material has not prevented its use.
4. Used oil: Frequently a hazardous waste if disposed of, and is regulated under the RCRA subtitle C standards. While used oil that is recycled is subject to a separate set of standards under subtitle C (and is not identified as a hazardous waste), "stigma" does not prevent home do-it-yourselfers from collecting used oil, or automotive shops from accepting it and sending it on for recovery. Collected used oil may be re-refined, reused, or used as a fuel in boilers, often at the site where it is collected. One large commercial used oil handler reports managing 500 million gallons of used oil a year.
5. Spent etchants: Directly used as ingredients in the production of a copper micronutrient for livestock.
6. Spent solvents: Generated from metals parts washing are directly used in the production of roofing shingles.

And in all such cases, these materials are generally RCRA hazardous wastes before reclamation. Many materials widely used in homes today can be classified as "hazardous" materials, and many come with warning labels. For example, motor oil comes with warning labels. Gasoline would be a characteristic hazardous waste if disposed of, as would many common drain cleaners and household cleaners. Cathode ray tube monitors for TVs and computers, as well as many fluorescent lamps are all hazardous wastes if disposed of. Fluorescent lamps (and CFLs) are potentially hazardous when disposed of because of mercury. Mercury is an indispensable resource, and virtually all of the mercury used for lamps and other uses in the U.S. is derived from discarded mercury or mercury products – that is, from hazardous waste. Even products as unlikely as nicotine gum or dental amalgam would be a hazardous waste when disposed of. Consumers are generally comfortable with these products, and their regulatory status does not discourage their use.

- **Differing Views About Prospect of Future "*Stigma*"**

Stakeholders have also expressed the concern that standards-setting organizations might prohibit the use of CCR in specific products or materials in their voluntary standards. Recently, the American Standards and Testing Materials (ASTM) International Committee C09, and its subcommittee, C09.24, in a December 23, 2009 letter to EPA indicated that ASTM would remove fly ash from the project specifications in its concrete standard if EPA determined that CCR were a hazardous waste. However, ASTM standards are developed through an open consensus process, and current standards cover the use of numerous hazardous materials in construction and other activities. For example, ASTM provides specifications for the reuse of solvents and thus, by implication, does not appear to take issue with the use of these recycled wastes, despite their classification as hazardous wastes.[137]

[137] For example, see ASTM Volume 15.05, Engine Coolants, Halogenated Organic Solvents and Fire Extinguishing Agents; Industrial and Specialty Chemicals, at or ASTM D5396 - 04 Standard Specification for Reclaimed Perchloroethylene.

Others take a different view on how standard-setting organizations will react. Most notably, a US Green Building Council representative has been quoted in the New York Times as saying that LEED incentives for using fly ash in concrete would remain in place, even under an EPA hazardous determination. If the Green Building Council (along with EPA) continues to recognize fly ash as an environmentally beneficial substitute for Portland cement, EPA believes that the use of this material is unlikely to decrease solely because of “stigma” concerns.

In addition, Congress directed government agencies to increase their purchase of recycled-content products. Specifically, section 6002 of RCRA requires EPA to designate products that can be made with recovered materials and to recommend practices for buying these products. Once a product is designated, “procuring agencies” [138] are required to purchase it with the highest recovered material content level practicable if they spend more than $10,000 a year on that item. EPA’s federal Comprehensive Procurement Guidelines (CPG), requiring the use of fly ash in cement for federally funded projects, would remain in place. Thus, any federal, state, or local agency carrying out federally funded construction projects would continue to be required to give a preference to fly ash as a Portland cement replacement.

Finally, many state governments have argued that their statutes or regulations prohibit the use of hazardous wastes in their state beneficial use programs, and therefore that, if EPA lists CCR as a hazardous waste (even if only for disposal), their use would be precluded in those states. EPA has reviewed the regulations of 10 states with the highest consumption of fly ash and/or cement and concluded that while these states do not allow the use of hazardous waste in their beneficial use programs, CCR that are beneficially reused will remain Bevill-exempt solid wastes, or in some cases, would not be considered wastes at all and thus, the continued use of CCR under these programs should not be affected by the proposed CCR rule. For EPA’s summary of 10 state government CCR beneficial use regulations, see **Appendix K12**. For the above reasons, this RIA presents the increased future CCR beneficial use (Scenario #1) as the “base case.” However, this RIA monetizes both scenarios (i.e., induced increase and induced “stigma” decrease) using the following 10-step method.

Step 1. Project Future Annual Tonnage CCR Generation

To estimate the levels of CCR beneficial use, the first task was to project the future annual tonnage of CCR generated by the electric utility industry. The amount of CCR is likely to increase proportionally, as utilities comply with new Clean Air Act requirements. Not reflecting this proportional increase, this RIA relied on the EIA future forecast for coal burned by the electric utility industry.[139] As displayed in **Exhibit 5C-6** below, the EIA data extends out to the year 2035. However, to remain consistent with the other cost and benefit estimates, this RIA extended this trend out to the year 2061 based on regression-fit extrapolation using the following first-order regression of coal burned as dependent variable against year as independent variable:

---

[138] Procuring agencies include all federal agencies, and any state or local agency or government contractor that uses appropriated federal funds.

[139] Source: Based on 2007 to 2035 annual short tons coal consumption by electric power sector forecast data from the Energy Information Administration (EIA), “Year-by-Year Reference Case Tables (2008-2035): Table 15 Coal Supply, Disposition, and Prices” from the report “Annual Energy Outlook 2010 Early Release,” December 14, 2009 at http://www.eia.doe.gov/oiaf/aeo. The EIA report presents a midterm projection and analysis of US energy supply, demand, and prices through 2035, based on the EIA’s National Energy Modeling System. Further information on the EIA’s projections is available at

$$y = \beta_0 + \beta_1 x$$

Where:

y	=	Tons coal burned at time = x
β_0	=	Tons coal burned at time = 0
β_1	=	Additional tons coal burned each year, on average
x	=	Time elapsed (years)

Running the regression, calculated a β_0 (or intercept) of 1,001,902,312; a β_1 (or slope) of 6,082,277; and an R-squared (or fit) of 87%. This regression was used to extrapolate the EIA projection out to the year 2061 as displayed in **Exhibit 5C-7** and as graphed in **Exhibit 5C-8** below.

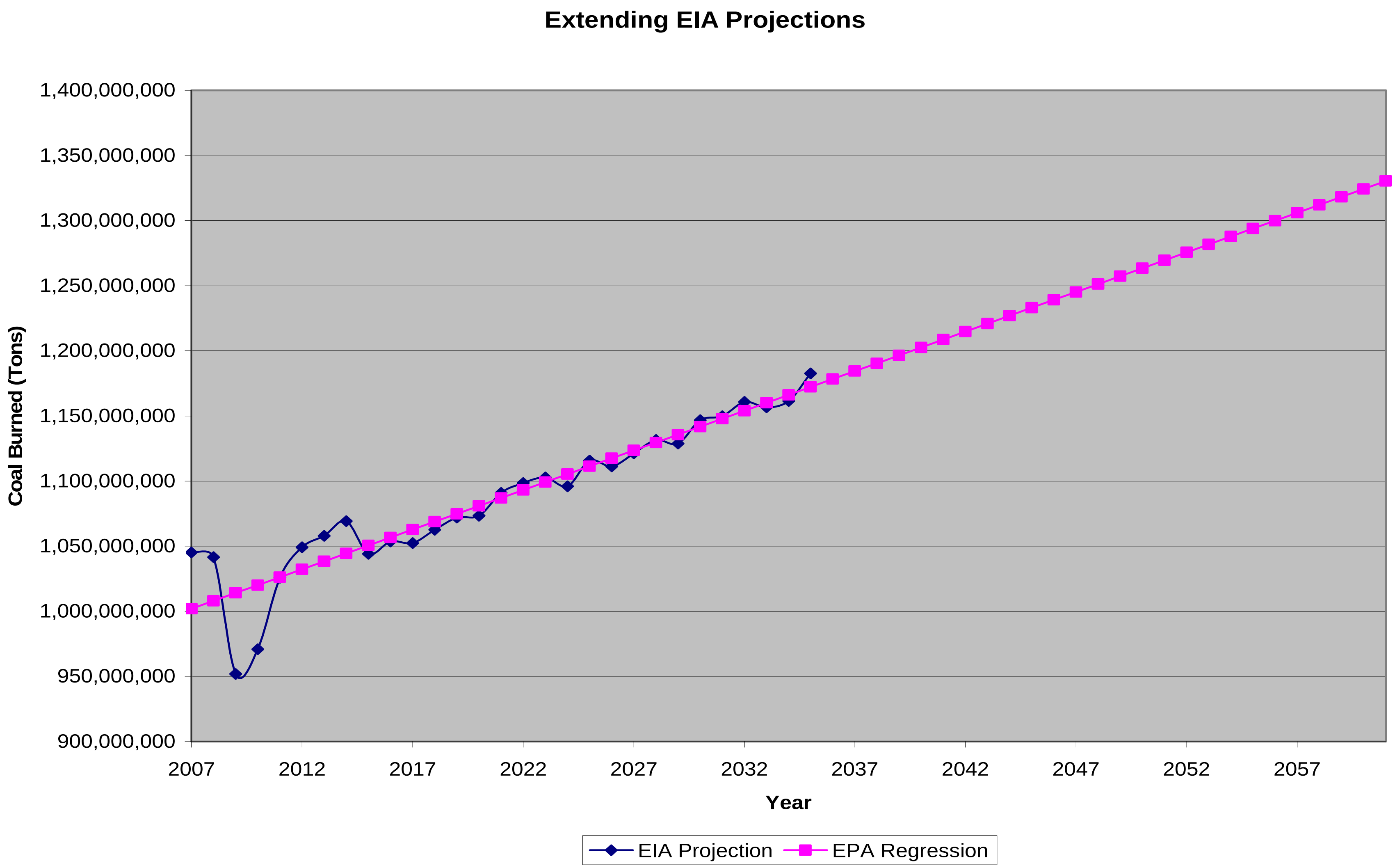
Table 5C-6
Coal Burned Forecast Data From EIA

Year	X = Time Elapsed	Y = EIA Projection (Tons Coal Burned)
2007	0	1,045,140,137
2008	1	1,041,599,976
2009	2	951,846,252
2010	3	970,887,207
2011	4	1,025,782,227
2012	5	1,049,056,519
2013	6	1,057,912,842
2014	7	1,069,233,154
2015	8	1,044,051,880
2016	9	1,053,579,224
2017	10	1,052,420,654
2018	11	1,062,561,646
2019	12	1,071,914,062
2020	13	1,073,440,308
2021	14	1,090,903,931
2022	15	1,098,539,673
2023	16	1,102,742,065
2024	17	1,096,057,129
2025	18	1,115,724,243
2026	19	1,111,202,026
2027	20	1,121,313,477
2028	21	1,131,518,677
2029	22	1,128,823,120
2030	23	1,146,826,782
2031	24	1,149,894,043
2032	25	1,160,750,977
2033	26	1,156,721,802
2034	27	1,161,479,736
2035	28	1,182,647,705

Exhibit 5C-7 EPA Extrapolation of EIA Projection to 2061			
Year	Tons Burned	Year	Tons Burned
2007	1,001,902,312	2035	1,172,206,065
2008	1,007,984,589	2036	1,178,288,342
2009	1,014,066,866	2037	1,184,370,619
2010	1,020,149,143	2038	1,190,452,896
2011	1,026,231,420	2039	1,196,535,173
2012	1,032,313,697	2040	1,202,617,450
2013	1,038,395,974	2041	1,208,699,727
2014	1,044,478,251	2042	1,214,782,003
2015	1,050,560,527	2043	1,220,864,280
2016	1,056,642,804	2044	1,226,946,557
2017	1,062,725,081	2045	1,233,028,834
2018	1,068,807,358	2046	1,239,111,111
2019	1,074,889,635	2047	1,245,193,388
2020	1,080,971,912	2048	1,251,275,665

Exhibit 5C-7 EPA Extrapolation of EIA Projection to 2061			
Year	Tons Burned	Year	Tons Burned
2021	1,087,054,189	2049	1,257,357,942
2022	1,093,136,466	2050	1,263,440,219
2023	1,099,218,743	2051	1,269,522,495
2024	1,105,301,019	2052	1,275,604,772
2025	1,111,383,296	2053	1,281,687,049
2026	1,117,465,573	2054	1,287,769,326
2027	1,123,547,850	2055	1,293,851,603
2028	1,129,630,127	2056	1,299,933,880
2029	1,135,712,404	2057	1,306,016,157
2030	1,141,794,681	2058	1,312,098,434
2031	1,147,876,958	2059	1,318,180,710
2032	1,153,959,235	2060	1,324,262,987
2033	1,160,041,511	2061	1,330,345,264
2034	1,166,123,788	Total	64,136,808,356

Exhibit 5C-8



Extending EIA Projections
1,400,000,000
1,350,000,000
1,300,000,000
1,250,000,000
1,200,000,000
1,150,000,000
1,100,000,000
1,050,000,000
1,000,000,000
950,000,000
900,000,000
Coal Burned (Tons)
2007
2012
2017
2022
2027
2032
2037
2042
2047
2052
2057
Year
EIA Projection
EPA Regression

Based on the most recent CCR beneficial use data from ACAA, EPA estimated the average tons of CCR generated for every ton of coal burned by electric utility plants. For this calculation, this RIA only used the most recent data year (2008) to estimate a conversion rate because over time, the quantities of CCR generated per ton of coal combusted has steadily increased. Thus an average of recent years would not reflect this trend. The steady increase over time is due to tightening of industrial air pollution regulations. This trend would likely continue in the future as further facilities undergo new source review, or implement new Clean Air Act requirements under upcoming EPA rules like the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR). Thus, the future annual tonnages of CCR estimated in this RIA are likely under-estimates. Dividing the 2008 tons of CCR generated (136 million tons) by the 2008 tons of coal burned by the electric power sector (1,042 million tons), EPA produced a CCR-to-coal relationship factor of 0.131. Applying this factor to the extrapolated coal consumption projection produced the future CCR generation scenario displayed below in **Exhibit 5C-9**.

Exhibit 5C-9
Projected Future Annual CCR Generation by the Electric Utility Industry:
Scenario Based on Extrapolation of EIA's Projection of Electric Power Sector Coal Burned 2007-2035
(Short Tons)

Year	CCR	Year	CCR	Year	CCR	Year	CCR
2012	134,764,862	2025	145,087,115	2038	155,409,369	2051	165,731,622
2013	135,558,881	2026	145,881,135	2039	156,203,388	2052	166,525,642
2014	136,352,901	2027	146,675,154	2040	156,997,408	2053	167,319,661
2015	137,146,920	2028	147,469,174	2041	157,791,427	2054	168,113,681
2016	137,940,940	2029	148,263,193	2042	158,585,447	2055	168,907,700
2017	138,734,959	2030	149,057,213	2043	159,379,466	2056	169,701,720
2018	139,528,979	2031	149,851,232	2044	160,173,486	2057	170,495,739
2019	140,322,998	2032	150,645,252	2045	160,967,505	2058	171,289,759
2020	141,117,018	2033	151,439,271	2046	161,761,525	2059	172,083,778
2021	141,911,037	2034	152,233,291	2047	162,555,544	2060	172,877,798
2022	142,705,057	2035	153,027,310	2048	163,349,564	2061	173,671,817
2023	143,499,076	2036	153,821,330	2049	164,143,583		
2024	144,293,096	2037	154,615,349	2050	164,937,603		

Appendix K5 to this RIA presents alternative estimates of future CCR generation. These estimates take into account the recent increasing trend in the ratio of tons CCR generated to the tons coal combustion. For example, in year 2035 the constant ratio projection above yields a value of 153 million tons CCR generated whereas the increasing ratio projection in **Appendix K5** yields a value of 191 million tons of CCR generated. While the exact magnitude of such an increase is uncertain, there would be at least some increase as a result of increased air pollution controls. These include future changes due to EPA's New Source Review (NSR), EPA's Clean Air Interstate Rule (CAIR), and EPA's Clean Air Mercury Rule (CAMR).

Step 2. Project Future Baseline Annual Tonnage CCR Beneficial Use (Without RCRA Regulation)

This step involves projecting the extent to which CCR would be beneficially used in the absence of the proposed RCRA regulation of CCR disposal (i.e., future baseline CCR beneficial use). **Exhibit 5C-10** below displays the recent (i.e., 2001 to 2008) trend in annual tonnage of CCR beneficial use, and as a percentage relative to annual CCR generation by the electric utility industry.

Exhibit 5C-10
Recent CCR Beneficial Use Trend (2001-2008)

Year	CCR Generation (short tons)	CCR Beneficial Use (short tons)	Fraction
2001	117,930,542	37,119,321	31.5%
2002	128,703,572	45,523,256	35.4%
2003	121,744,571	46,384,405	38.1%
2004	122,465,119	49,089,818	40.1%
2005	123,126,093	49,612,541	40.3%
2006	124,795,124	54,203,170	43.4%
2007	131,127,693	56,039,005	42.7%
2008	136,073,107	60,593,660	44.5%
Source: American Coal Ash Association (ACAA) at http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3			

If the recent trends in CCR generation and CCR beneficial use continued in a linear fashion, more than 100% of CCR would be beneficially used before year 2061. Furthermore, a linear extrapolation for beneficial use would not be appropriate because as more and more CCR is used, it would likely become increasingly difficult to use the remaining CCR due to saturation of local markets, competition between CCR generators, and other factors, depending on overall macro-economic factors. Thus, for purpose of extrapolation to the 50-year period-of-analysis (2012 to 2061), this RIA instead modeled the recent trend data as an asymptotic, exponential function of the form:

$$Y = 1 - \frac{1}{B^{C*(X+D)}}$$

Where:

Y = Percent of CCR beneficially used
X = Time elapsed relative to 2001
B = 1.021
C = 1.369
D = 13.99

Beneficial uses of CCR have been consistently growing in the recent past. Since the percent of CCR beneficially used has been growing, EPA sought to characterize that trend so that the future percent beneficially used could be applied to the future tons of CCR. The ACAA data from 2001 to 2008 indicate that this trend was increasing. After running several regressions, EPA disposed of the typical trend fits for various reasons. A first-order (linear) trend line was abandoned because it would have led to beneficial use above 100% well within the time-frame of the analysis. Higher order regressions led to oddities where beneficial use would trend away from 100% at some point in time. Once typical fits were ruled out, EPA assumed that CCR beneficial use would not exceed 100% of CCR generated.[140] Instead, it would potentially become more and more difficult to use CCR as a higher percent went to beneficial uses, because of market limitations. Thus, it made sense to use an exponential curve that approached, but never crossed an asymptote of 100% beneficial use.

To fit an exponential curve to the 2001 to 2008 CCR beneficial use data, a spreadsheet calculation solver was programmed to minimize the residual sum of squares between the actual and projected percent of CCR beneficial use by changing the regression equation variables B, C, and D. From solver result, B was set to 1.021, C was set to 1.369, and D was set to 13.99. Using these values, the future CCR beneficial use projection as measured on a percentage basis relative to CCR generation were estimated, as displayed in **Exhibit 5C-11** and **Exhibit 5C-12** below. The percentage of CCR beneficially used under the baseline (i.e., without RCRA regulation) is expected to gradually approach, but never reach 100% of CCR generation. By 2061 at the end of the 50-year period-of-analysis, 88% of CCR would be beneficially used under this projection. While this is a relatively high number, current experiences in at least one US state and in at least 16 other countries (i.e., 15 European countries + Japan), already demonstrate that very high CCR beneficial use rates of 90% and above are achievable:

1. <u>Wisconsin</u>: Several companies are developing technologies to convert CCR into bricks used in construction, and one such technology was recently commercialized in Wisconsin.[141] Some of these technologies have the potential for using **100%** CCR (fly ash) in brick production, as opposed to the conventional 30%-50% limit for replacing Portland cement in concrete.
2. <u>Europe</u>: As of 2007, 15 European countries reported a CCR beneficial use rate of **89%** (i.e., 55.449 million metric tons beneficially used in 2007 in 24 industrial applications, out of the 62.094 million metric tons generated in 2007).[142]
3. <u>Japan</u>: As of 2006, Japan reported a CCR beneficial use rate of **97%** (i.e., 10.657 million tons used in Japan in 2006 for 3 cement applications, 6 civil engineering applications, 3 construction applications, 2 agriculture/forestry/fisheries applications, and at least three other miscellaneous applications, out of the 10.969 million tons CCR generated in Japan in 2006).[143]

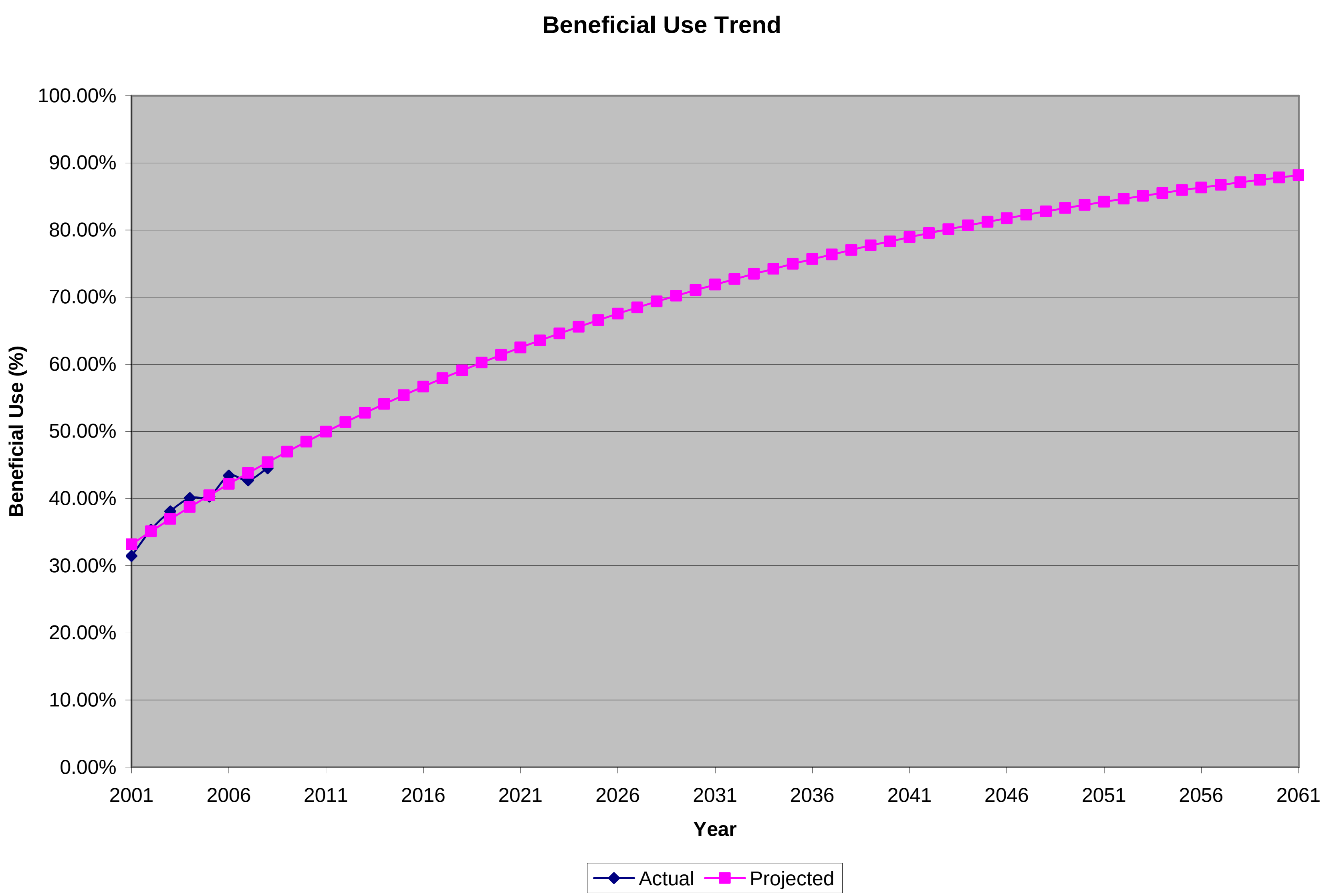
---

[140] The fact that some electric utility plants currently excavate previously disposed CCR for supplying to beneficial use markets suggests this may be a limiting assumption which could underestimate future potential growth of CCR beneficial use. For example, one electric utility company reported a 106% CCR beneficial use rate in 2006 for its four electricity plants because it recovered CCR that it had previously disposed.
[141] Source: "CalStar Gives Sneak Peek of Low-Carbon Brick Factory," Cleantech Group, 27 Oct 2009 at http://cleantech.com/news/5217/calstar-flyash-low-carbon-brick
[142] Source: Europe's 2007 CCR beneficial use rate is reported by ECOBA (European Coal Combustion Products Association) which was founded in 1990 by European energy producers to deal with matters related to the usage of construction raw materials from coal. As of 2009, membership in ECOBA consists of 24 companies and associations from 15 countries in Europe, all generators of electricity and heat. ECOBA members represent over 86 % of total CCR generation by the 27 total European countries. ECOBA's 15 member countries are Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Poland, Portugal, Romania, Russia, Spain, and United Kingdom. ECOBA's 2007 CCR beneficial use rate is reported in "Production and Utilisation of CCPs in 2007 in Europe (EU 15)" at: http://www.ecoba.com/evjm,media/statistics/ECOBA_Stat_2007_EU15.pdf
[143] Source: Japan's 2006 CCR beneficial use rate is reported by the Japan Coal Energy Center (JCOAL) in Table 3-1 of "Status of Coal Ash Production" at: http://www.jcoal.or.jp/coaltech_en/coalash/ash01e.html

Exhibit 5C-11 Projected Future Baseline CCR Beneficial Use Measured as Percentage of CCR Generation							
Year	% Beneficial Use	Year	% Beneficial Use	Year	% Beneficial Use	Year	% Beneficial Use
2001	33.22%	2016	56.67%	2031	71.89%	2046	81.76%
2002	35.11%	2017	57.91%	2032	72.69%	2047	82.28%
2003	36.96%	2018	59.10%	2033	73.47%	2048	82.79%
2004	38.75%	2019	60.27%	2034	74.22%	2049	83.28%
2005	40.49%	2020	61.39%	2035	74.95%	2050	83.75%
2006	42.19%	2021	62.49%	2036	75.67%	2051	84.21%
2007	43.83%	2022	63.56%	2037	76.36%	2052	84.66%
2008	45.43%	2023	64.60%	2038	77.03%	2053	85.10%
2009	46.98%	2024	65.60%	2039	77.68%	2054	85.52%
2010	48.49%	2025	66.58%	2040	78.32%	2055	85.93%
2011	49.95%	2026	67.53%	2041	78.94%	2056	86.33%
2012	51.37%	2027	68.45%	2042	79.53%	2057	86.72%
2013	52.76%	2028	69.35%	2043	80.12%	2058	87.10%
2014	54.10%	2029	70.22%	2044	80.68%	2059	87.47%
2015	55.41%	2030	71.07%	2045	81.23%	2060	87.82%
						2061	88.17%

Japan's 17 types of CCR beneficial use applications are listed for year 2003 in Table 1 "Breakdown of Fields for the Effective Use of Coal Ash" from "Part 2 CCT Overview Environmental Protection Technologies (Technologies to Effectively Use Coal Ash): 5C1. Coal Ash Generation Process and Application Fields" at http://www.brain-c-jcoal.info/cctinjapan-files/english/2_5C1.pdf

Exhibit 5C-12



Applying the percent of CCR beneficially used in each year to the quantities of CCR shown above, the following future annual tons of beneficially used CCR may be expected as displayed below in **Exhibit 5C-13**. The monetized value of this future baseline projection is:

	PV @3% discount	PV @7% discount
Economic value:	$102,290 million PV	$51,170 million PV
Lifecycle social value:	$1,554,323 million PV	$777,541 million PV

Exhibit 5C-13 **Baseline Projected Future CCR Beneficial Use** (Short Tons)							
Year	CCR Beneficial Use	Year	CCR Beneficial Use	Year	CCR Beneficial Use	Year	CCR Beneficial Use
2012	69,234,181	2025	96,599,301	2038	119,713,602	2051	139,569,037
2013	71,516,427	2026	98,514,244	2039	121,345,430	2052	140,985,202
2014	73,767,022	2027	100,404,645	2040	122,958,473	2053	142,387,139
2015	75,986,563	2028	102,270,993	2041	124,553,122	2054	143,775,155
2016	78,175,638	2029	104,113,770	2042	126,129,762	2055	145,149,549
2017	80,334,827	2030	105,933,448	2043	127,688,769	2056	146,510,616
2018	82,464,703	2031	107,730,494	2044	129,230,513	2057	147,858,644
2019	84,565,827	2032	109,505,366	2045	130,755,358	2058	149,193,918
2020	86,638,755	2033	111,258,513	2046	132,263,659	2059	150,516,713
2021	88,684,034	2034	112,990,378	2047	133,755,767	2060	151,827,302
2022	90,702,202	2035	114,701,396	2048	135,232,025	2061	153,125,952
2023	92,693,789	2036	116,391,994	2049	136,692,770		
2024	94,659,318	2037	118,062,592	2050	138,138,332		

Step 3. Estimate Potential Induced Effect of RCRA Regulation on CCR Beneficial Use

After establishing a future baseline of CCR beneficial use annual tonnage, this step involved formulating three alternative scenarios whereby future CCR beneficial use under RCRA regulation of CCR disposal could either:

- Scenario #1: Increase in beneficial use
- Scenario #2: Decrease
- Scenario #3: Remain unchanged from baseline

Increases due to increased disposal costs were estimated first and constitute the "base case" of this RIA. By increasing disposal costs, electric utility plants face an "*avoided disposal cost incentive*" to ship their CCR farther for beneficial uses by other industries; that is, utilities would be willing to pay more transportation costs to avoid the higher disposal costs. Thus, RCRA regulation of CCR disposal would likely open new markets at farther transport distances, or increase purchases by existing markets. The effect of this stimulus would be to increase CCR beneficial use. The concept of "*avoided disposal cost incentive*" is recognized and defined by the American Coal Ash Association (ACAA) on its website as follows:

> "*If a [coal-fired electric utility] plant markets its [CCR] into commercial applications, then disposal of this [CCR] is not required. Not only is a revenue stream created for the [coal-fired electricity plant] but also the need to dispose of the [CCR] is avoided. As discussed above, disposal is not just the transportation and placement of [CCR] in a disposal site. The need for future space is a concern. If [CCR is] marketed, then the need to develop future [CCR disposal] sites (including land acquisition, permitting, design and construction costs) is avoided …. It is not uncommon for a company to help offset the costs of transportation or placement at construction sites by providing the contractor or trucking firm a payment of some sort. For example, if the cost of disposal at a plant is normally four dollars a ton, then the company may arrange a payment of four dollars or less to the contractors to cover transportation and placement costs. The difference between the amount of this payment and the cost of disposal is also referred to as "avoided disposal costs.*" Source: ACAA Frequently Asked Question nr. 14 webpage at: http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=5#Q14

On the other hand, some stakeholders have claimed that a Subtitle C "hazardous waste" approach would have a "stigma" effect on CCR, reducing their use. That is, due to the label of "hazardous waste," some purchasers of CCR might opt to turn down the CCR for more expensive substitutes in fear that the CCR might either harm their sales or create liability, and generators might be reluctant to provide the material to users because of liability concerns. The final alternative, that beneficial use quantities remain the same, results in no net costs or benefits for the Subtitle C approach because it is assumed that the baseline trend plays out the same as it would absent a rule. Thus, no further analysis of this option was necessary.

