Response to Peer Review Comments:
CERCLA 108(b) Financial Responsibility Formula for Hardrock Mining Facilities Background Document

Draft

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U.S. Environmental Protection Agency
Office of Land and Emergency Management
Office of Resource Conservation and Recovery

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List of Abbreviations and Acronyms

AAETE	Average absolute external transfer error
ARD	Acid Rock Drainage
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOI	Department of Interior
ENR	Engineering News Record
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
GPM	Gallons per minute
FR	Financial Responsibility
HMF	Hardrock Mining Facility
MAPE	Mean absolute transfer error
MSHA	U.S. Mine Safety and Health Administration
NRD	Natural Resource Damages
O&M	Operation and Maintenance
QA/QC	Quality assurance/quality control
ROD	Record of Decision
U.S.	United States
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

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1. Introduction and Background

The Agency contracted with MDB, Inc. to conduct a blind, external, letter peer review of the draft *CERCLA 108(b) Financial Responsibility Formula for Hardrock Mining Facilities Background Document* (or background document). A peer review is a process for enhancing a scientific or technical work product so that the decision or position taken by the Agency based on that product has a sound, credible basis. This document provides draft responses to peer review comments received on the formula background document. Although the identities of the peer reviewers were masked during the peer review process, there were four peer reviewers with the following experience:

- Dr. Anna Alberini, Professor, Department of Agricultural and Resource Economics, University of Maryland, College Park;
- Dr. Graham Davis, William J. Coulter Professor of Mineral Economics, Division of Economics and Business, Colorado School of Mines;
- Dr. Lucija Muehlenbachs, Assistant Professor of Economics, Department of Economics, University of Calgary; and
- Dr. Hilary Sigman, Professor of Economics, Department of Economics, Rutgers University.

The peer reviewers above are referred to as commenters one through four in this response to peer review comments document. These numerical designations do not correspond to the order of the above list. The comments were submitted by reviewers without names, as the comments received from the contractor masked the reviewer identities.

EPA has established a docket for this action (Docket ID No. EPA-HQ-SFUND-2015-0781). All documents in the docket are listed on www.regulations.gov. Although all portions of the peer reviewers' comments have been included in this response to comments document, the public can also view the peer reviewers' comments, Agency charge questions, and other related materials as part of "Hardrock Mining Peer Review – Combined Documents" on the docket Web site. The docket is located at the EPA Docket Center, Public Reading Room, EPA West Building, 1301 Constitution Avenue, NW, Washington, D.C.

Background Document peer reviewers responded to six charge questions. EPA identified five comment themes spread across various charge questions. To best address the specific themes raised by commenters, EPA has rearranged these comments (while maintaining all text) into five themes. These themes are:

- **Data Collection** – these comments presented issues relating to the representativeness of the data collected, the accuracy of the primary data both before and after collection, and suggestions for additional data sources or data categories.

- **Response Component Analysis** – these comments presented issues relating to the use of CERCLA cost data, the transformations of the input variables, the presence of influential points, the regression process and the robustness of the results.
- **Natural Resource Damages (NRD) Component Analysis** – these comments presented issues relating to the NRD data and estimation methodology.
- **Formula Adjustments and Use** – these comments presented issues relating to the use of the formula such as the application of a source control assumption, state and regional differences, adjustments over time, and suggestions for additional adjustments.
- **Comments Related to the Documentation and Miscellaneous Comments** – these comments presented issues relating to the transparency of the text, grammar and presentation, overall impressions of the formula, and a number of miscellaneous comments.

The remaining sections of this document present each comment theme and issues raised by commenters. First, the comments are summarized, then full comment excerpts are provided by peer reviewer, and finally the Agency's draft response is presented. A final, revised response to peer review comments document will be placed in the docket supporting the final rule after considering all public comments.

2. Data Collection

The peer review comments relating to data collection are grouped into four subcategories:

- Sample representativeness
- Data quality assurance/quality control (QA/QC)
- Accuracy of underlying estimates
- Additional data sources.

2.1. Sample Representativeness

Comment Summary

Commenter 4 expressed concern that the sample is not representative as there is no cost data for many industrial minerals to be regulated (such as phosphate, barite, potash, boron, etc). Since the extraction and processing of industrial minerals has different environmental effects than the extraction and processing of metals, Commenter 4 encouraged EPA conduct analysis to determine if the Formula would perform better with separate categorizations for industrial minerals and metals. Commenter 4 expressed approval of the geographic representativeness of the sample.

Commenter 4

> I am generally happy with the geographic representativeness of the sample. I am concerned that there is no cost data for all but one of the industrial minerals that will be regulated (phosphate, barite, potash, phosphate, boron, zirconium, antimony, bauxite, Brucite, lithium, titanium, vermiculite, chromite, fluorspar, and magnesium). This group makes up 15% of the Full Universe according to Table 3-4. Generally the extraction and processing of industrial minerals has very different environmental effects from the extraction and processing of metals. Likewise, rare earths and uranium are different due to radioactivity. I have trouble with the EPA's methodology not having separate formulas for industrial minerals, and for radioactive rare earths and uranium. Or, at a minimum, I would like to see some data analysis that looks at the performance of the Formula for these mineral categorizations to identify whether it systematically underestimates or overestimates costs for these groups. The latter task will involve additional data collection for industrial minerals response costs since there is only two industrial minerals producers, both mining phosphates, in the sample.
>
> Section 3 devotes itself to estimating the response costs based on closure and remediation plans at 63 HMFs that are representative of HMFs likely to be impacted by the rule. Cost data more than 10 years old were not collected. EPA claims to have prioritized data collection such that the HMFs identified would be

> representative of the HMFs ultimately regulated. Tables 3-3 and 3-4 compare the full universe of 354 HMFs likely to be regulated with the 63 HMFs selected for data collection. In addition, three CERCLA facilities were used for water treatment cost data.
>
> Section 3.3 outlines the data collection exercise. Here EPA used actual engineering plans and cost estimates as presented by the operating company. This is an excellent approach, as it includes incredible cost detail. The raw summary cost data for each activity is presented in Appendix G.
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> […]
>
> I have included several suggestions in my comments above, all of which I believe are manageable in the near term. I have suggested above that more data is needed on response costs for industrial minerals facilities, and that these facilities may need their own formula. I am hoping that this can be done prior to the release of the Formula.
>
> […]
>
> For the longer term, more data is needed on slag piles, in-situ leaching that is not uranium, and water flows that are not based on CERCLA facility data.

EPA Response

Since the full universe of 354 potentially regulated facilities was initially developed, EPA has performed additional analysis to determine which facilities may be excluded by the rule. The rule proposes to exclude mines conducting only placer mining activities, mines conducting only exploration activities, mines of less than five acres of disturbance, and processors with less than five acres of disposal. EPA now believes that only 221 facilities may be subject to the rule. This universe and the specific facilities excluded are presented in Appendix A of the proposed rule regulatory impact analysis.

Considering this additional analysis, four of the 11 industrial mineral categories mentioned by the commenter may not be subject to the proposed rule. These are barite, chromite, fluorspar, and vermiculite which initially comprised 13 of the 354 facilities. A fourteenth industrial mineral facility (one of seven potash facilities) was also excluded in this analysis. The remaining industrial mineral facilities which EPA believes are subject to the rule include phosphate (13), potash (6), boron (4), brucite (2), lithium (2), titanium (2), and magnesium (1).

The commenter acknowledges that EPA has collected cost data from phosphate facilities, a group which makes up nearly half of this industrial mineral category. Thus, EPA believes that the most significant mineral has been represented. Nevertheless, EPA agrees that additional data on industrial mineral hardrock mining facilities could improve the analysis. Similarly, EPA agrees that additional data to represent slag piles, in-situ leaching, and water flows could improve the analysis as subsequently recommended by this commenter. While additional data cannot be collected prior to the December 1 court ordered deadline, EPA is soliciting comment on such data in the proposed rule preamble and will incorporate such data to the extent feasible in the final background document.

Furthermore, EPA has recalculated and replotted the cumulative distributions from Tables 3-3 and 3-4 and Figures 3-2 and 3-3 of the background document to show that the sample of 63 facilities is still representative of the major states and commodities potentially subject to the proposed rule. Particularly, EPA has captured multiple facilities in the most common states and commodities.

Table 2.1a – Regulated Universe and Data Collection Sample by State

#	State	Regulated Universe			Data Collection Sample		
		#	%	Total %	#	%	Total %
1	NV	45	20.4%	20.4%	17	27.0%	27.0%
2	AZ	21	9.5%	29.9%	9	14.3%	41.3%
3	MN	14	6.3%	36.2%	5	7.9%	49.2%
4	UT	13	5.9%	42.1%	1	1.6%	50.8%
5	CA	12	5.4%	47.5%	3	4.8%	55.6%
6	ID	9	4.1%	51.6%	4	6.3%	61.9%
7	MT	8	3.6%	55.2%	3	4.8%	66.7%
8	MO	7	3.2%	58.4%	0	0.0%	66.7%
9	FL	7	3.2%	61.5%	0	0.0%	66.7%
10	TN	7	3.2%	64.7%	0	0.0%	66.7%
11	AK	6	2.7%	67.4%	9	14.3%	81.0%
12	NM	6	2.7%	70.1%	4	6.3%	87.3%
13	TX	6	2.7%	72.9%	0	0.0%	87.3%
14	MI	5	2.3%	75.1%	0	0.0%	87.3%
15	WA	5	2.3%	77.4%	0	0.0%	87.3%
16	CO	4	1.8%	79.2%	3	4.8%	92.1%
17	WY	4	1.8%	81.0%	3	4.8%	96.8%
18	IN	4	1.8%	82.8%	0	0.0%	96.8%
19	NC	4	1.8%	84.6%	0	0.0%	96.8%
20	NY	4	1.8%	86.4%	0	0.0%	96.8%
21	KY	3	1.4%	87.8%	0	0.0%	96.8%
22	SC	3	1.4%	89.1%	1	1.6%	98.4%
23	LA	3	1.4%	90.5%	0	0.0%	98.4%
24	OH	3	1.4%	91.9%	0	0.0%	98.4%
25	OR	2	0.9%	92.8%	0	0.0%	98.4%
26	GA	2	0.9%	93.7%	0	0.0%	98.4%
27	PA	2	0.9%	94.6%	0	0.0%	98.4%
28	AR	2	0.9%	95.5%	0	0.0%	98.4%
29	IL	2	0.9%	96.4%	0	0.0%	98.4%
30	SD	1	0.5%	96.8%	0	0.0%	98.4%
31	VA	1	0.5%	97.3%	0	0.0%	98.4%

#	State	Regulated Universe			Data Collection Sample		
		#	%	Total %	#	%	Total %
32	AL	1	0.5%	97.7%	0	0.0%	98.4%
33	MS	1	0.5%	98.2%	0	0.0%	98.4%
34	NE	1	0.5%	98.6%	0	0.0%	98.4%
35	OK	1	0.5%	99.1%	0	0.0%	98.4%
36	RI	1	0.5%	99.5%	0	0.0%	98.4%
37	UT/WY	1	0.5%	100.0%	1	1.6%	100.0%
All States		**221**	**100.0%**	**100.0%**	**63**	**100.0%**	**100.0%**

Figure 2.1a – Cumulative Distribution by State in Regulated Universe vs. Data Collection Sample

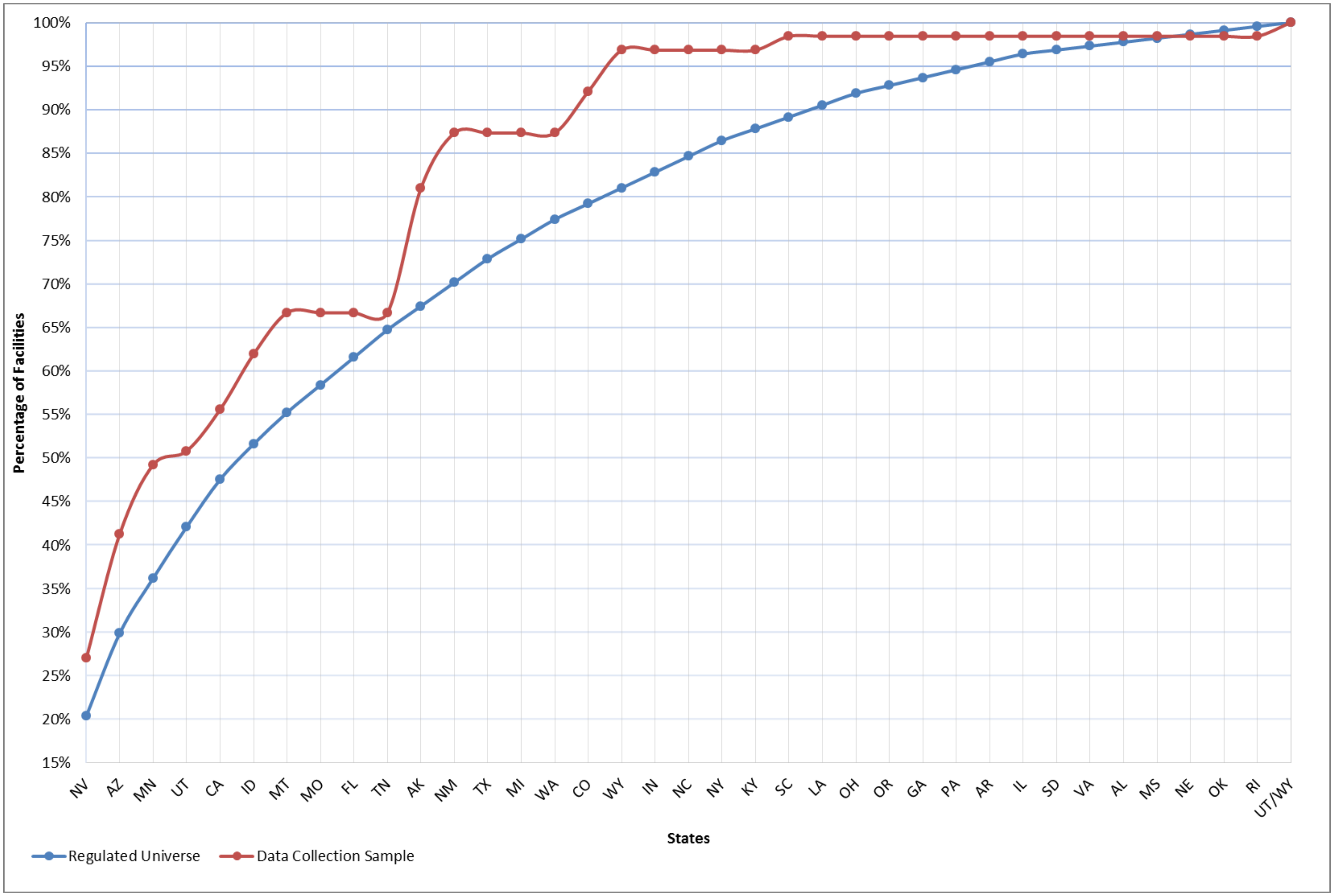
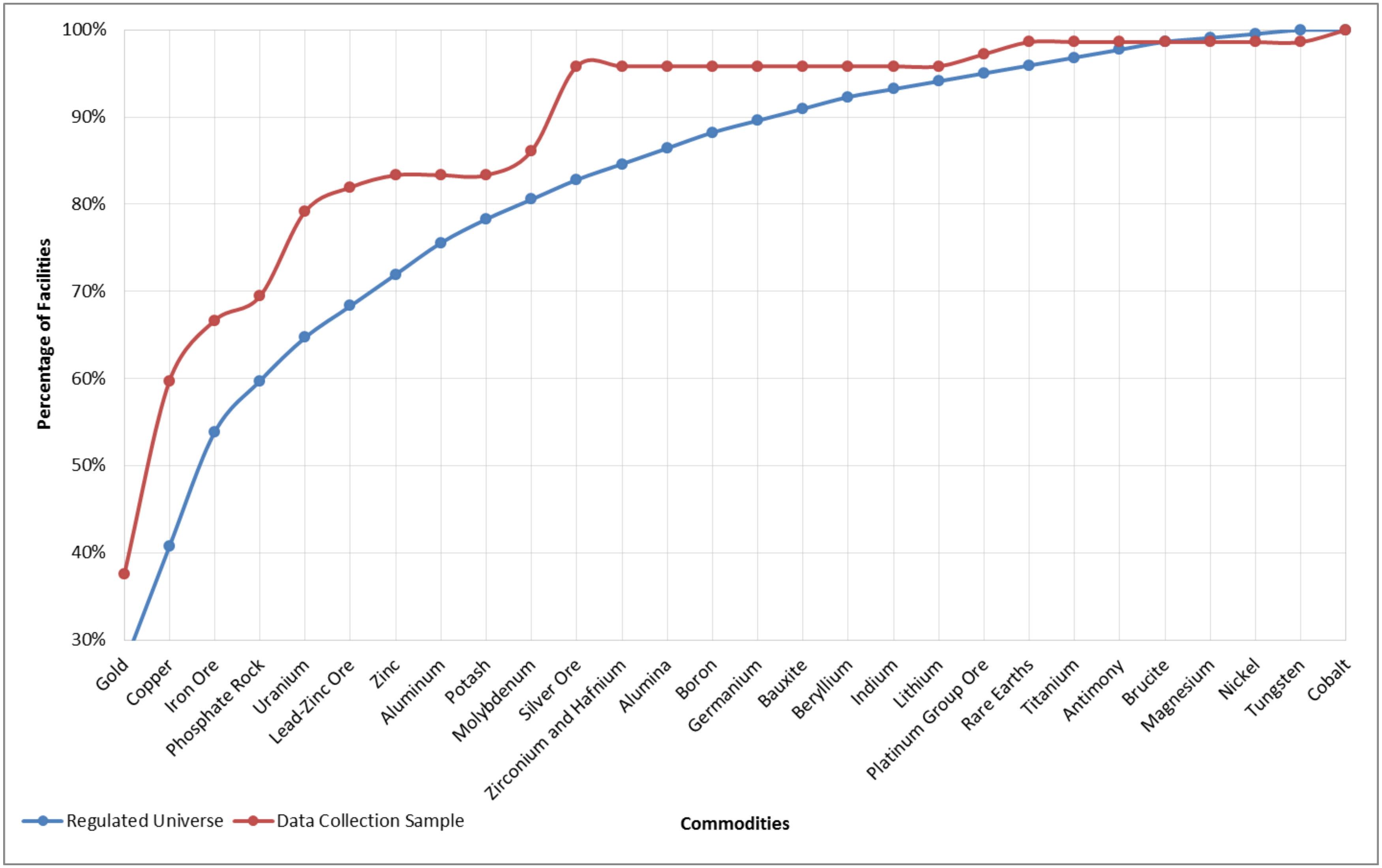


Table 2.1b – Regulated Universe and Data Collection Sample by Commodities Handled

#	Commodity	Full Universe			Data Collection Sample		
		Count	%	Total %	Count	%	Total %
1	Gold	60	27.1%	27.1%	27	37.5%	37.5%
2	Copper	30	13.6%	40.7%	16	22.2%	59.7%
3	Iron Ore	29	13.1%	53.8%	5	6.9%	66.7%
4	Phosphate Rock	13	5.9%	59.7%	2	2.8%	69.4%
5	Uranium	11	5.0%	64.7%	7	9.7%	79.2%
6	Lead-Zinc Ore	8	3.6%	68.3%	2	2.8%	81.9%
7	Zinc	8	3.6%	71.9%	1	1.4%	83.3%
8	Aluminum	8	3.6%	75.6%	0	0.0%	83.3%
9	Potash	6	2.7%	78.3%	0	0.0%	83.3%
10	Molybdenum	5	2.3%	80.5%	2	2.8%	86.1%
11	Silver Ore	5	2.3%	82.8%	7	9.7%	95.8%
12	Zirconium and Hafnium	4	1.8%	84.6%	0	0.0%	95.8%
13	Alumina	4	1.8%	86.4%	0	0.0%	95.8%
14	Boron	4	1.8%	88.2%	0	0.0%	95.8%
15	Germanium	3	1.4%	89.6%	0	0.0%	95.8%
16	Bauxite	3	1.4%	91.0%	0	0.0%	95.8%
17	Beryllium	3	1.4%	92.3%	0	0.0%	95.8%
18	Indium	2	0.9%	93.2%	0	0.0%	95.8%
19	Lithium	2	0.9%	94.1%	0	0.0%	95.8%
20	Platinum Group Ore	2	0.9%	95.0%	1	1.4%	97.2%
21	Rare Earths	2	0.9%	95.9%	1	1.4%	98.6%
22	Titanium	2	0.9%	96.8%	0	0.0%	98.6%
23	Antimony	2	0.9%	97.7%	0	0.0%	98.6%
24	Brucite	2	0.9%	98.6%	0	0.0%	98.6%
25	Magnesium	1	0.5%	99.1%	0	0.0%	98.6%
26	Nickel	1	0.5%	99.5%	0	0.0%	98.6%
27	Tungsten	1	0.5%	100.0%	0	0.0%	98.6%
32	Cobalt	0	0.0%	100.0%	1	1.4%	100.0%
All Commodities		**221**	**100.0%**	**100.0%**	**72**	**100.0%**	**100.0%**

NOTE: The data collection sample commodities do not total 63, the number of sites for which EPA collected data, because some sites mined or processed more than one commodity. For the regulated universe of 221 sites, the data showed just one primary commodity per site.

Figure 2.1b – Cumulative Distribution by Commodity of Regulated Universe vs. Data Collection Sample



With respect to testing the formula on additional industrial mineral facilities, EPA had engineering cost estimates for an additional three phosphate processors that were not used because those estimates were enforcement confidential. As a result of this comment, EPA tested these facilities in the model as out of sample data points and noticed that costs were underpredicted. Upon detailed examination, the agency realized that the discrepancy was due almost entirely to differences in the water treatment costs. Phosphate processors often use more expensive water treatment options such as reverse osmosis due to the unique characteristics of leachate from the phosphogypsum stacks (Bossler et al, 2009). As a result, EPA will solicit comment in the proposed rule preamble on expanding the water treatment variable currently named InSituLeach to capture additional facilities that would necessarily need more advanced water treatment due to the nature of their leachate.

2.2. Data QA/QC

Comment Summary

Commenter 4 expressed concern about the procedure used to collect cost and acreage data from the reclamation and closure plans. Commenter 4 suspects there are errors that result from a misunderstanding of the information in the original source documents and argued that EPA should redo the data collection using mining industry specialists.

Commenter 4

> While the source documents are excellent, I have grave concerns about the integrity of the data as collected. In preparing for my review I randomly sampled four source documents from which the data in Appendix G was allegedly taken (Rosemont Reclamation and Closure Plan 2007, Phoenix Mine Reclamation Permit 0223 2011, Pinto Valley Operations Closure and Post-Closure Strategy 2013, and Cripple Creek & Victor Gold Mining Company Reclamation Cost Model to Support Mine Life Extension Project 2 (MLE2) DRMS Warranty Version 2014). Using those source documents I attempted to do some spot checking of the data in Appendix G. Of the sampling I did I could not replicate a single cost number in the Appendix, and in some cases could not replicate the acreages. I tested to see whether I could reproduce the cost data under the assumption that it the data as presented in Appendix G was pre-conditioned per Equations 3-1 and 3-2. I could not. This is highly troubling given the assurance that “Reviewers independently replicated the data entry process using the original source documents…” (p. 3-17).
>
> Let me provide examples of my replication failures. At Pinto Valley, according to the source document, there are 3 tailings impoundments. The acreage of each, based on revegetation requirements, is 385, 363, and 965. Adding these gives 1,713 acres.

Table G.4 lists Pinto Valley as having 1,586 acres of tailings. I cannot find that number anywhere in the Pinto Valley document. Table G.4 lists the costs of tailings reclamation at Pinto Valley as \$74,854,056. This is greater than the total estimated closure cost of \$66,964,028 million as reported in the source document. In the source document the tailings reclamation costs add up to some \$28 million, not \$75 million.

I am astounded that the independent reviewers did not find these errors. A simple inspection of the Pinto Valley data in Appendix G compared with the data from other facilities leads me to believe that its response costs are some 10 times what they should be. If I am mistaken and the data in Appendix G is correct then the methods by which EPA preconditioned the primary source data should be made clear.

I am also not confident that those collecting the primary data from the source documents correctly understood the information in the documents or mine reclamation in general. Consider the Rosemont reclamation plan. On page 46 of the source document we see that the Rosemont pit will be 135 acres and upon closure will require the construction of a safety berm and some soil amendments and seeding. On page 52 we see that these costs total \$70,600 in direct costs and \$19,600 in indirect costs. Because of Rosemont's location next to the highway and because of the local opposition to the project there will also be a massive perimeter berm, constructed out of waste rock, to shield the workings from public view. That berm, which is unusual and specific to this particular mining facility, will be 402 acres and will cost \$1,673,000 in direct costs to regrade and seed, for a total cost of \$2,138,000 including indirect costs. It is not part of the open pit. It is more like a waste rock dump that needs contouring and revegetation. Table G.1 lists the open pit acreage at Rosemont as 402, which is the acreage of the berm, not the correct number of 135, which is the acreage of the pit. It lists the response cost associated with these 402 acres of berm as \$2,235,771. I do not know where this number comes from. The difference from \$1,673,000 cannot be preconditioning, as if I use Equation 3-1 to bring these 2007 direct costs up to 2014 I get \$1,673,000 x 9,806/7,966 = \$2,059,432, which after adjusting for Equation 3-2 gives \$2,059,432/0.96 = \$2,145,242. In any event, the correct data point here should be an open pit size of 135 acres and a direct response cost of \$70,600. If anything the 402 acre special berm should have been aggregated into the waste rock cost calculations.

Phoenix Historic heap leach treatment is also incorrectly interpreted. The heap leach is 472 acres and will undergo contouring, evapotranspiration covering (ET covering), and revegetation. The covering should be coded as source control. Page

> 14 of the source document lists costs for this of $3.6 million, which is approximately what is reported in Table G.3 but that table does not allocate some of this into source control. It should. Phoenix Historic also covers its tailings, and yet there is no demarcation for source control costs for Phoenix Historic in Table G.4. Table G.2 does correctly list source controls for waste dumps at Phoenix Historic. On page 26 of the source document we also see that the Phoenix Historic heap leach pad will be neutralized prior to coverage, at a cost of $8 million. Then there will be interim fluid management at the heap ($500,000) and at the wet tailings facility ($400,000), process fluid stabilization at the heap ($5 million) and the wet tailings facility ($11 million), and solution evaporation at the heap ($300,000) and the wet tailings facility ($8 million). These would all appear to be interim O&M expenditures. Table G.11 lists $9 million in Interim O&M for Phoenix Historic, which is not what these costs add up to.
>
> Please note that I have not checked every data entry in Appendix G for the four facilities I sampled. I am relating here my experiences from some spot checks. These checks should be enough to show that the original data collection and entry process is not reliable and that the subsequent review and replication exercise that is noted in the report was ineffective.
>
> […]
>
> And, as I noted above, I have little confidence that those who read the source documents in Appendix G and transferred the data from the source documents into the data file understood what they were reading. I would recommend that EPA redo this data collection exercise using mining industry interns or specialists who know how to read and interpret a mine reclamation and closure plan.

EPA Response

Commenter 4 believed several points to be inaccurate, and recommended that EPA utilize mining experts to review the data. In response to these comments generally, data collection was performed by a mining industry specialist, verified by reviewers as discussed in Section 3.3 of the background document, and spot-checked by EPA regional mining experts for accuracy. The individual discrepancies pointed out by the commenter are addressed below.

With respect to Pinto Valley, the reviewer found that the total acreage of the tailings facility was 1,713 acres and costs related to reclamation costs at the facility totaled $29,006,736. Appendix G gives the acreage of the tailings facility as 1,586 acres and reclamation costs of $74,854,056. The issue was the result of a citation error. The discrepancies occurred because the acreage and costs from the 2012 Reclamation and Closure Plan were listed in Appendix G, but with the 2013 Closure, Post-Closure Strategy document as the source. The 2012 and 2013 data are presented alongside each other in **Table 2.2a** below. The citation for Pinto Valley will be corrected in the final background document to the 2012 Reclamation and Closure Plan. However, the Agency will also solicit comment in the proposed rule preamble as to whether and why the 2013 document should be considered.

Table 2.2a – Tailings Data from 2012 and 2013 Pinto Valley Documents

	2012 Reclamation and Closure Plan (pp 7/29)	2013 Closure, Post-Closure Strategy (pps 23-24/24)
Total Acreage	**1,586**	**1,713**
Total Tailings Cost	**$68,210,473**	**$29,006,736**
ENR Inflation Factor	1.05	1.03
1/(USACE State Factor)	1.04	1.04
Adjusted Total Cost	**$74,485,837**	**$31,073,016**

With respect to Rosemont, this facility presented a somewhat unique scenario in that waste rock was being used to develop a very large berm around the open pit. However, the issue of waste rock and/or tailings being placed in another site feature was not unique to this facility. When EPA was initially developing its dataset, there were several facilities engaging in backfilling, codisposal, and other forms of mixed placement. In each case, EPA sought to best represent the intent of the regressions, which was to tie the acreage and other variables of a specific site feature to the engineering costs of that feature. Since a facility engaging in construction of a berm or backfilling could do so with waste rock or simple dirt from a borrow area with similar costs, EPA placed these costs on the site feature being reclaimed, and is relying on reduction criteria in the proposed rule to account for the cost reductions resulting from the decreased costs for the waste rock. Unlike the other facilities for which EPA made this determination, the commenter correctly points out that Rosemont is quite unique in its construction of a 402-acre berm of waste rock at its 135-acre open pit. Had the facility merely backfilled its open pit, that acreage and cost would be appropriate to include in the open pit regression. However, EPA realizes that given the unique actions called for here, this acreage and cost should have been combined with that of the remaining waste rock pile for the waste rock regression. Thus EPA agrees that the open pit data point should be limited to the adjusted $70,600 cost and 135 acres specific to that feature.

EPA will make this data change in the final background document, and has presented the data changes in a revised version of Appendix G attached to this response to comments document as **Attachment B**. EPA will also solicit comment in its proposed rule preamble on additional data points that may be more appropriately apportioned to other site features. In addition, EPA will rerun the open pit and waste rock regressions for the final background document. The revised regressions and smear factors for the open pit and waste rock regressions are presented below, and full summary statistics are provided in an attachment to this response to comments document. As can be seen in these revised regression results, the influence of reapportioning the Rosemont cost and acreage data was negligible.

$$OpenPit = 2.88 + 1.07 \times LogAcres_{OpenPit} + 1.39 \times SourceControl_{OpenPit}$$

$$WasteRock = 4.44 + 0.76 \times LogAcres_{WasteRock} + 0.72 \times SourceControl_{WasteRock}$$

Smear Factors = 5.38 (*OpenPit*), 1.84 (*WasteRock*)

With respect to Phoenix Historic, the reviewer raised three issues with both the heap leach and interim O&M data that Appendix G of the background document provided. First, the reviewer noted that page 14 of the 2011 Phoenix Reclamation Cost Estimate gives the total cost of reclamation activities related to the heap leach as $3.6 million. However, EPA went back to that document and confirmed that the 2011 Phoenix Mine Reclamation Permit's Cost Summary, p. 25/182, lists a $2,966,962 cost for earthwork/recontouring the heap, and a $383,707 cost for revegetating the heap. Those costs total $3,350,669. The specific worksheet that summarizes reclamation cost for the heap also gives total costs strictly related to earthwork and revegetation as $3,350,669. See p. 60-61/182. In the initial spreadsheets used to generate Appendix G, EPA used $3,350,676 due to rounding error, and will adjust this number to the correct value for the final background document.

With the application of *ENR*'s inflation adjustment and the USACE state-specific adjustments, the $2014 cost is $3,365,412. To improve transparency, EPA will update Appendix G of the final background document to present the ENR and USACE adjustments used for each data point, and has attached this revised appendix to this response to comments document as **Attachment B**.

Table 2.2b – Phoenix Historic Heap Leach and Interim O&M Costs

	2011 Reclamation and Closure Plan (pps. 25, 61-62/182)
Acreage	**472**
Earthwork & Revegetation	**$3,350,669**
ENR Inflation Factor	1.08
1/(USACE State Factor)	0.93
Adjusted Total Cost	**$3,365,412**

Second, the reviewer believed some of the cost of the heap should be allocated as a source control, since the cost covered the construction of an evapotranspiration cover. EPA restricted the imputation of source controls to engineering activities with reliable performance standards. These included synthetic covers, liners, and amendments that would reduce the amount of precipitation resulting in contact water requiring treatment by 95% or more. The performance of evapotranspiration covers, by contrast, varied too much for EPA to reliably allocate the costs of such covers to the source control category. Thus, in the case of Phoenix Historic, Appendix G does not allocate any of the heap leach capital costs to source controls. This definition for source controls, and the application thereof, will be further clarified in the final background document.

Third, the reviewer noted that the interim O&M costs as provided in the source document added up to far more than the $9,161,727 listed in Appendix G for interim O&M. However, Appendix G presents an annualized cost rather than a net present value. EPA confirmed its estimate by first recounting all of the individual costs on pages 81/182 through 93/182 of the source document. The total listed in Appendix G is the sum of the annualized Interim (Emergency) O&M cost, the annualized Process Fluid Stabilization (PFS) cost for the tailings, and the annualized PFS cost for the heap leach all using a 2.63 percent discount rate. See **Tables 2.2c, d,** and **e** below, for a summary of the heap leach and interim O&M costs.

Table 2.2c – Phoenix Historic Heap Leach Interim O&M Costs

	Timeframe (Years)	Appendix G
Heap Neutralization	0	$7,957,508
Heap PFS - Phase 1	0-3	$2,240,992
Heap PFS - Phase 2	4-6	$2,739,277
Heap PFS - Phase 3	7	$107,651
Heap Solution Disposal	8	$320,625
ARD Transportation (yr 10)	10	$2,722,803
Annualized Heap PFS	**N/A**	**$2,942,365**

Table 2.2d – Phoenix Historic Tailings Interim O&M Costs

	Timeframe (Years)	Appendix G
Tailings PFS Cost - Phase 1	0-2	$2,400,936
Tailings PFS Cost - Phase 2	3-13	$5,945,503
Tailings PFS Cost - Phase 3	14-29	$2,940,312
Tailings Solution Disposal	30	$8,382,575
Annualized Tailings PFS	**N/A**	**$4,324,220**

Table 2.2e – Phoenix Historic Emergency Interim O&M Costs

	Timeframe (Years)	Appendix G
Emergency O&M Cost	0.5	$948,831
Annualized Emergency O&M	**N/A**	**$1,885,426**

As seen in **Table 2.2f** below, adding those annualized values together, and then applying the *ENR*'s inflation adjustment and the U.S. Army Corps' state-specific adjustments, the $2014 cost is $9,161,728. Thus, Appendix G correctly allocates all of the above-listed costs to interim O&M, but presents an annualized cost rather than the sum of all of the expected costs.

Table 2.2f – Phoenix Historic Total Interim O&M Costs

	Appendix G
Interim O&M (Sum of Annualized Costs)	**$9,152,011**
ENR Inflation Factor	1.08
State Factor	0.93
Adjusted Interim O&M	**$9,161,728**

Note that the length of time required for each interim O&M and process fluid stabilization task used to calculate annualized values is given in the 2011 Reclamation Permit. See **Table 2.2g**, below, for a year-by-year summary of the interim O&M tasks over a 30-year reclamation period.

Table 2.2g – Year-by-Year Interim O&M Tasks

Year	**Interim O&M Tasks Performed**
0	Emergency O&M+Tailings PFS Phase 1+Heap Neutralization+Heap PFS Phase 1
1	Tailings PFS Phase 1+Heap PFS Phase 1
2	Tailings PFS Phase 1+Heap PFS Phase 1
3	Tailings PFS Phase 2+Heap PFS Phase 1
4	Tailings PFS Phase 2+Heap PFS Phase 2
5	Tailings PFS Phase 2+Heap PFS Phase 2
6	Tailings PFS Phase 2+Heap PFS Phase 2
7	Tailings PFS Phase 2+Heap PFS Phase 3
8	Tailings PFS Phase 2+Heap Solution Disposal
9	Tailings PFS Phase 2
10	Tailings PFS Phase 2+ARD Transportation
11	Tailings PFS Phase 2
12	Tailings PFS Phase 2
13	Tailings PFS Phase 2
14	Tailings PFS Phase 3
15	Tailings PFS Phase 3
16	Tailings PFS Phase 3
17	Tailings PFS Phase 3
18	Tailings PFS Phase 3

Year	Interim O&M Tasks Performed
19	Tailings PFS Phase 3
20	Tailings PFS Phase 3
21	Tailings PFS Phase 3
22	Tailings PFS Phase 3
23	Tailings PFS Phase 3
24	Tailings PFS Phase 3
25	Tailings PFS Phase 3
26	Tailings PFS Phase 3
27	Tailings PFS Phase 3
28	Tailings PFS Phase 3
29	Tailings PFS Phase 3
30	Tailings Solution Disposal

No additional action was taken to adjust the data heap leach or reclamation and closure data at Phoenix Historic.

With respect to Cresson, the reviewer contends that the rinsing/detoxification costs were listed as relating to heap leach reclamation, rather than correctly allocated to interim O&M. Pages 43-52/70 summarize the reclamation and rinsing/detoxification cost for the heaps. The heap leach reclamation costs are only the result of earthwork and revegetation tasks, and total $83,392,833 (see p. 45/70 - $52,865,123, p. 48/70 - $30,527,710). As seen in **Table 2.2h** below, after the application of *ENR*'s inflation index and the U.S. Army Corps' state-specific adjustments, the $2014 cost shown in Appendix G is $85,971,992.

Table 2.2h – Heap Leach and Interim O&M Data at Cresson

	Appendix G
Heap - Earthwork & Reveg	**$83,392,833**
ENR Inflation	1.00
State Factor	1.03
$2014 Adjusted Heap Cost	**$85,971,993**

The cost above does not include the rinsing/detoxification totals (from p. 43/70 - $31,327,125, and p. 47/70 - $17,774,771; total of $49,101,896). There are no other interim O&M costs that Cresson will incur. As a result, Cresson will experience the $49,101,896 in the year reclamation begins. That figure is then annualized using a 2.63 percent discount rate over the five year expected duration of interim O&M tasks. The annualized cost is $10,336,756. As seen in **Table 2.2i** below, after the application of *ENR*'s inflation index and the U.S. Army Corps' state-specific adjustments, the $2014 annualized cost shown in Appendix G is $10,656,450.

Table 2.2i – Heap Leach and Interim O&M Data at Cresson

	Appendix G
Heap - Rinse and Detox	**$49,101,896**
Duration (Years)	5
Annualized Interim O&M	**$10,336,756**
ENR Inflation Factor	1.00
State Factor	1.03
$2014 Annualized Interim O&M	**$10,656,450**

2.3. Accuracy of Underlying Estimates

Comment Summary

Commenter 2 pointed out that the weak estimated relationships between certain response costs and site characteristics may be due to oversights in states' models used to develop reclamation and closure plans. Commenter 3 pointed out that the estimates in reclamation and closures plans might be kept artificially low by companies in an effort to minimize potential future exposure to liability. Commenter 4 argued that cost estimates by engineers, used to develop the reclamation and closure plans, are often underestimated and suggested EPA consider using an overall upward adjustment for cost bias.

Commenter 2

2. By focusing on engineering cost estimates made by the states, much of EPA's analysis is effectively a reverse-engineering of the states' models and may thus import their oversights. For example, the weak estimated relationship between response costs and hydrologic characteristics of the site (distance to surface water, groundwater level, etc.) may reflect limited attention to these factors in the models.

   […]

   Except for the concern discussed above about the reliance on engineering cost estimates, the data seem appropriate.

Commenter 3

<u>* Data construction:</u>

I fear that the R&C reclamation and closure plans might be kept artificially low by the companies in an effort to minimize potential future exposure to liability or bond payments. I took a quick look at the various R&C costs for selected mining facilities in Colorado (the two molybdenum mines) in one of the Appendices, and they indeed seem low, considering the size of operations.

Commenter 4

> Cost estimates by engineers, the source of the data for the Formula, are often underestimated.[FN] That may also be the case here, since we to date have no fully reclaimed mining facility in the US that was undertaken in situations other than CERCLA management. This exercise may suggest that in addition to the smearing factors an overall upward adjustment for cost bias is necessary (in addition to the overhead and oversight adjustment, which includes contingency).
>
> [FN] There is a large literature on this. I suggest looking at some of Bent Flyvbjerg's work on cost overruns at large infrastructure projects. A recent survey by Ernst & Young found that 69% of mining megaprojects ran over budget by an average of 62%. Unfortunately, the raw data is not publically available and so an average overrun over all projects cannot be calculated. Nevertheless, this provides additional motivation to test the Formula's predictions against historical CERCLA spending to see if actual spends are substantially above the Formula's estimates.

EPA Response

EPA acknowledges the potential for all of the problems identified by the reviewers in the underlying cost estimates. While the estimates may fail to account for some relationships or may be intentionally or unintentionally biased low, these are the best data available to EPA.

EPA has attempted to correct for some of these potential pitfalls through the conservative assumptions of source controls, perpetual water treatment, and perpetual long-term O&M. However, EPA will solicit comment on the use of a 62% upward adjustment factor based on Ernst & Young (2015) referenced by the commenter.

2.4. Additional Cost Data and Cost Categories

Comment Summary

Commenters 1, 2, and 4 were not aware of additional data sources. Commenter 2 thought the choice of features was appropriate but suggested EPA expand the sample or allow greater use of the CERCLA cost data. Commenter 3 suggested EPA check if the Department of Interior Office of Surface Mining Reclamation and Enforcement produces reclamation cost estimates for their abandoned mine program. Commenter 3 also pointed EPA to the Bureau of Land Management Nevada website. Commenter 4 suggested EPA consider open pit backfilling, wetlands restoration, and decontamination as key explanatory variables. Commenter 4 pointed out that EPA has backfilling data and that there might be CERCLA data on wetlands remediation.

Commenter 1

> I am not aware of additional datasets.

Commenter 2

I am not aware of any additional pertinent data sources.

[…]

The choice of features seems appropriate. The inclusion of additional covariates does not seem to be a high priority for additional resources. Sample sizes are small, so the data may not provide enough information to estimate additional relationships precisely. Instead, if additional resources are available, I would recommend they go into expanding the sample or allowing greater use of the CERCLA cost data, as argued above.

Commenter 3

* Additional sources of data:

DoI's Office of Surface Mining: http://www.osmre.gov/index.shtm (details about bonds, permits and mining activities). They cover coal mines, which are not covered by the rule EPA examines in this document, but they too have a reclamation program for abandoned mines, which may be useful for getting reclamation cost estimates, and water and groundwater modeling tools.

BLM Hard Rock Mining

http://www.blm.gov/nv/st/en/prog/minerals/mining.html

Commenter 4

Open pit backfilling and wetlands restoration are facility features that EPA should consider now as key explanatory variables. There is data in the file on backfilling. I don't know if there is data on wetlands remediation, but perhaps CERCLA data could be used for this. Radiation decontamination is something that would be associated with uranium and rare earths extraction, and should be investigated as an additional feature.

