CHAPTER 4.0
COST ESTIMATES

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CHAPTER 4.0
COST ESTIMATES

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TABLES

ABBREVIATIONS AND ACRONYMS

bcy	Bank cubic yards
CMS	Corrective Measures Study
Distribs	Distributables
G&A	General and Administrative
ID	Identification
MCACES	A model used to provide cost estimates for some of the remedial alternatives
MCRIS	Modified CRCIA ranger/industrial scenario
O&M	Operations and maintenance
PM/CM	Project management/construction management
RACER	A model used to provide cost estimates for some of the remedial alternatives
Sub01	Mobilization & prep work costs
Sub02	Monitoring, sampling, & analysis costs
Sub08	Solid collection & containment costs
Sub20	Site restoration costs
Sub21	Demobilization costs
Sub70	Project/construction management & support cost

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4.0 COST ESTIMATES

4.1 Cost Estimates for the 100-NR-1 Source Waste Sites

The cost estimates for the 100-NR-1 source wastes sites were developed using the Micro Computer Aided Cost Estimating System (MCACES) software package or the Remedial Action Cost Engineering and Requirements (RACER) software package. The MCACES package was selected for estimating costs for the Remove/Dispose Remedial Alternative (using the crib and French drain, trench, and piping models) and the Containment Remedial Alternative (using the Resource Conservation and Recovery Act [RCRA] cap model). The cost models associated with these alternatives are presented in the *100 Areas Source Operable Unit Focused Feasibility Study Cost Models* (DOE-RL1995b). The MCACES and RACER packages were used for the move/ex situ bioremediation/dispose cost estimates. The RACER package was used for estimating costs for the remaining source remedial alternatives: in situ bioremediation, in situ solidification, and capping. Cost estimates provided by these two packages are suitable for comparative analysis of remedial alternatives but are not intended for establishing definitive cost estimates. The total costs as shown do not include design costs (3 percent) or costs for collecting design data in the field (3 percent).

Attachment 1 is the MCACES summary report for the UPR-100-N-1 site, and it typifies the reports generated for the remainder of the sites. In this model, costs are summarized into seven categories as follows:

Code	Cost category	Total Cost
01	Mobilization & Prep Work	14,320
02	Monitoring, Sampling, & Analysis	1,200
08	Solids Collection& Containment	34,390
18	Disposal (Other than Commercial)	11,970
20	Site Restoration	8,560
21	Demobilization	5,000
70	Project/Construction Mgmt & Supt	29,180

These costs are presented in Tables 4.1 and 4.2 for the Remove/Dispose Alternatives for both the Rural-Residential and Modified CRCIA Ranger/Industrial Exposure Scenarios.

These models rely upon a set of user-supplied input parameters. Six of these parameters (depth of excavation, top excavation length, bottom excavation length, contaminated soil volume, non-contaminated soil volume, and bottom area) are presented in Table 4.3 for the sites. The other five input parameters (hauling distance for borrow, hauling distance for contaminated soil, hauling distance for demo waste, transition zone soil percentages, and groundwater protection samples) are fixed for all the 100-NR-1 sites and areas presented on the third page of the example.

The cost estimating process for the Remove/Ex Situ Bioremediation/Dispose Remedial Alternative consisted of two steps. The initial step was to estimate the cost of removing the contaminated soil from the waste site and transporting it to the location selected for ex situ bioremediation. These costs were estimated using the MCACES program and are similar to the costs developed for similar tasks under the Remove/Dispose Alternative. The RACER program was then used to estimate the cost of the actual bioremediation. The minimum size remediation cell used in the estimate was 100 loose cubic yards (LCY) of material. Since the majority of sites were less than this volume, soils from these small sites were combined into one cell and the cost prorated on a LCY basis. These costs are presented in Tables 4.1 and 4.5.

The cost estimates for the Containment Remedial Alternative (capping) were determined in the same fashion as the Remove/Dispose Remedial Alternative and used the MCACES program.

