Appendix G

Supporting Documentation
for
Focused Feasibility Study

This page intentionally left blank

Contents

Section

Ground Water Models for Alternatives 3 and 4 ..... G1.0

Human Health Risk Assessment Calculations G2.0

Cost Analysis G3.0

This page intentionally left blank

Section G1.0

Ground Water Models for Alternatives 3 and 4

This page intentionally left blank

MMTS OU III Feasibility Study
Ground Water Modeling for Alternative 3: PRB Treatment

Objective

Evaluate the effect of the PRB on the flushing period of the alluvial aquifer assuming that the PRB is effective in removing uranium from ground water for separate periods of 3, 8, and 13 years, beginning October 2002. The flushing period for each treatment scenario defines the length of time required for uranium concentrations in the alluvial aquifer to decrease to less than 30 µg/L. The respective treatment periods will allow in-phase validation of the OU III model with the CERCLA 5-year review cycle.

Method

The baseline ground water model (see Section 3.0 of the RI), in which treatment by the PRB was not represented, is modified to simulate uranium removal from groundwater as it passes through the PRB (active treatment period). A second simulation is then represents the subsequent period of no treatment by the PRB. In the first simulation, a specified concentration boundary is applied at the PRB. Removing the boundary specification and specifying the predicted concentrations at the end of the first simulation as the new starting condition represent the inactive period. The cumulative time simulated in the two models is 50 years (length of active period plus length of inactive period). The combined results of the two models represent the net effect of PRB treatment on the flushing period of the alluvial aquifer. Details and assumptions of the PRB treatment models are:

- The initial model represents active treatment by the PRB through 50 years of simulation. The starting concentrations of uranium in ground water in this model are those as observed in October 2002, and are the same used in the baseline model. Removal of uranium from ground water flowing through the PRB is simulated by a concentration boundary applied to the PRB. Solute is removed from the model at the influent concentration to that boundary. Solute is simultaneously introduced from the same boundary at a specified concentration. In this model, the source concentration is 5 µg/L, which is the assumed concentration to which the PRB removes uranium. The concentration boundary has no effect on ground water flow. Except for the specified concentration boundary, this model is identical to the OU III baseline model.

- Separate models simulate inactive periods of 47, 42, and 37 years, starting at model time t = 0 years. There is no concentration boundary specification for the PRB in these models. The starting concentrations in groundwater in these models are the predicted concentrations at the end of 3, 8, and 13 years, respectively, from the active treatment model. The cumulative simulated time in the inactive period models is equal to model time plus the length of the preceding active period.

- In the inactive period models, the concentration of uranium entering the model from the concentration boundary at Wetland 3 is normalized to cumulative simulated time. The start of the inactive periods (model time t = 0) corresponds to 3, 8, and 13 years of cumulative model time; therefore, Wetland 3 source concentrations at the start of the inactive periods are respectively equivalent to those at the end of 3, 8, and 13 years in the active period model.

- Ground water flow is simulated as steady state and is identical to the flow predicted by the OU III baseline model.

- Treatment efficiency of the PRB is assumed constant through the active period.

Results and Discussion

Figures 1 through 6 illustrate uranium concentrations in ground water at times of 0, 3, 8, 13, and 25 years in the active period model (Figure 2 is a close-up view of Figure 1 in the area of the PRB). Concentration contours in the figures are 30, 100, 200, 500, and 800 µg/L; colors range from violet and blue at lower concentrations through green, yellow, and orange at higher values. Whitened areas signify concentrations less than 30 µg/L. Treated ground water is indicated by the white zone directly downgradient of the PRB. Dry cells are olive-colored and inactive regions of the model are black. Model results are summarized as follows:

- Active treatment for 3 years decreased the flushing period by 1 year relative to the baseline model (Figure 7). Increasing the active period to 8 years results in a net decrease in the flushing period for the alluvial aquifer of 2 years. No additional decrease resulted from 13 years of active treatment.

- Figures 8 and 9 illustrate the uranium plume after 13 and 25 years of active treatment, respectively. The plumes are similar to those predicted at corresponding times with active PRB treatment (Figures 5 and 6) and therefore the flushing periods with and without treatment are nearly equal.

- Greater treatment periods than about 8 years have no effect on the flushing period (Figure 7) because by then the bulk of the uranium plume migrates downgradient of the PRB.

- The sensitivity of the flushing period to PRB treatment is minor because the most contaminated ground water at the site, located near the south end of the south slurry wall (Figures 1 and 2), bypasses the PRB. Transport of this contaminant mass ultimately determines the flushing period of the alluvial aquifer. Figures 10 and 11 illustrate progressive dilution as this mass migrates east and mixes with effluent of the PRB. The high-concentration mass reaches well P92-06 prior to significant mixing with uncontaminated effluent of the PRB, such as results in the decreased concentrations at well 92-09 (Figure 11).

Figure 1. Starting concentrations of uranium in ground water

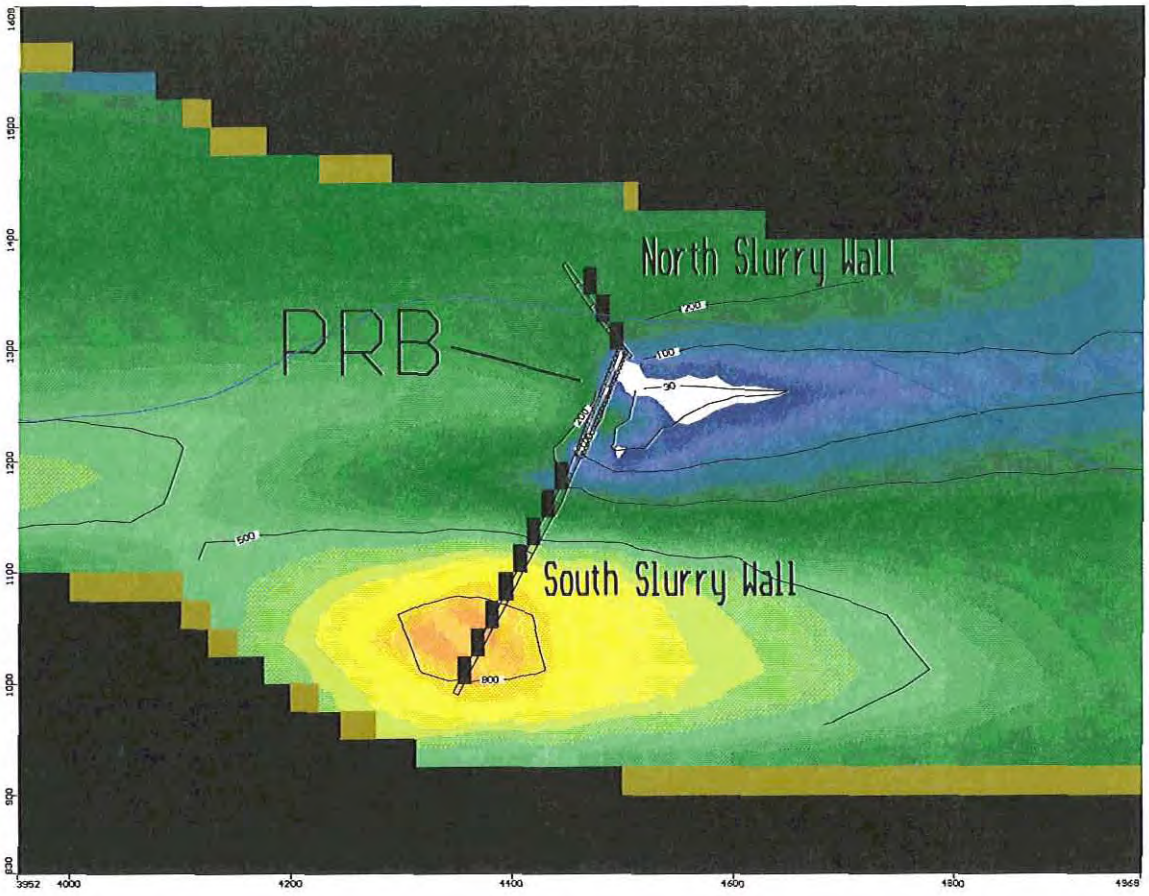

Figure 2. Starting concentrations of uranium in ground water near PRB

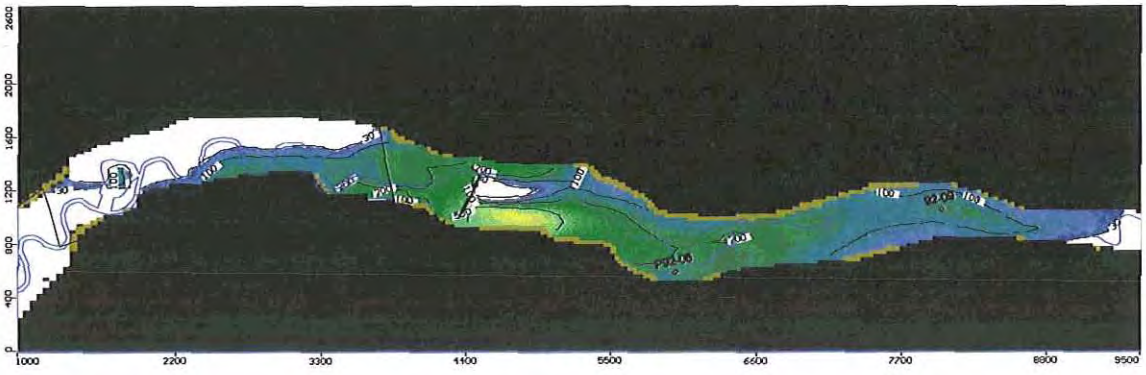

Figure 3. Concentrations of uranium in ground water after 3 years of PRB treatment

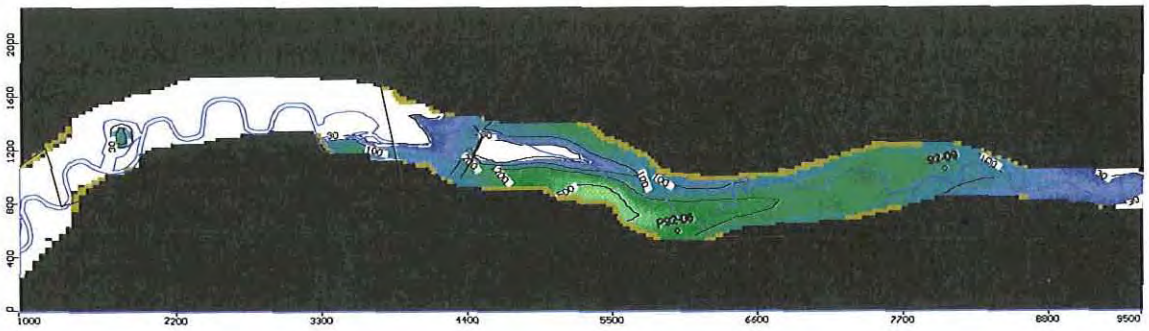

Figure 4. Concentrations of uranium in ground water after 8 years of PRB treatment