The two alternative Scenario analyses (i.e., Scenario #1, Scenario #2) in this section build upon the ACAA's historical CCR beneficial use data.[144] ACAA data on the beneficial use was modified to remove the use of CCR in minefilling applications because the proposed rule does not address minefilling operations. Excluding 100% of the ACAA reported quantity of CCR used in minefilling results in a reduction of 1.13 million tons per year in the amount beneficially used. As a result, the 2005 quantity of beneficial use relied upon for our analyses is 48.5 million tons per year of CCR, rather than the original 49.6 million tons per year reported by ACAA.

[144] Source: Historical CCR beneficial use data from the American Coal Ash Association (ACAA) "Coal Combustion Products -- Production & Use Statistics" webpage at: http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3

Step 4: Estimate Potential Induced Increase in Future CCR Beneficial Use (Scenario #1)

Under the assumptions and numerical framework described below, this RIA estimates that the Subtitle C option would initially induce an increase of 28% in CCR beneficial uses. This growth estimate is a generalized, aggregate estimate across all 15 existing CCR beneficial use markets. Due to a lack of available data (i.e., market location, elasticity, cross-elasticity, etc.), this estimate does not take into account unique economic supply or economic demand conditions in any single market or for any particular beneficial use, relative to the generalized aggregate estimate. However, key uses, such as use of fly ash as a Portland cement replacement, have great opportunity for increased use, far above 28% in the initial year. For example, if fly ash use in concrete increased to a 30% replacement rate for Portland cement (a very reasonable replacement rate, consistent with current specifications), fly ash usage could increase by more than 100% from the 14 million tons used annually at current replacement rates of 10% to 12%. One of the main barriers to this increase usage is transportation costs. Because EPA did not have specific data on this market, this RIA does not specifically quantify it; however, it is exactly the type of use that increased disposal costs could foster.

The method presented below may be characterized as a "*Raw Material Cost Method*" which represents the 1st stage of the generalized 4-stage materials flow lifecycle (MFL) through the economy. This 4-stage MFL conceptual framework has been integrated into existing cost modeling software systems[145] used by government agencies and the private sector, and consists of the following four material flow cradle-to-grave or cradle-to-cradle stages:

1st MFL stage: Raw materials acquisition
2nd MFL stage: Product manufacturing
3rd MFL stage: Product use, re-use, maintenance
4th MFL stage: Recycling, waste management

This method evaluates the difference in raw material acquisition cost under two alternative conditions. The first condition (Baseline) represents current conditions without RCRA regulation of CCR disposal. The second condition (Subtitle C) represents future conditions with RCRA regulation for CCR disposed by electric utilities.

The economic mechanism in this estimation method, which affects different raw material acquisition costs under the two alternative conditions, is the "*avoided disposal cost incentive*" described above. In other words, it is the avoided disposal cost under RCRA regulation compared to the industry's baseline disposal cost. This difference in cost is an incremental cost relative to baseline. From an economic standpoint, this represents an incremental economic incentive to electric utility plants to reduce or eliminate CCR disposal, thereby reducing or avoiding new regulatory compliance costs by increasing their future annual supply of CCR to beneficial use markets. This "*avoided disposal cost incentive*" induced by RCRA regulation has already been anticipated in 2009 by at least one CCR beneficial use industry (***bold face*** added for emphasis):

[145] Example cost modeling/estimation software systems using this 4-stage framework are 1. FAST, 2. EE Energy/ Environment Life-Cycle Assessments, 3. EPA Enviro Accounting Method, and 4. TEAM (Tools for Environmental Analysis and Mangement); source: "Table 3-1. Overview of Life-Cycle Stages and Costs Considered by Software Systems and Tools" at http://www.p2pays.org/ref/01/00047/00047e.htm

"*Using [coal] fly ash in building materials is nothing new, as it's already incorporated in products including Portland cement and asphalt concrete. However, it's estimated that 65 percent of fly ash from coal-fired power plants worldwide goes to landfills, with the U.S. reporting a slightly lower 57 percent, according to the American Coal Ash Association. Kane said the key to CalStar's products is that they offer the same performance as aesthetics as traditional bricks, but without the energy use. Currently, the cost to buy a ton of fly ash in the U.S. ranges from about $5 to $30, but* ***that could change as fly ash disposal faces tighter government restrictions, he said. "The cost to send fly ash to landfills will go up, and utilities will be faced with finding the most beneficial use,"*** *Kane said.*"[146]

The baseline average "*raw material acquisition cost*" is $94.50/ton, consisting of CCR price, CCR disposal cost, and CCR transportation cost:

1. CCR price: Price paid to electric utility plants by beneficial use industries for the purchase of CCR. ACAA identifies 15 industrial beneficial use markets involving the beneficial use of CCR, many of which involve the construction industry.[147] The average price paid by these industries to electric utility plants is $3.00 per ton, across a reported range of $0 to $45 per ton.[148]
2. CCR disposal cost: Cost to the electric utility industry for disposing CCR. This factor also represents the "*avoided disposal cost incentive*" in the sense that this is an "*avoided cost*" to the electric utility industry for CCR tonnages beneficially used by other industries. A unitized "total cost" ($ per ton) for CCR disposal consisting of both a 50-year amortized capital cost for CCR disposal units plus a 50-year amortized O&M costs for CCR disposal is used to monetize this cost factor.[149] The average baseline CCR disposal cost is $59/ton (source: **Exhibit 3L**). This is additive to the "CCR price" element because it represents a subsidy by electricity plants.
3. CCR transport cost: Average one-way CCR transport distance between electric utility plants and their CCR beneficial use customer industries. This method does not explicitly distinguish whether the transport cost is paid by the electric utility plants or by the beneficial use industries.[150] Average CCR transport cost from electric utility plants to beneficial use sites is estimated at ($0.26/mile/ton)[151] x (125 miles)[152] = $32.50/ton.

[146] Source: Cleantech Group, "CalStar Gives Sneak Peek of Low-Carbon Brick Factory," 29 Oct 2009 at http://cleantech.com/news/5217/calstar-flyash-low-carbon-brick
[147] ACAA lists 15 beneficial use markets: concrete, cement, flowable fill, structural fill/embankments, road base/sub-base, soil modification, mineral filler in asphalt, snow/ice control, blasting grit/roofing granules, mining applications, gypsum panel products, waste stabilization/solidification, agriculture, construction aggregate, and miscellaneous uses.
[148] $3 per-ton CCR price is from Column E of **Exhibit 5C-1**; this price represents the tonnage-weighted average across a reported price range of $0 to $45 per ton CCR.
[149] Although in the short-run (< 3 years), marginal business decisions may be made relative to short-term O&M costs, long-term (> 3 years) business decisions usually consider both amortized capital costs and O&M costs.
[150] The CCR price data used to monetize the CCR price factor above are reportedly based on "FOB" prices which may include some portion of transport cost (e.g., transport vehicle loading to a trans-shipment location).
[151] $0.26 per-ton-per-mile is the midpoint of the $0.15 to $0.37 per-ton-per-mile range reported in "Estimation of the Marginal Greenhouse Gas Abatement Curve for the Beneficial Use of Fly Ash as a Substitute for Portland Cement in Ready-Mix Concrete Production," EPA Office of Resource Conservation and Recovery (ORCR), 19 June 2009, page 11.
[152] 125 miles is the midpoint of the 100 to 150 mile range reported in footnote 74 on page 4-8 of EPA's 03 June 2008 "Report to Congress: Study on Increasing the Usage of Recovered Mineral Components in Federal Funded Projects Involving Procurement of Cement or Concrete to Address the Safe, Accountable, Flexible, Efficient Transportation, Equity Act: A Legacy for Uses by the EPA, the Department of Transportation (DOT) and the Department of Energy (DOE)," report nr. EPA530-R-08-007, available at http://www.epa.gov/waste/conserve/tools/cpg/products/cement2.htm.

In comparison to these baseline "*raw materials acquisition cost*" elements, CCR disposal costs are estimated to be $83/ton for the Subtitle C option (source: **Exhibit 4K**). While this represents a 44% increase ($26/ton) over the baseline disposal cost of $59/ton, this ignores the CCR price and the transportation cost elements. Factoring these components in, the $26/ton increase represents a 28% increase above the total baseline raw material cost of $94.50/ton. This RIA applies this 28% growth factor to represent demand elasticity[153] assumptions of:

+0.64 with respect to the CCR "*avoided disposal cost incentive*" factor (i.e., +28%/+44%).
+1.00 with respect to total "*raw material acquisition cost*" consisting of all three cost factors included (i.e., +28%/+28%).

This RIA applies the elasticity estimate of 1.0 in reference to the "*raw material acquisition cost*" to represent the potential increase in CCR beneficial use by 28% over the baseline under the Subtitle C option. The other regulatory options are proportionately adjusted below. In comparison to historical annual percentage changes in CCR beneficial use tonnages, this 28% increase is a reasonable assumption as it falls between the -22.6% decrease and +55.2% increase min-max range (annual mean = +8.2% increase) over the 43 year period 1966 to 2008,[154] as displayed in **Exhibit 5C-14** below.

Exhibit 5C-14
Historical Annual Percentage Change in CCR Beneficial Use (1966-2008)

A	B	C	D	E	F (E/C)	G
Item	Year	CCR generation (tons)	CCR disposal (tons)	CCR beneficial use (tons)	Percent CCR beneficial use	Annual % change in CCR beneficial use tons
1	1966	26,000,000	22,000,000	4,000,000	15%	
2	1967	28,000,000	23,000,000	5,000,000	18%	25.0%
3	1968	30,000,000	24,000,000	6,000,000	20%	20.0%
4	1969	31,500,000	26,000,000	5,500,000	17%	-8.3%
5	1970	39,000,000	33,200,000	5,800,000	15%	5.5%
6	1971	41,500,000	32,500,000	9,000,000	22%	55.2%
7	1972	46,000,000	38,000,000	8,000,000	17%	-11.1%
8	1973	50,000,000	41,500,000	8,500,000	17%	6.3%
9	1974	59,000,000	50,000,000	9,000,000	15%	5.9%
10	1975	60,000,000	50,000,000	10,000,000	17%	11.1%
11	1976	62,000,000	50,000,000	12,000,000	19%	20.0%
12	1977	67,000,000	53,000,000	14,000,000	21%	16.7%
13	1978	68,000,000	52,000,000	16,000,000	24%	14.3%
14	1979	75,500,000	60,000,000	15,500,000	21%	-3.1%
15	1980	66,000,000	54,000,000	12,000,000	18%	-22.6%
16	1981	68,000,000	51,500,000	16,500,000	24%	37.5%

[153] In economics, the elasticity of supply indicates the responsiveness of the quantity of a product or service supplied to the market relative to a change in its price (i.e., (% change in quantity supplied) / (% change in its price)). Similarly, the elasticity of demand indicates the responsiveness of the quantity of market demand for a product or service relative to a change in its price (i.e., (% change in quantity demanded) / (% change in its price)).
[154] Historical CCR beneficial use data for 1966-2008 from ACAA at http://www.acaa-usa.org/associations/8003/files/Revised_1966_2007_CCP_Prod_v_Use_Chart.pdf

Exhibit 5C-14 Historical Annual Percentage Change in CCR Beneficial Use (1966-2008)						
A	B	C	D	E	F (E/C)	G
Item	Year	CCR generation (tons)	CCR disposal (tons)	CCR beneficial use (tons)	Percent CCR beneficial use	Annual % change in CCR beneficial use tons
17	1982	65,000,000	51,000,000	14,000,000	22%	-15.2%
18	1983	64,000,000	51,000,000	13,000,000	20%	-7.1%
19	1984	69,000,000	53,000,000	16,000,000	23%	23.1%
20	1985	66,000,000	48,000,000	18,000,000	27%	12.5%
21	1986	67,500,000	53,000,000	14,500,000	21%	-19.4%
22	1987	82,000,000	63,000,000	19,000,000	23%	31.0%
23	1988	83,000,000	62,500,000	20,500,000	25%	7.9%
24	1989	87,000,000	69,500,000	17,500,000	20%	-14.6%
25	1990	86,000,000	64,000,000	22,000,000	26%	25.7%
26	1991	88,000,000	65,500,000	22,500,000	26%	2.3%
27	1992	82,000,000	62,000,000	20,000,000	24%	-11.1%
28	1993	88,000,000	69,000,000	19,000,000	22%	-5.0%
29	1994	89,000,000	66,000,000	23,000,000	26%	21.1%
30	1995	92,000,000	68,000,000	24,000,000	26%	4.3%
31	1996	102,000,000	76,000,000	26,000,000	25%	8.3%
32	1997	104,000,000	74,500,000	29,500,000	28%	13.5%
33	1998	108,000,000	77,000,000	31,000,000	29%	5.1%
34	1999	107,000,000	74,000,000	33,000,000	31%	6.5%
35	2000	108,500,000	76,500,000	32,000,000	29%	-3.0%
36	2001	117,930,542	80,811,221	37,119,321	31%	16.0%
37	2002	128,703,572	83,180,316	45,523,256	35%	22.6%
38	2003	121,744,571	75,360,166	46,384,405	38%	1.9%
39	2004	122,465,119	73,375,301	49,089,818	40%	5.8%
40	2005	123,126,093	73,513,552	49,612,541	40%	1.1%
41	2006	124,795,124	70,591,954	54,203,170	43%	9.3%
42	2007	131,127,693	75,088,688	56,039,005	43%	3.4%
43	2008	136,073,107	75,479,447	60,593,660	45%	8.1%
Minimum annual %=						-22.6%
Maximum annual % =						55.2%
Median annual % =						6.4%
Mean annual % =						8.2%
Overall percent growth =						1414.8%
Average annual compound growth =						6.5%

This is a limiting analysis because it does not include other developments that may be expected increasingly to push CCR to beneficial use:

1. Aspects of the proposed CCR rule: This analysis does not take into account that some RCRA regulatory options for CCR disposal require electricity plants to move to dry management of CCR, either through changes to air pollution control strategies or through drying of CCR after they have been generated. This will make the material more amenable to beneficial uses.
2. The analysis is based on current market conditions: It does not take into account new technologies and products now being developed, for example, involving the use of CCR in brick construction.[155] An increased "*avoided disposal cost incentive*" could be a great boon to such new beneficial use technologies, applications, and products.

- **Comparison of "*Raw Materials Acquisition Cost Method*" to "*Travel Cost Method*"**

The method applied above involved three cost components of the "*raw material acquisition cost*," not just in relation to the transportation cost component, which is relatively narrower approach that can be called a "*Transportation Cost Method*." Compared to this other method, the raw material acquisition cost method provides a smaller estimate of effect because the incremental cost is evaluated relative to a broader set of costs thereby translating numerically into a smaller percentage change, rather than relative to only one cost factor which would translate into a relatively larger percentage change. This methodological difference may be illustrated by using the calculation numbers applied above, to only the transportation cost factor. Using a simplistic transportation distance model which uses the CCR disposal unit cost ($ per ton) to determine the average circular radius of a CCR transportation market between electricity utility plant suppliers of CCR and their beneficial users customers, the increase in transport distance would be calculated as follows (relative to the 2005 49.6 million tons CCR beneficially used as reported by the ACAA):

- Baseline transportation cost (without CCR rule)
  ($0.26/mile/ton) x (125 miles one-way average CCR transport distance) x (49.6 million tons/year beneficial use in 2005) = $1,612 million/year transport cost
- Hypothetical new transportation cost (with rule)
  Transport subsidy equivalency = ($85/ton avoided disposal cost under rule) – ($59/ton avoided disposal cost without rule) = $26/ton subsidy equivalency
  (49.6 million tons/year beneficial use) x ($26/ton subsidy equivalency) = $1,290 million per year subsidy equivalency
- Hypothetical new transport distance:
  [($1,612 million/year) + ($1,290 million/year)] / (49.6 million tons per year beneficial use) / ($0.26/mile/ton) = 225 miles
  Percentage increase in transport distance:
  [(225 miles) – (125 miles)] / (125 miles) = 80% increase in radial transport distance

[155] Several companies are developing technologies to convert CCR into bricks used in construction, and one such technology was recently commercialized at a power plant in Wisconsin. Some of these technologies have the potential for using 100% CCR (fly ash) in brick production, as opposed to the conventional 30%-50% limit for replacing Portland cement in concrete.

- Hypothetical expansion of CCR customer delivery area:
  Baseline customer area @125 miles radial transport distance = (3.1415 x (125 miles)^2) = 49,100 square miles
  Expanded customer area @225 miles radial transport distance = (3.1415 x (225 miles)^2) = 159,000 square miles
  Incremental increase in customer area = (159,000 – 49,100 sq. miles) / (49,100 sq.miles) = 124% increase in delivery area

Step 5: Estimate Hypothetical "*Stigma*" Decrease in Future CCR Beneficial Use (Scenario #2)

A number of industry and state government stakeholders have asserted to the EPA, that designating CCR as a hazardous waste (even if the designation is only applicable to those CCR that are disposed of) would create a "stigma" that would reduce or curtail or eliminate the beneficial use of CCR. This RIA presents an alternative stigma effect scenario in an effort to evaluate what countervailing impact that "stigma" may have on the increased beneficial use of CCR estimated in this RIA above. This potential reduction scenario assumes different potential impacts in three categories of beneficial CCR usage (uses covered in the CPGs, consolidated uses, and unconsolidated uses). For documentation of the calculations discussed in this section, see **Appendix K13**.

- **"*Stigma*" on CCR in Consolidated Uses Specified in Comprehensive Procurement Guidelines**

First, some uses for CCR involve the production of specific products that are expressly covered by the federal Comprehensive Procurement Guidelines (CPGs), which require procuring agencies that spend more than $10,000 a year on an item to buy products containing recovered materials. Procuring agencies are federal, state, and local agencies, and their contractors, that use appropriated federal funds. For example, if a county agency spends more than $10,000 a year on an EPA-designated item and part of that money is from appropriated federal funds, then the agency must purchase that item made from recovered materials.[156] As such, if there were any impacts due to stigma, EPA believes that the markets for these uses are less likely to be affected by a hazardous waste label for CCR. CCR categories currently covered under the CPGs include concrete/concrete products/grout, flowable fill, and blasting grit/roofing granules.

According to U.S. Census data, the public portion of total construction spending equaled 20.7% in 2005, 21.4% in 2006, 24.6% in 2007, and had swelled to 35.4% by Nov. 2009 (likely in direct relationship to the current state of the economy and current federal stimulus spending). Similarly, U.S. EPA (2008d) estimates that for concrete projects, the cement demand attributable to federal concrete projects reflects approximately 20% of the annual total demand. EPA then apportioned the amounts of CCR usage into a public construction vs. a private construction split. Based on the Census Bureau and EPA data,[157] EPA established a 25% / 75% split of the totals for these products, such that 25% of the total usage is recognized as accruing to public construction and 75 % to private construction.

[156] Agencies may elect not to purchase designated items when the cost is unreasonable; inadequate competition exists; items are not available within a reasonable period of time; or items do not meet the agency's reasonable performance specifications.
[157] Source: EPA "Report to Congress: Study on Increasing the Usage of Recovered Mineral Components in Federal Funded Projects Involving Procurement of Cement or Concrete to Address the Safe, Accountable, Flexible, Efficient Transportation, Equity Act: A Legacy for Uses by the EPA, the Department of Transportation (DOT) and the Department of Energy (DOE)," EPA530-R-08-007, June 3, 2008 at: http://www.epa.gov/waste/conserve/tools/cpg/products/cement2.htm

Given that the public procurement of these products should continue because of their CPG designation, this RIA assumed that there will be no negative impact on the public portion of CCR usage. That is, the demand for CPG products made from CCR will be the same as it currently is for the public portion of the construction market. However, this RIA assumes a 50% reduction of total private uses.[158] This results in an estimated 6.8 million tons per year reduction in CCR use for this category of beneficial uses.

- **"*Stigma*" for CCR in Other Consolidated Uses**

Not all consolidated uses of CCR are covered under federal CPGs. Thus, this scenario also estimated the potential impacts on the use of CCR in non-CPG, consolidated uses. These CCR categories include blended cement/raw feed for clinker, mineral filler in asphalt, gypsum panel products, waste stabilization/solidification, and miscellaneous/other. In the case of CCR used in blended cement, mineral filler – asphalt, gypsum for wallboard, and miscellaneous/other applications, this RIA assumed that 50% of these uses will be reduced. Thus, the potential reductions in this category will total 6.8 million tons per year.

For the use of CCR in waste stabilization/solidification applications, this RIA assumed that stigma will not have a negative impact. For this use, the CCR are already being used in a waste management context. The CCR are used in secure landfills to immobilize wastes typically more hazardous than the CCR themselves. Therefore, this RIA projects no reduction in the future annual tonnage of CCR used for this purpose.

- **"*Stigma*" for Unconsolidated Uses**

In addition to the consolidated uses of CCR discussed above, CCR can be employed in unconsolidated uses. For some of these uses, the CCR products may be more similar to the disposed material proposed to be regulated. In addition, they have typically not been chemically fixed within a product. As a result, stigma concerns may be more plausible. Markets that involve unconsolidated uses of CCR include structural fill/embankments, road base/sub-base, soil modification/stabilization, snow/ice control, aggregate, agriculture, and miscellaneous/other. For purpose of the sensitivity analysis, this RIA assumed a potential reduction of 80%.[159] This results in an additional 11.1 million tons per year reduction of beneficially used CCR. By adding the 6.8 million tons from CPG consolidated uses, to the 6.8 million tons from non-CPG consolidated uses, plus the 11.1 million tons from unconsolidated uses, this RIA estimates that a severe stigma effect would lead to a 51% reduction of beneficial use.

---

[158] The 50% reduction is considered a worst-case assumption because these materials provide significant value at competitive costs – for example, concrete that includes fly ash typically performs better than non-CCR concrete, and is likely to retain favorable treatment under Leadership in Energy and Environmental Design (LEED). In addition, academic studies of "stigma" associated with products rarely leads to decreased usage to this extent.

[159] EPA has assumed this high "stigma" effect because a number of the uses may appear close to the disposal scenario, e.g., structural fills. Also, it is widely recognized that CCR in unconsolidated uses may present risks, if used in the wrong conditions. (Indeed, EPA takes comment on unconsolidated uses in the preamble to the CCR proposed rule due to the increased potential for risks.) Some of these uses are likely to be particularly sensitive to public concerns and liability concerns. These include agricultural uses and dispersive uses, like use of bottom ash or boiler slag for ice and snow control. Therefore, if stigma does have a role to play, EPA believes it is reasonable to assume it will be significant for unconsolidated uses. Even for the purposes of a worst-case sensitivity analysis, however, EPA believes that, given the success of many of these uses in states with rigorous beneficial use programs, "stigma" will not completely eliminate such uses; therefore, it has estimated a decrease of 80%.

Step 6: Apply Estimated Induced Effect Scenarios to Baseline CCR Beneficial Use

Applying the first effect (increase in the sale of CCR due to a decrease in price), EPA noted that a 28% increase with an elasticity of 1.0 would makes sense when there is ample room for growth. But as the market becomes more and more saturated, it is less and less likely that unit elasticity would apply. Instead, the elasticity is likely to decrease with increasing saturation. To account for this, the beneficial use increase was set to 28% of either the existing beneficial use tonnage, or to 28% of the remaining CCR tonnage, whichever was less. In other words, once beneficial use was greater than 50% of total CCR, the increase would be constrained to 28% of what was left over after beneficial use was accounted for. EPA also accounted for the fact that the price change would not fully affect the market until the rule (and therefore the costs) had been phased in. Full implementation was assumed to occur by 2019. However, industry would undoubtedly likely attempt to prepare for these increased costs as soon as a final rule was passed, and therefore the beneficial use increases were assumed to linearly approach 28% by 2019. The projected tons of beneficial use under Subtitle C are shown in Exhibit 28 below.

As seen below, subtitle C in EPA's analysis would drive more CCR toward beneficial use due to the increased costs of disposal. However, as discussed in Step 4 above, there is also the possibility that there would be a stigma associated with the "hazardous waste" designation. Here the beneficial use of CCR would be 49% of the baseline due to stigma. Since the maximum CCR beneficially used is less than 50% of all CCR, the constraint imposed on the straight 28% increase would not be necessary. Thus, once the full 51% decrease and 28% increase are accounted for, the future CCR beneficial use annual tonnages are calculated as displayed below in **Exhibit 5C-15**.

Exhibit 5C-15 Two Alternative Scenarios of Projected Future CCR Beneficial Use 2012-2061 (Short Tons)					
Year	Scenario #1: w/out Stigma	Scenario #2: w/Stigma	Year	Scenario #1: w/out Stigma	Scenario #2: w/Stigma
2012	71,527,755	33,924,749	2037	128,297,364	82,753,160
2013	75,999,399	36,206,995	2038	129,708,417	84,404,170
2014	80,338,539	38,457,590	2039	131,105,658	86,035,997
2015	84,549,013	40,677,131	2040	132,489,375	87,649,041
2016	88,634,566	42,866,206	2041	133,859,848	89,243,690
2017	92,598,855	45,025,395	2042	135,217,354	90,820,330
2018	96,445,450	47,155,270	2043	136,562,164	92,379,337
2019	100,177,835	49,256,395	2044	137,894,545	93,921,081
2020	101,892,669	51,329,323	2045	139,214,759	95,445,925
2021	103,587,595	53,374,602	2046	140,523,061	96,954,227
2022	105,263,001	55,392,770	2047	141,819,704	98,446,334
2023	106,919,270	57,384,357	2048	143,104,936	99,922,592
2024	108,556,775	59,349,885	2049	144,378,997	101,383,338
2025	110,175,889	61,289,868	2050	145,642,128	102,828,900
2026	111,776,973	63,204,812	2051	146,894,561	104,259,605
2027	113,360,387	65,095,213	2052	148,136,525	105,675,770
2028	114,926,484	66,961,561	2053	149,368,245	107,077,707
2029	116,475,608	68,804,337	2054	150,589,942	108,465,723
2030	118,008,102	70,624,016	2055	151,801,831	109,840,117
2031	119,524,301	72,421,062	2056	153,004,125	111,201,184
2032	121,024,534	74,195,934	2057	154,197,031	112,549,212
2033	122,509,126	75,949,081	2058	155,380,753	113,884,485
2034	123,978,394	77,680,946	2059	156,555,491	115,207,281
2035	125,432,652	79,391,964	2060	157,721,441	116,517,870
2036	126,872,208	81,082,562	2061	158,878,794	117,816,520

Step 7: Estimate Potential Induced Effects on Future Annual Tonnages of CCR Beneficial Use

Exhibit 5C-16 below shows beneficial use projected under Subtitle C. Beneficial use under the increasing disposal cost scenario would lead to an increase of 28% above the baseline estimate. However, as the market becomes more and more saturated, it will likely become harder to increase beneficial use. Thus, the increase is constrained to 28% of the remaining unused CCR. The elasticity column represents the effective percent change in quantity for each percent change in price once this constraint has been accounted for. While the elasticity is assumed to initially be 1.0, the effect of market saturation drives that elasticity towards zero over time as seen below.