The cost estimates are presented in Tables 4.6 and 4.7. The cost estimates for in situ bioremediation and in situ solidification were determined using the RACER program and are presented in Tables 4.8 and 4.9, respectively.

The cost estimate for site100-N-45, a septic system in the HGP area, was assumed the same as site 124-N-2. Site 100-N-46, an underground storage tank (UST) at HGP, was estimated following the existing practice for USTs at Hanford. A summary sheet for this estimate is on page G1-22. No estimates were made for three sites in the HGP area (100-N-50, 100-N-51a, and 100-N-51b) because of the limited data available. Cost estimates will be established during design.

The cost estimates for the river shoreline site followed Hanford cost estimating practices. These estimates are summarized, beginning on page G1-23. Institutional control costs need to be added to these numbers to reach the total costs presented in Section 8.0. No estimate was provided for site 100-N-65 (a petroleum intercepter trench) because remediation of this site depends, in part, upon the information developed during the remediation design of UPR-100-N-17, the source of this leak.

Table 4.1. 100-NR-1/2 CMS Residential Scenario Recalculate MCACES with 15 Percent PM/CM

Site ID	Sub01 $	Sub02 $	Sub08 $	Sub18 $	Sub20 $	Sub21 $	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost $
UPR-100-N-1	14,320	21,200	34,390	11,970	8,560	5,000	95,440	14,316	15,432	6,685	44,837	176,709
UPR-100-N-2	13,920	19,980	35,970	7,180	6,260	5,000	88,310	13,247	14,279	6,186	41,487	163,508
UPR-100-N-3	15,060	29,600	53,670	17,960	15,510	5,000	136,800	20,520	22,119	9,582	64,267	253,288
UPR-100-N-4	12,740	16,420	17,620	320	540	5,000	52,640	7,896	8,511	3,687	24,730	97,464
UPR-100-N-5	16,170	32,220	64,890	43,050	20,100	5,000	181,430	27,215	29,335	12,708	85,234	335,922
UPR-100-N-6	13,040	16,700	19,550	740	1,170	5,000	56,200	8,430	9,087	3,936	26,402	104,056
UPR-100-N-7	15,870	36,380	93,320	30,140	22,030	5,000	202,740	30,411	32,781	14,201	95,245	375,378
UPR-100-N-8	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-9	12,980	16,700	19,040	1,610	860	5,000	56,190	8,429	9,085	3,936	26,397	104,037
UPR-100-N-10	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-11	12,650	16,150	17,100	600	270	5,000	51,770	7,766	8,371	3,626	24,321	95,853
UPR-100-N-12	16,540	42,480	115,470	41,130	27,750	5,000	248,370	37,256	40,159	17,397	116,682	459,863
UPR-100-N-13	10,410	16,150	16,180	110	150	5,000	48,000	7,200	7,761	3,362	22,550	88,873
UPR-100-N-14	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-15												
UPR-100-N-17	18,100	284,460	767,570	31,920	194,150	5,000	1,301,200	195,180	210,391	91,142	611,290	2,409,203
UPR-100-N-18	13,070	16,970	20,060	180	1,430	5,000	56,710	8,507	9,169	3,972	26,642	105,000
UPR-100-N-19	13,140	16,970	20,180	420	1,510	5,000	57,220	8,583	9,252	4,008	26,881	105,944