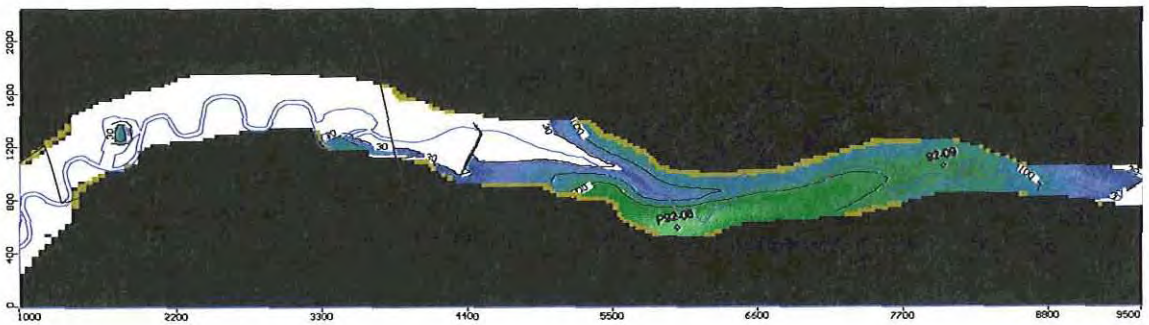

Figure 5. Concentrations of uranium in ground water after 13 years of PRB treatment

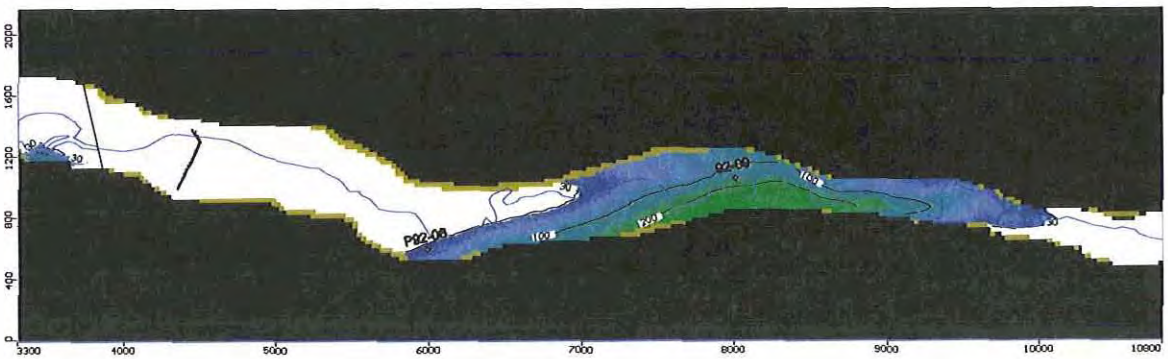

Figure 6. Concentrations of uranium in ground water after 25 years of PRB treatment

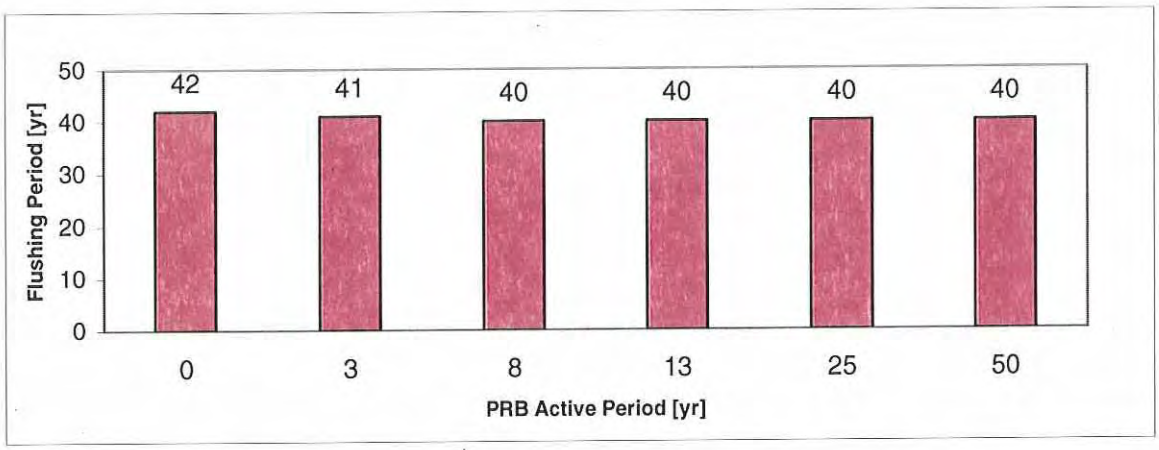

Figure 7. Effect of PRB treatment period on aquifer flushing

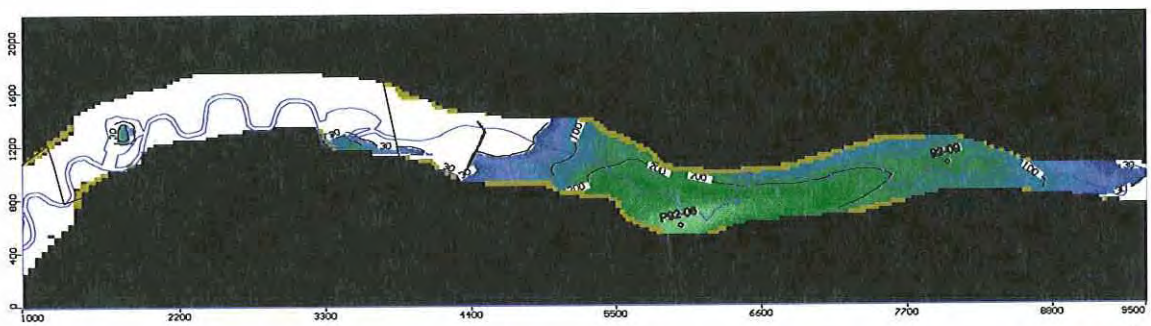

Figure 8. Concentrations of uranium in ground water after 13 years with no PRB treatment

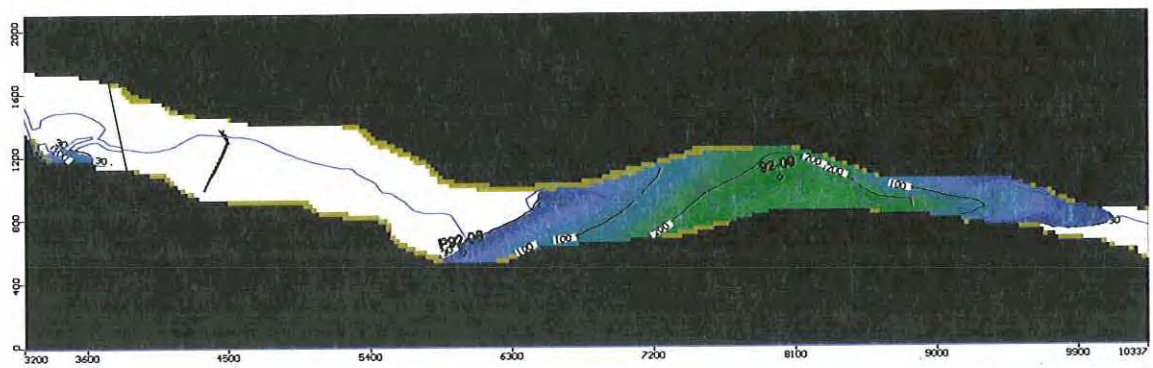

Figure 9. Concentrations of uranium in ground water after 25 years with no PRB treatment

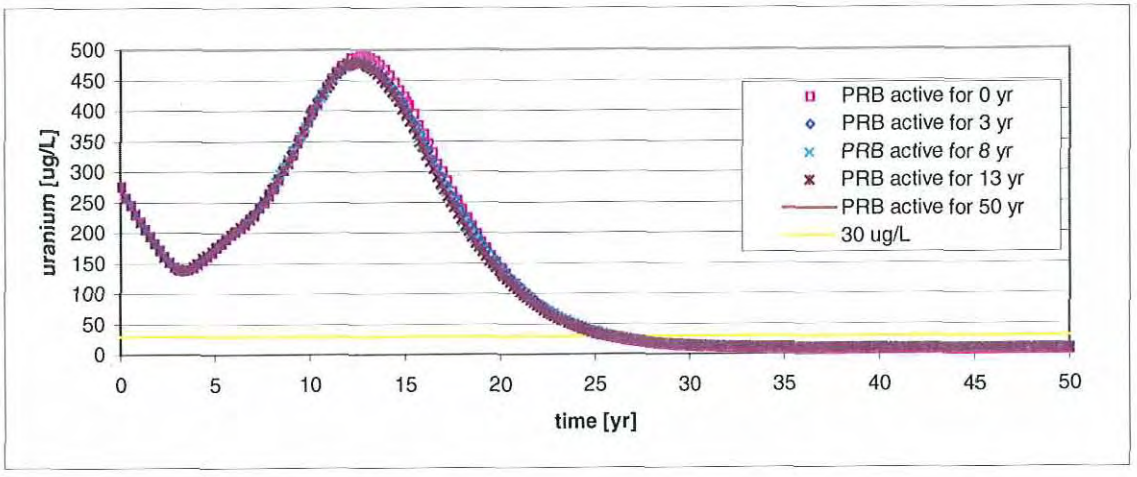

Figure 10. Predicted uranium concentrations at well P92-06 for various periods of PRB treatment; time t=0 is October 2002

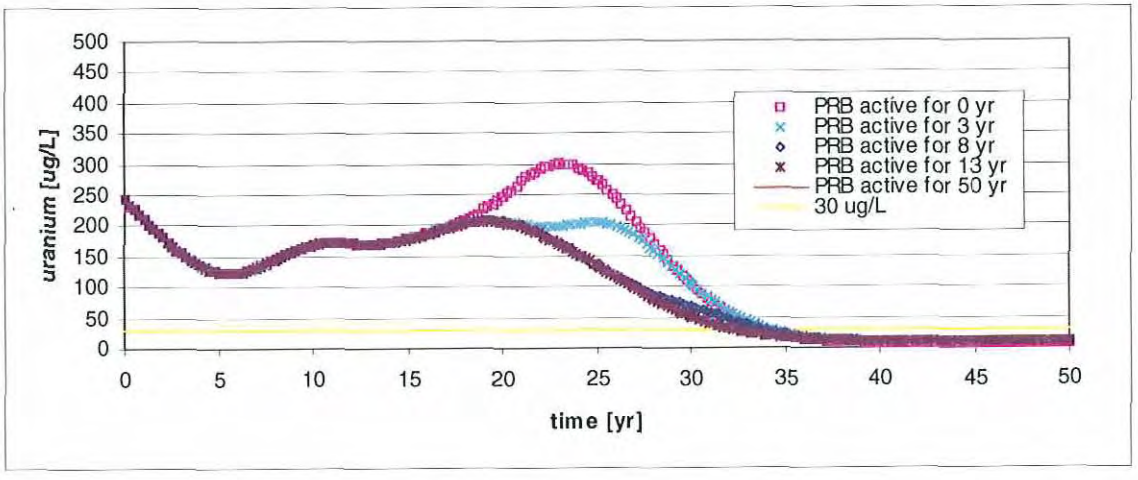

Figure 11. Predicted uranium concentrations at well 92-09 for various periods of PRB treatment; time t=0 is October 2002

MMTS OU III Feasibility Study
Ground Water Modeling for Alternative 4: PRB with Enhancements

Objective

Evaluate the effect on the flushing period of the alluvial aquifer assuming that the PRB is modified to decrease the quantity of untreated ground water that flows around the end of the south slurry wall (Figure 12). Two modifications to the existing system are evaluated: 1) ground water extraction at the point of bypass and treatment at the existing PRB, and 2) emplace reactive media and treat ground water at the point of bypass. The flushing period for each treatment scenario defines the length of time required for uranium concentrations in the alluvial aquifer to decrease to less than 30 µg/L.