Exhibit 5C-16 Scenario #1: Increase in Future CCR Beneficial Use Under the Subtitle C Option							
Year	CCR generation (tons)	% beneficial use	Beneficial use (tons)	% increase	Increased beneficial use (tons)	Increase w/o mine filling (tons)	Implied elasticity
2012	134,764,862	53.08%	71,527,755	3.31%	2,293,574	2,241,198	0.95
2013	135,558,881	56.06%	75,999,399	6.27%	4,482,972	4,380,599	0.90
2014	136,352,901	58.92%	80,338,539	8.91%	6,571,517	6,421,451	0.85
2015	137,146,920	61.65%	84,549,013	11.27%	8,562,450	8,366,919	0.80
2016	137,940,940	64.26%	88,634,566	13.38%	10,458,928	10,220,089	0.76
2017	138,734,959	66.75%	92,598,855	15.27%	12,264,028	11,983,968	0.73
2018	139,528,979	69.12%	96,445,450	16.95%	13,980,748	13,661,485	0.69
2019	140,322,998	71.39%	100,177,835	18.46%	15,612,008	15,255,494	0.66
2020	141,117,018	72.20%	101,892,669	17.61%	15,253,914	14,905,577	0.63
2021	141,911,037	72.99%	103,587,595	16.81%	14,903,561	14,563,225	0.60
2022	142,705,057	73.76%	105,263,001	16.05%	14,560,799	14,228,291	0.57
2023	143,499,076	74.51%	106,919,270	15.35%	14,225,480	13,900,629	0.55
2024	144,293,096	75.23%	108,556,775	14.68%	13,897,458	13,580,097	0.52
2025	145,087,115	75.94%	110,175,889	14.05%	13,576,588	13,266,555	0.50
2026	145,881,135	76.62%	111,776,973	13.46%	13,262,729	12,959,864	0.48
2027	146,675,154	77.29%	113,360,387	12.90%	12,955,743	12,659,887	0.46
2028	147,469,174	77.93%	114,926,484	12.37%	12,655,491	12,366,492	0.44
2029	148,263,193	78.56%	116,475,608	11.87%	12,361,839	12,079,545	0.42
2030	149,057,213	79.17%	118,008,102	11.40%	12,074,654	11,798,919	0.41
2031	149,851,232	79.76%	119,524,301	10.95%	11,793,807	11,524,485	0.39
2032	150,645,252	80.34%	121,024,534	10.52%	11,519,168	11,256,118	0.38
2033	151,439,271	80.90%	122,509,126	10.11%	11,250,612	10,993,695	0.36
2034	152,233,291	81.44%	123,978,394	9.72%	10,988,015	10,737,095	0.35
2035	153,027,310	81.97%	125,432,652	9.36%	10,731,256	10,486,198	0.33
2036	153,821,330	82.48%	126,872,208	9.00%	10,480,214	10,240,889	0.32
2037	154,615,349	82.98%	128,297,364	8.67%	10,234,772	10,001,052	0.31
2038	155,409,369	83.46%	129,708,417	8.35%	9,994,815	9,766,574	0.30
2039	156,203,388	83.93%	131,105,658	8.04%	9,760,228	9,537,345	0.29
2040	156,997,408	84.39%	132,489,375	7.75%	9,530,902	9,313,255	0.28
2041	157,791,427	84.83%	133,859,848	7.47%	9,306,725	9,094,198	0.27
2042	158,585,447	85.26%	135,217,354	7.20%	9,087,592	8,880,069	0.26
2043	159,379,466	85.68%	136,562,164	6.95%	8,873,395	8,670,764	0.25
2044	160,173,486	86.09%	137,894,545	6.70%	8,664,032	8,466,182	0.24
2045	160,967,505	86.49%	139,214,759	6.47%	8,459,401	8,266,224	0.23
2046	161,761,525	86.87%	140,523,061	6.24%	8,259,402	8,070,792	0.22
2047	162,555,544	87.24%	141,819,704	6.03%	8,063,938	7,879,791	0.22
2048	163,349,564	87.61%	143,104,936	5.82%	7,872,911	7,693,126	0.21
2049	164,143,583	87.96%	144,378,997	5.62%	7,686,228	7,510,706	0.20

Exhibit 5C-16 Scenario #1: Increase in Future CCR Beneficial Use Under the Subtitle C Option							
Year	CCR generation (tons)	% beneficial use	Beneficial use (tons)	% increase	Increased beneficial use (tons)	Increase w/o mine filling (tons)	Implied elasticity
2050	164,937,603	88.30%	145,642,128	5.43%	7,503,796	7,332,440	0.19
2051	165,731,622	88.63%	146,894,561	5.25%	7,325,524	7,158,239	0.19
2052	166,525,642	88.96%	148,136,525	5.07%	7,151,323	6,988,016	0.18
2053	167,319,661	89.27%	149,368,245	4.90%	6,981,106	6,821,687	0.18
2054	168,113,681	89.58%	150,589,942	4.74%	6,814,787	6,659,166	0.17
2055	168,907,700	89.87%	151,801,831	4.58%	6,652,282	6,500,372	0.16
2056	169,701,720	90.16%	153,004,125	4.43%	6,493,509	6,345,224	0.16
2057	170,495,739	90.44%	154,197,031	4.29%	6,338,387	6,193,644	0.15
2058	171,289,759	90.71%	155,380,753	4.15%	6,186,835	6,045,554	0.15
2059	172,083,778	90.98%	156,555,491	4.01%	6,038,778	5,900,878	0.14
2060	172,877,798	91.23%	157,721,441	3.88%	5,894,139	5,759,541	0.14
2061	173,671,817	91.48%	158,878,794	3.76%	5,752,842	5,621,471	0.13

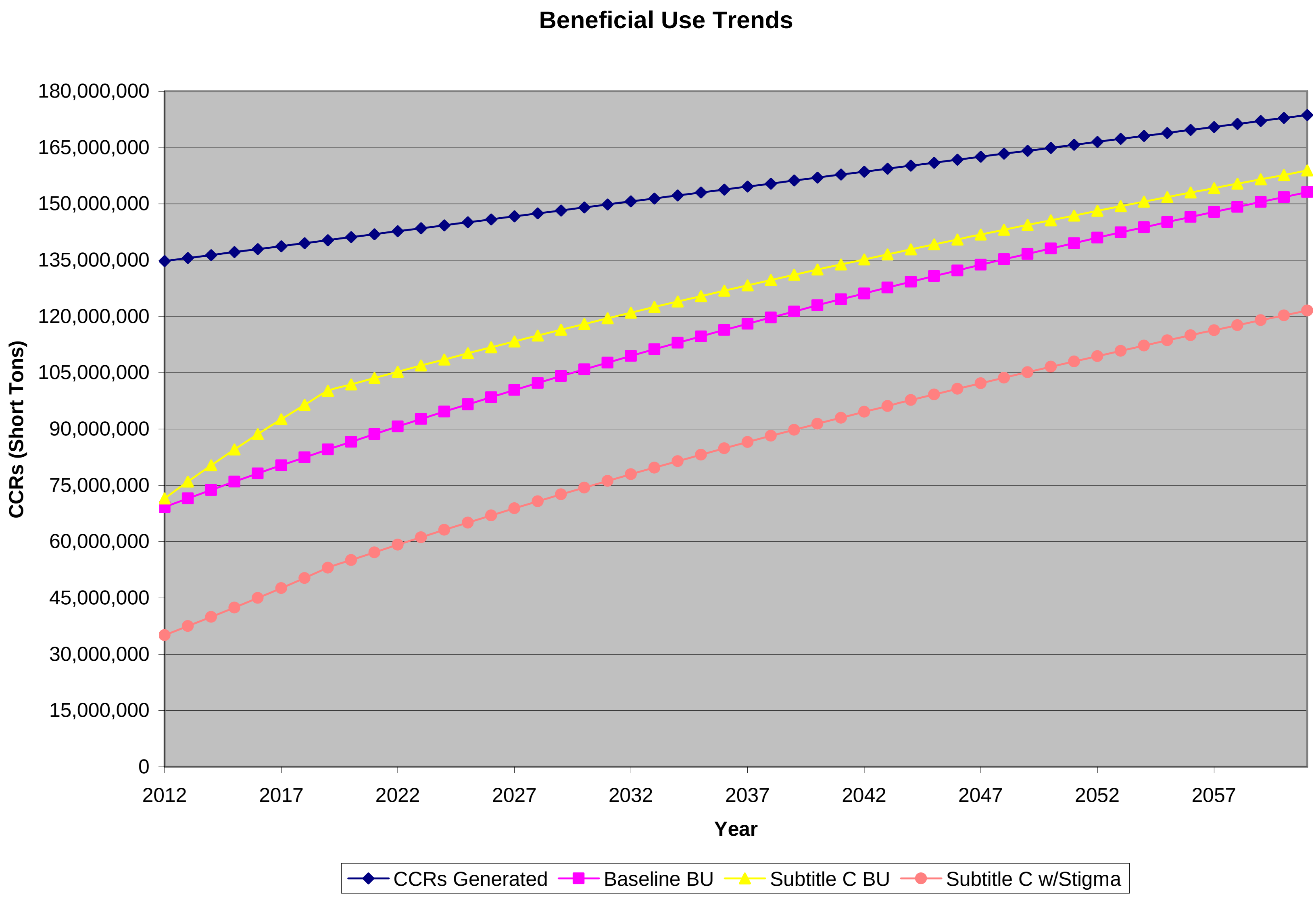
Exhibit 5C-17 below shows beneficial use projected under Subtitle C with a worst-case stigma assumption. Increased beneficial use under the increasing disposal costs of a Subtitle C rule are not accounted for. However, as soon as the rule becomes effective in 2012, the Scenario #2 of this RIA simulates a stigma effect which decreases the tons beneficially used by 51%. Once the disposal cost effect is fully captured by 2019, and the market has adjusted to stigma, beneficial use is assumed to grow at the same rate it would have otherwise.

Exhibit 5C-17 Scenario #2: Decrease in Future CCR Beneficial Use Because of Stigma Under Subtitle C Option						
Year	CCR generation tons	% beneficial use	Beneficial use tons	% Decrease	Decrease tons	Decrease w/out mine filling tons
2012	134,764,862	25.17%	33,924,749	-51.00%	-35,309,432	-33,342,859
2013	135,558,881	26.71%	36,206,995	-49.37%	-35,309,432	-33,342,859
2014	136,352,901	28.20%	38,457,590	-47.87%	-35,309,432	-33,342,859
2015	137,146,920	29.66%	40,677,131	-46.47%	-35,309,432	-33,342,859
2016	137,940,940	31.08%	42,866,206	-45.17%	-35,309,432	-33,342,859
2017	138,734,959	32.45%	45,025,395	-43.95%	-35,309,432	-33,342,859
2018	139,528,979	33.80%	47,155,270	-42.82%	-35,309,432	-33,342,859
2019	140,322,998	35.10%	49,256,395	-41.75%	-35,309,432	-33,342,859
2020	141,117,018	36.37%	51,329,323	-40.75%	-35,309,432	-33,342,859
2021	141,911,037	37.61%	53,374,602	-39.81%	-35,309,432	-33,342,859
2022	142,705,057	38.82%	55,392,770	-38.93%	-35,309,432	-33,342,859
2023	143,499,076	39.99%	57,384,357	-38.09%	-35,309,432	-33,342,859
2024	144,293,096	41.13%	59,349,885	-37.30%	-35,309,432	-33,342,859
2025	145,087,115	42.24%	61,289,868	-36.55%	-35,309,432	-33,342,859

Exhibit 5C-17 Scenario #2: Decrease in Future CCR Beneficial Use Because of Stigma Under Subtitle C Option						
Year	CCR generation tons	% beneficial use	Beneficial use tons	% Decrease	Decrease tons	Decrease w/out mine filling tons
2026	145,881,135	43.33%	63,204,812	-35.84%	-35,309,432	-33,342,859
2027	146,675,154	44.38%	65,095,213	-35.17%	-35,309,432	-33,342,859
2028	147,469,174	45.41%	66,961,561	-34.53%	-35,309,432	-33,342,859
2029	148,263,193	46.41%	68,804,337	-33.91%	-35,309,432	-33,342,859
2030	149,057,213	47.38%	70,624,016	-33.33%	-35,309,432	-33,342,859
2031	149,851,232	48.33%	72,421,062	-32.78%	-35,309,432	-33,342,859
2032	150,645,252	49.25%	74,195,934	-32.24%	-35,309,432	-33,342,859
2033	151,439,271	50.15%	75,949,081	-31.74%	-35,309,432	-33,342,859
2034	152,233,291	51.03%	77,680,946	-31.25%	-35,309,432	-33,342,859
2035	153,027,310	51.88%	79,391,964	-30.78%	-35,309,432	-33,342,859
2036	153,821,330	52.71%	81,082,562	-30.34%	-35,309,432	-33,342,859
2037	154,615,349	53.52%	82,753,160	-29.91%	-35,309,432	-33,342,859
2038	155,409,369	54.31%	84,404,170	-29.49%	-35,309,432	-33,342,859
2039	156,203,388	55.08%	86,035,997	-29.10%	-35,309,432	-33,342,859
2040	156,997,408	55.83%	87,649,041	-28.72%	-35,309,432	-33,342,859
2041	157,791,427	56.56%	89,243,690	-28.35%	-35,309,432	-33,342,859
2042	158,585,447	57.27%	90,820,330	-27.99%	-35,309,432	-33,342,859
2043	159,379,466	57.96%	92,379,337	-27.65%	-35,309,432	-33,342,859
2044	160,173,486	58.64%	93,921,081	-27.32%	-35,309,432	-33,342,859
2045	160,967,505	59.30%	95,445,925	-27.00%	-35,309,432	-33,342,859
2046	161,761,525	59.94%	96,954,227	-26.70%	-35,309,432	-33,342,859
2047	162,555,544	60.56%	98,446,334	-26.40%	-35,309,432	-33,342,859
2048	163,349,564	61.17%	99,922,592	-26.11%	-35,309,432	-33,342,859
2049	164,143,583	61.77%	101,383,338	-25.83%	-35,309,432	-33,342,859
2050	164,937,603	62.34%	102,828,900	-25.56%	-35,309,432	-33,342,859
2051	165,731,622	62.91%	104,259,605	-25.30%	-35,309,432	-33,342,859
2052	166,525,642	63.46%	105,675,770	-25.04%	-35,309,432	-33,342,859
2053	167,319,661	64.00%	107,077,707	-24.80%	-35,309,432	-33,342,859
2054	168,113,681	64.52%	108,465,723	-24.56%	-35,309,432	-33,342,859
2055	168,907,700	65.03%	109,840,117	-24.33%	-35,309,432	-33,342,859
2056	169,701,720	65.53%	111,201,184	-24.10%	-35,309,432	-33,342,859
2057	170,495,739	66.01%	112,549,212	-23.88%	-35,309,432	-33,342,859
2058	171,289,759	66.49%	113,884,485	-23.67%	-35,309,432	-33,342,859
2059	172,083,778	66.95%	115,207,281	-23.46%	-35,309,432	-33,342,859
2060	172,877,798	67.40%	116,517,870	-23.26%	-35,309,432	-33,342,859
2061	173,671,817	67.84%	117,816,520	-23.06%	-35,309,432	-33,342,859

Exhibit 5C-18 below shows the projected future annual CCR generation and three trends in beneficial use (i.e., scenario #1 increase without stigma, scenario #2 decrease with stigma, and scenario #3 no change in relation to the increasing baseline trend). Scenario #1 assumes that the increased cost of disposal from regulation will induce the electric utility industry to seek out additional CCR beneficial use markets thereby increasing future annual beneficial use of CCR above the increasing baseline trend. Experiences with the EPA RCRA Subtitle C hazardous waste program indicate that industry often increases annual recycling and materials recovery rates after RCRA regulation (e.g., after EPA has listed certain types and sources of secondary industrial materials as RCRA "hazardous wastes"). Thus, EPA regards the increased beneficial use Scenario #1 as the most likely outcome. A second curve in the Exhibit below displays the Scenario #2 decreased CCR beneficial use stigma effect under the Subtitle C regulatory option (this RIA does not apply scenario #2 under the Subtitle D options). The Exhibit also presents Scenario #3 in which future annual CCR beneficial use is projected to continue on its recent upwardly increasing trendline without any induced future change as a result of the CCR rule. The future annual beneficial use tonnages for both scenario #1 and scenario #2 are estimated in this RIA incrementally relative to the scenario #3 baseline trend.

Exhibit 5C-18



Step 8: Monetize Potential Induced Effects on Future CCR Beneficial Use

Based on multiplying a unitized average monetized social benefit value of **$559 per ton** consisting of (a) the $474 per ton unitized lifecycle benefit value, plus the (b) $85 per ton average avoided disposal cost estimated for the subtitle C option, to the 50-year (i.e., 2012 to 2061) projected future baseline tonnage displayed in **Exhibit 5C-18** above, produces an estimated future baseline social benefit value from CCR beneficial use of:

	PV @3% discount	PV @7% discount
Future baseline economic value:	$102,290 million PV	$51,170 million PV
Future baseline lifecycle social value*:	$1,554,323 million PV	$777,541 million PV

(* Includes avoided CCR disposal cost to electric utility industry)

- **Monetization of Scenario #1 (Induced Increase in CCR Beneficial Use)**

Exhibit 5C-19 below provides an estimate of the potential increase in future annual tonnage and economic and social benefits associated with CCR beneficial uses (not including minefilling) that could occur as a result of the CCR proposed rule. This quantity is incrementally calculated each year as the quantity projected under the Subtitle C option (without stigma), less the quantity projected under the baseline.

Exhibit 5C-19
Scenario #1: Benefit from Future Increase in CCR Beneficial User Under Subtitle C "Special Waste"

Year	CCR Beneficial Use Increase (tons)	Nominal Benefits (Millions)		Discounted Benefits @ 3% (Millions)		Discounted Benefits @ 7% (Millions)	
		Econ	Social	Econ	Social	Econ	Social
2012	2,241,198	$82	$1,253	$82	$1,253	$82	$1,253
2013	4,380,599	$161	$2,449	$156	$2,377	$151	$2,289
2014	6,421,451	$236	$3,590	$223	$3,384	$206	$3,135
2015	8,366,919	$308	$4,677	$282	$4,280	$251	$3,818
2016	10,220,089	$376	$5,713	$334	$5,076	$287	$4,359
2017	11,983,968	$441	$6,699	$380	$5,779	$314	$4,776
2018	13,661,485	$503	$7,637	$421	$6,396	$335	$5,089
2019	15,255,494	$561	$8,528	$456	$6,934	$350	$5,311
2020	14,905,577	$548	$8,332	$433	$6,578	$319	$4,850
2021	14,563,225	$536	$8,141	$411	$6,239	$291	$4,428
2022	14,228,291	$523	$7,954	$389	$5,918	$266	$4,043
2023	13,900,629	$511	$7,771	$369	$5,614	$243	$3,692
2024	13,580,097	$500	$7,591	$350	$5,324	$222	$3,371
2025	13,266,555	$488	$7,416	$332	$5,050	$203	$3,077

Exhibit 5C-19 Scenario #1: Benefit from Future Increase in CCR Beneficial User Under Subtitle C "Special Waste"							
Year	CCR Beneficial Use Increase (tons)	Nominal Benefits (Millions)		Discounted Benefits @ 3% (Millions)		Discounted Benefits @ 7% (Millions)	
		Econ	Social	Econ	Social	Econ	Social
2026	12,959,864	$477	$7,245	$315	$4,790	$185	$2,810
2027	12,659,887	$466	$7,077	$299	$4,542	$169	$2,565
2028	12,366,492	$455	$6,913	$284	$4,308	$154	$2,342
2029	12,079,545	$444	$6,753	$269	$4,085	$141	$2,138
2030	11,798,919	$434	$6,596	$255	$3,874	$128	$1,951
2031	11,524,485	$424	$6,442	$242	$3,674	$117	$1,781
2032	11,256,118	$414	$6,292	$229	$3,484	$107	$1,626
2033	10,993,695	$404	$6,146	$217	$3,304	$98	$1,484
2034	10,737,095	$395	$6,002	$206	$3,132	$89	$1,355
2035	10,486,198	$386	$5,862	$195	$2,970	$81	$1,237
2036	10,240,889	$377	$5,725	$185	$2,816	$74	$1,129
2037	10,001,052	$368	$5,591	$176	$2,670	$68	$1,030
2038	9,766,574	$359	$5,460	$167	$2,532	$62	$940
2039	9,537,345	$351	$5,331	$158	$2,400	$56	$858
2040	9,313,255	$343	$5,206	$150	$2,276	$52	$783
2041	9,094,198	$335	$5,084	$142	$2,157	$47	$715
2042	8,880,069	$327	$4,964	$135	$2,045	$43	$652
2043	8,670,764	$319	$4,847	$128	$1,939	$39	$595
2044	8,466,182	$311	$4,733	$121	$1,838	$36	$543
2045	8,266,224	$304	$4,621	$115	$1,742	$33	$496
2046	8,070,792	$297	$4,512	$109	$1,651	$30	$452
2047	7,879,791	$290	$4,405	$103	$1,565	$27	$413
2048	7,693,126	$283	$4,301	$98	$1,484	$25	$376
2049	7,510,706	$276	$4,199	$93	$1,406	$23	$343
2050	7,332,440	$270	$4,099	$88	$1,333	$21	$313
2051	7,158,239	$263	$4,002	$83	$1,263	$19	$286
2052	6,988,016	$257	$3,906	$79	$1,198	$17	$261
2053	6,821,687	$251	$3,813	$75	$1,135	$16	$238
2054	6,659,166	$245	$3,723	$71	$1,076	$14	$217
2055	6,500,372	$239	$3,634	$67	$1,019	$13	$198
2056	6,345,224	$233	$3,547	$64	$966	$12	$181
2057	6,193,644	$228	$3,462	$60	$916	$11	$165
2058	6,045,554	$222	$3,380	$57	$868	$10	$150
2059	5,900,878	$217	$3,299	$54	$822	$9	$137
2060	5,759,541	$212	$3,220	$51	$779	$8	$125
2061	5,621,471	$207	$3,142	$49	$738	$8	$114
			Present Value	$9,806	$149,001	$5,560	$84,489

- **Monetization of Potential "*Stigma*" Decrease in CCR Beneficial Use (Scenario #2)**

The **$559 per ton** social benefit value estimated above is the proper estimate for increased beneficial use because this RIA assumes that all beneficial uses will increase in equal proportions. However, it would not be appropriate to apply this same dollar estimate to decreased beneficial use from stigma because different uses decrease by different amounts, and therefore the decrease in benefits would not necessarily equal the 51% decrease in tons. Based on the breakdown of beneficial uses displayed below in **Exhibit 5C-20**, these individual use category losses were summed to create a weighted average benefit reduction of 42%. However, on a tonnage basis 51% of beneficial use tons are reduced. Dividing the weighted value by the unweighted value for each ton lost, the benefits decreased by only 82% of the average $559/ton, or $458/ton. This average unitized social benefits value is used to monetize the estimated tons lost from the stigma Scenario #2.

Exhibit 5C-20
Calculation of the "*Stigma*" Adjustment Factor for the CCR Beneficial Use Reduction Scenario #2

Beneficial Use Industrial Category	CCR Beneficial Use (2005 tons)	Disposal Cost Savings (millions)	Life Cycle Benefits (millions)	Total Benefits (millions)	Percent Lost From Stigma	Benefits Lost (millions)
1. Concrete/concrete products/grout	16,353,331	$1,390	$17,593	$18,983	37.5%	$7,118.6
2. Blended cement/raw feed for clinker	4,215,234	$358	Not estimated	$358	50%	$179.0
3. Flowable fill	259,907	$22	Not estimated	$22	37.5%	$8.3
4. Structural fill/embankments	8,349,999	$710	Not estimated	$710	80%	$568.0
5. Road base/sub-base	1,461,992	$124	Not estimated	$124	80%	$99.2
6. Soil modification/stabilization	1,139,640	$97	Not estimated	$97	80%	$77.6
7. Mineral filler in asphalt	140,838	$12	Not estimated	$12	50%	$6.0
8. Snow & ice control	547,541	$47	Not estimated	$47	80%	$37.6
9. Blasting grit/roofing granules	1,633,407	$139	Not estimated	$139	37.5%	$52.1
10. Gypsum panel products (wallboard)	8,178,079	$695	$5,387	$6,082	50%	$3,041.0
11. Waste stabilization/solidification	2,839,954	$241	Not estimated	$241	0%	$0.0
12. Agriculture	415,741	$35	Not estimated	$35	80%	$28.0
13. Aggregate	872,776	$74	Not estimated	$74	80%	$59.2
14. Miscellaneous other	2,071,157	$176	Not estimated	$176	65%	$114.4
Weighted Total =	48,479,596	$4,120	$22,980	$27,100	42%	$11,382
Unweighted Total =	48,479,596	$4,120	$22,980	$27,100	51%	$13,821
					Adjustment Factor =	**0.82**

Exhibit 5C-21 below provides an estimate of the beneficial use decrease scenario. This quantity is calculated each year as the quantity projected under subtitle C (with stigma) less the quantity projected under the baseline.