UPR-100-N-20	13,000	16,700	19,120	210	1,090	5,000	55,120	8,268	8,912	3,861	25,895	102,056
UPR-100-N-21	12,730	16,420	17,620	180	530	5,000	52,480	7,872	8,485	3,676	24,655	97,168
UPR-100-N-22	13,080	16,970	20,070	210	1,430	5,000	56,760	8,514	9,178	3,976	26,665	105,092
UPR-100-N-23	13,020	16,970	19,680	110	1,170	5,000	55,950	8,393	9,047	3,919	26,285	103,593
UPR-100-N-24	13,150	16,970	20,540	810	1,590	5,000	58,060	8,709	9,388	4,067	27,276	107,499
UPR-100-N-25	12,770	16,420	17,660	420	540	5,000	52,810	7,922	8,539	3,699	24,810	97,779
UPR-100-N-26	12,850	16,420	18,140	810	740	5,000	53,960	8,094	8,725	3,780	25,350	99,908
UPR-100-N-29	12,980	16,700	19,120	40	1,090	5,000	54,930	8,240	8,882	3,848	25,806	101,704
UPR-100-N-30	13,350	17,520	23,020	2,000	2,470	5,000	63,360	9,504	10,245	4,438	29,766	117,313
UPR-100-N-32	13,080	16,970	20,070	210	1,430	5,000	56,760	8,514	9,178	3,976	26,665	105,092
UPR-100-N-36	12,680	16,420	17,620	40	530	5,000	52,290	7,844	8,455	3,663	24,565	96,816
UPR-100-N-37	12,420	16,150	17,030	40	120	5,000	50,760	7,614	8,207	3,555	23,847	93,983
UPR-100-N-38	12,620	16,150	17,410	110	270	5,000	51,560	7,734	8,337	3,611	24,222	95,465
UPR-100-N-39	12,880	16,420	18,480	110	740	5,000	53,630	8,045	8,671	3,756	25,195	99,297
UPR-100-N-40	13,710	18,890	31,310	4,690	4,170	5,000	77,770	11,666	12,575	5,447	36,536	143,993
UPR-100-N-41	12,570	16,150	17,060	210	190	5,000	51,180	7,677	8,275	3,585	24,044	94,761
UPR-100-N-42	19,720	326,530	891,310	67,170	225,530	5,000	1,535,260	230,289	248,236	107,536	721,249	2,842,571
UPR-100-N-43	13,150	16,970	20,220	630	1,590	5,000	57,560	8,634	9,307	4,032	27,041	106,574
100-N-1	15,960	44,750	55,390	35,810	16,420	5,000	173,330	26,000	28,026	12,141	81,429	320,925
100-N-3	14,740	23,520	42,640	19,710	11,100	5,000	116,710	17,507	18,871	8,175	54,829	216,091
100-N-4	17,540	30,760	63,520	72,450	19,630	5,000	208,900	31,335	33,777	14,632	98,139	386,783
100-N-5	20,360	44,590	49,070	54,670	14,980	5,000	188,670	28,301	30,506	13,215	88,635	349,327
100-N-6	12,420	16,150	17,030	110	120	5,000	50,830	7,625	8,219	3,560	23,879	94,113
100-N-12	12,300	16,150	17,030	40	110	5,000	50,630	7,595	8,186	3,546	23,785	93,743
100-N-13	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-14	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-16	12,510	16,150	17,030	140	180	5,000	51,010	7,652	8,248	3,573	23,964	94,446
100-N-17	12,490	16,150	17,030	40	180	5,000	50,890	7,634	8,228	3,565	23,908	94,224
100-N-18	12,410	16,150	17,030	40	120	5,000	50,750	7,613	8,206	3,555	23,842	93,965
100-N-19	12,500	16,150	17,030	180	180	5,000	51,040	7,656	8,253	3,575	23,978	94,502
100-N-22	13,510	17,790	23,700	4,870	2,790	5,000	67,660	10,149	10,940	4,739	31,786	125,274
100-N-23	12,310	16,150	17,030	110	110	5,000	50,710	7,607	8,199	3,552	23,823	93,891
100-N-24	13,280	17,790	23,180	140	2,690	5,000	62,080	9,312	10,038	4,348	29,165	114,943
100-N-25	13,170	16,970	21,010	810	1,670	5,000	58,630	8,795	9,480	4,107	27,544	108,555