Method

The baseline ground water model (Section 3.0 of the RI) is first modified, in an identical manner as the active treatment period model for Alternative 3, to simulate uranium removal from groundwater as it passes through the PRB. Different boundaries are then applied in separate copies of the model to represent the respective treatment enhancements. Starting concentrations in each enhancement model are specified as those predicted at the end of two years of active treatment in Alternative 3, which used initial concentrations as observed in October 2002. The enhancement models simulate 48 years of transport beginning October 2004.

In each enhancement model, the concentration of uranium entering the model from the concentration boundary at Wetland 3 is modified to account for two years of elapsed time from the starting condition represented in the baseline model. Also, the specified concentration boundary representing uranium removal at the PRB is applied to each enhancement model and remains constant throughout the simulation.

No-enhancement Alternative. Removal of uranium from ground water flowing through the PRB is simulated by a specified concentration boundary applied to the PRB. Solute is removed at the influent concentration to that boundary. Solute is simultaneously introduced from the same boundary at a specified concentration. In this model, the specified concentration is 5 µg/L, which is the assumed concentration to which the PRB removes uranium. The specification remains constant in this model throughout 50 years of simulated time. The concentration boundary has no effect on ground water flow. Except for the specified concentration boundary, this model is identical to the OU III baseline model. It is also the same model used in the FS to evaluate the effects of various PRB treatment periods without enhancement.

Option 1: Pump and Treat Technology. A hydrologic sink (drain boundary) is applied at the end of the south slurry wall to simulate ground water extraction by pumping wells. An equal amount of water captured by the drain is applied to the PRB through a general head boundary (GHB) (Figure 13). The GHB represents inflow to the PRB from the extraction wells in the bypass zone.

Option 2: In-situ Treatment Technology. In-situ passive treatment is simulated by a specified concentration boundary applied to the end of the south slurry wall (Figure 14). Uranium is removed from the model at the influent concentration to the boundary without altering the flow dynamics. The concentration of uranium exiting the boundary is 5 µg/L. The boundary was specified in separate model runs to simulate partial and total treatment of ground water flow

through the bypass zone. The boundary shown in Figure 14 completely spans the bypass zone and thus represents one-hundred percent treatment efficiency.

Results and Discussion

Uranium concentrations in the no-enhancement model are shown in Figures 15 through 18 for simulated times of 0, 3, 8, and 13 years since October 2002. Concentration contours in these and subsequent figures are 30, 100, 200, 500, and 800 μg/L; colors range from violet and blue at lower concentrations through green, yellow, and orange at higher values. Whitened areas signify concentrations less than 30 μg/L. Treated ground water is indicated by the white zone directly downgradient of the PRB. Dry cells are olive-colored and inactive regions of the model are black. The flushing period for this model is 40 years.

Option 1

Applying the drain boundary increases the flow to the south bypass zone from about 3.2 gpm to 4.2 gpm. There is a corresponding reduction in flow to the PRB. Outflow from the model at the drain boundary (2 gpm) is balanced by 2 gpm of inflow to the PRB from the GHB. Approximately fifty-percent of the water that enters the bypass zone is captured, and the total flow through the PRB increases from 6.3 gpm in the baseline model to 7.3 gpm. Hydraulic heads are predicted to increase at the PRB by 0.3 ft as result of the additional inflow. The drain boundary results in local lowering of hydraulic head by about 0.8 ft.

Results of the uranium transport simulation for the pump and treat enhancement alternative are shown at cumulative model times of 3, 8, and 13 yrs in Figures 19 through 21, respectively. In comparison to the no-enhancement model, the effect of the enhancement is noted in these figures as the localized areas of lower concentration at the bypass zone and PRB. The flushing period for this model is 39 years, which is approximately equivalent to the flushing period without any enhancement to the PRB, assuming that the PRB remains effective for about 10 years.

Option 2

There are three model cells that span the south bypass zone. In Figure 14, each cell across the bypass zone is a specified concentration boundary. This specification represents 100% treatment of the flow through the bypass zone. Two other simulations were performed in which the specified concentration boundary was applied to only the center cell and the northern cell in the bypass zone. Water budget analysis indicates that the quantity of flow through these cells is 1.1 gpm, and 2 gpm, respectively. Total flow through the bypass zone in the model is 3.2 gpm, and therefore these two latter simulations represent treatment of 34% and 63% of the bypass flow.

Results of the uranium transport simulation for the in-situ enhancement alternative with 100% treatment are shown at cumulative model times of 3, 8, and 13 yrs, in Figures 22 through 24, respectively. The flushing period for this model is 37 years. The flushing period with 34% and 63% treatment is 38 and 37.5 years, respectively. If the PRB remains effective for about 10 years and an in-situ enhancement is 50% efficient, the aquifer flushing period (about 38 years) is 5% less than without an enhancement.

Summary

- Operation of the PRB with or without enhancements for more than about 10 years provides no additional reduction in the aquifer flushing period because by then the uranium plume will have migrated downgradient of the PRB.

- Effects of PRB enhancements on the flushing period are summarized in Table 1 and Figure 25.

Table 1. Summary of PRB Enhancement Effects

Enhancement Alternative	Flushing Period (years)	Reduction in flushing period (percent)
PRB treatment with no enhancement	40	Not applicable
Pump and treat enhancement (50% capture)	39	2.5%
In-situ treatment enhancement (100% efficient)	37	7.5%
In-situ treatment enhancement (50% efficient)	38	5%

- The flushing period is not very sensitive to the remedial options evaluated because the mass of contaminated ground water that ultimately determines the flushing period is downgradient of the PRB and beyond the influence of the enhancements when they become operational.

- The effects of the PRB and the enhancements on the uranium concentrations at well 92-09 are shown in Figure 26. Concentrations at that location are used in calculating future potential risk to human health (Sections 4.0 and 5.0).

- The models do not address a low-conductivity interface that may be present at the upgradient and downgradient edges of the PRB (DOE 2002). A comprehensive analysis of any enhancement that increases flow to the current PRB should determine if the inflow and outflow boundaries of the PRB are sufficiently conductive to transmit the added flow.

