BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
STATE OF WYOMING

In the Matter of the Appeal And Petition for Review of: BART Permit No. MD-6040 (Jim Bridger Power Plant); and BART Permit No. MD-6042 (Naughton Power Plant).	))))))	Docket No. 10-2801

RESPONSE TO PACIFICORP'S MOTION FOR PARTIAL SUMMARY JUDGMENT

PacifiCorp's BART App. Addendums for JB Units 1-4, 3/08

EXHIBIT 6

Addendum to Jim Bridger Unit 1 BART Report

RECEIVED MAR 2008 AIR QUALITY DIVISION

PREPARED FOR:	Wyoming Division of Air Quality
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DATE:	March 26, 2008

Introduction

In compliance with the Regional Haze Rule (40 Code of Federal Regulations [CFR] 51), the Wyoming Division of Air Quality (WDAQ) required PacifiCorp Energy to conduct a detailed Best Available Retrofit Technology (BART) review to analyze the effects to visibility in nearby Class I areas from plant emissions, both for baseline and for reasonable control technology scenarios. PacifiCorp submitted these evaluations to WDAQ in January 2007. A revised report was submitted in October 2007.

On January 3, 2008, PacifiCorp Energy personnel met with WDAQ staff to discuss the status of the BART reviews. At that time, the state requested that additional modeling scenarios for several of the PacifiCorp facilities be performed to aid in their BART review. This memorandum presents the economics analysis for two scenarios modeled, referred to as Scenario A and Scenario B and described as follows:

- Scenario A: PacifiCorp committed controls at permitted rates—low nitrogen oxide (NO_x) burners (LNBs) with over-fire air (OFA), sodium based flue gas desulfurization (FGD), ESP with SO_3 injection
- Scenario B: PacifiCorp committed controls and selective catalytic reduction (SCR) at permitted rates

The CALPUFF modeling system (v. 5.711a) was used for this analysis. All technical options and model triggers used in CALMET, CALPUFF, and CALPOST are consistent with those used for the previous BART analyses and described in the BART report submitted in October 2007.

Stack Parameters, Emissions Information, and Capital Cost

Table 1 summarizes the control equipment for Scenarios A and B as well as the current equipment installed at the plant. The overall capital cost of installing these options is also shown.

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TABLE 1
Control Scenario Summary
Jim Bridger Unit 1

	Equipment Type			Capital Cost
	NO_x	SO_2	PM_{10}	Million dollars
Baseline	LNB	Wet sodium FGD	ESP	—
Scenario A	LNB with OFA	Wet sodium FGD	ESP with SO_3 injection	$40.5
Scenario B	LNB with OFA and SCR	Wet sodium FGD	ESP with SO_3 injection	$207.0

Emissions were modeled for the following pollutants:

- Sulfur dioxide (SO_2)
- NO_x
- Coarse particulate ($PM_{2.5}$<diameter<PM_{10})
- Fine particulate (diameter<$PM_{2.5}$)
- Sulfates

Table 2 shows stack parameters and emission rates that were used for the Jim Bridger Unit 1 BART modeling and analysis.

TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 1

	BART Comparison[d]		
Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
Hourly Heat Input (mmBtu/hour)	6,000	6,000	6,000
Sulfur Dioxide (SO_2) Stack Emissions (lb/hr)	1,602	900	900
Nitrogen Oxide (NO_x) Stack Emissions (lb/hr)	2,700	1,560	420
PM_{10} Stack Emissions (lb/hr)	270	180.0	180.0
Coarse Particulate ($PM_{2.5}$ <diameter< PM_{10}) Stack Emissions (lb/hr)[a]	116	77.4	77.4
Fine Particulate (diameter<$PM_{2.5}$) Stack Emissions (lb/hr)[b]	154	102.6	102.6
Sulfuric Acid (H_2SO_4) Stack Emissions (lb/hr)	55.2	55.2	94.7
Ammonium Sulfate [$(NH_4)_2SO_4$] Stack Emissions (lb/hr)	—	—	7.0
$(NH_4)HSO_4$ Stack Emissions (lb/hr)	—	—	12.2
H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr)	54.1	54.1	92.8
$(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	5.1
$(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	10.2

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TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 1

Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
	BART Comparison[d]		
Total Sulfate (SO_4) (lb/hr)[c]	54.1	54.1	108.1
Stack Conditions			
Stack Height (meters)	152	152	152
Stack Exit Diameter (meters)	7.32	7.32	7.32
Stack Exit Temperature (Kelvin)	333	328	328
Stack Exit Velocity (meters per second)	25.6	24.7	24.7

NOTES:
[a] Based on AP-42, Table 1.1-6, the coarse particulates are counted as a percentage of PM_{10}. This equates to 43% ESP and 57% Baghouse. PM_{10} and $PM_{2.5}$ refer to particulate matter less than 10 and 2.5 micrometers, respectively, in aerodynamic diameter.
[b] Based on AP-42, Table 1.1-6, the fine particulates are counted as a percentage of PM_{10}. This equates to 57% ESP and 43% Baghouse.
[c] Total Sulfate (SO_4) (lb/hr) = H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr) + $(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr) + $(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)
[d] SO_2, NO_x, and PM rates are expressed in terms of permitted emission rates. Actual emissions will be less than the permitted rates.
[e] PacifiCorp Committed Controls @ permitted rates: LNB with OFA, Wet FGD, ESP with SO_3
[f] PacifiCorp Committed Controls and SCR @ permitted rates

Economic Analysis

In completing this additional analysis to supplement the previous BART study, technology alternatives were investigated and potential reductions in NO_x, SO_2, and PM_{10} emissions rates were identified.

A comparison of Scenarios A and B on the basis of costs, design control efficiencies, and tons of pollutant removed is summarized in Tables 3 through 5. Capital costs were provided by PacifiCorp. The complete economic analyses for these two scenarios are provided as Attachment 1.

TABLE 3
Scenario A Control Cost
Jim Bridger Unit 1

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario A
	LNB with OFA	Wet FGD	ESP with Gas Conditioning	Control Cost
Total Installed Capital Costs (million dollars)	$11.3	$25.3	$3.9	$40.50
Annualized First-Year Capital Costs	$1.07	$2.41	$0.37	$3.85
First Year Fixed & Variable O&M Costs (million dollars)	$0.07	$0.98	$0.18	$1.21
Total First Year Annualized Costs (million dollars) [a]	$1.15	$3.39	$0.55	$5.08
Power Consumption (MW)	—	0.53	0.05	0.58
Annual Power Usage (Million kWh/Yr)	—	4.18	0.39	4.57
Permitted Emission Rate (lb/mmBtu)	0.26	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	4,494	2,838	355	7,687
First Year Average Control Cost ($/Ton of Pollutant Removed)	255	1,194	1,541	661

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 4
Scenario B Control Cost
Jim Bridger Unit 1

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario B
	LNB with OFA & SCR	Wet FGD	ESP with Gas Conditioning	Control Cost
Total Installed Capital Costs (million dollars)	$177.8	$25.3	$3.9	$207.0
Annualized First-Year Capital Costs	$16.91	$2.41	$0.37	$19.69
First Year Fixed & Variable O&M Costs (million dollars)	$3.38	$0.98	$0.18	$4.54
Total First Year Annualized Costs (million dollars) [a]	$20.30	$3.39	$0.55	$24.23
Power Consumption (MW)	3.28	0.53	0.05	3.86
Annual Power Usage (Million kWh/Yr)	25.86	4.18	0.39	30.46
Permitted Emission Rate (lb/mmBtu)	0.07	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	8,988	2,838	355	12,181
First Year Average Control Cost ($/Ton of Pollutant Removed)	2,258	1,194	1,541	1,989

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 5
Incremental Control Costs, Scenario B compared to Scenario A
Jim Bridger Unit 1

	NO_x Control	SO_2 Control	PM_{10} Control	Total Control Cost
Incremental Installed Capital Costs (million dollars)	$166.5	0	0	$166.5
Incremental Annualized First-Year Capital Costs	$15.84	0	0	$15.84
Incremental First Year Fixed & Variable O&M Costs (million dollars)	$3.31	0	0	$3.31
Incremental First Year Annualized Costs (million dollars) [a]	$19.15	0	0	$19.15
Incremental Power Consumption (MW)	3.28	0	0	3.28
Incremental Annual Power Usage (Million kWh/Yr)	25.86	0	0	25.86
Incremental Improvement in Emission Rate (lb/mmBtu)	0.19	0	0	—
Incremental Tons of Pollutant Removed	4,494	0	0	4,494
Incremental First Year Average Control Cost ($/Ton of Pollutant Removed)	4,262	0	0	4,262

NOTE:
[a]Incremental first year annualized costs include power consumption costs.

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Modeling Results and Least-Cost Envelope Analysis

CH2M HILL modeled Jim Bridger Unit 1 for two post-control scenarios. The results determine the change in deciview based on each alternative at the Class I areas specific to the project. The Class I areas potentially affected are Bridger Wilderness, Fitzpatrick Wilderness, and Mount Zirkel Wilderness for this unit.

Modeled Scenarios

Current operations (baseline) and two alternative control scenarios were modeled to cover the range of effectiveness for the combination of the individual NO_x, SO_2, and PM control technologies being evaluated. The modeled scenarios include the following:

- Baseline: Current operations with LNB, Wet sodium FGD, and ESP
- Scenario A: LNB with OFA, Wet sodium FGD, and ESP with SO_3 injection
- Scenario B: Scenario A with SCR

Summary of Visibility Analysis

Tables 6 through 8 present a summary of the modeling period (2001–2003) results for each scenario and Class I area.

TABLE 6
Costs and Visibility Modeling Results as Applicable to Bridger Wilderness
Jim Bridger Unit 1

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	4.381	1.277	30
Scenario A	Scenario A: PacifiCorp Committed Controls	$5,081,645	2.919	0.829	17
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$24,232,712	1.647	0.481	10

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TABLE 7
Costs and Visibility Modeling Results as Applicable to Fitzpatrick Wilderness
Jim Bridger Unit 1

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	2.538	0.637	13
Scenario A	Scenario A: PacifiCorp Committed Controls	$5,081,645	1.747	0.379	7
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$24,232,712	0.959	0.232	4

TABLE 8
Costs and Visibility Modeling Results as Applicable to Mount Zirkel Wilderness
Jim Bridger Unit 1

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	3.458	1.651	48
Scenario A	Scenario A: PacifiCorp Committed Controls	$5,081,645	2.168	1.046	22
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$24,232,712	1.298	0.607	12

Results

Tables 9 through 11 present a summary of the costs and modeling results for each scenario and Class I area.

TABLE 9
Incremental Costs and Incremental Visibility Improvements Relative to Bridger Wilderness
Jim Bridger Unit 1

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98^{th} Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$5.08	0.448	13	$11.34	$0.39
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$24.23	0.796	20	$30.44	$1.21
Scenario B Compared To Scenario A	Addition of SCR	$19.15	0.348	7	$55.03	$2.74

TABLE 10
Incremental Costs and Incremental Visibility Improvements Relative to Fitzpatrick Wilderness
Jim Bridger Unit 1

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98^{th} Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$5.08	0.258	6	$19.70	$0.85
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$24.23	0.405	9	$59.83	$2.69
Scenario B Compared To Scenario A	Addition of SCR	$19.15	0.147	3	$130.28	$6.38

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TABLE 11
Incremental Costs and Incremental Visibility Improvements Relative to Mount Zirkel Wilderness
Jim Bridger Unit 1

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$5.08	0.605	26	$8.40	$0.20
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$24.23	1.044	36	$23.21	$0.67
Scenario B Compared To Scenario A	Addition of SCR	$19.15	0.439	10	$43.62	$1.92

Least-Cost Envelope Analysis

The least-cost envelope graphs for Bridger Wilderness are shown in Figures 1 and 2, for Fitzpatrick Wilderness in Figures 3 and 4, and for Mount Zirkel Wilderness in Figures 5 and 6.