[…]

I am not aware of additional nationwide data sources.

EPA Response

EPA agrees that expanding the sample size would improve the analysis. Thus, EPA is soliciting comment for additional cost estimates in the proposed rule preamble.

With respect to the OSMRE and BLM websites suggested, EPA visited these pages but was unable to identify additional, publicly available cost estimates.

With respect to the collection and use of additional data on wetlands restoration, EPA notes that this is already included as part of the NRD component. In particular, after reviewing a sample of NRD settlements and restoration plans in Appendix L of the background document, EPA identified the following examples that included wetland restoration:

- The Coeur d'Alene Basin RP/EA includes $900,000 for "Wetland-Based Restoration Projects" (p. 29)
- The Draft Wildlife and Wildlife Habitat RP/EA for the Chino, Cobre, and Tyrone Mine Facilities states: "Given the injuries to wildlife and wildlife habitat described above, the Trustees and FMI jointly reached a natural resource damage settlement for grasslands and wetlands wildlife resources in the amount of $5.5 million…" (p. 24. Additionally, specific wetland restoration projects are listed on p. 9)
- The Cyprus Tohono Draft Wetland RP/EA Fact Sheet states: "The restoration planning team proposes to use the settlement to create new wetlands and/or enhance existing wetlands to create habitat for migratory birds to compensate the public for the birds injured as a result of the alleged release of hazardous substances. The goal is to enhance or build approximately 20-40 acres of wetland habitat." (p. 1)
- The Final RP for the Cleveland Mill Site includes the Berrenda Creek wetlands project. "This project consists of the partial funding of a U.S. Fish and Wildlife Service Partners for Wildlife project on private land on Berrenda Creek. Money would be used in combination with Partners for Wildlife money to repair a reservoir which, in mm, would create a 40-acre wetland impoundment. In addition to the wildlife benefits of the impoundment, seepage from the reservoir would provide a perennial water supply for riparian habitat downstream for several miles of Berrenda Creek." (p. 9)
- The Commencement Bay RP describes six habitat focus areas (HFAs) which include "The Puyallup River wetlands/corridors" and "Hylebos and Wapato Creeks wetlands/corridors." (p. 7)

With respect to backfilling, see the response in Section 3.4 of this response to comments document.

Finally, with respect to radioactive decontamination, building decontamination is included in the solid and hazardous waste disposal response category of the formula. Perhaps the commenter meant for *radioactive* decontamination specifically to be considered further. However, several rare earth and uranium facilities were included in the solid and hazardous waste disposal dataset evaluated. Thus, no further response is necessary

3. Response Component Analysis

The peer review comments relating to response component analysis are grouped into six subcategories:

- Suggested uses of actual cost data
- Lognormality issues
- Stepwise regression
- Analysis of influential points
- Robustness and reasonableness.

3.1. Suggested Uses of Actual Cost Data

Comment Summary

Commenters 1, 2 and 4 suggested EPA take advantage of the data from historical NPL and Superfund alternative approach sites. Commenter 2 encouraged EPA to regress the realized response costs on site characteristics and compare the estimates with the current approach. Commenter 4 suggested EPA test the results of the Formula with the initial estimates of historical CERCLA expenditures at the NPL and Superfund alternative approach sites. Commenter 1 also suggested EPA take further efforts to describe why engineering cost estimates are representative of actual costs. Commenter 4 also encouraged EPA to account for the likelihood that a facility will be nominated to the NPL or whether or not facilities are already nominated for the NPL as response costs between NPL and Superfund alternative approach sites widely varies.

Commenter 1

> I did not think the data from historical NPL and Superfund-alternative-approach HRM sites are used in the subsequent analysis. (I thought it was the Engineering Cost Estimates that are used in the analysis.) One concern with using Actual Response Cost data from the NPL is that compared to data from currently operating facilities, the facilities on the NPL might be more costly than currently operating facilities to remediate (e.g. you have to be above a threshold in the hazard ranking system). So using NPL sites would result in an overestimate of costs.
>
> On the other hand data, engineering cost estimates often raise concerns--these are only estimates and not actual costs. So perhaps more could be done to show that

these are a good representation of actual costs. In the document there is much time spent demonstrating that the sample with Engineering Cost Estimates is similar to the sample of Currently Operating Facilities. Is there more that could be done to show that the Engineering Cost Estimates are similar to the response costs found in the Actual Response Costs?

Could you also use the Actual Response Costs dataset more? Do these data have variables listing the site characteristics such that they could be used in the final financial responsibility formula? I understand the current method of estimating the cost functions separately and then aggregating. However you could also regress aggregate costs on site characteristics (e.g., acres open pit). The reason listed to use the Engineering Cost Estimates rather than the Actual Response Costs data is that "response costs were in total dollars per site rather than in dollars per category of response activity." The reason should be that these data do not have information on specific characteristics. I don't see why you need dollars per category of response activity if you end up aggregating. You would need characteristics though, and perhaps that is why you moved to the Engineering Cost Estimates. If you have characteristics in the Actual Response Cost data, you could use this dataset and regress total dollars per site on site characteristics. This should let you back out estimates that are similar to your current estimates.

[…]

Documenting all work and datasets demonstrates that formula was very carefully developed, without leaving rocks unturned. However, not all pieces discussed are used for the final formula, which makes things less transparent to a reader. For example, much time is spent discussing the dataset on Actual Response Costs, yet as far as I can tell, these data are not being used for the final formula. It is impressive that you collected all these data, but other than calculating the average response costs for these sites, I don't understand their purpose. It might be that you could use these data more. For example, when looking at the formula, given the logs and powers of 10, it is hard to get an idea of how big the financial responsibility bond will eventually be. After listing the formula, it would be interesting to see what the amount required would be for the average facility. And then this could be compared to the average cost found in the Actual Response Cost dataset.

Similar to the comment above, could the typical costs seen in these data be compared to the final predictions from the financial responsibility formula?

[…]

If you have data on site characteristics in the Actual Response Cost dataset, then you could also predict these costs using the financial responsibility formula.

Commenter 2

A second and longer term methodological recommendation is to take more advantage of the realized response cost information from CERCLA. The engineering cost estimates from state permit documents for active facilities currently serve as the basis for most of the quantitative analysis. Although these engineering cost projections allow the Responsibility Formula to vary with more site features, this disaggregation comes at significant cost. Using the realized response cost would have had several advantages:

Realized response costs would give a better sense of the expected costs in the real world, including contingencies (mistakes, bad luck) that the idealized conditions in the engineering models may miss.

The CERCLA data would provide more observations and thus improve the reliability of the estimates. Some of the response cost categories have very small sample sizes with the current method.

It is difficult to judge whether the gains from EPA's disaggregated approach are worth these costs. For a partial assessment, an analysis could be run on the current data that would mimic the less disaggregated analysis that could be conducted on the realized costs data: sum the engineering costs over facility features to create a total facility response cost and run equations that use only the less detailed explanatory variables available for the CERCLA data (perhaps only total acreage, presence of some contaminants, and hydrologic variables). Then a comparison of these estimates with the current approach (disaggregate-estimate-reaggregate) would indicate how much the multi-step disaggregated approach actually improves the fit. In practice, the improvement may not be that great once all the categories are recombined (especially when some categories vary only with total acreage anyway). This comparison would still not determine whether the engineering estimates are good enough, but would give a sense of the benefits of disaggregation.

Commenter 4

EPA's first step was to attempt to estimate what types of response cost activities might take place at the HMFs regulated by 108(b). They collected data on historical CERCLA expenditures by all parties at 319 NPL and non-NPL cites, from which they estimate the current and future response costs at each of the facilities using one of three formulas presented in Section 2. Appendix B presents the results for each facility, while Table 2-1 presents summary statistics. The average response

> cost was $67 million (2014 dollars). The text notes that the response cost was higher for NPL facilities and much lower for non-NPL facilities.
>
> It is not clear that the results of this first analysis are used anywhere else in the report or in coming up with the Formula or testing the Formula for external validity. One might think, for example, that the Formula should produce response costs in the order of $67 million for the average facility. I have no idea if it does. Moreover, I can find no evidence that the Formula differentiates response costs estimates according to whether or not any of the 354 HMFs that EPA estimates will be subject to the proposed rule, and to which the Formula applies, are more likely than not to be NPL facilities. Or, more precisely, there has been no effort to establish an adjustment to the Formula should a facility already be nominated to be a NPL facility at the time of application of the Formula. Since the difference in response costs between an NPL and non- NPL CERCLA facility is on average $110.7 million - $6.6 million = $104.1 million, this must be addressed.
>
> […]
>
> As I noted above, I did not see that this historical NPL data was used in generating the Formula other than to identify and categorize response activities and to suggest order of magnitude response cost experiences. I would think that some marriage of this data with the Formula data would be useful, particularly in differentiating financial responsibility at facilities that are likely to become NPL facilities. It would also be useful to compare cost estimates for these NPL and non-NPL facilities generated using the Formula with the actual CERCLA spending.
>
> […]
>
> Though EPA will not likely have time to do this, I think it would be very useful to apply the Formula to the 63 facilities in Appendix G and see whether the results match historical CERCLA response costs. I realize that the historical CERCLA response costs may have been directed at specific releases and not total facility restoration. But if EPA suspects that the CERCLA data summarized in Table 2-1 is at all useful for external validity the exercise could be very informative.

EPA Response

The peer review draft of the background document presents EPA’s current approach to estimating the response component of financial responsibility formula. However, prior to its most recent efforts, the Agency also considered approaches using only historical response cost data from NPL and non-NPL CERCLA sites. EPA has included the draft regression work (U.S. EPA, 2011) from this prior effort in the docket for the proposed rule, but is not including it in this response to comments document or incorporating it into the final background document as it does not reflect the Agency's current approach. Though not included in this attachment, EPA ran a regression similar to that suggested by commenter 2 using only total costs and total acreage and did not find total acreage to be a good predictor of costs.

These approaches were ultimately not retained because many explanatory variables used in these regressions are not yet defined at operating mines. For instance, operating mines which have not experienced a release of hazardous substances will not yet know the contaminants of concern, the media affected, or the number of operable units. Furthermore, Small Entity Representatives stated that costs at CERCLA sites in operation prior to current state and federal laws may not be representative of current mining practice. Finally, such regressions will not show the full benefits of disaggregation. As discussed in the preamble of the proposed rule, EPA is soliciting comment on reduction criteria. These criteria are applicable to each individual site feature, and therefore it is possible for a facility to get partial credit. Should EPA go with an aggregated approach, the benefits of partial credit would disappear. Nevertheless, EPA will solicit comment on alternative uses of the CERCLA cost data.

With respect to comparing average CERCLA costs to average financial responsibility amounts estimated by the formula, EPA does not believe this is a relevant comparison. In the case of CERCLA sites, costs were incurred only at the portion of the facility resulting in a CERCLA response. In contrast, the formula conservatively assumes that all portions of a facility could require a CERCLA response tomorrow. EPA instead agrees with commenter 1 that a useful exercise might be to validate the formula by running it on CERCLA sites. EPA will conduct a validation on a limited number of CERCLA sites where response costs have been incurred across all site features, such as Summitville mine.

Finally, EPA disagrees that a distinction should be made in the formula for whether a site has been nominated to the NPL. One purpose of financial responsibility is to have funds available in a bankruptcy scenario. In such a case, the facility could go bankrupt prior to being listed to the NPL. Thus, by distinguishing sites as not yet listed on the NPL, the formula could underestimate financial responsibility in the situation for which those funds are most needed. Thus, no further response is necessary.

3.2. Lognormality Issues

Comment Summary

Commenters 1 and 4 expressed concern about the log transformations of variables when the variables take on a value of zero. Commenter 1 provided suggestions for properly dealing with these transformations, such as an inverse hyperbolic sine transformation. Commenter 2 suggested EPA provide support for the choice of functional form for the response cost equations and explained that the log-log function form is plausible for multiple reasons. Commenter 3 agreed that the log-log specification used for most regressions is appropriate but pointed EPA towards proper testing for assessing whether variables are lognormally distributed.

Commenter 1

Taking logs:

In the financial responsibility formula there are some variables that are logged but perhaps once this formula is implemented across more data, there might be instances when they take on a value of zero? For these variables that are logged, will it always be the case that they are greater than zero? (For example, will there always be at least one acre of open pit? Or at least one acre of waste rock?) If it is in the realm of possibility for a facility to have an observation of zero, then perhaps you should add 1 (or say if the variable is zero then set log(variable)=0). Some of the variables are log(variable+1) but why not all of them? If you do change this, then I suppose you should also re-estimate the parameters after transforming all your data to +1. Alternatively, you could use an inverse hyperbolic sine transform that does not require adding 1. This would be immediately feasible.

Commenter 2

Generally, the statistical models seem well chosen given the constraints imposed by the small sample sizes. OLS is suited to predicting the response costs under broader circumstances than the requirements for the Gauss-Markov Theorem (which are anyway not entirely correctly specified on p. 4-3 and include a typo in point 5), so if anything a stronger case could be made for the validity of the approach by focusing on conditions for the predictions themselves.

However, a more convincing case might be made for the choice of functional form for the response cost equations. Most of the analysis assumes a log-log relationship between the independent variables and the dependent variables. The EPA provides extensive analysis of the lognormality of the variables, but this analysis does not actually establish the form of the relationship between the variables (and is not really necessary in any other regard). Instead, the choice of functional form could be supported in several ways:

(a) The log-log functional form is plausible a priori because it allows the response costs to rise proportionately with acreage and other variables;

(b) The plots of the log-log relationships J1, J4, J6, and J8 make a compelling visual case that the relationships are linear after the log transformation and thus that the transformation is appropriate before OLS estimation.

(c) Explicit tests for the functional form would be appropriate. The Wooldridge text cited in the Background Document provides two straightforward tests, the Ramsey RESET test for general misspecification and a Davidson-MacKinnon test that could be implemented to test the choice of logs vs. levels for the explanatory variables.

Commenter 3

The EPA used a log-log specification for most regressions, which is appropriate, and included in some early and final specifications dummies denoting whether a certain type of process is present. The EPA conducted a large number of tests to check that all continuous variables (whether they are dependent variables or regressors in the regressions) are lognormally distributed, but the appropriate procedure is to run the regressions after taking the appropriate log transformations, and check that the regression *residuals* are normally distributed.

Commenter 4

I don't understand why some of the acreage data was normalized with +1. I do get that Log(0) is undefined, but the Formula is clear that one only puts in acreage data where it is relevant. *LogAcresTotal* is always > 0, so why the +1 adjustment?

EPA Response

Commenter 3 correctly points out that the Gauss-Markov Theorem requires that the *residuals* be normally distributed. EPA has checked the normality of the residuals both graphically and with the Anderson-Darling test and confirmed this to be the case. A summary of these results is presented below, while the full results are presented in **Attachment A** of this response to comments document and will be supplemented as an appendix to the final background document.

Table 2.2a - Residual Normality Test Results

Regression	Graphical Normality	Anderson-Darling Normality
Open Pit	Normal	Normal
Waste Rock	Normal	Normal
Heap/Dump Leach	Normal	Normal
Tailings Facility	Normal	Normal
Process Pond/Reservoir	Normal	Normal
Underground Mine	Uncertain	Normal
Drainage	Uncertain	Normal
Short-Term O&M/Monitoring	Normal	Normal
Long-Term O&M/Monitoring	Normal	Normal
Interim O&M	Normal	Normal
Water Treatment	Normal	Normal

With respect to commenters' 1 and 4 suggestion that all or none of the data should have a +1 transformation, EPA disagrees. The individual response categories of the response component are only applied when a site feature exists at a facility. For instance, a facility would not apply the open pit portion of the formula if it only had an underground mine. Thus, a facility would never enter a number into these categories unless that number is greater than zero, and a +1 transformation would be unnecessary. However, for two data elements this is not the case. For interim O&M, facilities must enter both heap/dump leach acres and wet tailings acres. Since a facility only needs one of these site features to incur this cost component, it is possible that a facility has no acreage for either (or both if the facility has only paste or dry stack). Thus a +1 transformation is necessary to ensure that the formula does not take log(0). Second, total acreage can in fact be zero because EPA defines total acreage as the sum of acreage of the other site features. EPA will clarify each of these elements for application of the formula in the final version of the background document.

With respect to the inverse, hyperbolic sine transformation suggested by commenter 1, EPA finds this to be an unnecessary complication to the model. At the outset, it is important to note that many of the data elements are the kind of data that appear lognormally distributed in nature (Limpert et al, 2001). Thus, the use of a lognormal distribution, even with the occasional +1 transformation, is more consistent with the natural behavior of the data. Furthermore, an inverse, hyperbolic sine transformation would complicate interpretation of the data. In the current $\log_{10}$ format, one can easily interpret results as the number of zeroes in the final cost. A result of 3 means $1,000, a result of 4 means $10,000, and so on.

Finally, EPA agrees with the suggestions presented by commenter 2. EPA will correct the Gauss-Markov Theory and will also include discussion of the appropriateness of the log-log functional form based on both a priori plausibility and consideration of the plots in current Appendix J.

Table 2.2b - Ramsey RESET Test Results

Dependent Variable	Degrees of Freedom		F-Statistic	p-value
	Numerator	Denominator		
OpenPit	3	31	0.82	0.492
WasteRock	3	40	7.46	**0.000**
HeapDumpLeach	3	22	4.42	**0.014**
TailingsFacility	3	27	0.83	0.490
ProcessPondReservoir	3	26	3.37	**0.034**
UndergroundMine	NA	NA	NA	NA
Drainage	3	22	1.69	0.199
ShortTermO&Mmonitoring	3	47	4.99	**0.004**
LongTermO&Mmonitoring	3	9	1.97	0.189
InterimO&M	3	25	0.02	0.996
WaterTreatment	3	11	1.75	0.214

EPA conducted the Ramsey RESET and Davidson-MacKinnon tests as suggested by commenter 2. The results of the Ramsey RESET test are summarized in **Table 2.2b** above. As seen in the table, a linear-linear regression would have been improvable with higher-order terms for four regressions (waste rock, heap/dump leach, process pond/reservoir, and short-term O&M/monitoring). This supports EPA's decision to use a log-log model for these regressions. For the remaining regressions, the test did not reject the null hypothesis that all higher order terms were insignificant. These results will be presented in the final background document.

The Davidson-MacKinnon test also returned mixed results. For the majority of the 66 tests, the null hypothesis could not be rejected for either the log-log specification or any alternative specification of the model. There were 6 exceptions presented below. The full set of test results can be viewed in **Attachment C** of this response to comments document.

- The log-log version of the process pond and reservoir equation was shown to be superior to the linear-linear and log-linear equation, but not the linear-log equation which showed ambiguous results.
- The linear-linear waste rock and heap/dump leach equations were shown to be superior to the log-log versions of those equations, but not to the log-linear or linear-log versions, though the waste rock linear-log equation was also superior to the log-log equation.
- The log-log equation for water treatment was shown to be superior to the linear-log version of the equation.

Though a small fraction of test results suggested a log-log model was not optimal, a similarly small fraction suggested that the log-log model was optimal. If EPA followed the results of this test literally, the linear model specifications for the waste rock and heap/dump leach equations lead to residuals that are not normally distributed. Given this finding, and the ambiguous results for the vast majority of the equations, EPA believes that the correct model specification was chosen, and that the two contrary Davidson-MacKinnon results may be due to the small sample sizes.

3.3. Stepwise Regression

Comment Summary

Commenter 2 suggested a different approach to forming present values of O&M costs in order to make the regression model simpler to specify. Commenter 3 expressed general disapproval of stepwise selection methodology but agreed that in this case the expected significant predictors are in line with theoretical expectations. Commenter 4 suggested EPA use a larger confidence interval when relying on methods such as stepwise selection.

Commenter 2

> Overall, the EPA's choices seem sound. I have a few comments on specifics:
>
> The handing of O&M costs might be simplified. The current approach estimates annual O&M and then constructs present values of these estimates. An alternative would be to form the present values first and take the log of them as dependent variable in the equation. Smearing could then be done on these PVs. OLS provides the best linear predictor of the dependent variable (see Angrist and Pischke, *Mostly Harmless Econometrics*, 2009). Forming the present value first would harness this feature of OLS in predicting the object of interest (the PV), rather than its component parts. It would also make the Financial Responsibility Formula simpler to specify.

Commenter 3

> <u>* Econometric analysis</u>
>
> I am generally not a fan of stepwise selection, whether it's backward or forward or back-and-forth. I much prefer the analyst to make decisions in terms of what should go into a model and what the final specification should be. Fortunately, in this case the automatic procedure and I agree. Based on my research experience, I had expected acres to be the only significant predictor of most types of costs—and they are. I had expected acres and one or two hydrology variable to be predictors of water treatment costs, and they are.

Commenter 4

> The main second concern that I have is that the confidence intervals in the bidirectional analysis for regression robustness are too generous. When one is "regression mining" one has no strong priors about what should or should not be in the regression. The chance of spurious results is high. I suggest a 99% confidence interval here when looking to add or drop independent variables.

EPA Response

EPA disagrees with commenter 2 that a regression run on net present values would be more accurate than one run on the annualized values and that it would make the final model easier to specify. Since all annualized values would be discounted using the same discount factor (essentially a monotonic transformation), the R-squared and estimated coefficients should remain the same. Only the intercept for each equation would change. EPA confirmed this result by performing the suggested regressions. Thus, no further response is necessary.

EPA agrees with commenter 3 that the variables selected by the stepwise procedure were consistent with those expected to be significant predictors.

Finally, with respect to commenter 4, EPA disagrees that the chance of spurious results is high for three reasons. First the results closely matched the expectations of both EPA and one of the other peer reviewers. Second, EPA only used a 90% confidence level for removal of variables that it had reason to believe *should* be in the final model. The remaining variables were tested with a 95% confidence level intentionally to reduce the chance of spurious results. That EPA was only able to add a single variable to a single regression is proof of the high bar that this confidence level established. Third, EPA conducted robustness analyses to examine the influence that the confidence levels selected had on the results. The results were shown to be relatively robust to the confidence level. Nevertheless, EPA has conducted an additional robustness analysis using the suggested 99% confidence level. This analysis shows that the models could differ somewhat from the current format if a pure forward stepwise regression with a 99% confidence level was used. For instance, acreage would not be significant in the drainage and short-term O&M equations, and hydraulic head would not be significant in the underground mine equation. However, if EPA only used the 99% confidence interval for addition, and kept the current 90% confidence interval for removal of a variable, the Agency notes that not a single variable would change from the current form. Full results of the forward stepwise regression are presented in **Attachment D** to this response to comments document and will be placed in an appendix for the final background document.

3.4. Analysis of influential points

Comment Summary

Commenter 4 suggested EPA conduct analysis of influential points, or data points with both leverage and outlier effect that have undue influence on the regression coefficient. If EPA discovers potential influential points, Commenter 4 suggested EPA conduct analysis to see if the model is incomplete and should include additional site features or if the data points contain errors.

Commenter 3

> An easy way to check the robustness of the results and identify unduly influential (in the statistical sense) observations is to cross-validation: re-run the regression after dropping one observation (or a handful), look at the estimated coefficients, then put back into the sample the observations that were excluded but drop another observation (or another handful), etc. When you observe a relatively large change in coefficients, the procedure is pointing you to an influential observation (a potential outlier). This procedure (cross-validation or the jackknife) allows the analyst to obtain standard errors around the estimated coefficients in the presence of heteroscedasticity or suspected outliers, and is easy to implement.

Commenter 4

> Section 4 performs the regression analysis to estimate the specific relationship between direct response costs and mine facility attribute. I find the approach here reasonable subject to five substantive caveats. First, a visual inspection of the data in Appendix G along with the regression plots in Appendix J convinces me that the data includes influential points (sometimes incorrectly called outliers by economists). Influential points are data points with both leverage and outlier effect that have undue influence on the regression coefficient. I have not seen any tests for influence points in the report (e.g., DFBETAS, robust regression), yet I am sure that influence points are having an effect on the regression coefficient estimates. Note that once influence points are identified they should not necessarily be removed from the data. Rather, they are likely to be showing that the model is incomplete or that the data point contains an error. One area where the model is incomplete, for example, is in open pit backfilling. Two obvious influence points are the open pit response costs and Cresson and Phoenix. Both have leverage (the acres is high) and outlier effect (the response costs are huge). What is different about these two facilities? Both require backfilling of the pit. Such backfilling is unusual, and very expensive. A test for influence points would likely reveal that the Cresson and Phoenix are influential points, and then a further review of the primary source data would reveal that these two properties require backfilling. The model

> can then be adjusted to include a dummy for open pit backfilling. Once this is done the coefficient on *LogAcresOpenPit* will likely drop to 0.5 (see below). Cresson is also an outlier in the Heap Leach activity. An inspection of the source document shows why: like Phoenix, Cresson will rinse and detoxify its leach piles, an unusual requirement that adds substantial closure costs. Whoever collected the data did not move these costs into Interim O&M. The influence point test directs us back to the source document to figure out what is going on at Cresson, which is why this is such a useful exercise.
>
> […]
>
> By the way, the technique used in K.3 can address influence points. Do the regression coefficients move around substantially when a data point is omitted? This is exactly what the DFBETAS test does.

EPA Response

EPA agrees with the commenter that additional consideration could be given to influential points through either evaluation of the coefficients in section K.3 of background document Appendix K or DFBETAS. Since the Agency did not save the individual coefficients from K.3, EPA elected to perform DFBETAS. A summary of the DFBETAS test is presented in **Table 3.4a** below, and the complete results are presented in **Attachment E** to this response to comments document. As seen in the table, the coefficients in every regression had one or more observations that could be overly influential on an estimated coefficient. The only coefficient in any regression without any influential points was that for source controls at tailings facilities. EPA also notes that heap/dump leach source controls and hydraulic head were regressed on a sample of two facilities' data. Thus, the fact that these coefficients returned both points as influential is not surprising, and merely reflects the fact that EPA would benefit from additional data, not that these data are biased by some unknown variable missing from the model.

A quick scan of the capital cost categories reveals that Hollister mine appears in the process pond and reservoir regression as well as the drainage regression. However, no other mine appears in multiple capital cost regressions. Thus, EPA does not believe that any of the facilities in the sample appear to be drastically different across the board with respect to capital costs such that the facility should be excluded.

Additionally, none of the facilities show up as influential for more than one coefficient in the *same* regression for the capital cost regression categories. Had Phoenix Historic been influential for both the open pit acreage and source controls terms, one might wonder whether an omitted explanatory variable is worthy of inclusion in the model, such as the backfilling dummy variable suggested by commenter 4. However, Phoenix Historic shows up as influential in the results for LogAcresOpenPit, but not for SourceControlOpenPit. The other facility conducting backfilling as mentioned by the commenter (Cresson) does not show up as influential for either coefficient. Furthermore, the inclusion of a backfilling dummy variable would not address the fact that three other mines that show up as influential points for one of the two open pit coefficients (Hycroft, Climax, and Robinson). For this reason, EPA does not believe that the addition of backfilling to the model is necessary.

Table 3.4a - DFBETAS Results

Regression	Coefficient	Influential Facilities	#
CAPITAL COST RESPONSE CATEGORIES			
OpenPit	$LogAcres_{OpenPit}$	Hycroft; Phoenix Historic	2
	$SourceControl_{OpenPit}$	Climax; Robinson	2
WasteRock	$LogAcres_{WasteRock}$	Greens Creek; Niblack; Chino; Tyrone	4
	$SourceControl_{WasteRock}$	Northshore; Robinson	2
HeapDumpLeach	$LogAcres_{HeapDumpLeach}$	Jerritt Canyon; Trenton Canyon	2
	$SourceControl_{HeapDumpLeach}$	Phoenix Copper; Lisbon Valley	2
TailingsFacility	$LogAcres_{Tailings}$	Nixon Fork; Red Dog; Rosemont	3
	$SourceControl_{Tailings}$	-	0
ProcessPondReservoir	$LogAcres_{ProcessPondReservoir}$	Goldstrike; Hollister	2
UndergroundMine	*HydraulicHead*	Pogo; Climax	2
Drainage	$LogAcres_{Total+1}$	Hollister	1
O&M RESPONSE CATEGORIES			
ShortTermO&MMonitoring	$LogAcres_{Total+1}$	Niblack; Nixon Fork; Idaho Cobalt; Hollister	4
LongTermO&MMonitoring	$LogAcres_{Total+1}$	Pinto Valley; Robinson	2
InterimO&M	*NetPrecipitation*	Greens Creek; Ray; Briggs; Mesquite; Continental; Chino	6
	$LogAcres_{HeapDumpLeach+1}$	Ray; Briggs; Continental; Chino	4
	$LogAcres_{WetTailings+1}$	Greens Creek; Continental; Chino	3
WaterTreatment	*LogFlow*	Phoenix Copper	1
	Treat	Pogo; Phoenix Copper	2
	InSituLeach	Phoenix Copper	1

Similar to the capital cost regressions, the O&M regressions do not have any facilities appearing as influential points for multiple regressions. Thus, EPA does not propose excluding data from any facilities. However, there are three facilities that appear as influential points for all of the coefficients in interim O&M (Continental and Chino) or for all the coefficients in water treatment (Phoenix Copper). For these facilities, EPA has not identified any characteristics that might account for their influence on the model, but will solicit comment on these influential points in the proposed rule preamble.

3.5. Robustness and Reasonableness

Comment Summary

Commenter 1 thought the regression results were robust and that EPA used innovative robustness tests, but still expressed concern that unrelated variables might be included in the regression. Commenter 3 argued that EPA should more clearly describe the robustness checks and suggested EPA use cross-validation to check for robustness. Commenter 4 generally disapproved of the lack of an attempt to form priors about regression coefficients. Commenter 4 provided information about various response activities and response cost estimates and argued that when the estimated coefficients are not in line with these theoretical expectations, EPA should investigate why. Commenter 4 suggested EPA test for external validity using the average regression error to see if the Formula gives response cost estimates within the error range (> -50% and < 100%).

Commenter 1

> The regression results are robust to changes in the stepwise procedure. One concern is that potentially unrelated variables that happen to be correlated with costs may still be included in the regression. However it is reassuring that when looking at the final regressions this does not appear to be the case (e.g. costs of tailings includes acres tailings).
>
> I think the second robustness test is very innovative—and is a great demonstration of how good the out-of-sample prediction is. It would be difficult to do another type of an out-of- sample prediction when samples are so small. My only comment is that it would be helpful to know how to interpret the magnitude of the external transfer (Table K-12). This is observed value minus predicted value: are the values "log response costs"? Is there a way to demonstrate this so it is easy to interpret, e.g., dollar terms or percent terms?

Commenter 3

> Charge question 6) asks me to discuss whether the models are appropriate and whether the "external transfer value." I teach econometrics at the graduate and undergraduate level, and yet I have no idea what this term and the text from the EPA document reproduced below mean.
>
> > "The second robustness check compared the external validity of the final model to two alternative specifications by analyzing the average external transfer value. This comparison of the average external transfer value allowed EPA to test the accuracy of the final model. The first alternative specification was an "average" model where a fixed, average cost was used but no additional variables were considered. The second alternative

> specification was an “all variable” model. This model included every initial and potential variable EPA considered. In every case, the final model had the lowest external transfer value, indicating that the final model out-performed the accuracy of the “average” and “all variable” versions when producing out of sample estimates.”

First of all, any model with regressors (whether or not those regressors have any explanatory power) will do better or no worse than a model with just the intercept, which effectively uses the average to predict the dependent variable. In that sense, the text above is stating the obvious. If the EPA is suggesting that they re-ran the regression using a subsample of observations, and reserved the remaining observations to check the quality of out-of-sample predictions, then they should say so clearly. They should also say whether they use the average forecast error squared (i.e., the variance of the forecast or prediction error) to judge the quality of the predictions. If this is what the EPA document is trying to say, there is insufficient documentation to understand whether this is just a general goodness-of-fit test, or if by strategically selecting the observations to leave out of the regression the EPA is testing the stability of the coefficients over geography, size, time when R&C plans were prepared, etc.

Commenter 4

The third caveat is that there was no attempt to form priors about the regression coefficients. Let’s take open pit reclamation. A review of the source documents will show that the main response activity for open pits is building fences or berms around the pit perimeter. If we assume that pits are circular their area will be r^2, where r is radius. Their circumference, which is what matters for building fences and berms, is πr^2 which is proportional to the square root of acreage.[FN] Hence, I would expect a coefficient of 0.5 on *LogAcresOpenPit*. The estimated coefficient is 1.08. Given my prior, and due to likely data errors and influence points, some of which I have identified above, I have no confidence in this number. The fact that it should be 0.50 gives me additional conviction about there being data errors.

[FN] $Circumference = 2\pi \mathrm{r} = 2\sqrt{\pi}\sqrt{\pi r^2} = (2\sqrt{\pi})\sqrt{acres}$

EPA will note in looking at the source documents that engineers use constant average costs when calculating response costs. There are no economies of scale in the source data. That means that the coefficients on independent variables like Waste Piles, Leach Pads, and Tailings Dams, whose response costs are proportional to acreage, should have coefficient estimates of near 1.00 or slightly above to take into account the diseconomies of scale associated with increased cycle times as distances grow (the total engineering costs on the larger piles are likely to be higher due to increased numbers of cost units per acre). Where the estimated coefficients are not in line with these priors there should be added emphasis to investigate why not.

Along these lines, if the coefficient on area is approximately 1.00 the first term in each Waste Piles, Leach Pads, and Tailings Dam regression provides the average response cost per acre. Take heap reclamation. Since the coefficient is 1.01 the regression results can be interpreted to reveal that the average response cost is 2.29 x $10^{4.57}$ = $44,651/acre. This is very high. Even without the source control adjustment the value is 2.29 x $10^{3.87}$ = $16,976/acre. I would expect something in the range of $5,000/acre to $10,000/acre. The value is likely high due to the smearing adjustments to the regression estimates. The smearing factor is heavily affected by outlying data. For example, in Table J.5 there are two observations that are creating a high smear factor. If one of these is Cresson and the other is the erroneous data for Pinto Valley, which I presume it is, then correcting these for the data entry problems will lower the smear factor and bring the average cost in line with industry norms. If we reduce the smear factor to 1.00 the average cost prior to source controls becomes $10^{3.87}$ = $7,413, which is right where I would expect it to be. Each of the coefficient estimates needs to be thought about in this way.

EPA could also test the source control effects on per acre response cost against known cost estimates for source control. Albright (2015) says tailings covers range from $25,000/acre to $125,000/acre. In the example of heap reclamation that I presented in the previous paragraph the source control cost adds $30,000/acre if the smearing factor is included and $15,000/acre if it is not. Is this reasonable? EPA should check for the reasonableness of the source control parameter estimates in each of the reclamation tasks.

[…]

My final concern is that the model is not tested for the type of reasonable accuracy that I referred to in my initial comments. Are the actual source data cost estimates within a range that is 50% below to 100% above the Formula estimates? One needs to look at the performance of the whole regression here, and not just each component, as the errors across components for a given facility are likely to be serially correlated. For example, take the estimated response cost for Pinto Valley absent source controls (and excluding agency direct and indirect costs, the NRD multiplier, and the health assessment cost, and adjusting the coefficient on water treatment from 0.05 to 1.00 given the absence of source controls) and compare it with the $60 million grand total direct and indirect cost estimated in the source document. Is the Formula estimate within range? My own application of the

Formula for my four sample properties indicates that reasonableness in accuracy as defined by -50% +100% is not achieved.[FN]

[FN] My application was approximate given that I did not know exactly how to apply the formula. What year in the operating life do I choose? Do I aggregate all waste dump piles into a single pile, or do I treat each as a separate formula element? Is *LogAcresTotal* the total acreage of the whole facility, or the total of the individual facility *k* elements; is *LogAcresTotal* = $\sum_{f=1}^{k} Acresf$? What is the set that *f* indexes? Where do obtain gross precipitation data? What acreages do I use for the open pit – reclaimed acres or total acres of disturbed area?

For that exercise I spent the most care estimating the financial responsibility direct response costs for Rosemont. Adjusting the results to 2007 to make them comparable with the 2007 Rosemont reclamation source document I get *TotalFinancialResponsibility*2007 of $99 million based on facility conditions at the termination of operations. The company estimates total response costs of $19 million at closure. If we add indirect costs the totals rise to $131 million and $24 million, respectively. Adding EPA oversight, NRD, and Health Assessment creates a final *TotalFinancialResponsibility*200 of $163 million for Rosemont. Unless Tetra Tech, a well- known mining engineering consulting company, has grossly misestimated the environmental cleanup costs at Rosemont I would say this exercise shows that the Formula is not producing reasonable numbers for this facility.

Appendix K.3, while it was used for robustness purposes, is also an external validity test. The test supports my assertion that the Formula is well wide of the source data response costs. The numbers in the first column of the table can be manipulated to give the average regression error as %*error*=$(10^{x}$-1) / 10, where *x* is the coefficient listed in the table. For example, if the average absolute value of 0.56 in the first row means that on average the error in the log estimate is either -0.56 or +0.56, then the average regression error on open pit costs is

%*error*=$(10^{0.56}$-1) / 10 = 263% when the log true cost is higher than the log estimated cost by 0.56. Put differently, the +0.56 value tells us that on average the true costs from the primary source data are 263% higher than the cost estimate by the Formula for an out-of-sample test. If we look at the other case, the average regression error is %*error*=(10-$^{0.56}$-1) / 10 = -72% when the true cost is lower than the estimated cost. If the goal is Class 5 bounds of the true value being between -50% and +100% of the Formula estimate then the average error obviously has to be lower than these numbers (> -50% and < 100%).[FN] As I noted before, errors are likely to be serially correlated across response activities (favorable geographic location that lowers diesel costs will affect each response cost's error in the same direction), and so based on the numbers in this table I hardly think that the Formula is giving total response estimates that are within +100%, -50% of the true numbers.

[FN] I would note that Class 5 estimates have lows of -20% to -50%, and highs of +30% to +100%. EPA's selection of -50% to +100% are the worst cases for Class 5 estimates. While not asked to comment on it, I hardly think a Formula whose performance is -50% +100%, and that could result in a company posting financial assurance that is twice that required is satisfactory.

[…]

Finally, I would suggest that the methodology not stop at the production of regression results, but that the results be interpreted and tested against industry benchmarks for reasonableness; the regression results need to be post processed. Sitting down with industry professionals and asking them about the results and special response cost situations is an important reasonableness check that has not apparently been done and that would have revealed the types of implementation flaws I have identified.

[…]

No. On the specification robustness tests I suggested above that the confidence level be increased to 99% in the bidirectional elimination to avoid spurious regressors. I also recommended that the regressions be tested for sample robustness (the impact of influence points) using a multi-row deletion test like DFBETAS. Robust regression could also be used to be sure single points are not driving the regression results.

EPA Response

EPA agrees with commenter 1 that the results of the regressions are robust. No further response is necessary.

With respect to commenter 3, EPA acknowledges that further clarity would help the interpretation of the second robustness check. Here, EPA reran each regression leaving out each observation, one at a time. Thus, if there were 10 observations, EPA would rerun the regression 10 times leaving out a different observation each time. Then, the resulting regression would be applied to the out-of-sample observation, and the absolute value difference between the actual and predicted value would be saved. These values were then averaged to obtain an average absolute external transfer error (AAETE). While the commenter is correct that this should always outperform a regression using just the intercept, EPA also presents a comparison to an "all variables" model to ensure that additional explanatory power from other variables are not missed. EPA will more clearly explain the AAETE and surrounding calculations in the final background document.

Commenter 1 questions what interpretation could be given to the AAETE values in section K.3 of background document Appendix K while commenter 4 presents one possible interpretation. EPA could not duplicate the calculations performed by commenter 4. However, EPA believes that the commenter was attempting to represent the mean absolute transfer error (MAPE). Here, EPA disagrees with the approach taken. First, EPA notes that the commenter must have erroneously included a divisor of 10 in the equation used to convert the AAETE to the MAPE. Second, the MAPE is more appropriately taken from the full regression rather than the external transfer error from a series of regressions leaving out one observation. This would necessarily result in larger percent error because the value being estimated is precisely the one left out of the equation. Finally, the MAPE is typically calculated using the actual regression residuals and input values. In contrast, the commenter here performed the calculation on unlogged values of the actual and expected costs. EPA used smearing factors precisely because log-log regressions are a biased estimator of the unlogged values. Thus, it is not clear that the commenter's comparison of unlogged, unsmeared values is the proper.

EPA estimated the MAPE of the logged regressions as seen in **Table 3.5a** below. Full MAPE calculations are presented in **Attachment F** to this response to comments document.

Table 3.5a – Mean Absolute Percent Errors (MAPE)

Equation	MAPE	Equation	MAPE
OpenPit	9%	*Drainage*	18%
WasteRock	6%	*ShortTermO&MMonitoring*	9%
HeapDumpLeach	7%	*LongTermO&MMonitoring*	7%
TailingsFacility	6%	*InterimO&M*	5%
ProcessPondReservoir	6%	*WaterTreatment*	3%
UndergroundMine	11%		

EPA disagrees with commenter 4 that the formula is unlikely to produce estimates in the +100% to -50% range. As pointed out by commenter 2 the realized costs at a site will ultimately be more reflective of the uncertainties and mishaps that are ignored in the idealized engineering cost models used to develop reclamation and closure plans. Thus, even for the example of Rosemont, costs could be significantly higher than estimated in the reclamation and closure plan. Specifically, if Rosemont became a CERCLA site, it would have an acreage of a similar magnitude to the Cyprus Tohono Mine. As seen in Appendix B of the background document, the Cyprus Tohono Mine has cost nearly $28 million in removal actions alone. Thus, while an amount similar to the engineering cost estimate in the Rosemont reclamation and closure plan might be adequate for addressing a removal action, it would then have no remaining funds left for longer-term remedial actions should the site be listed on the NPL. Considered in this light, EPA does not believe that a response component of $131 million with a +100% to -50% bound of $66 million to $262 million is inconsistent.

EPA also disagrees with commenter 4 that the +100% to -50% range is not satisfactory. As stated in U.S.EPA (1991), "[Feasibility Study] cost estimates should provide an accuracy of + 50 percent to -30 percent using data available in the [Remedial Investigation]." However, at the stage that facilities will be using this formula, there may not yet have been a release, and the facility almost certainly would not have undergone a remedial investigation. Thus, the premise that this same accuracy can or should be achieved in the absence of the presumed information is incorrect. While higher degrees of accuracy are purported by reclamation and closure plans, those plans have defined activities and criteria that are known with more certainty than the plethora of potential response actions that could be taken by EPA or another party.

Finally, with respect to the 99% confidence level and DFBETAS, EPA has addressed these issues in **Sections 3.3** and **3.4** of this response to comments document, respectively.