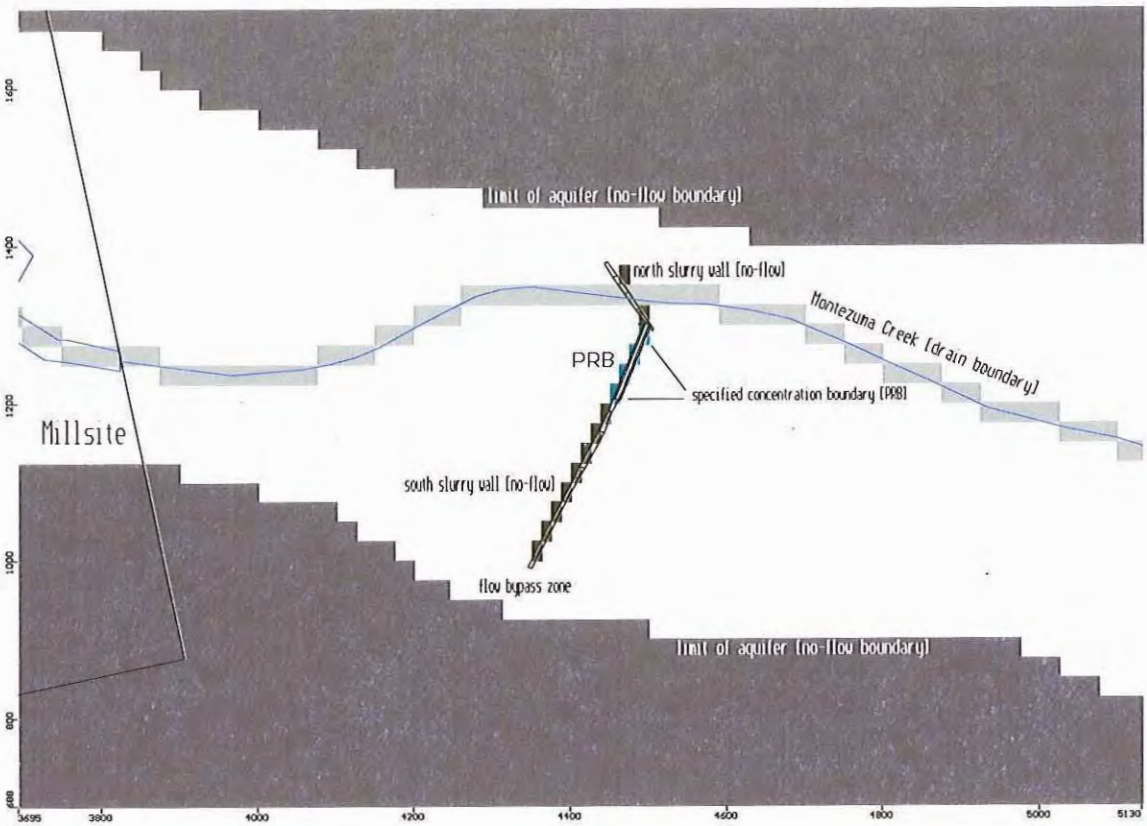

Figure 12. Ground water model boundaries in the PRB area, no PRB enhancements

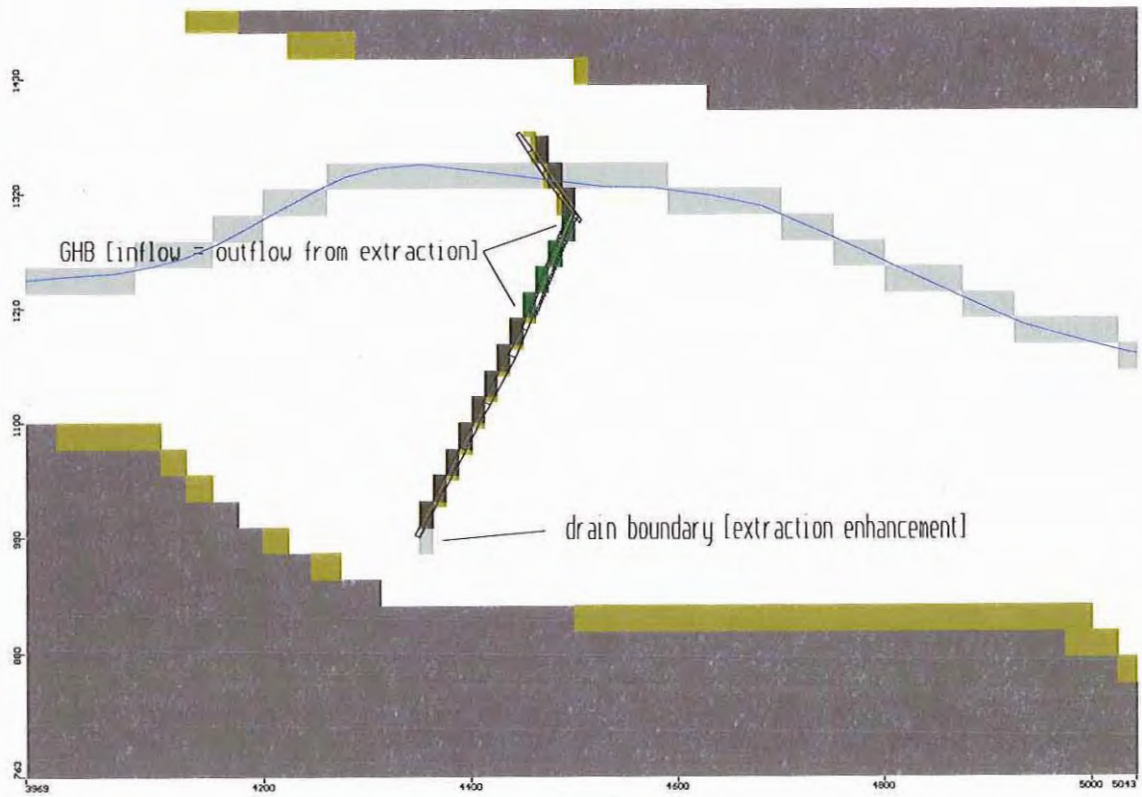

Figure 13. Model boundaries for pump and treat enhancement

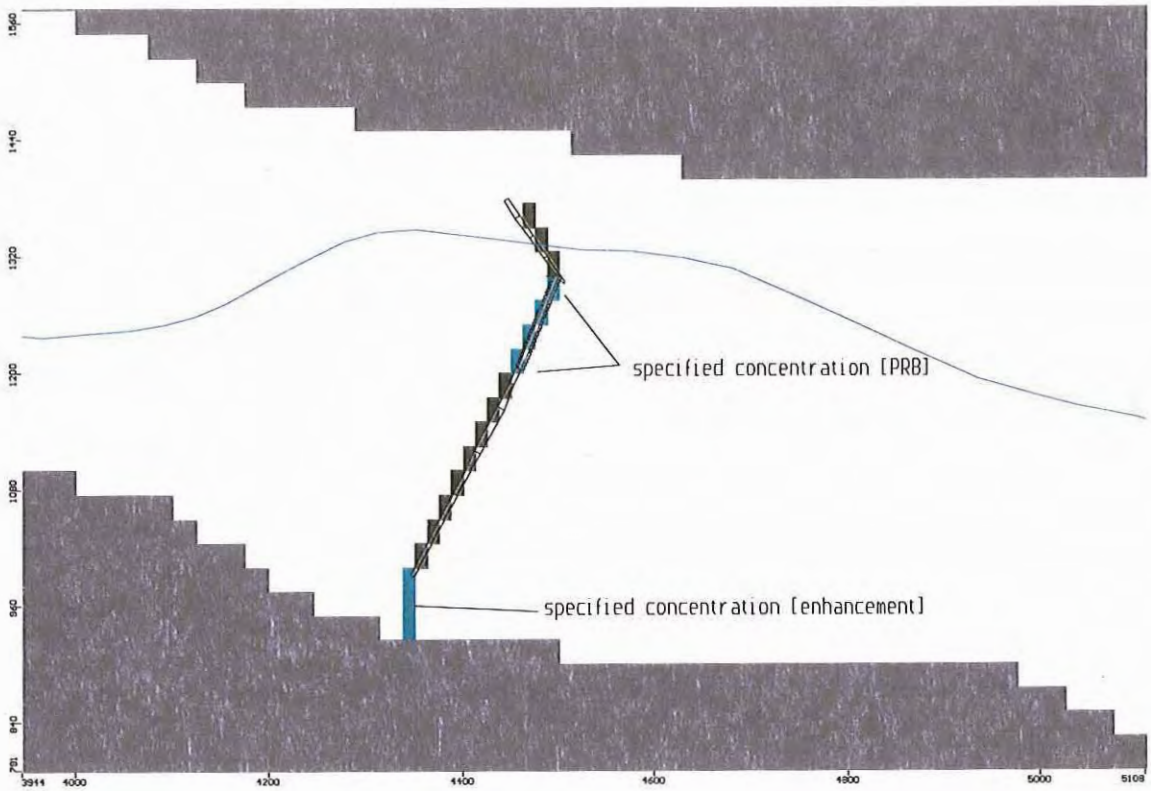

Figure 14. Model boundaries for in-situ treatment enhancement

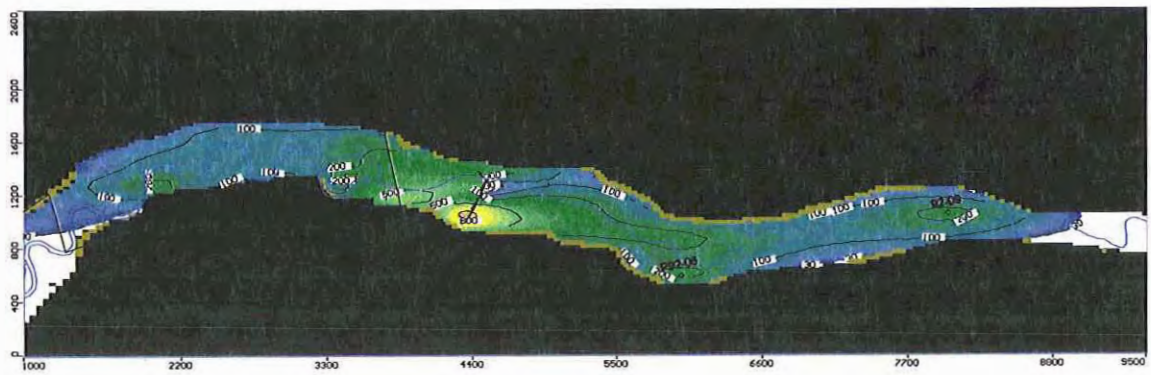

Figure 15. Initial uranium concentrations in ground water, October 2002. Model time t = 0

Figure 16. Uranium concentrations after 3 years of PRB operation, no enhancement

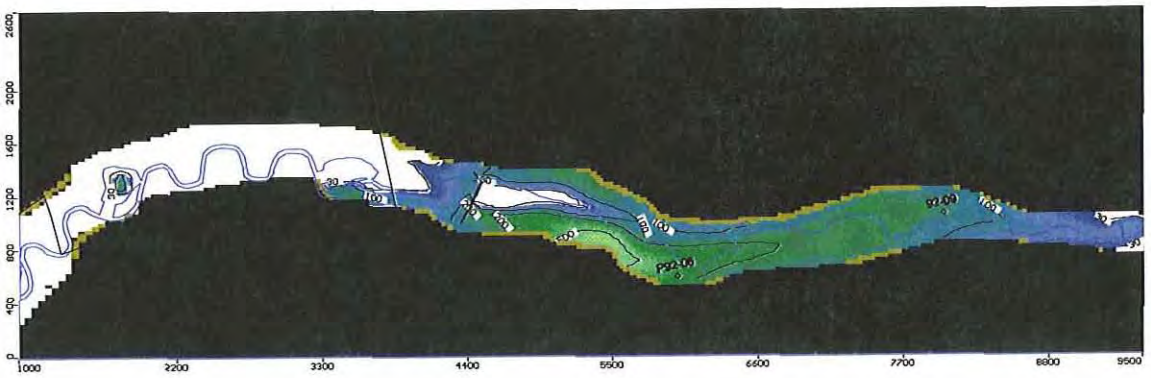

Figure 17. Uranium concentrations after 8 years of PRB operation, no enhancement

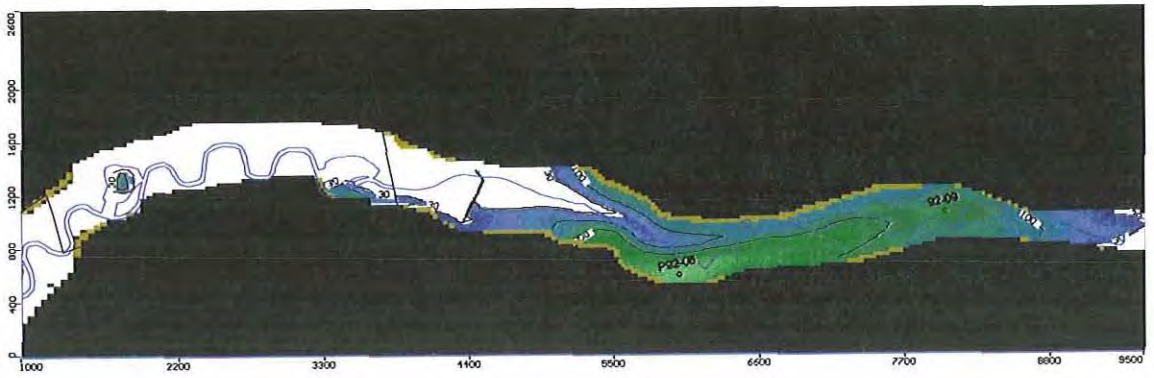

Figure 18. Uranium concentrations after 13 years of PRB operation, no enhancement

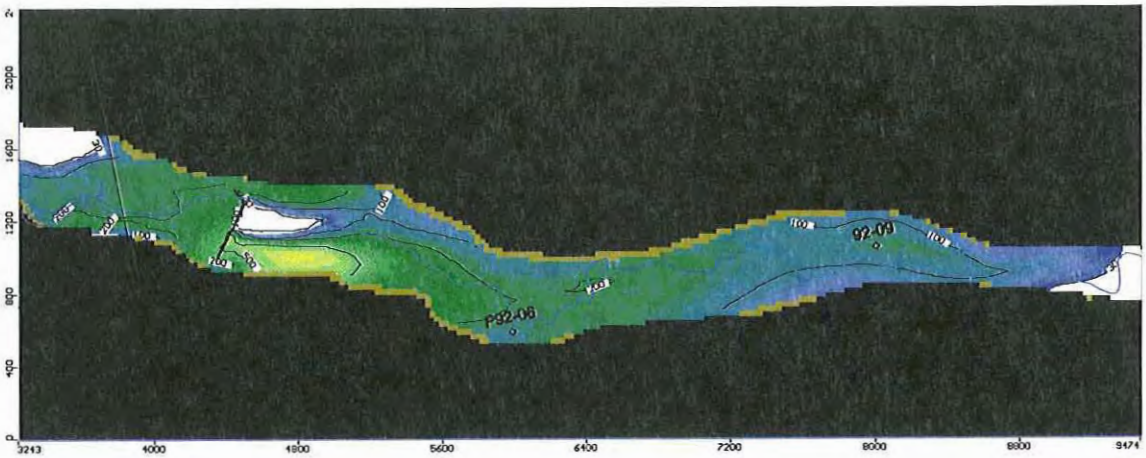

Figure 19. Uranium concentrations after 3 years of PRB operation and 1 year of pump and treat enhancement