Exhibit 5C-21 Scenario #2: Cost of Potential Future Reduction in CCR Beneficial Use Under Subtitle C with "*Stigma*"							
Year	CCR Beneficial Use Decrease (Short Tons)	Nominal Costs (Millions)		Discounted Costs @ 3% (Millions)		Discounted Costs @ 7% (Millions)	
		Economic	Social	Economic	Social	Economic	Social
2012	-33,342,859	-$1,269	-$15,816	-$1,269	-$15,816	-$1,269	-$15,816
2013	-33,342,859	-$1,269	-$15,816	-$1,232	-$15,355	-$1,186	-$14,781
2014	-33,342,859	-$1,269	-$15,816	-$1,196	-$14,908	-$1,109	-$13,814
2015	-33,342,859	-$1,269	-$15,816	-$1,162	-$14,474	-$1,036	-$12,910
2016	-33,342,859	-$1,269	-$15,816	-$1,128	-$14,052	-$968	-$12,066
2017	-33,342,859	-$1,269	-$15,816	-$1,095	-$13,643	-$905	-$11,276
2018	-33,342,859	-$1,269	-$15,816	-$1,063	-$13,245	-$846	-$10,539
2019	-33,342,859	-$1,269	-$15,816	-$1,032	-$12,860	-$790	-$9,849
2020	-33,342,859	-$1,269	-$15,816	-$1,002	-$12,485	-$739	-$9,205
2021	-33,342,859	-$1,269	-$15,816	-$973	-$12,122	-$690	-$8,603
2022	-33,342,859	-$1,269	-$15,816	-$944	-$11,768	-$645	-$8,040
2023	-33,342,859	-$1,269	-$15,816	-$917	-$11,426	-$603	-$7,514
2024	-33,342,859	-$1,269	-$15,816	-$890	-$11,093	-$564	-$7,022
2025	-33,342,859	-$1,269	-$15,816	-$864	-$10,770	-$527	-$6,563
2026	-33,342,859	-$1,269	-$15,816	-$839	-$10,456	-$492	-$6,134
2027	-33,342,859	-$1,269	-$15,816	-$815	-$10,152	-$460	-$5,732
2028	-33,342,859	-$1,269	-$15,816	-$791	-$9,856	-$430	-$5,357
2029	-33,342,859	-$1,269	-$15,816	-$768	-$9,569	-$402	-$5,007
2030	-33,342,859	-$1,269	-$15,816	-$746	-$9,290	-$376	-$4,679
2031	-33,342,859	-$1,269	-$15,816	-$724	-$9,020	-$351	-$4,373
2032	-33,342,859	-$1,269	-$15,816	-$703	-$8,757	-$328	-$4,087
2033	-33,342,859	-$1,269	-$15,816	-$682	-$8,502	-$307	-$3,820
2034	-33,342,859	-$1,269	-$15,816	-$662	-$8,254	-$287	-$3,570
2035	-33,342,859	-$1,269	-$15,816	-$643	-$8,014	-$268	-$3,336
2036	-33,342,859	-$1,269	-$15,816	-$624	-$7,780	-$250	-$3,118
2037	-33,342,859	-$1,269	-$15,816	-$606	-$7,554	-$234	-$2,914
2038	-33,342,859	-$1,269	-$15,816	-$589	-$7,334	-$219	-$2,723
2039	-33,342,859	-$1,269	-$15,816	-$571	-$7,120	-$204	-$2,545
2040	-33,342,859	-$1,269	-$15,816	-$555	-$6,913	-$191	-$2,379
2041	-33,342,859	-$1,269	-$15,816	-$539	-$6,711	-$178	-$2,223
2042	-33,342,859	-$1,269	-$15,816	-$523	-$6,516	-$167	-$2,078
2043	-33,342,859	-$1,269	-$15,816	-$508	-$6,326	-$156	-$1,942
2044	-33,342,859	-$1,269	-$15,816	-$493	-$6,142	-$146	-$1,815
2045	-33,342,859	-$1,269	-$15,816	-$479	-$5,963	-$136	-$1,696
2046	-33,342,859	-$1,269	-$15,816	-$465	-$5,789	-$127	-$1,585
2047	-33,342,859	-$1,269	-$15,816	-$451	-$5,621	-$119	-$1,481
2048	-33,342,859	-$1,269	-$15,816	-$438	-$5,457	-$111	-$1,384
2049	-33,342,859	-$1,269	-$15,816	-$425	-$5,298	-$104	-$1,294

Exhibit 5C-21 Scenario #2: Cost of Potential Future Reduction in CCR Beneficial Use Under Subtitle C with "*Stigma*"							
Year	CCR Beneficial Use Decrease (Short Tons)	Nominal Costs (Millions)		Discounted Costs @ 3% (Millions)		Discounted Costs @ 7% (Millions)	
		Economic	Social	Economic	Social	Economic	Social
2050	-33,342,859	-$1,269	-$15,816	-$413	-$5,144	-$97	-$1,209
2051	-33,342,859	-$1,269	-$15,816	-$401	-$4,994	-$91	-$1,130
2052	-33,342,859	-$1,269	-$15,816	-$389	-$4,848	-$85	-$1,056
2053	-33,342,859	-$1,269	-$15,816	-$378	-$4,707	-$79	-$987
2054	-33,342,859	-$1,269	-$15,816	-$367	-$4,570	-$74	-$923
2055	-33,342,859	-$1,269	-$15,816	-$356	-$4,437	-$69	-$862
2056	-33,342,859	-$1,269	-$15,816	-$346	-$4,308	-$65	-$806
2057	-33,342,859	-$1,269	-$15,816	-$336	-$4,182	-$60	-$753
2058	-33,342,859	-$1,269	-$15,816	-$326	-$4,060	-$56	-$704
2059	-33,342,859	-$1,269	-$15,816	-$316	-$3,942	-$53	-$658
2060	-33,342,859	-$1,269	-$15,816	-$307	-$3,827	-$49	-$615
2061	-33,342,859	-$1,269	-$15,816	-$298	-$3,716	-$46	-$574
			Present Value	-$33,639	-$419,145	-$18,744	-$233,549

Step 9: Estimate Potential Induced Effect on CCR Beneficial Use of the Other RCRA Regulatory Options

The analysis above demonstrates the valuation of beneficial use effects using only the subtitle C option. However, the results may be extrapolated to the other regulatory options. **Exhibit 5C-22** below displays the beneficial use effect scenarios linearly extrapolated in relation to the result of subtitle C based on the potential increase in CCR disposal cost. In other words, the ratio of the disposal cost estimated under those other scenarios to the subtitle C disposal cost can be applied to the beneficial use benefits under those alternative options.

Exhibit 5C-22 Potential Induced Effect of RCRA Regulation on Future CCR Beneficial Use: 2 Scenarios ($millions present value @7%)			
Component	Subtitle C Special waste	Subtitle D (version 2)	Subtitle "D prime"
Assumed scaling ratios relative to C value =	100%	40%	16%
Scenario #1: Increase in Beneficial Use (Base Case)			
Percentage increase relative to baseline =	+11%	+4%	+2%
Economic market value	+$5,560	+$2,224	+$890
Lifecycle social value	+$84,489	+$33,796	+$13,518
Scenario #2: Decrease in Beneficial Use			
Percentage increase relative to baseline =	-18%	N/A	N/A
Economic market value	-$18,744	N/A	N/A
Lifecycle social value	-$233,549	N/A	N/A

Step 10: Quantify Potential Capacity Impacts on Commercial Subtitle C Waste Landfills (Under Scenario #2)

For Scenario #2 estimated above involving a potential future reduction in annual CCR beneficial use, such loss would require additional disposal of 33.3 million tons CCR annually (source: **Exhibit 5C-16**) which will likely create four future industrial waste disposal problems:

1. Annual disposal rate exceedance: Relative to the 33.3 million lost beneficial use annnual tonnages, there is a much smaller quantity of 2 million tons per year of RCRA-regulated hazardous waste which is currently disposed in RCRA Subtitle C permitted onsite (captive) and offsite (commercial) landfills in the US.[160] This implies a potential 1,665% annual increase (i.e., 16.65 times larger) in demand for hazardous waste landfill capacity.
2. Limited geographic availability: There are currently 19 to 24 commercial hazardous waste landfills operating in 15 to 17 states.[161] However, the CCR which is currently beneficially used is generated by 272 electric utility plants located in 41 states.[162] Thus disposal at commercial hazardous waste landfills would require out-of-state shipment involving at least 24 to 26 states which do not have commercial hazardous waste landfills.
3. Remaining disposal capacity exceedance: The 19 to 24 commercial hazardous waste landfills have an available total remaining capacity of 21.7 million to 25.4 million tons hazardous waste.[163] The additional 33.3 million tons per year of CCR beneficial use needing disposal under the Scenario #2 will consume this entire remaining total capacity within less than one year.
4. Increase landfill prices: In addition, such a large increase in nationwide economic demand for commercial hazardous waste landfills could drive-up landfill tipping fees which recently (2004) ranged between $61 and $139 per ton nationwide ($90 per ton national average).[164] As verification of this potential effect on landfill prices, a recent (August 2009) market study[165] of the US commercial

---

[160] Source: 2 million tons per year is based on the annual average of landfill tonnages reported for years 2001 (2.09 million tons), 2003 (1.68 million tons), 2005 (2.04 million tons), and 2007 (1.94 million tons) in EPA's "RCRA National Analysis Biennial Hazardous Waste Report" at http://www.epa.gov/waste/inforesources/data/biennialreport/index.htm

[161] Source: These two ranges (i.e., 19 to 24 commercial haz waste landfill counts and 15 to 17 states) are from two alternative data sources:

- Source #1 of 2: 24 commercial RCRA-permitted hazardous waste landfill count and 17 state identities as listed in the Hazardous Waste Consultant "2007 Directory of US Commercial Hazardous Waste Management Facilities," Vol.25, Issue 1, 2007, pp.4.1 to 4.44. The 17 states are AL, AR, CA, CO, ID, IL, IN, LA, MI, NV, NJ, NY, OH, OK, OR, TX, UT.
- Source #2 of 2: As compiled 02 Oct 2009 by EPA OSWER-ORCR staff (Cpan Lee, Environmental Scientist), this available remaining capacity estimate is based on three sources: (a) actual capacity estimates provided to OSWER-ORCR by facilities in April-Sept 2009, (b) information provided to OSWER-ORCR by EPA Regions and States in April/May 2009, and (c) capacity estimates developed by OSWER-ORCR using 1995-2007 RCRA Biennial Report data. The 15 States are AL, CA, CO, ID, IL, IN, LA, MI, NV, NY, OH, OK, OR, TX, and UT.

[162] The 41 states are AL, AR, AZ, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, ,OH, OK, OR, SC, SD, TN, TX, UT, VA, WA, WI, WV, WY.

[163] Source: 02 Oct 2009 estimates by EPA OSWER-ORCR staff (Cpan Lee, Environmental Scientist) cited in a prior footnote in this section of the RIA.

[164] Source: US commercial hazardous waste landfill prices for bulk hazardous waste without treatment reported by the Environmental Technology Council (ETC) "May 2004 Incinerator and Landfill Cost Data" website at http://www.etc.org/costsurvey8.cfm

[165] Source: Page 10 of "Hazardous Waste Industry Review 2008-2009," Joan Berkowitz and Robert Crisp, Farkas Berkowitz & Company, August 2009; http://www.farkasberkowitz.com/marketresearch.htm

hazardous waste industry, provides the following empirical evidence of price increases by commercial hazardous waste landfills in response to annual increases in landfill disposal tonnage:

> "*On average, the number of surveyed landfill firms that increased prices exceeds the number that received higher volumes in 2008. Volumes increased for 50 percent of respondents and decreased for 42 percent, but 67 percent raised prices and 33 percent left prices unchanged. The survey did not ask how much, if any, of the reported price increase was due to fuel surcharges. The survey did determine that 92 percent of respondents applied fuel surcharges, but fuel surcharges cannot account for all of the price increases because the surcharges cover increased costs, and 77 percent of respondents reported increased [profit] margins.*"

Chapter 6
Comparison of Regulatory Benefits to Costs

Section 6A of this Chapter presents a series of exhibits which summarize and compare the results of the cost and benefit estimates presented in **Chapter 4** and **Chapter 5**, respectively, scaled to the three 2010 regulatory options. Section 6B of this Chapter provides explanation of the scaling method and factors applied.

6A. Comparison of Regulatory Benefits to Costs Based on Alternative Discount Rates

The series of six **Exhibits 6A to 6F** below summarize cost and benefits according to the three alternative beneficial use scenarios (i.e., induced increase, induced decrease, and no change), and according to the two OMB-prescribed alternative discount rates of 7% and 3% for use in RIAs:

7% discount rate: The 7% discount rate as a "base case" to represent the financial opportunity cost (i.e., borrowing cost) to affected businesses, which is consistent with OMB's 2003 Circular A-4 guidance[166] (page 33), and with OMB's 1992 Circular A-94 guidance[167] (page 8) which indicate that a 7% discount rate "base case" should be used for regulatory analyses when regulation is expected to primarily and directly affect businesses and industries.

3% discount rate: This is a second mandatory discount rate specified in OMB's 2003 Circular A-4 guidance (page 34).

In these six summary exhibits below, the comparison of regulatory benefits to costs involves two numerical comparisons:

1. Net benefits (i.e., benefits minus costs)
2. Benefit/cost ratios (i.e., benefits divided by costs)

	Two alternative discount rates:	
	7% discount rate	3% discount rate
Three alternative CCR beneficial use impact scenarios:	(base case in this RIA)	
Scenario #1: Induced increase (base case)	**Exhibit 6A**	**Exhibit 6B**
Scenario #2: Induced decrease	**Exhibit 6C**	**Exhibit 6D**
Scenario #3: No change	**Exhibit 6E**	**Exhibit 6F**

[166] OMB's 17 Sept 2003 Circular A-4 "Regulatory Analysis" guidance is available at: http://www.whitehouse.gov/omb/circulars_a004_a-4/
[167] OMB's 29 Oct 1992 Circular A-94 "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," is available at http://www.whitehouse.gov/omb/rewrite/circulars/a094/a094.html

Exhibit 6A Comparison of Regulatory Benefits to Costs Under Scenario #1 – Induced Beneficial Use Increase @7% Discount Rate – Detailed Summary ($Millions in 50-Year Present Values @2009$ Prices)						
Costs	**Subtitle C "Special Waste"**		**Subtitle D (version 2)**		**Subtitle "D prime"**	
1. Engineering Controls	$6,780		$3,254		$3,254	
2. Ancillary Costs	$1,480		$5		$5	
3. Dry Conversion	$12,089		4,836		$0	
Total Costs (1+2+3) =	$20,349		$8,095		$3,259	
Benefits						
4. Groundwater Protection Benefits*	$970		$375		$188	
Count of Human Cancer Risks Avoided**	726		296		148	
Monetized Value of Human Cancer Risks Avoided	$504		$207		$104	
Groundwater Remediation Costs Avoided	$466		$168		$84	
5. Induced Impact on CCR Beneficial Use	Econ. benefits	Social benefits	Econ. benefits	Social benefits	Econ. Benefits	Social benefits
Scenario #1 @7% discount rate =	$5,560	$84,489	$2,224	$33,796	$890	$13,518
6. CCR Impoundment Failure Costs Avoided						
If Based on Extrapolated Recent Failure Cases	$1,762		$793		$405	
If Based on 10% Future Failures	$8,366		$3,795		$1,897	
If Based on 20% Future Failures	$16,732		$7,590		$3,795	
7. Non-quantified Benefits***	Q		R		S	
Total Benefits (4+5+6):						
Total Benefits w/Extrapolated Recent Failure Cases =	$8,292	$87,221	$3,392	$34,964	$1,483	$14,111
Total Benefits @10% Future Failures =	$14,896	$93,825	$6,394	$37,966	$2,975	$15,603
Total Benefits @20% Future Failures =	$23,262	$102,191	$10,189	$41,761	$4,873	$17,501
Net Benefits (Total Benefits minus Total Costs)						
Net Benefits w/Extrapolated Recent Failure Cases =	($12,057)	$66,872	($4,703)	$26,869	($1,776)	$10,852
Net Benefits @10% Future Failures =	($5,453)	$73,476	($1,701)	$29,871	($284)	$12,344
Net Benefits @20% Future Failures =	$2,913	$81,842	$2,094	$33,666	$1,614	$14,242
Benefit/Cost Ratio (BCR)						
BCR w/Extrapolated Recent Failure Cases =	0.407	4.286	0.419	4.319	0.455	4.330
BCR @10% Future Failures =	0.732	4.611	0.790	4.690	0.913	4.788
BCR @20% Future Failures =	1.143	5.022	1.259	5.159	1.495	5.370

Notes:
* Cancer risk reflects the arsenic groundwater pathway only and does not include other human health mortality or morbidity risks from non-carcinogens, nor do they reflect ecological and socio-economic damages that could occur. Thus, the benefits are underestimated in this RIA.
** Cancer risks avoided are based on National Academy of Science (2001) data, which represents recent scientific information.
*** Q>R>S; For example, non-quantified ecological benefits could add 159%, and socio-economic benefits could add 24%, compared to avoided cleanup cost benefit.

Exhibit 6B Comparison of Regulatory Benefits to Costs Under Scenario #1 – Induced Beneficial Use Increase @3% Discount Rate ($Millions in 50-Year Present Values @2009$ Prices)						
Costs	**Subtitle C "Special Waste"**		**Subtitle D (version 2)**		**Subtitle "D prime"**	
1. Engineering Controls	$12,640		$6,067		$6,067	
2. Ancillary Costs	$2,759		$9		$9	
3. Dry Conversion	$22,538		$9,016		$0	
Total Costs (1+2+3) =	$37,938		$15,092		$6,076	
Benefits						
4. Groundwater Protection Benefits*	$3,316		$1,321		$661	
Count of Human Cancer Risks Avoided**	726		296		148	
Monetized Value of Human Cancer Risks Avoided	$1,825		$750		$375	
Groundwater Remediation Costs Avoided	$1,491		$571		$286	
5. Induced Impact on CCR Beneficial Use	Econ. benefits	Social benefits	Econ. benefits	Social benefits	Econ. Benefits	Social benefits
Scenario #1 @3% discount rate =	$9,806	$149,001	$3,922	$59,600	$1,569	$23,840
6. CCR Impoundment Failure Costs Avoided						
If Based on Extrapolated Recent Failure Cases	$3,124		$1,406		$719	
If Based on @ 10% Future Failures	$13,046		$5,918		$2,959	
If Based on @ 20% Future Failures	$26,092		$11,836		$5,918	
7. Non-quantified Benefits***	Q		R		S	
Total Benefits (4+5+6):						
Total Benefits w/Extrapolated Recent Failure Cases =	$16,246	$155,441	$6,649	$62,327	$2,949	25,220
Total Benefits @10% Future Failures =	$26,168	$165,363	$11,161	$66,839	$5,189	$27,460
Total Benefits @20% Future Failures =	$39,214	$178,409	$17,079	$72,757	$8,148	$30,419
Net Benefits (Total Benefits minus Total Costs)						
Net Benefits w/Extrapolated Recent Failure Cases =	($21,692)	$117,503	($8,443)	$47,235	($3,127)	$19,144
Net Benefits @10% Future Failures =	($11,770)	$127,425	($3,931)	$51,747	($887)	$21,384
Net Benefits @20% Future Failures =	$1,276	$140,471	$1,987	$57,665	$2,072	$24,343
Benefit/Cost Ratio (BCR)						
BCR w/Extrapolated Recent Failure Cases =	0.428	4.097	0.441	4.130	0.485	4.151
BCR @10% Future Failures =	0.690	4.359	0.740	4.429	0.854	4.519
BCR @20% Future Failures =	1.034	4.703	1.132	4.821	1.341	5.006

Notes:
* Cancer risk reflects the arsenic groundwater pathway only and does not include other human health mortality or morbidity risks from non-carcinogens, nor do they reflect ecological and socio-economic damages that could occur. Thus, the benefits are underestimated in this RIA.
** Cancer risks avoided are based on National Academy of Science (2001) data, which represents recent scientific information.
*** Q>R>S.

Exhibit 6C

Comparison of Regulatory Benefits to Costs Under Scenario #2 – Induced Beneficial Use Decrease @7% Discount Rate

($Millions in 50-Year Present Values @2009$ Prices)

Costs	**Subtitle C "Special Waste"**		**Subtitle D (version 2)**		**Subtitle "D prime"**	
1. Engineering Controls	$6,780		$3,254		$3,254	
2. Ancillary Costs	$1,480		$5		$5	
3. Dry Conversion	$12,089		4,836		$0	
Total Costs (1+2+3) =	$20,349		$8,095		$3,259	
Benefits						
4. Groundwater Protection Benefits*	$970		$375		$188	
Count of Human Cancer Risks Avoided**	726		296		148	
Monetized Value of Human Cancer Risks Avoided	$504		$207		$104	
Groundwater Remediation Costs Avoided	$466		$168		$84	
5. Induced Impact on CCR Beneficial Use	Econ. benefits	Social benefits	Econ. benefits	Social benefits	Econ. Benefits	Social benefits
Scenario #2 @7% discount rate =	($18,744)	($233,549)	$0 (no impact)	$0 (no impact)	$0 (no impact)	$0 (no impact)
6. CCR Impoundment Failure Costs Avoided						
If Based on Extrapolated Recent Failure Cases	$1,762		$793		$405	
If Based on 10% Future Failures	$8,366		$3,795		$1,897	
If Based on 20% Future Failures	$16,732		$7,590		$3,795	
7. Non-quantified Benefits***	Q		R		S	
Total Benefits (4+5+6):						
Total Benefits w/Extrapolated Recent Failure Cases =	($16,012)	($230,817)	$1,168	$1,168	$593	$593
Total Benefits @10% Future Failures =	($9,408)	($224,213)	$4,170	$4,170	$2,085	$2,085
Total Benefits @20% Future Failures =	($1,042)	($215,847)	$7,965	$7,965	$3,983	$3,983
Net Benefits (Total Benefits minus Total Costs)						
Net Benefits w/Extrapolated Recent Failure Cases =	($36,361)	($251,166)	($6,927)	($6,927)	($2,666)	($2,666)
Net Benefits @10% Future Failures =	($29,757)	($244,562)	($3,925)	($3,925)	($1,174)	($1,174)
Net Benefits @20% Future Failures =	($21,391)	($236,196)	($130)	($130)	$724	$724
Benefit/Cost Ratio (BCR)						
BCR w/Extrapolated Recent Failure Cases =	(0.787)	(11.343)	0.144	0.144	0.182	0.182
BCR @10% Future Failures =	(0.462)	(11.018)	0.515	0.515	0.640	0.640
BCR @20% Future Failures =	(0.051)	(10.607)	0.984	0.984	1.222	1.222

Notes:

* Cancer risk reflects the arsenic groundwater pathway only and does not include other human health mortality or morbidity risks from non-carcinogens, nor do they reflect ecological and socio-economic damages that could occur. Thus, the benefits are underestimated in this RIA.

** Cancer risks avoided are based on National Academy of Science (2001) data, which represents recent scientific information.

*** Q>R>S.

Exhibit 6D **Comparison of Regulatory Benefits to Costs Under Scenario #2 – Induced Beneficial Use Decrease @3% Discount Rate** ($Millions in 50-Year Present Values @2009$ Prices)						
Costs	**Subtitle C "Special Waste"**		**Subtitle D (version 2)**		**Subtitle "D prime"**	
1. Engineering Controls	$12,640		$6,067		$6,067	
2. Ancillary Costs	$2,759		$9		$9	
3. Dry Conversion	$22,538		$9,016		$0	
Total Costs (1+2+3) =	$37,938		$15,092		$6,076	
Benefits						
4. Groundwater Protection Benefits*	$3,316		$1,321		$661	
Count of Human Cancer Risks Avoided**	726		296		148	
Monetized Value of Human Cancer Risks Avoided	$1,825		$750		$375	
Groundwater Remediation Costs Avoided	$1,491		$571		$286	
5. Induced Impact on CCR Beneficial Use	Econ. benefits	Social benefits	Econ. benefits	Social benefits	Econ. Benefits	Social benefits
Scenario #2 @3% discount rate =	($34,946)	($435,419)	$0 (no impact)	$0 (no impact)	$0 (no impact)	$0 (no impact)
6. CCR Impoundment Failure Costs Avoided						
If Based on Extrapolated Recent Failure Cases	$3,124		$1,406		$719	
If Based on 10% Future Failures	$13,046		$5,918		$2,959	
If Based on 20% Future Failures	$26,092		$11,836		$5,918	
7. Non-quantified Benefits***	Q		R		S	
Total Benefits (4+5+6):						
Total Benefits w/Extrapolated Recent Failure Cases =	($28,506)	($428,979)	$2,727	$2,727	$1,380	$1,380
Total Benefits @10% Future Failures =	($18,584)	($419,057)	$7,239	$7,239	$3,620	$3,620
Total Benefits @20% Future Failures =	($5,538)	($406,011)	$13,157	$13,157	$6,579	$6,579
Net Benefits (Total Benefits minus Total Costs)						
Net Benefits w/Extrapolated Recent Failure Cases =	($66,443)	($466,917)	($12,365)	($12,365)	($4,696)	($4,696)
Net Benefits @10% Future Failures =	($56,521)	($456,995)	($7,853)	($7,853)	($2,456)	($2,456)
Net Benefits @20% Future Failures =	($43,475)	($443,949)	($1,935)	($1,935)	$503	$503
Benefit/Cost Ratio (BCR)						
BCR w/Extrapolated Recent Failure Cases =	(0.751)	(11.307)	0.181	0.181	0.227	0.227
BCR @10% Future Failures =	(0.490)	(11.046)	0.480	0.480	0.596	0.596
BCR @20% Future Failures =	(0.146)	(10.702)	0.872	0.872	1.083	1.083

Notes:
* Cancer risk reflects the arsenic groundwater pathway only and does not include other human health mortality or morbidity risks from non-carcinogens, nor do they reflect ecological and socio-economic damages that could occur. Thus, the benefits are underestimated in this RIA.
** Cancer risks avoided are based on National Academy of Science (2001) data, which represents recent scientific information.
*** Q>R>S.

Exhibit 6E

Comparison of Regulatory Benefits to Costs Under Scenario #3 – No Change to Beneficial Use @ 7% Discount Rate

($Millions in 50-Year Present Values @2009$ Prices)

Costs	**Subtitle C "Special Waste"**		**Subtitle D (version 2)**		**Subtitle "D prime"**	
1. Engineering Controls	$6,780		$3,254		$3,254	
2. Ancillary Costs	$1,480		$5		$5	
3. Dry Conversion	$12,089		4,836		$0	
Total Costs (1+2+3) =	$20,349		$8,095		$3,259	
Benefits						
4. Groundwater Protection Benefits*	$970		$375		$188	
Count of Human Cancer Risks Avoided**	726		296		148	
Monetized Value of Human Cancer Risks Avoided	$504		$207		$104	
Groundwater Remediation Costs Avoided	$466		$168		$84	
5. Induced Impact on CCR Beneficial Use	Econ. benefits	Social benefits	Econ. benefits	Social benefits	Econ. Benefits	Social benefits
Scenario #3 @7% discount rate =	$0 (no change)	$0 (no change)	$0 (no change)	$0 (no change)	$0 (no change)	$0 (no change)
6. CCR Impoundment Failure Costs Avoided						
If Based on Extrapolated Recent Failure Cases	$1,762		$793		$405	
If Based on 10% Future Failures	$8,366		$3,795		$1,897	
If Based on 20% Future Failures	$16,732		$7,590		$3,795	
7. Non-quantified Benefits***	Q		R		S	
Total Benefits (4+5+6):						
Total Benefits w/Extrapolated Recent Failure Cases =	$2,732	$2,732	$1,168	$1,168	$593	$593
Total Benefits @10% Future Failures =	$9,336	$9,336	$4,170	$4,170	$2,085	$2,085
Total Benefits @20% Future Failures =	$17,702	$17,702	$7,965	$7,965	$3,983	$3,983
Net Benefits (Total Benefits minus Total Costs)						
Net Benefits w/Extrapolated Recent Failure Cases =	($17,617)	($17,617)	($6,927)	($6,927)	($2,666)	($2,666)
Net Benefits @10% Future Failures =	($11,013)	($11,013)	($3,925)	($3,925)	($1,174)	($1,174)
Net Benefits @20% Future Failures =	($2,647)	($2,647)	($130)	($130)	$724	$724
Benefit/Cost Ratio (BCR)						
BCR w/Extrapolated Recent Failure Cases =	0.134	0.134	0.144	0.144	0.182	0.182
BCR @10% Future Failures =	0.459	0.459	0.515	0.515	0.640	0.640
BCR @20% Future Failures =	0.870	0.870	0.984	0.984	1.222	1.222

Notes:

* Cancer risk reflects the arsenic groundwater pathway only and does not include other human health mortality or morbidity risks from non-carcinogens, nor do they reflect ecological and socio-economic damages that could occur. Thus, the benefits are underestimated in this RIA.

** Cancer risks avoided are based on National Academy of Science (2001) data, which represents recent scientific information.

*** Q>R>S.

Exhibit 6F
Comparison of Regulatory Benefits to Costs Under Scenario #3 – No Change to Beneficial Use @ 3% Discount Rate
($Millions in 50-Year Present Values @2009$ Prices)

Costs	Subtitle C "Special Waste"		Subtitle D (version 2)		Subtitle "D prime"	
1. Engineering Controls	$12,640		$6,067		$6,067	
2. Ancillary Costs	$2,759		$9		$9	
3. Dry Conversion	$22,538		$9,016		$0	
Total Costs (1+2+3) =	$37,938		$15,092		$6,076	
Benefits						
4. Groundwater Protection Benefits*	$3,316		$1,321		$661	
Count of Human Cancer Risks Avoided**	726		296		148	
Monetized Value of Human Cancer Risks Avoided	$1,825		$750		$375	
Groundwater Remediation Costs Avoided	$1,491		$571		$286	
5. Induced Impact on CCR Beneficial Use	Econ. benefits	Social benefits	Econ. benefits	Social benefits	Econ. Benefits	Social benefits
Scenario #3 @3% discount rate =	$0 (no change)	$0 (no change)	$0 (no change)	$0 (no change)	$0 (no change)	$0 (no change)
6. CCR Impoundment Failure Costs Avoided						
If Based on Extrapolated Recent Failure Cases	$3,124		$1,406		$719	
If Based on 10% Future Failures	$13,046		$5,918		$2,959	
If Based on 20% Future Failures	$26,092		$11,836		$5,918	
7. Non-quantified Benefits***	Q		R		S	
Total Benefits (4+5+6):						
Total Benefits w/Extrapolated Recent Failure Cases =	$6,440	$6,440	$2,727	$2,727	$1,380	$1,380
Total Benefits @10% Future Failures =	$16,362	$16,362	$7,239	$7,239	$3,620	$3,620
Total Benefits @20% Future Failures =	$29,408	$29,408	$13,157	$13,157	$6,579	$6,579
Net Benefits (Total Benefits minus Total Costs)						
Net Benefits w/Extrapolated Recent Failure Cases =	($31,498)	($31,498)	($12,365)	($12,365)	($4,696)	($4,696)
Net Benefits @10% Future Failures =	($21,576)	($21,576)	($7,853)	($7,853)	($2,456)	($2,456)
Net Benefits @20% Future Failures =	($8,530)	($8,530)	($1,935)	($1,935)	$503	$503
Benefit/Cost Ratio (BCR)						
BCR w/Extrapolated Recent Failure Cases =	0.170	0.170	0.181	0.181	0.227	0.227
BCR @10% Future Failures =	0.431	0.431	0.480	0.480	0.596	0.596
BCR @20% Future Failures =	0.775	0.775	0.872	0.872	1.083	1.083

Notes:
* Cancer risk reflects the arsenic groundwater pathway only and does not include other human health mortality or morbidity risks from non-carcinogens, nor do they reflect ecological and socio-economic damages that could occur. Thus, the benefits are underestimated in this RIA.
** Cancer risks avoided are based on National Academy of Science (2001) data, which represents recent scientific information.
*** Q>R>S.