4. Natural Resource Damage Component Analysis

The peer review comments relating to Natural Resource Damages (NRD) component analysis are grouped into two subcategories:

- Data sources
- Estimation methodology

4.1. Data Sources

Comment Summary

Commenter 1 wrote that a few facilities would skew the NRD estimates if EPA did not drop them as outlier. Commenter 1 also suggested EPA provide a figure that presents the final sample used to calculate the NRD multiplier. Commenter 3 argued that it is uncertain if omitting very small and very large NRD estimates will produce acceptable and reliable results. Commenter 3 suggests we provide descriptive statistics for the combined data samples and each of the two subsamples separately. Commenter 4 wrote that it is not correct to combine NRD data from court settlements and voluntary payments without additional analysis.

Commenter 1

> "Response Costs and NRD at 24 HMFs" is stunning—it is really apparent that few facilities might really skew your estimates. However, this is not the sample you use. You drop the outliers, and are not using these data as they are presented. (As an aside, why not present Figure 5-1 for the sample you do use? It would not look as stark.)

Commenter 3

> The documents states at some point that the NRD sample may be unrepresentative in that it omits facilities with small NRD figures, but I wonder whether facilities where high and controversial NRD figures may likewise be missing from the sample. In practice, omitting very small and very large NRD may still produce acceptable and reliable result because these omissions are effectively working as a trimming/outlier elimination procedure, but we don't know this for sure. (I note that EPA did exclude some facilities with large NRD from its calculations, but the above discussion refers to cases that are missing from the sample in the first place.)

There is absolutely no information about the types of damages that went into the calculation of the NRDs. Did they include recreational use of the natural resources? Are the damages captured through market and market data, including quality of the soil used in agriculture, lost or compromised commercial harvests, etc.? Did the nature of the pollutant and the contaminated environmental media play a role? Were there any existence values? If this information were available or could be collected, it would enable the EPA to estimate regressions relating the NRD with site and community characteristics and improve the calculation of expected post-closure NRDs.

[…]

The NRD sample comes from two sources of data—EPA CERCLA sources and Israel (2013). The two sources overlap for 8 sites, and Israel is based mostly on state programs (mini-superfund and others). Descriptive statistics should be reported for the combined sample as well as for each of the two subsamples separately.

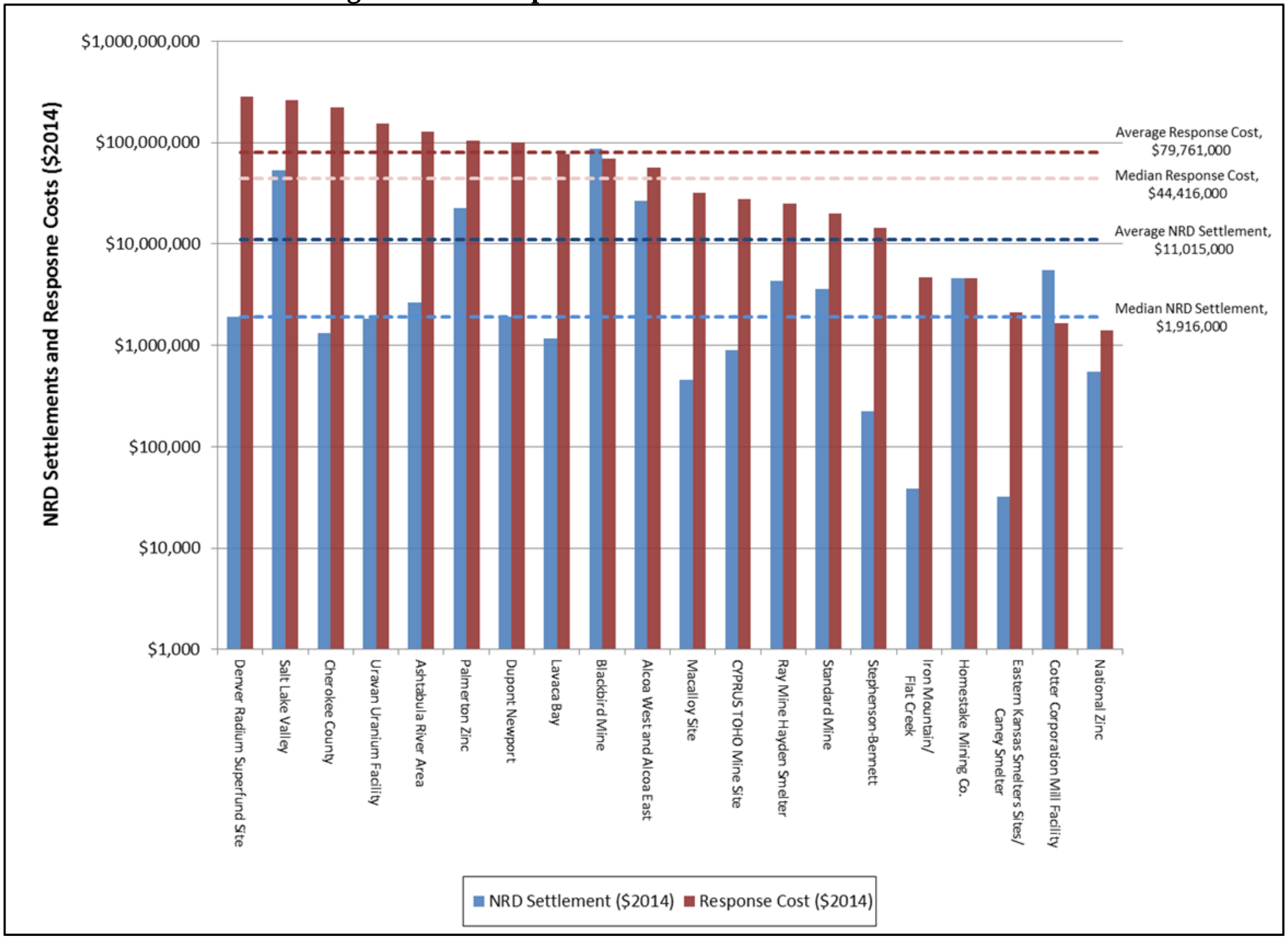
Commenter 4

Does the NRD data which comes from court settlements and judgements differ from that from voluntary payments. I suspect these are two different populations, and it is not correct to combine them without some analysis.

EPA Response

EPA agrees with commenter 1 that current Figure 5-1 does not accurately portray the data that was used. To more accurately portray the data used for the NRD multiplier, EPA will supplement Figure 5-1 in the final background document to include the distribution without the four outliers as seen in **Figure 4.1a** below.

Figure 4.1a – Response Costs and NRD at 20 HRMFs



EPA also agrees with commenter 3 that the effect of missing NRD is uncertain. Thus, EPA will solicit comment on additional NRD data in the proposed rule preamble.

With respect to the types of NRD at each site, EPA agrees that additional information about the types of damages could be informative. Prior to the court ordered deadline, EPA was able to review the descriptions of the 19 mining-related NRD settlements from Israel (2013) and has documented all of the NRD categories mentioned for each of these settlement in **Table 4.1a** below. EPA will supplement this table with that of the court settlements and judgments, and include this information in the final background document.

Table 4.1a

Case	NRD (2014$)	NRD Categories
ASARCO LLC	$7,114,942	wildlife habitat
Freeport-McMoRan Corp Morenci Mine	$7,024,172	birds, wildlife habitat, aquatic wildlife habitat, wildlife, aquatic wildlife
Iron Mountain Mine CERCLA Site	$9,147,782	aquatic wildlife, fish, fisheries, wildlife habitat
New Almaden Mine CERCLA Site	$6,860,837	aquatic wildlife, birds, fish
California Gulch Site	$210,842,637	surface water, wildlife habitat
Bunker Hill Mining Superfund Site	$541,778,632	birds, fish, aquatic wildlife, surface water, wildlife habitat
Blackbird Mine Superfund Site	$86,574,373	aquatic wildlife, fish, surface water
Cherokee County Superfund Site	$1,314,037	surface water, groundwater, sediments, birds, fish, wildlife
Cominco/Halliburton	$49,805	-
Newton County Mine Tailings Superfund Site	$21,845,036	aquatic wildlife, terrestrial wildlife, birds, fish, groundwater, surface water, sediments
Southeast Missouri Lead Mining District	$44,776,890	aquatic wildlife, terrestrial wildlife, groundwater, surface water, geological resources
Atlantic Richfield Company	$412,541,863	fish, groundwater, wildlife habitat
Rio Tinto Mine	$873,642	surface water
Freeport McMoRan	$19,864,329	groundwater, wildlife, wildlife habitat
SOHIO L-Bar Facility	$36,588	groundwater
Palmerton Zinc Superfund Site	$21,344,826	aquatic wildlife habitat, recreation
South Dakota v Homestake Mining Company	$4,585,161	groundwater, surface water
Southwest Jordan Valley	$53,387,530	groundwater, surface water
Consol Energy/ Dunkard Creek	$543,409	aquatic wildlife, fish

With respect to the overlapping data, EPA agrees that more information should have been provided on the different amounts and why EPA selected one amount over another. This information is presented in **Table 4.1b** below and will be included in the final background document.

Table 4.1b – Comparison of NRD from Court Documents and Israel (2013)

NRD Site	Court NRD (2014$)	Israel NRD (2014$)	Reasoning
Blackbird Mine	$5,053,694	**$86,574,373**	Israel number is more comprehensive because it includes $82 million for in-kind implementation of remedy that was not included in the court document.
Couer D'Alene/ Bunker Hill Mining & Metallurgical Complex	**$74,685,443**	$541,778,632	Israel number may include more than just NRD costs.
Hacienda Furnace Yard/Jacques Gulch/New Almaden Mines	$101,017	**$6,860,837**	Israel number appears to be more comprehensive.
Iron Mountain Mine	$13,307,665	**$9,147,782**	The number from the consent decree appears to include assessment costs.
Morenci Mine Site	**$6,929,157**	$7,024,172	Israel number appears to include assessment costs.
Palmerton Zinc	**$20,071,829**	$21,344,826	The court document number is listed in multiple source documents. The Israel number is only listed in one press release.
SOHIO L-Bar Facility	$35,451	**$36,588**	The two sources listed the same NRD value but with two different settlement dates, producing slightly different estimates after adjusting for inflation. The New Mexico ONRT website seems to verify the Israel settlement date: https://onrt.env.nm.gov/assessment-cases-restoration-projects/damage-assessment-cases/sohio-l-bar-facility-cibola-county/
Upper Arkansas River/California Gulch	**$11,511,780**	$210,842,637	Israel number appears to include more than one site.

Upon completion of the above table, EPA recognized that it had erroneously excluded NRD assessment costs from its analysis. These costs are considered in **Section 4.2** of this response to comments document.

With respect to "voluntary" NRD amounts, this term may be slightly misleading. NRD settlements and judgments occur in anticipation of or directly respondent to court action. Thus, commenter 4's suggestion that the populations of settlements and judgments may be a different population from those that were "voluntary" is not meaningful. To provide an example, the Cominco/Haliburton settlement may be considered "voluntary" as it was instigated by the PRPs. Israel (2013) describes this settlement as follows:

> "MDNR received a cooperative settlement totaling $49,000 for seven lead and copper metal concentrate spill sites for which Cominco American, Inc. and Halliburton Energy Services, Inc. are allegedly responsible. Of note, these settlements occurred at the instigation of the potentially responsible parties (PRPs)." (p. 44)

4.2. Estimation Methodology

Comment Summary

Commenter 1 argued that some HRM sites might face low response costs and high NRD or high response costs and low NRD. Commenter 1 suggested EPA use the coefficients in the Formula to obtain a predicted response costs for each of the 24 HRM sites and then predict each sites NRD for the multiplier. Commenter 2 argued that it would be sound to use the realized CERCLA costs to estimate NRD. Commenter 2 suggested EPA sum the response costs and NRD for each CERCLA HRM site to create a total social cost which would allow predicted NRD to vary with facility characteristics. Commenter 2 also questioned the application of Overhead and Oversight costs to NRD. Commenter 3 argued that it is incorrect to consider sediment dredging/disposal damages to natural resources and should instead be included in response costs. Commenter 3 suggested EPA run regressions to check the relationship between NRD amounts, site characteristics, and type of NRD claimed. Commenter 3 also suggested that if EPA uses an NRD multiplier, EPA should compute the ratio of NRD to total response costs at each individual facility then take the average rather than taking average NRD divided by average response costs. Commenter 4 suggested EPA not spend more time refining the NRD estimate, but conduct analysis to see if NRD is inversely related to response costs or that it changes by commodity type. Commenter 4 also suggested EPA consider the appropriateness of using the median or geographic mean.

Commenter 1

> Recommendations to improve soundness:
>
> Estimation of the Natural Resource Damages (NRD) multiplier:

EPA acknowledges that "natural resource damages and response costs are not independent of each other. Instead, response actions have regularly been shown to influence natural resource damages." Nonetheless, this interdependency is not accounted for when calculating the NRD multiplier, because of the reasoning that "the total magnitude of potential liabilities (response costs and natural resource damages combined) will increase or decrease together." I can imagine how generally this might be true: for example, sites that cover more acres will have higher response costs and higher NRD. But I can also imagine that it is possible that they do not always increase together. Couldn't it be the case that a stitch in time saves nine, and if response costs are increased NRD fall by a lot? If there is this interdependency between response costs and NRD then this is problematic for the way the NRD multiplier is currently calculated. For example, say that in the sample of 24 HRMs there are two different types of facilities: some facilities spend a lot on response costs, lowering NRD, and resulting in a smaller multiplier, while other facilities spend little on response costs, raising NRD, and resulting in a larger multiplier. This means that the distribution of the types of facilities in the sample will change the multiplier.

Ideally you could calculate the NRD multiplier in absence of this tradeoff. One idea, which I would label as immediately feasible, is to treat these type-specific differences as error.

Specifically, you could use coefficients in the financial responsibility formula to obtain a *predicted response cost* for each of the 24 HRMs (i.e., for each facility, use their characteristics and predict what their response cost would be). It is easier to obtain a predicted response cost than it is to obtain a predicted NRD, because you have already estimated the parameters that would be used in the prediction. For the NRD you would have to first estimate coefficients similar to the response cost coefficients and then predict each facility's predicted NRD would be. Then you could divide the predicted NRD by the predicted response cost to obtain the multiplier. The difference between the predicted costs and actual costs would just be error, and would not be included in the formula. If you have site features in the full NRD data, you could use data from outside of the 24 HRMs. If restricted to using only the 24 HRMs, dropping the outliers will also be important.

Commenter 2

Relying on CERCLA realized costs would allow a sounder approach to Natural Resource Damages (NRD). If the analysis sample were CERCLA sites, response costs and NRD could be summed to create a measure of the total social cost. This approach would capture the possible tradeoff between high response costs and high

NRD and allow the predicted NRD to vary appropriately with facility characteristics. The current approach, treating NRD as a multiple of response costs, is not supported by the data in Table 5-4. But some such ad hoc assumption is necessary because NRD values cannot be matched to active facilities.

The Responsibility Formula applies Overhead and Oversight costs (OOC) to NRD as well as the response costs. Although this may be appropriate for some components of NRD (e.g., Sediment dredging/disposal, c.f. p. 2-16), is it appropriate for most components of NRD?

Commenter 3

Sediment dredging. The EPA writes that

'Also excluded was "Sediment dredging/disposal." Although this element has appeared historically as a response category, EPA notes that it was already incorporated in the natural resource damages (NRD) component. For example, the final restoration plan for the Upper Arkansas River/California Gulch Superfund site (one of the data points used in developing the NRD multiplier) includes dredging of contaminated soils as a restoration alternative.1 Thus, EPA believes that since this cost is already represented in the NRD multiplier, it is inappropriate to duplicate that cost in the response component of the formula.'

I do not understand this argument. It seems to me that the capital and operating costs of dredging sediments should be included in the costs associated with reclamation and post-closure remediation. They should not be placed in the Natural Resource Damage (NRD).

Here's my reasoning. Suppose that contaminated sediments are impairing water quality and biota at a body of water. The body of water is used by recreational anglers, birdwatchers, hikers and backpackers, and is of cultural and historical significance to a Native American tribe. There are no commercial fishing activities at this body of water. Suppose that dredging the sediments takes 10 years, and at the end of these 10 years the water quality and the biota are back at the pre-contamination level. Then the trustees of the natural resources (which may include state, federal and tribal agencies), can demand payment of the natural resource damages, which should include the welfare losses experienced by recreational anglers, birdwatchers and hikers, and existence values for each of the 10 years when the body of water continues to be impaired. Sediment dredging costs have nothing to do with these values and should be placed in a different category. It is incorrect to regard the cost of remedies as the damages to the natural resources (although, in the complete absence of information about the NRD, I would presume that the agencies believe that the NRD figures are at least as high as the cost of the remedies). I briefly looked at EPA's own language on NRD, and the reasoning I provide above seems consistent with what I read at https://www.epa.gov/superfund/natural-resource-damages-frequently-asked-questions#7.

Natural Resource Damages

The EPA document simply does not provide enough information about the NRD. My concerns and comments:

[…]

One would expect NRD and cost of remedial activities to be *positively* correlated with the seriousness of the environmental contamination, which may depend in turn on the acres, proximity to ground and surface water at the facility, and processes used at the facility. Yet all we read in this EPA document is that

'Instead, response actions have regularly been shown to influence natural resource damages. This is particularly true in the case of sites receiving technical impracticability (TI) waivers. When a TI waiver is issued, previously projected response costs may be reduced. However, the remaining contamination may lead to additional natural resource damages.'

I would expect TI waiver to be the exception, rather than the rule, and it would be good for the Agency to compute, and report, the coefficient of correlation between response costs and NRD (with and without the TI waiver sites) and run some simple regressions to check the relationship between NRD amounts, site characteristics, and type of NRD claimed (e.g., recreational use, existence values, etc.)

The Agency chose to use the ratio of NRD to total response costs in the final formula and came up with a figure of 13.4%. The problem is that this was computed as average NRD divided by average response costs, and this is not the same as 1) computing the ratio of NRD to total response costs at each individual facility, and 2) then taking the average. The two procedures may give very different results, and I would recommend using the latter.

Also note that reassigning dredging sediment costs into total response costs rather than NRD may change all results, depending on how many facilities this affects and how large the figures are.

Commenter 4

Section 5 moves on to the NRD estimate, and concludes that it should be 13.4% of the response cost. Given the relatively minor impact of NRD and health assessment on the financial responsibility I don't suggest EPA spend more time refining this. I would like EPA to further investigate and document the possibility that NRD is inversely proportional to response cost, or that it changes by commodity type. Radioactive minerals are an obvious example. There is likely, also, to be sample bias in the NRD data given that this is taken from CERCLA sites that clearly had something go wrong well before EPA got there. I realize, however, that the data sample is small, and when this is the case averages are about all we can use.

[…]

Given the skewness of the truncated data in Table 5-4, would a median or geometric mean be more appropriate? Using the median would produce a 3.8% multiplier, so the question is not rhetorical.

EPA Response

Commenter 1 suggests running the response component of the model for facilities which EPA has NRD data as the first step of an alternative approach. However, EPA does not have readily available data (e.g., waste rock acreage) to do so at this time. Nevertheless, EPA will solicit comment on this alternate approach and examine its feasibility for the final background document.

EPA acknowledges that reliance on CERCLA costs and NRD for an estimate of total liabilities might be a preferable approach if sufficient data were available. While commenter 2 mentions this alternative in passing, the commenter also accurately points out that the assumptions and methods used in the current approach may be necessary since NRD cannot be matched to active facilities used in the analysis. One exception is that EPA did present an estimate of NRD from a joint settlement with three New Mexico mines that are still in operation. However, since the individual NRD amounts relating to each of the three mines were not presented, EPA should not compare the joint settlement amount to the individual response cost estimates for the two mines in the sample dataset.

With respect to overhead and oversight costs, commenter 2 misunderstands the direction of the multiplication. Though the order of the terms does not matter, the theory behind multiplying the direct response costs by the overhead and oversight cost percent and then by NRD multiplier is that the historical response costs used in the denominator of the NRD multiplier included such overhead and oversight costs. This can be seen in the proof below:

$$NRD\ Multiplier = 1 + \frac{NRD}{Response\ Costs}$$

$$Total\ Costs = NRD + Response\ Costs$$

Solving for NRD and combining equations yields:

$$NRD\ Multiplier = \frac{Response\ Costs}{Response\ Costs} + \frac{Total\ Costs - Response\ Costs}{Response\ Costs}$$

This equation can be simplified to:

$$Total\ Costs = Response\ Costs \times NRD\ Multiplier$$

Response costs in the formula are estimated as follows:

$$Formula\ Response\ Costs = Direct\ Costs \times (1 + Overhead\ and\ Oversight\ Percent)$$

Finally, using the formula response cost equation to replace the response costs in the above equation one can see that total costs in the formula require multiplying the NRD multiplier through the entirety of response costs, not just the direct costs.

$$Total\ Costs = Direct\ Costs \times (1 + Overhead\ and\ Oversight\ Percent) \times NRD\ Multiplier$$

EPA disagrees with commenter 3 that sediment dredging and disposal is more appropriately captured in the response component of the formula for two reasons. First, EPA has not identified currently operating facilities for which sediment dredging and disposal engineering costs have been estimated. Thus, EPA would have to rely on the exact same NRD documents which it currently uses. Second, while EPA agrees with the commenter's characterization of the two components of NRD associated with contaminated sediment, these two components are both represented in the very dataset that EPA uses to estimate the NRD multiplier. Specifically, EPA verified with an NRD expert that actual sediment dredging work can be performed either through a response action or through an NRD action. Furthermore, EPA verified that such engineering costs were included in the final restoration alternative for the Upper Arkansas River site.

EPA agrees with commenter 3 that response costs in general are likely positively correlated to NRD where no technical impracticability (TI) waiver or other similar tradeoff has occurred. EPA reviewed its NRD dataset and compared it against the list of TI waivers presented in U.S. EPA (2012). This comparison showed that four of the 64 NRD sites in EPA's dataset received TI waivers, with two of those sites (Dupont Newport and Cherokee County Superfund Site) represented in the 24 sites for which there were both NRD and response costs**. Table 4.2a** below presents the full list of 64 sites for which EPA identified NRD amounts in Appendix L of the background document. For these sites, EPA identifies those with TI waivers, and also presents whether there were NRDA costs available. Where such costs were available, EPA presents the corrected NRD amounts.

Table 4.2a – List of NRD Sites with Assessment Costs and TI Waivers

Site	Settlement Year	Current Appendix L NRD (2014$)	NRDA Costs?	NRD with NRDA Included (2014$)	TI Waiver?	24 Subset with Response Costs
Alcoa West and Alcoa East (Alcoa and Reynolds sites; Massena site)	2013	$25,557,000	Yes	$26,506,000		Yes
American Tunnel (part of Silverton Sites)	2009	$3,598,000		$3,598,000		
Antler Mine and Mill Site	2009	$3,598,000		$3,598,000		
Arrastra Gulch Dump (part of Silverton Sites)	2009	$3,598,000		$3,598,000		
Ashtabula River Area	2012	$616,000	Yes	$2,629,000		Yes
Blackhawk Mine	2009	$222,000		$222,000		
Cherokee Lanyon #2 Site	2008	$70,000	Yes	$73,000		
Chino Mine Site	2012	$6,487,000	Yes	$7,322,000		
Cleveland Mill	1995	$238,000		$238,000		
Cobre Mine Site	2012	$6,487,000	Yes	$7,322,000		
Commencement Bay/Hylebos Waterway	2003	$6,893,000		$6,893,000		Yes
Cotter Corporation Mill Facility	1988	$5,557,000		$5,557,000		Yes
Couer D'Alene/BUNKER HILL MINING & METALLURGICAL COMPLEX	2011 & 2010	$74,685,000		$74,685,000		
CYPRUS TOHONO MINE	2009	$891,000		$891,000		Yes
Deming Mine	2009	$222,000		$222,000		
Denver Radium Superfund Site	2002	$1,917,000		$1,917,000		Yes
Dona Ana	2009	$222,000		$222,000		
Dupont Newport	2006	$1,573,000	Yes	$1,914,000	Yes	Yes
Eastern Kansas Smelters Sites/Caney Smelter	2011	$32,000		$32,000		Yes
Eastern Kansas Smelters Sites/Dearing Smelter	2011	$32,000		$32,000		
Eastern Kansas Smelters Sites/Neodesha Smelter	2011	$32,000		$32,000		
East Helena site	2009	$6,159,000		$6,159,000	Yes	
Elkem/Eramet Marietta	2006	$2,348,000	Yes	$2,878,000		
Girard Zinc Works Site	2008	$70,000	Yes	$73,000		

Site	Settlement Year	Current Appendix L NRD (2014$)	NRDA Costs?	NRD with NRDA Included (2014$)	TI Waiver?	24 Subset with Response Costs
Grand Calumet River/United States Steel, LTV Steel and other parties	2005	$63,763,000	Yes	$66,972,000		
Grand Mogul Mine (part of Silverton Sites)	2009	$3,598,000		$3,598,000		
Iron Mountain/Flat Creek	2009	$39,000		$39,000		Yes
Lavaca Bay	2005	$232,000	Yes	$1,165,000		Yes
Macalloy Site	2006	$403,000	Yes	$460,000		Yes
Magdalena Mine	2009	$222,000		$222,000		
Mayflower Mill (part of Silverton Sites)	2009	$3,598,000		$3,598,000		
Mobil Mining	1996	$142,000	Yes	$326,000		
Mogul Mine (part of Silverton Sites)	2009	$3,598,000		$3,598,000		
Morenci Mine Site	2012	$6,929,000	Yes	$7,902,000		
Mulberry Phosphates Alafia River	2002	$4,673,000	Yes	$5,978,000		
National Zinc	2007	$554,000		$554,000		Yes
Oak Ridge Reservation	2010	$208,000		$208,000		Yes
Omaha Lead Superfund Site	2011	$105,000		$105,000		
Palmerton Zinc	2009	$20,072,000	Yes	$22,770,000		Yes
Ray Mine Hayden Smelter	2009	$4,318,000		$4,318,000		Yes
Ross Adams Site	2009	$3,598,000		$3,598,000		
Salt Lake Valley	1995	$53,425,000		$53,425,000		Yes
SOHIO L-Bar Facility	2005	$35,000	Yes	$42,000		
Standard Mine	2009	$3,598,000		$3,598,000		Yes
Stephenson-Bennett	2009	$222,000		$222,000		Yes
Sunnyside Mine (part of Silverton Sites)	2009	$3,598,000		$3,598,000		
Tyrone Mine Site	2012	$6,487,000	Yes	$7,322,000		
Upper Arkansas River/CALIFORNIA GULCH	2008	$11,512,000		$11,512,000	Yes	
Uravan Uranium Facility	1987	$1,823,000		$1,823,000		Yes
Fernald Preserve	2008	$15,075,000		$15,075,000		Yes
Blackbird Mine Superfund Site	1995	$86,574,000	Yes	$94,143,000		Yes

Site	Settlement Year	Current Appendix L NRD (2014$)	NRDA Costs?	NRD with NRDA Included (2014$)	TI Waiver?	24 Subset with Response Costs
New Almaden Mine CERCLA Site	2013	$6,861,000		$6,861,000		
Iron Mountain Mine CERCLA Site	2013	$9,148,000		$9,148,000		Yes
ASARCO LLC	2013	$7,115,000		$7,115,000		
Cherokee County Superfund Site	2008	$1,314,000		$1,314,000	Yes	Yes
Cominco/Halliburton	2013	$50,000		$50,000		
Newton County Mine Tailings Superfund Site	2009	$21,845,000		$21,845,000		
Southeast Missouri Lead Mining District	2009	$44,777,000		$44,777,000		
Atlantic Richfield Company	1999	$412,542,000		$412,542,000		
Rio Tinto Mine	2013	$874,000		$874,000		
Freeport McMoRan	2010	$19,864,000		$19,864,000		
South Dakota v Homestake Mining Company	2006	$4,585,000		$4,585,000		Yes
Southwest Jordan Valley	1995	$53,388,000		$53,388,000		
Consol Energy/Dunkard Creek	2009	$543,000	Yes	$543,000		

With respect to the suggestion by commenter 3 that EPA examine taking the ratio of NRD to response costs for each site before taking the average and other summary statistics, EPA agrees that this would yield different estimates of the NRD multiplier. EPA also agrees with commenter 4 that the data here do not exhibit a similar mean and median as was the case in US EPA (2014). Thus, EPA has estimated four sets of alternative NRD multipliers in **Table 4.2b** below to cover these alternative NRD multiplier suggestions. These multipliers make use of the corrected data presented in **Table 4.1a** above.

Table 4.2b – Estimates of NRD-to-Response Cost Ratios

Data Used	Descriptor	Statistics then Ratio	Ratio then Statistics
All Data Included	Median	3.1%	1.7%
	Mean	3.1%	31.2%
	Geometric Mean	4.2%	4.2%
Outliers Excluded	Median	4.3%	2.6%
	Mean	14.3%	37.4%
	Geometric Mean	6.6%	6.6%

As seen in the table above, the corrected data in **Table 4.1a** raised the mean NRD multiplier from 13.4% to 14.3%. The table also demonstrates that the geometric means tend to be higher than the medians, but lower than the means. The geometric means are also consistent whether calculated before or after ratios are taken. Thus, EPA finds this descriptor preferable to the median or the mean. Nevertheless, EPA will include the full suite of descriptors in the final background document, and will also solicit comment in the proposed rule preamble on which estimate is most appropriate.

Finally, EPA agrees with commenter 4 both that additional refinement of the NRD multiplier is not necessary given the relatively minor contribution to total financial assurance and also that simple averages are about all that is available to the Agency at this time.

5. Formula Adjustments and Use

The peer review comments relating to formula adjustments and use are grouped into four subcategories:

- Source control assumption
- State and regional differences
- Adjustments over time
- Suggestions for additional adjustments.

5.1. Source Control Assumption

Comment Summary

Commenter 2 expressed concern about EPA's source control assumption but agreed it might be valid if some factor other than the likelihood of needing source control determines whether source control response costs are evaluated in reclamation and closure plans. Commenter 4 pointed out that the added costs for source controls reduces other costs such as drainage, water treatment, and O&M and suggested EPA estimate the water treatment and O&M regressions with a dummy variable when an upstream source control is applied at a facility.

Commenter 2

> I have two recommendations for alternative methodologies:
>
> A first and smaller methodological concern is the inclusion of an indicator variable for source control in several of the capital cost equations. Future need for source control cannot be observed, so the EPA assumes all sites will eventually need source control and uses values with this variable set to one in the Responsibility Formula. In practice, however, the CERCLA data show that source control is not always used, so this assumption overstates the true expected future response costs. One solution would be simply to exclude the variable from the estimated equations. Such estimates would yield more accurate predictions for the expect costs, if the distribution of facilities at which the states evaluate source control reflects the distribution of facilities at which source control is especially likely. However, if some factor other than the likelihood of needing source control determines where source course response costs are evaluated, then EPA's conservative assumption may be at least as valid as any alternative approach.

Commenter 4

My fourth concern is the treatment of source controls in Section 7 of the report. My understanding is that some facilities' reclamation plans included cover for open pits, waste dumps, heaps, and tailings, and these are treated in the regression as additional costs indexed by a 1,0 dummy.[FN] The final expanded regression presented by EPA, in order to be conservative, assumes source controls will be needed in a financial assurance estimate and includes the added costs for these in the final Formula. Yet surely adding costs for source controls reduces other costs such as drainage, water treatment, and ongoing O&M. The only place I see any credit for source controls is in the impact of gross precipitation in the water treatment equation, where only 5% of the gross precipitation flow needs to be treated.[FN] A better approach would have been to estimate the water treatment and O&M regressions with a 1,0 dummy when there was upstream source controls applied at a facility. I would think the coefficient on the dummy should then be negative, indicating that there are downstream payoffs to enhanced upstream environmental controls.

[FN] The coefficient for source controls on heaps was not statistically significant, which is problematic since we know that source controls add costs. This is probably because of errors in the data file and the way in which it categorizes costs. Many of the heaps in the 63 HMF sample will have cover but this has not been recognized in the data collection exercise. The source document for Pinto Valley, for example, has ET cover on its heaps (source document Table 1), and yet this was not noted in the data in Appendix G. More generally, the definition of source controls is not clear. Does earth cover and revegetation, which is undertaken at all facilities, count as source control?

[FN] I presume that without source controls more gross precipitation would need to be treated. In my Rosemont Formula estimate I presumed 100% of precipitation would have to be treated given the absence of source controls.

I am also concerned at the outright assumption in the financial assurance formula that financial assurance necessarily include source controls, as represented in the Table 7-1 regressions. Is this to say that there will be no discretion in the financial assurance formula as to whether source controls are necessary at a specific facility?

EPA Response

EPA disagrees with the suggestion made by commenter 2. If EPA were to run a regression without source controls, the R-squared would decrease and the formula-generated costs for any facility needing such controls may be underestimated. Furthermore, as pointed out by several commenters, the underlying estimates sometimes appear low. While it is only a hypothesis, one reason might be due to the lack of these same source controls. Third, the increased costs from the assumptions of source controls in the capital cost portions of the formula are offsetting with the reductions in water treatment costs in the O&M portion of the formula. Water treatment at CERCLA sites can often be one of the largest expenses, and as mentioned by commenter 4, an alternative approach would be to assume that 100% of precipitation becomes contact water in need of treatment. Based on preliminary estimates, such volumes would lead to similarly high costs, making the assumption of source controls much less conservative than it initially appears. Even commenter 2 acknowledges that EPA's assumption may be as valid as any alternative approach. Therefore, no further response is necessary.

EPA agrees with commenter 4 that the use of source controls would lead to reductions in water treatment costs. However, EPA disagrees with the remaining portion of the comment about source controls leading to reductions elsewhere in the formula. Source controls either reduce percolation through the site features (and therefore reduce the flows of water requiring treatment) or they involve amendments that make water treatment unnecessary. However, the site-wide diversion costs and other O&M costs relate to maintaining the source controls. For instance, run-on and runoff of stormwater can damage covers, and yet the commenter finds these covers would reduce the need for diversion to prevent such damage. Similarly, site-wide O&M is designed to maintain source controls. Thus, it is just as likely that additional O&M costs would be incurred to maintain a cover making use of source controls rather than a net savings. Nevertheless, EPA will solicit comment on data demonstrating that source controls reduced the costs of diversion and/or O&M other than water treatment.

With respect to the question by commenter 4 about discretion, EPA does not allow for any discretion in the costs estimated by the formula. However, EPA notes that the rule also allows for reductions that could take account of the need for various controls, and is soliciting comment on these reductions in the proposed rule preamble. These reductions are outside the scope of this background document and peer review, but EPA encourages the commenter to review this aspect of the rule should they have additional time and interest.

5.2. State and Regional Differences

Comment Summary

Commenter 4 argued that EPA missed state-level controls and regional differences, including backfilling requirements in California, wetland restoration costs for phosphate mines in Florida, and other state-level special requirements.

Commenter 4

> There are also important state-level controls that are missing. SMARA requires California mining lands disturbed after 1976 to be backfilled. Even if backfilling is not part of the reclamation plans for the two California open pit mines in EPA's sample, a forward-looking Formula needs to take this into account with a California dummy in the open pit cost category. Florida has special wetland restoration costs for phosphate mines, but neither phosphate mine in the sample is from Florida and so this special characteristic would not be revealed in the data. Other states may have special requirements as well. New Mexico and Michigan do not allow mine designs that require perpetual water treatment, and to charge firms for ongoing O&M in these states is unwarranted. I cannot help but believe that reclamation in Alaska is an order of magnitude more difficult and expensive due to location and weather. These regional differences need to be accounted for and teased out of the data if possible.

EPA Response

EPA acknowledges that many states have individual requirements for mines. However, EPA is neither designing this formula to predict state reclamation costs nor to be site-specific. Rather, EPA is developing a nationwide formula which estimates FR under the assumption of future CERCLA liabilities. Since these CERCLA liabilities may or may not be consistent with the requirements under state reclamation and closure laws, no further response is necessary.

With respect to the suggestion that Alaska is much more expensive, EPA agrees, and already accounts for the engineering supply and labor cost differences between states through the use of the USACE state-specific adjustment factors.

5.3. Adjustments over Time

Comment Summary

Commenter 1 pointed out that the GDP deflator might not be sufficient to account for the inflationary pressures faced by operators in the mining industry if imported goods and services are widely used enough to materially impact estimated costs. Commenter 4 was critical of the current approach to discounting, which was to project engineering costs as constant and then apply the discount rate. He instead suggested the engineering costs be projected as nominal costs using the escalation factor from the historical ENR series for these specific costs, then discounted using the same deflator used to estimate the real discount rate.

Commenter 1

> -The proposed formula uses the GDP deflator to account for changes in inflation. The GDP deflator does not include any imported goods or services. A detailed

accounting of the goods and services used in the mining industry could be checked in order to ensure that imported goods and services are not, in fact, widely used or significant in enough to materially impact the estimated costs, as in that case usage of the GDP deflator would not be sufficient to account for the actual inflationary pressures faced by the operators.

[…]

Outside the scope of this charge:

Regarding implementation of the formula—will each facility's financial responsibility amount be recalculated every year? As time goes on, I imagine tailings would increase (which would mean collecting more money) but could also decrease (which would mean returning money).

Commenter 4

I have one question about use of the Formula that I will mention here. The methodology collected facility-level estimates of final closure response costs based on engineering plans and models used by the facility owner. Yet on our initial conference call the idea was that the facilities establish and maintain evidence of financial responsibility should bankruptcy, for example, occur at any moment and the facility be taken over for reclamation by the government. Can the Formula's estimates of final closure costs, determined by acreage of facility disturbance at closure *and facility conditions at closure*, reasonably represent likely financial responsibility at a facility *prior to closure*? This question has not been addressed or answered. I would think that this is yet another way in which the initial collection of NPL and non-NPL costs at CERCLA facilities can be compared against Formula estimates for these same facilities such that any shortcomings of the Formula for estimating costs prior to closure can be identified.

[…]

d) The discount rate used to calculate present values of O&M costs is real (deflated). The deflator is the implicit GDP deflator. That means that the cost stream that is discounted must be in real terms, *with the adjustment from nominal to real being made using this same deflator*. The current approach, which is to project the 2014 engineering costs as constants and then discount those at 2.63%, is not correct. The 2014 engineering costs must first be projected as nominal costs using the escalation factor for these specific costs, then discounted at the same deflator used to estimate the real discount rate (the GDP price deflator). The result will not result in constant real engineering costs over time since their inflation rate is different from the deflator used to calculate the real interest rate. I suggest inflating the engineering costs at average historical rate in the ENR data, Table 3-6. Then discount these nominal costsusing the projected GDP deflator to get the real series. This is then the series that is discounted at 2.63%.

e) Likewise, the inflator for response costs on page 7-2 should not be the GDP deflator. It should reflect the inflation in response costs, which are likely to be higher than the GDP basket. I would again suggest the escalation rate from the historical ENR series as a starting point.

EPA Response

Table 5.3a – Alternative Inflation Adjustment Rates

Year	ENR CCI	% Change ENR CCI	GDP IPD	% Change GDP IPD
1990	4680		67	
1991	4777	2.1%	69	3.3%
1992	4888	2.3%	71	2.3%
1993	5071	3.7%	72	2.4%
1994	5336	5.2%	74	2.1%
1995	5443	2.0%	75	2.1%
1996	5523	1.5%	77	1.8%
1997	5765	4.4%	78	1.7%
1998	5852	1.5%	79	1.1%
1999	6000	2.5%	80	1.5%
2000	6130	2.2%	82	2.3%
2001	6281	2.5%	84	2.3%
2002	6462	2.9%	85	1.5%
2003	6581	1.8%	87	2.0%
2004	6825	3.7%	89	2.7%
2005	7297	6.9%	92	3.2%
2006	7660	5.0%	95	3.1%
2007	7880	2.9%	97	2.7%
2008	8090	2.7%	99	2.0%
2009	8549	5.7%	100	0.8%
2010	8660	1.3%	101	1.2%
2011	8938	3.2%	103	2.1%
2012	9176	2.7%	105	1.8%
2013	9437	2.8%	107	1.6%
2014	9664	2.4%	109	1.6%
2015	9972	3.2%	110	1.0%
Geometric Mean		**2.8%**		**1.9%**

Commenters 1 and 4 both indicated potential issues with the use of the GDP deflator, while commenter 4 also indicated potential shortfalls of the 2.63% discount rate used for O&M costs. EPA acknowledges that engineering costs often rise at different rates than overall prices, and that these increases may also not be related to the rate of return of the Superfund. To confirm this, EPA calculated the geometric mean of both the ENR CCI and the GDP IDP as seen in **Table 5.3a** above.

EPA based the discount rate input on the average real interest rate realized by the Superfund over its existence. Under CERCLA, funds would often be deposited into either the Superfund or a special account. Thus, EPA believes the rate of return of investments held by those vehicles is the most appropriate indicator of the potential future growth of funds. For this reason, EPA does not find further analysis of the discount rate for O&M costs necessary.

With respect to future inflation, EPA notes that the ENR CCI increase has a geometric mean almost one percent higher than that of the GDP IDP over the past 15 years. If this trend continues, it indicates that future applications of the formula could potentially result in underestimates of financial responsibility. On the other hand, EPA stated in this background document that it chose the GDP deflator due to its familiarity and ease of use among the regulated community. For instance, in closure and post closure cost estimates for hazardous waste treatment, storage and disposal facilities, EPA requires the use of the GNP implicit price deflator – now GDP implicit price deflator (U.S. EPA, 1996) – even though it is not a precise match to the price index for the exact equipment/services used in closures/post-closure estimates. For example, see 40 CFR 264.142(b), 264.144(b), 265.142(b) and 265.144(b). Furthermore, given that there is considerable uncertainty around future price changes, it is not clear that there will be any material difference between the two indices in the long run. Nevertheless, EPA acknowledges that the GDP deflator has the potential to underestimate future costs, and thus the Agency will solicit comment on the appropriateness of the ENR CCI as an alternative inflation adjustment.

Finally, commenter 4 asked about the implementation of the formula for mines prior to closure. EPA intends the formula to be applied to a facility as currently operated. Thus, while the regressions were estimated based on closure plans that portrayed the expected acreage at closure, the formula will only require a facility to post financial responsibility for the current acreage in use (and other conditions) at the time of the estimate. EPA thanks the commenter for identifying that this aspect as unclear, and will add additional language to the final background document.

5.4. Suggestions for Additional Adjustments

Comment Summary

Commenter 4 suggested EPA adjust the formula to add a responsibility offset for salvage and patented land sales at closure.

Commenter 4

> This list is reasonable and complete but for a credit for salvage and patented land sales at closure, which should be added as a responsibility offset if legally permissible.[FN] At the Johnson Camp facility, for example, mine salvage costs are estimated to exceed all closure costs, in which case no financial assurance would be required. Most mine reclamation cost models do not include salvage, but these can usually be found in the technical studies for each facility (cf. fn [5]).
>
> [FN] A question could be whether more or less aggregation would be advisable. For instance, waste rock and tailings contouring are similar, suggesting more aggregation. Or, open pit fencing is different from open pit berms, suggesting less aggregation. I believe that the categorizations are reasonable, providing enough fidelity and yet not being too detailed so as to be overwhelming in the estimation process that follows.
>
> [FN] Johnson Camp Mine Project Feasibility Study, Cochise County, Arizona, Technical Report Pursuant to National Instrument 43-101 of the Canadian Securities Administrators. Prepared For Nord Resources Corp. Prepared By Bikerman Engineering & Technology Associates, Inc., Old Lyme, Connecticut, September 2007, p. 186.