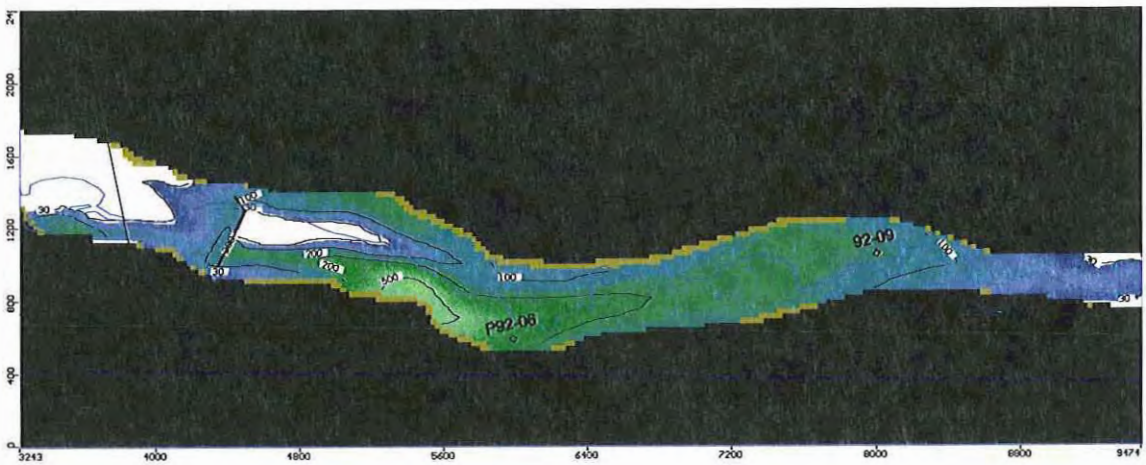

Figure 20. Uranium concentrations after 8 years of PRB operation and 6 years of pump and treat enhancement

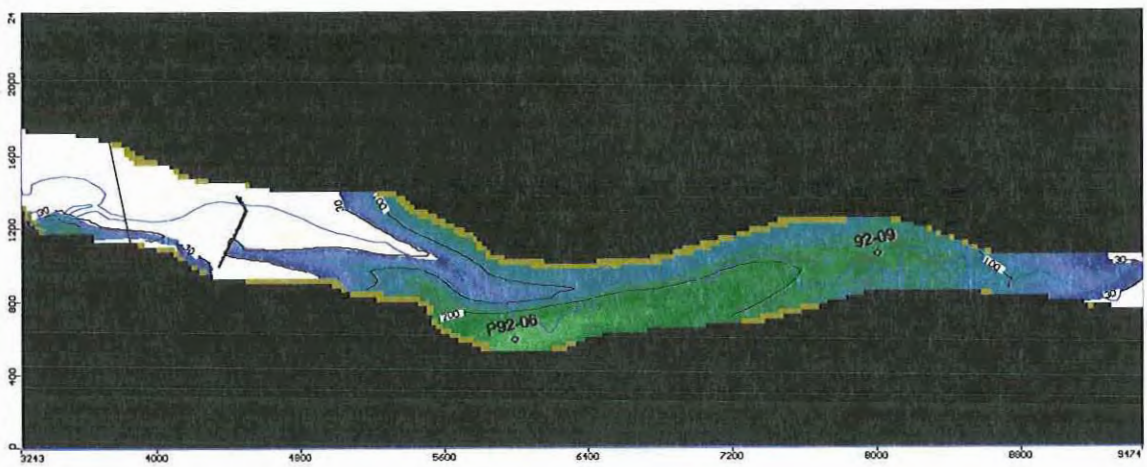

Figure 21. Uranium concentrations after 13 years of PRB operation and 11 years of pump and treat enhancement

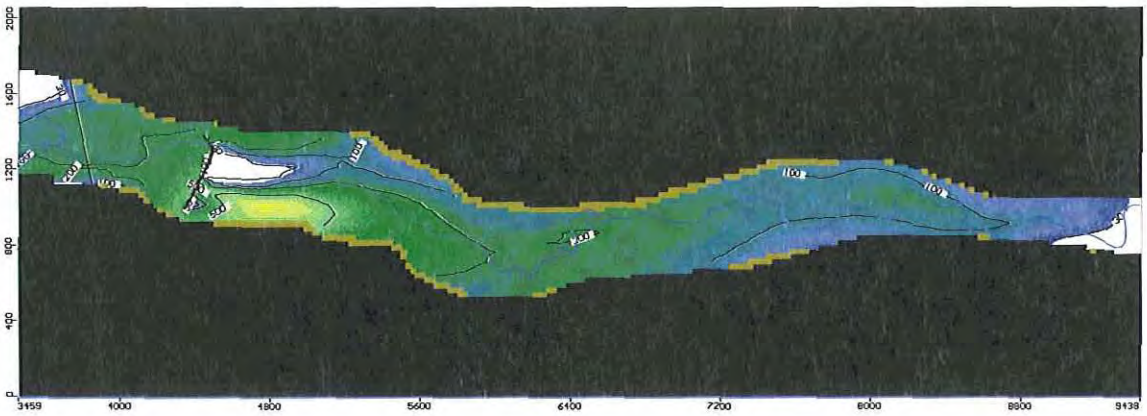

Figure 22. Uranium concentrations after 3 years of PRB operation and 1 year of in-situ treatment enhancement, 63% treatment efficiency

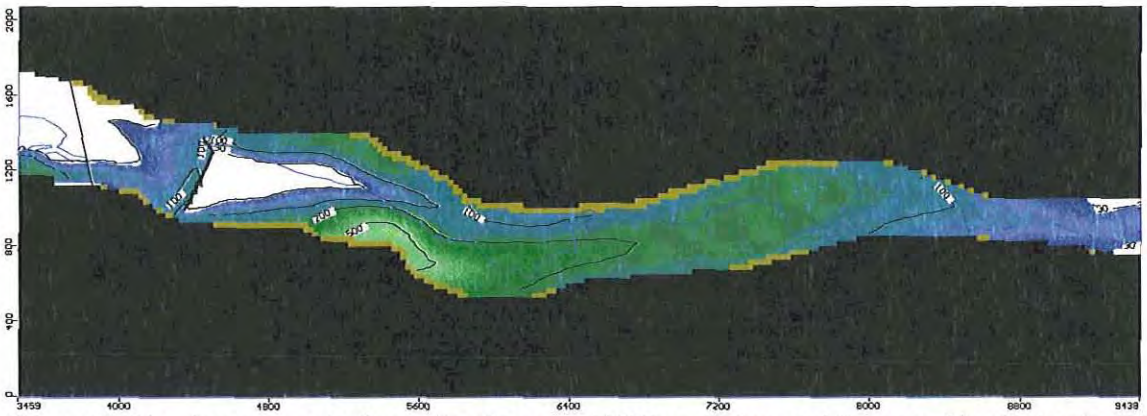

Figure 23. Uranium concentrations after 8 years of PRB operation and 6 years of in-situ treatment enhancement, 63% treatment efficiency

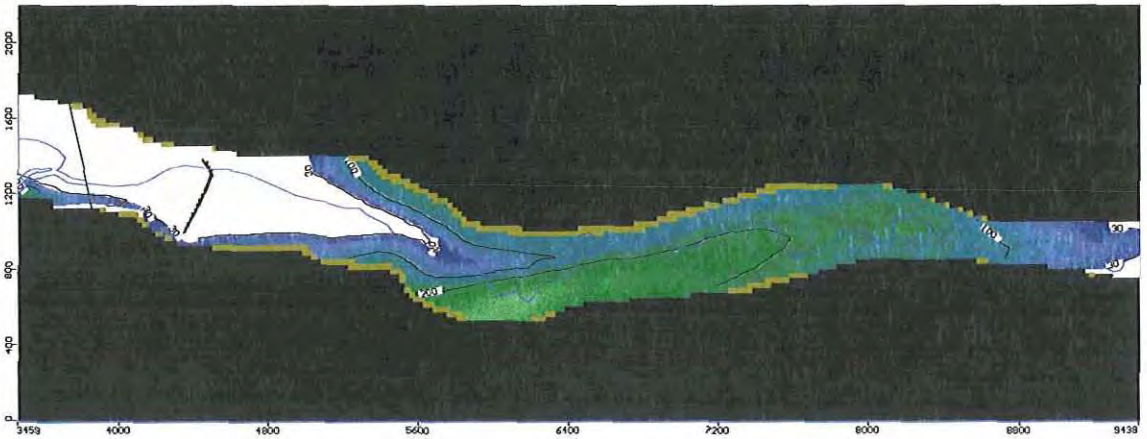

Figure 24. Uranium concentrations after 13 years of PRB operation and 11 years of in-situ treatment enhancement, 63% treatment efficiency