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FIGURE 1

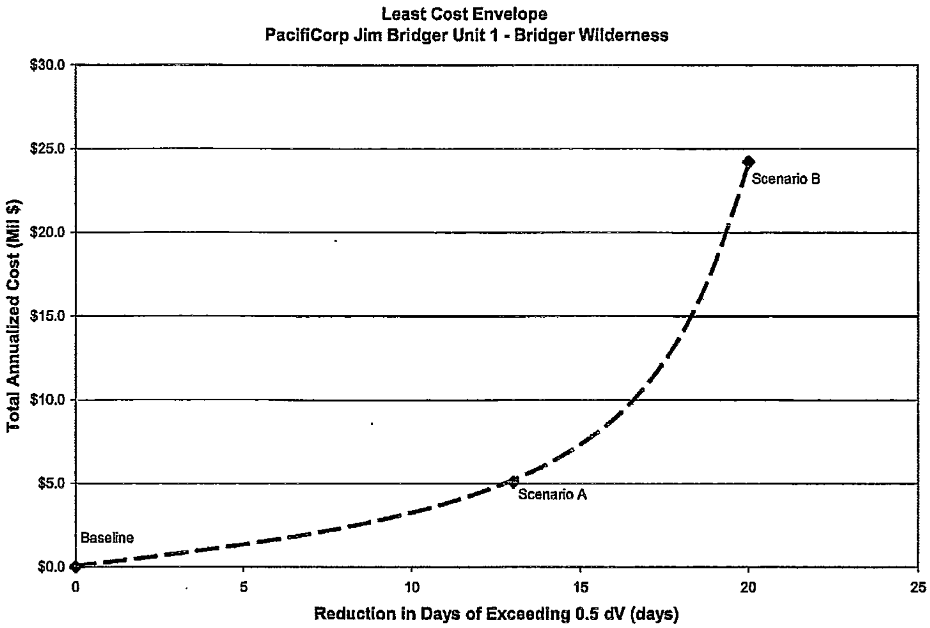

FIGURE 2

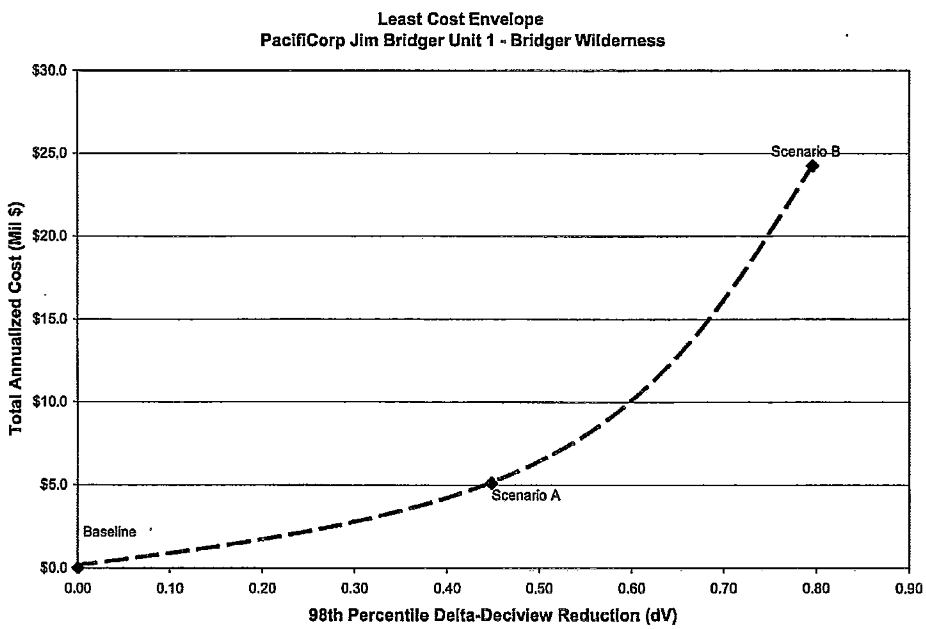

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FIGURE 3

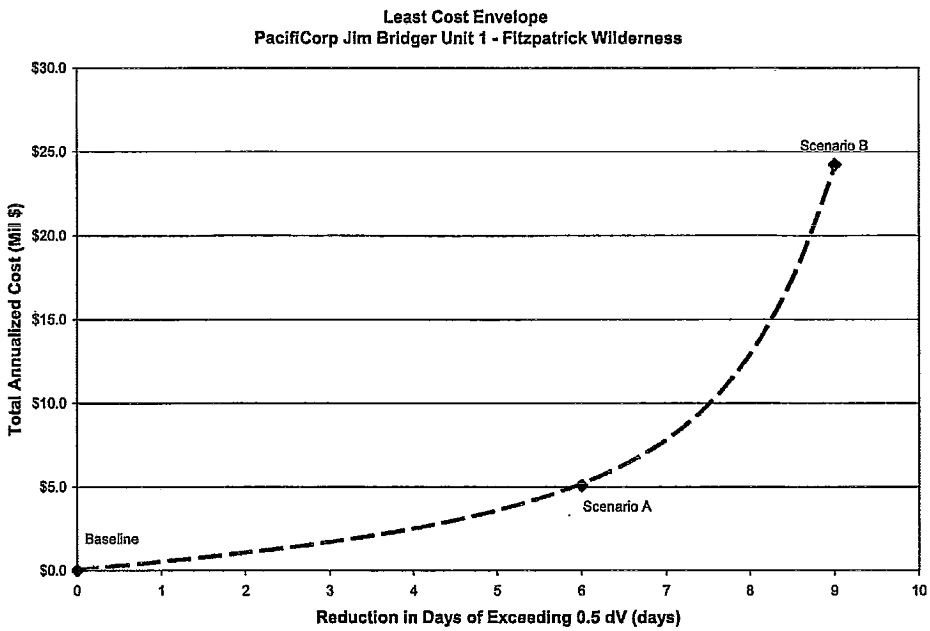

FIGURE 4

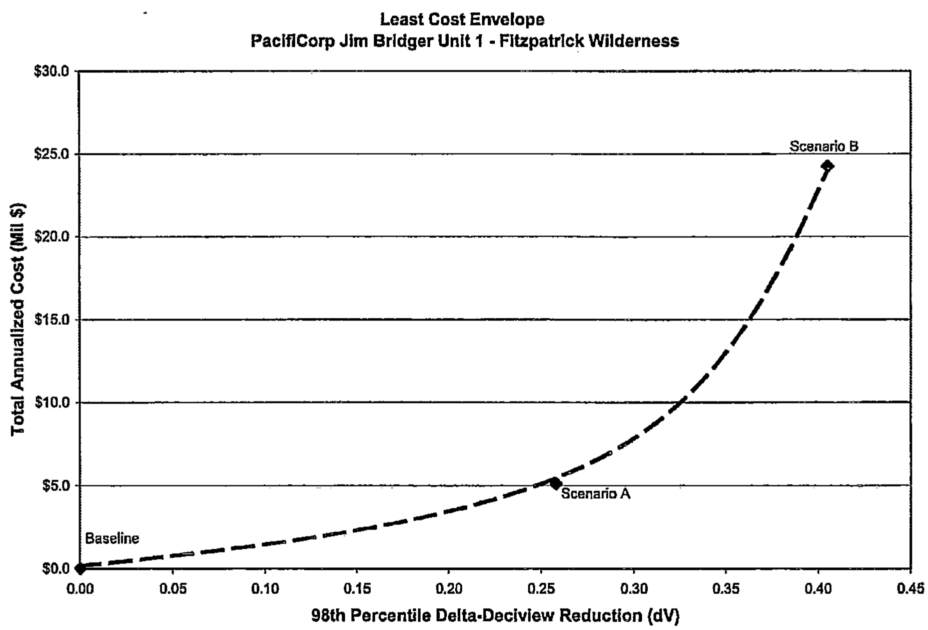

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FIGURE 5

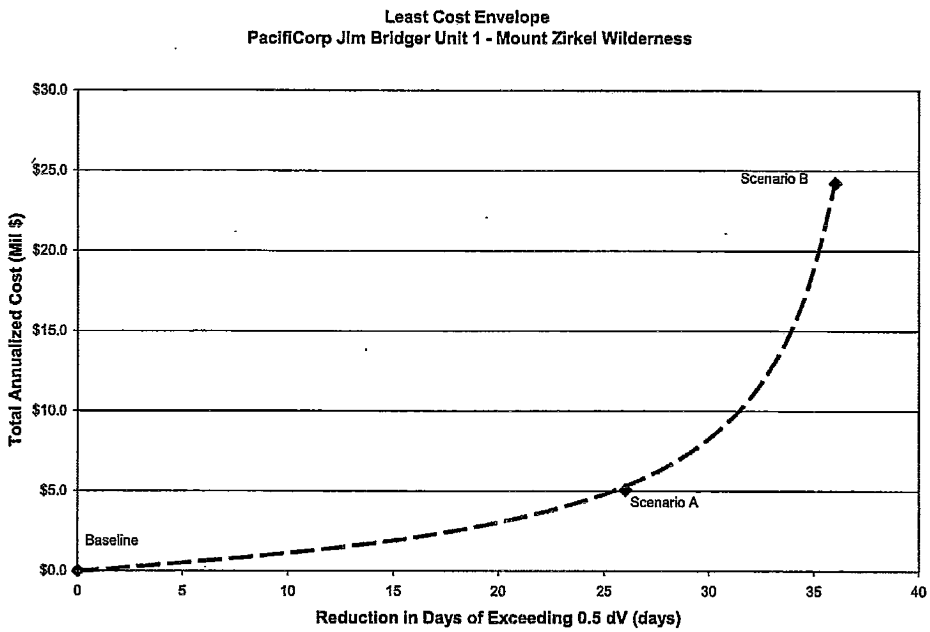
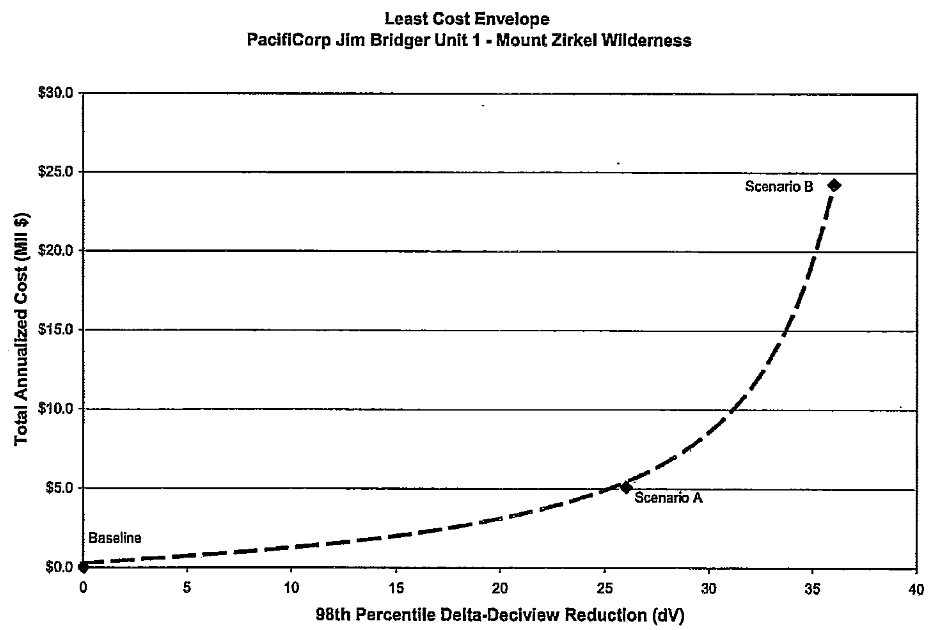


FIGURE 6



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ATTACHMENT 1

Complete Economic Analyses for Scenarios A and B

ECONOMIC ANALYSIS SUMMARY - FIRST YEAR COSTS

Jim Bridger 1 — Boiler Design: Opposed Wall-Fired PC

TYPE OF EMISSIONS CONTROLS		NO_x Control				SO_2 Control and PM			Scenario A	Scenario B
Technology Label	BASE	A	B	C	D	E	F	G	A+F	D+F
	Current Operation	Low NO_x Burners with Overfire Air	Rotating Overfire Air	Low NO_x Burners with Overfire Air and Non-Selective Catalytic Reduction	Low NO_x Burners with Overfire Air and Selective Catalytic Reduction	ESP w/ Gas Conditioning	N/A & Fabric Filter	Upgrade Wet FGD	LNB w/OFA, Wet Flue Gas Desulfurization and ESP w/gas condidtioning	LNB w/OFA, SCR, Wet Flue Gas Desulfurization and ESP w/gas condidtioning
ECONOMIC FACTORS										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20
CAPITAL INVESTMENT										
Total Installed Capital Costs ($)	$0	$11,300,000	$20,528,122	$22,127,239	$177,800,000	$3,900,000	$48,386,333	$25,300,000	$40,500,000	$207,000,000
FIRST YEAR DEBT SERVICE ($/Yr)	$0	$1,074,944	$1,952,796	$2,104,916	$16,913,727	$370,999	$4,602,887	$2,406,734	$3,852,677	$19,691,459
FIRST YEAR FIXED O&M Costs ($/Yr)										
Operating Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($/Yr)	$0	$28,000	$42,000	$123,000	$190,000	$0	$51,099	$25,500	$53,500	$215,500
Maintenance Labor ($/Yr)	$0	$42,000	$63,000	$184,500	$285,000	$10,000	$76,649	$17,033	$69,033	$312,033
Administrative Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL FIRST YEAR FIXED O&M COST	$0	$70,000	$105,000	$307,500	$475,000	$10,000	$127,748	$42,533	$122,533	$527,533
FIRST YEAR VARIABLE O&M Costs ($/Yr)										
Makeup Water Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$30,503	$30,503	$30,503
Reagent Costs ($/Yr)	$0	$0	$0	$89,411	$1,020,310	$145,854	$0	$383,167	$529,021	$1,549,331
SCR Catalyst / FF Bag Costs ($/Yr)	$0	$0	$0	$0	$594,000	$0	$300,040	$0	$0	$594,000
Waste Disposal Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$318,275	$318,275	$318,275
Electric Power Costs ($/Yr)	$0	$0	$2,526,822	$208,926	$1,292,976	$19,710	$1,336,338	$208,926	$228,636	$1,521,612
TOTAL FIRST YEAR VARIABLE O&M Costs ($/Yr)	$0	$0	$2,526,822	$298,337	$2,907,286	$165,564	$1,636,378	$940,871	$1,106,435	$4,013,721
SUMMARY OF FIRST YEAR COSTS ($/Yr)										
First Year Debt Service ($/Yr)	$0	$1,074,944	$1,952,796	$2,104,916	$16,913,727	$370,999	$4,602,887	$2,406,734	$3,852,677	$19,691,459
First Year Fixed O&M Costs ($/Yr)	$0	$70,000	$105,000	$307,500	$475,000	$10,000	$127,748	$42,533	$122,533	$527,533
First Year Variable O&M Costs ($/Yr)	$0	$0	$2,526,822	$298,337	$2,907,286	$165,564	$1,636,378	$940,871	$1,106,435	$4,013,721
Total First Year Costs ($/Yr)	$0	$1,144,944	$4,584,618	$2,710,753	$20,296,013	$546,563	$6,367,013	$3,390,138	$5,081,645	$24,232,713
CONTROL COST COMPARISONS										
NO_x Technology Comparison										
Additional NO_x Removed From Base Case (Tons/Yr)	0	4,494	5,440	5,440	8,988					
First Year Average Control Cost ($/Ton NO_x Removed)	$0	$255	$843	$498	$2,258					
Technology Case Comparison		A-BASE	B-A	C-A	D-A					
Incremental NO_x Removed (Tons/Yr)	0	4,494	946	946	4,494					
Incremental Control Cost ($/Ton NO_x Removed)	$0	$255	$3,636	$1,655	$4,262					
SO_2 Technology Comparison	77.5%					77.5%	77.5%	87.5%		
Additional SO_2 Removed From Base Case (Tons/Yr)	0					0	0	2,838		
First Year Average Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	#DIV/0!	$1,194		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental SO_2 Removed (Tons/Yr)	0					0	0	2,838		
Incremental Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	#DIV/0!	-$1,049		
PM Technology Comparison	0.0%									
Additional PM Removed From Base Case (Tons/Yr)	0					355	710	0		
First Year Average Control Cost ($/Ton PM Removed)	$0					$1,541	$8,973	#DIV/0!		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental PM Removed (Tons/Yr)	0					355	355	-710		
Incremental Control Cost ($/Ton PM Removed)	$0					$1,541	$16,406	$0		
SCENARIO A AND B COMPARISONS										
Additional NO_x, SO_2, & PM Removed From Base Case (Tons/Yr)	0								7,687	12,181
First Year Average Control Cost Compared to Base Case ($/Ton Removed)	$0								$661	$1,989
Incremental Tons Removed - Scenario B vs Scenario A (Tons/Yr)	0									4,494
Incremental Control Costs - Scenario B vs Scenario A ($/Ton Removed)	$0									$4,262

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INPUT CALCULATIONS

Jim Bridger 1 — Boiler Design: Opposed Wall-Fired PC

PARAMETER	Current Operation	NO_x Control Technologies				SO_2 and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO_x Emission Control System	LNCFS-1 & Windbox Mods.	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
General Plant Design and Operating Data										
Type of Unit	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
Annual Power Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Annual Operation (Hours/Year)	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Net Power Output (kW)	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000
Net Plant Heat Rate (Btu/kW-Hr)	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320
Boiler Heat Input, Measured by Fuel Input (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by Fuel Input (MMBtu/Year)	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846
Boiler Heat Input, Measured by CEM (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by CEM (MMBtu/Year)	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000
Plant Fuel Source										
Boiler Fuel Source	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground
Coal Heating Value (Btu/Lb)	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660
Coal Sulfur Content (wt.%)	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.580%	0.58%	0.58%
Coal Ash Content (wt.%)	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%
Coal Flow Rate (Lb/Hr)	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077
Coal Consumed (Ton/Yr)	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284
Nitrogen Oxide Emissions										
NO_x Emission Rate (Lb/MMBtu)	0.45	0.26	0.22	0.22	0.07				0.26	0.07
NO_x Emission Rate (Lb/Hr)	2,700	1,580	1,320	1,320	420				1,560	420
NO_x Emission Rate (Lb Moles/Hr)	89.97	51.98	43.99	43.99	14.00				51.98	14.00
NO_x Emission Rate (Ton/Yr)	10,643	6,150	5,203	5,203	1,656				6,150	1,656
Add'l NO_x Removed from Current Operations (Lb/Hr)	0	1,140	1,380	1,380	2,280				1,140	2,280
Add'l NO_x Removed from Current Operations (Ton/Yr)	0	4,494	5,440	5,440	8,988				4,494	8,988
Sulfur Dioxide Emissions										
Uncontrolled SO_2 (Lb/MMBtu)	1.20					1.20	1.20	1.20	1.20	1.20
Uncontrolled SO_2 (Lb/Hr)	7,198					7,198	7,198	7,198	7,198	7,198
Uncontrolled SO_2 (Lb Moles/Hr)	112.35					112.35	112.35	112.35	112.35	112.35
Uncontrolled SO_2 (Tons/Yr)	28,374					28,374	28,374	28,374	28,374	28,374
Controlled SO_2 Emission Rate (Lb/MMBtu)	0.27					0.27	0.27	0.15	0.15	0.15
SO_2 Removal Efficiency (%)	77.5%					77.5%	77.5%	87.5%	87.5%	87.5%
Controlled SO_2 Emissions (Lb/Hr)	1,620					1,620	1,620	900	900	900
Controlled SO_2 Emissions (Ton/Yr)	6,386					6,386	6,386	3,548	3,548	3,548
SO_2 Removed (Lb/Hr)	5,578					5,578	5,578	6,298	6,298	6,298
SO_2 Removed (Ton/Yr)	21,988					21,988	21,988	24,826	24,826	24,826
Add'l SO_2 Removed from Current Operations (Lb/Hr)	0					0	0	720	720	720
Add'l SO_2 Removed from Current Operations (Ton/Yr)	0					0	0	2,838	2,838	2,838
Particulate Matter Emissions										
Uncontrolled Fly Ash (Lb/Hr)	51,177					51,177	51,177	51,177	51,177	51,177
Uncontrolled Fly Ash (Lb/MMBtu)	8.529					8.529	8.529	8.529	8.529	8.529
Uncontrolled Fly Ash (Tons/Yr)	201,739					201,739	201,739	201,739	201,739	201,739
Controlled Fly Ash Emission Rate (Lb/MMBtu)	0.045					0.030	0.015	0.045	0.030	0.030
Controlled Fly Ash Removal Efficiency (%)	99.5%					99.6%	99.8%	99.5%	99.6%	99.6%
Controlled Fly Ash Emissions (Lb/Hr)	270					180	90	270	180	180
Controlled Fly Ash Emissions (Ton/Yr)	1,064					710	355	1,064	710	710
Fly Ash Removed (Lb/Hr)	50,907					50,997	51,087	50,907	50,997	50,997
Fly Ash Removed (Ton/Yr)	200,674					201,029	201,384	200,674	201,029	201,029
Add'l Ash Removed from Current Operation (Lb/Hr)	0					90	180	0	90	90
Add'l Ash Removed from Current Operation (Ton/Yr)	0					355	710	0	355	355
Economic Factors										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20

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INPUT CALCULATIONS										
Jim Bridger 1	Boiler Design:	Opposed Wall-Fired PC								
PARAMETER	Current Operation	NO_x Control Technologies				SO_2 and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO_x Emission Control System	LNCFS-1 & Windbox Mods.	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR	N/A	N/A	Upgrade Wet FGD	LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System	Wet FGD								Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
Installed Capital Costs										
NO_x Emission Control System ($2012)		$11,300,000	$20,528,122	$22,127,239	$177,800,000				$11,300,000	$177,800,000
SO_2 Emission Control System ($2012)						$0	$0	$25,300,000	$25,300,000	$25,300,000
PM Emission Control System ($2012)						$3,900,000	$48,386,333	$0	$3,900,000	$3,900,000
Total Emission Control System Capital Costs ($2012)		$11,300,000	$20,528,122	$22,127,239	$177,800,000	$3,900,000	$48,386,333	$25,300,000	$40,500,000	$207,000,000
NO_x Emission Control System ($/kW)		$21	$39	$42	$335				$21	$335
SO_2 Emission Control System ($/kW)								$48	$48	$48
PM Emission Control System ($/kW)						$7	$91		$7	$7
Total Emission Control Capital Costs ($/kW)		$21	$39	$42	$335	$7	$91	$48	$76	$391
Fixed Operating & Maintenance Costs										
Operating Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($)		$28,000	$42,000	$123,000	$190,000	$0	$51,099	$25,500	$53,500	$215,500
Maintenance Labor ($)		$42,000	$63,000	$184,500	$285,000	$10,000	$76,649	$17,033	$69,033	$312,033
Administrative Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Total 1st Fixed Year O&M Cost ($)		$70,000	$105,000	$307,500	$475,000	$10,000	$127,748	$42,533	$122,533	$527,533
Annual Fixed O&M Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Fixed O&M Cost ($/Yr)		$82,985	$124,478	$364,542	$563,114	$11,855	$151,446	$50,423	$145,263	$625,392
Variable Operating & Maintenance Costs										
Water Cost										
Makeup Water Usage (gpm)		0	0	0	0	0	0	53	53	53
Unit Price ($/1000 gallons)		$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22
First Year Water Cost ($)		$0	$0	$0	$0	$0	$0	$30,503	$30,503	$30,503
Annual Water Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Water Costs ($/Yr)		$0	$0	$0	$0	$0	$0	$36,161	$36,161	$36,161
Reagent Cost										
Type of Reagent		None	None	Urea	Anhydrous NH_3	Elemental Sulfur	Lime	Soda Ash	Soda Ash & Elemental Sulfur	Soda Ash, Elemental Sulfur, Anhydrous NH3
Unit Cost ($/Ton)		$0.00		$370.00	$400.00	$370.00	$91.25	$80.00		
Unit Cost ($/Lb)		$0.000		$0.185	$0.200	$0.185	$0.046	$0.040		
Molar Stoichiometry		0.00		0.45	1.00	0.00	1.15	1.02		
Reagent Purity (Wt.%)		100%		100%	100%	100%	90%	100%		
Reagent Usage (Lb/Hr)				61	647	100	0	1,215		
First Year Reagent Cost ($)		$0		$89,411	$1,020,310	$145,854	$0	$383,167	$529,021	$1,549,331
Annual Reagent Cost Escalation Rate (%)		2.00%		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Reagent Costs ($/Yr)				$105,997	$1,209,580	$172,910	$0	$454,246	$627,156	$1,836,737
SCR Catalyst / Fabric Filter Bag Replacement Cost										
Material Replaced					SCR Catalyst		Bags		0	& SCR Catalyst
Annual SCR Catalyst (m3) / No. FF Bags					198		2,885			
SCR Catalyst ($/m3) / Bag Cost ($/ea.)					$3,000		$104			
First Year SCR Catalyst / Bag Replacement Cost ($)					$594,000		$300,040		$0	$594,000
Annual SCR Catalyst / Bag Cost Escalation Rate (%)					2.00%		2.00%		0%	2.00%
Levelized Catalyst/Fabric Filter Bag Costs ($/Yr)					$704,189		$355,698		$0	$704,189
FGD Waste Disposal Cost										
FGD Solid Waste Disposal Rate, Dry (Lb/Hr)						0	0	3,319	3,319	3,319
FGD Waste Disposal Unit Cost ($/Dry Ton)						$24.33	$24.33	$24.33	$24.33	$24.33
First Year FGD Waste Disposal Cost ($)						$0	$0	$318,275	$318,275	$318,275
Annual Waste Disposal Cost Esc. Rate (%)						2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Waste Disposal Costs ($/Yr)						$0	$0	$377,316	$377,316	$377,316
Auxiliary Power Cost										
Auxiliary Power Requirement (MW)		0.00	6.41	0.53	3.28	0.05	3.39	0.53	0.58	3.86
Auxiliary Power Requirement (% of Plant Output)		0.00%	1.21%	0.10%	0.62%	0.01%	0.64%	0.10%	0.11%	0.73%
Auxiliary Power Usage (MWh)		0	50,536	4,179	25,860	394	26,727	4,179	4,573	30,432
Unit Cost ($2006/MW-Hr)		$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00
First Year Auxiliary Power Cost ($)		$0	$2,526,822	$208,926	$1,292,976	$19,710	$1,336,338	$208,926	$228,636	$1,521,612
Annual Power Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Auxiliary Power Costs ($/Yr)		$0	$2,995,555	$247,682	$1,532,827	$23,366	$1,584,233	$247,682	$271,049	$1,803,876

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Addendum to Jim Bridger Unit 2 BART Report

RECEIVED MAR 2008 AIR QUALITY DIVISION

PREPARED FOR: Wyoming Division of Air Quality

PREPARED BY: CH2M HILL

COPIES: Bill Lawson/PacifiCorp

DATE: March 26, 2008

Introduction

In compliance with the Regional Haze Rule (40 Code of Federal Regulations [CFR] 51), the Wyoming Division of Air Quality (WDAQ) required PacifiCorp Energy to conduct a detailed Best Available Retrofit Technology (BART) review to analyze the effects to visibility in nearby Class I areas from plant emissions, both for baseline and for reasonable control technology scenarios. PacifiCorp submitted these evaluations to WDAQ in January 2007. A revised report was submitted in October 2007.