EPA Response

EPA acknowledges that where a facility owns property and equipment it may receive money for the sale of that property and equipment upon closure. However, it is not clear that facilities own the majority of their property or equipment. For instance, in collecting data on the number of employees that facilities had for purposes of the RIA, EPA noted that most facilities employ mostly contractors. Contractors are likely to provide their own equipment, or to lease the equipment. Thus salvage would not be possible. Even where salvage occurs, companies often only receive pennies on the dollar. The same is true of land resale. Many facilities are located in whole or in part on state or Federal land that is leased (even some private land may be leased). Thus, the idea that salvage and resale would offset the costs of a CERCLA response is inapplicable at most facilities. Finally, even if salvage and land sale are available, EPA reminds the commenter that the point of this financial assurance program is to backstop the expenditure of taxpayer funds in the event that a facility cannot meet its CERCLA liabilities. In these cases, such as the recent ASARCO settlement, most creditors receive only pennies on the dollar, even after all assets such as salvage and land are accounted for. Thus, EPA declines to account for these offsetting values, which would only be realized in the scenario that financial responsibility is not necessary in the first place.

6. Comments Related to the Documentation and Miscellaneous Comments

The peer review comments relating to ecological exposure and toxicity are grouped into four subcategories:

1. Transparency issues and text edits
2. Overarching comments
3. Miscellaneous comments.

6.1. Transparency Issues and Text Edits

Comment Summary

Commenters 1, 3, and 4 suggested EPA provide a more detailed description of the data and how it was used to construct the formula in order to improve transparency. Commenters 1, 3, and 4 also suggested language and additional details EPA should include to improve clarity and transparency. Commenter 2 argued EPA should make clearer the intent to include only the cost for site features with non-zero acreages. Commenter 3 also argued EPA compare total response costs to the sum of each site feature cost. Commenter 4 questioned why EPA evaluated the types of response activities at a cross-section of NPL mining facilities. Commenter 4 discussed the underlying assumptions and agreed that the assumption that response control expenses are separable and additive across activities makes sense. Commenter 4 suggested EPA include all regressions, make source documents publically available, and provide the data files supporting the preconditions of the data and regression results. Commenter 4 also argued EPA could aid transparency by providing examples of how the Formula would be applied to facilities in the document.

Commenter 1

> Much work was put into carefully thinking about how different pieces of the financial responsibility formula could be estimated. Throughout reading the document, concerns that I came up with were quickly allayed by further reading.
>
> Recommendations to improve transparency:
>
> […]

I have a similar comment for the discussion of the Remedy Study Universe dataset. It is not clear how these data are used to construct the formula. Without using the Remedy Study Universe data, would you have arrived at the same 13 action categories as you have? That is the 13 action categories used to create the financial responsibility formula? Could you have not just looked at the Engineering Cost Estimate data to realize these 13 action categories? It would help if the purpose of the Remedy Study Universe data was made more apparent.

[…]

Description of data:

This document entails a lot of work with a lot of different datasets, however, as far as I can tell, not all datasets described are used to obtain the final formula, which makes the methodology less transparent. (I wrote out in the first charge question how I understand the different datasets and how they are used in the formula--if I am wrong, then this points to the need for clarity and if I am right then much of the text may be extraneous).

[…]

Minor comments:

-Similar to the comment above on increasing transparency, I don't understand why you need to show Table 5-3. You are not using column three to determine your multiplier.

[…]

-When reading equation 5-1 not clear that cost terms are costs from the same facility.

[…]

Very minor:

-Missing bracket in Equation ES-1 and Equation 7-5 around LogAcresProcessPondReservoir.

-Text moves from referring to "data" as singular to referring to data as plural. Change all to plural.

Commenter 2

The Responsibility Formula could make clearer the intent to include only the cost for those site features with non-zero acreages.

Commenter 3

<u>* General comments</u>: The work is generally described in detail (with the exceptions noted below), but because there are so many sources of data and so many different types of information that the EPA is trying to put together, I got lost several times, despite the fact that I was taking notes while reading the report, and in some places I just cannot follow the logic of the Agency.

Let me recap quickly what I learned and highlight where things are unclear.

1) They selected hard rock mining sites from the NPL list or from non-NPL CERCLA sites. This produces a total of 315 facilities, from which it is possible to get total cleanup costs for 185 sites. Total includes past and future, and is based on the records of decision (RODs), actual or anticipated expenditures, etc.

2) From NPL or Superfund alternative sites, it is possible to get activity-specific cost figures for a total of 488 operating units (OUs) at 88 sites. There are many specific activities, but these are aggregated into a total of 12 categories, such as water treatment, off-site disposal, on-site disposal, etc.

3) EPA collected the cost of removals from non-NPL, non-listed sites where removals took place. This is for a total of 171 response actions at 82 sites.

4) Then, the EPA developed an inventory of facilities registered with the Mining Safety and Health Administration and the US Geological Survey, restricting attention to those were identified in the 2009 notice and excluding facilities smaller than 5 acres and closed and abandoned facilities. This results in a total of 354 facilities.

5) They collected data from state and federal sources about the (expected) reclamation and closure (R&C) costs from a subset of these 354 facilities (63 to be exact). The EPA believes this subset to be sufficiently representative of the universe of 354. It turns that only at 15 currently open facilities is there any information about water treatment and water treatment costs, so EPA supplemented this information with data coming from 3 CERCLA facilities with exact information about water treatment costs.

6) EPA and matched the R&C activities from 5) as closely as possible with those listed in 2) for mining sites on the NPL. In this way, the engineering estimates of the costs of the activities in the R&C plans may be imputed to the remediation activities in 2).

7) Finally, a variety of sources are used to find information about site conditions, hydrology, processes, etc.

   Finally, data on specific activities are used to run regressions relating the costs to the facility size (in acres), and, when appropriate, to other site or process characteristics, such the hydrological conditions at the site or in-situ leaching.

   And this is where my questions start:

   - Which dataset was used to run the regressions? I thought it was the one in 2) the first time I read the report, 5) the second time, and I had literally no idea the third time around. Help!
   - Is the purpose of 2) to understand what kind of remediation may become necessary at closed or abandoned facilities, and thus should be covered by the financial responsibility formula? What is done with the data coming from these sites and the related activities?
   - What happens to the data documenting the cost of removals? Are they ever used again in this analysis, in their own right or to supplement other sources? If so, I couldn't find where.
   - Were the total response costs used only as the denominator of NRD to total response costs?
   - How do total response costs compare with activity-by-activity costs? Are they consistent, in that at one site total response costs exceed or are equal to the sum of activity-by-activity costs?

     Also see my response to charge questions 5 and 6 for more discussion on certain decisions made by EPA in constructing data and variables.

[…]

<u>* Variable construction:</u>

<u>Water treatment capital costs</u>

Why are you considering only O&M water treatment costs? Isn't there a capital cost for setting up water treatment equipment, or is that already included in the other categories of table 3-7? If so, it might help to state so explicitly.

[…]

<u>Health Assessment costs</u>

Please explain what an ATSDR health assessment entails. Do they get samples of blood from residents? Do they test the drinking water? Do they do an assessment at their desk based on the results of lab tests and published risk assessment and materials?

I went to their most relevant web page

(http://www.atsdr.cdc.gov/about/program_overview.html) and it was last updated only back in 2013.

Commenter 4

EPA then evaluated the types of response activities at a cross-section of 88 NPL mining facilities, presumably with a view to understanding what response activities to include in the Formula. The data set included a well-diversified sample across size, cleanup status, metal or mineral, and cleanup facility leads. This step of the process was not well motivated given the ultimate method by which the Formula was developed. The ultimate method looked to engineering remediation plans at a set of active HMFs, and estimated costs based on these plans. The plans included efforts to control solids and liquids, contour land, seal portals, and so on.

These *are* the response actions that are required. Was EPA worried that actual experience would reveal that mining companies are overlooking a response activity? Or were they looking for the broad categories of response activity that should be included in the Formula? The document needs clarity here.

In the end I have no idea what the relevance is of any of the data presented in Section 2.2. On page 2-15 EPA states "EPA's prior experience with CERCLA cleanups leads it to expect that similar types of remedies will continue to be selected for mining facilities in the future." There is no reason to make any presumptions here – the closure and reclamation plans and data collected in Section 3 indicate exactly what types of remedies are required at current HMFs. The engineering studies relied upon categorize the expense categories (tailings, leach dumps, pit, hazard removal, indirect costs, direct costs, etc., pp. 2-19 – 2-20). Perhaps the idea is that EPA was looking for justification for its methodology in Section 3, feeling it needed to prove that relying on company engineering plans was reasonable and that companies would not be leaving anything important out.

Despite the lack of methodological clarity, Section 2 does introduce some foundational assumptions. The first is that response control expenses are separable and additive across activities. This is a reasonable assumption, and is consistent with the way engineers think about the problem. The second is that costs would be categorized around the following unit operations: open pit, underground mine, waste rock, heap/dump leach, tailings facilities, process pond/reservoir, slag pile, solid hazardous waste disposal, drainage controls, water treatment, short term monitoring and treatment, long-term (perpetual) monitoring and treatment, and overhead and oversight costs.

[…]

I would also say, in a brief comment on incentives, that requiring $163 million in financial assurance for Rosemont, as opposed to the $18 million being planned by the company as of its 2007 technical study, would not have killed this mining project. Its economics at the time looked able to sustain the increased up-front capital expenditure. Nevertheless, in building up my Formula estimate of $163 million for Rosemont I found several areas that required data judgements that I can see companies and the EPA arguing over or even litigating over. For example, there is no definition of *LogAcresTotal*. Nor is there a clear definition of *LogAcresTailings* when it is dry stacked and mixed with waste rock. Even where the technology is fairly clear a given project will have several estimates for facility acreage (e.g., open pit acreage can be measured as actual pit, pit plus buffer, total pit disturbance including roads and ramps, reclaimed pit, etc.). It will be advantageous for the firm to select the lowest possible number in order to minimize its financial assurance.

[…]

I would add here comments related to transparency that are immediately feasible. First, I would suggest that all regression results be reported, not just those that were statistically significant.

Waste disposal regressions, for example, were not reported. Second, the source documents for the data should be publically available. I had to ask EPA to supply me with the closure reports that I sampled since I could not find them in the public domain. Third, there needs to be complete data files supporting the preconditioning of the data and the regression results such that one can exactly replicate this work. This would alleviate perhaps the concerns I have about the source data in Appendix G: if it is preconditioned data I could see how it was done. I would also recast the Formula (expanded) for public viewing in simplified form, as “smear factor x leach response cost factor x acres1.01” or “2.29 x 104.29 x acres1.01” or “$44,651 x acres1.01” or something like that. There is no reason to present the formula in its original and unsimplified logged form.

All data in the written documentation should have footnotes indicating where the data can be found (listing source document and page number). See my concerns above regarding reproduction of the source data used in Appendix G.

To aid transparency on how the Formula will be used I would suggest that EPA, in addition to giving the final expanded Formula in Section 7, provide worked examples of how the Formula would be applied to selected facilities (ideally, there would be an example for a mining facility, a processing facility, and a smelting facility). That is, take the information in one of its Appendix G source documents and use that to calculate the total financial responsibility for a given year for that facility. I have attempted to do this exercise for Rosemont, but my efforts would have been aided by a worked example with advisory notes.

[…]

As I mentioned above, a data file showing the pre-analysis should be provided to the public.

The first step in standardization was to bring all engineering costs to 2014. The index used was the ENR construction cost index. The index is appropriate for mining cost changes over time. The second step was to account for differences in state-level labor and materials costs using a US Army Core of Engineers cost index. This is reasonable, since the engineering costs in the source documents would have attempted to take these local variations in costs into account. Finally, EPA standardized the costs by converting into annualized costs using amortization. EPA should report the rate it used in the amortization.

[…]

Minor and editorial comments:

a) p. vi, "EPA considered how to develop an amount of financial responsibility that reflected an amount of funds that might be required in the event of a release from a regulated facility"? Why are the funds targeted to a specific release? We were told on the conference call that the funds reflect EPA responsibilities in the event of bankruptcy or project abandonment. The Formula estimates the total suite of response costs.

b) p. ix, "In addition to water-balance-related data, EPA collected data related to process methods for the four leaching processes identified at the 63 facilities in EPA's data set. These process method data included the use of floatation, cyanide, acid, and in- situ leaching processes." Flotation (note spelling) is not a leaching process. It is a chemical separation process.

c) The labels for short-term O&M monitoring, long-term O&M monitoring, and interim O&M are vague and confusing. Both the short term and interim O&M are taken over 10 years, for example, and so why the time differentiation?

[…]

f) On page 5-2, and elsewhere in the report, use common notation. On page 7-2 *Dy** is used to denote the deflator, and then *Deflatory** is used further down. Are these the same thing? Why develop *IFy* and then not use it in Equation 7-3?

[…]

i) Equation ES-1 is the expanded formula for a facility "with a single facility feature of each type (*e.g.*, a single heap leach)" (p. xvi). Does this mean that if a facility has two heaps the acreage of each would be costed separately? I suggest for clarity that EPA present an expanded formula for a facility that has two waste dumps, for example.

[…]

k) I found much of the discussion in Section 2 to be unrelated to the final Formula estimate. What, for example, is the relevance of the data in Figure 2-10? All of Section 2 could be edited with a view of relating the information and findings to the Formula. Table 2-2 is the most important portion of the section, and deserves more discussion. Source controls need to be included in the table.

l) p. 2-20, the discussion under tailings facility and process ponds incorrectly refers to eap and dump leaches.

m) p. 2-23, contingency does not describe cost overruns or project cost overruns. It is a catch-all cost element for items not explicitly contained in the engineering studies.

n) In Section 3.2 it is not clear if EPA obtained data directly from the source documents listed in Appendix G or whether it obtained secondary data from state governments who in turn claim to have taken the data from the source documents. There is no reason that for consistency of reporting EPA should not obtain the data from the primary sources.

o) The calculations in Appendix B are based on "the equations discussed in Section 2-1 of this document: (Appendix B-2)." With a view to transparency and replicability, the EPA needs to add clarity as to which equation was used for which facility. Moreover, Table 2-1 should list the response costs overall, as well as separated out for NPL and non-NPL facilities since the report quotes averages for each type of facility.

p) In equation 3-2 is *CS* the same as *Cost2014$* in equation 3-1?

[…]

r) p. 4-14, the hazardous waste disposal cost used in the Formula is not approximately $2.6 million. It is precisely $2.6 million.

s) p. 7-6, clarify what facility features *f* is indexed over. Is the first facility feature open pits, or open pit #1 in the case of there being several pits? Is $k = 3$ if there are open pits, waste dumps, and leach piles, or is it equal to the total number of open pits, waste dumps, and leach piles?

t) Response costs should be defined when it is first used in the document.

u) Please add units when presenting numbers. For example, in Table G.13d are the numbers $ or $/yr?

EPA Response

<u>*CERCLA Cost and Response Activity Data*</u>

Several commenters requested clarification as to both how and why the CERCLA cost data and response activity data were used. As stated in Section 1 of the background document:

> In CERCLA 108(b)(2), Congress directs EPA to initially establish the level of FR based on "the payment experience of the Fund, commercial insurers, courts settlements and judgments, and voluntary claims satisfaction…" EPA thus collected information in these categories as summarized in **Table 1-1** below.

Since the statute directs EPA to make use of this data, EPA evaluated and used it to the extent possible. First, EPA collected cost data from CERCLA sites in Section 2.1 of the background document. Then the Agency proceeded to collect the response activity data in Section 2.2. After collecting this full suite of data in response to the statutory mandate, EPA evaluated its potential usefulness, and at the outset of Section 2.3 stated that the Agency believed:

(1) That costs of specific response actions in Section 2.2 will vary with site characteristics, and

(2) That the cost data collected Section 2.1 could not be disaggregated into specific responses.

Thus, the discussion in Section 2.3 continued by explaining that the Agency linked these historical categories of responses to current cost estimates in order to generate relationships to site characteristics. Thus, while the Agency evaluated the data in Sections 2.1 and 2.2, it ultimately had to use proxy data from reclamation and closure plans in place of the actual cost data in Section 2.1 for the purposes of the regression analyses conducted.

However, as correctly pointed out by the commenters, the Agency did use the actual cost data as the denominator for the NRD multiplier estimated in Section 5 of the background document. To further clarify the uses of these datasets, EPA will add additional discussion to the final background document.

Other Transparency and Editorial Issues

EPA agrees that Table 5-3 of the background document is unnecessary, and potentially confusing. Therefore, the Agency will remove it from the final background document.

EPA also agrees that Equation 5-1 is unclear, and will state that the costs are from the same facility in the final background document.

With respect to Commenter 2, EPA agrees that it should more clearly state that each response category in the formula is only intended to be used with a non-zero acreage. This clarification will be added to the final background document.

Commenter 3 is correct that the O&M costs for water treatment include capital costs. As discussed on page 3-18 of the background document, these costs were amortized so that a single annualized value could be used in the regression analysis.

With respect to ATSDR health assessments, EPA will add additional references to the final background document which contain explanation of the health assessment process.

EPA agrees with commenter 4 that further definition of the model inputs would prevent companies from gaming ambiguous definitions. Disturbed acreage and other regulatory definitions are being provided in the proposed rule preamble, and after considering public comments, the agency will also include these definitions in the final background document for clarity to the regulated community. Specifically, the preamble states that acreage is aggregated across similar site features, and this will be clarified in the executive summary of the final background document.

With respect to the usability of the formula, EPA has included calculations of financial responsibility for 49 sites in the regulatory impact analysis of the proposed rule. No further action is necessary.

EPA agrees with commenter 4 that all references cited in the background document should be made publicly available and has placed each in the docket for the proposed rule which can be accessed at www.regulations.gov using Docket ID No. EPA-HQ-SFUND-2015-0781. No further response is necessary.

Commenter 4 also suggests that EPA provide the results of the regressions that were not significant and the underlying data transformations. EPA agrees that these would increase the transparency of the document and has therefore generated a new version of Appendix G that will be included in the final background document. The revised appendix is attached to this response to comments document as **Attachment B**. Additionally, EPA will add the regression results for the solid and hazardous waste disposal regression that returned no statistically significant variables. These results are presented in Table 6.1a below.

Table 6.1a – Solid and Hazardous Waste Disposal Capital Cost Regression Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.04
R Square	0.00
Adjusted R Square	-0.04
Standard Error	0.89
Observations	25.00

ANOVA

	df	***SS***	***MS***	***F***	***Significance F***
Regression	1.00	0.03	0.03	0.04	0.84
Residual	23.00	18.25	0.79		
Total	24.00	18.28			

	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***	***Lower 95.0%***	***Upper 95.0%***
Intercept	5.37	0.42	12.76	6.4E-12	4.50	6.24	4.50	6.24
LogAcres_Total+1	-0.03	0.15	-0.21	8.4E-01	-0.35	0.28	-0.35	0.28

RESIDUAL OUTPUT

Observation	***Residual (û)***	***10^û***
1.00	-1.64	0.02
2.00	-1.39	0.04
3.00	-1.32	0.05
4.00	-1.31	0.05
5.00	-0.89	0.13
6.00	-0.77	0.17
7.00	-0.69	0.20
8.00	-0.42	0.38
9.00	-0.19	0.64
10.00	-0.19	0.64
11.00	-0.11	0.78
12.00	-0.01	0.98
13.00	0.03	1.08
14.00	0.18	1.51
15.00	0.35	2.21
16.00	0.50	3.14
17.00	0.49	3.08
18.00	0.52	3.30
19.00	0.54	3.50
20.00	0.81	6.41
21.00	0.91	8.08
22.00	1.02	10.44
23.00	1.11	13.01
24.00	1.25	17.67
25.00	1.24	17.28
	Smear Factor	**3.79**

With respect to additional minor clarifications requested by commenter 4 that were not otherwise addressed elsewhere in this response to comments document:

a) CERCLA only allows recovery in the event of a release or threat of release of hazardous substances, so financial responsibility amounts are also only accessible for such releases;

b) EPA will correct the statement with respect to floatation in the final background document;

c) Interim O&M is a cost only incurred at facilities with heap and dump leaches or tailings facilities, and thus is distinguished from other site-wide short-term O&M. EPA will clarify this further in the final background document;

m) EPA will correct the definition of contingency in the final background document;

n) The Agency will be more clear in the final background document that data was obtained directly from the source documents (which were provided by other government agencies); and

s) EPA will clarify the meaning of *i* and *n* further in the final background document.

Finally, EPA agrees with the remaining editorial comments, including those calling for using consistent notation, and will make these technical corrections to the final background document.

6.2. Overarching Comments

Comment Summary

The commenters agreed that the overall methodology and approach is sound and reasonable, especially given the data, resource, time constraints. Commenter 4 argued that although the methodology is sound, EPA should improve the implementation of the data collection and analysis and closely interact with industry professionals to improve the development of the Formula.

Commenter 1

> CERCLA 108(b) Hard Rock Mining and Mineral Processing Financial Responsibility Formula details the tremendous work that went into the construction of the financial responsibility formula. The econometrics behind the formula make sense, and the EPA has found a parsimonious specification to assign financial assurance amounts across different facilities.
>
> An enormous data collection effort was undertaken to obtain information. These fall into six data categories:
>
> <u>Actual Response Costs</u>: A dataset on expenditures made on CERCLA hardrock mining facilities on the National Priorities List and non-National Priorities List.

These are actual expenditures in the past, as well as estimated future expenditures. There are 319 facilities in this dataset.

Remedy Study Universe: A dataset of actions taken for specific components at 88 national-priority-list or Superfund-alternative hardrock mining sites. Gives a general description of the type of features and the types of remedies.

Currently Operating Facilities: From MSHA and USGS, the EPA collected data on characteristics of currently-operating hardrock mining facilities, including only facilities that would be eligible to the proposed rule (e.g., dropping coal mines and abandoned mines). From this dataset there are 354 facilities that are predicted to be affected by the proposed rule.

Engineering Cost Estimates: Of the 354 Currently Operating Facilities, EPA obtained predicted engineering costs for reclamation and closure plans for 63 facilities.

Natural Resource Damages: Use data from 64 hardrock mining sites from CERCLA court settlements and judgements and voluntary payments. Of these 24 of the hardrock mining facilities are also found in the Engineering Cost Estimate dataset.

Health Assessment Costs: Various different sources providing examples of health assessment costs as well as averages.

Here I outline how I understand these different datasets are being used:

The Actual Response Costs are used to obtain an estimate of response costs that can be used to compare costs found in future sections of the document. For example, the response costs are compared to the NRD in section 5. The Remedy Study Universe gives insights into the size of sites, hazardous compounds on sites, and most frequently used response action (e.g., off-site disposal, water treatment etc.). The EPA uses the sample of 354 of Currently Operating Facilities to show that the 63 facilities with Engineering Cost Estimates are representative of the larger sample. The 63 facilities with Engineering Cost Estimates comprise the data that are used to estimate the response- cost parameters in the financial responsibility formula. The response actions in the Remedy Study Universe are different from the response categories in the Engineering Cost Estimates data (for example, the Remedy Study Universe has off-site disposal, on- site disposal, sediment dredging, water treatment, building deconstruction and the Engineering Cost Estimates have open pit capital costs, tailings facility capital costs, interim O&M costs, with Table 2-2 providing a crosswalk). In the Engineering Cost Estimates data, costs are formed into 13 different action categories. Cost functions for these 13 actions are estimated separately (each running stepwise regressions to determine the important determinants of cost). The Natural Resource Damage dataset is used together with facilities that are also found in the Engineering Cost Estimates data to calculate the NRD multiplier.

The document goes through the reasoning for all steps EPA takes, for example, the reasoning to turn to the Engineering Cost Estimates, the reasoning to log-transform the data, and the reasoning to drop outliers in the calculating the NRD multiplier. My overall assessment is that the methodology used to develop the formula is reasonable, especially given the small sample of facilities EPA had to work with.

Commenter 2

The EPA's overall methodology is sound and reasonable, given the information, resource, and time constraints. The categories of response costs, approach to their predictions, and handling of various adjustments in the formula all seem appropriate.

Commenter 3

I will start this report by noting that I do not have any conflict of interest, and that I have done research in the area of hazardous waste sites, remediation, and the public's willingness to pay and preferences for hazardous waste site policies. I have also lived in Colorado, where I saw several of the mining sites covered in the EPA document (you drive by them on the way to and from the ski slopes), other major Superfund sites, and documentation and records about cleanup under various programs at the Colorado Department of Public Health and Environment. I used to be familiar with the bond system—at least for the type of mining (coal) covered by Department of the Interior's Office of Surface Mining (more on this below).

I read the EPA document report with curiosity and interest, and I am most impressed with the effort to extract data from and link so many different databases and sources of information. It must have taken a small army of research assistants and programmers to get this done.

[…]

The general approach seems reasonable—estimate likely environmental remediation costs, given the size of the operation, proximity of natural resources such as ground- and surface water, and processes used. The approach dutifully takes into account constraints imposed by the statute, namely which categories of cost should be considered (NRD and health assessment cost) and which are not allowed.

[…]

In the absence of more detailed information, I am fine with assigning a fixed amount to the health assessment cost component of the formula.

Commenter 4

Financial assurance was to include response costs, natural resources damages, and health assessment costs.

The question mentions estimating "reasonable financial assurance amounts," and part of the evaluation of methodology has to be guided by a definition of what is "reasonable." On our conference call we were informed that the goal was that the Formula would provide an estimate of financial assurance that would be up to 100% higher than or 50% lower than the realized costs in the event of government cleanup of a facility, meaning that the realized cost should be in a range between 50% below or 100% above the estimated assurance cost. I take this to be the standard for each of the three categories of costs, and not the total cost and nor for each component of the response costs, though this was not made clear on the call.

EPA developed the Formula in a stepwise manner, first estimating total response costs for a specific facility, and then estimating natural resource damages and health assessment costs for that facility. In the end the health assessment cost was taken to be the same for each facility, at $550,000 (in 2014 dollars), and the natural resource damage was taken to be 13.4% of the estimated fully overheaded response cost for the facility. Given the magnitudes of the response costs the health assessment cost is, for all but the smallest facilities, trivial. For example, from Table 3-7 the average response costs, inclusive of overhead and oversight but ignoring ongoing annual operating and maintenance costs, is around $50 million.[FN] The natural damages multiplier of 13.4% is by inspection a fraction of the overall costs. Hence, the weight of the financial assurance in the Formula is placed on the response costs. Appropriately, then, the majority of EPA's methodological design and effort focused on response costs.

[FN] Of course, not every mine will have every response category, and so the estimate is simply to provide an order of magnitude of response costs estimated by the active facilities sampled by the EPA.

[…]

Likewise, I am fine with the analysis in Section 6. Any error in the HA costs will be swamped by the errors in the response costs.

[…]

> Let me summarize. Given the time constraints and data constraints experienced by EPA I am of the opinion that the overall methodology is sound. I especially appreciate the scientific, data- driven approach. However, even with the goal of presenting only a Class 5 facility-specific assurance cost, the implementation of the data collection and analysis leaves much to be desired, and a careful consideration of my previous comments is needed. I would also observe that if it has not done so EPA could benefit from closely interacting with industry professionals. While I have not been privy to the generation of the Formula or report, the little bit of close data inspection that I have done gives me the impression that there is a stark lack of understanding of the workings of the industry that the EPA is tasked with regulating.
>
> […]
>
> All of this is not to say that I don't think the proposed methodology can achieve EPA's goals. I am broadly in favor of the approach taken. It is just to say that the exercise is not yet over the finish line, and my hope is that my comments will help to move the exercise in that direction.

EPA Response

EPA acknowledges the comments that the formula approach is sound. EPA also acknowledges the comments that a fixed amount for health assessment costs is appropriate given the absence of additional data. No further response is necessary.

With respect to the suggestion from commenter 4 that EPA should engage mining professionals, EPA notes that it has relied on mining experts not only from within the EPA regional offices, but also external expertise from the mining community. No further response is necessary.

6.3. Miscellaneous Comments

Comment Summary

The commenters had comments on a variety of miscellaneous issues. Commenter 1 argued that excluding mines less than five acres from the proposed rule might encourage mines to bunch at 4.99 acres. Commenters 1 and 3 agreed that EPA's standardization procedures make sense. Commenter 4 also discussed the impact of the Formula on firm activity.

Commenter 1

> "Data were not collected for mines less than five acres…because EPA is proposing to exclude such mines from the proposed rule" --- With this type of cut off, you might end up with mines bunching at 4.99 acres?
>
> […]

These standardization steps make sense.

[…]

Not familiar enough to say.

[…]

-I was confused by the discussion of the Standardized Reclamation Cost Estimator model. You predicted costs using acreage, then used that prediction to regress on acreage to get a coefficient on acres? "This dataset included costs as well as related inputs that drive these costs components. For example, acreage is an input of the Standardized Reclamation Cost Estimator model used to conduct several of the collected engineering cost estimates." Is the reason that this was only one part of the engineering costs? Otherwise, you could skip the estimation procedure by knowing how the Standardized Reclamation Cost Estimator model determines the cost of acres.

Commenter 3

I am fine with the [data standardization] procedures used by EPA.

Commenter 4

I have two types of comments that are not covered in the questions above. The first relates to the effect of this Formula on firm activity, and the second are some minor points.

Based on the data provided in the study, the financial assurances required will be substantial in relation to other costs at the regulated facilities. I believe that firms will attempt to reduce exposure to these costs as in traditional microeconomic theory. They are not quite irreversible capital costs, however, since they would be returned once the facility is reclaimed. It would be better to think of them as reversible capital costs, rK, where r is the opportunity cost of having the funds tied up. If interest equal to r is provided by EPA while the funds are in escrow, then there is in theory no opportunity cost to the financial assurance. Nevertheless, given capital market imperfections and the difficulty many mining firms have in raising capital during the development phase of the project, I believe they will be incentivized to create design changes to avoid the costs. Since the Formula is mainly based on area (acres), there will be efforts to reduce the acreage of open pits, heaps, tailings facilities, and so on. “Use land efficiently” will be the industry’s new mantra. There will be incentives to prefer dry stack to wet tailings and locate in negative precipitation areas. There will be incentives to locate facilities in states where EPA oversight costs are lower. Some projects will not go forward given the additional up-front capital costs associated with the financial assurance. All of this would reduce risks and costs for the Superfund program.

That said, are any of these effects likely to be welfare-enhancing? I doubt it. I can't see that the externalities associated with mining are from privately selected acreage being greater than the social optimum. The incentive to dry stack tails and to locate facilities in arid areas may be beneficial from a water management and pollution point of view, but it can be damaging to water supply sources in arid areas.

EPA Response

The proposed rule preamble provides explanation of EPA's rationale for excluding mines and processors of less than five acres. However, this issue is outside the scope of this peer review, and therefore no further response is necessary.

With respect to the references to the SRCE model, EPA used the model to support the professional judgment of those deciding on the initial suite of variables to be used in the stepwise regression process. However, the SRCE model is a site-specific model that requires detailed engineering plans and judgment to be exercised prior to its use. In contrast, no remedial alternatives will have been considered prior to the use of the financial responsibility formula. Thus, no further response is necessary.

Finally, with respect to the impacts to firms and the incentives created by these impacts, EPA has conducted a regulatory impact analysis which is available in the docket for the proposed rule. As this issue is beyond the scope of the peer review, no further response is necessary.

7. References

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U.S. EPA (Environmental Protection Agency). 2012. *Summary of Technical Impracticability Waivers at National Priorities List Sites*. OSWER Directive 9230.2-24. August. Available online at: https://nepis.epa.gov/Exe/ZyNET.exe/P100EYIC.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2011+Thru+2015&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C11thru15%5CTxt%5C00000005%5CP100EYIC.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

Attachment A: Regression Residual Normality Test Results

This appendix presents the Anderson-Darling test results discussed in **Section 3.2 "Lognormality Issues"** of this document. The Anderson-Darling test was used to determine whether the regression residuals follow a normal distribution. Additionally, this appendix presents frequency plots for each independent and dependent variable.

A.1 Anderson-Darling Test

The hypotheses used in the Anderson-Darling test for a normal distribution are as follows:

- H_0: Data are sampled from a population that is normally distributed.
- H_A: Data are sampled from a population that is not normally distributed.

EPA presents the p-values and conclusions at the p = 0.05 (95%) significance level of the Anderson-Darling tests for each independent and dependent variable in **Table A.1**. Furthermore, EPA presents the results graphically in **Figures A.1** through **A.21**.

Table A.1 – Anderson-Darling Test Results

Variable	Anderson-Darling Normality	Normality Determination
Open Pit	p = 0.51, fail to reject null	Normal
Underground Mine	P = 0.27, fail to reject null	Normal
Waste Rock	p = 0.85, fail to reject null	Normal
Heap/Dump Leach	P = 0.91, fail to reject null	Normal
Tailings Facility	p = 0.55 fail to reject null	Normal
Process Pond/Reservoir	p = 0.54, fail to reject null	Normal
Drainage	p = 0.21, fail to reject null	Normal
Interim O&M Costs	p = 0.73, fail to reject null	Normal
Water Treatment Costs	p = 0.20, fail to reject null	Normal
Short-Term O&M/Monitoring Costs	p = 0.07, fail to reject null	Normal
Long-Term O&M/Monitoring Costs	p =0.46, fail to reject null	Normal

Figure A.1 – Normality Probability Plot for Open Pit Regression Residuals

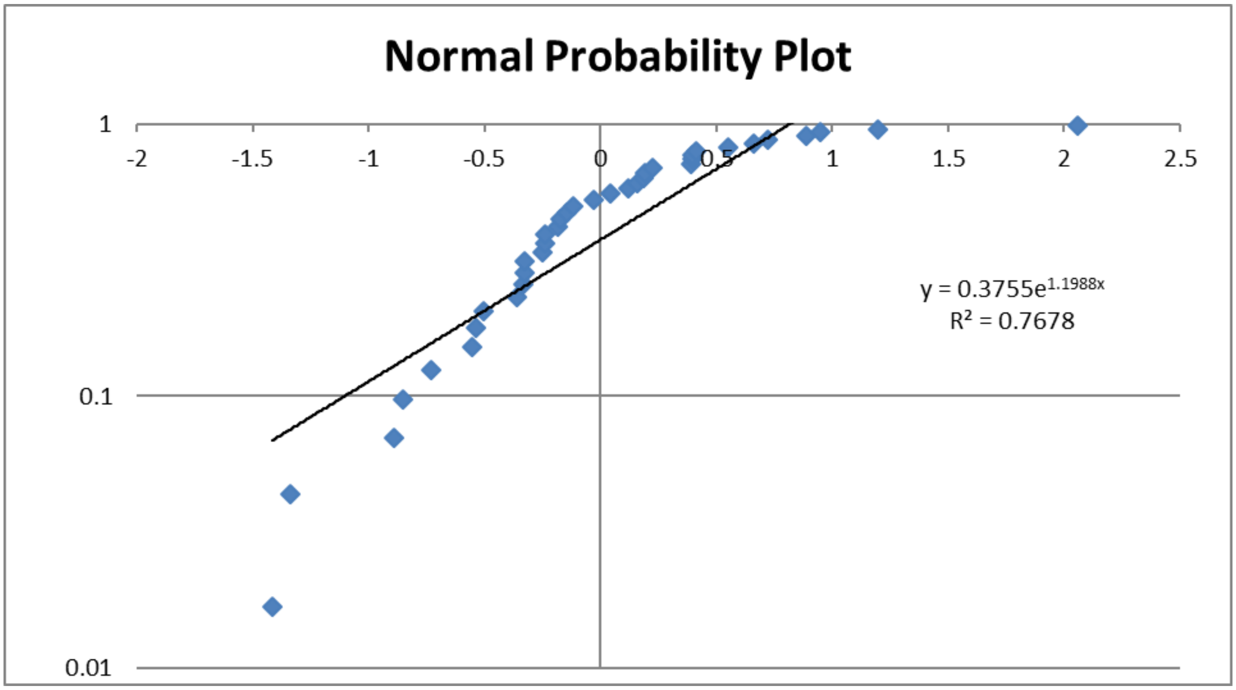


Figure A.2 – Normality Probability Plot for Underground Mine Regression Residuals

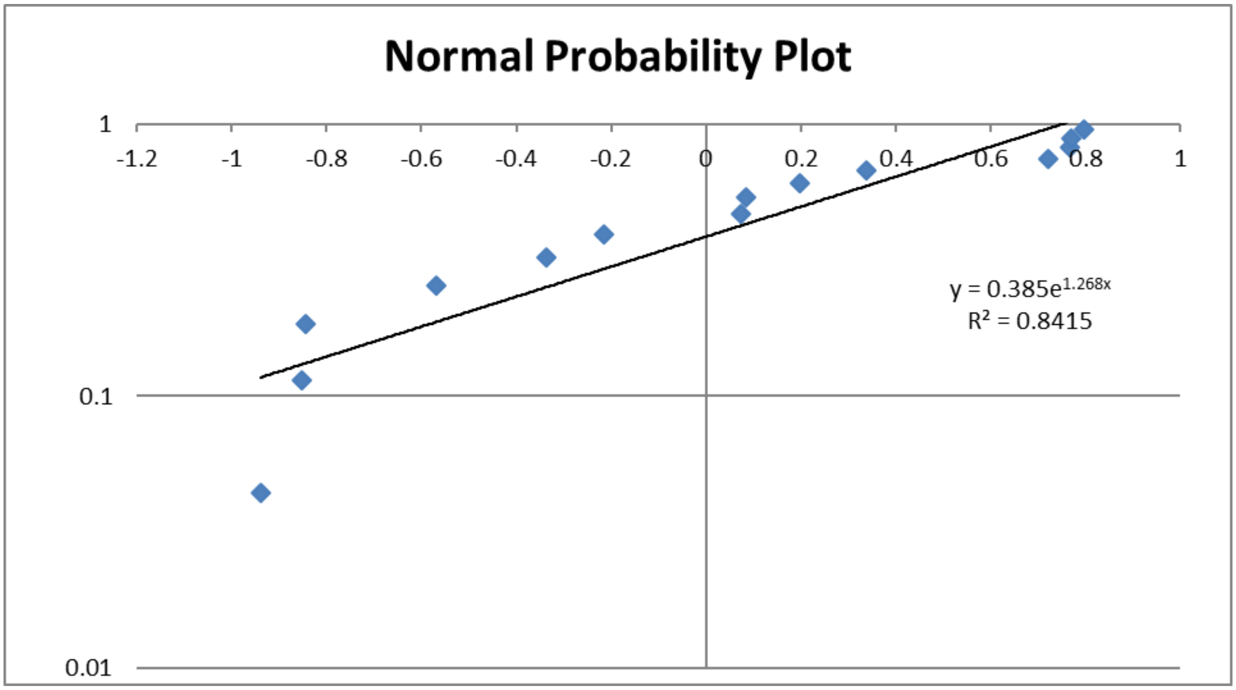


Figure A.3 – Normality Probability Plot for Waste Rock Regression Residuals

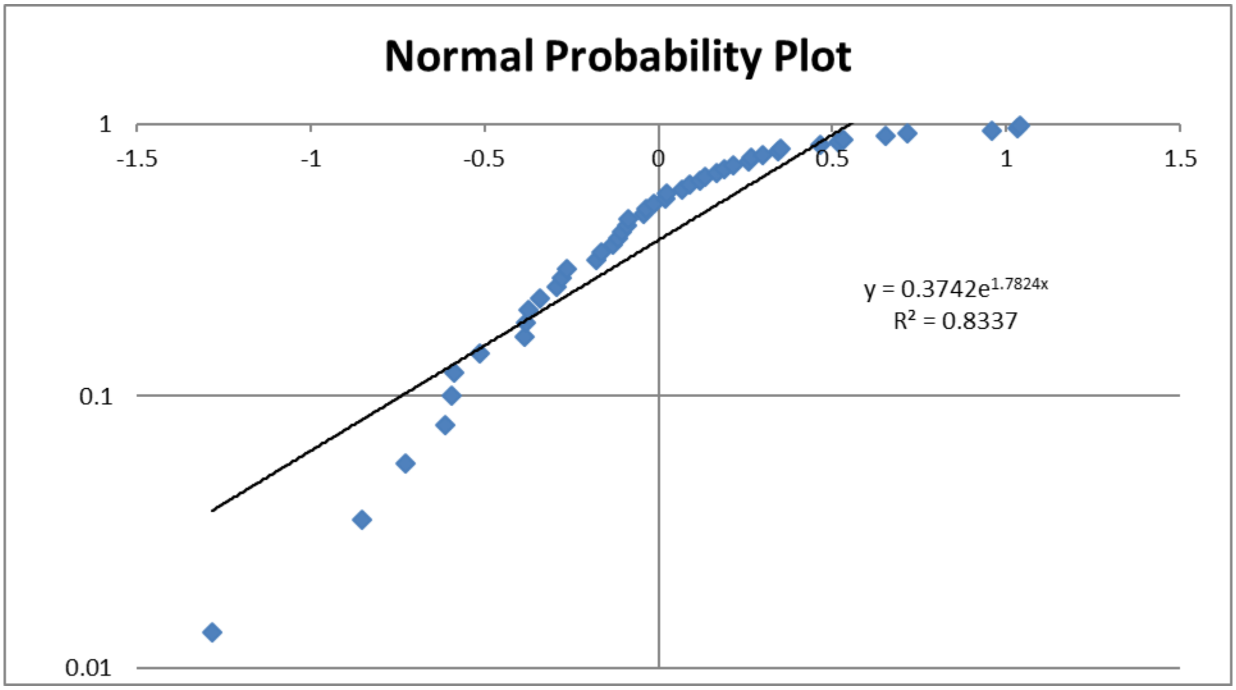


Figure A.4 – Normality Probability Plot for Heap/Dump Leach Regression Residuals

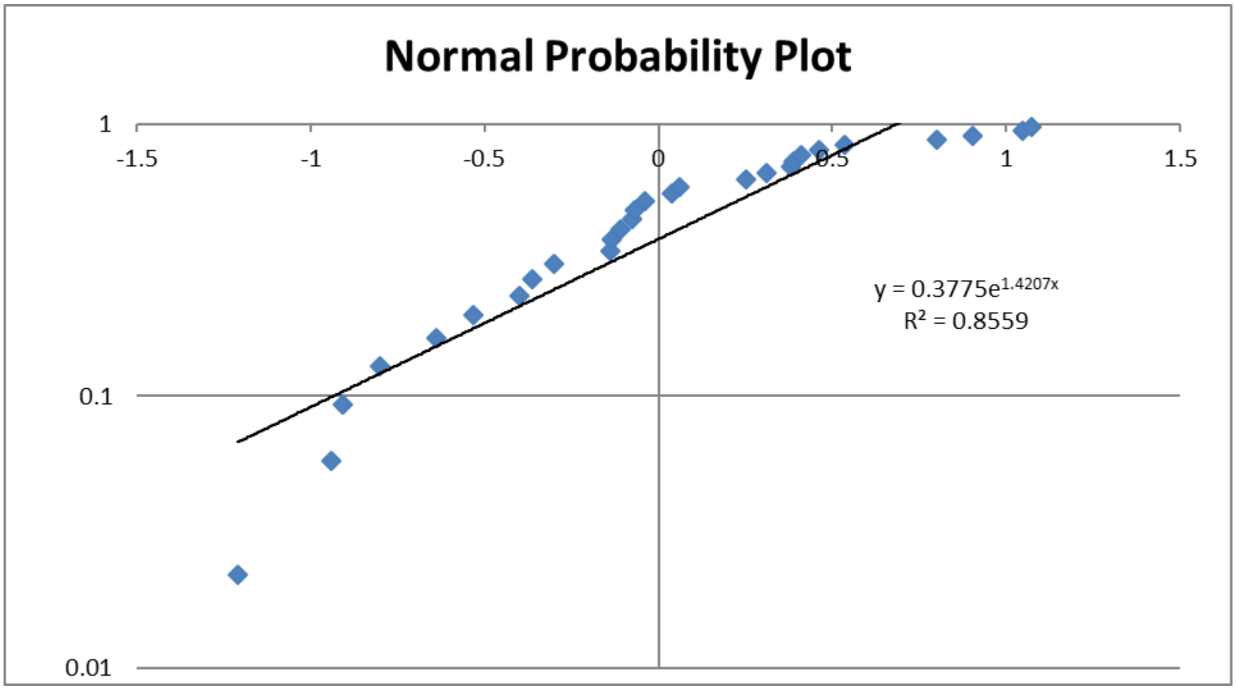


Figure A.5 – Normality Probability Plot for Tailings Facility Regression Residuals