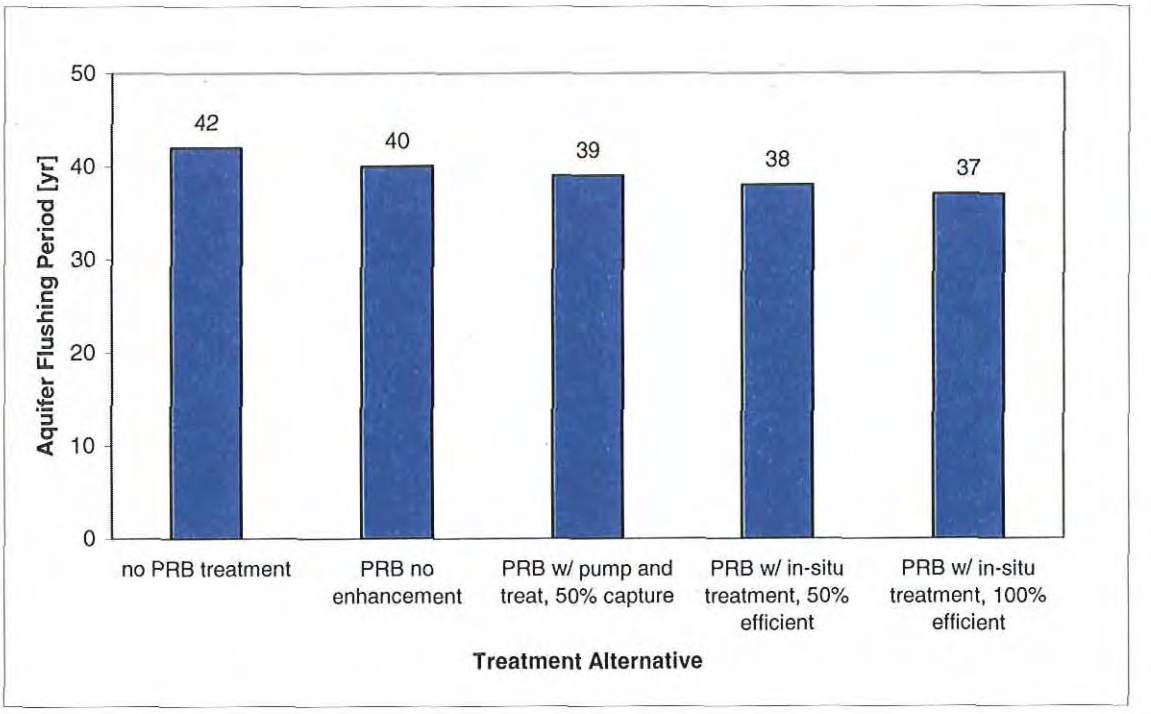

Figure 25. Effects of enhancements on flushing period

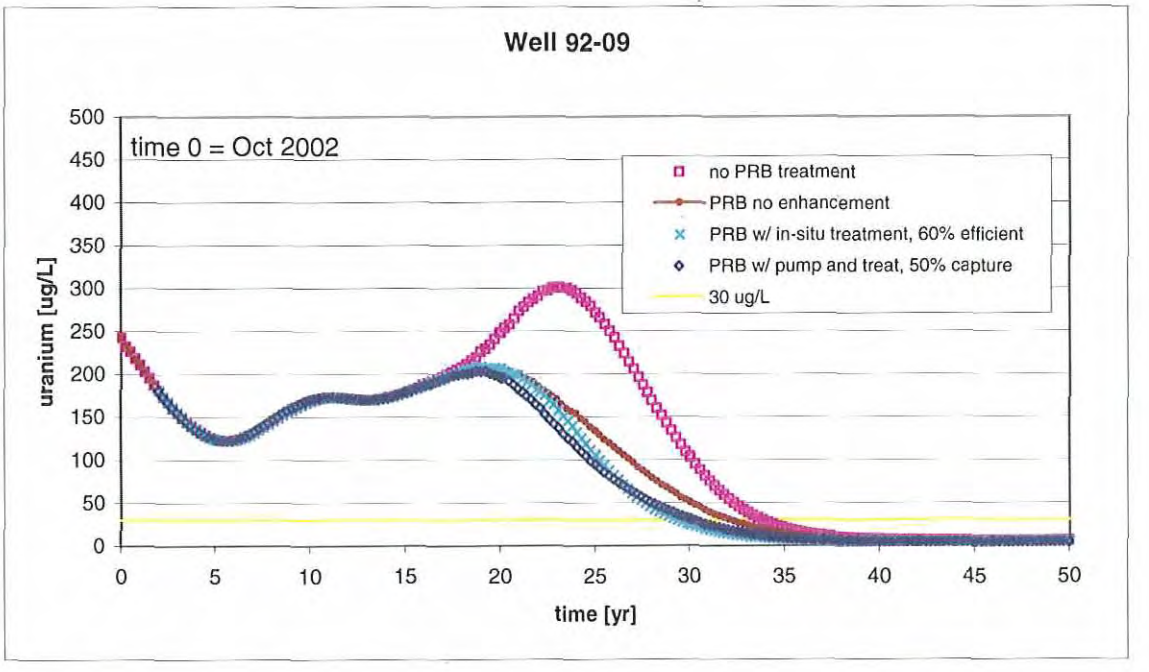

Figure 26. Effect of enhancements on uranium concentration at well 92-09

End of current text

Section G2.0

Human Health Risk Assessment Calculations

This page intentionally left blank

Input on the Monticello FS on Risk Issues

Changes in potential risks to human health were used to compare the four alternatives. Risk estimates for the future residential scenario (worst case) were modified by using data from different locations in the aquifer and predicted concentrations for uranium using the site groundwater model. Three timeframes were evaluated: Year 0 (current), Year 20, and Year 40. Risks for Year 0 were estimated from COC concentrations in well 92-11 from October 2002. Risk estimates for Year 20 and 40 were based on current concentrations in well 92-09 for all COCs except uranium. Uranium concentrations were based on the modeled results at well 92-09 for the referenced timeframes.

The risk assessment (Section 4.1 of the RI) provides different indicators of risk. Risks are presented for added cancer risks for non radionuclides (chemical) and Radionuclides, noncarcinogenic risks (presented as a hazard index), and dose. The only non radionuclide carcinogenic COC at the site is arsenic; therefore, all the risks within this category are from arsenic. Added cancer risks from Radionuclides are from the isotopes of uranium (uranium-244, uranium-235, and uranium-238) and external gamma radiation. Noncarcinogenic risks occurred from arsenic, manganese, molybdenum, nitrate, selenium, uranium, and vanadium. The dose assessment is based on the isotopes of uranium. These risks categories are indicators of risk based on the mechanism and anticipated effect and cannot be combined. Please note that some contaminants (e. g., arsenic) can cause multiple impacts and are therefore included in more than one category.

Uranium is the risk driver for the site. The highest cancer risks occur from Radionuclides, with uranium contributing most of this risk. The dose assessment was based entirely on the isotopes of uranium and uranium contributes the most risk (nearly 40 percent) to the hazard index.

Tables A and B present a comparison of the estimated risks for each risk category for the four alternatives for Year 0, Year 20, and Year 40; Table A is for risks estimated using central tendency (CT) exposure assumptions, and Table B is based on reasonable maximum exposure (RME) assumptions. These tables show a significant reduction in risks for all the alternatives by Year 40. Using CT assumptions, all risk categories are within or below established benchmarks by Year 40. In addition, all the alternatives, including the no action and natural attenuation show similar reductions in risk by the end of the evaluated timeframe.

Since added cancer risk from Radionuclides exceeds the EPA risk range using current concentrations and RME exposure assumptions, this was used to further evaluate the risk reductions from the alternatives. Tables C and D show the expected risk reductions and percent reductions for this category compared to the current estimates (Year 0) using RME and CT exposure assumptions, respectively. Risk reductions are essentially the same for all alternatives at Year 40. RME and CT risks are reduced by approximately 70 and 80 percent, respectively.

Table A. Comparison of Human Heath Risks for Various Alternatives at Monticello Based on RME Exposure Assumptions for the Future Residential Scenario

	Year 0				Year 20				Year 40			
	Added Cancer		Noncarcinogens	Dose	Added Cancer		Noncarcinogens	Dose	Added Cancer		Noncarcinogens	Dose
Alternative	Nonrad	Rad			Nonrad	Rad			Nonrad	Rad		
1 and 2	3.50E-04	4.70E-04	8.7	45.7	3.40E-05	4.00E-04	3.3	37.1	3.40E-05	1.40E-04	0.6	6.5
3	3.50E-04	4.70E-04	8.7	45.7	3.40E-05	3.50E-04	2.8	31.4	3.40E-05	1.40E-04	0.7	6.8
4 (Option 1)	3.50E-04	4.70E-04	8.7	45.7	3.40E-05	3.50E-04	2.8	31.7	3.40E-05	1.40E-04	0.6	6.2
4 (Option 2)	3.50E-04	4.70E-04	8.7	45.7	3.40E-05	3.40E-04	2.7	30.2	3.40E-05	1.40E-04	0.6	6.2

Notes:

Alternatives 1 and 2 are no action and natural flushing; both involve no additional treatment activities so risks are identical

Alternative 3 includes the PRB without enhancements

Alternative 4 (Option 1) is the PRB with a pump and treat enhancement

Alternative 4 (Option 2) is the PRB with a in-situ treatment enhancement

Year 0 case is based on current (October 2002) concentrations in Well 92-11 for all COCs

Year 20 and Year 40 case assumes current concentrations in Well 92-09 for all COCs except Uranium. Uranium concentrations are based on modeled results for Well 92-09 for the referenced timeframes. The following U (ug/l) results from the model were used:

Alternative	20 year	40 Year
1 and 2	249	7.4
3	204.2	10.2
4 (Option 2)	194.7	5

Cancer risks are expressed as a unitless probability, Noncarcinogens are given as a hazard index (unitless), and dose is in units of mrem/yr.

Table B. Comparison of Human Heath Risks for Various Alternatives at Monticello Based on Central Tendency Exposure Assumptions for the Future Residential Scenario

	Year 0				Year 20				Year 40			
	Added Cancer		Noncarcinogens	Dose	Added Cancer		Noncarcinogens	Dose	Added Cancer		Noncarcinogens	Dose
Alternative	Nonrad	Rad			Nonrad	Rad			Nonrad	Rad		
1 and 2	5.70E-05	7.90E-05	4.8	27.9	5.50E-06	6.40E-05	1.8	22.3	5.50E-06	1.40E-05	0.3	2.4
3	5.70E-05	7.90E-05	4.8	27.9	5.50E-06	5.50E-05	1.5	18.6	5.50E-06	1.50E-05	0.4	2.6
4 (Option 1)	5.70E-05	7.90E-05	4.8	27.9	5.50E-06	5.60E-05	1.5	18.8	5.50E-06	1.40E-05	0.3	2.2
4 (Option 2)	5.70E-05	7.90E-05	4.8	27.9	5.50E-06	5.30E-05	1.5	17.8	5.50E-06	1.40E-05	0.3	2.2

Notes:

Alternatives 1 and 2 are no action and natural flushing; both involve no additional treatment activities so risks are identical

Alternative 3 includes the PRB without enhancements

Alternative 4 (Option 1) is the PRB with a pump and treat enhancement

Alternative 4 (Option 2) is the PRB with a in-situ treatment enhancement

Year 0 case is based on current (October 2002) concentrations in Well 92-11 for all COCs

Year 20 and Year 40 case assumes current concentrations in Well 92-09 for all COCs except Uranium. Uranium concentrations are based on modeled results for Well 92-09 for the referenced timeframes. The following U (ug/l) results from the model were used:

Alternative	20 year	40 Year
1 and 2	249	7.4
3	204.2	10.2
4 (Option 1)	206	5.3
4 (Option 2)	194.7	5

Cancer risks are expressed as a unitless probability, Noncarcinogens are given as a hazard index (unitless), and dose is in units of mrem/yr.

Table C. Comparison of Added Cancer Risks from Radiological Contaminants Between the Base Case (Year 0) and Year 20 and Year 40 Estimates for the Various Alternatives—Reasonable Maximum Exposure Assumptions

	Year 20 Comparison		**Year 40 Comparison**	
Alternative	Risk Improvement	% Reduction	Risk Improvement	% Reduction
1 and 2	7.00E-05	14.9%	3.30E-04	70.2%
3	1.20E-04	25.5%	3.30E-04	70.2%
4 (Option 1)	1.20E-04	25.5%	3.30E-04	70.2%
4 (Option 2)	1.30E-04	27.7%	3.30E-04	70.2%

Table D. Comparison of Added Cancer Risks from Radiological Contaminants Between the Base Case (Year 0) and Year 20 and Year 40 Estimates for the Various Alternatives—Central Tendency Exposure Assumptions

	Year 20 Comparison		**Year 40 Comparison**	
Alternative	Risk Improvement	% Reduction	Risk Improvement	% Reduction
1 and 2	1.50E-05	19.0%	6.50E-05	82.3%
3	2.40E-05	30.4%	6.40E-05	81.0%
4 (Option 1)	2.30E-05	29.1%	6.50E-05	82.3%
4 (Option 2)	2.60E-05	32.9%	6.50E-05	82.3%

End of current text

Section G3.0

Cost Analysis

This page intentionally left blank

Cost Estimate for Alternative 1, No Further Remedial Action

Alternative Components and Basis of Estimate		Quantity
Capital Costs		
Establish onsite LTSM office		***0*** use existing onsite LTSM office
Decommission PRB direct cost		***1*** lump sum in year 2006
Decommission PRB contractor oversight		***20%*** of total decommissioning cost
Annual Costs		
LTSM office staffing and operating cost		***0%*** of total cost of LTSM office
LTSM ground water technical evaluation (1/yr)		***1*** analyze & report monitoring data
CERCLA 5-year review		***20%*** of 5-year cost
Monitoring 1 event/yr	***Yrs 1 - 40***	***1*** @ 25% of current annual cost
O&M		***1*** per year annual well maintenance

Annual cost will occur for 40 years. Start 10/04, end 10/44.