6B. Factors Applied for Scaling Benefits and Costs to the Three 2010 Regulatory Options

The regulatory compliance cost estimation presented in **Chapter 4** of this RIA was initially formulated with reference to the October 2009 draft RIA regulatory options. Furthermore, the regulatory benefits evaluation in **Chapter 5** of this RIA was based only on the 2010 regulatory options. To resolve this inconsistency in scope between the two different sets of regulatory options evaluated for costs and for benefits, respectively, this RIA applies the scaling factors (i.e., percentage extrapolation multipliers) displayed below in **Exhibit 6F**.

The cost analysis presented in **Chapter 4** of this RIA is built upon a detailed (i.e., plant-by-plant for all 495 coal-fired electric utility plants) engineering cost model which estimated "engineering control" costs associated with the RCRA 3004(x) custom-tailored technical standards of the 2009 regulatory options (i.e., Subtitle C "hazardous waste" option, Subtitle D non-hazardous waste option requiring composite liners for new CCR disposal units, and a "hybrid" C/D option). Although the engineering control costs were the same for each of the three October 2009 options, "ancillary costs" differed according to whether an option was formulated in reference to Subtitle C or to Subtitle D authority. For example, only the Subtitle C "hazardous waste" option and the Subtitle C component of the "Hybrid C/D" option required the cost associated with manifesting offsite shipments of CCR between coal-fired electric utility plants and offsite CCR disposal locations. The October 2009 draft RIA presented the "dry conversion cost" element as a separable "sub-option" for both the Subtitle C and Subtitle D options.

However, in 2010 EPA identified a different set of three regulatory options to describe in the proposed rule and evaluate in RIA (i.e., Subtitle C "special waste" option with wet disposal phase-out, Subtitle D option which in effect would phase-out wet CCR disposal by requiring retrofitting existing impoundments with composite liners, and a Subtitle "D prime" option requiring liners only for new disposal units). In order to meet EPA's end-of-March 2010 internal deadline for completing the 2nd draft of this RIA, EPA did not revised the **Chapter 4** cost analysis or the **Chapter 7** supplemental analyses, but applied scaling factors for bridging the cost estimates to the 2010 options. Numerically, the scaling factors represent alternative compliance rate assumptions in relation to the 2009 draft RIA's Subtitle C "hazardous waste" option as a reference case for both cost and benefit estimate scaling to the three 2010 regulatory options. The scaling factors assume less compliance under the non-Federally enforceable Subtitle D based options compared to the Federally-enforceable Subtitle C option. Section 6B of this RIA provides the numerical values assigned to the scaling factors on an itemized basis according to the separate cost element and benefit element categories, for each of the three 2010 regulatory options.

Exhibit 6F
Scaling Factors (Extrapolation Multipliers) Applied in this RIA to Estimate the Costs & Benefits of the 2010 Regulatory Options for CCR Disposal

Economic Impact Category	Subtitle C Special Waste	Subtitle D (version 2)	Subtitle "D prime"
Regulatory Compliance Costs:			
1. Engineering control costs	100%	48%	48%
2. Ancillary costs	100%	48%	48%
3. Dry conversion costs	100%	40%	0%
Regulatory Benefits:			

Exhibit 6F Scaling Factors (Extrapolation Multipliers) Applied in this RIA to Estimate the Costs & Benefits of the 2010 Regulatory Options for CCR Disposal			
Economic Impact Category	Subtitle C Special Waste	Subtitle D (version 2)	Subtitle "D prime"
1. Groundwater contamination prevention benefits:			
Groundwater remediation costs avoided	100%	48%	30%
Monetized value of human cancer risks avoided	100%	48%	30%
2. Impoundment structural failure cleanup costs avoided	100%	45%	23%
3. Induced impact on CCR beneficial use:			
Scenario #1: Induced increase	100%	40%	16%
Scenario #2: Induced decrease	100%	None (0%)	None (0%)
Scenario #3: No change	Not relevant	Not relevant	Not relevant

The following two sub-sections (6B.1 and 6B.2) provide explanation and documentation of the scaling factors displayed in **Exhibit 6F** above.

6B.1 Regulatory Cost Scaling Factors

- Engineering control costs: For both RCRA subtitle C and subtitle D, the engineering control costs would be identical under both options. However, state governments are not required to develop comparable programs under RCRA Subtitle D rules, and states cannot enforce Federal subtitle D rules. In addition, because of the nature of subtitle D authority, individual requirements (e.g., groundwater monitoring, impoundment closure) will be more generic, allowing industry great latitude in complying. Thus, actual costs under Subtitle D options will be lower than under Subtitle C, because facilities would not be expected to comply to the same extent. In estimating future annual tons of CCR that might be managed under new standards, and the extent to which they would be similar under the Subtitle C option, this RIA applies the percentage of tons of CCR disposed in states with groundwater monitoring requirements as a way to estimate the likely costs incurred by industry for the other options. Although the engineering control cost category consists of 10 cost elements as defined in this RIA, the percentage of states with groundwater monitoring programs is a reasonable surrogate indicator because states imposing groundwater monitoring requirements indicates which states will generally address specific units, and which are likely to upgrade their programs under subtitle D, if EPA were to issue a national subtitle D rule. In those states, management standards may significantly improve, although not to the level of subtitle C for the reasons discussed above. On the other hand, certainly some facilities in states without programs will choose to comply with the national regulation (taking full advantage of the more generic nature of the federal D standards). Taking these two factors together, using the percentage of CCR disposed in states with groundwater monitoring programs provides a reasonable estimate of the extent to which facilities will take steps to comply with the national standards, and therefore of the costs of compliance. For the federally-enforceable subtitle C option, the cost recognizes that all states (100%) will be required by the CCR rule to install groundwater monitoring (and all other engineering controls). For both the non-federally enforceable subtitle D and the "D prime" options, the cost estimates assume that the 48% of waste disposed of in states that currently require surface impoundments to have groundwater monitoring (either for new units only or for new and existing units) will generally upgrade their programs, improving compliance, and that a modest number of facilities in other states would independently make efforts to comply – giving an overall estimate of 48%. This 48% is applied as a scaling factor multiplier to estimate engineering control costs for both the Subtitle D and "D prime" in relation to the Subtitle C engineering cost estimate.

- Ancillary costs: The RIA separately estimated "ancillary" costs under both Subtitle C and Subtitle D assuming 100% nationwide adoption. For the Subtitle D or "D prime" options, the cost estimate only includes inspections of surface impoundments by qualified engineers. The same logic applies to this requirement as it does to the engineering controls, and therefore this RIA applied the same 48% scaling factor multiplier relative to the Subtitle D ancillary cost estimates.
- Dry conversion costs: For the dry conversion cost, 40% is only applied as a scaling multiplier under the Subtitle D option because the "D prime" option does not require dry conversion. The 40% value is calculated in **Exhibit 6G** below, which is based in part on assuming that the cost for retrofitting or building new impoundments is 63% of the cost of dry conversion under Subtitle C as calculated in **Exhibit 6H** below.

Exhibit 6G
Estimate of Subtitle D (version 2) Impoundment Liner Retrofit or Build New Lined Impoundment Cost

A	B	C	D	E	F	G (D x F x 63%**)
Row	Year	Count of existing electric utility plants with impoundments	**Subtitle C special waste**: Dry Conversion Cost	Percent existing CCR impoundments with composite liners*	Percent of CCR impoundments without composite liners	**Subtitle D (v.2)**: Must Retrofit or Build New Lined Impoundments
1	2012	158	$22,984,000,000	5.5%	94.5%	$13,709,900,000
2	2013	158	$0	5.5%	94.5%	$0
3	2014	158	$0	5.5%	94.5%	$0
4	2015	158	$0	5.5%	94.5%	$0
5	2016	158	$0	5.5%	94.5%	$0
6	2017	158	$15,800,000	5.5%	94.5%	$9,400,000
7	2018	158	$15,800,000	5.5%	94.5%	$9,400,000
8	2019	158	$15,800,000	5.5%	94.5%	$9,400,000
9	2020	158	$15,800,000	5.5%	94.5%	$9,400,000
10	2021	158	$15,800,000	5.5%	94.5%	$9,400,000
11	2022	158	$15,800,000	5.5%	94.5%	$9,400,000
12	2023	158	$15,800,000	5.5%	94.5%	$9,400,000
13	2024	158	$15,800,000	5.5%	94.5%	$9,400,000
14	2025	158	$15,800,000	5.5%	94.5%	$9,400,000
15	2026	158	$15,800,000	5.5%	94.5%	$9,400,000
16	2027	158	$15,800,000	5.5%	94.5%	$9,400,000
17	2028	158	$15,800,000	5.5%	94.5%	$9,400,000
18	2029	158	$15,800,000	5.5%	94.5%	$9,400,000
19	2030	158	$15,800,000	5.5%	94.5%	$9,400,000
20	2031	158	$15,800,000	5.5%	94.5%	$9,400,000

Exhibit 6G **Estimate of Subtitle D (version 2) Impoundment Liner Retrofit or Build New Lined Impoundment Cost**						
A	B	C	D	E	F	G (D x F x 63%**)
Row	Year	Count of existing electric utility plants with impoundments	**Subtitle C special waste**: Dry Conversion Cost	Percent existing CCR impoundments with composite liners*	Percent of CCR impoundments without composite liners	**Subtitle D (v.2)**: Must Retrofit or Build New Lined Impoundments
21	2032	158	$15,800,000	5.5%	94.5%	$9,400,000
22	2033	158	$15,800,000	5.5%	94.5%	$9,400,000
23	2034	158	$15,800,000	5.5%	94.5%	$9,400,000
24	2035	158	$15,800,000	5.5%	94.5%	$9,400,000
25	2036	158	$15,800,000	5.5%	94.5%	$9,400,000
26	2037	158	$15,800,000	5.5%	94.5%	$9,400,000
27	2038	158	$15,800,000	5.5%	94.5%	$9,400,000
28	2039	158	$15,800,000	5.5%	94.5%	$9,400,000
29	2040	158	$15,800,000	5.5%	94.5%	$9,400,000
30	2041	158	$15,800,000	5.5%	94.5%	$9,400,000
31	2042	158	$15,800,000	5.5%	94.5%	$9,400,000
32	2043	158	$15,800,000	5.5%	94.5%	$9,400,000
33	2044	158	$15,800,000	5.5%	94.5%	$9,400,000
34	2045	158	$15,800,000	5.5%	94.5%	$9,400,000
35	2046	158	$15,800,000	5.5%	94.5%	$9,400,000
36	2047	158	$15,800,000	5.5%	94.5%	$9,400,000
37	2048	158	$15,800,000	5.5%	94.5%	$9,400,000
38	2049	158	$15,800,000	5.5%	94.5%	$9,400,000
39	2050	158	$15,800,000	5.5%	94.5%	$9,400,000
40	2051	158	$22,984,000,000	5.5%	94.5%	$13,709,900,000
41	2052	158	$15,800,000	5.5%	94.5%	$9,400,000
42	2053	158	$15,800,000	5.5%	94.5%	$9,400,000
43	2054	158	$15,800,000	5.5%	94.5%	$9,400,000
44	2055	158	$15,800,000	5.5%	94.5%	$9,400,000
45	2056	158	$15,800,000	5.5%	94.5%	$9,400,000
46	2057	158	$15,800,000	5.5%	94.5%	$9,400,000
47	2058	158	$15,800,000	5.5%	94.5%	$9,400,000
48	2059	158	$15,800,000	5.5%	94.5%	$9,400,000
49	2060	158	$15,800,000	5.5%	94.5%	$9,400,000
50	2061	158	$15,800,000	5.5%	94.5%	$9,400,000
Non-discounted total cost =			$46,663,000,000			$27,833,000,000
Non-discounted average cost =			$933,000,000			$557,000,000
Present value cost (@7% disc.) =			$23,167,000,000			$13,819,000,000
Average annualized cost (@7%) =			$1,679,000,000			$1,001,000,000
Percent reduction in annualized cost compared to Subtitle C Option conversion cost =						**40%**
Notes:						

Exhibit 6G Estimate of Subtitle D (version 2) Impoundment Liner Retrofit or Build New Lined Impoundment Cost						
A	B	C	D	E	F	G (D x F x 63%**)
Row	Year	Count of existing electric utility plants with impoundments	**Subtitle C special waste**: Dry Conversion Cost	Percent existing CCR impoundments with composite liners*	Percent of CCR impoundments without composite liners	**Subtitle D (v.2)**: Must Retrofit or Build New Lined Impoundments
* 5.5% existing impoundments with composite liners based on EPA's 2000 CCR regulatory determination and on the August 2006 joint EPA-DOE survey report. ** EPA estimated the capital and annual O&M costs for the Subtitle D requirement for either retrofitting or building new CCR impoundments with composite liners, by assuming that the cost for those requirements are 63% of the $23.167 billion present value cost for dry conversion under the Subtitle C option. This 63% cost scaling factor is calculated in **Exhibit 6H** of this RIA.						

Exhibit 6H Reference Data for Calculation of "63% Cost Scaling Factor" Applied in Exhibit 6G								
		Capital cost	O&M cost	Row total	Percent	Capital cost	Percent	
Dry Coal Ash Management (35-year lifespan cost in 1980$)								
1	In-plant handling system	$19,500,000	$693,100,000	$712,600,000	76%	$19,500,000	23%	
2	Conveyance (transport)	$10,364,000	$116,996,000	$127,360,000	14%	$10,364,000	12%	
3	Disposal (lined landfill)	$53,952,000	$39,926,000	$93,878,000	10%	$53,952,000	64%	
	Total =	$83,816,000	$850,022,000	$933,838,000	100%	$83,816,000	100%	
Wet Coal Ash Management (35-year lifespan cost in 1980$)								
1	In-plant handling system	$8,500,000	$302,121,000	$310,621,000	69%	$8,500,000	9%	
2	Conveyance (transport)	$31,954,000	$42,140,000	$74,094,000	16%	$31,954,000	34%	
3	Disposal (lined impoundment)	$52,906,000	$14,448,000	$67,354,000	15%	$52,906,000	57%	**63%***
	Total =	$93,360,000	$358,709,000	$452,069,000	100%	$93,360,000	100%	
Source: Based on cost data for an example 2600 megawatt (MW) nameplate capacity electric utility plant from pages B-8 (dry) and C-9 (wet) of the EPA/TVA joint study "Economic Analysis of Wet Versus Dry Ash Disposal Systems: Interagency Energy/Environment R&D Program Report," report nr. EPA-600/7-81-013, January 1981: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20006ORT.txt * EPA estimated the capital and annual O&M costs for the Subtitle D requirement for either retrofitting or building new CCR impoundments with composite liners, by assuming that the cost for those requirements are 63% of the $23.167 billion present value cost for dry conversion under the Subtitle C option. This 63% cost scaling factor is calculated in this exhibit.								

6B.2 Regulatory Benefits Scaling Factors

- Groundwater contamination benefits: Percentages are based on an examination of state programs related to groundwater monitoring requirements as described in **Chapter 5** of this RIA. The percentages given in **Exhibit 6F** above refer only to the input values to the estimation of groundwater protection benefits presented in **Chapter 5** of this RIA. For the Subtitle C option, all states will be required by the rule to have groundwater monitoring in place so that 100% of facilities over the baseline would detect contamination early and thus human cancers would be prevented. For the Subtitle D option, 48% of CCR are placed in surface impoundments in states with groundwater monitoring in place for new units only (or for new and existing units). It is likely that these states with some level of attention to groundwater monitoring would increase their attention (e.g., because they already have a RCRA program infrastructure) to groundwater monitoring, providing for much more effective systems, while other states would tend not to (although some individual facilities within those states would upgrade groundwater monitoring to some extent). Thus, this RIA estimates that overall, the new regulation would result in 48% of facilities detecting contamination early and 48% of cancers would be prevented. For the Subtitle D prime option, retrofitting existing units would not be required, and therefore existing and future releases would continue to occur from unlined surfaced impoundments. Currently 12% of CCR are placed in surface impoundments in states with groundwater monitoring. Some of these states would certainly upgrade their regulations, but given that surface impoundments would remain a potential source of release in all states, the Subtitle D prime option is less protective of groundwater than the Subtitle D option. Since this fraction is likely to fall between 48% and 12%, the mid-point of 30% was chosen as a best estimate for the D prime option.

- Impoundment structural failure cleanup costs avoided: This factor is not based on estimates of percentages of states likely to implement the new requirements (which for subtitle D would require liners for existing surface impoundments); it is unlikely that many states will choose to implement this requirement. Instead, compliance will not be enforceable, and will be left up to self-imposed schedules of industry or citizens suits. While most impoundments may eventually close, it will be a lengthy process. As a general estimate, through delaying closures and lengthening the process, industry may be able to reduce costs by 50%. In addition, since 5.5% of surface impoundments have composite liners already, they would remain in place, and therefore would not incur costs. Taking these figures together, this RIA applies a 45% scaling factor for this benefit.
- Induced impact on CCR beneficial uses:
  - Under Scenario #1 induced increase in beneficial use, beneficial uses are assumed to be linear with respect to total costs because increases in usage are directly proportional to the cost of the regulatory options. Therefore, under the Subtitle D option, the net reduction in total costs compared to the Subtitle C option is 40%. Under the Subtitle "D prime" option, since the dry conversion costs are 0%, a net result of 16% was applied. This percentage was derived by dividing the Subtitle "D prime" option cost by the total cost of Subtitle C.
  - Under Scenario #2 induced decrease in beneficial use, for the reasons described in Section 5C of this RIA, this RIA assumes that potential induced future decrease on beneficial use only applies to the Subtitle C regulatory option, not to the Subtitle D-based options.
  - Under Scenario #3 no change in beneficial use (relative to baseline), there is no impacts under any of the regulatory options, so no scaling assumptions are applied.

Chapter 7
Supplemental Analyses Required by Congressional Statutes or White House Executive Orders

Note: The computations presented in this Chapter are based on the cost estimates for the October 2009 draft RIA regulatory options using the larger dry conversion cost estimate prior to its update in **Chapter 4**. Because the high-end cost of the October 2009 draft RIA regulatory options (i.e., for the Subtitle C "hazardous waste" option) is larger than the high-end cost for the 2010 options (i.e., for the Subtitle C "special waste" option), the effects estimated in this Chapter are proportionately over-estimated.

7A. Electricity Price Impact (Executive Order 13211)

The 2001 Executive Order 13211[168] "Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use" requires Federal agencies to evaluate and prepare a statement on any potential adverse effects of economically-significant rulemakings on energy supply, distribution or use, including:

- Shortfall in energy supply
- Energy price increases
- Increased use of foreign energy supplies

The OMB's 13 July 2001 Memorandum M-01-27[169] guidance for implementing this Executive Order identifies nine numerical indicators (thresholds) of potential adverse energy effects, three of which are relevant for evaluation in this RIA:

- Increases in the cost of energy production in excess of 1%
- Increases in the cost of energy distribution in excess of 1%
- Other similarly adverse outcomes.

Because this RIA did not collect and analyze data on energy production cost or energy distribution cost, this RIA evaluated the potential impact of the CCR regulatory options on electricity prices relative to the 1% threshold of both indicators as an indicator of "other similarly adverse outcome". This RIA calculated the potential increase in statewide electricity prices that the industry compliance costs might induce under each CCR regulatory option. This calculation involved plant-by-plant annual revenue estimates and annualized compliance cost estimates, and respective statewide average electricity prices for the 495 electric utility plants, according to the following four steps.

[168] The 18 May 2001 EO-13211 is available at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2001_register&docid=fr22my01-133.pdf
[169] OMB's 13 July 2001 Memorandum M-01-27 is available at: http://www.whitehouse.gov/omb/memoranda_m01-27/

- Step 1: Downloaded the annual million megawatt capacity data for each of the 495 plants from the DOE-EIA website (2007), and estimated annual electricity output for each plant, by multiplying the capacity data by three factors:
  - o 365 operating days per year
  - o 24 operating hours per day
  - o 86.8% capacity utilization per year[170]

- Step 2: Estimated the annual electricity sales revenue for each plant by multiplying the estimated annual electricity output sold by each plant (from Step 1), by the respective statewide average retail price (May 2009) of electricity for all sectors (i.e., residential, commercial, industrial, transportation) from DOE-EIA at http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html

- Step 3: Added the estimated incremental regulatory costs on a plant-by-plant basis, to the estimated annual electricity sales revenue for each plant, to obtain a hypothetical future annual revenue target, which represents a 100% cost pass-thru scenario. This simple scenario represents an upper-bound case of potential electricity price increase. Furthermore, if this 100% cost pass-thru is averaged over the entire electricity supply in each state, not just averaged over the 495 coal-fired electricity plants as done in this RIA, the potential percentage increase in electricity price would be less than this upper-bound case presented in this RIA.

- Step 4: Divided the hypothetical future annual revenue target by the estimated annual electricity output for each plant, to obtain a hypothetical future (higher) target price for each plant, which incorporates the added regulatory cost. Compared the higher target price to the current price to calculate the potential price increase on a percentage basis for each of the 495 plants.

Exhibit 7A below presents the findings of this energy price evaluation on a state-by-state basis. As displayed in the bottom row of **Exhibit 7A**, none of the options have an expected nationwide average energy price increase >1%. **Appendix L** presents the plant-by-plant calculation spreadsheet used for this electricity price impact analysis.

Exhibit 7A State by State Breakout of Average Electricity Price Increases Per Option						
Item	Number of Plants	State	May 2009 statewide average electricity price ($ per kilowatt hour)	**Subtitle C hazardous waste** Average Price Increase	**Subtitle D (version 1)** Average Price Increase	**C - impoundments D - landfills** Average Price Increase
	Average annualized cost (from **Exhibit 4F**) =			**$2,274**	**$492**	**$2,176**
1	2	AK	$0.1518	1.30%	1.23%	1.25%
2	10	AL	$0.0856	1.43%	0.189%	1.419%

[170] Source: 86.8% capacity utilization is the 1972-2008 annual average published in the 15 May 2009 Federal Reserve Statistical Release G.17 "Industrial Production & Capacity Utilization" data for Utilities at http://www.federalreserve.gov/releases/g17/Current/default.htm

Exhibit 7A State by State Breakout of Average Electricity Price Increases Per Option						
Item	Number of Plants	State	May 2009 statewide average electricity price ($ per kilowatt hour)	**Subtitle C hazardous waste** Average Price Increase	**Subtitle D (version 1)** Average Price Increase	**C - impoundments D - landfills** Average Price Increase
3	3	AR	$0.0762	0.293%	0.225%	0.283%
4	6	AZ	$0.1002	1.141%	0.622%	1.113%
5	6	CA	$0.1337	0.717%	0.676%	0.687%
6	14	CO	$0.0797	0.121%	0.006%	0.017%
7	2	CT	$0.1712	0.074%	0.000%	0.000%
8	0	DC	$0.1337			
9	3	DE	$0.1236	0.156%	0.127%	0.129%
10	15	FL	$0.1136	0.131%	0.077%	0.113%
11	11	GA	$0.0859	1.160%	0.163%	1.152%
12	2	HI	$0.1892	0.245%	0.171%	0.174%
13	19	IA	$0.0710	0.548%	0.198%	0.537%
14	0	ID	$0.0602			
15	25	IL	$0.0924	0.531%	0.099%	0.488%
16	26	IN	$0.0766	1.387%	0.207%	1.348%
17	8	KS	$0.0822	0.545%	0.190%	0.532%
18	21	KY	$0.0640	2.307%	0.593%	2.237%
19	4	LA	$0.0748	0.464%	0.040%	0.462%
20	4	MA	$0.1534	0.027%	0.000%	0.000%
21	8	MD	$0.1316	0.080%	0.017%	0.037%
22	1	ME	$0.1222	0.520%	0.346%	0.352%
23	22	MI	$0.0986	0.459%	0.052%	0.455%
24	16	MN	$0.0804	2.013%	0.471%	1.993%
25	20	MO	$0.0757	0.817%	0.116%	0.798%
26	5	MS	$0.0893	0.197%	0.106%	0.193%
27	5	MT	$0.0720	5.582%	1.193%	5.531%
28	22	NC	$0.0839	1.122%	0.148%	1.102%
29	7	ND	$0.0698	0.994%	0.012%	0.982%
30	7	NE	$0.0705	0.223%	0.206%	0.210%
31	2	NH	$0.1544	0.055%	0.004%	0.004%
32	7	NJ	$0.1421	0.118%	0.045%	0.045%
33	3	NM	$0.0769	2.103%	0.407%	1.729%
34	2	NV	$0.0960	0.548%	0.518%	0.526%
35	13	NY	$0.1543	0.024%	0.000%	0.000%
36	26	OH	$0.0930	1.193%	0.132%	1.157%
37	6	OK	$0.0698	0.151%	0.050%	0.081%
38	1	OR	$0.0751	0.212%	0.200%	0.204%
39	34	PA	$0.0960	0.702%	0.229%	0.665%

Exhibit 7A State by State Breakout of Average Electricity Price Increases Per Option						
Item	Number of Plants	State	May 2009 statewide average electricity price ($ per kilowatt hour)	**Subtitle C hazardous waste** Average Price Increase	**Subtitle D (version 1)** Average Price Increase	**C - impoundments D - landfills** Average Price Increase
40	0	RI	$0.1343			
41	14	SC	$0.0826	0.394%	0.028%	0.384%
42	2	SD	$0.0742	0.098%	0.084%	0.086%
43	7	TN	$0.0860	0.517%	0.001%	0.504%
44	19	TX	$0.1019	0.292%	0.038%	0.256%
45	6	UT	$0.0690	0.602%	0.336%	0.588%
46	16	VA	$0.0916	0.688%	0.078%	0.629%
47	0	VT	$0.1282			
48	1	WA	$0.0684	0.000%	0.000%	0.000%
49	17	WI	$0.0918	0.082%	0.063%	0.078%
50	16	WV	$0.0668	1.441%	0.615%	1.379%
51	9	WY	$0.0602	1.396%	0.315%	1.351%
Summary:						
		Minimum =	$0.0602	0.0000%	0.0000%	0.0000%
		Maximum =	$0.1892	5.5822%	1.2259%	5.5313%
		Average =	$0.0985	0.7489%	0.2259%	0.7076%
		Median =	$0.0860	0.5205%	0.1316%	0.4876%
		Nationwide =	**$0.0884**	**0.795%**	**0.172%**	**0.761%**

Because this price analysis is based only on the 495 potentially affected coal-fired electric utility plants (with 333,500 megawatts nameplate capacity) rather than on all electric utility and independent electricity producer plants in each state using other fuels such as natural gas, nuclear, hydroelectric, etc. (with 678,200 megawatts nameplate capacity), these price effects are higher than would be if the regulatory costs were averaged over the entire electric utility and independent electricity producer supply (totaling 1,011,700 megawatts, not counting the 76,100 megawatts of combined heat and electricity producers).[171]

- **Electricity Impact Findings**

On a nationwide basis for all 495 plants, compared to the estimated average electricity price of $0.0884 per kilowatt-hour across the 495 plants, the 100% regulatory cost pass-thru scenario may increase prices for the 495 plants by **0.172% to 0.795%** across the regulatory options. None of the regulatory options exceed the 1% threshold of EO 13211, thus this RIA does not include a "Statement of Energy Effect" as would be required by Section 1 of EO 13211 if the price impact indicator as estimated in this RIA exceeded 1%.

[171] Source: 2007 megawatt nameplate capacity data from the Energy Information Administration "Table 2.3. Existing Capacity by Producer Type, 2007" at http://www.eia.doe.gov/cneaf/electricity/epa/epaxlfile2_3.pdf

7B. Small Business Impact Analysis (RFA/SBREFA)

According to the requirements of the 1980 Regulatory Flexibility Act (RFA) as amended by the 1996 Small Business Regulatory Enforcement Fairness Act (SBREFA), Federal regulatory agencies are required to make initial determinations if proposed regulatory actions may have a "significant economic impact on a substantial number of small entities" (SISNOSE). Small entities include small businesses, small organizations, and small governmental jurisdictions. Agencies are required to conduct a Regulatory Flexibility Screening Analysis (RFSA) to make this determination. This section of the RIA presents the methodology and findings for the RFSA conducted for the proposed rule.

Unless Agencies are able to certify that a particular regulatory action is not expected to have a SISNOSE, the RFA/SBREFA requires a formal analysis of the potential adverse economic impacts on small entities, completion of a Small Business Advocacy Review Panel (proposed rule stage), preparation of a Small Entity Compliance Guide (final rule stage), and Agency review of the rule within 10 years of promulgation.