Site ID	Sub01 $	Sub02 $	Sub08 $	Sub18 $	Sub20 $	Sub21 $	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost $
100-N-26	12,940	16,700	19,040	110	1,080	5,000	54,870	8,231	8,872	3,843	25,777	101,593
100-N-27												
100-N-29	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-30	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-31	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-32	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-33	13,250	16,970	19,710	1,510	1,230	5,000	57,670	8,651	9,325	4,039	27,093	106,777
100-N-34	12,340	16,150	17,030	40	110	5,000	50,670	7,601	8,193	3,549	23,804	93,817
100-N-35	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-36	12,550	16,150	17,030	250	180	5,000	51,160	7,674	8,272	3,583	24,034	94,724
100-N-37	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
100-N-38	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-39	12,830	16,150	17,500	810	360	5,000	52,650	7,898	8,513	3,688	24,734	97,483
100-N-47	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
120-N-3	13,350	17,790	23,620	740	2,770	5,000	63,270	9,491	10,230	4,432	29,724	117,146
124-N-2	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-3	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-4	21,330	75,940	125,480	143,360	43,070	5,000	414,180	62,127	66,969	29,011	194,577	766,864
128-N-1	14,740	18,580	21,500	11,550	4,530	5,000	75,900	11,385	12,272	5,316	35,657	140,531
130-N-1												
600-32	37,130	242,580	289,620	417,410	113,510	5,000	1,105,250	165,788	178,708	77,416	519,235	2,046,397
600-35	17,750	28,350	17,740	13,410	4,850	5,000	87,100	13,065	14,083	6,101	40,919	161,268
Pipelines	$855,845	$2,162,119	$3,138,771		$2,375,727	$5,000	$18,601,082	$2,790,162	$3,007,609	$1,302,899	$8,738,596	$34,440,348
Totals:							$28,010,722					$51,862,521

Table 4.2. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Recalculate MCACES with 15 Percent PM/CM

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
UPR-100-N-1	14,020	19,710	28,920	7,980	5,500	5,000	81,130	12,170	13,118	5,683	38,114	150,214
UPR-100-N-2							-	-	-	-	-	-
UPR-100-N-3							-	-	-	-	-	-
UPR-100-N-4	12,740	16,420	17,620	320	540	5,000	52,640	7,896	8,511	3,687	24,730	97,464
UPR-100-N-5	14,960	23,120	42,680	21,530	10,970	5,000	118,260	17,739	19,121	8,283	55,557	218,961
UPR-100-N-6	13,040	16,700	19,550	740	1,170	5,000	56,200	8,430	9,087	3,936	26,402	104,056
UPR-100-N-7							-	-	-	-	-	-
UPR-100-N-8	12,610	16,150	17,450	40	270	5,000	51,520	7,728	8,330	3,609	24,204	95,391
UPR-100-N-9	12,980	16,700	19,040	1,610	860	5,000	56,190	8,429	9,085	3,936	26,397	104,037
UPR-100-N-10	12,610	16,150	17,450	40	270	5,000	51,520	7,728	8,330	3,609	24,204	95,391
UPR-100-N-11	12,640	16,150	17,100	600	270	5,000	51,760	7,764	8,369	3,625	24,316	95,835
UPR-100-N-12							-	-	-	-	-	-
UPR-100-N-13	10,410	16,150	16,180	110	150	5,000	48,000	7,200	7,761	3,362	22,550	88,873
UPR-100-N-14	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-15							-	-	-	-	-	-
UPR-100-N-17	18,100	284,460	767,570	31,920	194,150	5,000	1,301,200	195,180	210,391	91,142	611,290	2,409,203
UPR-100-N-18	12,980	16,700	19,080	140	1,090	5,000	54,990	8,249	8,891	3,852	25,834	101,815
UPR-100-N-19	13,030	16,700	19,470	350	1,170	5,000	55,720	8,358	9,009	3,903	26,177	103,167
UPR-100-N-20	12,990	16,700	19,080	210	1,090	5,000	55,070	8,261	8,904	3,857	25,871	101,963
UPR-100-N-21	12,720	16,420	17,620	180	530	5,000	52,470	7,871	8,484	3,675	24,650	97,149
UPR-100-N-22	12,990	16,700	19,080	180	1,090	5,000	55,040	8,256	8,899	3,855	25,857	101,908
UPR-100-N-23	12,930	16,700	19,040	70	1,080	5,000	54,820	8,223	8,864	3,840	25,754	101,501
UPR-100-N-24	13,110	16,970	20,190	770	1,510	5,000	57,550	8,633	9,305	4,031	27,036	106,555