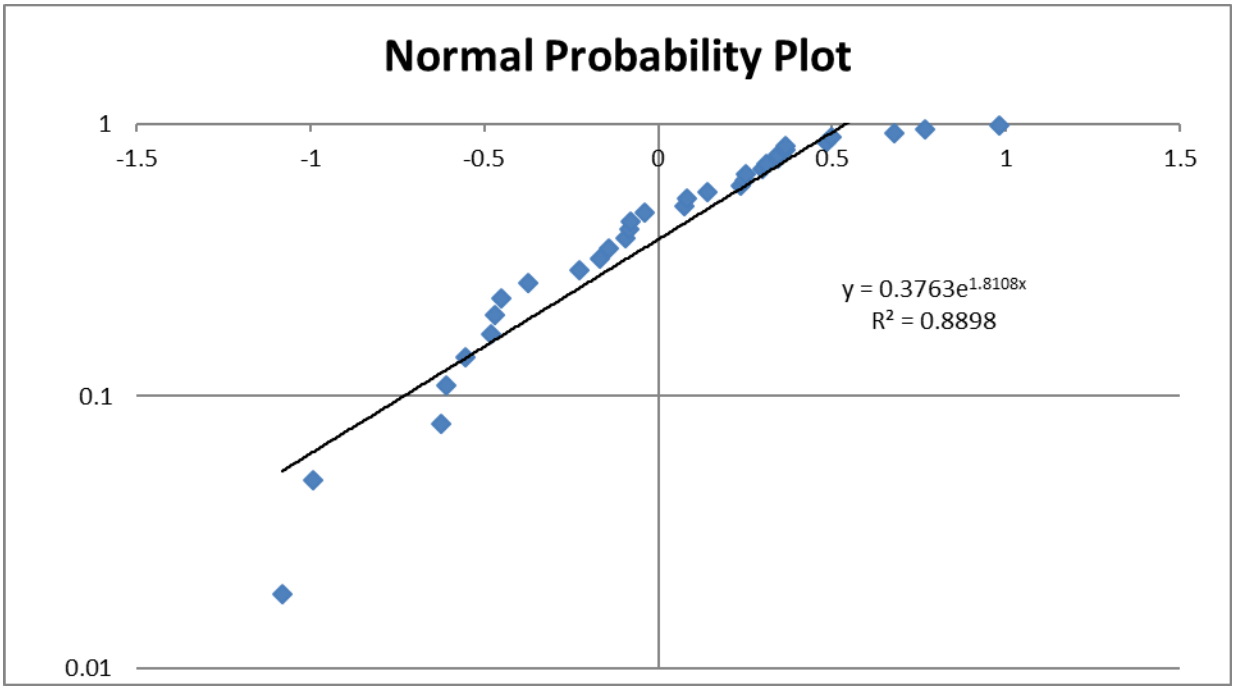


Figure A.6 – Normality Probability Plot for Process Pond Reservoirs Regression Residuals

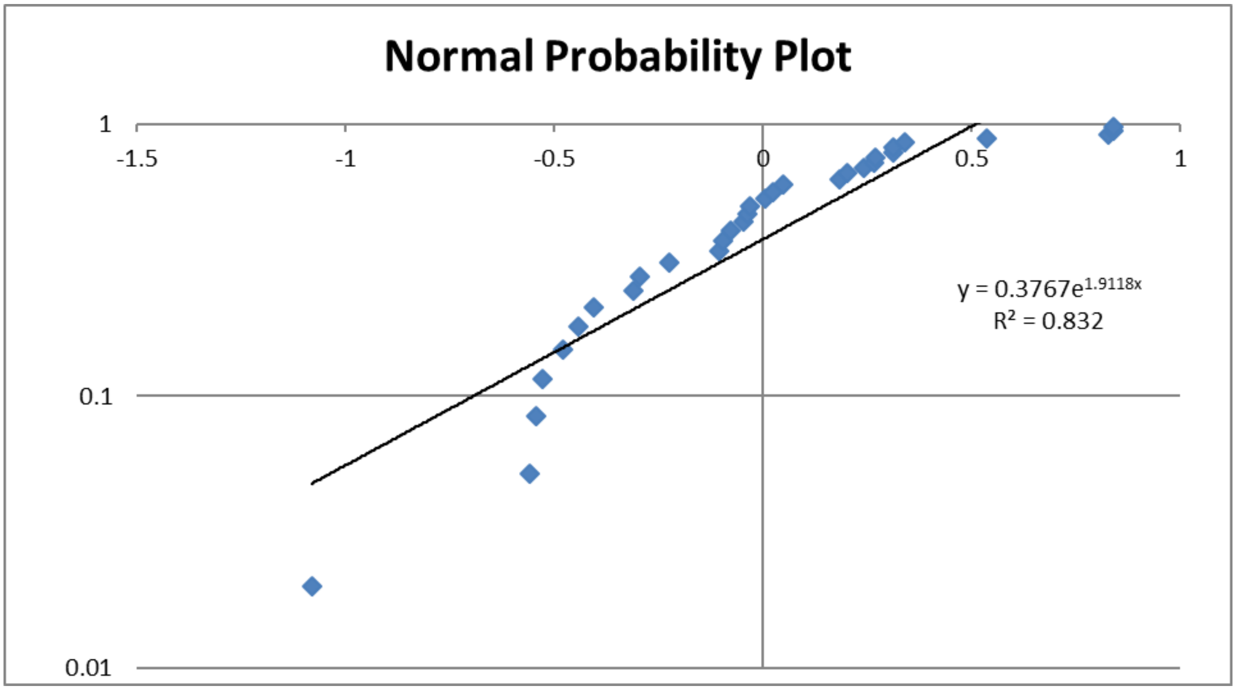


Figure A.7 – Normality Probability Plots for Drainage Capital Costs

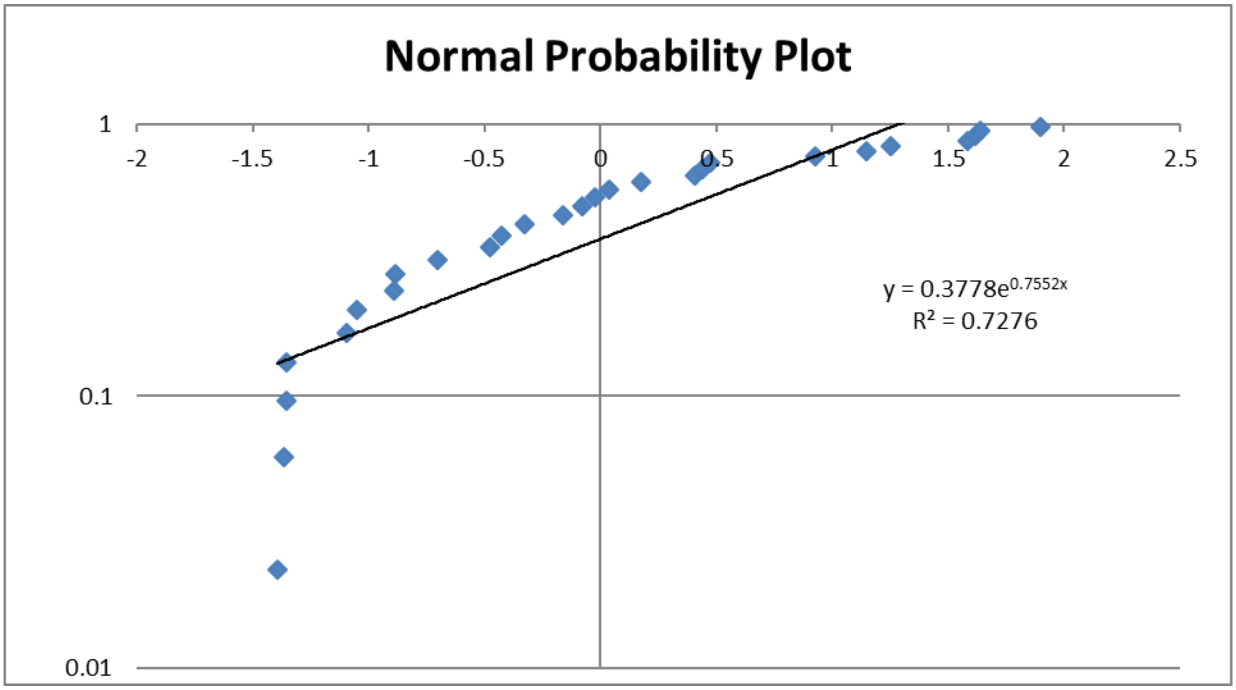


Figure A.8 – Normality Probability Plots for Interim O&M Costs

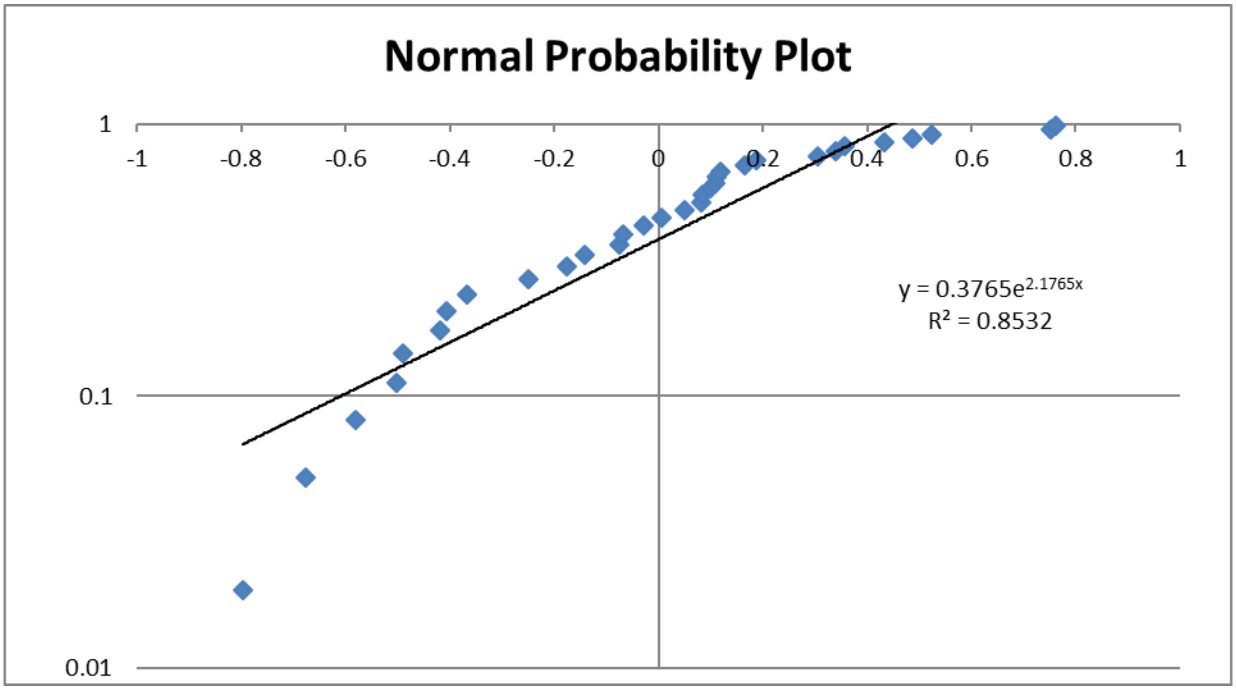


Figure A.9 – Normality Probability Plots for Water Treatment Costs

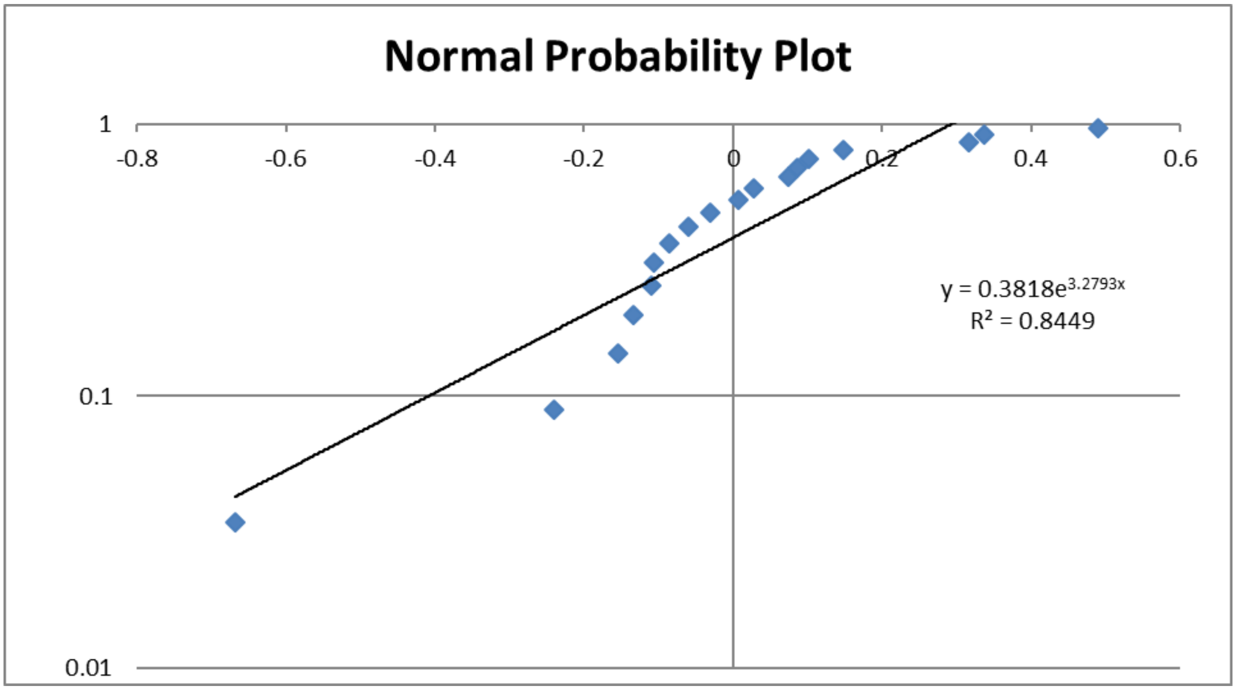


Figure A.10 – Normality Probability Plots for Short-Term O&M/Monitoring Costs

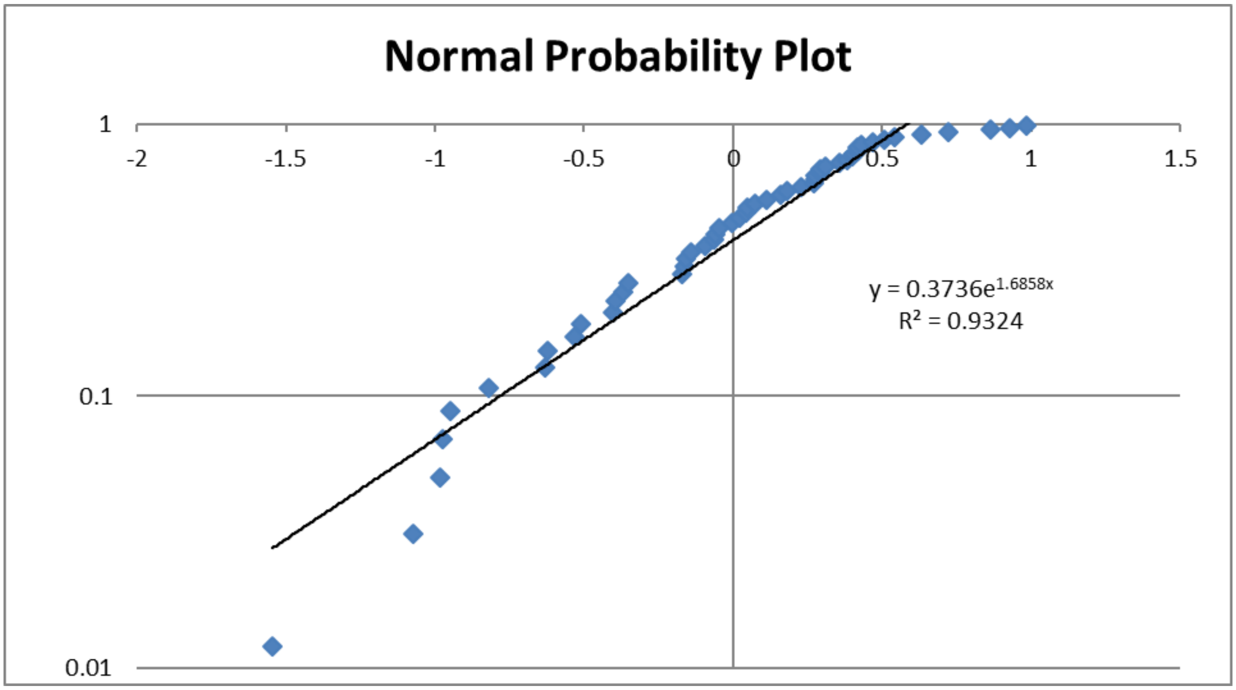
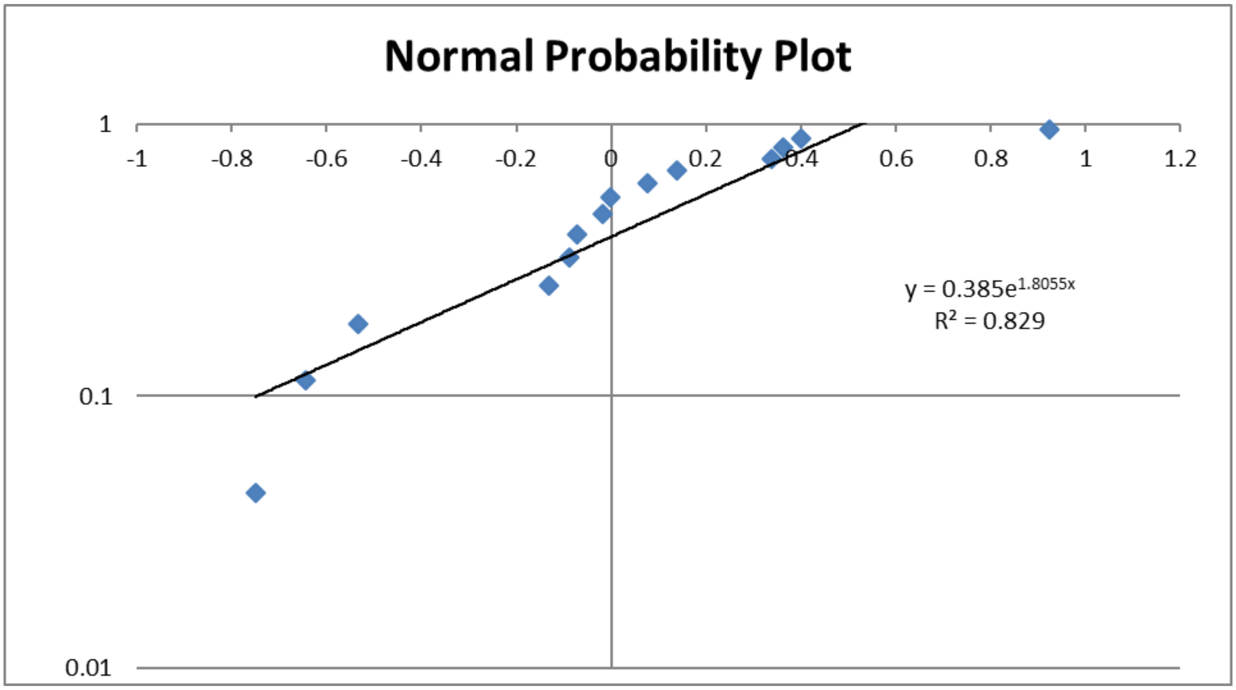


Figure A.11 – Normality Probability Plots for Long-Term O&M/Monitoring Costs



X.2. Visual Observation of Frequency Plots

To confirm the results of the Anderson-Darling test, EPA also visually examined the data in frequency plot form. To ensure data was visually inspected consistently, EPA binned data for each variable as follows:

- ≤ average – 2 x standard deviation
- > average – 2 x standard deviation, ≤ average – 1 x standard deviation
- > average – 1 x standard deviation, ≤ average
- > average, ≤ average + 1 x standard deviation
- > average + 1 x standard deviation, ≤ average + 2 x standard deviation
- > average + 2 x standard deviation

In **Figures A.12** through **A.22** below, the x-axis presents the maximum value in each bin. In most cases, data appeared right-skewed when presented linearly, but appeared to conform to a bell shape when presented in a lognormal format. There are four exceptions to this general pattern discussed below.

A summary of these findings is presented in **Table A.2** below.

Table A.2 – Graphical Examination of Regression Residual Normality Results

Variable	Normality Determination
Open Pit	Normal
Underground Mine	Uncertain
Waste Rock	Normal
Heap/Dump Leach	Normal
Tailings Facility	Normal
Process Pond/Reservoir	Normal
Drainage	Uncertain
Interim O&M Costs	Normal
Water Treatment Costs	Normal
Short-Term O&M/Monitoring Costs	Normal
Long-Term O&M/Monitoring Costs	Normal

Figure A.12 – Frequency Plots for Open Pit Residuals

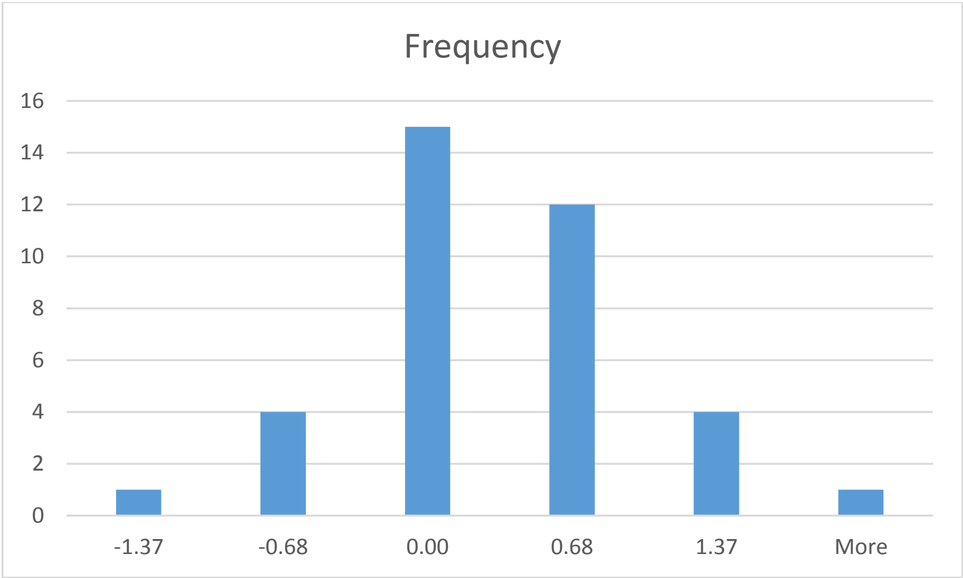


Figure A.13 – Frequency Plots for Underground Mine Residuals

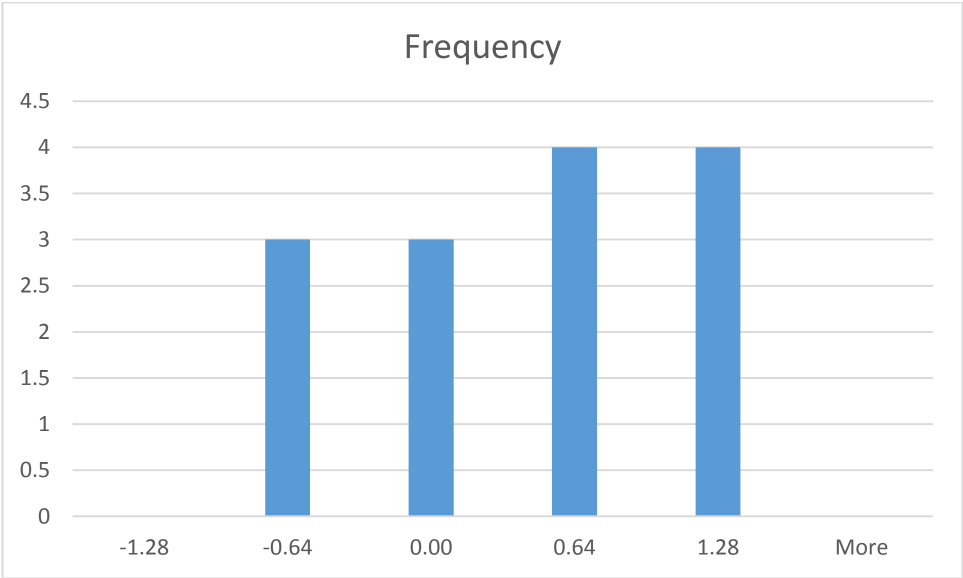


Figure A.14 – Frequency Plots for Waste Rock Residuals

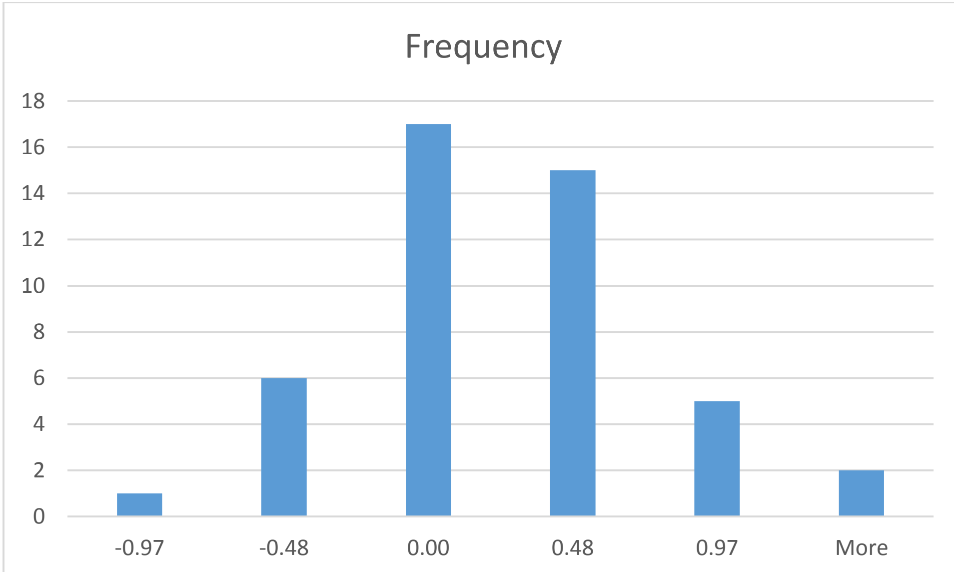


Figure A.15 – Frequency Plots for Heap/Dump Leach Residuals

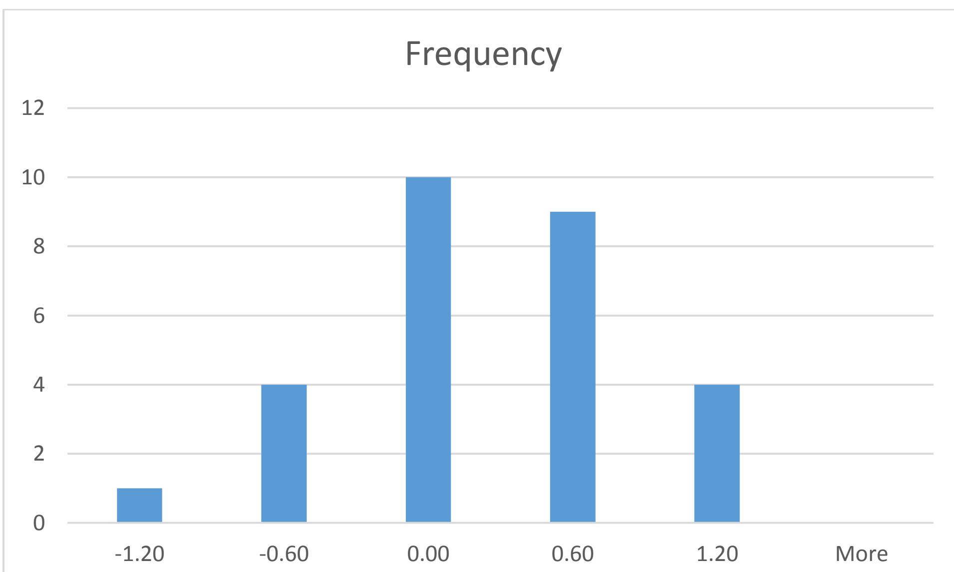


Figure A.16 – Frequency Plots for Tailings Facility Residuals

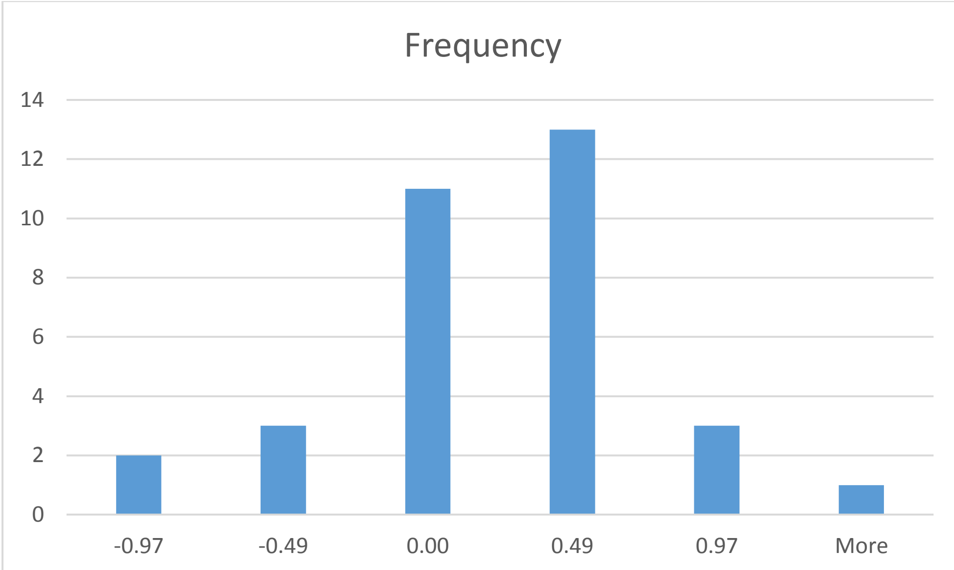


Figure A.17 – Frequency Plots for Process Pond/Reservoir Residuals

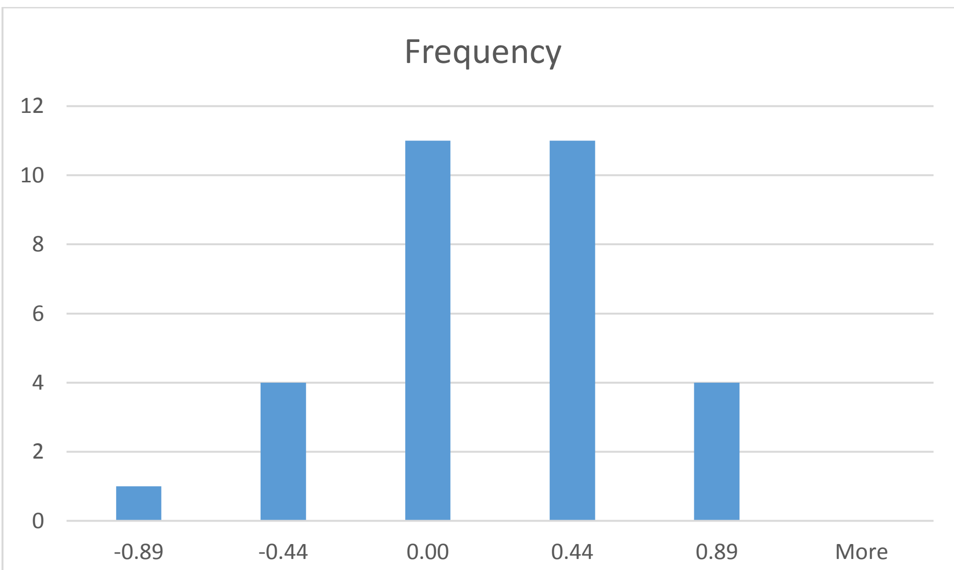


Figure A.18 – Frequency Plots for Drainage Residuals

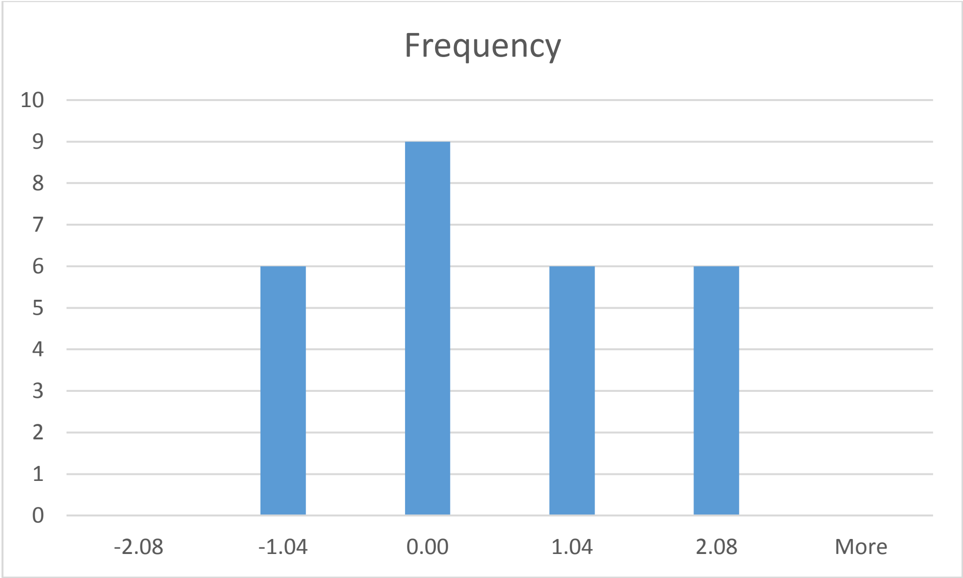


Figure A.19 – Frequency Plots for Interim O&M Residuals

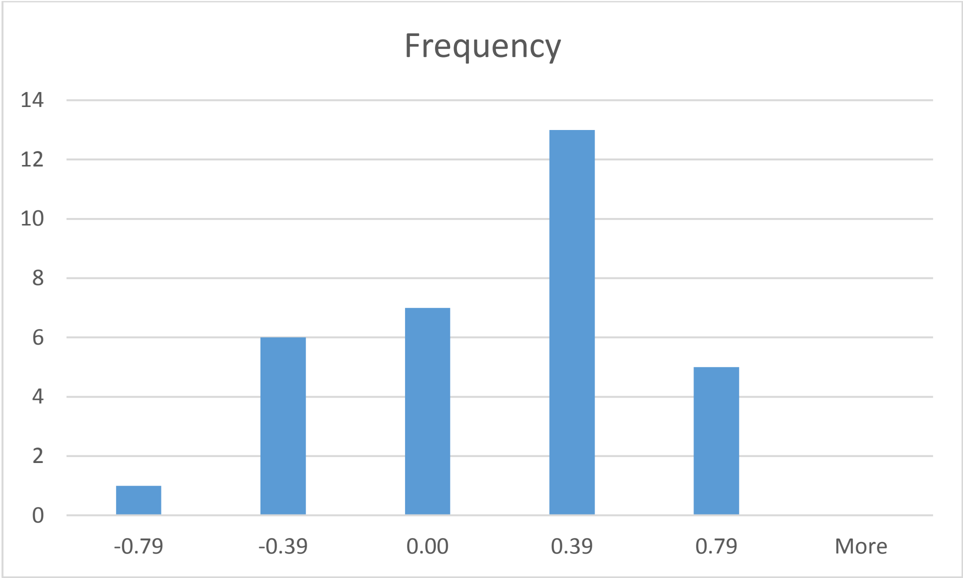


Figure A.20 – Frequency Plots for Water Treatment Residuals

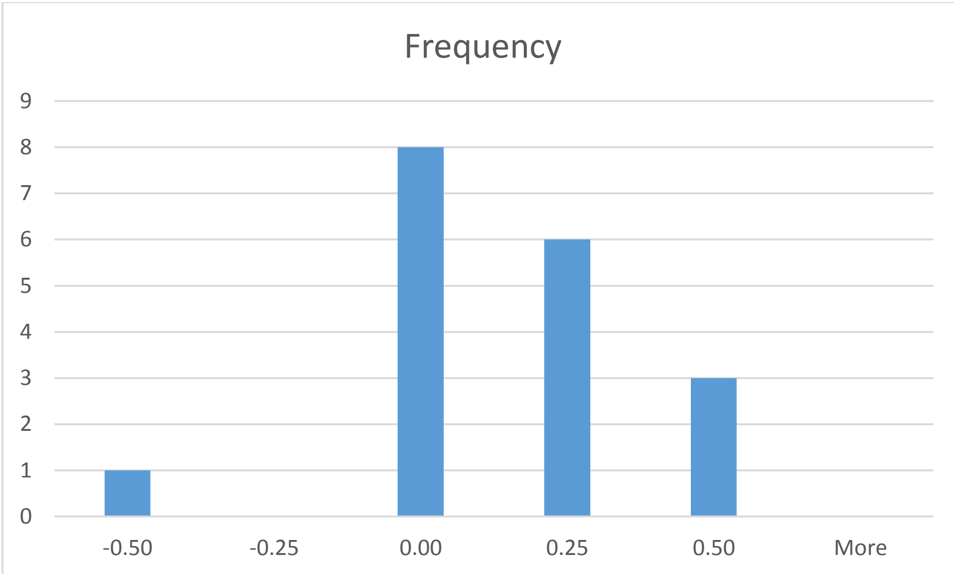


Figure A.21 – Frequency Plots for Short-Term O&M/Monitoring Residuals

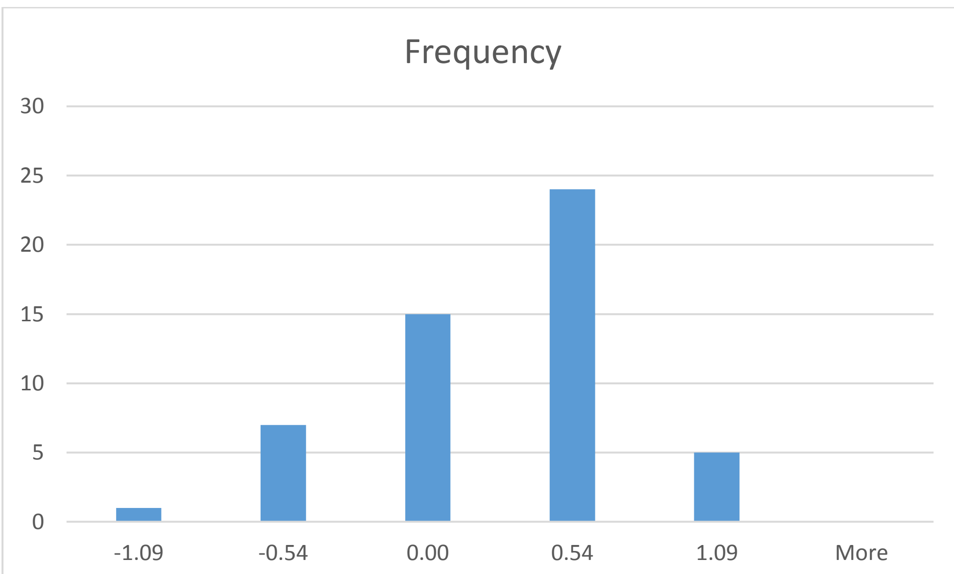
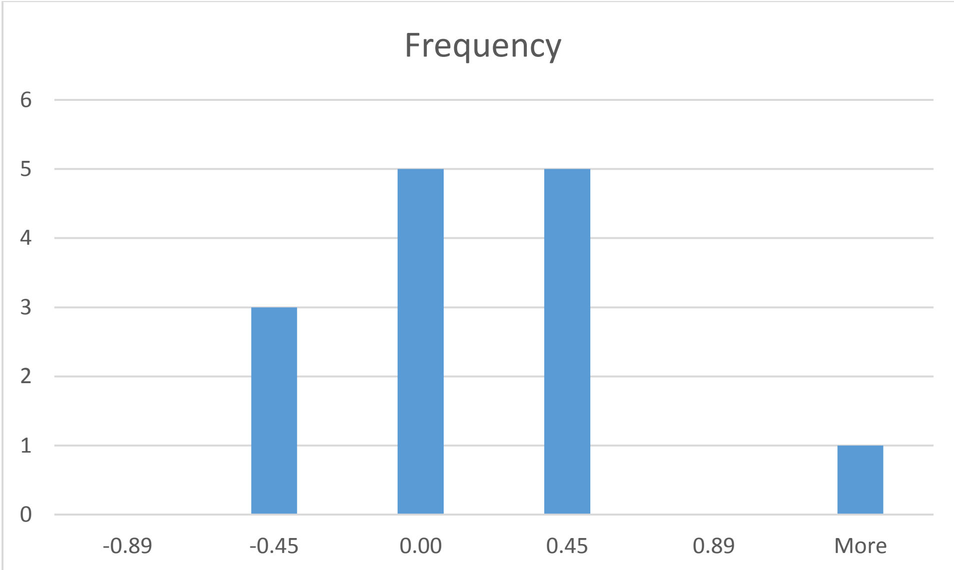