The small business impact analysis of this RIA follows the four analytic steps described in EPA's RFA/SBREFA analysis guidance[172]:

Step 1: Determine which small entities are subject to the rule's requirements
Step 2: Select appropriate measures for determining economic impacts on these small entities and estimate those impacts
Step 3: Determine whether the rule may be certified as not having a significant impact on small entities (SISNOSE)
Step 4: Document the screening analysis and include the appropriate RFA statements in the preamble

- **Step 1: Identification of Small Entities**

The scope of entities addressed by this analysis includes the affected coal-fired electric utility plants in NAICS code 221112. Not included in the scope of this RFA/SBREFA analysis are offsite commercial landfills which currently receive and dispose CCR generated by electric utility plants. EPA's RCRA statute does not provide EPA with authority to collect information from solid waste facilities; it only provides EPA with authority to collect information from RCRA-regulated hazardous waste management facilities (via the RCRA biennial report). EPA does not know the identity, company size, or other information about the offsite landfills currently used by the electric utility industry. Therefore, this RFA/SBREFA analysis is limited to only electric utility plants. Consistent with EPA's RFA/SBREFA guidance (page 15), this RIA applies the following small size definitions for owner entities of electric utility plants:

Small company: Based on the US Small Business size standard for NAICS code 221112 (fossil fuel electric utility plants): a company which generates less than 4 million megawatt-hours electricity output per year.

[172] EPA's RFA/SBREFA guidance: "EPA's Action Development Process: Final Guidance for EPA Rulewriters: Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act", EPA Office of Policy, Economics & Innovation, Nov 2006, 105 pages: http://www.epa.gov/sbrefa/documents/rfaguidance11-00-06.pdf

Small government: Based on the RFA/SBREFA's definition (5 US Code section 601(5)) of small government jurisdiction as the government of a city, county, town, township, village, school district, or special district with population <50,000.

Based on the nameplate megawatt (MW) capacity for all electricity generating units (including those powered by non-coal fuel types) at each electricity plant from the 2007 DOE-EIA 860 database, this RIA estimated annual megawatt-hours electricity generation capacity by multiplying the nameplate capacity by (a) 365 days per year, and (b) 24 hours per day to calculate each owner entity's annual electricity capacity. **Appendix D** of this RIA indicates the assigned size of the owner company or city government for each electric utility plant according to two size categories: "Small" or "Non-small".[173] **Exhibit 7B** below presents the resultant count and summary of the characteristics of the small electric utility entities as estimated in this RIA.

Exhibit 7B
Summary of Characteristics of Small Electric Utility Entities

	A	B	C	D	E (D / B)
Small Entity Sub-Categories	Count of coal-fired electric utility plants (2005/2007)	Estimated count of owner entities (2005/2007)	Estimated 2007 annual megawatt hours (mwh) capacity for all electricity plants owned by all entities	Estimated 2009 annual electricity sales for all entities ($millions/year)	2009 average annual electricity sales revenue per entity ($millions/year)
1. Small City Government	33	33	34.0	$2,592	$78.5
2. Small Company	12	11	10.6	$948	$86.2
3. Small Cooperative	6	6	12.0	$947	$157.8
4. Small County Government	1	1	0.3	$23	$23
Summary:					
All small entities =	**52 plants (11%)**	**51 entities (26%)**	**56.8 (1%)**	**$4,509 (1%)**	**$88.4**
All non-small entities =	443 plants (89%)	149 entities (74%)	5,380.5 (99%)	$419,056 (99%)	$2,812.5
All entities (non-small + small) =	495 plants	200 entities	5,437 million mwh*	$423,565**	$2,118

Notes:
* Annual electricity generation capacity based on all electric plants and types of electric generation units (e.g. coal-fired, oil-fired, hydropower, nuclear, wind, biomass, etc.) owned by these companies, not just coal-fired electricity generation capacity.
** $423.6 billion per year annual electricity sales estimated in this RIA is 73% of the $581.6 billion per year total revenues reported for NAICS code 22 (Utilities sector) in the 2007 Economic Census at: http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=D&-ds_name=EC0700A1&-_lang=en

[173] It should be noted that some of the companies identified as small using the SBA size standard for NAICS 22 and the utility code specification in the 2007 EIA 860 database to identify each corporate entity may be subsidiaries of a larger holding company (classified under a different NAICS) rather than a larger power company. In addition some of these power companies may have merged. For example, State Line is owned by Dominion Resources of Virginia, Northeastern Power is owned by Suez Energy North America, Inc. (SEGNA), Rio Bravo Poso and Rio Bravo Jasmin are owned by the North American Power Group, Ltd (NAPG), TES Filer City Station LP is owned by TONDU, Public Service Enterprise Group (PSEG) and Excelon are merged. This approach likely overstates the number of small entities.

- **Step 2: Measures for Determining Economic Impacts on Small Entities**

According to Exhibit 1 of EPA's 2006 RFA/SBREFA small business impact analytic guidance, there are the following suggested tests that may be used to determine if small entities may be significantly impacted by a proposed rule:

- Small business impact tests:
  - Sales test: Annualized compliance costs as a percentage of sales
  - Cash flow test: Debt-financed capital compliance costs relative to current cash flow
  - Profit test: Annualized compliance costs as a percentage of profits

- Small government impact tests:
  - Revenue test: Annualized compliance costs as a percentage of annual government revenues
  - Income test: Annualized compliance costs to household (per capita) as a percentage of median household (per capita) income

Based on annual electricity generation data for the small owner entities in the electric utility industry identified in **Appendix D** of this RIA, the annual sales/annual revenue test was used for this analysis. As itemized and estimated for each owner entity in the spreadsheets presented as **Appendix M** to this RIA, for each small entity EPA computed the respective sales revenue test percentages by the equation below:

(AEGC x 1,000) x (ASP) x (CU) = annual $sales or $revenues per small entity

Where:

AEGC = Annual electricity generation capacity per-entity in annual million megawatts (per-entity megawatt data is displayed in **Appendix D**). This estimate involved downloading the annual million megawatt capacity data for each of the 495 electricity plants from the DOE-EIA website (2007), and then multiplying the capacity data by two factors:
  - 365 operating days per year
  - 24 operating hours per day

ASP = February 2009 average statewide retail price to ultimate consumers for electricity (i.e., cents per kilowatt-hour) for the relevant state or states applicable to the location of electric plants owned by each company; electricity price reflects the composite price charged to residential, commercial, industry and transportation sectors[174]

CU = 86.8% electric utility industry capacity utilization from 1972-2008 average reported by the 15 May 2009 Federal Reserve Statistical Release G.17 “Industrial Production & Capacity Utilization” data for Utilities at: http://www.federalreserve.gov/releases/g17/Current/default.htm

[174] DOE's Energy Information Administration (EIA) publishes state-by-state average retail electricity prices for four end-user sectors (i.e., residential, commercial, industrial, transportation) and on a composite basis at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html

- **Step 3 & Step 4: Determine and document whether the proposed rule may be certified as having "No SISNOSE"**

EPA determined whether each regulatory option may have a "significant impact on a substantial number of small entities" (i.e., SISNOSE) which may become subject to the requirements of the proposed rule. This determination involved comparing the estimated regulatory compliance costs for each entity as displayed in **Appendix J** of this RIA and as summarized in **Exhibit 7C** below (small entity row items 6, 7, 8, 9), to the respective annual sales and revenues for each entity estimated in Step 2 above. Numerically, this comparison involved calculating the percentage of regulatory compliance costs relative to annual sales and revenues for each company for each of the regulatory options. Then compared the percentage results for each small entity to the following three impact thresholds defined in Table 2 of EPA's RFA/SBREFA analytic guidance. **Exhibit 7D** below displays the numerical results of this analysis and the suggested RFA/SBREFA impact interpretation according to the three thresholds.

<1% threshold:	Annualized regulatory costs may be less then 1% of annual sales or revenues for small entities
1% or more threshold:	Annualized regulatory costs may be 1% or more of annual sales or revenues for affected small entities
3% or more threshold:	Annualized regulatory costs may be 3% or more of annual sales or revenues for affected small entities

Exhibit 7C
Summary of Regulatory Cost Estimates According to Electric Utility Plant Owner Entity Size/Type Category
($millions in 2009 price level; average annual amortized @7% discount rate over 50-year period 2012 to 2061)

Size/Type of Entity*	Count of plants in category***	Subtitle C Hazardous waste	Subtitle D (version 1)	Subtitle C for impoundments Subtitle D for landfills
1. Non-Small City	27 plants	$46.9	$27.1	$43.9
2. Non-Small Company	372 plants	$1,897.2	$378.5	$1,821.2
3. Non-Small Coop	20 plants	$87.7	$34.6	$85.3
4. Non-Small Federal	11 plants	$183.2	$20.8	$181.0
5. Non-Small State**	13 plants	$41.6	$27.1	$39.8
6. Small City	33 plants	$2.8	$1.6	$2.5
7. Small Company	12 plants	$4.1	$1.9	$2.0
8. Small Coop	6 plants	$10.4	$0.3	$0.3
9. Small County	1 plant	$0.004	$0.004	$0.004
Total all 9 categories =	**495 plants*** **	**$2,274**	**$492**	**$2,176**

Notes:
* Size/Type classification methodology defined according to **Exhibit 3B** of this RIA.
** State government costs include costs to (a) state government electric utility plants regulatory costs, plus (b) state government RCRA-authorized programs for option implementation.
*** The total count of coal-fired electric utility plants is shown in the Exhibit; however, only a sub-total of 467 of the 495 may incur these regulatory costs because 28 plants solely supply their CCR for beneficial uses.

Exhibit 7D **Estimated Impact of Regulatory Options on Small Entities (RFA/SBREFA Analysis Results)** ($millions average annualized direct costs @7% discount rate over 50-year period 2012-2061)			
Cost as Percentage of Annual Electricity Revenues	Subtitle C Hazardous waste	Subtitle D (version 1)	Subtitle C for impoundments Subtitle D for landfills
A. Count of Small Entities:			
Annualized cost on small entities:*	$17.3	$3.8	$4.8
Less than 1%	46	50	50
1% or greater	5	1	1
3% or greater	0	0	0
B. % of Small Entities:			
Less than 1%	90%	98%	98%
1% or greater	10%	2%	2%
3% or greater	0%	0%	0%
C. SISNOSE Findings:			
Less than 1%	Presumed No SISNOSE	Presumed No SISNOSE	Presumed No SISNOSE
1% or greater	Presumed No SISNOSE	Presumed No SISNOSE	Presumed No SISNOSE
3% or greater	Presumed No SISNOSE	Presumed No SISNOSE	Presumed No SISNOSE
* Source: Costs for each option based on total cost for the four small entity categories displayed as rows 6 + 7 + 8 + 9 from **Exhibit 7C**.			

- **Limitations of RFA/SBREFA Determination**

Not included in the RFA/SBREFA analysis of this RIA are **two factors** unique to the electric utility industry, which may reduce the small entity impacts relative to the estimates above in this RIA:

- Factor #1 of 2: According to the 2007 DOE-EIA database on electric utility plants, two-thirds of the coal-fired electricity generation units at electric utility plants owned by small entities can switch to at least one of six other fuels:
    1. Agricultural byproducts (database code = AB)
    2. Distillate fuel oil (DFO)
    3. Natural gas (NG)
    4. Petroleum coke (PC)
    5. Propane (PG)
    6. Wood & wood waste solids (WDS)

- Factor #2 of 2: The small business impact analysis in this RIA applies the full industry compliance cost to the revenue and sales tests. However, because consumer demand for electricity is (a) highly price-inelastic and (b) projected go grow by 30% by year 2025[175], electric utility plants may be expected to pass-thru much, if not all, of their regulatory costs (pending state government utility rate hike approval). The next section of this RIA evaluates the possibility of regulatory compliance cost pass-thru.

- **Compliance Cost Pass-Thru Analysis**

  - Ability to Raise Electricity Prices

Traditionally, the electric utility industry has functioned as a regulated monopoly, providing essential electrical services under an exclusive franchise in exchange for having rates closely regulated by State public utility commissions (PUCs; sometimes called PSC public service commissions) and the Federal Energy Regulatory Commission (FERC). The FERC regulates rates charged for sales of bulk power between utilities, even if they are in the same state. It also regulates the pricing and use of transmission for wheeling, and asset transfers, including mergers. In most states (California de-regulated electricity in 1998), the PUCs/PSCs set allowable rates upon application by the utility, with other affected parties allowed to present testimony. By law the utility must recover its cost of service, which includes "prudently" incurred expenses and a "fair" return on equity.[176]

Based on the electricity ratemaking process described by the Pennsylvania PUC[177]as a case example, when an electric utility company seeks a price increase (aka rate hike), it must file a request with the PUC showing the proposed new rates and effective date, and must prove that the increase is needed. The utility also must notify customers at least 60 days in advance. The notice must include the amount of the proposed rate increase, the proposed effective date, and how much more the ratepayer can expect to pay. Under the law, the utility is entitled to recovery of its reasonably incurred expenses and a fair return on its investment. The PUC evaluates each utility's request for a rate increase based on those criteria. During the investigation, hearings are held before an Administrative Law Judge (ALJ) at which the evidence in support of the rate increase is examined and expert witnesses testify. In addition, consumers are offered an opportunity to voice their opinions and give testimony. Briefs may be submitted by the formal parties. A recommendation to the PUC is made by the ALJ. Finally, the matter is brought before the Commissioners for a vote and final decision. Together with the 60-day notice period, the rate increase process takes about nine months. Recent (2008) examples of requested or PUC-approved electricity rate hikes are summarized in **Exhibit 7E** below:[178]

---

[175] 30% additional electricity demand forecst for year 2025 relative to year 2005, from slide 17 of "Energy & Water: Emerging Issues and Trands" by Richard Kottenstette and Mike Hightower, Sandia National Laboratories, at: http://www.ct-si.org/Summit2007/spk/RKottenstette.pdf

[176] Source: "Electric Utility Regulation" by Robert J. Michaels in the Concise Encyclopedia of Economics at: http://www.econlib.org/library/Enc1/ElectricUtilityRegulation.html

[177] Source: Pennsylvania Public Utility Commission, "The PUC Ratemaking Process and the Role of Consumers", January 2008 at: http://www.puc.state.pa.us/general/consumer_ed/pdf/Ratemaking_Complaints.pdf

[178] Source: "Recent Examples of Rate Increases in Vertically Integrated States", The Compete Coalition, Washington DC, 05 November 2008 at: http://www.competecoalition.com/resources/recent-examples-rate-increases-vertically-integrated-states

Exhibit 7E **Summary of 2008 US Electricity Price Hikes**			
Item	State	Effective date	Requested or approved price hike
1	AL	Oct 2008	14.6%
2	CO	Feb 2008	28%
3	FL	July to Oct 2008	10 to 37% (8 companies)
4	KS	2008	15%
5	MO	Jan 2008	28%
6	NC	Sept 2008 to Jan 2009	10% to 17.7% (3 companies)
7	SC	July to Oct 2008	6% to 10% (4 companies)
8	TVA (7 states)	Oct 2008	20%
	Overall range =	Jan to Oct 2008	6% to 37%
		Average (20 electricity plant owner entities) =	**19%**

Some state governments have deregulated the electric utility industry, thereby allowing multiple electric suppliers, not just a monopoly electricity supplier, to compete and set their own retail prices in those state markets. As of 2003, 18 states have deregulated and six states may soon deregulate:[179]

- Deregulated states (18): AZ, CT, DE, DC, IL, ME, MD, MA, MI, NH, NJ, NY, OH, OR, PA, RI, TX, VA (11 of these states no longer have a price cap)
- May soon deregulate (6): AR, MT, NM, NV, OK, WV (note: CA deregulated in 1998 but has suspended)

While average prices rose 21% in regulated states from 2002 to 2006, prices increased 36% during that period in 11 of the 18 deregulated states where rate caps expired, suggesting greater pricing flexibility in deregulated states.[180]

- Inelastic Demand for Electricity

At the wholesale level, as a result of technological and regulatory barriers, the majority of electricity pricing plans do not allow end users to see and react to the actual market value of their electricity consumption/ conservation. Since end-users do not face the real-time market price in making their consumption decisions, there is little demand reaction to changes in real time wholesale electricity prices.[181] At the retail level, consumer demand for electricity has been largely inelastic. The lack of real time metering at the retail level means that consumers don't know

[179] Source: "Status of State Electric Industry Restructuring Activity as of February 2003", US Dept of Energy, Energy Information Administration at: http://www.eia.doe.gov/cneaf/electricity/chg_str/restructure.pdf

[180] Source: "Shocking Electricity Prices Follow Deregulation", USA Today, 10 Aug 2007 at: http://www.usatoday.com/money/industries/energy/2007-08-09-power-prices_n.htm

[181] Source: page 1 of "Demand Responsiveness in Electricity Markets", Ronald Lafferty et al., Office of Markets, Tariffs and Rates, 15 Jan 2001 at: http://www.naseo.org/committees/energyproduction/documents/demand_responsiveness_in_electricity_markets.pdf

how much they use or indeed how much electricity costs until after the fact. Thus consumers cannot react to high prices easily by cutting consumption.[182]

- Cost Pass-Thru Conclusion

Based on the above three cost pass-thru factors consisting of (a) 20 examples of recent (2008) PUC-regulated rate hikes which average almost 19% per company which far exceeds the 1% and 3% SISNOSE screening analysis thresholds defined by EPA's guidance, (b) 11 of the 18 deregulated states which have de-regulated the price of electricity, and (c) the fact that consumer demand for electricity has been relatively inelastic, this RIA concludes that it is likely that electric utility suppliers could pass-thru all, or nearly all, of the future average annual regulatory compliance costs for the CCR proposed rule such that a significant impact on small entities and non-small entities would not occur.

[182] Source: "Power Price Volatility and Risk Management: An Introduction", Anne Ku, Sept 2000 (this is the original, unedited article, later submitted to Global Energy Business magazine Sept/Oct 2000) at: http://www.analyticalq.com/energy/volatility/default.htm

7C. Minority & Low-Income Population Statistics (Executive Order 12898)

Under the 1994 Executive Order (EO) 12898[183] it is the responsibility of Federal agencies to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice (EJ) part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on (a) **minority** populations and (b) **low-income** populations. Although not defined in EO 12898, for purpose of this RIA the following definitions are applied:

- Minority population: Numerically measured according to Census Bureau "non-white" statistics (does not include Hispanics).
- Low-income population: Numerically measured according to Census Bureau "individuals below poverty[184] level."

Furthermore, section 3-302(b) of EO 12898 provides a trigger which indicates that Federal agencies shall collect and evaluate EJ data for any facilities or sites expected to have "substantial environmental, human health, or economic effect" when such facilities or sites become subject to "substantial" Federal environmental action:

> "*In connection with the development and implementation of agency strategies in section 1-103 of this order, each Federal agency, whenever practicable and appropriate, shall collect, maintain and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have* ***substantial*** *environmental, human health, or economic* ***effect*** *on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action. Such information shall be made available to the public unless prohibited by law*."

The EO 12898 does not establish quantitative thresholds for "substantial effect" on the surrounding populations, nor does this RIA formulate a quantitative threshold. This RIA uses the (1) CCR disposal baseline environmental and human health hazards (e.g., damage cases), and (2) the environmental and human health protection objectives described in the CCR proposed rule, as indicators of "substantial effect". For that reason, this section of the RIA presents an EJ data collection and analysis involving a 5-step process to compare minority and low-income population data for each electric utility plant location, to respective statewide population data, to identify whether these two population sub-groups disproportionately reside in geographic areas where electric utility plants are located. In addition, this RIA identifies two other possible affects of the CCR proposed rule on (a) environmental justice populations surrounding offsite landfills which may receive CCR, and (b) environmental justice populations within electric utility plant customer service areas.

183 Source: 1994 Executive Order 12898 is available at: http://www.epa.gov/fedrgstr/eo/eo12898.htm

184 The US Census Bureau defines "poverty" following the Office of Management and Budget's (OMB) Statistical Policy Directive 14. The Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. Poverty income thresholds are available at http://www.census.gov/hhes/www/poverty/threshld/thresh08.html

- **Collection of Minority & Low-Income Demographic Data**

Step 1: Plant address 5-digit "Zip Code Tabulation Areas" (ZCTAs) formed the geographic basis for this EJ population data collection. Because ZCTAs represent irregularly shaped geographic areas, this ZCTA based data collection may be considered a "screening level" analysis. The US Bureau of Census uses over 33,000 ZCTA for its Census counts of population and other demographic statistics based on the US Postal Service's over 42,000 nationwide ZCTAs.[185] Currently, there are no size restrictions limiting how large or small a ZCTA can be in terms of either a minimum/maximum number of housing units or geographic area. Any particular ZCTA may be as small as a few city blocks or may cover many square miles. Many ZCTAs are for villages, census-designated places, portions of cities, or other entities that are not municipalities. The nationwide average ZCTA population is about 7,200 persons (i.e., (306.6 million mid-2009 US population) / (42,500 ZCTAs)). The nationwide average ZCTA area is about 83 square miles (i.e., (3,536,278 square miles total US land and water area) / (42,500 ZCTAs)), which is a land area equivalent to a five-mile radial distance (i.e., ((83 square miles) / (3.1416))^0.5). In comparison, the radial area monitored for contamination in response to the December 2009 TVA Kingston TN electric plant CCR spill is reportedly four miles,[186]and this average four-mile ZCTA radial distance falls between the 1-mile to 15-mile radial distances used by EPA's Superfund "Hazard Ranking System" (HRS) to define affected populations of sites having either (a) soil contamination only (1-mile), (b) groundwater and/or airborne contamination (4-miles), or (c) surface water contamination (15-miles downstream). More information about EPA's HRS is available at http://www.epa.gov/superfund/programs/npl_hrs/hrsint.htm.

Using the Census search engine Factfinder (http:factfinder.census.gov/home/saff/main.html?_lang=en), EPA retrieved population statistics for 464 (94%) of the 495 electric utility plants. For 42 plants (8%) there was no ZCTA Census data because the plants did not have complete address data from DOE, or because the Census search engine did not have data for the ZCTA.

Step 2: EPA collected statewide percentage data for minority and low-income subgroups for purpose of benchmark comparison to the plant-by-plant sub-group population statistics.

- EPA collected low-income population statewide percentages (3-year averages for 1998 to 2000) from the following Census Bureau website: http://www.census.gov/hhes/www/poverty/poverty00/tabled.pdf
- EPA collected statewide percentages for white population sub-group (data year 2000) from the Census Bureau website: . EPA then subtracted the percentage of white population in each state from 100% to produce the respective minority percentage for each state. For data year 2000, the Census Bureau expanded the white population classification by collecting both data for people who claimed to be "white-only" and for people who claimed to be "mixed white". Since the purpose of the EJ analysis is to evaluate all minorities, this step involved collecting the "white-only" data in order to calculate the minority percentage which includes people who reported to be of mixed race. **Exhibit 7F** below displays the statewide Census data for low-income and minority sub-populations.

[185] Source: US Census Bureau ZIP Code Tabulation Area (ZCTA) Frequently Asked Questions at: Nationwide total ZCTA count is from the US Postal Service's FAQ website at: http://zip4.usps.com/zip4/welcome.jsp
[186] Source: 4 mile radial monitoring area reported by Waste & Recycling News, 13 Feb 2009; http://www.wasterecyclingnews.com/email.html?id=1234543579

Exhibit 7F
Statewide Benchmark Data on Low-Income and Minority Populations (2000)

Item	State	Low Income %	Minority %
1	AK	8.4%	30.7%
2	AL	14.7%	28.9%
3	AR	15.8%	20.0%
4	AZ	13.5%	24.5%
5	CA	14.0%	40.5%
6	CO	8.5%	17.2%
7	CT	7.7%	18.4%
8	DC	17.4%	69.2%
9	DE	9.9%	25.4%
10	FL	12.1%	22.0%
11	GA	12.5%	34.9%
12	HI	10.6%	75.7%
13	IA	7.9%	6.1%
14	ID	13.3%	9.0%
15	IL	10.5%	26.5%
16	IN	8.3%	12.5%
17	KS	10.5%	13.9%
18	KY	12.5%	9.9%
19	LA	18.5%	36.1%
20	MA	10.1%	15.5%
21	MD	7.3%	36.0%
22	ME	9.8%	3.1%
23	MI	10.2%	19.8%
24	MN	7.8%	10.6%
25	MO	9.8%	15.1%
26	MS	15.5%	38.6%
27	MT	16.%	9.4%
28	NC	13.2%	27.9%

Item	State	Low Income %	Minority %
29	ND	12.7%	7.6%
30	NE	10.7%	10.4%
31	NH	7.6%	4.0%
32	NJ	8.1%	27.4%
33	NM	19.3%	33.2%
34	NV	10.1%	24.8%
35	NY	14.7%	32.1%
36	OH	11.1%	15.0%
37	OK	14.1%	23.8%
38	OR	12.9%	13.4%
39	PA	9.8%	14.6%
40	RI	10.2%	15.0%
41	SC	12.0%	32.8%
42	SD	9.4%	11.3%
43	TN	13.4%	19.8%
44	TX	14.9%	29.0%
45	UT	8.1%	10.8%
46	VA	8.1%	27.7%
47	VT	10.3%	3.2%
48	WA	9.5%	18.2%
49	WI	9.0%	11.1%
50	WV	15.8%	5.0%
51	WY	11.1%	7.9%
	Min =	7.3% (MD)	3.1% (ME)
	Max =	19.3% (NM)	75.7% (HI)
	National =	**11.9%**	**24.9%**

- **Comparison of Minority & Low-Income Populations Surrounding Electric Utility Plants to Statewide Benchmarks**

Step 3, Step 4 and Step 5 of this evaluation described below involved three complementary levels of data comparisons. All three comparisons also involved two complementary numerical comparisons, one based on calculating numerical percentages and the other on numerical ratios:

1. Plant level: Plant-by-plant disaggregated data comparison to statewide benchmarks
2. State level: State-by-state aggregated plant data comparison to statewide benchmarks
3. Nationwide level: Nationwide aggregated plant data comparison to nationwide benchmarks

- **Calculation of Three Alternative Demographic Statistics Comparison Methods**

Step 3: On a plant-by-plant basis, EPA compared the plant ZCTA percentage minority and percentage low-income population data, to the respective statewide average percentages for each sub-group. This constituted the 1st level of data comparison.

Step 4: For purpose of summary, EPA aggregated the plant level population comparison data for each state as displayed in **Exhibit 7G** below. This constituted the 2nd level of data comparison. There are no data displayed for DC, ID, RI or VT because there are no coal-fired electric utility plants in those states. **Appendix N** of this RIA presents the plant-by-plant Census data on which this Exhibit is based. This step also involved aggregating the data across all 495 plants for comparison with the nationwide aggregate minority and low-income percentage benchmarks. This constituted the 3rd level of data comparison.