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
UPR-100-N-25	12,770	16,420	17,660	420	540	5,000	52,810	7,922	8,539	3,699	24,810	97,779
UPR-100-N-26	12,850	16,420	18,140	810	740	5,000	53,960	8,094	8,725	3,780	25,350	99,908
UPR-100-N-29	12,920	16,700	18,690	40	1,000	5,000	54,350	8,153	8,788	3,807	25,533	100,630
UPR-100-N-30	13,270	17,250	21,590	1,680	2,120	5,000	60,910	9,137	9,849	4,266	28,615	112,776
UPR-100-N-32	12,990	16,700	19,080	180	1,090	5,000	55,040	8,256	8,899	3,855	25,857	101,908
UPR-100-N-36	12,680	16,420	17,620	40	530	5,000	52,290	7,844	8,455	3,663	24,565	96,816
UPR-100-N-37	12,420	16,150	17,030	40	120	5,000	50,760	7,614	8,207	3,555	23,847	93,983
UPR-100-N-38	12,620	16,150	17,410	110	270	5,000	51,560	7,734	8,337	3,611	24,222	95,465
UPR-100-N-39	12,880	16,420	18,480	110	740	5,000	53,630	8,045	8,671	3,756	25,195	99,297
UPR-100-N-40	13,510	18,070	23,940	3,120	3,140	5,000	66,780	10,017	10,798	4,678	31,373	123,645
UPR-100-N-41	12,570	16,150	17,060	210	190	5,000	51,180	7,677	8,275	3,585	24,044	94,761
UPR-100-N-42	19,720	326,530	891,310	67,170	225,530	5,000	1,535,260	230,289	248,236	107,536	721,249	2,842,571
UPR-100-N-43	13,080	16,970	19,710	530	1,430	5,000	56,720	8,508	9,171	3,973	26,646	105,018
100-N-1	15,660	42,710	51,540	29,820	14,430	5,000	159,160	23,874	25,735	11,148	74,772	294,689
100-N-3	14,100	19,440	28,450	11,830	5,170	5,000	83,990	12,599	13,580	5,883	39,458	155,509
100-N-4	17,450	30,760	63,520	72,450	19,630	5,000	208,810	31,322	33,762	14,626	98,097	386,617
100-N-5	20,360	44,590	49,070	54,670	14,980	5,000	188,670	28,301	30,506	13,215	88,635	349,327
100-N-6	12,420	16,150	17,030	110	120	5,000	50,830	7,625	8,219	3,560	23,879	94,113
100-N-12	12,300	16,150	17,030	40	110	5,000	50,630	7,595	8,186	3,546	23,785	93,743
100-N-13	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-14	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-16	12,510	16,150	17,030	140	180	5,000	51,010	7,652	8,248	3,573	23,964	94,446
100-N-17	12,490	16,150	17,030	40	180	5,000	50,890	7,634	8,228	3,565	23,908	94,224
100-N-18	12,410	16,150	17,030	40	120	5,000	50,750	7,613	8,206	3,555	23,842	93,965
100-N-19	12,500	16,150	17,030	180	180	5,000	51,040	7,656	8,253	3,575	23,978	94,502
100-N-22	13,510	17,790	23,700	4,870	2,790	5,000	67,660	10,149	10,940	4,739	31,786	125,274
100-N-23	12,310	16,150	17,030	110	110	5,000	50,710	7,607	8,199	3,552	23,823	93,891
100-N-24	12,940	16,700	19,040	70	1,080	5,000	54,830	8,225	8,865	3,841	25,759	101,519
100-N-25	13,100	16,970	20,190	670	1,510	5,000	57,440	8,616	9,287	4,023	26,985	106,352
100-N-26	12,940	16,700	19,040	110	1,080	5,000	54,870	8,231	8,872	3,843	25,777	101,593
100-N-27	12,950	16,700	18,690	180	1,010	5,000	54,530	8,180	8,817	3,820	25,618	100,964
100-N-29												
100-N-30												
100-N-31												
100-N-32												
100-N-33	13,250	16,970	19,710	1,510	1,230	5,000	57,670	8,651	9,325	4,039	27,093	106,777
100-N-34	12,340	16,150	17,030	40	110	5,000	50,670	7,601	8,193	3,549	23,804	93,817
100-N-35	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-36	12,550	16,150	17,030	250	180	5,000	51,160	7,674	8,272	3,583	24,034	94,724
100-N-37	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
100-N-39	12,830	16,150	17,500	810	360	5,000	52,650	7,898	8,513	3,688	24,734	97,483
100-N-47	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
120-N-3	13,070	16,700	19,540	420	1,170	5,000	55,900	8,385	9,038	3,915	26,261	103,500
124-N-2	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-3	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-4	21,330	75,940	125,480	143,360	43,070	5,000	414,180	62,127	66,969	29,011	194,577	766,864
128-N-1	14,740	18,580	21,500	11,550	4,530	5,000	75,900	11,385	12,272	5,316	35,657	140,531
130-N-1							-	-	-	-	-	-
600-32	37,130	242,580	289,620	417,410	113,510	5,000	1,105,250	165,788	178,708	77,416	519,235	2,046,397
600-35	17,750	28,350	17,740	13,410	4,850	5,000	87,100	13,065	14,083	6,101	40,919	161,268
Pipelines	855,845	2,162,199	3,138,771		2,375,727	5,000	18,601,162	2,790,174	3,007,622	1,302,904	8,738,633	34,440,496
Totals:							$26,872,142					$49,754,413