Figure A.22 – Frequency Plots for Long-Term O&M/Monitoring Residuals



Attachment B: Appendix G Revisions

Table B.0 – Engineering Cost Estimate Source Documents

Site ID	State	Mine Name	Document	Year
1	Alaska	Fort Knox	Fort Knox Mine Reclamation and Closure Plan	2013
2	Alaska	Greens Creek	SCRE for Greens Creek Reclamation Plan Update	2014
3	Alaska	Kensington	Reclamation and Closure Plan Update for the Kensington Gold Project, Borough of Juneau, Alaska	2013
4	Alaska	Niblack	Niblack Reclamation and Closure Plan, 2012 Post-Construction Update	2012
5	Alaska	Nixon Fork	Nixon Fork Mine Plan of Operations & Reclamation, Plan Version 2, Volume II of II	2011
6	Alaska	Pogo	Appendix B Updated Reclamation Cost Estimate	2011
7	Alaska	Red Dog	Red Dog Mine Closure and Reclamation Plan, Final	2009
8	Alaska	Rock Creek	Rock Creek Mine Plan of Operations Volume 4, Reclamation Plan	2006
9	Alaska	True North	True North Gold Mine Reclamation and Closure Plan	2012
10	Arizona	Arizona 1	Cost Estimate for Update to Arizona I Bond - APP Permit Number P-102008	2008
11	Arizona	Bagdad	Closure Strategy and Cost Estimate Update - APP No. P-105258	2010
12	Arizona	Johnson Camp	Aquifer Protection Permit No. P- 100514, Johnson Camp Mine Closure Cost Estimate Comparison	2011
13	Arizona	Mission	ASARCO Mission Mine Complex- Closure and Post-closure Costs APP No. P-100508	2007
14	Arizona	Pinto Valley	Pinto Valley Operations Mined Lands Reclamation Plan	2012
16	Arizona	Rosemont	Rosemont Reclamation and Closure Plan	2007
17	Arizona	Safford	Safford Mine Reclamation Plan	2005
18	Arizona	Ray	Aquifer Protection Permit Application, ASARCO, LLC - Ripsey Wash TSF	2014
19	Arizona	Silver Bell	Financial Assurance for permits P-100510 and P-103190 - REVISED	2008
20	California	Briggs	Financial Assurance Cost Estimate for CR Briggs Corporation, Briggs Mine including Gold Tooth South Project	2014
21	California	Mesquite	Mesquite Mine Reclamation Cost Estimate	2013
22	California	Mountain Pass	Financial Assurance Cost Estimate Molycorp Minerals, LLC, Mountain Pass Mine	2013

Site ID	State	Mine Name	Document	Year
23	Colorado	Climax	Climax Molybdenum Company Permit M-1977-493 Exhibit L - Reclamation Costs	2010
24	Colorado	Cresson	Cripple Creek & Victor Gold Mining Company Reclamation Cost Model to Support Mine Life Extension Project 2 (MLE2) DRMS Warranty Version	2014
25	Colorado	Revenue	Revenue Mine Cost Summary, CIRCES Cost Estimating Software	2014
26	Idaho	Blackfoot Bridge	P4 Production, LLC, Blackfoot Bridge Project Financial Assurance Cost Estimates	2010
27	Idaho	Idaho Cobalt	Idaho Cobalt Reclamation Cost Estimate Summary	2006
28	Idaho	Smoky Canyon	Simplot Smoky Canyon Mine Panel F 1st Year Reclamation Bond - BLM Calculation	2008
29	Idaho	Thompson Creek	EPA CERCLA 108b Financial Assurance Cost Estimation Summary Spreadsheet, Thompson Creek Mine, Reclamation Cost Summary	2011
30	Minnesota	Essar	Essar Reclamation Cost Estimate	2014
31	Minnesota	Hibbing Taconite	Hibbing Taconite Company Task Detail Report FASB 143 Estimate	2008
32	Minnesota	Minntac	U.S. Steel Minntac Mine Extension Financial Assurance	2014
33	Minnesota	Northshore	Financial Assurance Cost Estimate, Cliffs Natural Resources	2014
34	Minnesota	SCRAM	Permit to Mine, Minor Amendment Application, SCRAM Mineral Recovery Plant 2	2013
35	Montana	Continental	Montana Resources, Operating Permit # 00030, 00030A, 00041, 00108, 5 - Year Bond Review	2008
36	Montana	East Boulder	Stillwater Mining Company, East Boulder Project, Calculation of Reclamation Liability	2014
37	Montana	Golden Sunlight	Golden Sunlight Mine, Operating Permit #00065, 5-Year Bond Review, Partial Bond Release, & Amendment 11 Calculation	2008
38	Nevada	Bald Mountain (North)	Bald Mountain Mine North Area Operations Reclamation Bond Cost Estimate - 3 Year Update	2014
39	Nevada	Emigrant	Nevada Standardized Reclamation Bond Calculation, Emigrant Mine	2011
40	Nevada	Goldstrike	Barrick Goldstrike Mines Inc. Reclamation Plan and 2012 Three-Year Update for the Goldstrike Mine Project	2012
41	Nevada	Hollister	Hollister Mine Project Update to the Plan of Operations	2013
42	Nevada	Hycroft	Hycroft Mine (NVN-064641; 0134) Amendment to Reclamation Plan Hycroft Mine Expansion Project	2012
43	Nevada	Jerritt Canyon	2009 Annual Work Plan, Queenstake Resources USA, Inc. Jerrit Canyon Mine	2009
44	Nevada	Lone Tree	Newmont Mining Corporation, Lone Tree Mine Reclamation Plan	2011
45	Nevada	Marigold	Marigold Mining Company Reclamation Bonding Annual Update	2008
46	Nevada	Phoenix Historic	Phoenix Mine Reclamation Permit 0223, Cumulative Reclamation Cost Estimate	2011

Site ID	State	Mine Name	Document	Year
47	Nevada	Phoenix Copper	Newmont Mining Corporation - Phoenix Copper Leach Project, SRCE	2012
48	Nevada	Robinson	Reclamation Plan Revision for Disturbance up to December 2015	2014
49	Nevada	Rochester	Amendment #8 to the Plan of Operations/Reclamation Permit	2010
50	Nevada	Round Mountain	Round Mountain Gold Corporation 2011 Revised Comprehensive Reclamation Plan and Bond Cost Estimate	2011
51	Nevada	Ruby Hill	Ruby Hill Mine Reclamation Bond Estimate	2009
52	Nevada	SOAP	Reclamation and Operating Plan SOAP Mine	2012
53	Nevada	Standard	Standard Mine SRCE Bond Calculation	2008
54	Nevada	Trenton Canyon	Trenton Canyon Mine Reclamation Cost Estimate Update	2011
55	New Mexico	Chino	Chino Closure/Closeout Plan Update, Chino Mines Company, Hurley, New Mexico	2007
56	New Mexico	Mt Taylor	Mt Taylor Mine Plan for Mine Closeout/DP-61 Closure	2012
57	New Mexico	St Anthony	St Anthony Closeout Plan - 2010-07-30 Concept Level R1	2010
58	New Mexico	Tyrone	Tyrone Closure/Closeout Plan Earthwork Cost Estimate Summary Report	2013
59	South Carolina	Haile	Haile Gold Mine Reclamation Plan	2013
60	Utah	Lisbon Valley	Lisbon Valley Mining Co Bond Worksheet	2014
61	Nebraska	Crow Butte	Crow Butte Uranium Mine 2015 Surety Estimate	2015
62	Wyoming	Nichols Ranch	Nichols Ranch Project Surety Estimate Adjustment Summary 2013-2014	2014
63	Wyoming	Smith/Reynolds Ranch	Smith Ranch/Reynolds Ranch and Highland Combined Operations, 2014-2015 Surety Estimate	2013
64	Wyoming	Highland	Smith Ranch/Reynolds Ranch and Highland Combined Operations, 2014-2015 Surety Estimate	2013
65	Colorado	Clear Creek	Clear Creek Cost Info	2011
66	Colorado	Summitville	Summitville Mine Wastewater Treatment Plant Construction Cost Estimate Summary	2009
67	Montana	Zortman and Landusky	Engineering Evaluation/Cost Analysis (EE/CA) For Water Management at the Zortman and Landusky Mines Phillips County, Montana	2006

Table B.1 – Open Pit Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	660	$122,849	$0	$122,849	1.03	0.84	$106,035
7	Alaska	Red Dog	Zn-Pb	2009	307	$930,000	$0	$930,000	1.14	0.84	$894,226
12	Arizona	Johnson Camp	Cu	2011	145	$26,534	$0	$26,534	1.08	1.04	$29,882
16	Arizona	Rosemont	Cu	2007	135	$70,600	$0	$70,600	1.23	1.04	$90,312
17	Arizona	Safford	Cu	2005	105	$127,146	$0	$127,146	1.32	1.04	$174,422
21	California	Mesquite	Au	2012	1,290	$832,009	$0	$832,009	1.05	0.85	$749,165
22	California	Mountain Pass	Rare Earth	2013	69	$295,078	$0	$295,078	1.03	0.85	$259,045
23	Colorado	Climax	Mo	2010	100	$0	$630,249	$630,249	1.11	1.03	$723,854
24	Colorado	Cresson	Au	2014	899	$8,667,967	$0	$8,667,967	1.00	1.03	$8,936,048
26	Idaho	Blackfoot Bridge	P	2010	426	$1,846,957	$25,058,748	$26,905,705	1.11	1.03	$30,901,757
28	Idaho	Smoky Canyon	P	2008	197	$2,896,264	$0	$2,896,264	1.18	1.03	$3,523,362
29	Idaho	Thompson Creek	Mo	2011	443	$18,680	$0	$18,680	1.08	1.03	$20,820
30	Minnesota	Essar	Fe	2014	26	$70,715	$0	$70,715	1.00	0.89	$63,138
31	Minnesota	Hibbing Taconite	Fe	2008	126	$1,175,181	$0	$1,175,181	1.18	0.89	$1,238,162
32	Minnesota	Minntac	Fe	2014	628	$414,780	$0	$414,780	1.00	0.89	$370,339
35	Montana	Continental	Cu	2008	648	$3,527,751	$0	$3,527,751	1.18	1.03	$4,291,578
37	Montana	Golden Sunlight	Au, Ag	2008	218	$1,184,423	$6,145,142	$7,329,565	1.18	1.03	$8,916,560
38	Nevada	Bald Mountain (North)	Au, Ag	2014	268	$158,402	$0	$158,402	1.00	0.93	$146,669
39	Nevada	Emigrant	Au	2010	33	$17,872	$0	$17,872	1.11	0.93	$18,436
40	Nevada	Goldstrike	Au	2012	112	$84,464	$0	$84,464	1.05	0.93	$82,392
41	Nevada	Hollister	Au	2013	4	$1,639	$0	$1,639	1.03	0.93	$1,559
42	Nevada	Hycroft	Au	2012	1,282	$79,657	$0	$79,657	1.05	0.93	$77,703
43	Nevada	Jerritt Canyon	Au	2009	896	$152,728	$0	$152,728	1.14	0.93	$161,810
44	Nevada	Lone Tree	Au	2011	58	$35,900	$3,409,713	$3,445,613	1.08	0.93	$3,449,271
45	Nevada	Marigold	Au	2008	239	$71,065	$0	$71,065	1.18	0.93	$77,647

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
46	Nevada	Phoenix Historic	Au, Ag	2011	1,455	$222,588,978	$0	$222,588,978	1.08	0.93	$222,825,301
48	Nevada	Robinson	Cu	2013	199	$277,438	$1,436,000	$1,713,438	1.03	0.93	$1,629,557
49	Nevada	Rochester	Ag	2010	46	$34,625	$0	$34,625	1.11	0.93	$35,717
50	Nevada	Round Mountain	Au	2010	119	$118,331	$0	$118,331	1.11	0.93	$122,063
51	Nevada	Ruby Hill	Au	2009	36	$56,749	$0	$56,749	1.14	0.93	$60,124
52	Nevada	SOAP	Au	2012	87	$62,236	$0	$62,236	1.05	0.93	$60,709
53	Nevada	Standard	Au	2008	38	$24,881	$0	$24,881	1.18	0.93	$27,185
54	Nevada	Trenton Canyon	Au	2010	109	$66,037	$0	$66,037	1.11	0.93	$68,120
55	New Mexico	Chino	Cu	2007	1,500	$1,971,239	$0	$1,971,239	1.23	1.09	$2,637,564
58	New Mexico	Tyrone	Cu	2013	1,600	$1,117,240	$0	$1,117,240	1.03	1.09	$1,247,336
59	South Carolina	Haile	Au	2013	182	$693,264	$3,711,616	$4,404,880	1.03	1.15	$5,200,436
60	Utah	Lisbon Valley	Cu	2013	100	$144,900	$0	$144,900	1.03	1.05	$156,664
										Minimum	$1,559
										Maximum	$222,825,301
										Median	$161,810
										Mean	$8,091,901

Table B.2 – Waste Rock Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	865	$6,525,813	$0	$6,525,813	1.03	0.84	$5,632,648
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	70	$42,932	$0	$42,932	1.00	0.84	$36,077
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	3	$211,800	$0	$211,800	1.05	0.84	$187,506
5	Alaska	Nixon Fork	Cu	2011	8	$110,078	$0	$110,078	1.08	0.84	$100,009
7	Alaska	Red Dog	Zn-Pb	2009	190	$1,600,000	$0	$1,600,000	1.14	0.84	$1,538,452
8	Alaska	Rock Creek	Au	2012	256	$1,620,597	$0	$1,620,597	1.05	0.84	$1,434,708
9	Alaska	True North	Au	2012	106	$1,128,599	$0	$1,128,599	1.05	0.84	$999,144
12	Arizona	Johnson Camp	Cu	2011	168	$301,083	$0	$301,083	1.08	1.04	$339,078
14	Arizona	Pinto Valley	Cu	2012	367	$11,380,257	$0	$11,380,257	1.05	1.04	$12,488,675
16	Arizona	Rosemont	Cu	2007	2,002	$9,344,700	$0	$9,344,700	1.23	1.04	$11,982,453
17	Arizona	Safford	Cu	2005	660	$2,227,704	$0	$2,227,704	1.32	1.04	$3,056,012
20	California	Briggs	Au	2014	129	$525,840	$0	$525,840	1.00	0.85	$449,436
21	California	Mesquite	Au	2012	1,204	$1,222,376	$0	$1,222,376	1.05	0.85	$1,100,663
22	California	Mountain Pass	Rare Earth	2013	168	$828,050	$0	$828,050	1.03	0.85	$726,935
23	Colorado	Climax	Mo	2010	852	$4,606,375	$0	$4,606,375	1.11	1.03	$5,290,517
24	Colorado	Cresson	Au	2014	740	$7,896,355	$0	$7,896,355	1.00	1.03	$8,140,572
26	Idaho	Blackfoot Bridge	P	2010	206	$2,853,498	$6,974,255	$9,827,753	1.11	1.03	$11,287,377
29	Idaho	Thompson Creek	Mo	2011	850	$2,470,079	$12,275,340	$14,745,419	1.08	1.03	$16,435,010
30	Minnesota	Essar	Fe	2014	157	$346,107	$0	$346,107	1.00	0.89	$309,024
31	Minnesota	Hibbing Taconite	Fe	2008	1,147	$4,395,459	$0	$4,395,459	1.18	0.89	$4,631,024
32	Minnesota	Minntac	Fe	2014	483	$2,994,600	$0	$2,994,600	1.00	0.89	$2,673,750
33	Minnesota	Northshore	Fe	2013	42	$287,000	$5,829,000	$6,116,000	1.03	0.89	$5,608,858
35	Montana	Continental	Cu	2008	475	$7,930,025	$0	$7,930,025	1.18	1.03	$9,647,031
37	Montana	Golden Sunlight	Au, Ag	2008	480	$8,245,446	$0	$8,245,446	1.18	1.03	$10,030,748

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
38	Nevada	Bald Mountain (North)	Au, Ag	2014	3,968	$20,544,933	$0	$20,544,933	1.00	0.93	$19,023,086
39	Nevada	Emigrant	Au	2010	106	$1,003,630	$6,962,370	$7,966,000	1.11	0.93	$8,217,261
40	Nevada	Goldstrike	Au	2012	3,749	$22,060,047	$0	$22,060,047	1.05	0.93	$21,518,807
41	Nevada	Hollister	Au	2013	8	$209,130	$0	$209,130	1.03	0.93	$198,892
42	Nevada	Hycroft	Au	2012	1,757	$3,657,205	$0	$3,657,205	1.05	0.93	$3,567,476
43	Nevada	Jerritt Canyon	Au	2009	1,095	$1,335,723	$0	$1,335,723	1.14	0.93	$1,415,154
44	Nevada	Lone Tree	Au	2011	1,220	$834,033	$0	$834,033	1.08	0.93	$834,918
45	Nevada	Marigold	Au	2008	1,011	$3,130,133	$0	$3,130,133	1.18	0.93	$3,420,030
46	Nevada	Phoenix Historic	Au, Ag	2011	2,221	$19,537,227	$70,278,195	$89,815,422	1.08	0.93	$89,910,779
48	Nevada	Robinson	Cu	2013	2,904	$11,678,060	$7,935,494	$19,613,554	1.03	0.93	$18,653,379
49	Nevada	Rochester	Ag	2010	402	$11,203,833	$0	$11,203,833	1.11	0.93	$11,557,220
50	Nevada	Round Mountain	Au	2010	2,024	$6,470,470	$0	$6,470,470	1.11	0.93	$6,674,559
51	Nevada	Ruby Hill	Au	2009	691	$3,385,996	$0	$3,385,996	1.14	0.93	$3,587,350
52	Nevada	SOAP	Au	2012	2,764	$5,775,510	$0	$5,775,510	1.05	0.93	$5,633,809
53	Nevada	Standard	Au	2008	156	$479,577	$0	$479,577	1.18	0.93	$523,993
54	Nevada	Trenton Canyon	Au	2010	657	$7,961,803	$0	$7,961,803	1.11	0.93	$8,212,931
55	New Mexico	Chino	Cu	2007	2,438	$82,461,203	$0	$82,461,203	1.23	1.09	$110,335,032
56	New Mexico	Mt Taylor	U	2012	22	$465,961	$0	$465,961	1.05	1.09	$533,577
57	New Mexico	St Anthony	U	2010	320	$16,299,386	$0	$16,299,386	1.11	1.09	$19,737,582
58	New Mexico	Tyrone	Cu	2013	2,426	$96,345,245	$0	$96,345,245	1.03	1.09	$107,564,119
59	South Carolina	Haile	Au	2013	683	$4,683,934	$4,416,984	$9,100,918	1.03	1.15	$10,744,616
60	Utah	Lisbon Valley	Cu	2013	419	$1,043,891	$0	$1,043,891	1.03	1.05	$1,128,643
										Minimum	$36,077
										Maximum	$110,335,032
										Median	$4,960,771
										Mean	$12,328,672

Table B.3 – Heap and Dump Leach Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	556	$2,508,837	$0	$2,508,837	1.03	0.84	$2,165,461
11	Arizona	Bagdad	Cu	2010	631	$3,068,550	$0	$3,068,550	1.11	1.04	$3,561,004
12	Arizona	Johnson Camp	Cu	2011	356	$720,763	$0	$720,763	1.08	1.04	$811,719
14	Arizona	Pinto Valley	Cu	2012	762	$43,197,448	$0	$43,197,448	1.05	1.04	$47,404,806
17	Arizona	Safford	Cu	2005	739	$4,820,644	$0	$4,820,644	1.32	1.04	$6,613,063
19	Arizona	Silver Bell	Cu	2008	1,214	$957,000	$0	$957,000	1.18	1.04	$1,176,336
20	California	Briggs	Au	2014	150	$585,228	$0	$585,228	1.00	0.85	$500,195
21	California	Mesquite	Au	2012	783	$417,082	$0	$417,082	1.05	0.85	$375,553
24	Colorado	Cresson	Au	2014	936	$83,392,833	$0	$83,392,833	1.00	1.03	$85,971,993
35	Montana	Continental	Cu	2008	398	$2,163,443	$0	$2,163,443	1.18	1.03	$2,631,871
38	Nevada	Bald Mountain (North)	Au, Ag	2014	1,093	$7,733,057	$0	$7,733,057	1.00	0.93	$7,160,238
39	Nevada	Emigrant	Au	2010	130	$754,892	$0	$754,892	1.11	0.93	$778,703
40	Nevada	Goldstrike	Au	2012	161	$145,946	$0	$145,946	1.05	0.93	$142,365
42	Nevada	Hycroft	Au	2012	1,321	$4,231,647	$0	$4,231,647	1.05	0.93	$4,127,824
43	Nevada	Jerritt Canyon	Au	2009	23	$37,910	$0	$37,910	1.14	0.93	$40,164
44	Nevada	Lone Tree	Au	2011	308	$4,267,793	$0	$4,267,793	1.08	0.93	$4,272,324
45	Nevada	Marigold	Au	2008	802	$13,937,794	$0	$13,937,794	1.18	0.93	$15,228,641
46	Nevada	Phoenix Historic	Au, Ag	2011	472	$3,350,669	$0	$3,350,676	1.08	0.93	$3,365,412
47	Nevada	Phoenix Copper	Cu	2012	322	$9,211,205	$71,608,620	$80,819,825	1.05	0.93	$78,836,923
48	Nevada	Robinson	Cu	2013	163	$1,439,508	$0	$1,439,508	1.03	0.93	$1,369,037
49	Nevada	Rochester	Ag	2010	129	$2,303,114	$0	$2,303,114	1.11	0.93	$2,375,758
50	Nevada	Round Mountain	Au	2010	995	$5,502,049	$0	$5,502,049	1.11	0.93	$5,675,593
51	Nevada	Ruby Hill	Au	2009	130	$2,424,324	$0	$2,424,324	1.14	0.93	$2,568,491
52	Nevada	SOAP	Au	2012	1,289	$21,103,166	$0	$21,103,166	1.05	0.93	$20,585,403
53	Nevada	Standard	Au	2008	127	$2,589,451	$0	$2,589,451	1.18	0.93	$2,829,273

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
54	Nevada	Trenton Canyon	Au	2010	101	$8,351,320	$0	$8,351,320	1.11	0.93	$8,614,734
58	New Mexico	Tyrone	Cu	2013	273	$6,467,894	$0	$6,467,894	1.03	1.09	$7,221,045
60	Utah	Lisbon Valley	Cu	2013	185	$300,755	$739,834	$1,040,589	1.03	1.05	$1,125,073
										Minimum	$40,164
										Maximum	$85,971,993
										Median	$3,091,753
										Mean	$11,339,922

Table B.4 – Tailings Facility Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	1,069	$8,253,191	$0	$8,253,191	1.03	0.84	$7,123,606
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	349	$1,110,573	$10,833,528	$11,944,101	1.00	0.84	$10,037,060
3	Alaska	Kensington	Au	2013	86	$2,514,985	$0	$2,514,985	1.03	0.84	$2,170,768
5	Alaska	Nixon Fork	Cu	2011	10	$106,638	$356,008	$462,645	1.08	0.84	$420,326
6	Alaska	Pogo	Au	2012	149	$3,933,757	$0	$3,933,757	1.05	0.84	$3,482,540
7	Alaska	Red Dog	Zn-Pb	2009	77	$5,010,000	$0	$5,010,000	1.14	0.84	$4,817,279
8	Alaska	Rock Creek	Au	2012	135	$1,131,471	$0	$1,131,471	1.05	0.84	$1,001,687
11	Arizona	Bagdad	Cu	2010	465	$5,236,000	$0	$5,236,000	1.11	1.04	$6,076,296
13	Arizona	Mission	Cu	2007	2,106	$6,126,360	$0	$6,126,360	1.23	1.04	$7,855,663
14	Arizona	Pinto Valley	Cu	2012	1,586	$68,210,473	$0	$68,210,473	1.05	1.04	$74,854,057
16	Arizona	Rosemont	Cu	2007	4,140	$2,783,200	$0	$2,783,200	1.23	1.04	$3,568,821
18	Arizona	Ray	Cu	2014	1,970	$2,967,143	$0	$2,967,143	1.00	1.04	$3,090,774
22	California	Mountain Pass	Rare Earth	2013	119	$508,902	$0	$508,902	1.03	0.85	$446,759
23	Colorado	Climax	Mo	2010	698	$6,920,818	$0	$6,920,818	1.11	1.03	$7,948,702
27	Idaho	Idaho Cobalt	Co	2006	36	$542,954	$3,657,166	$4,200,120	1.27	1.03	$5,478,026
29	Idaho	Thompson Creek	Mo	2011	609	$11,563,094	$0	$11,563,094	1.08	1.03	$12,888,041
30	Minnesota	Essar	Fe	2014	137	$467,478	$0	$467,478	1.00	0.89	$417,391
31	Minnesota	Hibbing Taconite	Fe	2008	6,200	$6,619,359	$0	$6,619,359	1.18	0.89	$6,974,110
32	Minnesota	Minntac	Fe	2014	200	$220,000	$0	$220,000	1.00	0.89	$196,429
34	Minnesota	SCRAM	Fe	2013	600	$366,500	$0	$366,500	1.03	0.89	$336,110
35	Montana	Continental	Cu	2008	355	$7,120,055	$0	$7,120,055	1.18	1.03	$8,661,687
36	Montana	East Boulder	PGM	2014	103	$2,625,745	$0	$2,625,745	1.00	1.03	$2,706,954
37	Montana	Golden Sunlight	Au, Ag	2008	286	$3,496,688	$0	$3,496,688	1.18	1.03	$4,253,790
40	Nevada	Goldstrike	Au	2012	2,114	$57,182,556	$0	$57,182,556	1.05	0.93	$55,779,591
43	Nevada	Jerritt Canyon	Au	2009	361	$3,290,781	$0	$3,290,781	1.14	0.93	$3,486,473

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate			$2014 Adjustment		
						Earthwork and Revegetation	Source Controls	Total	Inflation Factor	State Adjustment	$2014 Adjusted Total
44	Nevada	Lone Tree	Au	2011	320	$1,903,594	$0	$1,903,594	1.08	0.93	$1,905,615
45	Nevada	Marigold	Au	2008	184	$408,449	$0	$408,449	1.18	0.93	$446,277
46	Nevada	Phoenix Historic	Au, Ag	2011	1,396	$14,683,263	$0	$14,683,263	1.08	0.93	$14,698,852
48	Nevada	Robinson	Cu	2013	1,639	$5,020,532	$0	$5,020,532	1.03	0.93	$4,774,753
50	Nevada	Round Mountain	Au	2010	1,051	$4,791,365	$0	$4,791,365	1.11	0.93	$4,942,493
52	Nevada	SOAP	Au	2012	2,316	$24,089,856	$0	$24,089,856	1.05	0.93	$23,498,815
55	New Mexico	Chino	Cu	2007	4,229	$28,541,446	$7,462,353	$36,003,799	1.23	1.09	$48,173,931
59	South Carolina	Haile	Au	2013	396	$4,526,552	$9,487,368	$14,013,920	1.03	1.15	$16,544,946
										Minimum	$196,429
										Maximum	$74,854,057
										Median	$4,817,279
										Mean	$10,577,534

Table B.5 – Process Pond and Reservoir Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate	$2014 Adjustment		
							Inflation Factor	State Adjustment	$2014 Adjusted Total
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	14	$401,802	1.00	0.84	$337,649
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	1	$20,055	1.05	0.84	$17,755
11	Arizona	Bagdad	Cu	2010	4	$146,740	1.11	1.04	$170,289
12	Arizona	Johnson Camp	Cu	2011	20	$32,174	1.08	1.04	$36,234
14	Arizona	Pinto Valley	Cu	2012	100	$4,202,526	1.05	1.04	$4,611,845
16	Arizona	Rosemont	Cu	2007	20	$521,000	1.23	1.04	$668,064
18	Arizona	Ray	Cu	2014	11	$462,976	1.00	1.04	$482,267
21	California	Mesquite	Au	2012	31	$219,270	1.05	0.85	$197,437
26	Idaho	Blackfoot Bridge	P	2010	9	$307,053	1.11	1.03	$352,657
27	Idaho	Idaho Cobalt	Co	2006	7	$180,757	1.27	1.03	$235,753
38	Nevada	Bald Mountain (North)	Au, Ag	2014	34	$5,659,239	1.00	0.93	$5,240,036
40	Nevada	Goldstrike	Au	2012	216	$1,901,073	1.05	0.93	$1,854,430
41	Nevada	Hollister	Au	2013	1	$6,116	1.03	0.93	$5,817
42	Nevada	Hycroft	Au	2012	51	$1,102,783	1.05	0.93	$1,075,726
44	Nevada	Lone Tree	Au	2011	43	$379,465	1.08	0.93	$379,868
45	Nevada	Marigold	Au	2008	28	$521,468	1.18	0.93	$569,764
46	Nevada	Phoenix Historic	Au, Ag	2011	27	$356,471	1.08	0.93	$356,849
47	Nevada	Phoenix Copper	Cu	2012	1	$20,458	1.05	0.93	$19,956
48	Nevada	Robinson	Cu	2013	6	$66,969	1.03	0.93	$63,691
49	Nevada	Rochester	Ag	2010	38	$5,721,006	1.11	0.93	$5,901,456
50	Nevada	Round Mountain	Au	2010	141	$2,677,704	1.11	0.93	$2,762,163
51	Nevada	Ruby Hill	Au	2009	19	$108,061	1.14	0.93	$114,487
52	Nevada	SOAP	Au	2012	28	$497,697	1.05	0.93	$485,486
53	Nevada	Standard	Au	2008	5	$208,491	1.18	0.93	$227,800
54	Nevada	Trenton Canyon	Au	2010	3	$63,091	1.11	0.93	$65,081

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Disturbed Acres	Source Document Cost Estimate	$2014 Adjustment		
							Inflation Factor	State Adjustment	$2014 Adjusted Total
56	New Mexico	Mt Taylor	U	2012	44	$286,891	1.05	1.09	$328,522
58	New Mexico	Tyrone	Cu	2013	21	$329,981	1.03	1.09	$368,405
60	Utah	Lisbon Valley	Cu	2013	15	$146,539	1.03	1.05	$158,436
61	Nebraska	Crow Butte	U (ISL)	2015	30	$1,201,444	1.00	1.03	$1,238,602
63	Wyoming	Smith/Reynolds Ranch	U (ISL)	2013	3	$95,810	1.03	1.09	$106,967
64	Wyoming	Highland	U (ISL)	2013	38	$5,115,702	1.03	1.09	$5,711,397
								Minimum	$5,817
								Maximum	$5,901,456
								Median	$352,657
								Mean	$1,101,448

Table B.6 – Underground Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$678,325	1.00	0.84	$570,021
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$161,832	1.05	0.84	$143,269
5	Alaska	Nixon Fork	Cu	2011	$61,265	1.08	0.84	$55,661
6	Alaska	Pogo	Au	2012	$4,980,030	1.05	0.84	$4,408,801
10	Arizona	Arizona 1	U	2008	$90,296	1.18	1.04	$110,991
12	Arizona	Johnson Camp	Cu	2011	$26,300	1.08	1.04	$29,619
23	Colorado	Climax	Mo	2010	$811,837	1.11	1.03	$932,412
25	Colorado	Revenue	Au, Ag	2014	$12,657	1.00	1.03	$13,048
27	Idaho	Idaho Cobalt	Co	2006	$82,834	1.27	1.03	$108,037
36	Montana	East Boulder	PGM	2014	$518,984	1.00	1.03	$535,035
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$13,830	1.00	0.93	$12,806
40	Nevada	Goldstrike	Au	2012	$10,782	1.05	0.93	$10,517
41	Nevada	Hollister	Au	2013	$25,918	1.03	0.93	$24,649
43	Nevada	Jerritt Canyon	Au	2009	$505,671	1.14	0.93	$535,742
56	New Mexico	Mt Taylor	U	2012	$419,113	1.05	1.09	$479,931
							Minimum	$10,517
							Maximum	$4,408,801
							Median	$110,991
							Mean	$531,369

Table B.7 – Drainage Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$893,332	1.03	0.84	$771,065
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$6,139	1.05	0.84	$5,435
7	Alaska	Red Dog	Zn-Pb	2009	$1,780,000	1.14	0.84	$1,711,528
8	Alaska	Rock Creek	Au	2012	$82,310	1.05	0.84	$72,869
9	Alaska	True North	Au	2012	$3,338	1.05	0.84	$2,955
13	Arizona	Mission	Cu	2007	$58,140	1.23	1.04	$74,551
23	Colorado	Climax	Mo	2010	$11,967,396	1.11	1.03	$13,744,801
28	Idaho	Smoky Canyon	P	2008	$3,851	1.18	1.03	$4,685
35	Montana	Continental	Cu	2008	$229,423	1.18	1.03	$279,098
36	Montana	East Boulder	PGM	2014	$90,000	1.00	1.03	$92,784
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$15,803	1.00	0.93	$14,632
39	Nevada	Emigrant	Au	2010	$7,775	1.11	0.93	$8,020
40	Nevada	Goldstrike	Au	2012	$14,635,482	1.05	0.93	$14,276,403
41	Nevada	Hollister	Au	2013	$180,214	1.03	0.93	$171,392
42	Nevada	Hycroft	Au	2012	$339,133	1.05	0.93	$330,812
44	Nevada	Lone Tree	Au	2011	$7,763	1.08	0.93	$7,771
45	Nevada	Marigold	Au	2008	$8,322,994	1.18	0.93	$9,093,827
46	Nevada	Phoenix Historic	Au, Ag	2011	$239,440	1.08	0.93	$239,694
48	Nevada	Robinson	Cu	2013	$44,007	1.03	0.93	$41,853
49	Nevada	Rochester	Ag	2010	$4,022,786	1.11	0.93	$4,149,671
50	Nevada	Round Mountain	Au	2010	$137,003	1.11	0.93	$141,324
51	Nevada	Ruby Hill	Au	2009	$5,064	1.14	0.93	$5,365
52	Nevada	SOAP	Au	2012	$129,205	1.05	0.93	$126,035
53	Nevada	Standard	Au	2008	$2,806	1.18	0.93	$3,066
54	Nevada	Trenton Canyon	Au	2010	$324,572	1.11	0.93	$334,810

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
59	South Carolina	Haile	Au	2013	$1,072,451	1.03	1.15	$1,266,144
60	Utah	Lisbon Valley	Cu	2013	$19,882	1.03	1.05	$21,496
							Minimum	$2,955
							Maximum	$14,276,403
							Median	$126,035
							Mean	$1,740,448

Table B.8a – Solid and Hazardous Waste Disposal Data (Total: All Sub-categories)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
3	Alaska	Kensington	Au	2013	$230,077	1.03	0.84	$198,587
7	Alaska	Red Dog	Zn-Pb	2009	$1,610,000	1.14	0.84	$1,548,068
14	Arizona	Pinto Valley	Cu	2012	$2,934,000	1.05	1.04	$3,219,767
20	California	Briggs	Au	2014	$9,351	1.00	0.85	$7,993
23	Colorado	Climax	Mo	2010	$174,603	1.11	1.03	$200,535
25	Colorado	Revenue	Au, Ag	2014	$11,251	1.00	1.03	$11,599
27	Idaho	Idaho Cobalt	Co	2006	$491,677	1.27	1.03	$641,272
31	Minnesota	Hibbing Taconite	Fe	2008	$1,749,006	1.18	0.89	$1,842,740
36	Montana	East Boulder	PGM	2014	$9,398	1.00	1.03	$9,689
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$290,410	1.00	0.93	$268,898
40	Nevada	Goldstrike	Au	2012	$571,720	1.05	0.93	$557,693
41	Nevada	Hollister	Au	2013	$145,757	1.03	0.93	$138,622
42	Nevada	Hycroft	Au	2012	$118,333	1.05	0.93	$115,430
44	Nevada	Lone Tree	Au	2011	$37,311	1.08	0.93	$37,351
47	Nevada	Phoenix Copper	Cu	2012	$1,283,041	1.05	0.93	$1,251,562
48	Nevada	Robinson	Cu	2013	$416,310	1.03	0.93	$395,930
49	Nevada	Rochester	Ag	2010	$144,253	1.11	0.93	$148,803
50	Nevada	Round Mountain	Au	2010	$66,032	1.11	0.93	$68,115
51	Nevada	Ruby Hill	Au	2009	$30,007	1.14	0.93	$31,791
52	Nevada	SOAP	Au	2012	$23,206	1.05	0.93	$22,637
53	Nevada	Standard	Au	2008	$4,110	1.18	0.93	$4,491
61	Nebraska	Crow Butte	U (ISL)	2015	$672,463	1.00	1.03	$693,260
62	Wyoming	Nichols Ranch	U (ISL)	2014	$756,030	1.00	1.09	$821,772
63	Wyoming	Smith/Reynolds Ranch	U (ISL)	2013	$2,616,205	1.03	1.09	$2,920,848
64	Wyoming	Highland	U (ISL)	2013	$3,232,103	1.03	1.09	$3,608,464
							Minimum	$4,491

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
							Maximum	$3,608,464
							Median	$200,535
							Mean	$750,637

Table B.9 – Short-Term O&M and Monitoring Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$650,373	1.03	0.84	$561,359
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$231,602	1.00	0.84	$194,623
3	Alaska	Kensington	Au	2013	$56,558	1.03	0.84	$48,817
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$6,535	1.05	0.84	$5,785
5	Alaska	Nixon Fork	Cu	2011	$8,084	1.08	0.84	$7,344
6	Alaska	Pogo	Au	2012	$18,452	1.05	0.84	$16,336
7	Alaska	Red Dog	Zn-Pb	2009	$233,333	1.14	0.84	$224,358
8	Alaska	Rock Creek	Au	2012	$44,953	1.05	0.84	$39,797
9	Alaska	True North	Au	2012	$67,756	1.05	0.84	$59,984
10	Arizona	Arizona 1	U	2008	$6,703	1.18	1.04	$8,239
13	Arizona	Mission	Cu	2007	$22,069	1.23	1.04	$28,299
14	Arizona	Pinto Valley	Cu	2013	$76,960	1.03	1.04	$82,342
18	Arizona	Ray	Cu	2014	$18,288	1.00	1.04	$19,050
19	Arizona	Silver Bell	Cu	2008	$107,000	1.18	1.04	$131,524
20	California	Briggs	Au	2014	$11,460	1.00	0.85	$9,795
21	California	Mesquite	Au	2012	$20,865	1.05	0.85	$18,788
22	California	Mountain Pass	Rare Earth	2013	$120,764	1.03	0.85	$106,017
23	Colorado	Climax	Mo	2010	$224,773	1.11	1.03	$258,156
24	Colorado	Cresson	Au	2014	$232,748	1.00	1.03	$239,946
26	Idaho	Blackfoot Bridge	P	2010	$203,571	1.11	1.03	$233,805
27	Idaho	Idaho Cobalt	Co	2006	$241,995	1.27	1.03	$315,623
28	Idaho	Smoky Canyon	P	2008	$45,162	1.18	1.03	$54,940
29	Idaho	Thompson Creek	Mo	2011	$208,723	1.08	1.03	$232,640
30	Minnesota	Essar	Fe	2014	$30,269	1.00	0.89	$27,026
31	Minnesota	Hibbing Taconite	Fe	2008	$534,793	1.18	0.89	$563,454
32	Minnesota	Minntac	Fe	2014	$5,000	1.00	0.89	$4,464

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
33	Minnesota	Northshore	Fe	2013	$87,833	1.03	0.89	$80,550
35	Montana	Continental	Cu	2008	$15,600	1.18	1.03	$18,978
36	Montana	East Boulder	PGM	2014	$139,994	1.00	1.03	$144,323
37	Montana	Golden Sunlight	Au, Ag	2008	$1,107,063	1.18	1.03	$1,346,763
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$751,683	1.00	0.93	$696,003
39	Nevada	Emigrant	Au	2010	$287,899	1.11	0.93	$296,980
40	Nevada	Goldstrike	Au	2012	$1,547,126	1.05	0.93	$1,509,168
41	Nevada	Hollister	Au	2013	$128,959	1.03	0.93	$122,646
42	Nevada	Hycroft	Au	2012	$281,185	1.05	0.93	$274,286
43	Nevada	Jerritt Canyon	Au	2009	$82,450	1.14	0.93	$87,353
44	Nevada	Lone Tree	Au	2011	$534,987	1.08	0.93	$535,555
45	Nevada	Marigold	Au	2008	$185,699	1.18	0.93	$202,898
46	Nevada	Phoenix Historic	Au, Ag	2011	$390,125	1.08	0.93	$390,539
47	Nevada	Phoenix Copper	Cu	2012	$63,501	1.05	0.93	$61,943
48	Nevada	Robinson	Cu	2013	$707,419	1.03	0.93	$672,788
49	Nevada	Rochester	Ag	2010	$367,719	1.11	0.93	$379,317
50	Nevada	Round Mountain	Au	2010	$607,958	1.11	0.93	$627,134
51	Nevada	Ruby Hill	Au	2009	$214,857	1.14	0.93	$227,634
52	Nevada	SOAP	Au	2012	$668,086	1.05	0.93	$651,695
53	Nevada	Standard	Au	2008	$76,019	1.18	0.93	$83,059
54	Nevada	Trenton Canyon	Au	2010	$348,349	1.11	0.93	$359,336
55	New Mexico	Chino	Cu	2007	$100,000	1.23	1.09	$133,802
56	New Mexico	Mt Taylor	U	2012	$89,489	1.05	1.09	$102,474
57	New Mexico	St Anthony	U	2010	$639,059	1.11	1.09	$773,862
59	South Carolina	Haile	Au	2013	$89,578	1.03	1.15	$105,756
60	Utah	Lisbon Valley	Cu	2013	$79,649	1.03	1.05	$86,116

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
							Minimum	$4,464
							Maximum	$1,509,168
							Median	$132,663
							Mean	$258,913

Table B.10 – Long-term O&M and Monitoring

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$147,967	1.03	0.84	$127,715
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$44,334	1.00	0.84	$37,255
6	Alaska	Pogo	Au	2012	$69,679	1.05	0.84	$61,686
8	Alaska	Rock Creek	Au	2012	$8,646	1.05	0.84	$7,654
11	Arizona	Bagdad	Cu	2008	$50,000	1.18	1.04	$61,460
13	Arizona	Mission	Cu	2007	$106,666	1.23	1.04	$136,775
14	Arizona	Pinto Valley	Cu	2013	$1,057,880	1.03	1.04	$1,131,853
26	Idaho	Blackfoot Bridge	P	2010	$14,600	1.11	1.03	$16,768
37	Montana	Golden Sunlight	Au, Ag	2008	$60,450	1.18	1.03	$73,539
39	Nevada	Emigrant	Au	2010	$46,060	1.11	0.93	$47,513
47	Nevada	Phoenix Copper	Cu	2012	$91,102	1.05	0.93	$88,867
48	Nevada	Robinson	Cu	2013	$45,055	1.03	0.93	$42,850
55	New Mexico	Chino	Cu	2007	$182,383	1.23	1.09	$244,033
58	New Mexico	Tyrone	Cu	2013	$341,142	1.03	1.09	$380,866
							Minimum	$7,654
							Maximum	$1,131,853
							Median	$67,613
							Mean	$175,631