Exhibit 7G
Minority and Low-Income Population Data Aggregated on State-by-State Basis

A	B	C	D	E	F (E/D)	G (**Exh 7F**)	H (DxG)	I	J	K (DxJ)	L (**Exh 7F**)	M (DxL)	N
General Population Data				**Low Income Population Data (Below Poverty)**					**Minority Population Data**				
Item	State	ZCTA count	2000 population residing in electric utility plant ZCTA areas	Count of plant ZCTA residents below poverty level	% of plant ZCTA residents below poverty level	State % below poverty level	Expected count of residents below poverty based on state%	Count of plants with ZCTA% > state% poverty level	% of plant ZCTA residents that are minority	Count of plant ZCTA residents that are minority	State-wide % minority	Expected count of minority based on state%	Count of plants with ZCTA% > state% minority level
1	AK	2	18,552	2,284	12.31%	8.40%	1,558	1	31.95%	5,928	30.70%	5,695	1
2	AL	9	82,854	20,331	24.54%	14.70%	12,180	6	42.17%	34,942	28.90%	23,945	4
3	AR	3	11,786	1,214	10.30%	15.80%	1,862	0	7.74%	912	20.00%	2,357	0
4	AZ	6	34,941	7,433	21.27%	13.50%	4,717	5	43.70%	15,270	24.50%	8,561	3
5	CA	4	112,895	24,749	21.92%	14.00%	15,805	5	45.22%	51,049	40.50%	45,722	2
6	CO	15	214,095	29,395	13.73%	8.50%	18,198	10	17.88%	38,275	17.20%	36,824	8
7	CT	2	42,716	6,427	15.05%	7.70%	3,289	1	45.14%	19,284	18.40%	7,860	1
8	DC	ND											

Exhibit 7G Minority and Low-Income Population Data Aggregated on State-by-State Basis													
A	B	C	D	E	F (E/D)	G **(Exh 7F)**	H (DxG)	I	J	K (DxJ)	L **(Exh 7F)**	M (DxL)	N
General Population Data				**Low Income Population Data (Below Poverty)**					**Minority Population Data**				
Item	State	ZCTA count	2000 population residing in electric utility plant ZCTA areas	Count of plant ZCTA residents below poverty level	% of plant ZCTA residents below poverty level	State % below poverty level	Expected count of residents below poverty based on state%	Count of plants with ZCTA% > state% poverty level	% of plant ZCTA residents that are minority	Count of plant ZCTA residents that are minority	State-wide % minority	Expected count of minority based on state%	Count of plants with ZCTA% > state% minority level
9	DE	3	46,925	3,979	8.48%	9.90%	4,646	1	28.86%	13,543	25.40%	11,919	1
10	FL	13	224,502	23,866	10.63%	12.10%	27,165	5	20.76%	46,617	22.00%	49,390	3
11	GA	9	202,973	29,461	14.51%	12.50%	25,372	4	42.66%	86,581	34.90%	70,838	4
12	HI	1	25,054	1,150	4.59%	10.60%	2,656	0	78.17%	19,584	75.70%	18,966	1
13	IA	14	324,050	31,434	9.70%	7.90%	25,600	13	7.02%	22,744	6.10%	19,767	9
14	ID	ND											
15	IL	23	455,834	83,407	18.30%	10.50%	47,863	14	41.46%	188,970	26.50%	120,796	8
16	IN	17	323,323	25,460	7.87%	8.30%	26,836	10	6.96%	22,488	12.50%	40,415	2
17	KS	6	59,517	7,718	12.97%	10.50%	6,249	4	36.76%	21,881	13.90%	8,273	3
18	KY	17	255,033	32,497	12.74%	12.50%	31,879	7	8.48%	21,615	9.90%	25,248	2
19	LA	4	30,381	7,546	24.84%	18.50%	5,620	3	45.16%	13,721	36.10%	10,968	2
20	MA	3	95,798	14,420	15.05%	10.10%	9,676	1	20.69%	19,819	15.50%	14,849	1
21	MD	7	101,141	10,622	10.50%	7.30%	7,383	4	12.39%	12,527	36.00%	36,411	1
22	ME	1	6,748	1,037	15.37%	9.80%	661	1	1.30%	88	3.10%	209	0
23	MI	20	383,284	30,735	8.02%	10.20%	39,095	8	10.56%	40,477	19.80%	75,890	2
24	MN	15	187,012	20,910	11.18%	7.80%	14,587	10	10.78%	20,157	10.60%	19,823	3
25	MO	19	251,484	24,714	9.83%	9.80%	24,645	10	7.47%	18,794	15.10%	37,974	2
26	MS	4	69,209	17,675	25.54%	15.50%	10,727	3	51.63%	35,735	38.60%	26,715	2
27	MT	5	53,209	8,441	15.86%	16.00%	8,513	2	13.25%	7,050	9.40%	5,002	4
28	NC	16	238,874	37,388	15.65%	13.20%	31,531	9	34.49%	82,397	27.90%	66,646	12
29	ND	5	27,087	2,440	9.01%	12.70%	3,440	1	4.40%	1,193	7.60%	2,059	0
30	NE	6	79,313	8,992	11.34%	10.70%	8,486	2	11.38%	9,027	10.40%	8,249	2
31	NH	2	53,302	4,355	8.17%	7.60%	4,051	2	5.40%	2,877	4.00%	2,132	2
32	NJ	6	119,286	17,958	15.05%	8.10%	9,662	3	43.96%	52,438	27.40%	32,684	3
33	NM	4	17,491	4,638	26.52%	19.30%	3,376	3	55.72%	9,746	33.20%	5,807	3
34	NV	3	8,471	823	9.72%	10.10%	856	1	15.75%	1,334	24.80%	2,101	1
35	NY	13	226,416	29,187	12.89%	14.70%	33,283	3	17.42%	39,451	32.10%	72,680	3
36	OH	23	391,705	42,242	10.78%	11.10%	43,479	7	12.24%	47,953	15.00%	58,756	2
37	OK	6	30,357	6,117	20.15%	14.10%	4,280	4	38.84%	11,791	23.80%	7,225	1
38	OR	1	3,884	596	15.35%	12.90%	501	1	39.19%	1,522	13.40%	520	1
39	PA	28	167,254	15,499	9.27%	9.80%	16,391	15	6.61%	11,048	14.60%	24,419	3
40	RI	ND											
41	SC	12	222,414	28,746	12.92%	12.00%	26,690	8	31.40%	69,831	32.80%	72,952	6
42	SD	2	30,508	1,763	5.78%	9.40%	2,868	1	5.55%	1,694	11.30%	3,447	0

Exhibit 7G
Minority and Low-Income Population Data Aggregated on State-by-State Basis

A	B	C	D	E	F (E/D)	G (**Exh 7F**)	H (DxG)	I	J	K (DxJ)	L (**Exh 7F**)	M (DxL)	N
General Population Data				**Low Income Population Data (Below Poverty)**					**Minority Population Data**				
Item	State	ZCTA count	2000 population residing in electric utility plant ZCTA areas	Count of plant ZCTA residents below poverty level	% of plant ZCTA residents below poverty level	State % below poverty level	Expected count of residents below poverty based on state%	Count of plants with ZCTA% > state% poverty level	% of plant ZCTA residents that are minority	Count of plant ZCTA residents that are minority	State-wide % minority	Expected count of minority based on state%	Count of plants with ZCTA% > state% minority level
43	TN	8	158,267	26,572	16.79%	13.40%	21,208	4	37.38%	59,159	19.80%	31,337	1
44	TX	17	98,402	14,147	14.38%	14.90%	14,662	10	22.41%	22,052	29.00%	28,537	3
45	UT	6	34,209	3,885	11.36%	8.10%	2,771	6	5.22%	1,784	10.80%	3,695	0
46	VA	15	220,800	21,822	9.88%	8.10%	17,885	11	37.78%	83,411	27.70%	61,162	11
47	VT	ND											
48	WA	1	21,842	3,394	15.54%	9.50%	2,075	1	9.54%	2,083	18.20%	3,975	0
49	WI	13	178,705	23,577	13.19%	9.00%	16,083	8	12.00%	21,446	11.10%	19,836	4
50	WV	13	64,771	15,577	24.05%	15.80%	10,234	11	6.45%	4,179	5.00%	3,239	2
51	WY	8	69,736	6,439	9.23%	11.10%	7,741	1	4.92%	3,428	7.90%	5,509	0
Summary:													
Column totals		430	6,076,410	**783,062**	**12.9%**	11.9%	**658,336**	240	**21.7%**	**1,317,895**	24.9%	**1,241,382**	129
				18.9%								**-5.8%**	
				Min =	4.6%	7.3%			1.3%		3.1%		
				Max =	26.5%	19.3%			78.2%		75.7%		
Extrapolated to 495 plants =								**256**					**138**

Step 5: Ratios: EPA compared the percentages of minority and low-income populations surrounding the plants to their respective statewide benchmark percentages and to the nationwide percentages of these populations as calculated in Step 4, by calculating numerical ratios between the plant ZCTA group populations compared to statewide and nationwide percentages of minority and low-income populations. The purpose of these ratios is to indicate the relative degree by which the percentages are below or above the statewide percentages. **Exhibit 7H** below displays the results.

Exhibit 7H
Comparison of Minority and Low-Income Populations Near Coal-Fired Electric Utility Plants to Statewide Percentages

A	B	C	D	E	F (D–E)	G (D/E)	H	I	J (H–I)	K (I/J)
			Low-Income Data Comparison				**Minority Data Comparison**			
Item	State	Count of plants	Percent Low-Income Population Surrounding Plants	Statewide Low-Income Percentage (**Exhibit 7F**)	Difference	Ratio	Percent Minority Population Surrounding Plants	Statewide Minority Percentage (**Exhibit 7F**)	Difference	Ratio
1	AK	2	12.3%	8.4%	3.9%	1.47	32.0%	30.7%	1.3%	1.04
2	AL	9	24.5%	14.7%	9.8%	1.67	42.2%	28.9%	13.3%	1.46
3	AR	3	10.3%	15.8%	-5.5%	0.65	7.7%	20.0%	-12.3%	0.39
4	AZ	6	21.3%	13.5%	7.8%	1.58	43.7%	24.5%	19.2%	1.78
5	CA	5	21.9%	14.0%	7.9%	1.57	45.2%	40.5%	4.7%	1.12
6	CO	15	13.7%	8.5%	5.2%	1.62	17.9%	17.2%	0.7%	1.04
7	CT	2	15.0%	7.7%	7.3%	1.95	45.1%	18.4%	26.7%	2.45
8	DC	NR	NA	NA	NA	NA	NA	NA	NA	NA
9	DE	3	8.5%	9.9%	-1.4%	0.86	28.9%	25.4%	3.5%	1.14
10	FL	14	10.6%	12.1%	-1.5%	0.88	20.8%	22.0%	-1.2%	0.94
11	GA	9	14.5%	12.5%	2.0%	1.16	42.7%	34.9%	7.8%	1.22
12	HI	1	4.6%	10.6%	-6.0%	0.43	78.2%	75.7%	2.5%	1.03
13	IA	17	9.7%	7.9%	1.8%	1.23	7.0%	6.1%	0.9%	1.15
14	ID	NR	NA	NA	NA	NA	NA	NA	NA	NA
15	IL	25	18.3%	10.5%	7.8%	1.74	41.5%	26.5%	15.0%	1.56
16	IN	19	7.9%	8.3%	-0.4%	0.95	7.0%	12.5%	-5.5%	0.56
17	KS	7	13.0%	10.5%	2.5%	1.24	36.8%	13.9%	22.9%	2.64
18	KY	19	12.7%	12.5%	0.2%	1.02	8.5%	9.9%	-1.4%	0.86
19	LA	4	24.8%	18.5%	6.3%	1.34	45.2%	36.1%	9.1%	1.25
20	MA	4	15.1%	10.1%	5.0%	1.49	20.7%	15.5%	5.2%	1.33
21	MD	8	10.5%	7.3%	3.2%	1.44	12.4%	36.0%	-23.6%	0.34
22	ME	1	15.4%	9.8%	5.6%	1.57	1.3%	3.1%	-1.8%	0.42
23	MI	23	8.0%	10.2%	-2.2%	0.79	10.6%	19.8%	-9.2%	0.53
24	MN	15	11.2%	7.8%	3.4%	1.43	10.8%	10.6%	0.2%	1.02
25	MO	19	9.8%	9.8%	0.0%	1.00	7.5%	15.1%	-7.6%	0.49
26	MS	4	25.5%	15.5%	10.0%	1.65	51.6%	38.6%	13.0%	1.34

Exhibit 7H Comparison of Minority and Low-Income Populations Near Coal-Fired Electric Utility Plants to Statewide Percentages										
A	B	C	D	E	F (D–E)	G (D/E)	H	I	J (H–I)	K (I/J)
			Low-Income Data Comparison				**Minority Data Comparison**			
Item	State	Count of plants	Percent Low-Income Population Surrounding Plants	Statewide Low-Income Percentage (**Exhibit 7F**)	Difference	Ratio	Percent Minority Population Surrounding Plants	Statewide Minority Percentage (**Exhibit 7F**)	Differenc e	Ratio
27	MT	6	15.9%	16.0%	-0.1%	0.99	13.2%	9.4%	3.8%	1.41
28	NC	19	15.7%	13.2%	2.5%	1.19	34.5%	27.9%	6.6%	1.24
29	ND	7	9.0%	12.7%	-3.7%	0.71	4.4%	7.6%	-3.2%	0.58
30	NE	6	11.3%	10.7%	0.6%	1.06	11.4%	10.4%	1.0%	1.09
31	NH	2	8.2%	7.6%	0.6%	1.08	5.4%	4.0%	1.4%	1.35
32	NJ	6	15.1%	8.1%	7.0%	1.86	44.0%	27.4%	16.6%	1.60
33	NM	4	26.5%	19.3%	7.2%	1.37	55.7%	33.2%	22.5%	1.68
34	NV	3	9.7%	10.1%	-0.4%	0.96	15.7%	24.8%	-9.1%	0.63
35	NY	13	12.9%	14.7%	-1.8%	0.88	17.4%	32.1%	-14.7%	0.54
36	OH	24	10.8%	11.1%	-0.3%	0.97	12.2%	15.0%	-2.8%	0.82
37	OK	6	20.2%	14.1%	6.1%	1.43	38.8%	23.8%	15.0%	1.63
38	OR	1	15.3%	12.9%	2.4%	1.19	39.2%	13.4%	25.8%	2.92
39	PA	31	9.3%	9.8%	-0.5%	0.95	6.6%	14.6%	-8.0%	0.45
40	RI	NR	NA	NA	NA	NA	NA	NA	NA	NA
41	SC	12	12.9%	12.0%	0.9%	1.08	31.4%	32.8%	-1.4%	0.96
42	SD	2	5.8%	9.4%	-3.6%	0.61	5.6%	11.3%	-5.7%	0.49
43	TN	8	16.8%	13.4%	3.4%	1.25	37.4%	19.8%	17.6%	1.89
44	TX	18	14.4%	14.9%	-0.5%	0.96	22.4%	29.0%	-6.6%	0.77
45	UT	6	11.4%	8.1%	3.3%	1.40	5.2%	10.8%	-5.6%	0.48
46	VA	16	9.9%	8.1%	1.8%	1.22	37.8%	27.7%	10.1%	1.36
47	VT	NR	NA	NA	NA	NA	NA	NA	NA	NA
48	WA	1	15.5%	9.5%	6.0%	1.64	9.5%	18.2%	-8.7%	0.52
49	WI	15	13.2%	9.0%	4.2%	1.47	12.0%	11.1%	0.9%	1.08
50	WV	16	24.0%	15.8%	8.2%	1.52	6.5%	5.0%	1.5%	1.29
51	WY	9	9.2%	11.1%	-1.9%	0.83	4.9%	7.9%	-3.0%	0.62
Summary:										
		Min =	4.6%	7.3%	-6.0%	0.43	4.4%	3.1%	-23.6%	0.34
		Max =	26.5%	19.3%	10.0%	1.95	78.2%	75.7%	26.7%	2.92
Nationwide =		464	12.9%	11.9%	1.0%	**1.08**	21.7%	24.9%	-3.2%	**0.87**

- **Minority & Low-Income Demographic Findings**

Below is a summary of the three alternative but complementary comparison approaches based on the same minority and low-income population data: (a) itemized plant-by-plant basis, (b) nationwide aggregation basis, and (c) state-by-state aggregation basis. For purpose of determining the relative degree by which either group living near the 495 plants may exceed their respective statewide population percentages, the percentages are compared as a numerical ratio whereby a ratio of 1.00 indicates that the group population percentage living near a plant is equal to the statewide average, a ratio greater than 1.00 indicates the group population percentage near the plant is higher than the statewide population, and a ratio less than 1.00 indicates the group population is less than the respective statewide average.

- General population findings:
  - 464 plants (i.e., 94% of the 495 universe) for which year 2000 Census plant address ZCTA data are available are located in 47 states.
  - The plant address ZCTA population surrounding the 464 plants with ZCTA data is **6.08 million**, which is an average of 13,091 surrounding population per plant.

- Low-income population findings:
  - **0.78 million** low-income population surrounding the 464 plants represents **12.9%** of the 6.08 million total surrounding populations; this is higher than the **11.9%** national percentage.
  - State-by-state low-income population percentages surrounding these plants range from 4.6% in HI to 26.5% in NM.
  - Extrapolated and aggregated across all 495 plants, 256 plants (**52%**) have surrounding populations which exceed their statewide benchmark percentage of low-income population.
  - The ratios of low-income population percentages surrounding these plants range from 0.43 to 1.95, and the average of the ratios compared to the national average ratio of the low-income population is 1.08.
  - Approximately 29 of the 47 states (62%) have higher percentages of low-income populations compared to their respective statewide benchmarks.
  - States with the largest difference in low-income populations surrounding the plants compared to their statewide benchmarks are:

    1. Mississippi (26% vs. 16%)
    2. Alabama (25% vs. 15%)
    3. Illinois (18% vs. 11%)
    4. New Jersey (15% vs. 8%)
    5. Connecticut (15% vs. 8%)

- Minority population findings:
  - **1.32 million** minority population surrounding the 464 plants represents **21.7%** of the 6.08 million total surrounding populations; this is lower than the **24.9%** national minority population.

- The state-by-state range of minority population percentages surrounding these plants ranges from 1.3% in ME to 78.2% in HI.
- Extrapolated and aggregated across all 495 plants, 138 plants (**28%**) have surrounding populations which exceed their statewide benchmark minority percentage of population.
- The ratio of minority population percentages surrounding these plants range from 0.34 to 2.92, and the average of the ratios compared to the national average ratio of the minority population is 0.87.
- Approximately 24 of the 47 states (51.1%) have disproportionately high percentages of minority populations within the plant address ZCTA area compared to the rest of the state.
- States with the largest difference in minority populations between the ZCTA where the plants are located compared to the rest of the state are as follows:

1. Connecticut (45% vs. 18%)
2. Arizona (44% vs. 25%)
3. Oregon (39% vs. 13%)
4. Tennessee (37% vs. 20%)
5. Kansas (37% vs. 14%)

- Plant level results:

Using the plant-by-plant (i.e., itemized ZCTA) basis, 138 plants (28%) have surrounding minority populations which exceed their statewide minority benchmark percentages, whereas 357 plants (72%) have minority populations below their statewide benchmarks, which represents a plant ZCTA ratio of 0.39 (i.e., 138/357). Because this ratio is 61% less than 1.00 (i.e., 1.00 minus 0.39), this finding indicates that only a relatively small count of plants have surrounding minority population percentages which disproportionately exceed their statewide benchmarks. Also on a plant-by-plant ZCTA basis, 256 plants (52%) have surrounding low-income populations which exceed their respective statewide benchmarks, whereas 239 plants (48%) have surrounding low-income populations below their statewide benchmarks, which represents a plant ZCTA ratio of 1.07 (i.e., 256/239). Because this ratio is only slightly (7%) above 1.00, it indicates that a slightly disproportionate count of plants have surrounding low-income population percentages which exceed their statewide benchmarks.

- State level results:

Using the state-by-state aggregation basis, the percentages of minority and low-income populations surrounding the plants were compared to their respective statewide population benchmarks. From this, state ratios revealed that 24 of the 47 states (51%) have higher minority percentages, and 29 of the 47 states (62%) have higher low-income percentages surrounding the 495 plants, suggesting a slightly disproportionate higher minority surrounding population and a relatively large disproportionate, higher low-income surrounding population. However, in comparison to the other two numerical comparisons, this state-by-state count approach does not include numerically-weighting of state plant counts or state surrounding populations, which explains why this comparison method yields a different numerical result. This method illustrates how population comparison results may be sensitive to the comparison method.

- Nationwide results:

Using the nationwide aggregation basis across all 495 plants in all 47 states where the plants are located, 6.08 million people live in ZCTA surrounding the plants, which include a sub-total of 1.32 million (21.7%) minority and a sub-total of 0.8 million (12.9%) low-income population groups. A comparison of these percentages to the national benchmark averages across all states of 24.9% minority and 11.9% low-income, represents a minority ratio of 0.87 (i.e., 21.7%/24.9%) and a low-income ratio of 1.08 (i.e., 12.9%/11.9%). These nationwide aggregate ratios indicate a slightly lower disproportionate minority population surrounding the 495 plants, and a slightly higher disproportionate low-income population surrounding the plants. Comparison of nationwide population sub-totals for all plants for each demographic group compared to the expected value based on statewide averages, reveals that:

- **+18.9%** additional low-income residents near the plants compared to the expected low-income population based on statewide averages (i.e., 783,062 low-income population for all 464 plants compared to 658,336 expected count if based on statewide averages.)
- **-5.8%** less minority residents near the plants compared to the expected minority population based on statewide averages (i.e., 1,317,896 minority population for all 464 plants compared to 1,241,382 expected count if based on statewide averages).

These three alternative comparisons indicate that the current (baseline) environmental and human health hazards and risks from electric utility CCR disposal units, and the expected future benefits of the regulatory options, may have a disproportionately lower effect on minority populations and may have a disproportionately higher effect on low-income populations.

- **Other Potentially Affected Minority & Low-Income Populations**

There are two other potential differential effects of the regulatory options on two other population groups: (a) populations surrounding offsite CCR landfills, and (b) populations within the customer service areas of the 495 electric utility plants.

- Offsite CCR Landfills

The potential effect on offsite landfills involves the RCRA Subtitle C based regulatory options whereby four different fractions of CCR generation may be required to be disposed in RCRA Subtitle C permitted landfills rather than in non-RCRA permitted waste landfills:

- CCR fraction #1: Electric utility plants may switch the management of CCR, in whole or in part, from current onsite disposal to offsite commercial RCRA-permitted hazardous waste landfills (56.8 million is disposed in onsite landfills, and 22.4 million is disposed in onsite impoundments, totaling 79.2 million tons disposed onsite).
- CCR fraction #2: Some or all of the CCR which is currently disposed in offsite landfills that do not have RCRA Subtitle C permits may also switch to RCRA-permitted commercial hazardous waste landfills if the current receiving landfills do not obtain RCRA Subtitle C permits (15.0 million tons is disposed offsite).

- CCR fraction #3: Annual CCR generation which is currently supplied for industrial beneficial use applications could also switch to offsite commercial RCRA Subtitle C permitted landfills if such use becomes curtailed in part or in whole from either state government regulations or from market stigma (47.0 million tons is beneficially used).
- CCR fraction #4: Future cleanup of CCR disposal unit failures (e.g., impoundment collapse) would require disposal in RCRA Subtitle-permitted waste landfills (the two CCR impoundment release case studies in **Exhibit 4A** of this RIA represent a range of 0.25 million to 3.3 million tons per failure event).

One or more of these four potential shifts of CCR disposal from current non-hazardous landfills to hazardous waste landfills, could have a disproportionate effect on populations surrounding these locations, and in particular, minority and low-income populations surrounding commercial hazardous waste facilities, if current landfills operated by electric utility plants do not obtain future Subtitle C permits (Option 1). A recent (2007) study determined that minority and low-income populations disproportionately live near commercial hazardous waste facilities, although the study included other types of commercial hazardous waste treatment and disposal facilities in addition to commercial hazardous waste landfills.[187] An example of such potential EJ concerns is a 2009 US national news item involving the decision made by the Tennessee Valley Authority (TVA) to train transport 3 million tons of the TVA's (Kingston TN electricity plant) December 2008 CCR impoundment collapse site cleanup waste, 350 miles away to a landfill in a rural Alabama county which reportedly has about 70% minority (African American) and 33% low-income residents.[188] However, this example serves to illustrate that EJ concerns are not necessarily conclusive or shared by all affected EJ populations, as evidenced by the following remarks made to news reporters by the Alabama county government officials and county residents:[189]

> "*To county leaders, the train's loads, which will total three million cubic yards of coal ash from a massive spill at a power plant in east Tennessee last December [2008], are a tremendous financial windfall. A per-ton "host fee" that the landfill operators pay the county will add more than $3 million to the county's budget of about $4.5 million. The ash has created more than 30 jobs for local residents in a county where the unemployment rate is 17 percent and a third of all households are below the poverty line. A sign on the door of the landfill's scale house says job applications are no longer being accepted — 1,000 were more than enough. But some residents worry that their leaders are taking a short-term view, and that their community has been too easily persuaded to take on a wealthier, whiter community's problem…. County leaders, who are mostly black, bristle at accusations of environmental injustice, saying that the ash is perfectly safe and that criticism has been fostered by outsiders, or even competitors who wanted the ash disposal contract for themselves….. Bob Deacy, vice president of clean strategies and*

---

[187] Source: United Church of Christ, "Toxic Wastes and Race at Twenty 1987-2007", March 2007. . This study evaluated and made findings on minority and low-income population data within a 1.8-mile radius "host neighborhood" of 413 commercial hazardous waste facilities, compared to "non-host" areas. The study (page x) found that "Host neighborhoods of commercial hazardous waste facilities are 56% people of color whereas non-host areas are 30% of color… Poverty rates in the host neighborhoods are 1.5 times greater than non-host areas (18% vs. 12%)."

[188] Source: Shaila Dewan, "Clash in Alabama Over Tennessee Coal Ash," The New York Times, 30 Aug 2009 at http://www.nytimes.com/2009/08/30/us/30ash.html

[189] Source: At least two news organizations identically reported these remarks on 30 Aug 2009:
#1 of 2: New York Times, "Clash in Alabama Over Tennessee Coal Ash" at http://www.nytimes.com/2009/08/30/us/30ash.html
#2 of 2: Waste Business Journal, "Waste From TVA Spill Begins to Arrive at Alabama Landfill Amid Controversy" at http://www.wastebusinessjournal.com/news/wbj20090901D.htm

project development for the Tennessee Valley Authority, whose Kingston Fossil Plant was the site of the ash spill that covered almost 300 acres of land and waterways, said Arrowhead [Alabama landfill] was chosen because it was reachable by train instead of truck, because it underbid other sites and because, unlike closer landfills, it had the capacity to handle all the ash."

- Electricity Service Area Customers

A third potential effect of the regulatory options described in today's notice is the price of electricity supplied by some or all of the affected 495 electric utility plants could increase to cover the cost of regulatory compliance. Thus customers in electric utility service areas could experience price increases, although the RIA estimates that future potential price increases could be expected to be below 1% increase relative to the $0.0900 per kilowatt hour national average price (February 2009) for all four customer sectors (i.e., residential, commercial, industrial, and transportation). The RIA for today's action did not evaluate the customer service area populations for the 495 plants.

7D. Child Population Statistics (Executive Order 13045)

- **Purpose of Child Population Data Analysis**

Under Executive Order (EO) 13045 of 21 April 1997, Federal Agencies shall make it a high priority (a) to identify and assess environmental health and safety risks that may disproportionately affect children, and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. Although the EO does not define children, the US Census Bureau defines "children" as follows[190]:

> *Children: The term "children"… are all persons under 18 years, excluding people who maintain households, families, or subfamilies as a reference person or spouse.*

The purpose of this section is not to evaluate children risks, but to evaluate whether disproportionate percentages of children live near electric utility plants. This analysis involves a 5-step process for comparing children population data for each electric utility plant location, to statewide children population data to identify whether children disproportionately reside in geographic areas where electric utility plants are located.

- **Collection of Child Demographic Data**

Step 1: Plant address 5-digit "Zip Code Tabulation Areas" (ZCTAs) formed the geographic basis for this child population data collection. Because ZCTAs represent irregularly shaped geographic areas, this ZCTA based data collection may be considered a "screening level" analysis. The US Bureau of Census uses over 33,000 ZCTAs for its Census counts of population and other demographic statistics based on the US Postal Service's over 42,000 nationwide ZCTAs.[191] Currently, there are no size restrictions limiting how large or small a ZCTA can be in terms of either a minimum/maximum number of housing units or geographic area. Any particular ZCTA may be as small as a few city blocks or may cover many square miles. Many ZCTAs are for villages, census-designated places, portions of cities, or other entities that are not municipalities. The nationwide average ZCTA population is about 7,200 persons (i.e., (306.6 million mid-2009 US population) / (42,500 ZCTAs)). The nationwide average ZCTA area is about 83 square miles (i.e., (3,536,278 square miles total US land and water area) / (42,500 ZCTAs)), which is a land area equivalent to a 5-mile radial distance (i.e., ((83 square miles) / (3.1416))^0.5). In comparison, the radial area monitored for contamination in response to the December 2009 TVA Kingston TN electric plant CCR spill is reportedly four miles,[192] and this average 5-mile ZCTA radial distance falls between the 1-mile to 15-mile radial distances used by EPA's Superfund "Hazard Ranking System" (HRS)[193] to define affected populations of sites having either (a) soil contamination only (1-mile), (b) groundwater and/or airborne contamination (4-miles), or (c) surface water contamination (15-miles

---

[190] The US Census Bureau definition of "children" is from its "Current Population Survey (CPS) - Definitions and Explanations" website at: http://www.census.gov/population/www/cps/cpsdef.html

[191] Source: US Census Bureau ZIP Code Tabulation Area (ZCTA) Frequently Asked Questions.: Nationwide total ZCTA count is from the US Postal Service's FAQ website at: http://zip4.usps.com/zip4/welcome.jsp

[192] Source: 4 mile radial monitoring area reported by Waste & Recycling News, 13 Feb 2009; http://www.wasterecyclingnews.com/email.html?id=1234543579

[193] More background information about EPA's HRS is available at http://www.epa.gov/superfund/programs/npl_hrs/hrsint.htm.

downstream). Using the Census search engine Factfinder (http:factfinder.census.gov/home/saff/main.html?_lang=en), EPA retrieved total population and people 18 and over for 464 (94%) of the 495 electric utility plants. For 42 plants (8%) there was no ZCTA Census data because the plants did not have complete address data from DOE or because the Census search engine did not have data for the ZCTA.

Step 2: EPA collected 3-year (2005 to 2007) average statewide percentages for people 18 and older data as displayed in **Exhibit 7I** below.