On January 3, 2008, PacifiCorp Energy personnel met with WDAQ staff to discuss the status of the BART reviews. At that time, the state requested that additional modeling scenarios for several of the PacifiCorp facilities be performed to aid in their BART review. This memorandum presents the economics analysis for two scenarios modeled, referred to as Scenario A and Scenario B and described as follows:

- Scenario A: PacifiCorp committed controls at permitted rates—low nitrogen oxide (NO_x) burners (LNBs) with over-fire air (OFA), sodium based flue gas desulfurization (FGD), SO_3 injection
- Scenario B: PacifiCorp committed controls and selective catalytic reduction (SCR) at permitted rates

The CALPUFF modeling system (v. 5.711a) was used for this analysis. All technical options and model triggers used in CALMET, CALPUFF, and CALPOST are consistent with those used for the previous BART analyses and described in the BART report submitted in October 2007.

Stack Parameters, Emissions Information, and Capital Cost

Table 1 summarizes the control equipment for Scenarios A and B as well as the current equipment installed at the plant. The overall capital cost of installing these options is also shown.

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TABLE 1
Control Scenario Summary
Jim Bridger Unit 2

	Equipment Type			Capital Cost
	NO_x	SO_2	PM_{10}	Million dollars
Baseline	LNB with OFA	Wet sodium FGD	ESP	—
Scenario A	LNB with OFA	Wet sodium FGD	ESP with SO_3 injection	$29.2
Scenario B	LNB with OFA and SCR	Wet sodium FGD	ESP with SO_3 injection	$195.7

Emissions were modeled for the following pollutants:

- Sulfur dioxide (SO_2)
- NO_x
- Coarse particulate ($PM_{2.5}$<diameter<PM_{10})
- Fine particulate (diameter<$PM_{2.5}$)
- Sulfates

Table 2 shows stack parameters and emission rates that were used for the Jim Bridger Unit 2 BART modeling and analysis.

TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 2

	BART Comparison[d]		
Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
Hourly Heat Input (mmBtu/hour)	6,000	6,000	6,000
Sulfur Dioxide (SO_2) Stack Emissions (lb/hr)	1,602	900	900
Nitrogen Oxide (NO_x) Stack Emissions (lb/hr)	1,440	1,560	420
PM_{10} Stack Emissions (lb/hr)	444	180.0	180.0
Coarse Particulate ($PM_{2.5}$ <diameter< PM_{10}) Stack Emissions (lb/hr)[a]	191	77.4	77.4
Fine Particulate (diameter<$PM_{2.5}$) Stack Emissions (lb/hr)[b]	253	102.6	102.6
Sulfuric Acid (H_2SO_4) Stack Emissions (lb/hr)	55.2	55.2	94.7
Ammonium Sulfate [$(NH_4)_2SO_4$] Stack Emissions (lb/hr)	—	—	7.0
$(NH_4)HSO_4$ Stack Emissions (lb/hr)	—	—	12.2
H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr)	54.1	54.1	92.8
$(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	5.1
$(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	10.2

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TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 2

Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
	BART Comparison[d]		
Total Sulfate (SO_4) (lb/hr)[c]	54.1	54.1	108.1
Stack Conditions			
Stack Height (meters)	152	152	152
Stack Exit Diameter (meters)	7.32	7.32	7.32
Stack Exit Temperature (Kelvin)	333	328	328
Stack Exit Velocity (meters per second)	27.4	24.7	24.7

NOTES:
[a] Based on AP-42, Table 1.1-6, the coarse particulates are counted as a percentage of PM_{10}. This equates to 43% ESP and 57% Baghouse. PM_{10} and $PM_{2.5}$ refer to particulate matter less than 10 and 2.5 micrometers, respectively, in aerodynamic diameter.
[b] Based on AP-42, Table 1.1-6, the fine particulates are counted as a percentage of PM_{10}. This equates to 57% ESP and 43% Baghouse.
[c] Total Sulfate (SO_4) (lb/hr) = H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr) + $(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr) + $(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)
[d] SO_2, NO_x, and PM rates are expressed in terms of permitted emission rates. Actual emissions will be less than the permitted rates.
[e] PacifiCorp Committed Controls @ permitted rates: LNB with OFA, Wet FGD, ESP with SO_3
[f] PacifiCorp Committed Controls and SCR @ permitted rates

Economic Analysis

In completing this additional analysis to supplement the previous BART study, technology alternatives were investigated and potential reductions in NO_x, SO_2, and PM_{10} emissions rates were identified.

A comparison of Scenarios A and B on the basis of costs, design control efficiencies, and tons of pollutant removed is summarized in Tables 3 through 5. Capital costs were provided by PacifiCorp. The complete economic analyses for these two scenarios are provided as Attachment 1.

TABLE 3
Scenario A Control Cost
Jim Bridger Unit 2

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario A
	Existing LNB with OFA	**Wet FGD**	**ESP with Gas Conditioning**	**Control Cost**
Total Installed Capital Costs (million dollars)	—	$25.3	$3.90	$29.20
Annualized First-Year Capital Costs	—	$2.41	$0.37	$2.78
First Year Fixed & Variable O&M Costs (million dollars)	—	$0.98	$0.18	$1.16
Total First Year Annualized Costs (million dollars) [a]	—	$3.39	$0.55	$3.94
Power Consumption (MW)	—	0.53	0.05	0.58
Annual Power Usage (Million kWh/Yr)	—	4.18	0.39	4.57
Permitted Emission Rate (lb/mmBtu)	0.26	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	—	2,838	1,041	3,879
First Year Average Control Cost ($/Ton of Pollutant Removed)	—	1,194	525	1,015

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 4
Scenario B Control Cost
Jim Bridger Unit 2

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario B
	LNB with OFA & SCR	**Wet FGD**	**ESP with Gas Conditioning**	**Control Cost**
Total Installed Capital Costs (million dollars)	$166.5	$25.3	$3.90	$195.70
Annualized First-Year Capital Costs	$15.84	$2.41	$0.37	$18.62
First Year Fixed & Variable O&M Costs (million dollars)	$3.37	$0.98	$0.18	$4.53
Total First Year Annualized Costs (million dollars) [a]	$19.21	$3.39	$0.55	$23.15
Power Consumption (MW)	3.25	0.53	0.05	3.83
Annual Power Usage (Million kWh/Yr)	25.65	4.18	0.39	30.22
Permitted Emission Rate (lb/mmBtu)	0.07	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	4.494	2.838	1.041	8.373
First Year Average Control Cost ($/Ton of Pollutant Removed)	4.275	1.194	525	2.764

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 5
Incremental Control Costs, Scenario B compared to Scenario A
Jim Bridger Unit 2

	NO_x Control	SO_2 Control	PM_{10} Control	Total Control Cost
Incremental Installed Capital Costs (million dollars)	$166.5	0	0	$166.5
Incremental Annualized First-Year Capital Costs	$15.84	0	0	$15.84
Incremental First Year Fixed & Variable O&M Costs (million dollars)	$3.37	0	0	$3.37
Incremental First Year Annualized Costs (million dollars) [a]	$19.21	0	0	$19.21
Incremental Power Consumption (MW)	3.25	0	0	3.25
Incremental Annual Power Usage (Million kWh/Yr)	25.62	0	0	25.62
Incremental Improvement in Emission Rate (lb/mmBtu)	0.19	0	0	—
Incremental Tons of Pollutant Removed	4,494	0	0	4,494
Incremental First Year Average Control Cost ($/Ton of Pollutant Removed)	4,275	0	0	4,275

NOTE:
[a]Incremental first year annualized costs include power consumption costs.

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Modeling Results and Least-Cost Envelope Analysis

CH2M HILL modeled Jim Bridger Unit 2 for two post-control scenarios. The results determine the change in deciview based on each alternative at the Class I areas specific to the project. The Class I areas potentially affected are Bridger Wilderness, Fitzpatrick Wilderness, and Mount Zirkel Wilderness for this unit.

Modeled Scenarios

Current operations (baseline) and two alternative control scenarios were modeled to cover the range of effectiveness for the combination of the individual NO_x, SO_2, and PM control technologies being evaluated. The modeled scenarios include the following:

- Baseline: Current operations with LNB, Wet sodium FGD, and ESP
- Scenario A: LNB with OFA, Wet sodium FGD, and ESP with SO_3 injection
- Scenario B: Scenario A with SCR

Summary of Visibility Analysis

Tables 6 through 8 present a summary of the modeling period (2001–2003) results for each scenario and Class I area.

TABLE 6
Costs and Visibility Modeling Results as Applicable to Bridger Wilderness
Jim Bridger Unit 2

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	3.074	0.935	23
Scenario A	Scenario A: PacifiCorp Committed Controls	$3,936,700	2.919	0.829	17
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$23,145,945	1.647	0.481	10

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TABLE 7
Costs and Visibility Modeling Results as Applicable to Fitzpatrick Wilderness
Jim Bridger Unit 2

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	1.666	0.434	9
Scenario A	Scenario A: PacifiCorp Committed Controls	$3,936,700	1.747	0.379	7
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$23,145,945	0.959	0.232	4

TABLE 8
Costs and Visibility Modeling Results as Applicable to Mount Zirkel Wilderness
Jim Bridger Unit 2

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	2.475	1.154	25
Scenario A	Scenario A: PacifiCorp Committed Controls	$3,936,700	2.168	1.046	22
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$23,145,945	1.298	0.607	12

Results

Tables 9 through 11 present a summary of the costs and modeling results for each scenario and Class I area.

TABLE 9
Incremental Costs and Incremental Visibility Improvements Relative to Bridger Wilderness
Jim Bridger Unit 2

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$3.94	0.106	6	$37.14	$0.66
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$23.15	0.454	13	$50.98	$1.78
Scenario B Compared To Scenario A	Addition of SCR	$19.21	0.348	7	$55.20	$2.74

TABLE 10
Incremental Costs and Incremental Visibility Improvements Relative to Fitzpatrick Wilderness
Jim Bridger Unit 2

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$3.94	0.055	2	$71.58	$1.97
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$23.15	0.202	5	$114.58	$4.63
Scenario B Compared To Scenario A	Addition of SCR	$19.21	0.147	3	$130.68	$6.40

TABLE 11
Incremental Costs and Incremental Visibility Improvements Relative to Mount Zirkel Wilderness
Jim Bridger Unit 2

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$3.94	0.108	3	$36.45	$1.31
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$23.15	0.547	13	$42.31	$1.78
Scenario B Compared To Scenario A	Addition of SCR	$19.21	0.439	10	$43.76	$1.92

Least-Cost Envelope Analysis

The least-cost envelope graphs for Bridger Wilderness are shown in Figures 1 and 2, for Fitzpatrick Wilderness in Figures 3 and 4, and for Mount Zirkel Wilderness in Figures 5 and 6.