Item	Description		Unit	Quantity	Cost/Unit	Cost per Item	Subtotal/Total
1	**Capital Costs**						
2	LTSM capital costs		lump sum	0%	***$0***	$0	
3	*Decommission PRB direct cost*		*lump sum*	1	***$26,760***	$26,760	
4	Decommission PRB indirect cost		lump sum	20%	$26,760	$5,352	
5	Total direct capital cost						$26,760
6	Total indirect capital cost						$5,352
7	**Total capital cost**						**$32,112**
8	**Annual Costs**						
9	LTSM staff & office		lump sum	0	***$225,000***	$0	
10	LTSM technical data review		lump sum	1	***$5,000***	$5,000	
11	Annualized CERCLA 5-year review cost		lump sum	20%	***$2,000***	$400	
12	O & M (well maintenance)		lump sum	1	***$500***	$500	
13	Monitoring						
14	a	Yrs 1 - 40	lump sum	1	***$25,000***	$25,000	
15							
16	Yrs 1 - 40						
17	Total direct annual cost						$30,900
18	Overhead on direct annual costs		lump sum	***20%***	$30,900	$6,180	
19	Total indirect annual cost yrs						$6,180
20	**Total annual cost**						**$37,080**
21	**Net Present Value**						
22	Yrs 1 - 40						
23		Total annual cost				$ 37,080	
24	*	Present worth mulitplier				***13.33***	
25		Present value of annual cost					$ 494,339
26							
27	Total capital cost						$ 32,112
28							
29	**Net present value of alternative**						**$ 526,451**

Note: required input in ***bold italic***, all else formula driven.

* 7% discount rate, uniform series

Cost Estimate for Alternative 2, MNA

Alternative Components and Basis of Estimate		Quantity
Capital Costs		
Establish LTSM office		***0*** use existing onsite LTSM office
Decommission PRB direct cost		***1*** lump sum in year 2014
Decommission PRB contractor oversight		***20%*** of total decommissioning cost
Annual Costs		
LTSM office staffing and operating cost		***0%*** of total cost of LTSM office
LTSM ground water technical evaluation (2/yr)		***1*** analyze & report monitoring data
CERCLA 5-year review		***20%*** *of 5-year cost*
Monitoring 2 events /yr	***Yrs 1 - 10***	***1*** @ 75% of current annual cost
Monitoring 2 events/yr	***Yrs 11 - 40***	***1*** @ 67% of current annual cost
O&M		***1*** per year annual well maintenance

Annual cost will occur for 40 years beginning 10/04 and split betweeen yrs 1 - 10 and 11 - 40. End 2044.

Item		Unit	Quantity	Cost/Unit	Cost per Item	Subtotal/Total
1	**Capital Costs**					
2	LTSM capital cost	lump sum	0%	***$0***	$0	
3	Decommission PRB direct cost	lump sum	1	***$26,760***	$26,760	
4	Decommission PRB indirect cost	lump sum	20%	$26,760	$5,352	
5	Total direct capital cost					$26,760
6	Total indirect capital cost					$5,352
7	**Total capital cost**					**$32,112**
8	**Annual Costs**					
9	LTSM staff & office	lump sum	0%	***$225,000***	$0	
10	*LTSM technical data review*	*lump sum*	1	***$10,000***	$10,000	
11	Annualized CERCLA 5-year review cost	lump sum	20%	***$2,000***	$400	
12	O & M (well maintenance)	lump sum	1	***$500***	$500	
13	Monitoring					
14	Yrs 1 - 10	lump sum	1	***$83,000***	$83,000	
15	Yrs 11 - 40	lump sum	1	***$75,000***	$75,000	
16						
17	Yrs 1 - 10					
18	Total direct annual cost					$93,900
19	Overhead	lump sum	***20%***		$93,900	$18,780
20	**Total annual cost**					**$112,680**
21						
22	Yrs 11 - 40					
23	Total direct annual cost					$85,900
24	Overhead	lump sum	***20%***		$85,900	$17,180
25	**Total annual cost**					**$103,080**
26	**Net Present Value**					
27	Yrs 1 - 10					
28	Total annual cost				$ 112,680	
29	* Present worth mulitplier				***7.024***	
30	Present value of annual cost					$ 791,464
31						
32	Yrs 11 - 40					
33	Total annual cost				$ 103,080	
34	* Present worth mulitplier				***12.41***	
35	Value of total annual cost at start of series				$ 1,279,120	
36	** Present worth multiplier				***0.5083***	
37	Value of annual cost at yr 0					$ 650,177
38						
39	Total capital cost					$ 32,112
40						
41	**Net present value of alternative**					**$ 1,473,753**

Note: required input in ***bold italic***, all else formula driven.

* 7% discount rate, uniform series

** 7% discount of single payment at start of series

Cost Estimate for Alternative 3, PRB

Alternative Components and Basis of Estimate		Quantity
Capital Costs		
Establish onsite LTSM office		***0*** use existing onsite LTSM office
Decommission PRB direct cost		***1*** lump sum in year 2006
Decommission PRB contractor oversight		***20%*** of total decommissioning cost
Annual Costs		***0%*** of total cost of LTSM office
LTSM office staffing and operating cost		***0%*** of total cost of LTSM office
LTSM ground water technical evaluation (2/yr)		***1*** analyze & report monitoring data
CERCLA 5-year review		***20%*** of 5-year cost
Monitoring 2 events /yr	***Yrs 1 - 10***	***1*** @ 75% of current annual cost
Monitoring 2 events/yr	***Yrs 11 - 38***	***1*** @ 67% of current annual cost
O&M		***1*** per year annual well maintenance

Annual cost will occur for 38 years beginning 10/04 and split betweeen yrs 1 - 10 and 11 - 38. End 2042.

Item		Unit	Quantity	Cost/Unit	Cost per Item	Subtotal/Total
1	**Capital Costs**					
2	LTSM capital cost	lump sum	0%	***$0***	$0	
3	Decommission PRB direct cost	lump sum	1	***$26,760***	$26,760	
4	Decommission PRB indirect cost	lump sum	20%	$26,760	$5,352	
5	Total direct capital cost					$26,760
6	Total indirect capital cost					$5,352
7	**Total capital cost**					**$32,112**
8	**Annual Costs**					
9	LTSM staff & office	lump sum	0%	***$225,000***	$0	
10	LTSM technical data review	lump sum	1	***$10,000***	$10,000	
11	Annualized CERCLA 5-year review cost	lump sum	20%	***$2,000***	$400	
12	O & M (well maintenance)	lump sum	1	***$500***	$500	
13	Monitoring					
14	Yrs 1 - 10	lump sum	1	***$83,000***	$83,000	
15	Yrs 11 - 38	lump sum	1	***$75,000***	$75,000	
16						
17	Yrs 1 - 10					
18	Total direct annual cost					$93,900
19	Overhead	lump sum	***20%***		$93,900	$18,780
20	**Total annual cost**					**$112,680**
21						
22	Yrs 11 - 38					
23	Total direct annual cost					$85,900
24	Overhead	lump sum	***20%***		$85,900	$17,180
25	**Total annual cost**					**$103,080**
26	**Net Present Value**					
27	Yrs 1 - 10					
28	Total annual cost				$ 112,680	
29	* Present worth mulitplier				***7.024***	
30	Present value of annual cost					$ 791,464
31						
32	Yrs 11 - 38					
33	Total annual cost				$ 103,080	
34	* Present worth mulitplier				***12.14***	
35	Value of total annual cost at start of series				$ 1,251,391	
36	** Present worth multiplier				***0.5083***	
37	Value of annual cost at yr 0					$ 636,082
38						
39	Total capital cost					$ 32,112
40						
41	**Net present value of alternative**					***$ 1,459,658***

Note: required input in ***bold italic***, all else formula driven.
* 7% discount rate, uniform series
** 7% discount of single payment at start of series

Cost Estimate for Alternative 4, PRB With Active Treatment Enhancement

Alternative Components and Basis of Estimate		Quantity	
Capital Costs			
Establish onsite LTSM office		***0***	use existing onsite LTSM office
Construct PRB enhancement direct cost		***1***	lump sum in year 2005
Construct PRB enhancement contractor oversight		***20%***	of total construction cost
Decommission PRB & enhancemnet direct cost		***1***	lump sum in year 2006
Decommission PRB & enhancemnet contractor oversight		***20%***	of total decommissioning cost
Annual Costs			
LTSM office staffing and operating cost		***0%***	of total cost of LTSM office
LTSM ground water technical evaluation (2/yr)		***1***	analyze & report monitoring data
CERCLA 5-year review		***20%***	of 5-year cost
Monitoring 2 events /yr	***Yrs 1 - 10***	***1***	@ 75% of current annual cost
Monitoring 2 events/yr	***Yrs 11 - 37***	***1***	@ 67% of current annual cost
O&M		***1***	per year monitor well maintenance
O&M		***1***	per year for 10 yr extraction system maintenance

Annual cost will occur for 37 years beginning 10/04 and split betweeen yrs 1 - 10 and 11 - 37. End 2041

Item		Unit	Quantity	Cost/Unit	Cost per Item	Subtotal/Total
1	**Capital Costs**					
2	LTSM capital cost	lump sum	0%	***$0***	$0	
3	Construct PRB enhancement direct	lump sum	1	***$18,768***	$18,768	
4	Decommission PRB direct	lump sum	1	***$26,760***	$26,760	
5	Decommission enhancement direct	lump sum	1	***$4,692***	$4,692	
6						
7	Construct PRB enhancement indirect	lump sum	20%	$18,768	$3,754	
8	Decommission PRB indirect	lump sum	20%	$26,760	$5,352	
9	Decommission enhancement indirect	lump sum	20%	$4,692	$938	
10	Total direct capital costs					$50,220
11	Total indirect capital costs					$10,044
12	**Total capital costs**					**$60,264**
13	**Annual Costs**					
14	LTSM staff & office	lump sum	0%	***$225,000***	$0	
15	LTSM technical data review	lump sum	1	***$10,000***	$10,000	
16	Annualized CERCLA 5-year review cost	lump sum	20%	***$2,000***	$400	
17	O & M (extraction system maintenance)	lump sum	1	***$4,000***	$4,000	
18	O & M (monitor well maintenance)	lump sum	1	***$500***	$500	
19	Monitoring					
20	Yrs 1 - 10	lump sum	1	***$83,000***	$83,000	
21	Yrs 11 - 37	lump sum	1	***$75,000***	$75,000	
22						
23	Yrs 1 - 10					
24	Total direct annual cost					$97,900
25	Overhead	lump sum	***20%***		$97,900	$19,580
26	**Total annual cost**					**$117,480**
27						
28	Yrs 11 - 37					
29	*Total direct annual cost*					$85,900
30	Overhead	lump sum	***20%***		$85,900	$17,180
31	**Total annual cost**					**$103,080**
32	**Net Present Value**					
33	Yrs 1 - 10					
34	Total annual cost				$ 117,480	
35	* Present worth mulitplier				***7.024***	
36	Present value of annual cost					$825,180
37						
38	Yrs 11 - 37					
39	Total annual cost				$ 103,080	
40	* Present worth mulitplier				***11.99***	
41	Value of total annual cost at start of series				$ 1,235,589	
42	** Present worth multiplier				***0.5083***	
43	Value of annual cost at yr 0					$628,050
44						
45	Total capital cost					$60,264
46						
47	**Net present value of alternative**					**$1,513,494**