Exhibit 7I
State-by-State Data on Child Populations (2005-2007 Average)

Row	State	% children in state
1	AK	27.0%
2	AL	24.4%
3	AR	24.8%
4	AZ	26.4%
5	CA	25.9%
6	CO	24.7%
7	CT	23.7%
8	DC	19.5%
9	DE	23.9%
10	FL	22.3%
11	GA	26.5%
12	HI	22.3%
13	IA	23.9%
14	ID	27.3%
15	IL	25.1%
16	IN	25.1%
17	KS	25.2%
18	KY	23.9%
19	LA	25.4%
20	MA	22.5%
21	MD	24.4%
22	ME	21.5%
23	MI	24.6%
24	MN	24.5%
25	MO	24.4%
26	MS	26.3%
27	MT	23.2%
28	NC	24.4%
29	ND	22.5%
30	NE	25.3%

Row	State	% children in state
31	NH	23.1%
32	NJ	24.0%
33	NM	25.6%
34	NV	25.8%
35	NY	23.2%
36	OH	24.2%
37	OK	24.9%
38	OR	23.2%
39	PA	22.6%
40	RI	22.3%
41	SC	24.2%
42	SD	24.8%
43	TN	24.1%
44	TX	27.7%
45	UT	30.9%
46	VA	23.9%
47	VT	21.6%
48	WA	23.9%
49	WI	23.8%
50	WV	21.5%
51	WY	24.0%
	Max (UT)	30.9%
	Min (DC)	19.5%
	Nationwide	**24.7%**

- **Comparison of Child Populations Living Near Electric Utility Plants to Statewide Benchmarks**

Step 3, Step 4 and Step 5 of this evaluation described below involved three complementary levels of data comparisons. All three comparisons also involved two complementary numerical comparisons, one based on calculating numerical percentages and the other based on calculating numerical ratios:

1. Plant level: Plant-by-plant disaggregated data comparison to statewide benchmarks
2. State level: State-by-state aggregated plant data comparison to statewide benchmarks
3. National level: National aggregated plant data comparison to statewide benchmarks

Step 3: On a plant-by-plant basis, EPA compared the plant ZCTA percentage children, to the respective statewide average percentage children.

Step 4: For purpose of summary, EPA aggregated the plant level children population comparison data for each state as displayed in **Exhibit 7J** below. There are no data displayed for DC, ID, RI or VT because there are no coal-fired electric utility plants in those states. **Appendix O** of this RIA presents the plant-by-plant Census data on which this Exhibit is based.

Exhibit 7J
State-by-State Child Population Data for Coal-Fired Electric Utility Plants

General Population Data					**Child Population Data**				
Item	Count of plant unique ZCTAds	State	Count of plant ZCTAs which have Census population data	2000 plant ZCTA resident population	Child population count (<18 years) in plant ZCTAs	Child population percentage in plant ZCTAs	Statewide percentage child population	Expected children count in plant ZCTAs if based on state %	If plant ZCTA child% > state children%
1	2	AK	2	18,552	5,188	27.96%	27.00%	5,009	2
2	9	AL	9	82,854	21,978	26.53%	24.40%	20,216	4
3	3	AR	3	11,786	3,359	28.50%	24.80%	2,923	3
4	6	AZ	6	34,941	11,526	32.99%	26.40%	9,224	5
5	5	CA	4	112,895	36,285	32.14%	25.90%	29,240	5
6	15	CO	15	214,095	49,190	22.98%	24.70%	52,881	11
7	2	CT	2	42,716	10,743	25.15%	23.70%	10,124	1
8	NA	DC							
9	3	DE	3	46,925	11,169	23.80%	23.90%	11,215	1
10	14	FL	13	224,502	55,025	24.51%	22.30%	50,064	11
11	9	GA	9	202,973	50,964	25.11%	26.50%	53,788	5
12	1	HI	1	25,054	8,158	32.56%	22.30%	5,587	1
13	17	IA	14	324,050	77,708	23.98%	23.90%	77,448	15
14	NA	ID							

Exhibit 7J State-by-State Child Population Data for Coal-Fired Electric Utility Plants									
General Population Data					**Child Population Data**				
Item	Count of plant unique ZCTAds	State	Count of plant ZCTAs which have Census population data	2000 plant ZCTA resident population	Child population count (<18 years) in plant ZCTAs	Child population percentage in plant ZCTAs	Statewide percentage child population	Expected children count in plant ZCTAs if based on state %	If plant ZCTA child% > state children%
15	25	IL	23	455,834	129,772	28.47%	25.10%	114,414	14
16	19	IN	17	323,323	83,594	25.85%	25.10%	81,154	14
17	7	KS	6	59,517	16,532	27.78%	25.20%	14,998	6
18	19	KY	17	255,033	63,012	24.71%	23.90%	60,953	15
19	4	LA	4	30,381	8,617	28.36%	25.40%	7,717	4
20	4	MA	3	95,798	23,078	24.09%	22.50%	21,555	1
21	8	MD	7	101,141	23,529	23.26%	24.40%	24,678	5
22	1	ME	1	6,748	1,561	23.13%	21.50%	1,451	1
23	23	MI	20	383,284	94,994	24.78%	24.60%	94,288	13
24	15	MN	15	187,012	46,208	24.71%	24.50%	45,818	5
25	19	MO	19	251,484	60,084	23.89%	24.40%	61,362	12
26	4	MS	4	69,209	19,867	28.71%	26.30%	18,202	4
27	6	MT	5	53,209	14,115	26.53%	23.20%	12,344	5
28	19	NC	16	238,874	57,728	24.17%	24.40%	58,285	6
29	7	ND	5	27,087	7,411	27.36%	22.50%	6,095	4
30	6	NE	6	79,313	20,853	26.29%	25.30%	20,066	4
31	2	NH	2	53,302	10,713	20.10%	23.10%	12,313	0
32	6	NJ	6	119,286	29,806	24.99%	24.00%	28,629	4
33	4	NM	4	17,491	5,656	32.34%	25.60%	4,478	3
34	2	NV	2	8,471	1,827	21.57%	25.80%	2,186	1
35	13	NY	13	226,416	57,612	25.45%	23.20%	52,529	9
36	24	OH	23	391,705	101,253	25.85%	24.20%	94,793	14
37	6	OK	6	30,357	8,513	28.04%	24.90%	7,559	6
38	1	OR	1	3,884	1,378	35.48%	23.20%	901	1
39	31	PA	28	167,254	36,581	21.87%	22.60%	37,799	13
40	NA	RI							
41	12	SC	12	222,414	60,391	27.15%	24.20%	53,824	10
42	2	SD	2	30,508	7,510	24.62%	24.80%	7,566	1
43	8	TN	8	158,267	40,682	25.70%	24.10%	38,142	4
44	18	TX	17	98,402	27,471	27.92%	27.70%	27,257	7
45	6	UT	6	34,209	11,769	34.40%	30.90%	10,571	4
46	16	VA	15	220,800	55,824	25.28%	23.90%	52,771	10
47	NA	VT							
48	1	WA	1	21,842	5,514	25.24%	23.90%	5,220	1
49	15	WI	13	178,705	36,428	20.38%	23.80%	42,532	10

Exhibit 7J State-by-State Child Population Data for Coal-Fired Electric Utility Plants									
General Population Data					**Child Population Data**				
Item	Count of plant unique ZCTAds	State	Count of plant ZCTAs which have Census population data	2000 plant ZCTA resident population	Child population count (<18 years) in plant ZCTAs	Child population percentage in plant ZCTAs	Statewide percentage child population	Expected children count in plant ZCTAs if based on state %	If plant ZCTA child% > state children%
50	16	WV	13	64,771	10,946	16.90%	21.50%	13,926	10
51	9	WY	8	69,736	19,732	28.30%	24.00%	16,737	6
Summary:									
Total	464		429	6,076,410	**1,541,854**	25.37%	24.70%	**1,480,831**	**291**
					4.1%				
					Min=	16.90%	21.50%		
					Max=	35.48%	30.90%		
Extrapolated to 495 plants =									**310**

Step 5: The percentage of children population surrounding the plant ZCTAs were compared to overall state percentages and the nationwide percentage of this sub-group population, by calculating ratios between the plant ZCTA children populations compared to statewide and nationwide percentages of children population. **Exhibit 7K** below displays the results.

Exhibit 7K Comparison of Child Population Data on a State-by-State Basis						
Item	State	Plants	Percentage of ZCTA Population Under 18 Years Old	Statewide Percentage of Children (**Exhibit 7I**)	Difference	Ratio
1	AK	2	28.0%	27.0%	1.0%	1.04
2	AL	9	26.5%	24.4%	2.1%	1.09
3	AR	3	28.5%	24.8%	3.7%	1.15
4	AZ	6	33.0%	26.4%	6.6%	1.25
5	CA	5	32.1%	25.9%	6.2%	1.24
6	CO	15	23.0%	24.7%	-1.7%	0.93
7	CT	2	25.1%	23.7%	1.4%	1.06
8	DC	NR	NA	NA	NA	NA
9	DE	3	23.8%	23.9%	-0.1%	1.00
10	FL	14	24.5%	22.3%	2.2%	1.10
11	GA	9	25.1%	26.5%	-1.4%	0.95
12	HI	1	32.6%	22.3%	10.3%	1.46

Exhibit 7K Comparison of Child Population Data on a State-by-State Basis						
Item	State	Plants	Percentage of ZCTA Population Under 18 Years Old	Statewide Percentage of Children (**Exhibit 7I**)	Difference	Ratio
13	IA	17	24.0%	23.9%	0.1%	1.00
14	ID	NR	NA	NA	NA	NA
15	IL	25	28.5%	25.1%	3.4%	1.13
16	IN	19	25.9%	25.1%	0.8%	1.03
17	KS	7	27.8%	25.2%	2.6%	1.10
18	KY	19	24.7%	23.9%	0.8%	1.03
19	LA	4	28.4%	25.4%	3.0%	1.12
20	MA	4	24.1%	22.5%	1.6%	1.07
21	MD	8	23.3%	24.4%	-1.1%	0.95
22	ME	1	23.1%	21.5%	1.6%	1.08
23	MI	23	24.8%	24.6%	0.2%	1.01
24	MN	15	24.7%	24.5%	0.2%	1.01
25	MO	19	23.9%	24.4%	-0.5%	0.98
26	MS	4	28.7%	26.3%	2.4%	1.09
27	MT	6	26.5%	23.2%	3.3%	1.14
28	NC	19	24.2%	24.4%	-0.2%	0.99
29	ND	7	27.4%	22.5%	4.9%	1.22
30	NE	6	26.3%	25.3%	1.0%	1.04
31	NH	2	20.1%	23.1%	-3.0%	0.87
32	NJ	6	25.0%	24.0%	1.0%	1.04
33	NM	4	32.3%	25.6%	6.7%	1.26
34	NV	2	21.6%	25.8%	-4.2%	0.84
35	NY	13	25.4%	23.2%	2.2%	1.10
36	OH	24	25.8%	24.2%	1.6%	1.07
37	OK	6	28.0%	24.9%	3.1%	1.13
38	OR	1	35.5%	23.2%	12.3%	1.53
39	PA	31	21.9%	22.6%	-0.7%	0.97
40	RI	NR	NA	NA	NA	NA
41	SC	12	27.2%	24.2%	3.0%	1.12
42	SD	2	24.6%	24.8%	-0.2%	0.99
43	TN	8	25.7%	24.1%	1.6%	1.07
44	TX	18	27.9%	27.7%	0.2%	1.01
45	UT	6	34.4%	30.9%	3.5%	1.11
46	VA	16	25.3%	23.9%	1.4%	1.06
47	VT	NR	NA	NA	NA	NA
48	WA	1	25.2%	23.9%	1.3%	1.06

Exhibit 7K Comparison of Child Population Data on a State-by-State Basis						
Item	State	Plants	Percentage of ZCTA Population Under 18 Years Old	Statewide Percentage of Children (**Exhibit 7I**)	Difference	Ratio
49	WI	15	20.4%	23.8%	-3.4%	0.86
50	WV	16	16.9%	21.5%	-4.6%	0.79
51	WY	9	28.3%	24.0%	4.3%	1.18
		Min =	16.9%	19.5%	-4.6%	0.79
		Max =	35.5%	30.9%	12.3%	1.53
	Nationwide =	464	25.4%	24.7%	0.7%	**1.03**

- **Child Population Data Findings**

Below is a summary of the three alternative but complementary comparison approaches based on the same children population data: (a) plant-by-plant (i.e., itemized ZCTA) basis, (b) nationwide aggregation basis, and (c) state-by-state aggregation basis. For purpose of determining the relative degree by which children may exceed these statewide percentages, the percentages are compared as a numerical ratio whereby a ratio of 1.00 indicates that the child population percentage living near a plant is equal to the statewide average, a ratio greater than 1.00 indicates the child population percentage near the plant is higher than the statewide population, and a ratio less than 1.00 indicates the child population is less than the respective statewide average.

- General population findings
    - 464 plants (i.e., 94% of the 495 universe) for which Census plant address ZCTA data are located in 47 states.
    - The plant address ZCTA population surrounding these plants is 6.08 million, which is an average of 13,091 surrounding population per plant.

- Child population findings
    - The sub-total number of children surrounding these 464 plants is 1.54 million (i.e., 25.4% of 6.08 million). In comparison, the national average of the child population in the US is 24.7%.
    - The ratios of the children population percentages surrounding these plants range from 0.79 to 1.53, and the average of the ratios compared to the national average ratio of the low-income population is 1.03.
    - 27 of the 47 states (57%) have disproportionately high percentages of children within the plant address ZCTAs compared to the statewide percentages.
    - States with the largest difference in the children population between the ZCTAs where the plants are located compared to the statewide percentages are as follows:
        1. Oregon (36% vs. 23%)

2. Hawaii (33% vs. 22%)
3. New Mexico (32% vs. 26%)
4. Arizona (33% vs. 26%)
5. California (32% vs. 26%)

- A sub-total of 291 plants (63%) have surrounding children populations which exceed their respective statewide percentage.

- Plant level results:

Using the plant-by-plant (i.e. itemized ZCTA) basis, 310 plants (63%) have surrounding child populations which exceed their statewide children benchmark percentages, whereas 185 plants (37%) have children populations below their statewide benchmarks, which represents a plant ZCTA ratio of 1.68 (i.e., 310/185). Since this ratio is much greater than 1.00, this finding indicates that a highly disproportionate count of plants have surrounding child population percentages which exceed their statewide benchmark.

- State level results:

Using the state-by-state aggregation basis, the percentage of child populations surrounding the plants were compared to their respective statewide population benchmarks. The state-by-state ratios revealed that approximately 27 of the 47 states (57%) have disproportionate percentages of children within the plant address ZCTA compared to the rest of the state suggesting a disproportionate surrounding child population. However, in comparison to the other two numerical comparisons above, this state-by-state count approach does not include numerically-weighting of state plant counts or state surrounding populations, which explains why this comparison method yields a different numerical result. This method illustrates how population comparison results may be sensitive to the comparison method.

- Nationwide results:

Using the nationwide aggregation basis across all 495 plants in all 47 states where the plants are located, 6.08 million people live in ZCTAs surrounding the plants, which include a sub-total of 1.54 million children (25.4%). Comparison of this percentage to the national aggregate benchmark across all states of 24.7% children yields a ratio of 1.03 (i.e., 25.4%/24.7%). This ratio indicates a slightly higher disproportionate child population surrounding the 495 plants. Comparison of the nationwide child population sub-total for all plants reveals that **+4.1%** additional children reside near the plants, compared to the expected child population if based on state averages (i.e., 1,541,854 children living near the 464 plants compared to 1,480,831 expected children count).

These three alternative comparisons indicate that the current (baseline) environmental and human health hazards and risks from electric utility CCR disposal units, and the expected future benefits of the regulatory options, may have a disproportionately higher effect on child populations.

7E. Unfunded Mandates (UMRA) & Federalism Implications Analysis (Executive Order 13132)

- **UMRA**

Among its other purposes and Federal agency rulemaking requirements, Title II of the 1995 Unfunded Mandates Reform Act (UMRA; 2 U.S.C. 1531-1538), requires Federal agencies, unless otherwise prohibited by law, to assess the effects of their regulatory actions on State, local, and tribal governments and on the private sector, to determine whether any proposed rulemaking:

> "*…is likely to result in promulgation of any rule that includes any Federal mandate that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more in any one year*."

Section 202 of UMRA requires Federal agencies which propose rules that are likely to exceed this $100 million expenditure threshold on either the private sector or on state/local/tribal governments, to prepare a "Written Statement" containing the following five components, and supply the Written Statement to OMB as well as summarize it in the Federal Register notice (aka "preamble") for the proposed rule:

1. Identification of the applicable authorizing Federal law
2. Qualitative and quantitative assessment of the anticipated costs and benefits of the rule including the costs and benefits to State, local, and tribal governments or the private sector, and an analysis of whether Federal resources may be available to pay these costs
3. Estimates of future compliance costs and any disproportionate budgetary effects
4. Estimates of effects on the national economy such as productivity, economic growth, employment, job creation, international competitiveness
5. Description and summary of agency's prior consultation with elected representatives of the affected State, local and tribal governments.

Section 202 of UMRA allows Federal agencies to prepare the "Written Statement "in conjunction with or as a part of any other statement or analysis. Accordingly, the purpose of this section of the RIA is to determine whether the regulatory options evaluated in this RIA exceed this UMRA direct cost threshold.

Findings: The private sector and the state/local government shares of direct compliance costs under each option are displayed below in **Exhibit 7L**, which indicates that:

- Private sector cost test: All of the regulatory options are expected to result in expenditures of $100 million or more in the aggregate for the private sector, in any one year (i.e., 139 companies and cooperatives of the total 200 owner entities).
- State/local/tribal government cost test: None of the regulatory options are expected to result in expenditures of $100 million or more for State, local, and tribal governments in the aggregate in any one year (there are 60 state/local government owner entities identified in **Exhibit 7M** below, no known tribal owner entities, plus one Federal owner).

According to the private sector test finding, EPA has prepared an "UMRA Written Statement" which is attached to this RIA as **Appendix P**.

- **Federalism (Executive Order 13132)**

The 1999 Federalism Executive Order 13132 (Federal Register, Vol.64, No. 153, 10 Aug 1999) furthers the policies of the 1995 Unfunded Mandates Reform Act (UMRA) by establishing federalism principles, federalism policymaking criteria, and a state/local government consultation process for the development of Federal regulations that have federalism implications. Federalism implications refers to regulations and other Federal policies and actions that have substantial direct effects on states, on the relationship between the Federal government and the states, or on the distribution of power and responsibilities among the various levels of government.

For purpose of complying with the Section 6 consultation process of EO 13132, this section of the RIA evaluates whether the CCR regulatory options may "impose substantial direct compliance costs" on state/local governments. As summarized in **Exhibit 7L**, the proposed rule might impose four types of direct costs on the 60 state/local government owner entities identified in **Exhibit 7M** below:

- State/local government owned electric utility plants:
  1. Engineering control costs for CCR disposal units located at electric utility plants owned by state/local governments.
  2. Ancillary costs for CCR disposal units located at electric utility plants owned by state/local governments.
  3. Conversion to dry disposal costs for CCR disposal units located at electricity utility plants owned by state/local governments.
- State government environmental agencies:
  4. Regulatory implementation, administration, and enforcement costs to RCRA-authorized state government programs/agencies.

Consistent with the "direct cost" scope of EO 13132, not included in **Exhibit 7L** are potential indirect costs in the form of potential lost annual revenues to electricity plants associated with potential reductions in CCR sold by plants for beneficial use under the three Subtitle C options for which such an possible indirect effect is estimated in this RIA.

EPA's 2008 guidance[194] for compliance with EO 13132 describes two numerical methods (i.e., numerical tests) for evaluating whether an EPA rule may have federalism implications with respect to "substantial direct compliance costs":

1. $25 million test: Annualized direct compliance cost expenditures to state/local governments in aggregate of $25 million or more[195]
2. 1% test: Annualized direct compliance costs faced by state/local governments is likely to equal or exceed 1% of their annual revenues* [* Note: Page 29 of "Attachment A: Guidance for Implementing the Federalism 1% Test" to EPA's Nov 2008 "Guidance on Executive Order 13132: Federalism" defines small government "general revenue" as "made up of intergovernmental revenue plus revenue from their own sources and excludes utility, liquor store and employee retirement revenue." However, given that the CCR proposed rule affects electric utility industry, this RIA applies the "1% Test" in relation to only State/local government electric utility annual revenue.]

[194] The two methods are from page 6 of "EPA's Action Development Process -- Guidance on Executive Order 13132: Federalism," OPEI Regulatory Development Series, Nov 2008, 62 pages at http://intranet.epa.gov/adplibrary/documents/federalismguide11-00-08.pdf

[195] Although one of the stated purposes of EO 13132 in its first paragraph is "to further the policies of the 1995 Unfunded Mandates Reform Act (UMRA), EPA's $25 million annual direct cost trigger is 75% lower than the $100 million annual direct cost trigger prescribed in Section 202 of UMRA.

- **Findings for UMRA Impact and Federalism Implication Tests**

Based on estimated regulatory costs on state/local governments displayed in **Exhibit 4B** of this RIA for each regulatory option, **Exhibit 7L** below displays whether the costs potentially exceed the UMRA and Federalism thresholds defined above.

- UMRA finding: All options >$100 million private sector test; all options <$100 million state/local government test
- Federalism finding: All options >$25 million state/local government test; all options <1% state/local government test

However, for consistency with the RFA/SBREFA small business impact analysis presented in a separate section above in this RIA, this RIA estimates it is highly likely that the direct compliance costs under each option may be passed-thru to electricity plant customers in the form of higher electricity prices. The feasibility of such a compliance cost pass-thru scenario is evaluated and confirmed by the information presented in the RFA/SBREFA small business impact section of this RIA.

Exhibit 7L
UMRA and Federalism Tests for CCR Disposal Regulatory Options
($millions average annualized costs @7% discount rate over 50-years 2012 to 2061, 2009$)

Type of Direct Compliance Cost	Subtitle C Hazardous waste	Subtitle D (version 1)	Subtitle C for impoundments Subtitle D for landfills
Average annualized cost (source: **Exhibit 5F**):	**$2,274**	**$492**	**$2,176**
UMRA Test:			
1. Private sector $100 million direct cost threshold test	$1,999.4	$415.3	$1,908.8
2. State/local government $100 million direct cost threshold test*	$96.7	$55.9	$91.6
Federalism Test:			
1. $25 million threshold test: sub-total State/Local govt cost	$96.7	$55.9	$91.6
2. 1% Test: State/local govt cost as percentage of State/Local government electric utility annual revenues	0.227%	0.131%	0.215%

* Note:
Remainder Federal government costs represent costs associated with Federally-owned electric utility plants (i.e., Tennessee Valley Authority) which are not subject to either the UMRA or Federalism tests. Therefore, the sub-total private sector direct cost plus the state/local government direct cost does not add-up to the total annual cost estimate under each option; the remainder cost is for the Federally-owned plants.

Exhibit 7M **List of 74 Coal-Fired Electric Utility Generation Plants Which EPA Estimates Are Owned by 60 State/Local Governments** Source: Compiled by EPA-OSWER-ORCR based on 2007 data from the US Energy Information Administration*				
Item	Owner Entity Name	Electric Utility Plant Name	State	Owner Entity Size/Type**
1	Grand River Dam Authority	GRDA	OK	Non-Small State
2	Lower Colorado River Authority	Fayette Power Project	TX	Non-Small State
3	Nebraska Public Power District	Gerald Gentleman	NE	Non-Small State
4	Nebraska Public Power District	Sheldon	NE	Non-Small State
5	Omaha Public Power District	Nebraska City	NE	Non-Small State
6	Omaha Public Power District	North Omaha	NE	Non-Small State
7	Platte River Power Authority	Rawhide	CO	Non-Small State
8	Salt River Project	Coronado	AZ	Non-Small State
9	Salt River Project	Navajo	AZ	Non-Small State
10	South Carolina Pub Service Auth	Cross	SC	Non-Small State
11	South Carolina Pub Service Auth	Dolphus M Grainger	SC	Non-Small State
12	South Carolina Pub Service Auth	Jefferies	SC	Non-Small State
13	South Carolina Pub Service Auth	Winyah	SC	Non-Small State
14	American Municipal Power-Ohio, Inc	Richard Gorsuch	OH	Non-Small City
15	Ames City of	Ames Electric Services Power Plant	IA	Non-Small City
16	City of Columbia	Columbia	MO	Non-Small City
17	City of Hamilton	Hamilton	OH	Non-Small City
18	City of Lakeland	C D McIntosh Jr	FL	Non-Small City
19	City of Owensboro	Elmer Smith	KY	Non-Small City
20	City of Springfield	Dallman	IL	Non-Small City
21	City of Springfield	Lakeside	IL	Non-Small City
22	City Utilities of Springfield	James River Power Station	MO	Non-Small City
23	City Utilities of Springfield	Southwest Power Station	MO	Non-Small City
24	Colorado Springs City of	Martin Drake	CO	Non-Small City
25	Colorado Springs City of	Ray D Nixon	CO	Non-Small City
26	Gainesville Regional Utilities	Deerhaven Generating Station	FL	Non-Small City
27	Independence City of	Blue Valley	MO	Non-Small City
28	Independence City of	Missouri City	MO	Non-Small City
29	JEA	Northside Generating Station	FL	Non-Small City
30	JEA	St Johns River Power Park	FL	Non-Small City
31	Kansas City City of	Nearman Creek	KS	Non-Small City
32	Kansas City City of	Quindaro	KS	Non-Small City
33	Lansing Board of Water and Light	Eckert Station	MI	Non-Small City
34	Lansing Board of Water and Light	Erickson Station	MI	Non-Small City
35	Los Angeles City of	Intermountain Power Project	UT	Non-Small City
36	Orlando Utilities Comm	Stanton Energy Center	FL	Non-Small City
37	Rochester Public Utilities	Silver Lake	MN	Non-Small City

Exhibit 7M **List of 74 Coal-Fired Electric Utility Generation Plants Which EPA Estimates Are Owned by 60 State/Local Governments** Source: Compiled by EPA-OSWER-ORCR based on 2007 data from the US Energy Information Administration*				
Item	Owner Entity Name	Electric Utility Plant Name	State	Owner Entity Size/Type**
38	San Antonio City of	J K Spruce	TX	Non-Small City
39	San Antonio City of	J T Deely	TX	Non-Small City
40	Vineland City of	Howard Down	NJ	Non-Small City
41	Crisp County Power Comm	Crisp Plant	GA	Small - County
42	Austin City of	Austin Northeast	MN	Small City
43	Board of Water Electric & Communications	Muscatine Plant #1	IA	Small City
44	Cedar Falls Utilities	Streeter Station	IA	Small City
45	City of Dover	Dover	OH	Small City
46	City of Grand Haven	J B Sims	MI	Small City
47	City of Holland	James De Young	MI	Small City
48	City of Jasper	Jasper 2	IN	Small City
49	City of Logansport	Logansport	IN	Small City
50	City of Marquette	Shiras	MI	Small City
51	City of Marshall	Marshall	MO	Small City
52	City of Menasha	Menasha	WI	Small City
53	City of Orrville	Orrville	OH	Small City
54	City of Painesville	Painesville	OH	Small City
55	City of Richmond	Whitewater Valley	IN	Small City
56	City of Shelby	Shelby Municipal Light Plant	OH	Small City
57	City of Sikeston	Sikeston Power Station	MO	Small City
58	City of Virginia	Virginia	MN	Small City
59	Crawfordsville Electric Light & Power	Crawfordsville	IN	Small City
60	Fremont City of	Lon Wright	NE	Small City
61	Grand Island City of	Platte	NE	Small City
62	Greenwood Utilities Commission	Henderson	MS	Small City
63	Hastings City of	Whelan Energy Center	NE	Small City
64	Henderson City Utility Commission	Henderson I	KY	Small City
65	Hibbing Public Utilities Commission	Hibbing	MN	Small City
66	Jamestown Board of Public Utilities	S A Carlson	NY	Small City
67	Manitowoc Public Utilities	Manitowoc	WI	Small City
68	Michigan South Central Power Agency	Endicott Station	MI	Small City
69	New Ulm Public Utilities Commission	New Ulm	MN	Small City
70	Pella City of	Pella	IA	Small City
71	Peru City of	Peru	IN	Small City
72	Texas Municipal Power Agency	Gibbons Creek	TX	Small City
73	Willmar Municipal Utils Commission	Willmar	MN	Small City
74	Wyandotte Municipal Service Commission	Wyandotte	MI	Small City

Exhibit 7M (Continued)
List of 74 Coal-Fired Electric Utility Generation Plants Which EPA Estimates Are Owned by 60 State/Local Governments
Source: Compiled by EPA-OSWER-ORCR based on 2007 data from the US Energy Information Administration*

Footnotes:
* NAICS code 22 electric "utility" generator plants listed in EIA's 2007 data source at:
http://www.eia.doe.gov/cneaf/electricity/page/eia860.html
**Type of owner entity assigned by EPA ORCR based on business type disclosed in owner name or plant-by-plant internet research on type of ownership. Size class determined according to the following numerical criteria consistent with EPA's Nov 2006 guidance for Regulatory Flexibility Act (RFA) Small Business Regulatory Enforcement Fairness Act (SBREFA) compliance:

- Small non-government = Based on the US Small Business Administration NAICS code 221112 small business size standard of <4 million megawatt hours per year total annual electricity generation by all plants owned by the entity.
- Non-small non-government = Entity's total annual electricity generation >4 million megawatt hours per year.
- Small government = Based on the RFA's definition (5 US Code section 601(5)) of "small government jurisdiction" as the government of a city, county, town, township, village, school district, or special district with a population less than 50,000.
- Non-small government = Entity's jurisdiction population with more than 50,000 people.