FIGURE 1

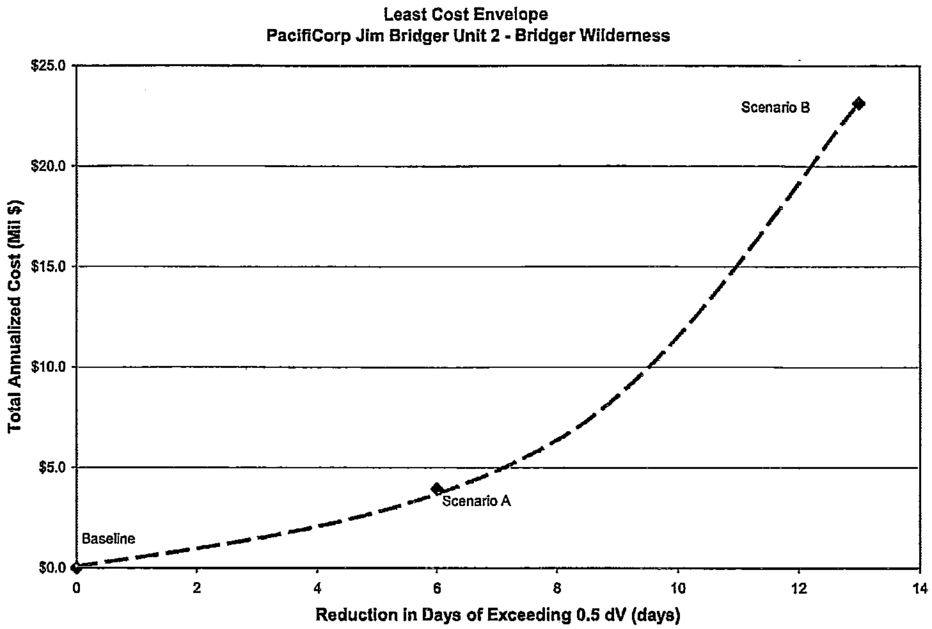

FIGURE 2

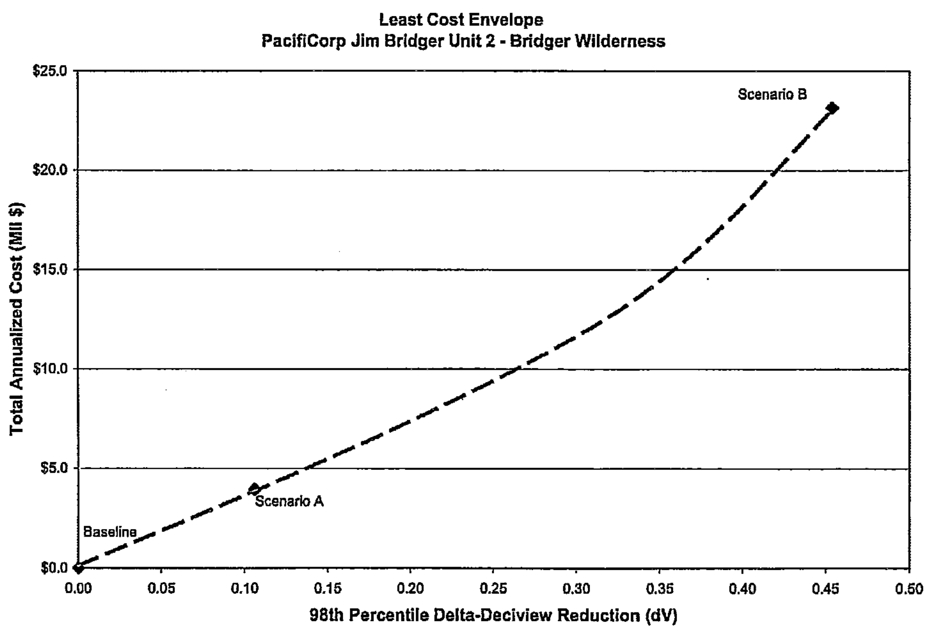

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FIGURE 3

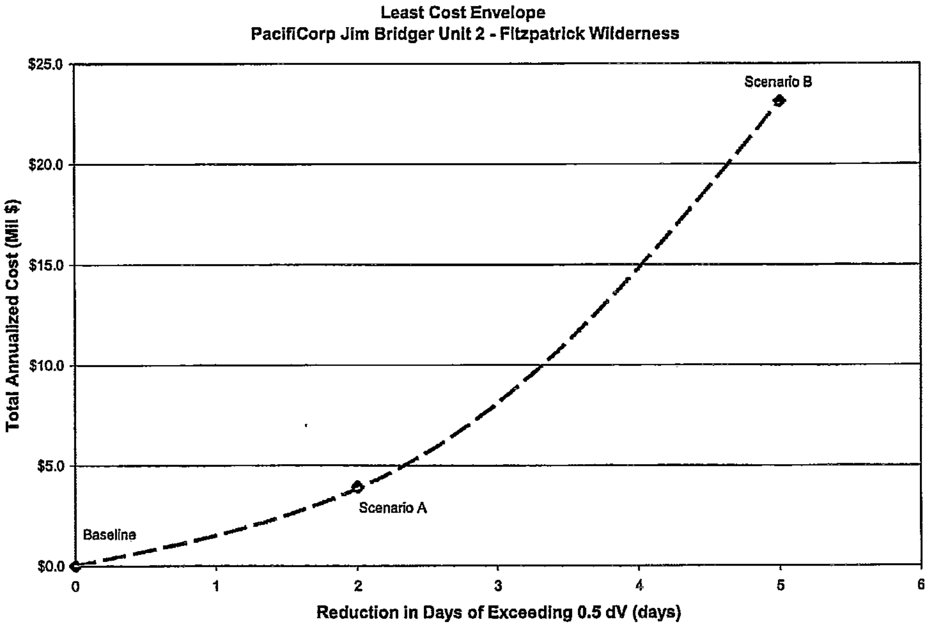

FIGURE 4

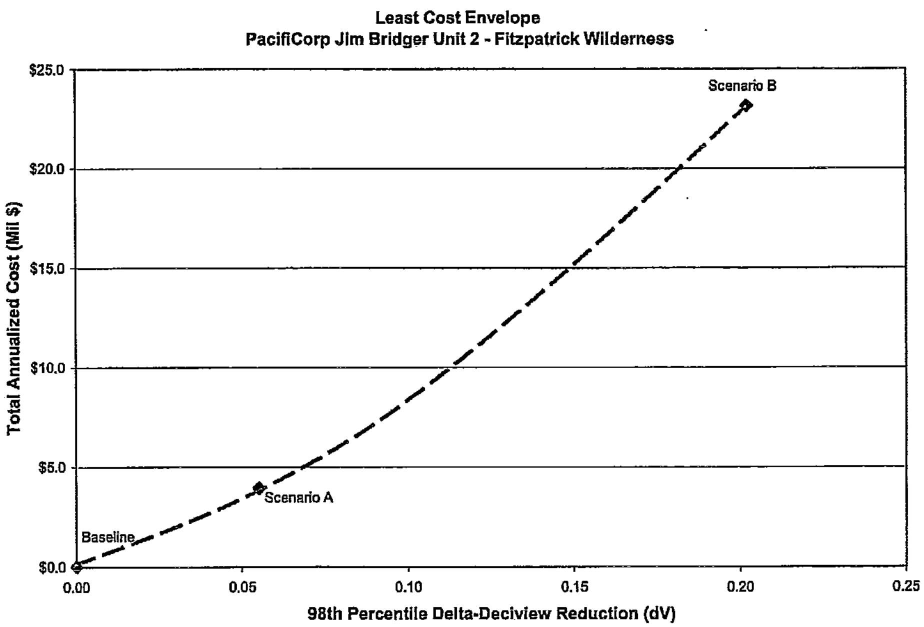

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FIGURE 5

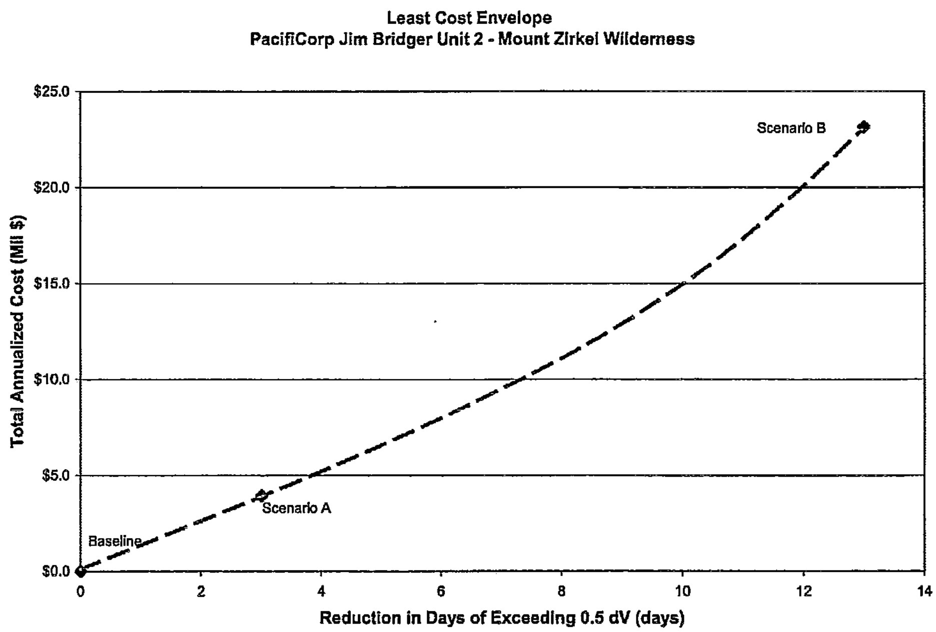
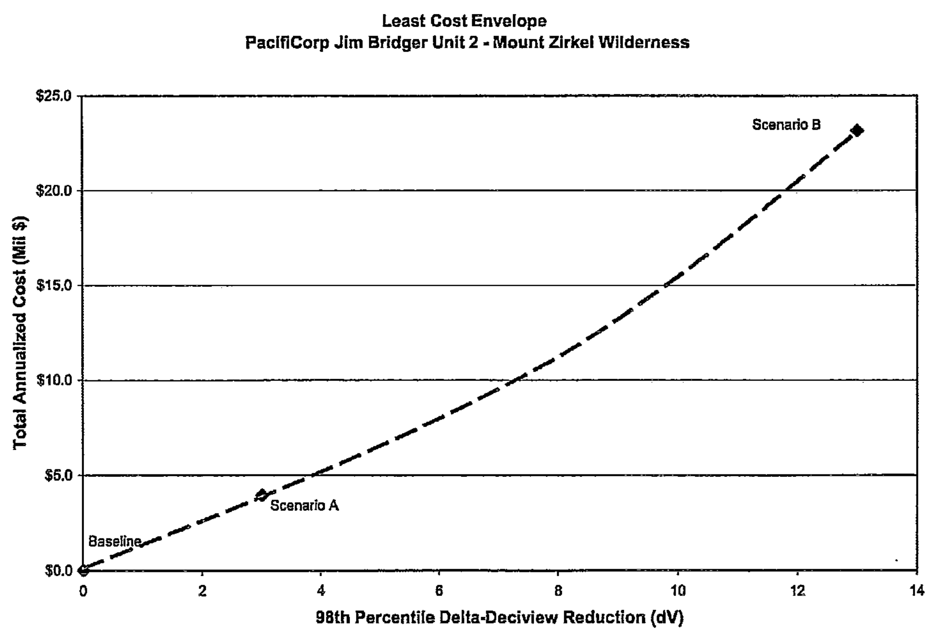


FIGURE 6



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ATTACHMENT 1

Complete Economic Analyses for Scenarios A and B

ECONOMIC ANALYSIS SUMMARY - FIRST YEAR COSTS

Jim Bridger 2 — Boiler Design: Tangential-Fired PC

TYPE OF EMISSIONS CONTROLS		NO_x Control				SO_2 and PM Control		Scenario A	Scenario B
Technology Label	BASE	A	B	C	D	E	G	A+F	D+F
	Current Operation	Low NO_x Burners with Overfire Air	Rotating Overfire Air	Low NO_x Burners with Overfire Air and Non-Selective Catalytic Reduction	Low NO_x Burners with Overfire Air and Selective Catalytic Reduction	ESP w/ Gas Conditioning	Upgrade Wet FGD	LNB w/OFA, upgrate Wet FGD, ESP w/ gas conditioning	LNB w/OFA, SCR, upgrate Wet FGD, ESP w/ gas conditioning
ECONOMIC FACTORS									
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20
CAPITAL INVESTMENT									
Total Installed Capital Costs ($)	$0	$0	$20,528,122	$13,427,239	$166,500,000	$3,900,000	$25,300,000	$29,200,000	$195,700,000
FIRST YEAR DEBT SERVICE ($/Yr)	$0	$0	$1,952,796	$1,277,304	$15,838,783	$370,999	$2,406,734	$2,777,732	$18,616,515
FIRST YEAR FIXED O&M Costs ($/Yr)									
Operating Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($/Yr)	$0	$0	$42,000	$123,000	$190,000	$0	$25,500	$25,500	$215,500
Maintenance Labor ($/Yr)	$0	$0	$63,000	$184,500	$285,000	$10,000	$17,033	$27,033	$312,033
Administrative Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL FIRST YEAR FIXED O&M COST	$0	$0	$105,000	$307,500	$475,000	$10,000	$42,533	$52,533	$527,533
FIRST YEAR VARIABLE O&M Costs ($/Yr)									
Makeup Water Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$30,503	$30,503	$30,503
Reagent Costs ($/Yr)	$0	$0	$0	$89,411	$1,020,310	$145,854	$383,167	$529,021	$1,549,331
SCR Catalyst / FF Bag Costs ($/Yr)	$0	$0	$0	$0	$594,000	$0	$0	$0	$594,000
Waste Disposal Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$318,275	$318,275	$318,275
Electric Power Costs ($/Yr)	$0	$0	$2,526,822	$208,926	$1,281,150	$19,710	$208,926	$228,636	$1,509,766
TOTAL FIRST YEAR VARIABLE O&M Costs ($/Yr)	$0	$0	$2,526,822	$298,337	$2,895,460	$165,564	$940,871	$1,106,435	$4,001,895
SUMMARY OF FIRST YEAR COSTS ($/Yr)									
First Year Debt Service ($/Yr)	$0	$0	$1,952,796	$1,277,304	$15,838,783	$370,999	$2,406,734	$2,777,732	$18,616,515
First Year Fixed O&M Costs ($/Yr)	$0	$0	$105,000	$307,500	$475,000	$10,000	$42,533	$52,533	$527,533
First Year Variable O&M Costs ($/Yr)	$0	$0	$2,526,822	$298,337	$2,895,460	$165,564	$940,871	$1,106,435	$4,001,895
Total First Year Costs ($/Yr)	$0	$0	$4,584,618	$1,883,141	$19,209,242	$546,563	$3,390,138	$3,936,700	$23,145,943
CONTROL COST COMPARISONS									
NO_x Technology Comparison									
Additional NO_x Removed From Base Case (Tons/Yr)	0	0	946	946	4,494				
First Year Average Control Cost ($/Ton NO_x Removed)	$0	#DIV/0!	$4,846	$1,990	$4,275				
Technology Case Comparison		A-BASE	B-A	C-A	D-A				
Incremental NO_x Removed (Tons/Yr)	0	0	946	946	4,494				
Incremental Control Cost ($/Ton NO_x Removed)	$0	#DIV/0!	$4,846	$1,990	$4,275				
SO_2 Technology Comparison	77.5%					77.5%	87.5%		
Additional SO_2 Removed From Base Case (Tons/Yr)	0					0	2,838		
First Year Average Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	$1,194		
Technology Case Comparison						E-BASE	G-F		
Incremental SO_2 Removed (Tons/Yr)	0					0	2,838		
Incremental Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	-$1,046		
PM Technology Comparison	0.0%								
Additional PM Removed From Base Case (Tons/Yr)	0					1,041	0		
First Year Average Control Cost ($/Ton PM Removed)	$0					$525	#DIV/0!		
Technology Case Comparison						E-BASE	G-F		
Incremental PM Removed (Tons/Yr)	0					1,041	-1,395		
Incremental Control Cost ($/Ton PM Removed)	$0					$525	$2,128		
SCENARIO A AND B COMPARISONS									
Additional NO_x, SO_2, & PM Removed From Base Case (Tons/Yr)	0							3,879	8,373
First Year Average Control Cost Compared to Base Case ($/Ton Removed)	$0							$1,015	$2,764
Incremental Tons Removed - Scenario B vs Scenario A (Tons/Yr)	0								4,494
Incremental Control Costs - Scenario B vs Scenario A ($/Ton Removed)	$0								$4,275

INPUT CALCULATIONS

Jim Bridger 2 — Boiler Design: Tangential-Fired PC

PARAMETER	Current Operation	NO_x Control Technologies				SO_2 and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO_x Emission Control System	LNB - TFS 2000	Existing LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				Existing LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
General Plant Design and Operating Data										
Type of Unit	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
Annual Power Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Annual Operation (Hours/Year)	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Net Power Output (kW)	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000
Net Plant Heat Rate (Btu/kW-Hr)	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320
Boiler Heat Input, Measured by Fuel Input (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by Fuel Input (MMBtu/Year)	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846
Boiler Heat Input, Measured by CEM (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by CEM (MMBtu/Year)	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000
Plant Fuel Source										
Boiler Fuel Source	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground
Coal Heating Value (Btu/Lb)	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660
Coal Sulfur Content (wt.%)	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.580%	0.58%	0.58%
Coal Ash Content (wt.%)	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%
Coal Flow Rate (Lb/Hr)	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077
Coal Consumed (Ton/Yr)	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284
Nitrogen Oxide Emissions										
NO_x Emission Rate (Lb/MMBtu)	0.26	0.26	0.22	0.22	0.07				0.26	0.07
NO_x Emission Rate (Lb/Hr)	1,560	1,560	1,320	1,320	420				1,560	420
NO_x Emission Rate (Lb Moles/Hr)	51.98	51.98	43.99	43.99	14.00				51.98	14.00
NO_x Emission Rate (Ton/Yr)	6,150	6,150	5,203	5,203	1,656				6,150	1,656
Add'l NO_x Removed from Current Operations (Lb/Hr)	0	0	240	240	1,140				0	1,140
Add'l NO_x Removed from Current Operations (Ton/Yr)	0	0	946	946	4,494				0	4,494
Sulfur Dioxide Emissions										
Uncontrolled SO_2 (Lb/MMBtu)	1.20					1.20	1.20	1.20	1.20	1.20
Uncontrolled SO_2 (Lb/Hr)	7,198					7,198	7,198	7,198	7,198	7,198
Uncontrolled SO_2 (Lb Moles/Hr)	112.35					112.35	112.35	112.35	112.35	112.35
Uncontrolled SO_2 (Tons/Yr)	28,374					28,374	28,374	28,374	28,374	28,374
Controlled SO_2 Emission Rate (Lb/MMBtu)	0.27					0.27	0.27	0.15	0.15	0.15
SO_2 Removal Efficiency (%)	77.5%					77.5%	77.5%	87.5%	87.5%	87.5%
Controlled SO_2 Emissions (Lb/Hr)	1,620					1,620	1,620	900	900	900
Controlled SO_2 Emissions (Ton/Yr)	6,386					6,386	6,386	3,548	3,548	3,548
SO_2 Removed (Lb/Hr)	5,578					5,578	5,578	6,298	6,298	6,298
SO_2 Removed (Ton/Yr)	21,988					21,988	21,988	24,826	24,826	24,826
Add'l SO_2 Removed from Current Operations (Lb/Hr)	0					0	0	720	720	720
Add'l SO_2 Removed from Current Operations (Ton/Yr)	0					0	0	2,838	2,838	2,838
Particulate Matter Emissions										
Uncontrolled Fly Ash (Lb/Hr)	51,177					51,177	51,177	51,177	51,177	51,177
Uncontrolled Fly Ash (Lb/MMBtu)	8.529					8.529	8.529	8.529	8.529	8.529
Uncontrolled Fly Ash (Tons/Yr)	201,739					201,739	201,739	201,739	201,739	201,739
Controlled Fly Ash Emission Rate (Lb/MMBtu)	0.074					0.030	0.015	0.074	0.030	0.030
Controlled Fly Ash Removal Efficiency (%)	99.1%					99.6%	99.8%	99.1%	99.6%	99.6%
Controlled Fly Ash Emissions (Lb/Hr)	444					180	90	444	180	180
Controlled Fly Ash Emissions (Ton/Yr)	1,750					710	355	1,750	710	710
Fly Ash Removed (Lb/Hr)	50,733					50,997	51,087	50,733	50,997	50,997
Fly Ash Removed (Ton/Yr)	199,988					201,029	201,384	199,988	201,029	201,029
Add'l Ash Removed from Current Operation (Lb/Hr)	0					264	354	0	264	264
Add'l Ash Removed from Current Operation (Ton/Yr)	0					1,041	1,395	0	1,041	1,041
Economic Factors										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20

INPUT CALCULATIONS

Jim Bridger 2 — Boiler Design: Tangential-Fired PC

PARAMETER	Current Operation	NO$_x$ Control Technologies				SO$_2$ and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO$_x$ Emission Control System	LNB - TFS 2000	Existing LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				Existing LNB w/OFA	LNB w/OFA & SCR
SO$_2$ Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
Installed Capital Costs										
NO$_x$ Emission Control System ($2012)		$0	$20,528,122	$13,427,239	$166,500,000				$0	$166,500,000
SO$_2$ Emission Control System ($2012)						$0	$0	$25,300,000	$25,300,000	$25,300,000
PM Emission Control System ($2012)						$3,900,000	$48,386,333	$0	$3,900,000	$3,900,000
Total Emission Control System Capital Costs ($2012)		$0	$20,528,122	$13,427,239	$166,500,000	$3,900,000	$48,386,333	$25,300,000	$29,200,000	$195,700,000
NO$_x$ Emission Control System ($/kW)			$39	$25	$314					$314
SO$_2$ Emission Control System ($/kW)								$48	$48	$48
PM Emission Control System ($/kW)						$7	$91		$7	$7
Total Emission Control Capital Costs ($/kW)			$39	$25	$314	$7	$91	$48	$55	$369
Fixed Operating & Maintenance Costs										
Operating Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($)		$0	$42,000	$123,000	$190,000	$0	$51,099	$25,500	$25,500	$215,500
Maintenance Labor ($)		$0	$63,000	$184,500	$285,000	$10,000	$76,649	$17,033	$27,033	$312,033
Administrative Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Total 1st Fixed Year O&M Cost ($)		$0	$105,000	$307,500	$475,000	$10,000	$127,748	$42,533	$52,533	$527,533
Annual Fixed O&M Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Fixed O&M Cost ($/Yr)		$0	$124,478	$364,542	$563,114	$11,855	$151,446	$50,423	$62,278	$625,392
Variable Operating & Maintenance Costs										
Water Cost										
Makeup Water Usage (gpm)		0	0	0	0	0	0	53	53	53
Unit Price ($/1000 gallons)		$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22
First Year Water Cost ($)		$0	$0	$0	$0	$0	$0	$30,503	$30,503	$30,503
Annual Water Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Water Costs ($/Yr)		$0	$0	$0	$0	$0	$0	$36,161	$36,161	$36,161
Reagent Cost										
Type of Reagent		None	None	Urea	Anhydrous NH$_3$	Elemental Sulfur	Lime	Soda Ash	Soda Ash & Elemental Sulfur	Soda Ash, Elemental Sulfur, Anhydrous NH$_3$
Unit Cost ($/Ton)		$0.00		$370.00	$400.00	$370.00	$91.25	$80.00		
Unit Cost ($/Lb)		$0.000		$0.185	$0.200	$0.185	$0.046	$0.040		
Molar Stoichiometry		0.00		0.45	1.00	0.00	1.15	1.02		
Reagent Purity (Wt.%)		100%		100%	100%	100%	90%	100%		
Reagent Usage (Lb/Hr)				61	647	100	0	1,215		
First Year Reagent Cost ($)		$0		$89,411	$1,020,310	$145,854	$0	$383,167	$529,021	$1,549,331
Annual Reagent Cost Escalation Rate (%)		2.00%		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Reagent Costs ($/Yr)				$105,997	$1,209,580	$172,910	$0	$454,246	$627,156	$1,836,737
SCR Catalyst / Fabric Filter Bag Replacement Cost										
Material Replaced					SCR Catalyst		Bags		0	& SCR Catalyst
Annual SCR Catalyst (m3) / No. FF Bags					198		2,885			
SCR Catalyst ($/m3) / Bag Cost ($/ea.)					$3,000		$104			
First Year SCR Catalyst / Bag Replacement Cost ($)					$594,000		$300,040		$0	$594,000
Annual SCR Catalyst / Bag Cost Escalation Rate (%)					2.00%		2.00%		0%	2.00%
Levelized Catalyst/Fabric Filter Bag Costs ($/Yr)					$704,189		$355,698		$0	$704,189
FGD Waste Disposal Cost										
FGD Solid Waste Disposal Rate, Dry (Lb/Hr)						0	0	3,319	3,319	3,319
FGD Waste Disposal Unit Cost ($/Dry Ton)						$24.33	$24.33	$24.33	$24.33	$24.33
First Year FGD Waste Disposal Cost ($)						$0	$0	$318,275	$318,275	$318,275
Annual Waste Disposal Cost Esc. Rate (%)						2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Waste Disposal Costs ($/Yr)						$0	$0	$377,316	$377,316	$377,316
Auxiliary Power Cost										
Auxiliary Power Requirement (MW)		0.00	6.41	0.53	3.25	0.05	3.37	0.53	0.58	3.83
Auxiliary Power Requirement (% of Plant Output)		0.00%	1.21%	0.10%	0.61%	0.01%	0.64%	0.10%	0.11%	0.72%
Auxiliary Power Useage (MWh)		0	50,536	4,179	25,623	394	26,569	4,179	4,573	30,196
Unit Cost ($2008/MW-Hr)		$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00
First Year Auxiliary Power Cost ($)		$0	$2,526,822	$208,926	$1,281,150	$19,710	$1,328,454	$208,926	$228,636	$1,509,786
Annual Power Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Auxiliary Power Costs ($/Yr)		$0	$2,995,555	$247,682	$1,518,807	$23,366	$1,574,886	$247,682	$271,049	$1,789,856

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Addendum to Jim Bridger Unit 3 BART Report

PREPARED FOR: Wyoming Division of Air Quality

PREPARED BY: CH2M HILL

COPIES: Bill Lawson/PacifiCorp

DATE: March 26, 2008

RECEIVED MAR 2008 AIR QUALITY DIVISION

Introduction

In compliance with the Regional Haze Rule (40 Code of Federal Regulations [CFR] 51), the Wyoming Division of Air Quality (WDAQ) required PacifiCorp Energy to conduct a detailed Best Available Retrofit Technology (BART) review to analyze the effects to visibility in nearby Class I areas from plant emissions, both for baseline and for reasonable control technology scenarios. PacifiCorp submitted these evaluations to WDAQ in January 2007. A revised report was submitted in October 2007.

On January 3, 2008, PacifiCorp Energy personnel met with WDAQ staff to discuss the status of the BART reviews. At that time, the state requested that additional modeling scenarios for several of the PacifiCorp facilities be performed to aid in their BART review. This memorandum presents the economics analysis for two scenarios modeled, referred to as Scenario A and Scenario B and described as follows:

- Scenario A: PacifiCorp committed controls at permitted rates—low nitrogen oxide (NO_x) burners (LNBs) with over-fire air (OFA), sodium based flue gas desulfurization (FGD), SO_3 injection
- Scenario B: PacifiCorp committed controls and selective catalytic reduction (SCR) at permitted rates

The CALPUFF modeling system (v. 5.711a) was used for this analysis. All technical options and model triggers used in CALMET, CALPUFF, and CALPOST are consistent with those used for the previous BART analyses and described in the BART report submitted in October 2007.