Table 4.3. 100-NR-1 CMS MCACES Input Parameters

Site Name	Depth of Excavation Res (ft)	Depth of Excavation Rec (ft)	Top Excavation Length (ft)	Top Excavation Width (ft)	Contaminated Soil Res (bcf)	Non-Contaminated Soil Res (bcf)	Contaminated Soil Rec (bcf)	Non-Contaminated Soil Rec (bcf)	Bottom Area Rec (sq. ft.)	Bottom Area Res (sq. ft.)
UPR-100-N-1	12 00	10 00	72 60	72 60	8,021	30,761	5,348	23,017	1,340	1,340
UPR-100-N-2	15 00		62 90	62 90	4,813	28,787				320
UPR-100-N-3	15 00		94 10	94 10	12,032	70,751				2,411
UPR-100-N-4	6 00	6 00	23 80	23 80	201	1,490	201	1,490	34	34
UPR-100-N-5	15 00	10 00	98 80	98 80	28,877	64,287	14,439	34,612	2,894	2,894
UPR-100-N-6	9 25	9 25	36 55	36 55	481	5,657	481	5,657	77	77
UPR-100-N-7	15 00		108 60	108 60	20,214	96,880				4,045
UPR-100-N-8	6 00	6 00	19 50	19 50	13	1,026	13	1,026	2	2
UPR-100-N-9	6 25	6 25	31 75	31 75	1,059	2,500	1,059	2,500	169	169
UPR-100-N-10	6 00	6 00	19 50	19 50	13	1,026	13	1,026	2	2
UPR-100-N-11	2 00	2 00	20 00	20 00	392	200	392	200	196	196
UPR-100-N-12	15 00		120 00	120 00	27,852	120,375				5,625
UPR-100-N-13	3 00	3 00	13 20	13 20	53	221	53	221	18	18
UPR-100-N-14	6 00	6 00	19 80	19 80	19	1,058	19	1,058	3	3
UPR-100-N-17	64 00	64 00	210 90	210 90	21,390	1,282,248	21,390	1,282,248	357	357
UPR-100-N-18	11 25	11 25	37 85	37 85	107	7,336	107	7,336	17	17
UPR-100-N-19	11 25	11 25	40 25	40 25	267	8,375	267	8,375	42	42
UPR-100-N-20	10 25	10 25	35 35	35 35	134	5,842	134	5,842	21	21
UPR-100-N-21	6 25	6 25	22 85	22 85	107	1,457	107	1,457	17	17
UPR-100-N-22	11 25	11 25	38 35	38 35	134	7,548	134	7,548	21	21
UPR-100-N-23	11 25	11 25	36 65	36 65	53	6,838	53	6,838	8	8
UPR-100-N-24	10 25	10 25	40 05	40 05	535	7,585	535	7,585	86	86