Note: required input in ***bold italic***, all else formula driven.
* 7% discount rate, uniform series
** 7% discount of single payment at start of series

Cost Estimate for Alternative 4, PRB With Passive Treatment Enhancement

Alternative Components and Basis of Estimate		Quantity
Capital Costs		
Establish onsite LTSM office		***0*** use existing onsite LTSM office
Construct PRB enhancement *direct cost*		***1*** lump sum in year 2005
Construct PRB enhancement contractor oversight		***20%*** of total construction cost
Decommission PRB & enhancemnet direct cost		***1*** lump sum in year 2006
Decommission PRB & enhancemnet contractor oversight		***20%*** of total decommissioning cost
Annual Costs		
LTSM office staffing and operating cost		***0%*** of total cost of LTSM office
LTSM ground water technical evaluation (2/yr)		***1*** analyze & report monitoring data
CERCLA 5-year review		***20%*** of 5-year cost
Monitoring 2 events /yr	***Yrs 1 - 10***	***1*** @ 75% of current annual cost
Monitoring 2 events/yr	***Yrs 11 - 36***	***1*** @ 67% of current annual cost
O&M		***1*** per year annual well maintenance

Annual cost will occur for 36 years beginning 10/04 and split betweeen yrs 1 - 10 and 11 - 36. End 2040.

Item		Unit	Quantity	Cost/Unit	Cost per Item	Subtotal/Total
1	**Capital Costs**					
2	LTSM capital cost	lump sum	0%	***$0***	$0	
3	Construct PRB enhancement direct	lump sum	1	***$40,509***	$40,509	
4	Decommission PRB direct	lump sum	1	***$26,760***	$26,760	
5	Decommission enhancement direct	lump sum	1	***$36,887***	$36,887	
6						
7	Construct PRB enhancement indirect	lump sum	20%	$40,509	$8,102	
8	Decommission PRB indirect	lump sum	20%	$26,760	$5,352	
9	Decommission enhancement indirect	lump sum	20%	$36,887	$7,377	
10	Total direct capital costs					$104,156
11	Total indirect capital costs					$20,831
12	**Total capital costs**					**$124,988**
13	**Annual Costs**					
14	LTSM staff & office	lump sum	0%	***$225,000***	$0	
15	LTSM technical data review	lump sum	1	***$10,000***	$10,000	
16	Annualized CERCLA 5-year review cost	lump sum	20%	***$2,000***	$400	
17	O & M (monitor well maintenance)	lump sum	1	***$500***	$500	
18	*Monitoring*					
19	Yrs 1 - 10	lump sum	1	***$83,000***	$83,000	
20	Yrs 11 - 36	lump sum	1	***$75,000***	$75,000	
21						
22	Yrs 1 - 10					
23	Total direct annual cost					$93,900
24	Overhead	lump sum	***20%***		$93,900	$18,780
25	**Total annual cost**					**$112,680**
26						
27	Yrs 11 - 36					
28	Total direct annual cost					$85,900
29	Overhead	lump sum	***20%***		$85,900	$17,180
30	**Total annual cost**					**$103,080**
31	**Net Present Value**					
32	Yrs 1 - 10					
33	Total annual cost				$ 112,680	
34	* Present worth mulitplier				***7.024***	
35	Present value of annual cost					$791,464
36						
37	Yrs 11 - 36					
38	Total annual cost				$ 103,080	
39	* Present worth mulitplier				***11.83***	
40	Value of total annual cost at start of series				$ 1,219,436	
41	** Present worth multiplier				***0.5083***	
42	Value of annual cost at yr 0					$619,840
43						
44	Total capital cost					$124,988
45						
46	**Net present value of alternative**					**$1,536,291**

Note: required input in ***bold italic***, all else formula driven.
* 7% discount rate, uniform series
** 7% discount of single payment at start of series

Installation of PRB Enhancement for Alternative 4										
Option 1: Ground water extraction and treatemnt at PRB										
Qty	Description	Crew	Daily Output	Labor Hours	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total
2.00	Mobilization or demobilization, truck-mounted crane over 75 ton	A3E	2.50	6.400	Ea.	$ -	$ 431.20	$ 64.90	$ 496.10
120.00	Well, domestic water, drilled in normal soil, 4" to 6" dia	B23	120	.333	L.F.	$ -	$ 732.00	$ 2,460.00	$ 3,192.00
3.00	Wells, pumps, installed in wells to 50' D, 2" submersible, 1/2 h.p	Q1	3.22	4.969	Ea.	$ 828.00	$ 292.80	$ -	$ 1,120.80
120.00	Piping, not including excavation or backfill, class 160, 2" diameter	B20	685	.035	L.F.	$ 115.20	$ 85.20	$ -	$ 200.40
30.00	Well, domestic water, screen assembly, slotted PVC, 6" dia	B23A	126	.190	L.F.	$ 162.00	$ 117.30	$ 561.00	$ 840.30
440.00	Piping, not including excavation or backfill, class 160, 6" diameter	B20	315	.076	L.F.	$ 3,168.00	$ 682.00	$ -	$ 3,850.00
100.00	Piping, subdrainage, perforated PVC, 6" dia	B14	300	.160	L.F.	$ 141.00	$ 305.00	$ 73.00	$ 519.00
3.00	Valves, bronze, relief, 2" size, pressure, water, ASME, threaded	1 Plum	16	.500	Ea.	$ 91.50	$ 4.25	$ -	$ 95.75
3.00	Pipe, plastic ftngs, epoxy resin, fbgl reinf, gen svce, elb, 90<, 2"	Q1	33	.483	Ea.	$ 136.50	$ 36.90	$ -	$ 173.40
6.00	Pipe, plastic ftngs, epoxy resin, fbgl reinf, gen service, tee, 2"	Q1	20	.800	Ea.	$ 330.00	$ 123.00	$ -	$ 453.00
3.00	Fiberglass reinf epoxy, general service, couplings, 6"	Q1	10.10	1.584	Ea.	$ 114.00	$ 121.50	$ -	$ 235.50
350.00	Excavate trench, cont ftg, no sht/dewtrg, 1-4'D,3/8 CY tractor lder/backhoe	B11C	150	.107	C.Y.	$ -	$ 1,099.00	$ 511.00	$ 1,610.00
350.00	Excavate trench, backfill trench, FE loader, whl mtd, 1 CY bkt, min haul	B10R	400	.030	C.Y.	$ -	$ 325.50	$ 178.50	$ 504.00
350.00	Excavate trench, for tamping backfilled trenches, air tamp, add	A1	100	.080	C.Y.	$ -	$ 710.50	$ 203.00	$ 913.50
4.60	Non-metallic sheathed cable, 600V, copper w/ground, #10, 3 conductor	1 Elec	1.80	4.444	C.L.F.	$ 223.10	$ 533.60	$ -	$ 756.70
1.00	Grounding, rod, copper clad, 8' long, 1/2" dia	1 Elec	5.50	1.455	Ea.	$ 15.85	$ 38.00	$ -	$ 53.85
								Subtotal	$ 15,014
								25% OH&P	$ 3,754
								Total	$ 18,768

Installation of PRB Enhancement for Alternative 4									
Option 2: In Situ Passive Treatment Enhancement									
Qty	Description	Crew	Daily Output	Labor Hours	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total
2	Mobilization or demobilization, truck-mounted crane over 75 ton	A3E	2.50	6.400	Ea.	$ -	$ 431.20	$ 64.90	$ 496.10
0	Mob/demob, for each additional 5 miles haul distance, add						10%	10%	
480	Well, domestic water, drilled in normal soil, 8" to 10" dia	B23	95	0.42	L.F.	$ -	$ 2,928.00	$ 9,840.00	$ 12,768.00
36	Pack wells, ZVI @ 10 L.F. each well				Ton	$ 14,400.00	$ 1,800.00	$ -	$ 16,200.00
360	Backfill wells	B23	95	0.42	L.F.	$ -	$ 2,196.00	$ 747.00	$ 2,943.00
								Subtotal	$ 32,407
								25% OH&P	$ 8,102
								Total	$ 40,509

Decommissioning PRB w/o Enhancements

Qty	Description	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total	Note
4	Mobil or demob, dzr, ldr, backhoe, excv, grdr, pvr, roller, above 150 HP	Ea.	$ -	$ 282.00	$ 792.00	$ 1,074.00	Includes mobilization for 2 pieces of equipment and includes demobilization of same.
120	Excavate trench, 4'-6' deep, 1 CY hyd backhoe	C.Y.	$ -	$ 153.60	$ 157.20	$ 310.80	Removal and replacement of clean overburden 3 feet thick.
120	Excavate trench, backfill trench, FE loader, whl mtd, 1 CY bkt, min haul	C.Y.	$ -	$ 111.60	$ 61.20	$ 172.80	
480	Excavate trench, common earth, 14'-20' D, 1 CY backhoe	C.Y.	$ -	$ 883.20	$ 905.28	$ 1,788.48	(Adjusted by 023154409024) to load 480 cy.
0	Excavating, structural, for loading onto trucks, add					15%	Adjustment for loading trucks on-site (line 023159001300).
480	Hauling, LCY, no loading, 20 c.y dump trailer, 20 MI RT, .5 lds/hr	C.Y.	$ -	$ 1,691.04	$ 3,588.00	$ 5,279.04	(Adjusted by 023202001400) for added haul mileage, loaded highway miles.
0	Hauling, hauling in medium traffic, heavy traffic, add	C.Y.				30%	Adjusted for additional 280 loaded highway miles to Cheney Disposal site in Grand Junction, Colorado from Monticello ,Utah.
500	Revegetation, erosion control, revegetation and matting, webbed	S.Y.	$ 2,900.00	$ 200.00	$ -	$ 3,100.00	For revegetation and reclamation of disturbed area.
530	Borrow, bank measure, common earth, shovel, 1-1/2 CY bucket	C.Y.	$ 4,478.50	$ 238.50	$ 482.30	$ 5,199.30	Common borrow replacement of ZVI material @ 10% shrinkage. Assumes material is wheel rolled into dense state using on-site equipment.
530	Hauling, LCY, no loading, 12 c.y dump truck, 5 MI RT, 1 lds/hr	C.Y.	$ -	$ 1,436.30	$ 3,047.50	$ 4,483.80	Haul assumed 5 miles roundtrip from borrow source to backfill area.
					Subtotal	$ 21,408	
					OH&P	$ 5,352	
					Total	$ 26,760	

End of current text