Stack Parameters, Emissions Information, and Capital Cost

Table 1 summarizes the control equipment for Scenarios A and B as well as the current equipment installed at the plant. The overall capital cost of installing these options is also shown.

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TABLE 1
Control Scenario Summary
Jim Bridger Unit 3

	Equipment Type			Capital Cost
	NO_x	SO_2	PM_{10}	Million dollars
Baseline	LNB	Wet sodium FGD	ESP	—
Scenario A	LNB with OFA	Wet sodium FGD	ESP with SO_3 injection	$40.5
Scenario B	LNB with OFA and SCR	Wet sodium FGD	ESP with SO_3 injection	$207.0

Emissions were modeled for the following pollutants:

- Sulfur dioxide (SO_2)
- NO_x
- Coarse particulate ($PM_{2.5}$<diameter<PM_{10})
- Fine particulate (diameter<$PM_{2.5}$)
- Sulfates

Table 2 shows stack parameters and emission rates that were used for the Jim Bridger Unit 3 BART modeling and analysis.

TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 3

	BART Comparison[d]		
Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
Hourly Heat Input (mmBtu/hour)	6,000	6,000	6,000
Sulfur Dioxide (SO_2) Stack Emissions (lb/hr)	1,602	900	900
Nitrogen Oxide (NO_x) Stack Emissions (lb/hr)	2,700	1,560	420
PM_{10} Stack Emissions (lb/hr)	342	180.0	180.0
Coarse Particulate ($PM_{2.5}$ <diameter< PM_{10}) Stack Emissions (lb/hr)[a]	147	77.4	77.4
Fine Particulate (diameter<$PM_{2.5}$) Stack Emissions (lb/hr)[b]	195	102.6	102.6
Sulfuric Acid (H_2SO_4) Stack Emissions (lb/hr)	55.2	55.2	94.7
Ammonium Sulfate [$(NH_4)_2SO_4$] Stack Emissions (lb/hr)	—	—	7.0
$(NH_4)HSO_4$ Stack Emissions (lb/hr)	—	—	12.2
H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr)	54.1	54.1	92.8
$(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	5.1
$(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	10.2

TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 3

	BART Comparison[d]		
Model Input Data	**Baseline**	**Scenario A [e]**	**Scenario B [f]**
Total Sulfate (SO_4) (lb/hr)[c]	54.1	54.1	108.1
Stack Conditions			
Stack Height (meters)	152	152	152
Stack Exit Diameter (meters)	7.32	7.32	7.32
Stack Exit Temperature (Kelvin)	333	328	328
Stack Exit Velocity (meters per second)	25.6	24.7	24.7

NOTES:
[a] Based on AP-42, Table 1.1-6, the coarse particulates are counted as a percentage of PM_{10}. This equates to 43% ESP and 57% Baghouse. PM_{10} and $PM_{2.5}$ refer to particulate matter less than 10 and 2.5 micrometers, respectively, in aerodynamic diameter.
[b] Based on AP-42, Table 1.1-6, the fine particulates are counted as a percentage of PM_{10}. This equates to 57% ESP and 43% Baghouse.
[c] Total Sulfate (SO_4) (lb/hr) = H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr) + $(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr) + $(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)
[d] SO_2, NO_x, and PM rates are expressed in terms of permitted emission rates. Actual emissions will be less than the permitted rates.
[e] PacifiCorp Committed Controls @ permitted rates: LNB with OFA, Wet FGD, ESP with SO_3
[f] PacifiCorp Committed Controls and SCR @ permitted rates

Economic Analysis

In completing this additional analysis to supplement the previous BART study, technology alternatives were investigated and potential reductions in NO_x, SO_2, and PM_{10} emissions rates were identified.

A comparison of Scenarios A and B on the basis of costs, design control efficiencies, and tons of pollutant removed is summarized in Tables 3 through 5. Capital costs were provided by PacifiCorp. The complete economic analyses for these two scenarios are provided as Attachment 1.

TABLE 3
Scenario A Control Cost
Jim Bridger Unit 3

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario A
	LNB with OFA	Wet FGD	ESP with Gas Conditioning	Control Cost
Total Installed Capital Costs (million dollars)	$11.3	$25.3	$3.90	$40.5
Annualized First-Year Capital Costs	$1.07	$2.41	$0.37	$3.85
First Year Fixed & Variable O&M Costs (million dollars)	$0.07	$0.98	$0.18	$1.22
Total First Year Annualized Costs (million dollars) [a]	$1.15	$3.39	$0.55	$5.08
Power Consumption (MW)	—	0.52	0.05	0.57
Annual Power Usage (Million kWh/Yr)	—	4.10	0.39	4.49
Permitted Emission Rate (lb/mmBtu)	0.26	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	4,494	2,838	639	7,971
First Year Average Control Cost ($/Ton of Pollutant Removed)	255	1,193	856	637

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 4
Scenario B Control Cost
Jim Bridger Unit 3

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario B
	LNB with OFA & SCR	Wet FGD	ESP with Gas Conditioning	Control Cost
Total Installed Capital Costs (million dollars)	$177.8	$25.3	$3.90	$207.0
Annualized First-Year Capital Costs	$16.91	$2.41	$0.37	$19.69
First Year Fixed & Variable O&M Costs (million dollars)	$3.36	$0.98	$0.18	$4.52
Total First Year Annualized Costs (million dollars) [a]	$20.28	$3.39	$0.55	$24.21
Power Consumption (MW)	3.22	0.52	0.05	3.79
Annual Power Usage (Million kWh/Yr)	25.39	4.10	0.39	29.89
Permitted Emission Rate (lb/mmBtu)	0.07	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	8,988	2,838	639	12,465
First Year Average Control Cost ($/Ton of Pollutant Removed)	2,256	1,193	856	1,942

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 5
Incremental Control Costs, Scenario B compared to Scenario A
Jim Bridger Unit 3

	NO_x Control	SO_2 Control	PM_{10} Control	Total Control Cost
Incremental Installed Capital Costs (million dollars)	$166.5	0	0	$166.5
Incremental Annualized First-Year Capital Costs	$15.84	0	0	$15.84
Incremental First Year Fixed & Variable O&M Costs (million dollars)	$3.30	0	0	$3.30
Incremental First Year Annualized Costs (million dollars) [a]	$19.13	0	0	$19.13
Incremental Power Consumption (MW)	3.22	0	0	3.22
Incremental Annual Power Usage (Million kWh/Yr)	25.39	0	0	25.39
Incremental Improvement in Emission Rate (lb/mmBtu)	0.19	0	0	—
Incremental Tons of Pollutant Removed	4,494	0	0	4,494
Incremental First Year Average Control Cost ($/Ton of Pollutant Removed)	4,258	0	0	4,258

NOTE:
[a]Incremental first year annualized costs include power consumption costs.

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Modeling Results and Least-Cost Envelope Analysis

CH2M HILL modeled Jim Bridger Unit 3 for two post-control scenarios. The results determine the change in deciview based on each alternative at the Class I areas specific to the project. The Class I areas potentially affected are Bridger Wilderness, Fitzpatrick Wilderness, and Mount Zirkel Wilderness for this unit.

Modeled Scenarios

Current operations (baseline) and two alternative control scenarios were modeled to cover the range of effectiveness for the combination of the individual NO_x, SO_2, and PM control technologies being evaluated. The modeled scenarios include the following:

- Baseline: Current operations with LNB, Wet sodium FGD, and ESP
- Scenario A: LNB with OFA, Wet sodium FGD, and ESP with SO_3 injection
- Scenario B: Scenario A with SCR

Summary of Visibility Analysis

Tables 6 through 8 present a summary of the modeling period (2001–2003) results for each scenario and Class I area.

TABLE 6
Costs and Visibility Modeling Results as Applicable to Bridger Wilderness
Jim Bridger Unit 3

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	4.381	1.265	30
Scenario A	Scenario A: PacifiCorp Committed Controls	$5,077,127	2.919	0.829	17
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$24,210,545	1.647	0.481	10

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TABLE 7
Costs and Visibility Modeling Results as Applicable to Fitzpatrick Wilderness
Jim Bridger Unit 3

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	2.542	0.615	13
Scenario A	Scenario A: PacifiCorp Committed Controls	$5,077,127	1.747	0.379	7
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$24,210,545	0.959	0.232	4

TABLE 8
Costs and Visibility Modeling Results as Applicable to Mount Zirkel Wilderness
Jim Bridger Unit 3

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	3.460	1.642	47
Scenario A	Scenario A: PacifiCorp Committed Controls	$5,077,127	2.168	1.046	22
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$24,210,545	1.298	0.607	12

Results

Tables 9 through 11 present a summary of the costs and modeling results for each scenario and Class I area.

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TABLE 9
Incremental Costs and Incremental Visibility Improvements Relative to Bridger Wilderness
Jim Bridger Unit 3

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$5.08	0.436	13	$11.64	$0.39
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$24.21	0.784	20	$30.88	$1.21
Scenario B Compared To Scenario A	Addition of SCR	$19.13	0.348	7	$54.98	$2.73

TABLE 10
Incremental Costs and Incremental Visibility Improvements Relative to Fitzpatrick Wilderness
Jim Bridger Unit 3

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$5.08	0.236	6	$21.51	$0.85
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$24.21	0.383	9	$63.21	$2.69
Scenario B Compared To Scenario A	Addition of SCR	$19.13	0.147	3	$130.16	$6.38

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TABLE 11
Incremental Costs and Incremental Visibility Improvements Relative to Mount Zirkel Wilderness
Jim Bridger Unit 3

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$5.08	0.596	25	$8.52	$0.20
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$24.21	1.035	35	$23.39	$0.69
Scenario B Compared To Scenario A	Addition of SCR	$19.13	0.439	10	$43.58	$1.91

Least-Cost Envelope Analysis

The least-cost envelope graphs for Bridger Wilderness are shown in Figures 1 and 2, for Fitzpatrick Wilderness in Figures 3 and 4, and for Mount Zirkel Wilderness in Figures 5 and 6.

FIGURE 1

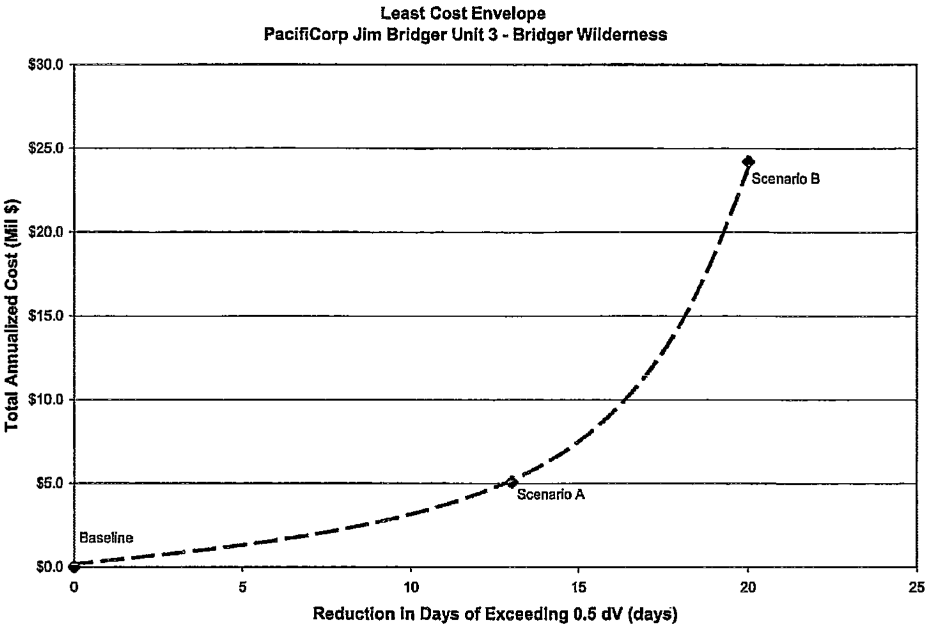

FIGURE 2

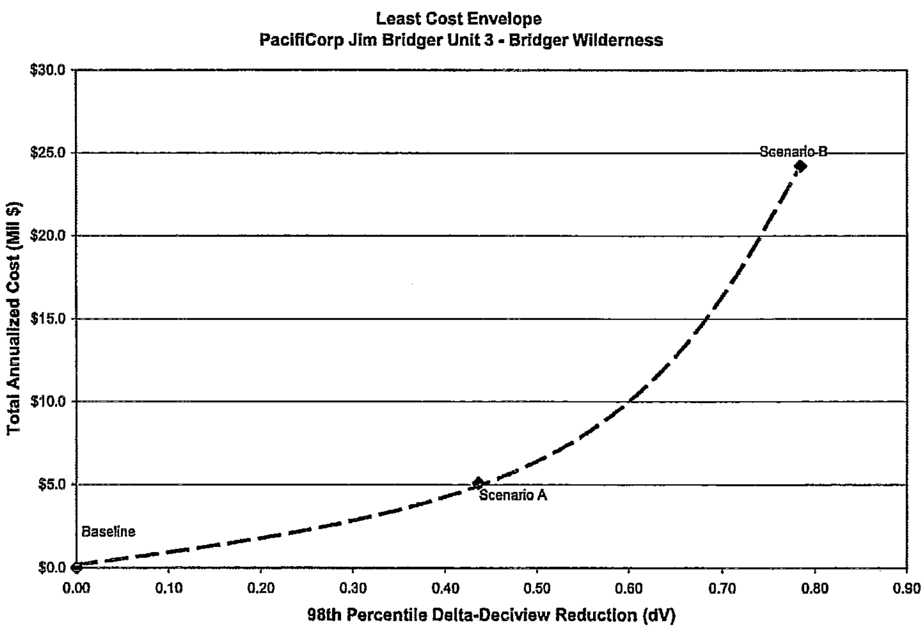

FIGURE 3

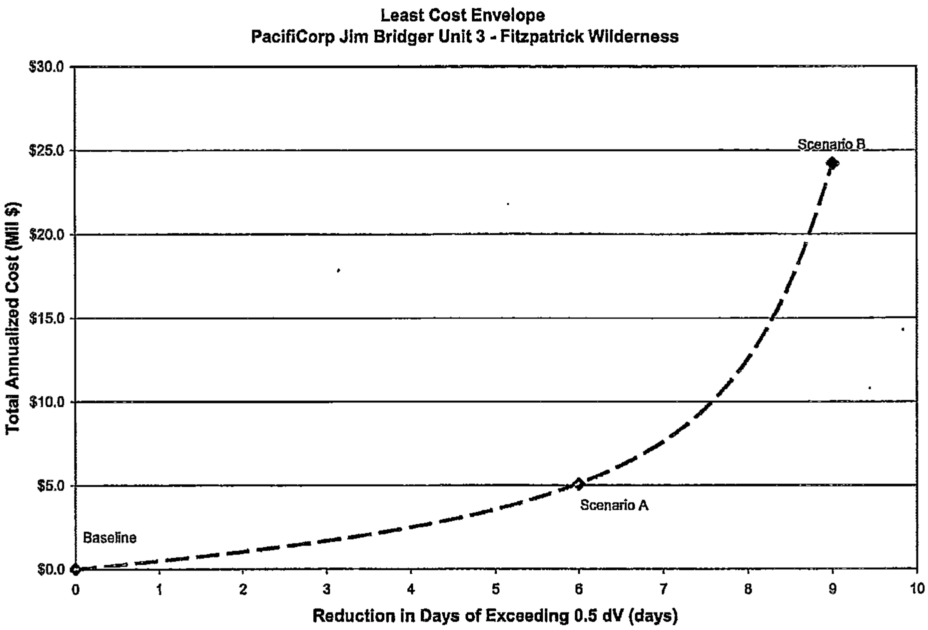

FIGURE 4

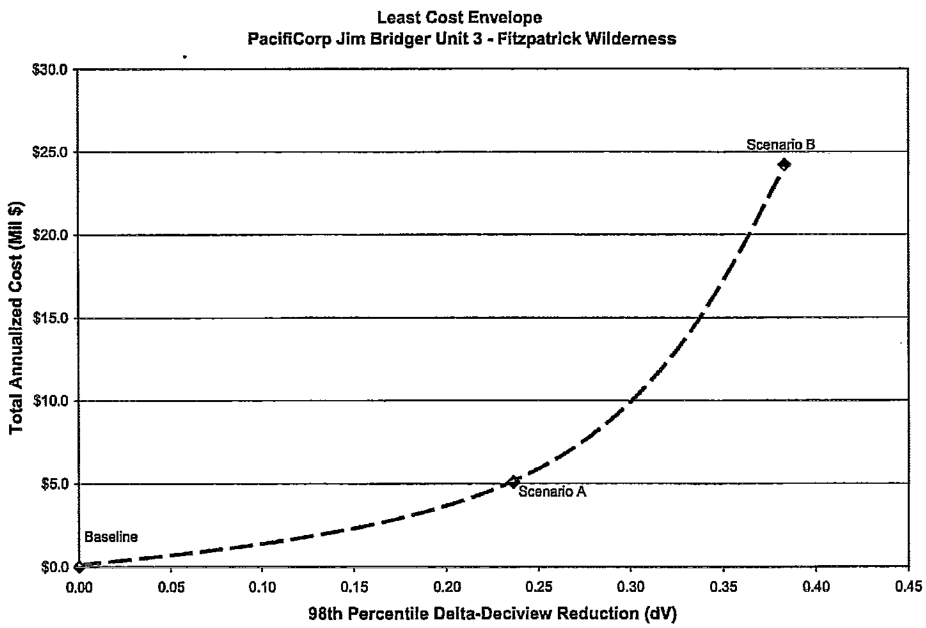

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FIGURE 5

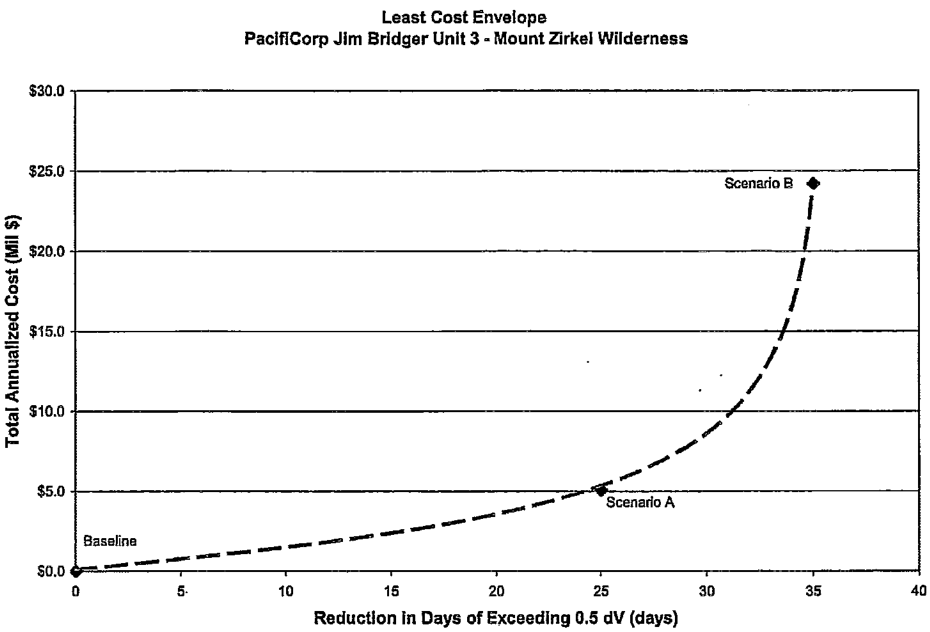
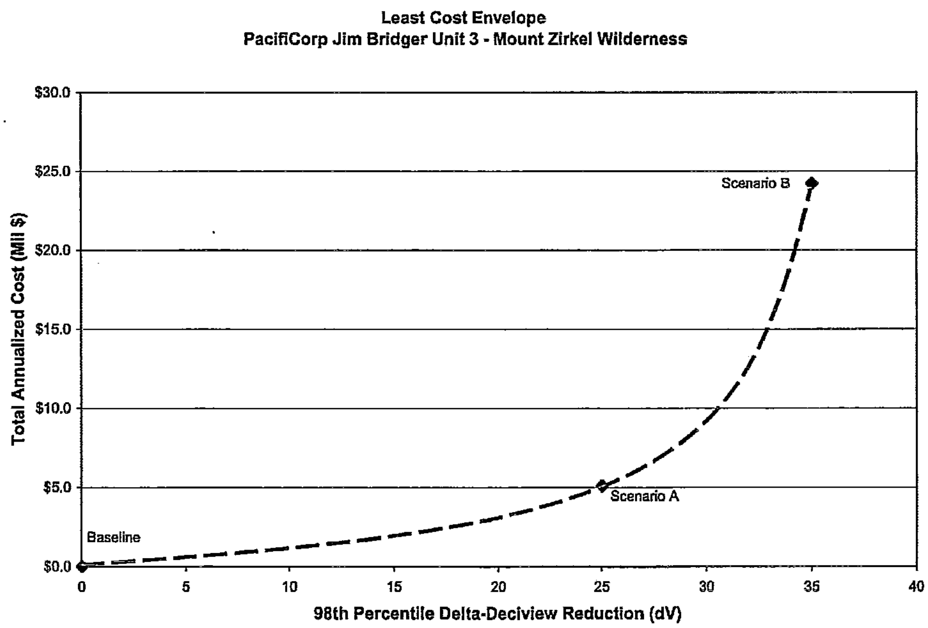