Table B.11 – Interim O&M

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$11,165,453	1.03	0.84	$9,637,277
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$790,614	1.00	0.84	$664,381
3	Alaska	Kensington	Au	2013	$5,408,313	1.03	0.84	$4,668,097
5	Alaska	Nixon Fork	Cu	2011	$551,379	1.08	0.84	$500,942
6	Alaska	Pogo	Au	2012	$1,616,375	1.05	0.84	$1,430,970
7	Alaska	Red Dog	Zn-Pb	2009	$11,987,698	1.14	0.84	$11,526,565
18	Arizona	Ray	Cu	2014	$194,875	1.00	1.04	$202,995
19	Arizona	Silver Bell	Cu	2008	$605,000	1.18	1.04	$743,661
20	California	Briggs	Au	2014	$99,040	1.00	0.85	$84,649
21	California	Mesquite	Au	2012	$9,780,362	1.05	0.85	$8,806,525
23	Colorado	Climax	Mo	2010	$2,510,431	1.11	1.03	$2,883,282
24	Colorado	Cresson	Au	2014	$10,336,756	1.00	1.03	$10,656,450
27	Idaho	Idaho Cobalt	Co	2006	$2,062,806	1.27	1.03	$2,690,425
29	Idaho	Thompson Creek	Mo	2011	$1,098,008	1.08	1.03	$1,223,823
36	Montana	East Boulder	PGM	2014	$1,135,583	1.00	1.03	$1,170,704
37	Montana	Golden Sunlight	Au, Ag	2008	$1,001,948	1.18	1.03	$1,218,890
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$13,677,593	1.00	0.93	$12,664,438
39	Nevada	Emigrant	Au	2010	$2,785,332	1.11	0.93	$2,873,186
40	Nevada	Goldstrike	Au	2012	$2,306,217	1.05	0.93	$2,249,634
42	Nevada	Hycroft	Au	2012	$11,277,925	1.05	0.93	$11,001,223
43	Nevada	Jerritt Canyon	Au	2009	$4,321,194	1.14	0.93	$4,578,161
44	Nevada	Lone Tree	Au	2011	$6,604,605	1.08	0.93	$6,611,617
45	Nevada	Marigold	Au	2008	$3,105,446	1.18	0.93	$3,393,056
46	Nevada	Phoenix Historic	Au, Ag	2011	$9,152,010	1.08	0.93	$9,161,727
47	Nevada	Phoenix Copper	Cu	2012	$7,809,496	1.05	0.93	$7,617,891
48	Nevada	Robinson	Cu	2013	$6,958,117	1.03	0.93	$6,617,485

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
50	Nevada	Round Mountain	Au	2010	$16,710,823	1.11	0.93	$17,237,910
51	Nevada	Ruby Hill	Au	2009	$1,461,966	1.14	0.93	$1,548,904
53	Nevada	Standard	Au	2008	$1,747,579	1.18	0.93	$1,909,430
55	New Mexico	Chino	Cu	2007	$1,357,738	1.23	1.09	$1,816,685
58	New Mexico	Tyrone	Cu	2013	$1,982,167	1.03	1.09	$2,212,979
60	Utah	Lisbon Valley	Cu	2013	$489,912	1.03	1.05	$529,687
							Minimum	$84,649
							Maximum	$17,237,910
							Median	$2,781,805
							Mean	$4,691,677

Table B.12 – Water Treatment Data

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$622,621	1.00	0.84	$523,211
6	Alaska	Pogo	Au	2012	$121,541	1.05	0.84	$107,600
7	Alaska	Red Dog	Zn-Pb	2009	$12,408,350	1.14	0.84	$11,931,035
8	Alaska	Rock Creek	Au	2006	$1,546,828	1.27	0.84	$1,644,482
11	Arizona	Bagdad	Cu	2008	$90,607	1.18	1.04	$111,373
27	Idaho	Idaho Cobalt	Co	2006	$12,740	1.27	1.03	$16,616
36	Montana	East Boulder	PGM	2014	$859,453	1.00	1.03	$886,034
37	Montana	Golden Sunlight	Au, Ag	2008	$2,010,654	1.18	1.03	$2,446,000
47	Nevada	Phoenix Copper	Cu	2012	$75,915	1.05	0.93	$74,052
55	New Mexico	Chino	Cu	2007	$3,516,848	1.23	1.09	$4,705,625
58	New Mexico	Tyrone	Cu	2013	$3,215,477	1.03	1.09	$3,589,901
59	South Carolina	Haile	Au	2013	$21,346	1.03	1.15	$25,201
62	Wyoming	Nichols Ranch	U (ISL)	2014	$389,521	1.00	1.09	$423,392
63	Wyoming	Smith/Reynolds Ranch	U (ISL)	2013	$4,491,316	1.03	1.09	$5,014,305
64	Wyoming	Highland	U (ISL)	2013	$3,240,164	1.03	1.09	$3,617,464
65	Colorado	Clear Creek	Au, Ag	2011	$1,472,475	1.08	1.03	$1,641,198
66	Colorado	Summitville	Au, Ag	2009	$5,579,084	1.14	1.03	$6,581,157
67	Montana	Zortman and Landusky	Au, Ag	2006	$1,500,000	1.27	1.03	$1,956,382
							Minimum	$16,616
							Maximum	$11,931,035
							Median	$1,642,840
							Mean	$2,516,391

Table B.13a – Overhead and Oversight Costs (Mobilization and Demobilization)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$349,861	1.03	0.84	$301,977
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$666,430	1.00	0.84	$560,025
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$80,000	1.05	0.84	$70,824
6	Alaska	Pogo	Au	2012	$1,227,381	1.05	0.84	$1,086,596
7	Alaska	Red Dog	Zn-Pb	2009	$6,050,000	1.14	0.84	$5,817,273
8	Alaska	Rock Creek	Au	2006	$416,311	1.27	0.84	$442,594
9	Alaska	True North	Au	2012	$76,864	1.05	0.84	$68,047
10	Arizona	Arizona 1	U	2008	$10,000	1.18	1.04	$12,292
11	Arizona	Bagdad	Cu	2010	$253,500	1.11	1.04	$294,183
12	Arizona	Johnson Camp	Cu	2011	$14,573	1.08	1.04	$16,412
17	Arizona	Safford	Cu	2005	$243,163	1.32	1.04	$333,576
20	California	Briggs	Au	2014	$77,749	1.00	0.85	$66,452
21	California	Mesquite	Au	2012	$32,712	1.05	0.85	$29,455
22	California	Mountain Pass	Rare Earth	2013	$32,236	1.03	0.85	$28,300
23	Colorado	Climax	Mo	2010	$374,636	1.11	1.03	$430,277
24	Colorado	Cresson	Au	2014	$2,264,990	1.00	1.03	$2,335,041
25	Colorado	Revenue	Au, Ag	2014	$4,780	1.00	1.03	$4,928
26	Idaho	Blackfoot Bridge	P	2010	$1,131,136	1.11	1.03	$1,299,133
27	Idaho	Idaho Cobalt	Co	2006	$208,111	1.27	1.03	$271,430
28	Idaho	Smoky Canyon	P	2008	$719,500	1.18	1.03	$875,286
29	Idaho	Thompson Creek	Mo	2011	$965,635	1.08	1.03	$1,076,281
33	Minnesota	Northshore	Fe	2013	$950,000	1.03	0.89	$871,225
35	Montana	Continental	Cu	2008	$957,679	1.18	1.03	$1,165,035
36	Montana	East Boulder	PGM	2014	$527,975	1.00	1.03	$544,304
37	Montana	Golden Sunlight	Au, Ag	2008	$670,358	1.18	1.03	$815,504
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$537,205	1.00	0.93	$497,412

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
39	Nevada	Emigrant	Au	2010	$212,731	1.11	0.93	$219,441
40	Nevada	Goldstrike	Au	2012	$742,389	1.05	0.93	$724,175
41	Nevada	Hollister	Au	2013	$132,459	1.03	0.93	$125,975
42	Nevada	Hycroft	Au	2012	$397,319	1.05	0.93	$387,571
43	Nevada	Jerritt Canyon	Au	2009	$657,080	1.14	0.93	$696,154
44	Nevada	Lone Tree	Au	2011	$292,214	1.08	0.93	$292,524
46	Nevada	Phoenix Historic	Au, Ag	2011	$2,641,034	1.08	0.93	$2,643,838
47	Nevada	Phoenix Copper	Cu	2012	$67,907	1.05	0.93	$66,241
48	Nevada	Robinson	Cu	2013	$347,692	1.03	0.93	$330,671
49	Nevada	Rochester	Ag	2010	$124,593	1.11	0.93	$128,523
50	Nevada	Round Mountain	Au	2010	$1,356,046	1.11	0.93	$1,398,818
51	Nevada	Ruby Hill	Au	2009	$159,198	1.14	0.93	$168,665
52	Nevada	SOAP	Au	2012	$125,232	1.05	0.93	$122,159
53	Nevada	Standard	Au	2008	$185,908	1.18	0.93	$203,126
54	Nevada	Trenton Canyon	Au	2010	$182,242	1.11	0.93	$187,990
55	New Mexico	Chino	Cu	2007	$1,394,677	1.23	1.09	$1,866,110
56	New Mexico	Mt Taylor	U	2012	$62,673	1.05	1.09	$71,767
57	New Mexico	St Anthony	U	2010	$1,188,782	1.11	1.09	$1,439,544
58	New Mexico	Tyrone	Cu	2013	$1,058,959	1.03	1.09	$1,182,269
60	Utah	Lisbon Valley	Cu	2013	$35,000	1.03	1.05	$37,842
							Minimum	$4,928
							Maximum	$5,817,273
							Median	$332,124
							Mean	$687,114

Table B.13b – Overhead and Oversight Costs (Engineering Design and Redesign)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$2,742,285	1.03	0.84	$2,366,958
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$1,881,859	1.00	0.84	$1,581,394
3	Alaska	Kensington	Au	2013	$800,075	1.03	0.84	$690,572
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$36,583	1.05	0.84	$32,387
5	Alaska	Nixon Fork	Cu	2011	$240,000	1.08	0.84	$218,046
6	Alaska	Pogo	Au	2012	$935,350	1.05	0.84	$828,062
7	Alaska	Red Dog	Zn-Pb	2009	$1,360,000	1.14	0.84	$1,307,685
8	Alaska	Rock Creek	Au	2006	$85,031	1.27	0.84	$90,399
9	Alaska	True North	Au	2012	$76,493	1.05	0.84	$67,719
10	Arizona	Arizona 1	U	2008	$23,980	1.18	1.04	$29,476
11	Arizona	Bagdad	Cu	2010	$895,800	1.11	1.04	$1,039,562
18	Arizona	Ray	Cu	2014	$256,979	1.00	1.04	$267,686
20	California	Briggs	Au	2014	$103,665	1.00	0.85	$88,603
21	California	Mesquite	Au	2012	$135,035	1.05	0.85	$121,589
22	California	Mountain Pass	Rare Earth	2013	$183,788	1.03	0.85	$161,345
23	Colorado	Climax	Mo	2010	$3,556,618	1.11	1.03	$4,084,849
25	Colorado	Revenue	Au, Ag	2014	$9,446	1.00	1.03	$9,738
26	Idaho	Blackfoot Bridge	P	2010	$1,506,598	1.11	1.03	$1,730,359
27	Idaho	Idaho Cobalt	Co	2006	$305,656	1.27	1.03	$398,653
31	Minnesota	Hibbing Taconite	Fe	2008	$365,878	1.18	0.89	$385,486
33	Minnesota	Northshore	Fe	2013	$229,000	1.03	0.89	$210,011
35	Montana	Continental	Cu	2008	$1,596,131	1.18	1.03	$1,941,725
36	Montana	East Boulder	PGM	2014	$527,975	1.00	1.03	$544,304
37	Montana	Golden Sunlight	Au, Ag	2008	$1,117,263	1.18	1.03	$1,359,172
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$3,624,304	1.00	0.93	$3,355,837
39	Nevada	Emigrant	Au	2010	$2,333,945	1.11	0.93	$2,407,561

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
40	Nevada	Goldstrike	Au	2012	$7,315,761	1.05	0.93	$7,136,270
41	Nevada	Hollister	Au	2013	$511,698	1.03	0.93	$486,648
42	Nevada	Hycroft	Au	2012	$1,290,667	1.05	0.93	$1,259,001
43	Nevada	Jerritt Canyon	Au	2009	$497,573	1.14	0.93	$527,162
44	Nevada	Lone Tree	Au	2011	$1,974,733	1.08	0.93	$1,976,830
45	Nevada	Marigold	Au	2008	$1,583,147	1.18	0.93	$1,729,770
46	Nevada	Phoenix Historic	Au, Ag	2011	$15,394,188	1.08	0.93	$15,410,532
47	Nevada	Phoenix Copper	Cu	2012	$4,970,347	1.05	0.93	$4,848,400
48	Nevada	Robinson	Cu	2013	$3,214,660	1.03	0.93	$3,057,287
49	Nevada	Rochester	Ag	2010	$1,884,354	1.11	0.93	$1,943,790
50	Nevada	Round Mountain	Au	2010	$4,322,331	1.11	0.93	$4,458,664
51	Nevada	Ruby Hill	Au	2009	$948,312	1.14	0.93	$1,004,705
52	Nevada	SOAP	Au	2012	$4,054,825	1.05	0.93	$3,955,340
53	Nevada	Standard	Au	2008	$561,152	1.18	0.93	$613,123
54	Nevada	Trenton Canyon	Au	2010	$1,487,424	1.11	0.93	$1,534,340
55	New Mexico	Chino	Cu	2007	$5,707,862	1.23	1.09	$7,637,254
56	New Mexico	Mt Taylor	U	2012	$188,018	1.05	1.09	$215,301
58	New Mexico	Tyrone	Cu	2013	$2,647,397	1.03	1.09	$2,955,672
60	Utah	Lisbon Valley	Cu	2013	$192,058	1.03	1.05	$207,651
							Minimum	$9,738
							Maximum	$15,410,532
							Median	$1,039,562
							Mean	$1,917,265

Table B.13c – Overhead and Oversight Costs (Contingency)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$6,855,711	1.03	0.84	$5,917,394
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$8,896,061	1.00	0.84	$7,475,682
3	Alaska	Kensington	Au	2013	$2,560,239	1.03	0.84	$2,209,828
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$41,324	1.05	0.84	$36,584
5	Alaska	Nixon Fork	Cu	2011	$480,000	1.08	0.84	$436,093
6	Alaska	Pogo	Au	2012	$6,754,192	1.05	0.84	$5,979,460
7	Alaska	Red Dog	Zn-Pb	2009	$4,450,000	1.14	0.84	$4,278,821
8	Alaska	Rock Creek	Au	2006	$283,438	1.27	0.84	$301,332
9	Alaska	True North	Au	2012	$191,233	1.05	0.84	$169,298
10	Arizona	Arizona 1	U	2008	$39,966	1.18	1.04	$49,126
11	Arizona	Bagdad	Cu	2010	$845,100	1.11	1.04	$980,725
12	Arizona	Johnson Camp	Cu	2011	$145,370	1.08	1.04	$163,715
13	Arizona	Mission	Cu	2007	$1,988,442	1.23	1.04	$2,549,725
14	Arizona	Pinto Valley	Cu	2013	$297,004	1.03	1.04	$317,772
17	Arizona	Safford	Cu	2005	$810,543	1.32	1.04	$1,111,920
18	Arizona	Ray	Cu	2014	$342,639	1.00	1.04	$356,916
19	Arizona	Silver Bell	Cu	2008	$899,800	1.18	1.04	$1,106,027
20	California	Briggs	Au	2014	$181,414	1.00	0.85	$155,055
21	California	Mesquite	Au	2012	$540,138	1.05	0.85	$486,356
22	California	Mountain Pass	Rare Earth	2013	$225,668	1.03	0.85	$198,111
24	Colorado	Cresson	Au	2014	$11,324,951	1.00	1.03	$11,675,207
26	Idaho	Blackfoot Bridge	P	2010	$4,098,321	1.11	1.03	$4,707,006
27	Idaho	Idaho Cobalt	Co	2006	$2,424,254	1.27	1.03	$3,161,845
28	Idaho	Smoky Canyon	P	2008	$123,263	1.18	1.03	$149,952
29	Idaho	Thompson Creek	Mo	2011	$1,277,901	1.08	1.03	$1,424,328
30	Minnesota	Essar	Fe	2014	$332,790	1.00	0.89	$297,134

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
31	Minnesota	Hibbing Taconite	Fe	2008	$3,150,745	1.18	0.89	$3,319,603
32	Minnesota	Minntac	Fe	2014	$472,938	1.00	0.89	$422,266
33	Minnesota	Northshore	Fe	2013	$2,542,000	1.03	0.89	$2,331,216
34	Minnesota	SCRAM	Fe	2013	$50,000	1.03	0.89	$45,854
35	Montana	Continental	Cu	2008	$3,192,262	1.18	1.03	$3,883,449
36	Montana	East Boulder	PGM	2014	$2,639,872	1.00	1.03	$2,721,518
37	Montana	Golden Sunlight	Au, Ag	2008	$1,117,263	1.18	1.03	$1,359,172
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$2,609,681	1.00	0.93	$2,416,371
39	Nevada	Emigrant	Au	2010	$2,912,240	1.11	0.93	$3,004,097
40	Nevada	Goldstrike	Au	2012	$5,546,933	1.05	0.93	$5,410,840
41	Nevada	Hollister	Au	2013	$389,014	1.03	0.93	$369,970
42	Nevada	Hycroft	Au	2012	$1,936,000	1.05	0.93	$1,888,501
43	Nevada	Jerritt Canyon	Au	2009	$561,097	1.14	0.93	$594,464
44	Nevada	Lone Tree	Au	2011	$2,334,089	1.08	0.93	$2,336,567
45	Nevada	Marigold	Au	2008	$2,252,245	1.18	0.93	$2,460,836
46	Nevada	Phoenix Historic	Au, Ag	2011	$15,394,188	1.08	0.93	$15,410,532
47	Nevada	Phoenix Copper	Cu	2012	$4,007,857	1.05	0.93	$3,909,525
48	Nevada	Robinson	Cu	2013	$2,409,660	1.03	0.93	$2,291,696
49	Nevada	Rochester	Ag	2010	$2,165,695	1.11	0.93	$2,234,005
50	Nevada	Round Mountain	Au	2010	$3,523,305	1.11	0.93	$3,634,436
51	Nevada	Ruby Hill	Au	2009	$715,598	1.14	0.93	$758,152
52	Nevada	SOAP	Au	2012	$3,627,100	1.05	0.93	$3,538,110
53	Nevada	Standard	Au	2008	$372,678	1.18	0.93	$407,194
54	Nevada	Trenton Canyon	Au	2010	$1,642,458	1.11	0.93	$1,694,264
55	New Mexico	Chino	Cu	2007	$2,535,939	1.23	1.09	$3,393,146
56	New Mexico	Mt Taylor	U	2012	$313,363	1.05	1.09	$358,835
57	New Mexico	St Anthony	U	2010	$1,214,004	1.11	1.09	$1,470,086

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	**State Adjustment**	**$2014 Adjusted Total**
58	New Mexico	Tyrone	Cu	2013	$2,117,917	1.03	1.09	$2,364,537
60	Utah	Lisbon Valley	Cu	2013	$384,115	1.03	1.05	$415,301
61	Nebraska	Crow Butte	U (ISL)	2015	$5,450,417	1.00	1.03	$5,618,987
62	Wyoming	Nichols Ranch	U (ISL)	2014	$1,343,707	1.00	1.09	$1,460,551
63	Wyoming	Smith/Reynolds Ranch	U (ISL)	2013	$15,948,718	1.03	1.09	$17,805,859
64	Wyoming	Highland	U (ISL)	2013	$11,736,441	1.03	1.09	$13,103,085
							Minimum	$36,584
							Maximum	$17,805,859
							Median	$1,888,501
							Mean	$2,849,634

Table B.13d – Overhead and Oversight Costs (Contractor Profit)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$10,283,567	1.03	0.84	$8,876,092
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$10,606,842	1.00	0.84	$8,913,313
3	Alaska	Kensington	Au	2013	$2,400,224	1.03	0.84	$2,071,714
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$182,916	1.05	0.84	$161,934
5	Alaska	Nixon Fork	Cu	2011	$560,000	1.08	0.84	$508,775
6	Alaska	Pogo	Au	2012	$5,784,038	1.05	0.84	$5,120,586
7	Alaska	Red Dog	Zn-Pb	2009	$4,440,000	1.14	0.84	$4,269,206
8	Alaska	Rock Creek	Au	2006	$283,438	1.27	0.84	$301,332
9	Alaska	True North	Au	2012	$669,314	1.05	0.84	$592,541
10	Arizona	Arizona 1	U	2008	$15,987	1.18	1.04	$19,651
11	Arizona	Bagdad	Cu	2010	$963,400	1.11	1.04	$1,118,011
12	Arizona	Johnson Camp	Cu	2011	$145,730	1.08	1.04	$164,120
16	Arizona	Rosemont	Cu	2007	$1,995,124	1.23	1.04	$2,558,293
17	Arizona	Safford	Cu	2005	$1,868,301	1.32	1.04	$2,562,976
20	California	Briggs	Au	2014	$501,933	1.00	0.85	$429,003
21	California	Mesquite	Au	2012	$783,200	1.05	0.85	$705,216
22	California	Mountain Pass	Rare Earth	2013	$435,218	1.03	0.85	$382,073
23	Colorado	Climax	Mo	2010	$6,895,006	1.11	1.03	$7,919,056
24	Colorado	Cresson	Au	2014	$5,662,476	1.00	1.03	$5,837,604
25	Colorado	Revenue	Au, Ag	2014	$36,069	1.00	1.03	$37,185
26	Idaho	Blackfoot Bridge	P	2010	$4,098,321	1.11	1.03	$4,707,006
27	Idaho	Idaho Cobalt	Co	2006	$1,212,127	1.27	1.03	$1,580,922
28	Idaho	Smoky Canyon	P	2008	$657,402	1.18	1.03	$799,742
29	Idaho	Thompson Creek	Mo	2011	$2,774,826	1.08	1.03	$3,092,777
32	Minnesota	Minntac	Fe	2014	$650,000	1.00	0.89	$580,357
33	Minnesota	Northshore	Fe	2013	$2,617,000	1.03	0.89	$2,399,997

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$6,524,202	1.00	0.93	$6,040,928
39	Nevada	Emigrant	Au	2010	$4,853,733	1.11	0.93	$5,006,828
40	Nevada	Goldstrike	Au	2012	$13,867,333	1.05	0.93	$13,527,100
41	Nevada	Hollister	Au	2013	$648,357	1.03	0.93	$616,617
42	Nevada	Hycroft	Au	2012	$3,226,666	1.05	0.93	$3,147,500
43	Nevada	Jerritt Canyon	Au	2009	$1,659,313	1.14	0.93	$1,757,987
44	Nevada	Lone Tree	Au	2011	$3,890,148	1.08	0.93	$3,894,278
45	Nevada	Marigold	Au	2008	$3,753,741	1.18	0.93	$4,101,393
46	Nevada	Phoenix Historic	Au, Ag	2011	$38,485,470	1.08	0.93	$38,526,330
47	Nevada	Phoenix Copper	Cu	2012	$10,019,642	1.05	0.93	$9,773,812
48	Nevada	Robinson	Cu	2013	$6,024,149	1.03	0.93	$5,729,239
49	Nevada	Rochester	Ag	2010	$3,609,492	1.11	0.93	$3,723,341
50	Nevada	Round Mountain	Au	2010	$8,808,262	1.11	0.93	$9,086,089
51	Nevada	Ruby Hill	Au	2009	$1,192,663	1.14	0.93	$1,263,587
52	Nevada	SOAP	Au	2012	$9,067,751	1.05	0.93	$8,845,275
53	Nevada	Standard	Au	2008	$621,129	1.18	0.93	$678,655
54	Nevada	Trenton Canyon	Au	2010	$2,737,429	1.11	0.93	$2,823,772
55	New Mexico	Chino	Cu	2007	$31,699,232	1.23	1.09	$42,414,319
56	New Mexico	Mt Taylor	U	2012	$313,363	1.05	1.09	$358,835
57	New Mexico	St Anthony	U	2010	$3,382,037	1.11	1.09	$4,095,445
58	New Mexico	Tyrone	Cu	2013	$15,884,380	1.03	1.09	$17,734,029
60	Utah	Lisbon Valley	Cu	2013	$180,199	1.03	1.05	$194,829
							Minimum	$19,651
							Maximum	$42,414,319
							Median	$2,693,374
							Mean	$5,188,535

Table B.13e – Overhead and Oversight Costs (Contractor Liability)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$184,909	1.03	0.84	$159,601
3	Alaska	Kensington	Au	2013	$240,022	1.03	0.84	$207,171
5	Alaska	Nixon Fork	Cu	2011	$21,000	1.08	0.84	$19,079
6	Alaska	Pogo	Au	2012	$665,164	1.05	0.84	$588,867
7	Alaska	Red Dog	Zn-Pb	2009	$120,000	1.14	0.84	$115,384
9	Alaska	True North	Au	2012	$6,805	1.05	0.84	$6,024
16	Arizona	Rosemont	Cu	2007	$187,559	1.23	1.04	$240,502
23	Colorado	Climax	Mo	2010	$1,258,945	1.11	1.03	$1,445,924
24	Colorado	Cresson	Au	2014	$1,755,367	1.00	1.03	$1,809,657
25	Colorado	Revenue	Au, Ag	2014	$5,464	1.00	1.03	$5,633
26	Idaho	Blackfoot Bridge	P	2010	$614,749	1.11	1.03	$706,052
27	Idaho	Idaho Cobalt	Co	2006	$45,455	1.27	1.03	$59,285
28	Idaho	Smoky Canyon	P	2008	$14,850	1.18	1.03	$18,065
29	Idaho	Thompson Creek	Mo	2011	$53,572	1.08	1.03	$59,711
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$246,906	1.00	0.93	$228,617
39	Nevada	Emigrant	Au	2010	$209,864	1.11	0.93	$216,483
40	Nevada	Goldstrike	Au	2012	$825,711	1.05	0.93	$805,452
41	Nevada	Hollister	Au	2013	$19,335	1.03	0.93	$18,388
42	Nevada	Hycroft	Au	2012	$149,656	1.05	0.93	$145,984
43	Nevada	Jerritt Canyon	Au	2009	$142,205	1.14	0.93	$150,661
44	Nevada	Lone Tree	Au	2011	$246,213	1.08	0.93	$246,474
45	Nevada	Marigold	Au	2008	$207,415	1.18	0.93	$226,625
46	Nevada	Phoenix Historic	Au, Ag	2011	$1,235,690	1.08	0.93	$1,237,002
47	Nevada	Phoenix Copper	Cu	2012	$125,358	1.05	0.93	$122,282
48	Nevada	Robinson	Cu	2013	$313,937	1.03	0.93	$298,568
49	Nevada	Rochester	Ag	2010	$187,349	1.11	0.93	$193,258

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
50	Nevada	Round Mountain	Au	2010	$543,138	1.11	0.93	$560,269
51	Nevada	Ruby Hill	Au	2009	$64,704	1.14	0.93	$68,552
52	Nevada	SOAP	Au	2012	$463,279	1.05	0.93	$451,913
53	Nevada	Standard	Au	2008	$31,437	1.18	0.93	$34,349
54	Nevada	Trenton Canyon	Au	2010	$160,113	1.11	0.93	$165,163
57	New Mexico	St Anthony	U	2010	$372,442	1.11	1.09	$451,005
							Minimum	$5,633
							Maximum	$1,809,657
							Median	$200,215
							Mean	$345,688

Table B.13f – Overhead and Oversight Costs (Payment and Performance Bonds)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$2,056,713	1.03	0.84	$1,775,218
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$2,052,937	1.00	0.84	$1,725,157
3	Alaska	Kensington	Au	2013	$480,044	1.03	0.84	$414,342
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$10,975	1.05	0.84	$9,716
5	Alaska	Nixon Fork	Cu	2011	$137,000	1.08	0.84	$124,468
6	Alaska	Pogo	Au	2012	$1,330,329	1.05	0.84	$1,177,735
7	Alaska	Red Dog	Zn-Pb	2009	$1,090,000	1.14	0.84	$1,048,071
9	Alaska	True North	Au	2012	$57,279	1.05	0.84	$50,709
16	Arizona	Rosemont	Cu	2007	$187,559	1.23	1.04	$240,502
20	California	Briggs	Au	2014	$10,815	1.00	0.85	$9,244
23	Colorado	Climax	Mo	2010	$654,402	1.11	1.03	$751,594
24	Colorado	Cresson	Au	2014	$1,132,495	1.00	1.03	$1,167,521
25	Colorado	Revenue	Au, Ag	2014	$2,840	1.00	1.03	$2,928
26	Idaho	Blackfoot Bridge	P	2010	$1,229,498	1.11	1.03	$1,412,104
27	Idaho	Idaho Cobalt	Co	2006	$109,643	1.27	1.03	$143,002
28	Idaho	Smoky Canyon	P	2008	$123,263	1.18	1.03	$149,952
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$1,957,261	1.00	0.93	$1,812,279
39	Nevada	Emigrant	Au	2010	$1,456,120	1.11	0.93	$1,502,048
40	Nevada	Goldstrike	Au	2012	$4,160,200	1.05	0.93	$4,058,130
41	Nevada	Hollister	Au	2013	$194,507	1.03	0.93	$184,985
42	Nevada	Hycroft	Au	2012	$968,000	1.05	0.93	$944,250
43	Nevada	Jerritt Canyon	Au	2009	$853,229	1.14	0.93	$903,968
44	Nevada	Lone Tree	Au	2011	$1,167,044	1.08	0.93	$1,168,283
45	Nevada	Marigold	Au	2008	$1,126,122	1.18	0.93	$1,230,418
46	Nevada	Phoenix Historic	Au, Ag	2011	$11,545,641	1.08	0.93	$11,557,899
47	Nevada	Phoenix Copper	Cu	2012	$3,005,892	1.05	0.93	$2,932,143

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
48	Nevada	Robinson	Cu	2013	$1,807,245	1.03	0.93	$1,718,772
49	Nevada	Rochester	Ag	2010	$1,082,848	1.11	0.93	$1,117,003
50	Nevada	Round Mountain	Au	2010	$2,642,479	1.11	0.93	$2,725,827
51	Nevada	Ruby Hill	Au	2009	$357,799	1.14	0.93	$379,076
52	Nevada	SOAP	Au	2012	$2,720,325	1.05	0.93	$2,653,582
53	Nevada	Standard	Au	2008	$186,339	1.18	0.93	$203,597
54	Nevada	Trenton Canyon	Au	2010	$821,229	1.11	0.93	$847,132
57	New Mexico	St Anthony	U	2010	$158,908	1.11	1.09	$192,428
							Minimum	$2,928
							Maximum	$11,557,899
							Median	$996,161
							Mean	$1,362,767

Table B.13g – Overhead and Oversight Costs (Agency Direct Costs)

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
1	Alaska	Fort Knox	Au	2013	$5,484,569	1.03	0.84	$4,733,916
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	2014	$4,790,187	1.00	0.84	$4,025,367
3	Alaska	Kensington	Au	2013	$1,120,104	1.03	0.84	$966,799
4	Alaska	Niblack	Cu-Au-Ag-Zn	2012	$8,650	1.05	0.84	$7,658
5	Alaska	Nixon Fork	Cu	2011	$436,000	1.08	0.84	$396,118
6	Alaska	Pogo	Au	2012	$1,853,591	1.05	0.84	$1,640,977
7	Alaska	Red Dog	Zn-Pb	2009	$1,920,000	1.14	0.84	$1,846,143
8	Alaska	Rock Creek	Au	2006	$85,031	1.27	0.84	$90,399
9	Alaska	True North	Au	2012	$152,986	1.05	0.84	$135,438
10	Arizona	Arizona 1	U	2008	$7,993	1.18	1.04	$9,825
11	Arizona	Bagdad	Cu	2010	$169,000	1.11	1.04	$196,122
12	Arizona	Johnson Camp	Cu	2011	$58,292	1.08	1.04	$65,648
14	Arizona	Pinto Valley	Cu	2013	$500,000	1.03	1.04	$534,963
16	Arizona	Rosemont	Cu	2007	$2,813,385	1.23	1.04	$3,607,526
17	Arizona	Safford	Cu	2005	$1,215,814	1.32	1.04	$1,667,880
20	California	Briggs	Au	2014	$156,793	1.00	0.85	$134,011
21	California	Mesquite	Au	2012	$405,104	1.05	0.85	$364,768
22	California	Mountain Pass	Rare Earth	2013	$391,696	1.03	0.85	$343,865
23	Colorado	Climax	Mo	2010	$3,556,618	1.11	1.03	$4,084,849
24	Colorado	Cresson	Au	2014	$5,662,476	1.00	1.03	$5,837,604
25	Colorado	Revenue	Au, Ag	2014	$15,744	1.00	1.03	$16,231
26	Idaho	Blackfoot Bridge	P	2010	$1,664,245	1.11	1.03	$1,911,420
27	Idaho	Idaho Cobalt	Co	2006	$545,457	1.27	1.03	$711,415
28	Idaho	Smoky Canyon	P	2008	$287,613	1.18	1.03	$349,887
29	Idaho	Thompson Creek	Mo	2011	$2,576,037	1.08	1.03	$2,871,210
30	Minnesota	Essar	Fe	2014	$90,000	1.00	0.89	$80,357

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
32	Minnesota	Minntac	Fe	2014	$390,000	1.00	0.89	$348,214
33	Minnesota	Northshore	Fe	2013	$2,542,000	1.03	0.89	$2,331,216
34	Minnesota	SCRAM	Fe	2013	$33,000	1.03	0.89	$30,264
35	Montana	Continental	Cu	2008	$3,192,262	1.18	1.03	$3,883,449
36	Montana	East Boulder	PGM	2014	$1,291,962	1.00	1.03	$1,331,920
37	Montana	Golden Sunlight	Au, Ag	2008	$2,234,525	1.18	1.03	$2,718,344
38	Nevada	Bald Mountain (North)	Au, Ag	2014	$3,914,521	1.00	0.93	$3,624,556
39	Nevada	Emigrant	Au	2010	$2,912,240	1.11	0.93	$3,004,097
40	Nevada	Goldstrike	Au	2012	$8,320,400	1.05	0.93	$8,116,260
41	Nevada	Hollister	Au	2013	$518,685	1.03	0.93	$493,293
42	Nevada	Hycroft	Au	2012	$1,936,000	1.05	0.93	$1,888,501
43	Nevada	Jerritt Canyon	Au	2009	$6,226,594	1.14	0.93	$6,596,869
44	Nevada	Lone Tree	Au	2011	$2,334,089	1.08	0.93	$2,336,567
45	Nevada	Marigold	Au	2008	$2,252,245	1.18	0.93	$2,460,836
46	Nevada	Phoenix Historic	Au, Ag	2011	$23,091,282	1.08	0.93	$23,115,798
47	Nevada	Phoenix Copper	Cu	2012	$6,011,785	1.05	0.93	$5,864,287
48	Nevada	Robinson	Cu	2013	$3,614,490	1.03	0.93	$3,437,544
49	Nevada	Rochester	Ag	2010	$2,165,695	1.11	0.93	$2,234,005
50	Nevada	Round Mountain	Au	2010	$5,284,957	1.11	0.93	$5,451,653
51	Nevada	Ruby Hill	Au	2009	$954,130	1.14	0.93	$1,010,869
52	Nevada	SOAP	Au	2012	$5,440,650	1.05	0.93	$5,307,164
53	Nevada	Standard	Au	2008	$496,904	1.18	0.93	$542,925
54	Nevada	Trenton Canyon	Au	2010	$1,642,458	1.11	0.93	$1,694,264
55	New Mexico	Chino	Cu	2007	$6,339,846	1.23	1.09	$8,482,863
56	New Mexico	Mt Taylor	U	2012	$219,354	1.05	1.09	$251,185
58	New Mexico	Tyrone	Cu	2013	$2,117,917	1.03	1.09	$2,364,537
59	South	Haile	Au	2013	$1,968,000	1.03	1.15	$2,323,437

Site ID	State	Mine Name	Commodity	Year of Cost Estimate	Source Document Cost Estimate	$2014 Adjustment		
						Inflation Factor	State Adjustment	$2014 Adjusted Total
	Carolina							
61	Nebraska	Crow Butte	U (ISL)	2015	$3,633,611	1.00	1.03	$3,745,991
							Minimum	$7,658
							Maximum	$23,115,798
							Median	$1,867,322
							Mean	$2,622,617

Attachment C: Davidson-MacKinnon Test Results

Table C1: Log-Log Predicted Values Plugged into Level-Level Model

<table>
<tr><th>Dependent Variable</th><th>T-Stat</th><th>P>|t|</th></tr>
<tr><td>OpenPit</td><td>0.43</td><td>0.674</td></tr>
<tr><td>WasteRock</td><td>0.59</td><td>0.557</td></tr>
<tr><td>HeapDumpLeach</td><td>0.93</td><td>0.364</td></tr>
<tr><td>TailingsFacility</td><td>1.87</td><td>0.072</td></tr>
<tr><td>ProcessPondsResevoirs</td><td>-2.82</td><td>0.009</td></tr>
<tr><td>UndergroundMine</td><td colspan="2">Test Not Applicable</td></tr>
<tr><td>Drainage</td><td>0.73</td><td>0.473</td></tr>
<tr><td>ShortTermO&MMonitoring</td><td>0.49</td><td>0.626</td></tr>
<tr><td>LongTermO&MMonitoring</td><td>1.36</td><td>0.2</td></tr>
<tr><td>InterimO&M</td><td>0.88</td><td>0.386</td></tr>
<tr><td>WaterTreatment</td><td>1.84</td><td>0.089</td></tr>
<tr><td colspan="3">Shading indicates a significant T-statistic</td></tr>
</table>

Table C2: Level-Level Predicted Values Plugged into Log-Log Model

<table>
<tr><th>Dependent Variable</th><th>T-Stat</th><th>P>|t|</th></tr>
<tr><td>OpenPit</td><td>-1.15</td><td>0.265</td></tr>
<tr><td>WasteRock</td><td>2.49</td><td>0.017</td></tr>
<tr><td>HeapDumpLeach</td><td>-2.18</td><td>0.039</td></tr>
<tr><td>TailingsFacility</td><td>-0.7</td><td>0.489</td></tr>
<tr><td>ProcessPondsResevoirs</td><td>-0.72</td><td>0.475</td></tr>
<tr><td>UndergroundMine</td><td colspan="2">Test Not Applicable</td></tr>
<tr><td>Drainage</td><td>0.03</td><td>0.98</td></tr>
<tr><td>ShortTermO&MMonitoring</td><td>0.45</td><td>0.654</td></tr>
<tr><td>LongTermO&MMonitoring</td><td>0.35</td><td>0.735</td></tr>
<tr><td>InterimO&M</td><td>1.45</td><td>0.159</td></tr>
<tr><td>WaterTreatment</td><td>0.31</td><td>0.764</td></tr>
<tr><td colspan="3">Shading indicates a significant T-statistic</td></tr>
</table>

Table C3: Log-Log Predicted Values Plugged into Log-Level Model

Dependent Variable	T-Stat	P>|t|
OpenPit	0.85	0.402
WasteRock	-0.68	0.498
HeapDumpLeach	1.87	0.074
TailingsFacility	1.14	0.262
ProcessPondsResevoirs	-5.11	0
UndergroundMine	Test Not Applicable	
Drainage	1.75	0.094
ShortTermO&MMonitoring	1.49	0.142
LongTermO&MMonitoring	1.33	0.209
InterimO&M	1	0.326
WaterTreatment	0.72	0.482
Shading indicates a significant T-statistic		

Table C4: Log-Level Predicted Values Plugged into Log-Log Model

Dependent Variable	T-Stat	P>|t|
OpenPit	0.18	0.855
WasteRock	0.8	0.425
HeapDumpLeach	-0.85	0.403
TailingsFacility	-1.28	0.211
ProcessPondsResevoirs	-0.9	0.374
UndergroundMine	Test Not Applicable	
Drainage	-0.16	0.876
ShortTermO&MMonitoring	0.84	0.407
LongTermO&MMonitoring	0.02	0.984
InterimO&M	1.75	0.09
WaterTreatment	1.66	0.121
Shading indicates a significant T-statistic		

Table C5: Log-Log Predicted Values Plugged into Level-Log Model

Dependent Variable	T-Stat	P>|t|
OpenPit	0.81	0.425
WasteRock	1.63	0.11
HeapDumpLeach	0.21	0.834
TailingsFacility	0.78	0.441
ProcessPondsResevoirs	0.01	0.994
UndergroundMine	Test Not Applicable	
Drainage	0.19	0.849
ShortTermO&MMonitoring	1.8	0.079
LongTermO&MMonitoring	-0.41	0.691
InterimO&M	-0.15	0.88
WaterTreatment	5.22	0
Shading indicates a significant T-statistic		

Table C6: Level-Log Predicted Values Plugged into Log-Log Model

Dependent Variable	T-Stat	P>|t|
OpenPit	-0.84	0.407
WasteRock	3.04	0.004
HeapDumpLeach	-1.93	0.066
TailingsFacility	1.69	0.104
ProcessPondsResevoirs	-0.2	0.845
UndergroundMine	Test Not Applicable	
Drainage	0.76	0.458
ShortTermO&MMonitoring	-0.62	0.539
LongTermO&MMonitoring	-0.46	0.658
InterimO&M	0.97	0.339
WaterTreatment	-0.47	0.647
Shading indicates a significant T-statistic		

Attachment D:
0.99 Confidence Level Stepwise Regression Results

Table D-1: Open Pit Capital Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	Forward 0.99		Final Model
Including BelowGroundWater	Yes	No	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	34	37	**37**
Adjusted R-Squared	0.55	0.55	**0.55**
Estimated Coefficients			
Open Pit Acreage	1.08*** (0.21)	1.08*** (0.20)	**1.08*** (0.20)**
Open Pit Source Control	1.38*** (0.32)	1.36*** (0.31)	**1.36*** (0.31)**
Constant	2.85*** (0.51)	2.88*** (0.48)	**2.88*** (0.48)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-2: Waste Rock Capital Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	Forward 0.99		Final Model
Including BelowGroundWater	Yes	No	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	43	46	**46**
Adjusted R-Squared	0.59	0.59	**0.59**
Estimated Coefficients			
Waste Rock Acreage	0.74*** (0.11)	0.75*** (0.10)	**0.75*** (0.10)**
Waste Rock Source Control	0.72*** (0.21)	0.73*** (0.20)	**0.73*** (0.20)**
Constant	4.48*** (0.29)	4.45*** (0.28)	**4.45*** (0.28)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-3: Heap/Dump Leach Capital Cost Regression 0.99 Confidence Level Results