UPR-100-N-25	6 25	6 25	25 25	25 25	267	1,738	267	1,738	42	42
UPR-100-N-26	6 25	6 25	28 05	28 05	535	2,066	535	2,066	86	86
UPR-100-N-29	11 00	10 00	34 50	34 50	13	5,880	11	4,461	2	2
UPR-100-N-30	11 00	10 00	47 90	47 90	1,337	11,843	1,114	9,580	222	222
UPR-100-N-32	11 25	10 00	38 35	38 35	134	7,548	107	5,486	21	21
UPR-100-N-36	7 00	7 00	22 40	22 40	13	1,588	13	1,588	2	2
UPR-100-N-37	3 00	3 00	10 30	10 30	5	143	5	143	2	2
UPR-100-N-39	9 00	9 00	30 60	30 60	53	3,856	53	3,856	13	13
UPR-100-N-40	12 00	10 00	58 80	58 80	3,128	19,881	2,086	13,959	520	520
UPR-100-N-41	4 00	4 00	17 10	17 10	134	553	134	553	26	26
UPR-100-N-42	65 00	65 00	222 40	222 40	45,046	1,449,549	45,046	1,449,549	751	751
UPR-100-N-43	11 00	11 00	41 20	41 20	401	8,637	401	8,637	67	67
100-N-1	15 00	10 00	145 00	85 00	24,000	80,750	20,000	45,000	4,000	4,000
100-N-3	17 50	17 50	85 00	85 00	15,840	53,938	15,840	53,938	1,056	1,056
100-N-4	6 00	6 00	118 00	99 00	48,600	10,638	48,600	10,638	8,100	8,100
100-N-5	2 00	2 00	141 00	141 00	36,664	1,652	36,664	1,652	18,225	18,225
100-N-6	1 00	1 00	10 30	10 30	53	26	53	26	53	53
100-N-12	1 00	1 00	5 60	5 60	7	12	7	12	7	7
100-N-13	8 00	8 00	28 20	28 20	54	2,943	54	2,943	18	18
100-N-14	8 00	8 00	28 20	28 20	54	2,943	54	2,943	18	18
100-N-16	3 00	3 00	14 50	14 50	90	317	90	317	30	30
100-N-17	3 00	3 00	13 20	13 20	18	257	18	257	18	18
100-N-18	2 00	2 00	10 20	10 20	18	100	18	100	18	18
100-N-19	1 00	1 00	13 40	13 40	108	35	108	35	108	108
100-N-22	10 00	10 00	49 00	49 00	3,249	10,061	3,249	10,061	361	361
100-N-23	1 00	1 00	5 70	5 70	53	12	53	12	7	7
100-N-24	15 00	10 00	48 00	48 00	90	15,570	45	4,945	9	9
100-N-25	11 00	10 00	42 40	42 40	535	9,178	446	7,262	88	88
100-N-26	10 00	10 00	33 00	33 00	53	4,945	53	4,945	9	9