FIGURE 6



ATTACHMENT 1

Complete Economic Analyses for Scenarios A and B

ECONOMIC ANALYSIS SUMMARY - FIRST YEAR COSTS

Jim Bridger 3 — Boiler Design: Tangential fired PC

TYPE OF EMISSIONS CONTROLS		NO_x Control				SO_2 Control and PM			Scenario A	Scenario B
Technology Label	BASE	A	B	C	D	E	F	G	A+F	D+F
	Current Operation	Low NO_x Burners with Overfire Air	Rotating Overfire Air	Low NO_x Burners with Overfire Air and Non-Selective Catalytic Reduction	Low NO_x Burners with Overfire Air and Selective Catalytic Reduction	ESP w/ Gas Conditioning	Fabric Filter	Upgrade Wet FGD	LNB w/OFA, Upgrade Wet FGD and ESP w/gas conditioning	LNB w/OFA, SCR, Upgrade Wet FGD and ESP w/gas conditioning
ECONOMIC FACTORS										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20
CAPITAL INVESTMENT										
Total Installed Capital Costs ($)	$0	$11,300,000	$20,528,122	$21,973,632	$177,800,000	$3,900,000	$48,386,333	$25,300,000	$40,500,000	$207,000,000
FIRST YEAR DEBT SERVICE ($/Yr)	$0	$1,074,944	$1,952,796	$2,090,304	$16,913,727	$370,999	$4,602,887	$2,406,734	$3,852,677	$19,691,459
FIRST YEAR FIXED O&M Costs ($/Yr)										
Operating Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($/Yr)	$0	$28,000	$42,000	$122,000	$190,000	$0	$51,099	$25,500	$53,500	$215,500
Maintenance Labor ($/Yr)	$0	$42,000	$63,000	$183,000	$285,000	$10,000	$76,649	$17,033	$69,033	$312,033
Administrative Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL FIRST YEAR FIXED O&M COST	$0	$70,000	$105,000	$305,000	$475,000	$10,000	$127,748	$42,533	$122,533	$527,533
FIRST YEAR VARIABLE O&M Costs ($/Yr)										
Makeup Water Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$29,927	$29,927	$29,927
Reagent Costs ($/Yr)	$0	$0	$0	$89,411	$1,020,310	$145,854	$0	$383,167	$529,021	$1,549,331
SCR Catalyst / FF Bag Costs ($/Yr)	$0	$0	$0	$0	$600,000	$0	$294,008	$0	$0	$600,000
Waste Disposal Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$318,275	$318,275	$318,275
Electric Power Costs ($/Yr)	$0	$0	$2,526,822	$204,984	$1,269,324	$19,710	$1,312,686	$204,984	$224,694	$1,494,018
TOTAL FIRST YEAR VARIABLE O&M Costs ($/Yr)	$0	$0	$2,526,822	$294,395	$2,889,634	$165,564	$1,606,694	$936,353	$1,101,917	$3,991,551
SUMMARY OF FIRST YEAR COSTS ($/Yr)										
First Year Debt Service ($/Yr)	$0	$1,074,944	$1,952,796	$2,090,304	$16,913,727	$370,999	$4,602,887	$2,406,734	$3,852,677	$19,691,459
First Year Fixed O&M Costs ($/Yr)	$0	$70,000	$105,000	$305,000	$475,000	$10,000	$127,748	$42,533	$122,533	$527,533
First Year Variable O&M Costs ($/Yr)	$0	$0	$2,526,822	$294,395	$2,889,634	$165,564	$1,606,694	$936,353	$1,101,917	$3,991,551
Total First Year Costs ($/Yr)	$0	$1,144,944	$4,584,618	$2,689,699	$20,278,361	$546,563	$6,337,329	$3,385,620	$5,077,127	$24,210,544
CONTROL COST COMPARISONS										
NO_x Technology Comparison										
Additional NO_x Removed From Base Case (Tons/Yr)	0	4,494	5,440	5,440	8,988					
First Year Average Control Cost ($/Ton NO_x Removed)	$0	$255	$843	$494	$2,256					
Technology Case Comparison		A-BASE	B-A	C-A	D-A					
Incremental NO_x Removed (Tons/Yr)	0	4,494	946	946	4,494					
Incremental Control Cost ($/Ton NO_x Removed)	$0	$255	$3,636	$1,633	$4,258					
SO_2 Technology Comparison	77.5%					77.5%	77.5%	87.5%		
Additional SO_2 Removed From Base Case (Tons/Yr)	0					0	0	2,838		
First Year Average Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	#DIV/0!	$1,193		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental SO_2 Removed (Tons/Yr)	0					0	0	2,838		
Incremental Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	#DIV/0!	-$1,040		
PM Technology Comparison	0.0%									
Additional PM Removed From Base Case (Tons/Yr)	0					639	993	0		
First Year Average Control Cost ($/Ton PM Removed)	$0					$856	$6,380	#DIV/0!		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental PM Removed (Tons/Yr)	0					639	355	-993		
Incremental Control Cost ($/Ton PM Removed)	$0					$856	$16,322	$2,971		
SCENARIO A AND B COMPARISONS										
Additional NO_x, SO_2, & PM Removed From Base Case (Tons/Yr)	0								7,971	12,465
First Year Average Control Cost Compared to Base Case ($/Ton Removed)	$0								$637	$1,942
Incremental Tons Removed - Scenario B vs Scenario A (Tons/Yr)	0									4,494
Incremental Control Costs - Scenario B vs Scenario A ($/Ton Removed)	$0									$4,258

INPUT CALCULATIONS

Jim Bridger 3 — Boiler Design: Tangential-Fired PC

PARAMETER	Current Operation	NO$_x$ Control Technologies				SO$_2$ and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO$_x$ Emission Control System	LNCFS-1 & Windbox Mods.	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO$_2$ Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
General Plant Design and Operating Data										
Type of Unit	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
Annual Power Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Annual Operation (Hours/Year)	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Net Power Output (kW)	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000
Net Plant Heat Rate (Btu/kW-Hr)	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320
Boiler Heat Input, Measured by Fuel Input (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by Fuel Input (MMBtu/Year)	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846
Boiler Heat Input, Measured by CEM (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by CEM (MMBtu/Year)	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000
Plant Fuel Source										
Boiler Fuel Source	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground
Coal Heating Value (Btu/Lb)	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660
Coal Sulfur Content (wt.%)	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.580%	0.58%	0.58%
Coal Ash Content (wt.%)	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%
Coal Flow Rate (Lb/Hr)	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077
Coal Consumed (Ton/Yr)	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284
Nitrogen Oxide Emissions										
NO$_x$ Emission Rate (Lb/MMBtu)	0.45	0.26	0.22	0.22	0.07				0.26	0.07
NO$_x$ Emission Rate (Lb/Hr)	2,700	1,560	1,320	1,320	420				1,560	420
NO$_x$ Emission Rate (Lb Moles/Hr)	89.97	51.98	43.99	43.99	14.00				51.98	14.00
NO$_x$ Emission Rate (Ton/Yr)	10,643	6,150	5,203	5,203	1,656				6,150	1,656
Add'l NO$_x$ Removed from Current Operations (Lb/Hr)	0	1,140	1,380	1,380	2,280				1,140	2,280
Add'l NO$_x$ Removed from Current Operations (Ton/Yr)	0	4,494	5,440	5,440	8,988				4,494	8,988
Sulfur Dioxide Emissions										
Uncontrolled SO$_2$ (Lb/MMBtu)	1.20					1.20	1.20	1.20	1.20	1.20
Uncontrolled SO$_2$ (Lb/Hr)	7,198					7,198	7,198	7,198	7,198	7,198
Uncontrolled SO$_2$ (Lb Moles/Hr)	112.35					112.35	112.35	112.35	112.35	112.35
Uncontrolled SO$_2$ (Tons/Yr)	28,374					28,374	28,374	28,374	28,374	28,374
Controlled SO$_2$ Emission Rate (Lb/MMBtu)	0.27					0.27	0.27	0.15	0.15	0.15
SO$_2$ Removal Efficiency (%)	77.5%					77.5%	77.5%	87.5%	87.5%	87.5%
Controlled SO$_2$ Emissions (Lb/Hr)	1,620					1,620	1,620	900	900	900
Controlled SO$_2$ Emissions (Ton/Yr)	6,386					6,386	6,386	3,548	3,548	3,548
SO$_2$ Removed (Lb/Hr)	5,578					5,578	5,578	6,298	6,298	6,298
SO$_2$ Removed (Ton/Yr)	21,988					21,988	21,988	24,826	24,826	24,826
Add'l SO$_2$ Removed from Current Operations (Lb/Hr)	0					0	0	720	720	720
Add'l SO$_2$ Removed from Current Operations (Ton/Yr)	0					0	0	2,838	2,838	2,838
Particulate Matter Emissions										
Uncontrolled Fly Ash (Lb/Hr)	51,177					51,177	51,177	51,177	51,177	51,177
Uncontrolled Fly Ash (Lb/MMBtu)	8.529					8.529	8.529	8.529	8.529	8.529
Uncontrolled Fly Ash (Tons/Yr)	201,739					201,739	201,739	201,739	201,739	201,739
Controlled Fly Ash Emission Rate (Lb/MMBtu)	0.057					0.030	0.015	0.057	0.030	0.030
Controlled Fly Ash Removal Efficiency (%)	99.3%					99.6%	99.8%	99.3%	99.6%	99.6%
Controlled Fly Ash Emissions (Lb/Hr)	342					180	90	342	180	180
Controlled Fly Ash Emissions (Ton/Yr)	1,348					710	355	1,348	710	710
Fly Ash Removed (Lb/Hr)	50,835					50,997	51,087	50,835	50,997	50,997
Fly Ash Removed (Ton/Yr)	200,390					201,029	201,384	200,390	201,029	201,029
Add'l Ash Removed from Current Operation (Lb/Hr)	0					162	252	0	162	162
Add'l Ash Removed from Current Operation (Ton/Yr)	0					639	993	0	639	639
Economic Factors										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20

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INPUT CALCULATIONS										
Jim Bridger 3	Boiler Design:	Tangential-Fired PC								
PARAMETER	**Current Operation**	**NO_x Control Technologies**				**SO_2 and PM Control Technologies**			**Scenario A**	**Scenario B**
Control Technologies										
NO_x Emission Control System	LNCFS-1 & Windbox Mods.	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
Installed Capital Costs										
NO_x Emission Control System ($2012)		$11,300,000	$20,528,122	$21,973,832	$177,800,000				$11,300,000	$177,800,000
SO_2 Emission Control System ($2012)						$0	$0	$25,300,000	$25,300,000	$25,300,000
PM Emission Control System ($2012)						$3,900,000	$48,386,333	$0	$3,900,000	$3,900,000
Total Emission Control System Capital Costs ($2012)		$11,300,000	$20,528,122	$21,973,632	$177,800,000	$3,900,000	$48,386,333	$25,300,000	$40,500,000	$207,000,000
NO_x Emission Control System ($/kW)		$21	$39	$41	$335				$21	$335
SO_2 Emission Control System ($/kW)								$48	$48	$48
PM Emission Control System ($/kW)						$7	$91		$7	$7
Total Emission Control Capital Costs ($/kW)		$21	$39	$41	$335	$7	$91	$48	$76	$391
Fixed Operating & Maintenance Costs										
Operating Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($)		$28,000	$42,000	$122,000	$190,000	$0	$51,099	$25,500	$53,500	$215,500
Maintenance Labor ($)		$42,000	$63,000	$183,000	$285,000	$10,000	$76,649	$17,033	$69,033	$312,033
Administrative Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Total 1st Fixed Year O&M Cost ($)		$70,000	$105,000	$305,000	$475,000	$10,000	$127,748	$42,533	$122,533	$527,533
Annual Fixed O&M Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Fixed O&M Cost ($/Yr)		$82,985	$124,478	$361,578	$563,114	$11,855	$151,446	$50,423	$145,263	$625,392
Variable Operating & Maintenance Costs										
Water Cost										
Makeup Water Usage (gpm)		0	0	0	0	0	0	52	52	52
Unit Price ($/1000 gallons)		$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22
First Year Water Cost ($)		$0	$0	$0	$0	$0	$0	$29,927	$29,927	$29,927
Annual Water Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Water Costs ($/Yr)		$0	$0	$0	$0	$0	$0	$35,479	$35,479	$35,479
Reagent Cost										
Type of Reagent		None	None	Urea	Anhydrous NH_3	Elemental Sulfur	Lime	Soda Ash	Soda Ash & Elemental Sulfur	Soda Ash, Elemental Sulfur, Anhydrous NH_3
Unit Cost ($/Ton)		$0.00		$370.00	$400.00	$370.00	$91.25	$80.00		
Unit Cost ($/Lb)		$0.000		$0.185	$0.200	$0.185	$0.046	$0.040		
Molar Stoichiometry		0.00		0.45	1.00	0.00	1.15	1.02		
Reagent Purity (Wt.%)		100%		100%	100%	100%	90%	100%		
Reagent Usage (Lb/Hr)				61	847	100	0	1,215		
First Year Reagent Cost ($)		$0		$89,411	$1,020,310	$145,854	$0	$383,167	$529,021	$1,549,331
Annual Reagent Cost Escalation Rate (%)		2.00%		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Reagent Costs ($/Yr)				$105,997	$1,209,580	$172,910	$0	$454,246	$627,156	$1,836,737
SCR Catalyst / Fabric Filter Bag Replacement Cost										
Material Replaced					SCR Catalyst		Bags		0	& SCR Catalyst
Annual SCR Catalyst (m3) / No. FF Bags					200		2,827			
SCR Catalyst ($/m3) / Bag Cost ($/ea.)					$3,000		$104			
First Year SCR Catalyst / Bag Replacement Cost ($)					$600,000		$294,008		$0	$600,000
Annual SCR Catalyst / Bag Cost Escalation Rate (%)					2.00%		2.00%		0%	2.00%
Levelized Catalyst/Fabric Filter Bag Costs ($/Yr)					$711,302		$348,547		$0	$711,302
FGD Waste Disposal Cost										
FGD Solid Waste Disposal Rate, Dry (Lb/Hr)						0	0	3,319	3,319	3,319
FGD Waste Disposal Unit Cost ($/Dry Ton)						$24.33	$24.33	$24.33	$24.33	$24.33
First Year FGD Waste Disposal Cost ($)						$0	$0	$318,275	$318,275	$318,275
Annual Waste Disposal Cost Esc. Rate (%)						2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Waste Disposal Costs ($/Yr)						$0	$0	$377,316	$377,316	$377,316
Auxiliary Power Cost										
Auxiliary Power Requirement (MW)		0.00	6.41	0.52	3.22	0.05	3.33	0.52	0.57	3.79
Auxiliary Power Requirement (% of Plant Output)		0.00%	1.21%	0.10%	0.61%	0.01%	0.63%	0.10%	0.11%	0.72%
Auxiliary Power Useage (MWh)		0	50,536	4,100	25,386	394	26,254	4,100	4,494	29,880
Unit Cost ($2006/MW-Hr)		$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00
First Year Auxiliary Power Cost ($)		$0	$2,526,822	$204,984	$1,269,324	$19,710	$1,312,686	$204,984	$224,694	$1,494,018
Annual Power Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Auxiliary Power Costs ($/Yr)		$0	$2,995,555	$243,009	$1,504,787	$23,366	$1,556,193	$243,009	$266,375	$1,771,163

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TECHNICAL MEMORANDUM **CH2MHILL**

Addendum to Jim Bridger Unit 4 BART Report

PREPARED FOR: Wyoming Division of Air Quality

PREPARED BY: CH2M HILL

COPIES: Bill Lawson/PacifiCorp

DATE: March 26, 2008

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Introduction

In compliance with the Regional Haze Rule (40 Code of Federal Regulations [CFR] 51), the Wyoming Division of Air Quality (WDAQ) required PacifiCorp Energy to conduct a detailed Best Available Retrofit Technology (BART) review to analyze the effects to visibility in nearby Class I areas from plant emissions, both for baseline and for reasonable control technology scenarios. PacifiCorp submitted these evaluations to WDAQ in January 2007. A revised report was submitted in October 2007.

On January 3, 2008, PacifiCorp Energy personnel met with WDAQ staff to discuss the status of the BART reviews. At that time, the state requested that additional modeling scenarios for several of the PacifiCorp facilities be performed to aid in their BART review. This memorandum presents the economics analysis for two scenarios modeled, referred to as Scenario A and Scenario B and described as follows:

- Scenario A: PacifiCorp committed controls at permitted rates—low nitrogen oxide (NO_x) burners (LNBs) with over-fire air (OFA), sodium based flue gas desulfurization (FGD), SO_3 injection
- Scenario B: PacifiCorp committed controls and selective catalytic reduction (SCR) at permitted rates

The CALPUFF modeling system (v. 5.711a) was used for this analysis. All technical options and model triggers used in CALMET, CALPUFF, and CALPOST are consistent with those used for the previous BART analyses and described in the BART report submitted in October 2007.

Stack Parameters, Emissions Information, and Capital Cost

Table 1 summarizes the control equipment for Scenarios A and B as well as the current equipment installed at the plant. The overall capital cost of installing these options is also shown.