Direction Confidence Level	**Forward 0.99**		**Final Model**
Including BelowGroundWater	**Yes**	**No**	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	25	28	**28**
Adjusted R-Squared	0.42	0.28	**0.31**
Estimated Coefficients			
Heap/Dump Leach Acreage	1.24*** (0.29)	0.96*** (0.28)	**1.01*** (0.28)**
Heap/Dump Leach Source Control			**0.70 (0.46)**
Constant	3.29*** (0.76)	4.04*** (0.74)	**3.87*** (0.73)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-4: Tailings Facility Capital Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	**Forward 0.99**		**Final Model**
Including BelowGroundWater	**Yes**	**No**	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	31	33	**33**
Adjusted R-Squared	0.39	0.32	**0.40**
Estimated Coefficients			
Tailings Facility Acreage	0.65*** (0.15)	0.59*** (0.15)	**0.68*** (0.14)**
Tailings Facility Source Control			**0.59** (0.25)**
Constant	4.94*** (0.39)	5.05*** (0.40)	**4.73*** (0.40)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-5: Process Pond/Reservoir Capital Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	**Forward 0.99**		**Final Model**
Including BelowGroundWater	**Yes**	**No**	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	29	31	**29**
Adjusted R-Squared	0.64	0.64	**0.67**
Estimated Coefficients			
Process Pond Acreage	1.06*** (0.15)	1.04*** (0.14)	**0.96*** (0.13)**
Constant	4.25*** (0.20)	4.29*** (0.19)	**4.32*** (0.16)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-6: Underground Mine Capital Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	**Forward 0.99**		**Final Model**
Including BelowGroundWater	**Yes**	**No**	
Variable Addition Level:	0.01	0.01	**0.05**
Variable Removal Level:	0.02	0.02	**0.10**
Observations:	14	14	**14**
Adjusted R-Squared:	0	0	**0.32**
Estimated Coefficients			
High Hydraulic Head			**1.35** (0.51)**
Constant	5.15*** (0.21)	5.15*** (0.21)	**4.96*** (0.19)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-7: Drainage Capital Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	Forward 0.99		Final Model
Including BelowGroundWater	Yes	No	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	25	27	**27**
Adjusted R-Squared	0.00	0.00	**0.12**
Estimated Coefficients			
Total Acreage (plus 1)			**0.57** (0.26)**
Constant	5.13*** (0.23)	5.08*** (0.22)	**3.42*** (0.80)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-8: Short-Term O&M/Monitoring Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	Forward 0.99		Final Model
Including BelowGroundWater	Yes	No	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	48	52	**52**
Adjusted R-Squared	0.23	0.24	**0.25**
Estimated Coefficients			
Total Acreage (plus 1)	0.37*** (0.10)	0.38*** (0.09)	**0.38*** (0.09)**
Constant	4.03*** (0.28)	4.01*** (0.26)	**4.01*** (0.26)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-9: Long-Term O&M/Monitoring Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	Forward 0.99		Final Model
Including BelowGroundWater	Yes	No	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	14	14	**14**
Adjusted R-Squared	0.00	0.00	**0.28**
Estimated Coefficients			
Total Acreage (plus 1)			**0.58** **(0.24)**
Constant	4.90*** (0.15)	4.59*** (0.15)	**3.12***** **(0.73)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-10: Interim O&M/Monitoring Cost Regression 0.99 Confidence Level Results

Direction: Confidence Level:	Forward 0.99		Final Model
Including BelowGroundWater	Yes	No	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	32	34	**32**
Adjusted R-Squared	0.38	0.00	**0.44**
Estimated Coefficients			
Heap/Dump Leach Acreage (plus 1)	0.32*** (0.07)		**0.34***** **(0.07)**
Wet Tailings Facility Acreage (plus 1)			**0.10*** **(0.05)**
Net Precipitation	0.01*** (0.002)		**0.01***** **(0.002)**
Constant	6.17*** (0.13)	6.38*** (0.10)	**6.04***** **(0.15)**
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1			

Table D-11: Water Treatment Cost Regression 0.99 Confidence Level Results

Direction and Confidence Level	**Forward 0.99**		**Section 5 Final Result**
Including BelowGroundWater	**Yes**	**No**	
Variable Addition Level	0.01	0.01	**0.05**
Variable Removal Level	0.02	0.02	**0.10**
Observations	18	18	**18**
Adjusted R-Squared	0.45	0.90	**0.90**
Gallons Per Minute	0.94*** (0.24)	1.10*** (0.11)	**1.10*** (0.11)**
Treatment		1.05*** (0.21)	**1.06*** (0.21)**
Alkaline		**0.70*** (0.18)**	**0.70*** (0.18)**
Constant	3.53*** (0.62)	2.15*** (0.32)	**2.16*** (0.32)**

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Attachment E: DFBETA Measures for Regressions

Table E-1: Variable Shorthand for Attachment E

Variable Name	**Attachment Shorthand**
$LogAcres_{OpenPit}$	acres_op
$LogAcres_{WasteRock}$	acres_wr
$LogAcres_{HeapDumpLeach}$	acres_hdl
$LogAcres_{HeapDumpLeach+1}$	wet_acres_p1_hdl
$LogAcres_{Tailings}$	acres_tf
$LogAcres_{WetTailings+1}$	wet_acres_p1_tf
$LogAcres_{ProcessPondReservoir}$	acres_ppr
$LogAcres_{Total+1}$	acres_p1_total
LogFlow	flow
$SourceControl_{OpenPit}$	sc_op
HydraulicHead	hh
$SourceControl_{WasteRock}$	sc_wr
$SourceControl_{HeapDumpLeach}$	sc_hdl
$SourceControl_{Tailings}$	sc_tf
NetPrecipitation	np
InSituLeach	isl
Treat	treat

Table E-2: DFBETA Measures for Open Pit Regression

site_id	state	mine_name	commodity	Nominal Value		Absolute Value	
				DFacres_op	DFsc_op	DFacres_op	DFsc_op
1	Alaska	Fort Knox	Au	-0.196	0.086	0.196	0.086
7	Alaska	Red Dog	Zn-Pb	0.029	-0.039	0.029	0.039
12	Arizona	Johnson Camp	Cu	0.044	0.080	0.044	0.080
16	Arizona	Rosemont	Cu	0.082	-0.066	0.082	0.066
17	Arizona	Safford	Cu	-0.022	-0.021	0.022	0.021
21	California	Mesquite	Au	-0.126	0.033	0.126	0.033
22	California	Mountain Pass	Rare Earth	-0.107	-0.065	0.107	0.065
23	Colorado	Climax	Mo	0.056	-0.337	0.056	**0.337**
24	Colorado	Cresson	Au	0.249	-0.084	0.249	0.084
26	Idaho	Blackfoot Bridge	P	0.083	0.270	0.083	0.270
28	Idaho	Smoky Canyon	P	-0.008	-0.132	0.008	0.132
29	Idaho	Thompson Creek	Mo	-0.214	0.147	0.214	0.147
30	Minnesota	Essar	Fe	-0.158	-0.054	0.158	0.054
31	Minnesota	Hibbing Taconite	Fe	-0.082	-0.107	0.082	0.107
32	Minnesota	Minntac	Fe	-0.068	0.031	0.068	0.031
35	Montana	Continental	Cu	0.154	-0.069	0.154	0.069
37	Montana	Golden Sunlight	Au, Ag	0.011	0.118	0.011	0.118
38	Nevada	Bald Mountain (North)	Au, Ag	-0.017	0.033	0.017	0.033
39	Nevada	Emigrant	Au	0.084	0.032	0.084	0.032
40	Nevada	Goldstrike	Au	0.018	0.019	0.018	0.019
41	Nevada	Hollister	Au	0.309	0.064	0.309	0.064
42	Nevada	Hycroft	Au	-0.495	0.129	**0.495**	0.129
43	Nevada	Jerritt Canyon	Au	-0.237	0.080	0.237	0.080
44	Nevada	Lone Tree	Au	-0.089	0.253	0.089	0.253
45	Nevada	Marigold	Au	-0.017	0.057	0.017	0.057
46	Nevada	Phoenix Historic	Au, Ag	0.902	-0.217	**0.902**	0.217
48	Nevada	Robinson	Cu	-0.021	-0.323	0.021	**0.323**
49	Nevada	Rochester	Ag	0.032	0.015	0.032	0.015
50	Nevada	Round Mountain	Au	0.003	0.003	0.003	0.003
51	Nevada	Ruby Hill	Au	-0.070	-0.028	0.070	0.028
52	Nevada	SOAP	Au	0.029	0.022	0.029	0.022
53	Nevada	Standard	Au	0.047	0.019	0.047	0.019

site_id	state	mine_name	commodity	Nominal Value		Absolute Value	
				DFacres_op	DFsc_op	DFacres_op	DFsc_op
54	Nevada	Trenton Canyon	Au	0.027	0.028	0.027	0.028
55	New Mexico	Chino	Cu	0.043	-0.010	0.043	0.010
58	New Mexico	Tyrone	Cu	-0.089	0.020	0.089	0.020
59	South Carolina	Haile	Au	0.001	0.027	0.001	0.027
60	Utah	Lisbon Valley	Cu	-0.020	-0.017	0.020	0.017

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .33 for the Open Pit regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-3: DFBETA Measures for Waste Rock Regression

site_id	state	mine_name	commodity	Nominal value		Absolute Value	
				DFacres_wr	DFsc_wr	DFacres_wr	DFsc_wr
1	Alaska	Fort Knox	Au	0.013	-0.011	0.013	0.011
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	0.454	0.171	**0.454**	0.171
4	Alaska	Niblack	Cu-Au-Ag-Zn	-0.519	-0.059	**0.519**	0.059
5	Alaska	Nixon Fork	Cu	0.106	0.016	0.106	0.016
7	Alaska	Red Dog	Zn-Pb	-0.003	-0.003	0.003	0.003
8	Alaska	Rock Creek	Au	0.008	0.013	0.008	0.013
9	Alaska	True North	Au	-0.005	-0.003	0.005	0.003
12	Arizona	Johnson Camp	Cu	0.094	0.076	0.094	0.076
14	Arizona	Pinto Valley	Cu	-0.010	-0.095	0.010	0.095
16	Arizona	Rosemont	Cu	-0.002	0.001	0.002	0.001
17	Arizona	Safford	Cu	-0.008	0.011	0.008	0.011
20	California	Briggs	Au	0.081	0.048	0.081	0.048
21	California	Mesquite	Au	-0.157	0.101	0.157	0.101
22	California	Mountain Pass	Rare Earth	0.042	0.034	0.042	0.034
23	Colorado	Climax	Mo	0.009	-0.008	0.009	0.008
24	Colorado	Cresson	Au	0.036	-0.040	0.036	0.040
26	Idaho	Blackfoot Bridge	P	-0.022	0.111	0.022	0.111
29	Idaho	Thompson Creek	Mo	-0.022	-0.131	0.022	0.131
30	Minnesota	Essar	Fe	0.105	0.078	0.105	0.078
31	Minnesota	Hibbing Taconite	Fe	-0.017	0.011	0.017	0.011
32	Minnesota	Minntac	Fe	-0.001	0.005	0.001	0.005
33	Minnesota	Northshore	Fe	-0.187	0.311	0.187	**0.311**
35	Montana	Continental	Cu	0.019	-0.067	0.019	0.067
37	Montana	Golden Sunlight	Au, Ag	0.020	-0.070	0.020	0.070
38	Nevada	Bald Mountain (North)	Au, Ag	0.054	-0.018	0.054	0.018
39	Nevada	Emigrant	Au	-0.063	0.172	0.063	0.172
40	Nevada	Goldstrike	Au	0.084	-0.028	0.084	0.028
41	Nevada	Hollister	Au	-0.142	-0.021	0.142	0.021
42	Nevada	Hycroft	Au	-0.096	0.047	0.096	0.047
43	Nevada	Jerritt Canyon	Au	-0.115	0.080	0.115	0.080
44	Nevada	Lone Tree	Au	-0.190	0.120	0.190	0.120

site_id	state	mine_name	commodity	Nominal value		Absolute Value	
				DFacres_wr	DFsc_wr	DFacres_wr	DFsc_wr
45	Nevada	Marigold	Au	-0.031	0.024	0.031	0.024
46	Nevada	Phoenix Historic	Au, Ag	0.088	0.208	0.088	0.208
48	Nevada	Robinson	Cu	-0.210	-0.428	0.210	**0.428**
49	Nevada	Rochester	Ag	0.002	-0.085	0.002	0.085
50	Nevada	Round Mountain	Au	-0.038	0.017	0.038	0.017
51	Nevada	Ruby Hill	Au	-0.004	0.005	0.004	0.005
52	Nevada	SOAP	Au	-0.108	0.041	0.108	0.041
53	Nevada	Standard	Au	0.066	0.047	0.066	0.047
54	Nevada	Trenton Canyon	Au	0.033	-0.044	0.033	0.044
55	New Mexico	Chino	Cu	0.383	-0.155	**0.383**	0.155
56	New Mexico	Mt Taylor	U	-0.155	-0.033	0.155	0.033
57	New Mexico	St Anthony	U	-0.035	-0.128	0.035	0.128
58	New Mexico	Tyrone	Cu	0.377	-0.155	**0.377**	0.155
59	South Carolina	Haile	Au	-0.025	-0.224	0.025	0.224
60	Utah	Lisbon Valley	Cu	-0.004	0.048	0.004	0.048

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .29 for the Waste Rock regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-4: DFBETA Measures for Heap Dump Leach Regression

site_id	state	mine_name	commodity	Nominal Value		Absolute Value	
				DFacres_hdl	DFsc_hdl	DFacres_hdl	DFsc_hdl
1	Alaska	Fort Knox	Au	-0.042	0.021	0.042	0.021
11	Arizona	Bagdad	Cu	-0.025	0.010	0.025	0.010
12	Arizona	Johnson Camp	Cu	0.004	0.046	0.004	0.046
14	Arizona	Pinto Valley	Cu	0.226	-0.059	0.226	0.059
17	Arizona	Safford	Cu	0.014	-0.004	0.014	0.004
19	Arizona	Silver Bell	Cu	-0.379	0.046	0.379	0.046
20	California	Briggs	Au	0.105	0.043	0.105	0.043
21	California	Mesquite	Au	-0.324	0.081	0.324	0.081
24	Colorado	Cresson	Au	0.353	-0.064	0.353	0.064
35	Montana	Continental	Cu	-0.002	0.006	0.002	0.006
38	Nevada	Bald Mountain (North)	Au, Ag	-0.030	0.004	0.030	0.004
39	Nevada	Emigrant	Au	0.037	0.013	0.037	0.013
40	Nevada	Goldstrike	Au	0.260	0.114	0.260	0.114
42	Nevada	Hycroft	Au	-0.172	0.018	0.172	0.018
43	Nevada	Jerritt Canyon	Au	0.826	0.165	**0.826**	0.165
44	Nevada	Lone Tree	Au	-0.013	-0.023	0.013	0.023
45	Nevada	Marigold	Au	0.099	-0.024	0.099	0.024
46	Nevada	Phoenix Historic	Au, Ag	-0.002	0.002	0.002	0.002
47	Nevada	Phoenix Copper	Cu	0.146	1.857	0.146	**1.857**
48	Nevada	Robinson	Cu	-0.011	-0.005	0.011	0.005
49	Nevada	Rochester	Ag	-0.131	-0.048	0.131	0.048
50	Nevada	Round Mountain	Au	-0.047	0.008	0.047	0.008
51	Nevada	Ruby Hill	Au	-0.142	-0.051	0.142	0.051
52	Nevada	SOAP	Au	0.132	-0.014	0.132	0.014
53	Nevada	Standard	Au	-0.163	-0.058	0.163	0.058
54	Nevada	Trenton Canyon	Au	-0.489	-0.152	**0.489**	0.152
58	New Mexico	Tyrone	Cu	-0.047	-0.051	0.047	0.051
60	Utah	Lisbon Valley	Cu	0.146	-1.827	0.146	**1.827**

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .38 for the Heap Dump Leach regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-5: DFBETA Measures for Tailings Facility Regression

site_id	state	mine_name	commodity	Nominal Value		Absolute Value	
				DFacres_tf	DFsc_tf	DFacres_tf	DFsc_tf
1	Alaska	Fort Knox	Au	0.013	-0.007	0.013	0.007
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	-0.007	-0.039	0.007	0.039
3	Alaska	Kensington	Au	-0.152	-0.087	0.152	0.087
5	Alaska	Nixon Fork	Cu	0.403	-0.336	**0.403**	0.336
6	Alaska	Pogo	Au	-0.116	-0.082	0.116	0.082
7	Alaska	Red Dog	Zn-Pb	-0.362	-0.202	**0.362**	0.202
8	Alaska	Rock Creek	Au	0.061	0.041	0.061	0.041
11	Arizona	Bagdad	Cu	-0.008	-0.038	0.008	0.038
13	Arizona	Mission	Cu	-0.027	0.004	0.027	0.004
14	Arizona	Pinto Valley	Cu	0.294	-0.077	0.294	0.077
16	Arizona	Rosemont	Cu	-0.362	0.005	**0.362**	0.005
18	Arizona	Ray	Cu	-0.159	0.028	0.159	0.028
22	California	Mountain Pass	Rare Earth	0.193	0.125	0.193	0.125
23	Colorado	Climax	Mo	0.016	-0.032	0.016	0.032
27	Idaho	Idaho Cobalt	Co	-0.194	0.330	0.194	0.330
29	Idaho	Thompson Creek	Mo	0.016	-0.069	0.016	0.069
30	Minnesota	Essar	Fe	0.200	0.137	0.200	0.137
31	Minnesota	Hibbing Taconite	Fe	-0.316	-0.009	0.316	0.009
32	Minnesota	Minntac	Fe	0.271	0.228	0.271	0.228
34	Minnesota	SCRAM	Fe	-0.036	0.161	0.036	0.161
35	Montana	Continental	Cu	-0.051	-0.085	0.051	0.085
36	Montana	East Boulder	PGM	-0.151	-0.092	0.151	0.092
37	Montana	Golden Sunlight	Au, Ag	-0.037	-0.044	0.037	0.044
40	Nevada	Goldstrike	Au	0.290	-0.043	0.290	0.043
43	Nevada	Jerritt Canyon	Au	-0.008	-0.014	0.008	0.014
44	Nevada	Lone Tree	Au	0.019	0.026	0.019	0.026
45	Nevada	Marigold	Au	0.173	0.137	0.173	0.137
46	Nevada	Phoenix Historic	Au, Ag	0.078	-0.026	0.078	0.026
48	Nevada	Robinson	Cu	-0.064	0.016	0.064	0.016
50	Nevada	Round Mountain	Au	-0.014	0.008	0.014	0.008

site_id	state	mine_name	commodity	Nominal Value		Absolute Value	
				DFacres_tf	DFsc_tf	DFacres_tf	DFsc_tf
52	Nevada	SOAP	Au	0.141	-0.018	0.141	0.018
55	New Mexico	Chino	Cu	-0.115	-0.147	0.115	0.147
59	South Carolina	Haile	Au	0.034	0.149	0.034	0.149

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .35 for the Tailings Facility regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-6: DFBETA Measures for Process Ponds Reservoirs Regression

site_id	state	mine_name	commodity	Nominal Value	Absolute value
				DFacres_pp	DFacres_pp
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	-0.001	0.001
4	Alaska	Niblack	Cu-Au-Ag-Zn	0.040	0.040
11	Arizona	Bagdad	Cu	-0.135	0.135
12	Arizona	Johnson Camp	Cu	-0.101	0.101
14	Arizona	Pinto Valley	Cu	0.235	0.235
16	Arizona	Rosemont	Cu	0.015	0.015
18	Arizona	Ray	Cu	-0.031	0.031
21	California	Mesquite	Au	-0.121	0.121
26	Idaho	Blackfoot Bridge	P	-0.045	0.045
27	Idaho	Idaho Cobalt	Co	-0.047	0.047
38	Nevada	Bald Mountain (North)	Au, Ag	0.224	0.224
40	Nevada	Goldstrike	Au	-0.417	**0.417**
41	Nevada	Hollister	Au	0.530	**0.530**
42	Nevada	Hycroft	Au	-0.013	0.013
44	Nevada	Lone Tree	Au	-0.131	0.131
45	Nevada	Marigold	Au	-0.007	0.007
46	Nevada	Phoenix Historic	Au, Ag	-0.040	0.040
47	Nevada	Phoenix Copper	Cu	-0.009	0.009
48	Nevada	Robinson	Cu	0.087	0.087
49	Nevada	Rochester	Ag	0.256	0.256
50	Nevada	Round Mountain	Au	-0.061	0.061
51	Nevada	Ruby Hill	Au	-0.040	0.040
52	Nevada	SOAP	Au	-0.020	0.020
53	Nevada	Standard	Au	-0.120	0.120
54	Nevada	Trenton Canyon	Au	-0.011	0.011
56	New Mexico	Mt Taylor	U	-0.159	0.159
58	New Mexico	Tyrone	Cu	-0.009	0.009
60	Utah	Lisbon Valley	Cu	0.000	0.000
61	Nebraska	Crow Butte	U (ISL)	0.056	0.056
63	Wyoming	Smith/Reynolds Ranch	U (ISL)	-0.126	0.126
64	Wyoming	Highland	U (ISL)	0.253	0.253

site_id	state	mine_name	commodity	Nominal Value	Absolute value
				DFacres_pp	DFacres_pp

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .36 for the Process Ponds Reservoirs regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-7: DFBETA Measures for Underground Mine Regression

site_id	state	mine_name	commodity	Nominal Value	Absolute Value
				DFhh_ug	DFhh_ug
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	-0.147	0.147
4	Alaska	Niblack	Cu-Au-Ag-Zn	-0.034	0.034
5	Alaska	Nixon Fork	Cu	0.036	0.036
6	Alaska	Pogo	Au	0.646	**0.646**
10	Arizona	Arizona 1	U	-0.015	0.015
23	Colorado	Climax	Mo	-0.646	**0.646**
25	Colorado	Revenue	Au, Ag	0.156	0.156
27	Idaho	Idaho Cobalt	Co	-0.012	0.012
36	Montana	East Boulder	PGM	-0.141	0.141
38	Nevada	Bald Mountain (North)	Au, Ag	0.158	0.158
40	Nevada	Goldstrike	Au	0.178	0.178
41	Nevada	Hollister	Au	0.101	0.101
43	Nevada	Jerritt Canyon	Au	-0.141	0.141
56	New Mexico	Mt Taylor	U	-0.130	0.130

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .53 for the Underground Mine regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-8: DFBETA Measures for Drainage Regression

site_id	state	mine_name	commodity	Nominal Value	Absolute Value
				DFacres_p1_total	DFacres_p1_total
1	Alaska	Fort Knox	Au	0.069	0.069
4	Alaska	Niblack	Cu-Au-Ag-Zn	0.058	0.058
7	Alaska	Red Dog	Zn-Pb	-0.053	0.053
8	Alaska	Rock Creek	Au	0.002	0.002
9	Alaska	True North	Au	0.256	0.256
13	Arizona	Mission	Cu	-0.040	0.040
23	Colorado	Climax	Mo	0.140	0.140
28	Idaho	Smoky Canyon	P	0.166	0.166
35	Montana	Continental	Cu	0.015	0.015
36	Montana	East Boulder	PGM	-0.094	0.094
38	Nevada	Bald Mountain (North)	Au, Ag	-0.280	0.280
39	Nevada	Emigrant	Au	0.111	0.111
40	Nevada	Goldstrike	Au	0.361	0.361
41	Nevada	Hollister	Au	-0.616	**0.616**
42	Nevada	Hycroft	Au	0.007	0.007
44	Nevada	Lone Tree	Au	-0.124	0.124
45	Nevada	Marigold	Au	0.178	0.178
46	Nevada	Phoenix Historic	Au, Ag	-0.033	0.033
48	Nevada	Robinson	Cu	-0.169	0.169
49	Nevada	Rochester	Ag	-0.058	0.058
50	Nevada	Round Mountain	Au	-0.058	0.058
51	Nevada	Ruby Hill	Au	-0.002	0.002
52	Nevada	SOAP	Au	-0.105	0.105
53	Nevada	Standard	Au	0.143	0.143
54	Nevada	Trenton Canyon	Au	0.001	0.001
59	South Carolina	Haile	Au	0.038	0.038
60	Utah	Lisbon Valley	Cu	0.012	0.012

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .38 for the Drainage regression.
3.) Shading indicates a potentially influential observation.

Table E-9: DFBETA Measures for Short Term O&M Monitoring Regression

site_id	state	mine_name	commodity	Nominal Value	Absolute Value
				DFacres_p1_total	DFacres_p1_total
1	Alaska	Fort Knox	Au	0.091	0.091
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	-0.012	0.012
3	Alaska	Kensington	Au	0.015	0.015
4	Alaska	Niblack	Cu-Au-Ag-Zn	0.376	**0.376**
5	Alaska	Nixon Fork	Cu	0.310	**0.310**
6	Alaska	Pogo	Au	0.119	0.119
7	Alaska	Red Dog	Zn-Pb	-0.002	0.002
8	Alaska	Rock Creek	Au	0.024	0.024
9	Alaska	True North	Au	0.000	0.000
10	Arizona	Arizona 1	U	0.098	0.098
13	Arizona	Mission	Cu	-0.137	0.137
14	Arizona	Pinto Valley	Cu	-0.080	0.080
18	Arizona	Ray	Cu	-0.159	0.159
19	Arizona	Silver Bell	Cu	-0.005	0.005
20	California	Briggs	Au	0.101	0.101
21	California	Mesquite	Au	-0.253	0.253
22	California	Mountain Pass	Rare Earth	-0.004	0.004
23	Colorado	Climax	Mo	0.023	0.023
24	Colorado	Cresson	Au	0.014	0.014
26	Idaho	Blackfoot Bridge	P	0.002	0.002
27	Idaho	Idaho Cobalt	Co	-0.321	**0.321**
28	Idaho	Smoky Canyon	P	0.021	0.021
29	Idaho	Thompson Creek	Mo	0.017	0.017
30	Minnesota	Essar	Fe	0.045	0.045
31	Minnesota	Hibbing Taconite	Fe	0.092	0.092
32	Minnesota	Minntac	Fe	-0.170	0.170
33	Minnesota	Northshore	Fe	-0.102	0.102
35	Montana	Continental	Cu	-0.148	0.148
36	Montana	East Boulder	PGM	-0.091	0.091
37	Montana	Golden Sunlight	Au, Ag	0.062	0.062
38	Nevada	Bald Mountain (North)	Au, Ag	0.122	0.122
39	Nevada	Emigrant	Au	-0.059	0.059

site_id	state	mine_name	commodity	Nominal Value	Absolute Value
				DFacres_p1_total	DFacres_p1_total
40	Nevada	Goldstrike	Au	0.234	0.234
41	Nevada	Hollister	Au	-0.336	**0.336**
42	Nevada	Hycroft	Au	0.012	0.012
43	Nevada	Jerritt Canyon	Au	-0.064	0.064
44	Nevada	Lone Tree	Au	0.073	0.073
45	Nevada	Marigold	Au	0.004	0.004
46	Nevada	Phoenix Historic	Au, Ag	0.047	0.047
47	Nevada	Phoenix Copper	Cu	0.015	0.015
48	Nevada	Robinson	Cu	0.118	0.118
49	Nevada	Rochester	Ag	0.000	0.000
50	Nevada	Round Mountain	Au	0.108	0.108
51	Nevada	Ruby Hill	Au	0.011	0.011
52	Nevada	SOAP	Au	0.113	0.113
53	Nevada	Standard	Au	0.004	0.004
54	Nevada	Trenton Canyon	Au	0.020	0.020
55	New Mexico	Chino	Cu	-0.130	0.130
56	New Mexico	Mt Taylor	U	-0.093	0.093
57	New Mexico	St Anthony	U	-0.080	0.080
59	South Carolina	Haile	Au	-0.016	0.016
60	Utah	Lisbon Valley	Cu	-0.003	0.003

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .28 for the Short Term O&M Monitoring regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-10: DFBETA Measures for Long Term O&M Monitoring Regression

site_id	state	mine_name	commodity	Nominal Value	Absolute Value
				DFacres_p1_total	DFacres_p1_total
1	Alaska	Fort Knox	Au	-0.038	0.038
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	0.045	0.045
6	Alaska	Pogo	Au	-0.525	0.525
8	Alaska	Rock Creek	Au	0.484	0.484
11	Arizona	Bagdad	Cu	0.002	0.002
13	Arizona	Mission	Cu	0.025	0.025
14	Arizona	Pinto Valley	Cu	0.536	**0.536**
26	Idaho	Blackfoot Bridge	P	0.161	0.161
37	Montana	Golden Sunlight	Au, Ag	0.000	0.000
39	Nevada	Emigrant	Au	-0.113	0.113
47	Nevada	Phoenix Copper	Cu	-0.253	0.253
48	Nevada	Robinson	Cu	-0.592	**0.592**
55	New Mexico	Chino	Cu	-0.020	0.020
58	New Mexico	Tyrone	Cu	0.254	0.254

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .53 for the Long Term O&M Monitoring regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-11: DFBETA Measures for Interim O&M Monitoring Regression

site_id	state	mine_name	commodity	Nominal Value			Absolute Value		
				DFnp	DFacres_p1_hdl	DFwet_acres_p1_tf	DFnp	DFacres_p1_hdl	DFwet_acres_p1_tf
1	Alaska	Fort Knox	Au	-0.106	-0.129	-0.100	0.106	0.129	0.100
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	-0.487	0.108	0.361	**0.487**	0.108	**0.361**
3	Alaska	Kensington	Au	0.117	-0.019	0.007	0.117	0.019	0.007
5	Alaska	Nixon Fork	Cu	-0.127	0.171	0.105	0.127	0.171	0.105
6	Alaska	Pogo	Au	0.029	-0.061	-0.076	0.029	0.061	0.076
7	Alaska	Red Dog	Zn-Pb	0.239	-0.256	0.037	0.239	0.256	0.037
18	Arizona	Ray	Cu	0.442	0.398	-0.265	**0.442**	**0.398**	0.265
19	Arizona	Silver Bell	Cu	0.200	-0.067	0.136	0.200	0.067	0.136
20	California	Briggs	Au	1.207	0.467	0.336	**1.207**	**0.467**	0.336
21	California	Mesquite	Au	-0.490	0.046	-0.280	**0.490**	0.046	0.280
23	Colorado	Climax	Mo	0.029	-0.038	0.045	0.029	0.038	0.045
24	Colorado	Cresson	Au	0.088	0.170	-0.131	0.088	0.170	0.131
26	Idaho	Blackfoot Bridge	P	0.092	0.248	0.198	0.092	0.248	0.198
27	Idaho	Idaho Cobalt	Co	0.023	-0.272	-0.282	0.023	0.272	0.282
29	Idaho	Thompson Creek	Mo	0.004	0.019	-0.014	0.004	0.019	0.014
35	Montana	Continental	Cu	-0.377	-0.505	-0.355	**0.377**	**0.505**	**0.355**
36	Montana	East Boulder	PGM	0.000	0.001	0.000	0.000	0.001	0.000
37	Montana	Golden Sunlight	Au, Ag	0.002	0.015	-0.008	0.002	0.015	0.008
38	Nevada	Bald Mountain (North)	Au, Ag	0.136	0.163	-0.096	0.136	0.163	0.096
39	Nevada	Emigrant	Au	-0.009	0.010	-0.056	0.009	0.010	0.056
40	Nevada	Goldstrike	Au	-0.046	-0.150	-0.280	0.046	0.150	0.280
42	Nevada	Hycroft	Au	0.063	0.186	-0.136	0.063	0.186	0.136
43	Nevada	Jerritt Canyon	Au	0.011	0.006	0.052	0.011	0.006	0.052
44	Nevada	Lone Tree	Au	0.004	0.037	0.042	0.004	0.037	0.042
45	Nevada	Marigold	Au	-0.043	-0.156	-0.106	0.043	0.156	0.106
46	Nevada	Phoenix Historic	Au, Ag	0.005	0.066	0.093	0.005	0.066	0.093
47	Nevada	Phoenix Copper	Cu	-0.011	0.093	-0.173	0.011	0.093	0.173
48	Nevada	Robinson	Cu	0.006	0.023	0.042	0.006	0.023	0.042
50	Nevada	Round Mountain	Au	-0.022	0.216	0.265	0.022	0.216	0.265
51	Nevada	Ruby Hill	Au	0.003	-0.013	0.057	0.003	0.013	0.057

site_id	state	mine_name	commodity	Nominal Value			Absolute Value		
				DFnp	DFacres_p1_hdl	DFwet_acres_p1_tf	DFnp	DFacres_p1_hdl	DFwet_acres_p1_tf
53	Nevada	Standard	Au	-0.008	-0.014	0.043	0.008	0.014	0.043
55	New Mexico	Chino	Cu	-0.613	-0.533	0.428	**0.613**	**0.533**	**0.428**
58	New Mexico	Tyrone	Cu	-0.073	-0.002	-0.063	0.073	0.002	0.063
60	Utah	Lisbon Valley	Cu	-0.132	-0.176	0.313	0.132	0.176	0.313

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .35 for the Interim O&M Monitoring regression.
3.) Bold/shading indicates a potentially influential observation.

Table E-12: DFBETA Measures for Water Treatment Regression

site_id	state	mine_name	commodity	Nominal Value			Absolute Value		
				DFflow	DFtreat	DFisl	DFflow	DFtreat	DFisl
2	Alaska	Greens Creek	Pb, Zn, Ag, Au	0.027	-0.044	0.053	0.027	0.053	0.027
6	Alaska	Pogo	Au	0.390	-0.407	0.494	0.390	**0.494**	0.390
7	Alaska	Red Dog	Zn-Pb	0.379	0.087	-0.083	0.379	0.083	0.379
8	Alaska	Rock Creek	Au	-0.021	-0.019	0.021	0.021	0.021	0.021
11	Arizona	Bagdad	Cu	0.075	-0.425	0.017	0.075	0.017	0.075
27	Idaho	Idaho Cobalt	Co	0.075	0.402	0.017	0.075	0.017	0.075
36	Montana	East Boulder	PGM	-0.058	-0.084	0.095	0.058	0.095	0.058
37	Montana	Golden Sunlight	Au, Ag	0.024	0.123	-0.143	0.024	0.143	0.024
47	Nevada	Phoenix Copper	Cu	-2.215	0.717	-0.943	**2.215**	**0.943**	**2.215**
55	New Mexico	Chino	Cu	0.024	0.007	-0.007	0.024	0.007	0.024
58	New Mexico	Tyrone	Cu	-0.023	-0.008	0.008	0.023	0.008	0.023
59	South Carolina	Haile	Au	0.333	-0.113	0.147	0.333	0.147	0.333
62	Wyoming	Nichols Ranch	U (ISL)	0.156	-0.024	-0.389	0.156	0.389	0.156
63	Wyoming	Smith/Reynolds Ranch	U (ISL)	0.072	-0.011	0.409	0.072	0.409	0.072
64	Wyoming	Highland	U (ISL)	0.003	0.000	0.015	0.003	0.015	0.003
65	Colorado	Clear Creek	Au, Ag	-0.064	-0.042	0.046	0.064	0.046	0.064
66	Colorado	Summitville	Au, Ag	0.082	0.019	-0.018	0.082	0.018	0.082
67	Montana	Zortman and Landusky	Au, Ag	0.023	0.034	-0.039	0.023	0.039	0.023

Notes:

1.) The observation could potentially be influential if the ABS(value) is greater than 1 or the ABS(value) is greater than 2/Square Root(N).
2.) 2/Square Root(N) is approximately .47 for the Water Treatment regression.
3.) Bold/shading indicates a potentially influential observation.

Attachment F: Mean Absolute Percent Error (MAPE)

Table F-1: Open Pit MAPE

Residual	***APE***	***Residual***	***APE***
-0.33	10%	0.21	4%
-0.23	5%	0.58	11%
-1.38	32%	-0.29	5%
-0.13	3%	-0.54	9%
-0.71	16%	-0.32	5%
-0.10	2%	0.42	7%
0.24	5%	0.98	16%
-0.16	3%	-0.20	3%
0.41	9%	-0.50	8%
-0.22	4%	0.16	2%
-0.52	11%	0.39	6%
-1.30	27%	1.22	19%
-0.15	3%	0.76	11%
-0.19	4%	0.04	1%
-0.86	17%	0.19	3%
0.00	0%	0.93	13%
-0.30	6%	0.42	6%
0.19	4%	2.10	25%
-0.82	16%	**MAPE =**	**9%**

APE = Absolute Percent Error

Table F-2: Waste Rock MAPE

Residual	***APE***	***Residual***	***APE***
-1.28	28%	0.06	1%
-0.13	3%	0.36	5%
0.47	9%	0.08	1%
0.17	3%	-0.30	4%
-0.62	11%	-0.12	2%
-0.60	11%	0.29	4%
-0.39	7%	0.34	5%
-0.38	7%	0.22	3%
0.27	5%	0.51	7%
-0.27	5%	0.53	8%
-0.86	15%	-0.28	4%
0.02	0%	0.14	2%
-0.73	12%	0.65	9%
-0.38	6%	0.13	2%
-0.59	10%	0.71	10%
-0.11	2%	-0.17	2%
0.02	0%	-0.52	7%
-0.05	1%	0.11	2%
-0.09	1%	0.96	13%
-0.18	3%	0.18	2%
-0.35	5%	0.25	3%
-0.04	1%	1.02	13%
-0.09	1%	1.03	13%
		MAPE =	**6%**

APE = Absolute Percent Error

Table F-3: Heap/Dump Leach MAPE

Residual	***APE***	***Residual***	***APE***
-0.64	14%	-0.04	1%
-0.94	18%	-0.14	2%
-1.21	22%	-0.40	6%
-0.36	6%	0.25	4%
-0.11	2%	-0.14	2%
-0.53	9%	0.06	1%
-0.80	13%	-0.08	1%
-0.91	15%	0.53	8%
0.04	1%	1.05	15%
-0.30	5%	0.39	5%
0.38	6%	0.31	4%
0.41	6%	0.90	12%
-0.07	1%	0.80	10%
		MAPE =	**7%**

APE = Absolute Percent Error

Table F-4: Tailings Facility MAPE

Residual	***APE***	***Residual***	***APE***
-0.99	19%	-0.08	1%
-1.08	20%	0.37	5%
-0.55	10%	0.25	4%
-0.37	7%	-0.45	7%
-0.61	11%	0.07	1%
-0.48	9%	-0.08	1%
-0.17	3%	0.25	4%
-0.14	2%	0.48	7%
0.30	5%	-0.04	1%
0.34	5%	0.50	7%
-0.47	7%	0.31	4%
0.34	5%	0.14	2%
0.08	1%	0.37	5%
-0.62	10%	-0.09	1%
0.24	4%	0.77	10%
-0.23	3%	0.98	12%
0.68	10%	**MAPE =**	**6%**

APE = Absolute Percent Error

Table F-5: Process Pond/Reservoir MAPE

Residual	***APE***	***Residual***	***APE***
-0.53	14%	-0.22	4%
-0.04	1%	-0.10	2%
0.01	0%	-0.40	7%
-1.08	24%	0.31	5%
-0.30	6%	-0.11	2%
0.03	1%	-0.04	1%
0.24	5%	0.18	3%
-0.56	11%	-0.03	0%
-0.31	6%	0.27	4%
0.31	6%	-0.44	7%
-0.54	10%	-0.08	1%
0.34	6%	0.54	8%
0.20	4%	0.84	13%
-0.48	9%	0.83	12%
0.05	1%	0.84	12%
0.27	5%	**MAPE =**	**6%**

APE = Absolute Percent Error

Table F-6: Underground Mine MAPE

Residual	***APE***	***Residual***	***APE***
-0.94	23%	0.20	4%
-0.85	21%	0.72	13%
-0.84	21%	0.77	13%
-0.57	13%	0.77	13%
-0.21	5%	0.80	14%
0.07	1%	-0.34	6%
0.09	2%	0.34	5%
		MAPE =	**11%**

APE = Absolute Percent Error

Table F-7: Drainage MAPE

Residual	***APE***	***Residual***	***APE***
-1.10	32%	-0.33	6%
-1.36	39%	1.15	22%
-1.05	29%	-0.16	3%
-1.36	36%	0.17	3%
-0.08	2%	0.04	1%
-1.39	36%	0.44	8%
-0.89	23%	0.47	8%
-1.36	33%	0.93	15%
-0.70	16%	1.25	20%
-0.89	19%	1.62	24%
-0.03	1%	1.64	24%
-0.43	9%	1.90	27%
0.41	8%	1.58	22%
-0.48	9%	**MAPE =**	**18%**

APE = Absolute Percent Error

Table F-8: Short-Term O&M/Monitoring MAPE

Residual	***APE***	***Residual***	***APE***
-1.54	42%	-0.37	7%
-0.51	14%	0.38	7%
-0.63	16%	0.28	5%
-0.09	2%	0.02	0%
-0.95	24%	0.29	5%
-0.62	15%	0.23	4%
-1.07	25%	0.11	2%
-0.97	23%	0.29	5%
-0.98	23%	0.07	1%
-0.53	12%	0.18	3%
-0.82	18%	0.04	1%
-0.39	9%	0.54	10%
-0.06	1%	0.87	16%
-0.14	3%	0.43	8%
0.00	0%	0.51	9%
-0.17	4%	0.16	3%
0.28	6%	0.47	8%
-0.40	8%	0.40	7%
-0.05	1%	0.27	5%
-0.16	3%	0.41	7%
-0.35	7%	0.36	6%
0.31	6%	0.42	7%
-0.16	3%	0.42	7%
0.05	1%	0.93	16%
0.63	12%	0.98	16%
-0.06	1%	0.72	12%
		MAPE =	**9%**

APE = Absolute Percent Error

Table F-9: Long-Term O&M/Monitoring MAPE

Residual	***APE***	***Residual***	***APE***
-0.75	19%	0.00	0%
-0.53	13%	0.36	7%
-0.09	2%	-0.07	1%
-0.64	14%	0.08	1%
0.14	3%	-0.02	0%
-0.13	3%	0.34	6%
0.40	8%	0.92	15%
		MAPE =	**7%**

APE = Absolute Percent Error

Table F-10: Interim O&M MAPE

Residual	***APE***	***Residual***	***APE***
-0.68	14%	0.12	2%
-0.41	8%	0.08	1%
-0.50	9%	-0.37	6%
-0.80	14%	0.11	2%
-0.58	10%	0.10	1%
-0.42	7%	0.05	1%
-0.03	0%	0.01	0%
-0.07	1%	0.43	6%
-0.07	1%	0.76	11%
0.11	2%	0.09	1%
-0.18	3%	-0.25	4%
0.52	8%	0.31	4%
-0.14	2%	0.34	5%
0.17	3%	0.75	11%
-0.49	8%	0.19	3%
0.49	8%	0.36	5%
		MAPE =	**5%**

APE = Absolute Percent Error

Table F-11: Water Treatment MAPE

Residual	***APE***	***Residual***	***APE***
0.49	10%	0.32	5%
-0.11	2%	-0.24	4%
-0.16	3%	0.10	2%
-0.09	2%	-0.06	1%
-0.67	13%	-0.13	2%
-0.11	2%	-0.03	0%
0.15	2%	0.03	0%
0.01	0%	0.34	5%
0.09	2%	0.07	1%
		MAPE =	**3%**

APE = Absolute Percent Error