TABLE 1
Control Scenario Summary
Jim Bridger Unit 4

	Equipment Type			Capital Cost
	NO_x	SO_2	PM_{10}	Million dollars
Baseline	LNB	Wet sodium FGD	ESP with SO_3 injection	—
Scenario A	LNB with OFA	Wet sodium FGD	ESP with SO_3 injection	$12.9
Scenario B	LNB with OFA and SCR	Wet sodium FGD	ESP with SO_3 injection	$179.4

Emissions were modeled for the following pollutants:

- Sulfur dioxide (SO_2)
- NO_x
- Coarse particulate ($PM_{2.5}$<diameter<PM_{10})
- Fine particulate (diameter<$PM_{2.5}$)
- Sulfates

Table 2 shows stack parameters and emission rates that were used for the Jim Bridger Unit 4 BART modeling and analysis.

TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 4

	BART Comparison[d]		
Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
Hourly Heat Input (mmBtu/hour)	6,000	6,000	6,000
Sulfur Dioxide (SO_2) Stack Emissions (lb/hr)	1,002	900	900
Nitrogen Oxide (NO_x) Stack Emissions (lb/hr)	2,700	1,560	420
PM_{10} Stack Emissions (lb/hr)	180	180	180
Coarse Particulate ($PM_{2.5}$ <diameter< PM_{10}) Stack Emissions (lb/hr)[a]	77.4	77.4	77.4
Fine Particulate (diameter<$PM_{2.5}$) Stack Emissions (lb/hr)[b]	103	102.6	102.6
Sulfuric Acid (H_2SO_4) Stack Emissions (lb/hr)	55.2	55.2	94.7
Ammonium Sulfate [$(NH_4)_2SO_4$] Stack Emissions (lb/hr)	—	—	7.0
$(NH_4)HSO_4$ Stack Emissions (lb/hr)	—	—	12.2
H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr)	54.1	54.1	92.8
$(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	5.1
$(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)	—	—	10.2

TABLE 2
Calpuff Model Inputs
Jim Bridger Unit 4

Model Input Data	Baseline	Scenario A [e]	Scenario B [f]
	BART Comparison[d]		
Total Sulfate (SO_4) (lb/hr)[c]	54.1	54.1	108.1
Stack Conditions			
Stack Height (meters)	152	152	152
Stack Exit Diameter (meters)	9.45	9.45	9.45
Stack Exit Temperature (Kelvin)	322	322	322
Stack Exit Velocity (meters per second)	12.9	12.9	12.9

NOTES:
[a] Based on AP-42, Table 1.1-6, the coarse particulates are counted as a percentage of PM_{10}. This equates to 43% ESP and 57% Baghouse. PM_{10} and $PM_{2.5}$ refer to particulate matter less than 10 and 2.5 micrometers, respectively, in aerodynamic diameter.
[b] Based on AP-42, Table 1.1-6, the fine particulates are counted as a percentage of PM_{10}. This equates to 57% ESP and 43% Baghouse.
[c] Total Sulfate (SO_4) (lb/hr) = H_2SO_4 as Sulfate (SO_4) Stack Emissions (lb/hr) + $(NH_4)_2SO_4$ as SO_4 Stack Emissions (lb/hr) + $(NH_4)HSO_4$ as SO_4 Stack Emissions (lb/hr)
[d] SO_2, NO_x, and PM rates are expressed in terms of permitted emission rates. Actual emissions will be less than the permitted rates.
[e] PacifiCorp Committed Controls @ permitted rates: LNB with OFA, Wet FGD, ESP with SO_3
[f] PacifiCorp Committed Controls and SCR @ permitted rates

Economic Analysis

In completing this additional analysis to supplement the previous BART study, technology alternatives were investigated and potential reductions in NO_x, SO_2, and PM_{10} emissions rates were identified.

A comparison of Scenarios A and B on the basis of costs, design control efficiencies, and tons of pollutant removed is summarized in Tables 3 through 5. Capital costs were provided by PacifiCorp. The complete economic analyses for these two scenarios are provided as Attachment 1.

TABLE 3
Scenario A Control Cost
Jim Bridger Unit 4

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario A
	LNB with OFA	**Wet FGD**	**Existing ESP with Gas Conditioning**	**Control Cost**
Total Installed Capital Costs (million dollars)	$11.3	$1.60	—	$12.9
Annualized First-Year Capital Costs	$1.07	$0.15	—	$1.23
First Year Fixed & Variable O&M Costs (million dollars)	$0.07	$0.38	$0.17	$0.62
Total First Year Annualized Costs (million dollars) [a]	$1.14	$0.54	$0.17	$1.85
Power Consumption (MW)	—	0.53	0.05	0.58
Annual Power Usage (Million kWh/Yr)	—	4.18	0.39	4.57
Permitted Emission Rate (lb/mmBtu)	0.26	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	4,494	473	—	4,967
First Year Average Control Cost ($/Ton of Pollutant Removed)	255	1,113	—	372

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 4
Scenario B Control Cost
Jim Bridger Unit 4

	NO_x Control	SO_2 Control	PM_{10} Control	Scenario B
	LNB with OFA & SCR	Wet FGD	Existing ESP with Gas Conditioning	Control Cost
Total Installed Capital Costs (million dollars)	$177.8	$1.60	—	$179.4
Annualized First-Year Capital Costs	$16.91	$0.15	—	$17.07
First Year Fixed & Variable O&M Costs (million dollars)	$3.46	$0.38	$0.17	$4.01
Total First Year Annualized Costs (million dollars) [a]	$20.37	$0.54	$0.17	$21.07
Power Consumption (MW)	3.36	0.53	0.05	3.94
Annual Power Usage (Million kWh/Yr)	26.49	4.18	394	31.06
Permitted Emission Rate (lb/mmBtu)	0.07	0.15	0.03	—
Additional Tons of Pollutant Removed per Year over Baseline	8,988	473	—	9,461
First Year Average Control Cost ($/Ton of Pollutant Removed)	2,267	1,133	—	2,228

NOTE:
[a] First year annualized costs include power consumption costs.

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TABLE 5
Incremental Control Costs, Scenario B compared to Scenario A
Jim Bridger Unit 4

	NO_x Control	SO_2 Control	PM_{10} Control	Total Control Cost
Incremental Installed Capital Costs (million dollars)	$166.5	0	0	$166.5
Incremental Annualized First-Year Capital Costs	$15.84	0	0	$15.84
Incremental First Year Fixed & Variable O&M Costs (million dollars)	$3.39	0	0	$3.39
Incremental First Year Annualized Costs (million dollars) [a]	$19.23	0	0	$19.23
Incremental Power Consumption (MW)	3.36	0	0	3.36
Incremental Annual Power Usage (Million kWh/Yr)	26.49	0	0	26.49
Incremental Improvement in Emission Rate (lb/mmBtu)	0.19	0	0	—
Incremental Tons of Pollutant Removed	4,494	0	0	4,494
Incremental First Year Average Control Cost ($/Ton of Pollutant Removed)	4,279	0	0	4,279

NOTE:
[a]Incremental first year annualized costs include power consumption costs.

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Modeling Results and Least-Cost Envelope Analysis

CH2M HILL modeled Jim Bridger Unit 4 for two post-control scenarios. The results determine the change in deciview based on each alternative at the Class I areas specific to the project. The Class I areas potentially affected are Bridger Wilderness, Fitzpatrick Wilderness, and Mount Zirkel Wilderness for this unit.

Modeled Scenarios

Current operations (baseline) and two alternative control scenarios were modeled to cover the range of effectiveness for the combination of the individual NO_x, SO_2, and PM control technologies being evaluated. The modeled scenarios include the following:

- Baseline: Current operations with LNB, Wet sodium FGD, and ESP with SO_3 injection
- Scenario A: LNB with OFA, Wet sodium FGD, and ESP with SO_3 injection
- Scenario B: Scenario A with SCR

Summary of Visibility Analysis

Tables 6 through 8 present a summary of the modeling period (2001–2003) results for each scenario and Class I area.

TABLE 6
Costs and Visibility Modeling Results as Applicable to Bridger Wilderness
Jim Bridger Unit 4

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	4.247	1.203	30
Scenario A	Scenario A: PacifiCorp Committed Controls	$1,846,618	2.899	0.819	18
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$21,077,225	1.632	0.490	11

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TABLE 7
Costs and Visibility Modeling Results as Applicable to Fitzpatrick Wilderness
Jim Bridger Unit 4

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	2.606	0.606	13
Scenario A	Scenario A: PacifiCorp Committed Controls	$1,846,618	1.713	0.404	8
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$21,077,225	0.937	0.231	3

TABLE 8
Costs and Visibility Modeling Results as Applicable to Mount Zirkel Wilderness
Jim Bridger Unit 4

Scenario	Controls	Total First Year Annualized Cost	Highest ΔdV	98th Percentile ΔdV	Maximum Annual Number of Days Above 0.5 dV
Baseline	Current Operations with FGD and ESP	—	3.134	1.541	38
Scenario A	Scenario A: PacifiCorp Committed Controls	$1,846,618	2.139	1.030	23
Scenario B	Scenario B: PacifiCorp Committed Controls and SCR	$21,077,225	1.278	0.606	12

Results

Tables 9 through 11 present a summary of the costs and modeling results for each scenario and Class I area.

TABLE 9
Incremental Costs and Incremental Visibility Improvements Relative to Bridger Wilderness
Jim Bridger Unit 4

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$1.85	0.384	12	$4.81	$0.15
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$21.08	0.713	19	$29.56	$1.11
Scenario B Compared To Scenario A	Addition of SCR	$19.23	0.329	7	$58.45	$2.75

TABLE 10
Incremental Costs and Incremental Visibility Improvements Relative to Fitzpatrick Wilderness
Jim Bridger Unit 4

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$1.85	0.202	5	$9.14	$0.37
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$21.08	0.375	10	$56.21	$2.11
Scenario B Compared To Scenario A	Addition of SCR	$19.23	0.173	5	$111.16	$3.85

TABLE 11
Incremental Costs and Incremental Visibility Improvements Relative to Mount Zirkel Wilderness
Jim Bridger Unit 4

Scenario Comparison	Controls	Incremental Annualized Cost (Million$)	Reduction in 98th Percentile maximum dV	Reduction in Number of Days Above 0.5 dV	Cost per dV Reduction (Million$/dV Reduced)	Cost per Day to Achieve a Reduction in the Days above 0.5 dV (Million$/Day)
Scenario A Compared to Baseline	Scenario A: PacifiCorp Committed Controls	$1.85	0.511	15	$3.61	$0.12
Scenario B Compared to Baseline	Scenario B: PacifiCorp Committed Controls and SCR	$21.08	0.935	26	$22.54	$0.81
Scenario B Compared To Scenario A	Addition of SCR	$19.23	0.424	11	$45.36	$1.75

Least-Cost Envelope Analysis

The least-cost envelope graphs for Bridger Wilderness are shown in Figures 1 and 2, for Fitzpatrick Wilderness in Figures 3 and 4, and for Mount Zirkel Wilderness in Figures 5 and 6.

FIGURE 1

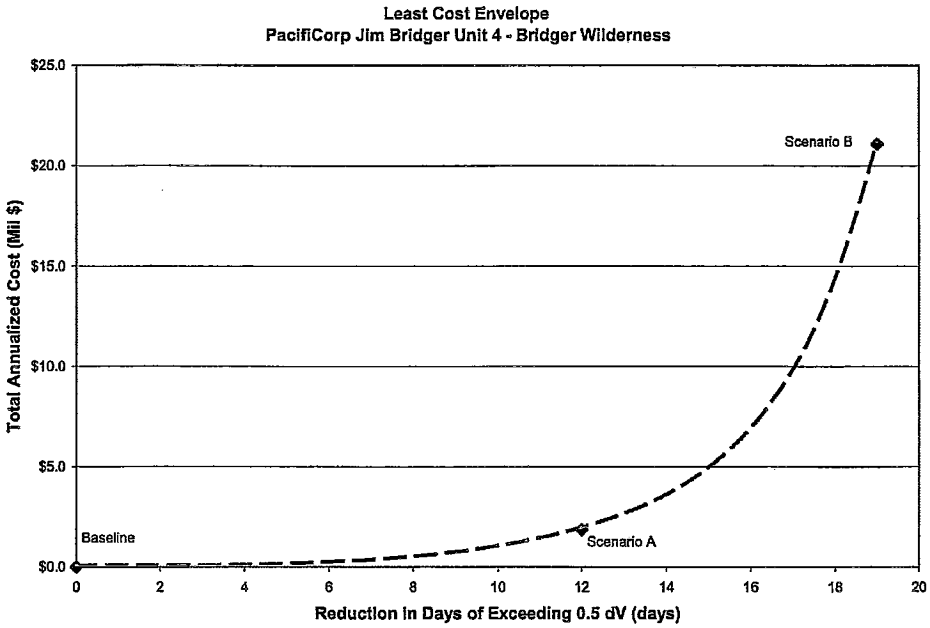

FIGURE 2

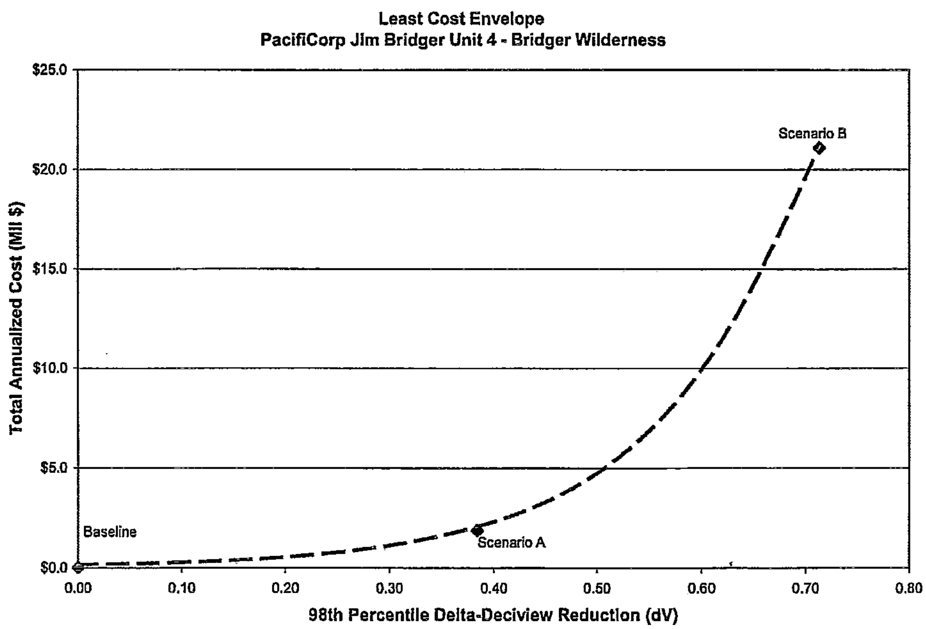

FIGURE 3

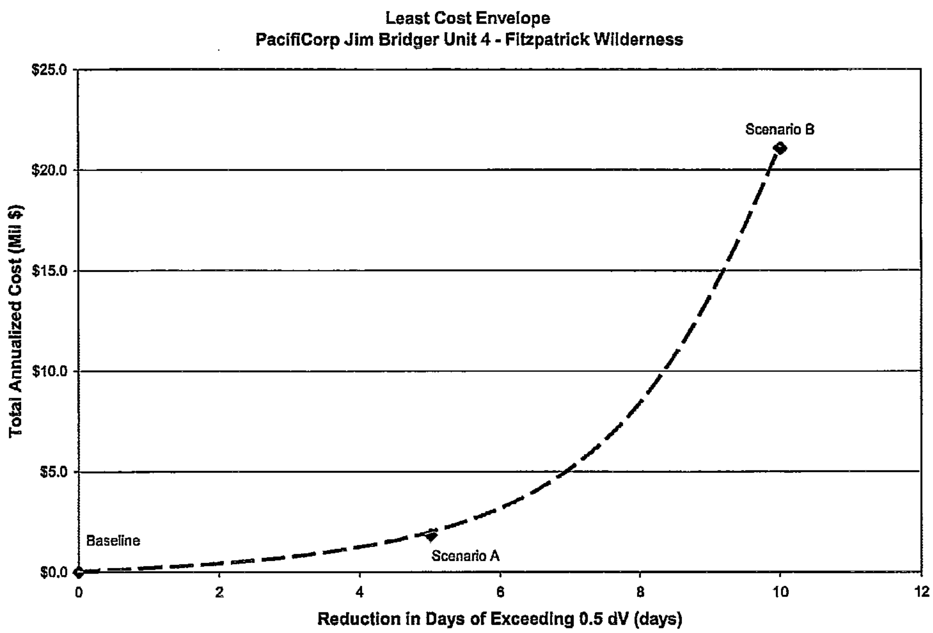

FIGURE 4

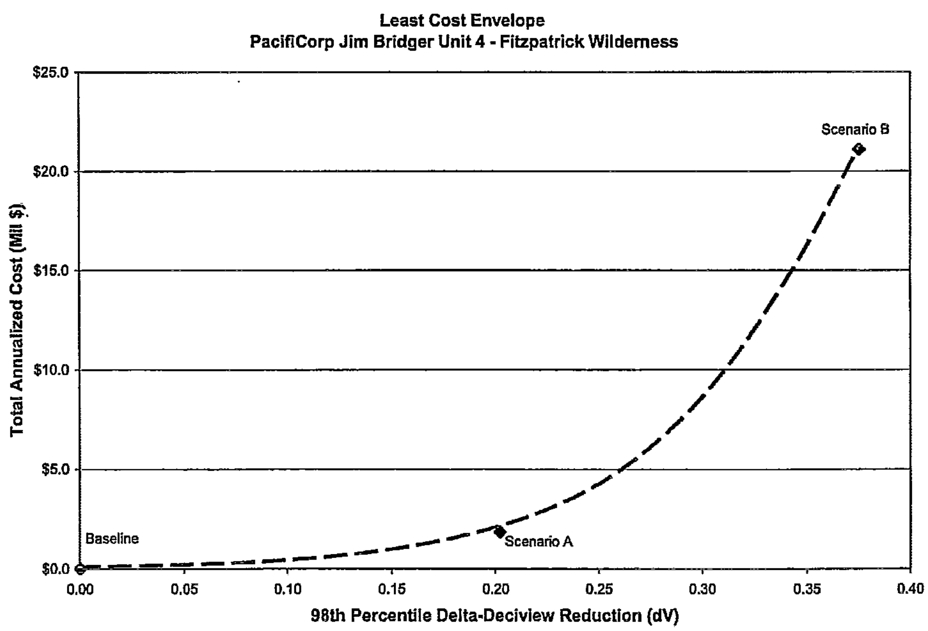

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FIGURE 5

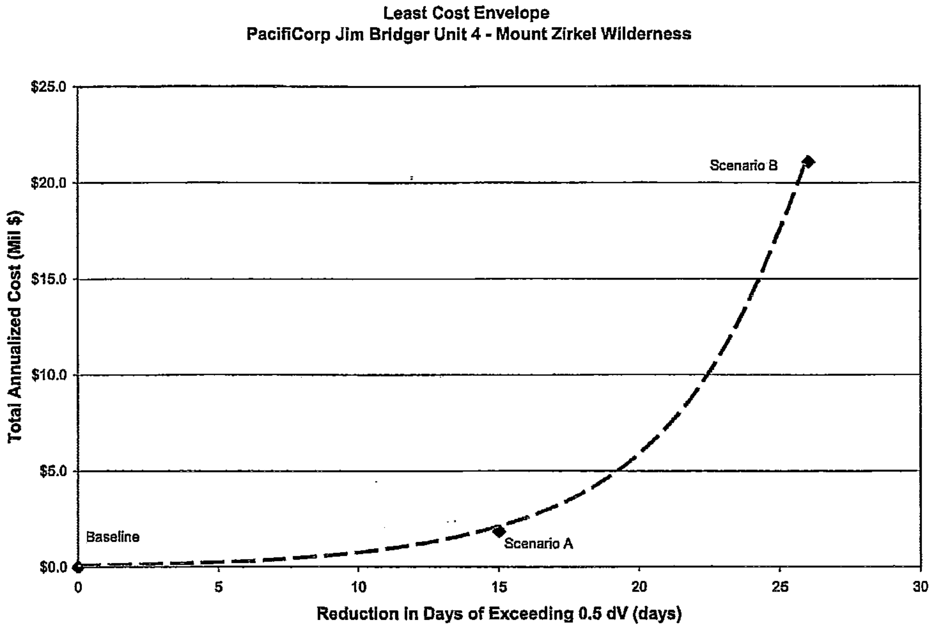
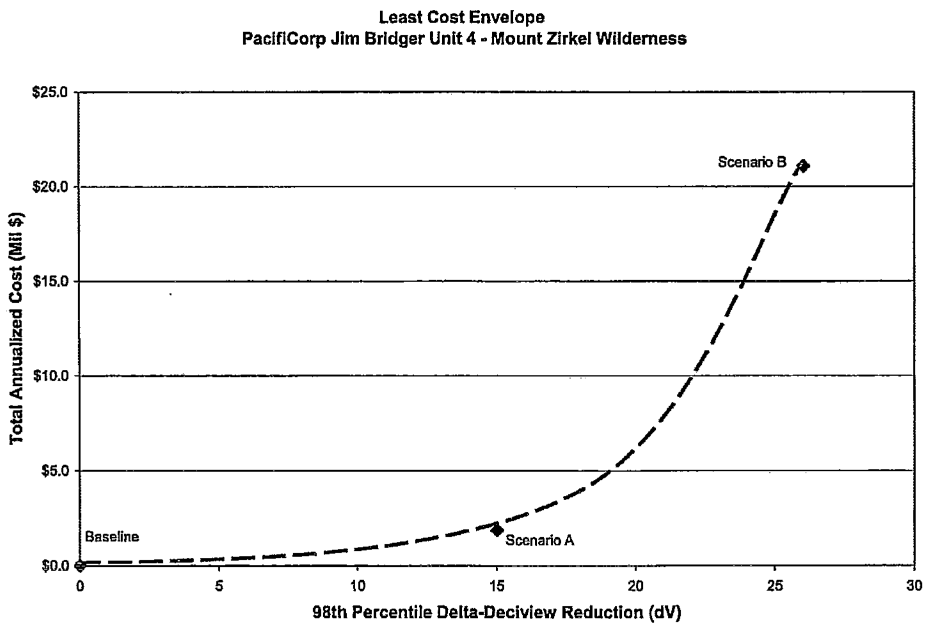


FIGURE 6



ATTACHMENT 1

Complete Economic Analyses for Scenarios A and B

ECONOMIC ANALYSIS SUMMARY - FIRST YEAR COSTS

Jim Bridger 4 — Boiler Design: Tangential fired PC

TYPE OF EMISSIONS CONTROLS		NO_x Control				SO_2 and PM Control			Scenario A	Scenario B
Technology Label	BASE	A	B	C	D	E	F	G	A+F	D+F
	Current Operation	Low NO_x Burners with Overfire Air	Rotating Overfire Air	Low NO_x Burners with Overfire Air and Non-Selective Catalytic Reduction	Low NO_x Burners with Overfire Air and Selective Catalytic Reduction	ESP w/ Gas Conditioning	Fabric Filter	Upgrade Wet FGD	LNB w/OFA, upgrade wet FGD, ESP w/ gas conditioning	LNB w/OFA, SCR, upgrade wet FGD, ESP w/ gas conditioning
ECONOMIC FACTORS										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20
CAPITAL INVESTMENT										
Total Installed Capital Costs ($)	$0	$11,300,000	$20,528,122	$22,127,239	$177,800,000	$0	$48,386,333	$1,600,000	$12,900,000	$179,400,000
FIRST YEAR DEBT SERVICE ($/Yr)	$0	$1,074,944	$1,952,796	$2,104,916	$16,913,727	$0	$4,602,887	$152,205	$1,227,149	$17,065,931
FIRST YEAR FIXED O&M Costs ($/Yr)										
Operating Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($/Yr)	$0	$28,000	$42,000	$123,000	$190,000	$0	$51,099	$25,500	$53,500	$215,500
Maintenance Labor ($/Yr)	$0	$42,000	$63,000	$184,500	$285,000	$0	$76,649	$17,033	$59,033	$302,033
Administrative Labor ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL FIRST YEAR FIXED O&M COST	$0	$70,000	$105,000	$307,500	$475,000	$0	$127,748	$42,533	$112,533	$517,533
FIRST YEAR VARIABLE O&M Costs ($/Yr)										
Makeup Water Costs ($/Yr)	$0	$0	$0	$0	$0	$0	$0	$15,539	$15,539	$15,539
Reagent Costs ($/Yr)	$0	$0	$0	$89,411	$1,020,310	$145,854	$0	$63,861	$209,715	$1,230,025
SCR Catalyst / FF Bag Costs ($/Yr)	$0	$0	$0	$0	$642,000	$0	$300,040	$0	$0	$642,000
Waste Disposal Costs ($/Yr)	$0	$0	$0	$0	$0	$0	#DIV/0!	$53,046	$53,046	$53,046
Electric Power Costs ($/Yr)	$0	$0	$2,526,822	$208,926	$1,324,512	$19,710	$1,336,338	$208,926	$228,636	$1,553,148
TOTAL FIRST YEAR VARIABLE O&M Costs ($/Yr)	$0	$0	$2,526,822	$298,337	$2,986,822	$165,564	#DIV/0!	$341,372	$506,936	$3,493,758
SUMMARY OF FIRST YEAR COSTS ($/Yr)										
First Year Debt Service ($/Yr)	$0	$1,074,944	$1,952,796	$2,104,916	$16,913,727	$0	$4,602,887	$152,205	$1,227,149	$17,065,931
First Year Fixed O&M Costs ($/Yr)	$0	$70,000	$105,000	$307,500	$475,000	$0	$127,748	$42,533	$112,533	$517,533
First Year Variable O&M Costs ($/Yr)	$0	$0	$2,526,822	$298,337	$2,986,822	$165,564	#DIV/0!	$341,372	$506,936	$3,493,758
Total First Year Costs ($/Yr)	$0	$1,144,944	$4,584,618	$2,710,753	$20,375,549	$165,564	#DIV/0!	$536,110	$1,846,618	$21,077,223
CONTROL COST COMPARISONS										
NO_x Technology Comparison										
Additional NO_x Removed From Base Case (Tons/Yr)	0	4,494	5,440	5,440	8,988					
First Year Average Control Cost ($/Ton NO_x Removed)	$0	$255	$843	$498	$2,267					
Technology Case Comparison		A-BASE	B-A	C-A	D-A					
Incremental NO_x Removed (Tons/Yr)	0	4,494	946	946	4,494					
Incremental Control Cost ($/Ton NO_x Removed)	$0	$255	$3,636	$1,655	$4,279					
SO_2 Technology Comparison	85.8%					85.8%	85.8%	87.5%		
Additional SO_2 Removed From Base Case (Tons/Yr)	0					0	0	473		
First Year Average Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	#DIV/0!	$1,133		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental SO_2 Removed (Tons/Yr)	0					0	0	473		
Incremental Control Cost ($/Ton SO_2 Removed)	$0					#DIV/0!	#DIV/0!	#DIV/0!		
PM Technology Comparison	0.0%									
Additional PM Removed From Base Case (Tons/Yr)	0					0	355	0		
First Year Average Control Cost ($/Ton PM Removed)	$0					#DIV/0!	#DIV/0!	#DIV/0!		
Technology Case Comparison						E-BASE	F-E	G-F		
Incremental PM Removed (Tons/Yr)	0					0	355	-355		
Incremental Control Cost ($/Ton PM Removed)	$0					#DIV/0!	#DIV/0!	#DIV/0!		
SCENARIO A AND B COMPARISONS							$0			
Additional NO_x, SO_2, & PM Removed From Base Case (Tons/Yr)	0								4,967	9,461
First Year Average Control Cost Compared to Base Case ($/Ton Removed)	$0								$372	$2,228
Incremental Tons Removed - Scenario B vs Scenario A (Tons/Yr)	0									4,494
Incremental Control Costs - Scenario B vs Scenario A ($/Ton Removed)	$0									$4,279

INPUT CALCULATIONS

Jim Bridger 4 — Boiler Design: Tangential fired PC

PARAMETER	Current Operation	NO$_x$ Control Technologies				SO$_2$ and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO$_x$ Emission Control System	LNCFS-1 & Windbox Mods.	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO$_2$ Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
General Plant Design and Operating Data										
Type of Unit	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
Annual Power Plant Capacity Factor	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Annual Operation (Hours/Year)	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884	7,884
Net Power Output (kW)	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000
Net Plant Heat Rate (Btu/kW-Hr)	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320	11,320
Boiler Heat Input, Measured by Fuel Input (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by Fuel Input (MMBtu/Year)	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846	47,300,846
Boiler Heat Input, Measured by CEM (MMBtu/Hr)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Annual Heat Input, Measured by CEM (MMBtu/Year)	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000	47,304,000
Plant Fuel Source										
Boiler Fuel Source	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground	Bridger Mine Underground
Coal Heating Value (Btu/Lb)	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660	9,660
Coal Sulfur Content (wt.%)	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%	0.580%	0.58%	0.58%
Coal Ash Content (wt.%)	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%	10.30%
Coal Flow Rate (Lb/Hr)	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077	621,077
Coal Consumed (Ton/Yr)	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284	2,448,284
Nitrogen Oxide Emissions										
NO$_x$ Emission Rate (Lb/MMBtu)	0.45	0.26	0.22	0.22	0.07				0.26	0.07
NO$_x$ Emission Rate (Lb/Hr)	2,700	1,560	1,320	1,320	420				1,560	420
NO$_x$ Emission Rate (Lb Moles/Hr)	89.97	51.98	43.99	43.99	14.00				51.98	14.00
NO$_x$ Emission Rate (Ton/Yr)	10,643	6,150	5,203	5,203	1,656				6,150	1,656
Add'l NO$_x$ Removed from Current Operations (Lb/Hr)	0	1,140	1,380	1,380	2,280				1,140	2,280
Add'l NO$_x$ Removed from Current Operations (Ton/Yr)	0	4,494	5,440	5,440	8,988				4,494	8,988
Sulfur Dioxide Emissions										
Uncontrolled SO$_2$ (Lb/MMBtu)	1.20					1.20	1.20	1.20	1.20	1.20
Uncontrolled SO$_2$ (Lb/Hr)	7,198					7,198	7,198	7,198	7,198	7,198
Uncontrolled SO$_2$ (Lb Moles/Hr)	112.35					112.35	112.35	112.35	112.35	112.35
Uncontrolled SO$_2$ (Tons/Yr)	28,374					28,374	28,374	28,374	28,374	28,374
Controlled SO$_2$ Emission Rate (Lb/MMBtu)	0.17					0.17	0.17	0.15	0.15	0.15
SO$_2$ Removal Efficiency (%)	85.8%					85.8%	85.8%	87.5%	87.5%	87.5%
Controlled SO$_2$ Emissions (Lb/Hr)	1,020					1,020	1,020	900	900	900
Controlled SO$_2$ Emissions (Ton/Yr)	4,021					4,021	4,021	3,548	3,548	3,548
SO$_2$ Removed (Lb/Hr)	6,178					6,178	6,178	6,298	6,298	6,298
SO$_2$ Removed (Ton/Yr)	24,353					24,353	24,353	24,826	24,826	24,826
Add'l SO$_2$ Removed from Current Operations (Lb/Hr)	0					0	0	120	120	120
Add'l SO$_2$ Removed from Current Operations (Ton/Yr)	0					0	0	473	473	473
Particulate Matter Emissions										
Uncontrolled Fly Ash (Lb/Hr)	51,177					51,177	51,177	51,177	51,177	51,177
Uncontrolled Fly Ash (Lb/MMBtu)	8.529					8.529	8.529	8.529	8.529	8.529
Uncontrolled Fly Ash (Tons/Yr)	201,739					201,739	201,739	201,739	201,739	201,739
Controlled Fly Ash Emission Rate (Lb/MMBtu)	0.030					0.030	0.015	0.030	0.030	0.030
Controlled Fly Ash Removal Efficiency (%)	99.6%					99.6%	99.8%	99.6%	99.6%	99.6%
Controlled Fly Ash Emissions (Lb/Hr)	180					180	90	180	180	180
Controlled Fly Ash Emissions (Ton/Yr)	710					710	355	710	710	710
Fly Ash Removed (Lb/Hr)	50,997					50,997	51,087	50,997	50,997	50,997
Fly Ash Removed (Ton/Yr)	201,029					201,029	201,384	201,029	201,029	201,029
Add'l Ash Removed from Current Operation (Lb/Hr)	0					0	90	0	0	0
Add'l Ash Removed from Current Operation (Ton/Yr)	0					0	355	0	0	0
Economic Factors										
Interest Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Discount Rate (%)	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%	7.10%
Plant Economic Life (Years)	20	20	20	20	20	20	20	20	20	20

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INPUT CALCULATIONS										
Jim Bridger 4	Boiler Design:	Tangential fired PC								
PARAMETER	Current Operation	NO_x Control Technologies				SO_2 and PM Control Technologies			Scenario A	Scenario B
Control Technologies										
NO_x Emission Control System	LNCFS-1 & Windbox Mods.	LNB w/OFA	ROFA	LNB w/OFA & SNCR	LNB w/OFA & SCR				LNB w/OFA	LNB w/OFA & SCR
SO_2 Emission Control System	Wet FGD					N/A	N/A	Upgrade Wet FGD	Upgrade Wet FGD	Upgrade Wet FGD
PM Emission Control System	ESP					ESP w/ Gas Conditioning	Fabric Filter	ESP	ESP w/ Gas Conditioning	ESP w/ Gas Conditioning
Installed Capital Costs										
NO_x Emission Control System ($2006)		$11,300,000	$20,528,122	$22,127,239	$177,800,000				$11,300,000	$177,800,000
SO_2 Emission Control System ($2006)						$0	$0	$1,600,000	$1,600,000	$1,600,000
PM Emission Control System ($2006)						$0	$48,386,333	$0	$0	$0
Total Emission Control System Capital Costs ($2006)		$11,300,000	$20,528,122	$22,127,239	$177,800,000	$0	$48,386,333	$1,600,000	$12,900,000	$179,400,000
NO_x Emission Control System ($/kW)		$21	$39	$42	$335				$21	$335
SO_2 Emission Control System ($/kW)								$3	$3	$3
PM Emission Control System ($/kW)							$91			
Total Emission Control Capital Costs ($/kW)		$21	$39	$42	$335		$91	$3	$24	$338
Fixed Operating & Maintenance Costs										
Operating Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Material ($)		$28,000	$42,000	$123,000	$190,000	$0	$51,099	$25,500	$53,500	$215,500
Maintenance Labor ($)		$42,000	$63,000	$184,500	$285,000	$0	$76,649	$17,033	$59,033	$302,033
Administrative Labor ($)		$0	$0	$0	$0	$0	$0	$0	$0	$0
Total 1st Fixed Year O&M Cost ($)		$70,000	$105,000	$307,500	$475,000	$0	$127,748	$42,533	$112,533	$517,533
Annual Fixed O&M Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Fixed O&M Cost ($/Yr)		$82,985	$124,478	$364,542	$563,114	$0	$151,446	$50,423	$133,408	$613,537
Variable Operating & Maintenance Costs										
Water Cost										
Makeup Water Usage (gpm)		0	0	0	0	0	0	27	27	27
Unit Price ($/1000 gallons)		$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22
First Year Water Cost ($)		$0	$0	$0	$0	$0	$0	$15,539	$15,539	$15,539
Annual Water Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Water Costs ($/Yr)		$0	$0	$0	$0	$0	$0	$18,422	$18,422	$18,422
Reagent Cost										
Type of Reagent		None	None	Urea	Anhydrous NH_3	Elemental Sulfur	none	Soda Ash	Soda Ash & Elemental Sulfur	Soda Ash, Elemental Sulfur, Anhydrous NH_3
Unit Cost ($/Ton)		$0.00		$370.00	$400.00	$370.00	$91.25	$80.00		
Unit Cost ($/Lb)		$0.000		$0.185	$0.200	$0.185	$0.046	$0.040		
Molar Stoichiometry		0.00		0.45	1.00	0.00	0.00	1.02		
Reagent Purity (Wt.%)		100%		100%	100%	100%	90%	100%		
Reagent Usage (Lb/Hr)				61	647	100	0	203		
First Year Reagent Cost ($)		$0		$89,411	$1,020,310	$145,854	$0	$63,861	$209,715	$1,230,025
Annual Reagent Cost Escalation Rate (%)		2.00%		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Reagent Costs ($/Yr)				$105,997	$1,209,580	$172,910	$0	$75,708	$248,618	$1,458,198
SCR Catalyst / Fabric Filter Bag Replacement Cost										
Material Replaced					SCR Catalyst		Bags		0	& SCR Catalyst
Annual SCR Catalyst (m3) / No. FF Bags					214		2,885			
SCR Catalyst ($/m3) / Bag Cost ($/ea.)					$3,000		$104			
First Year SCR Catalyst / Bag Replacement Cost ($)					$642,000		$300,040		$0	$642,000
Annual SCR Catalyst / Bag Cost Escalation Rate (%)					2.00%		2.00%		0%	2.00%
Levelized Catalyst/Fabric Filter Bag Costs ($/Yr)					$761,093		$355,698		$0	$761,093
FGD Waste Disposal Cost										
FGD Solid Waste Disposal Rate, Dry (Lb/Hr)						0	#DIV/0!	553	553	553
FGD Waste Disposal Unit Cost ($/Dry Ton)						$24.33	$24.33	$24.33	$24.33	$24.33
First Year FGD Waste Disposal Cost ($)						$0	#DIV/0!	$53,046	$53,046	$53,046
Annual Waste Disposal Cost Esc. Rate (%)						2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Waste Disposal Costs ($/Yr)						$0	#DIV/0!	$62,886	$62,886	$62,886
Auxiliary Power Cost										
Auxiliary Power Requirement (MW)		0.00	6.41	0.53	3.36	0.05	3.39	0.53	0.58	3.94
Auxiliary Power Requirement (% of Plant Output)		0.00%	1.21%	0.10%	0.63%	0.01%	0.64%	0.10%	0.11%	0.74%
Auxiliary Power Usage (MWh/Yr)		0	50,536	4,179	26,490	394	26,727	4,179	4,573	31,063
Unit Cost ($2006/MW-Hr)		$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00
First Year Auxiliary Power Cost ($)		$0	$2,526,822	$208,926	$1,324,512	$19,710	$1,336,338	$208,926	$228,636	$1,553,146
Annual Power Cost Escalation Rate (%)		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Levelized Auxiliary Power Costs ($/Yr)		$0	$2,995,555	$247,682	$1,570,213	$23,366	$1,584,233	$247,682	$271,049	$1,841,262

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