Site Name	Depth of Excavation Res (ft)	Depth of Excavation Rec (ft)	Top Excavation Length (ft)	Top Excavation Width (ft)	Contaminated Soil Res (bcf)	Non-Contaminated Soil Res (bcf)	Contaminated Soil Rec (bcf)	Non-Contaminated Soil Rec (bcf)	Bottom Area Rec (sq. ft.)	Bottom Area Res (sq. ft.)
100-N-29	15 00		54 40	54 40	446	20,729				88
100-N-30	15 00		54 40	54 40	446	20,729				88
100-N-31	15 00		54 40	54 40	446	20,729				88
100-N-32	15 00		54 40	54 40	446	20,729				88
100-N-33	4 00	4 00	43 60	43 60	999	4,768	999	4,768	999	999
100-N-34	1 00	1 00	6 40	6 30	11	14	11	14	11	11
100-N-35	8 00	8 00	28 20	28 20	53	2,943	53	2,943	18	18
100-N-36	1 00	1 00	15 00	15 00	144	40	144	40	144	144
100-N-37	1 00	1 00	103 00	103 00	10,000	304	10,000	304	10,000	10,000
100-N-38	15 00		54 40	54 40	446	20,729				88
100-N-39	1 00	1 00	26 10	26 10	535	73	535	73	534	534
100-N-47	1 00	1 00	103 00	103 00	10,000	304	10,000	304	10,000	10,000
120-N-3	14 00	10 00	49 30	49 30	481	15,535	267	6,456	53	53
124-N-2	10 00	10 00	49 00	49 00	3,249	10,061	3,249	10,061	361	361
124-N-3	10 00	10 00	49 00	49 00	3,249	10,061	3,249	10,061	361	361
124-N-4	8 33	8 33	120 99	188 99	96,164	76,606	96,164	76,606	15,744	15,744
128-N-1	1 00	1 00	91 00	91 00	7,744	268	7,744	268	7,744	7,744
600-32	2 00	2 00	380 00	380 00	280,000	4,520	280,000	4,520	139,876	139,876
600-35	1 00	1 00	98 00	98 00	9,000	289	9,000	289	9,025	9,025

Table 4.4. Ex Situ Bioremediation Costs from RACER Model

Waste Site	Volume (LCY)	Unit Cost (/LCY)	Cost ()
UPR-100-N-18	5	359.39	1,797
UPR-100-N-19	11	359.39	3,953
UPR-100-N-20	6	359.39	2,156
UPR-100-N-21	5	359.39	1,797
UPR-100-N-22	6	359.39	2,156
UPR-100-N-23	2	359.39	719
UPR-100-N-24	23	359.39	8,266
UPR-100-N-36	1	359.39	359
UPR-100-N-43	17	359.39	6,110
100-N-3	562	N/A	64,335
100-N-12	1	359.39	359
100-N-35	2	359.39	719
100-N-36	6	359.39	2,156
124-N-2	138	N/A	38,649

Table 4.5. 100-NR-1 CMS Summary of Ex Situ Bioremediation Costs

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
UPR-100-N-18	13,070	16,970	20,060		1,430	5,000	56,530	8,480	9,140	3,960	26,557	104,667
XSITU-BIO							1,797	270	291	126	844	3,328
Total	13,070	16,970	20,060	-	1,430	5,000	58,327	8,749	9,431	4,086	27,402	107,995
UPR-100-N-19	13,140	16,970	20,180		1,510	5,000	56,800	8,520	9,184	3,979	26,684	105,167
XSITU-BIO							3,953	593	639	277	1,857	7,319
Total	13,140	16,970	20,180	-	1,510	5,000	60,753	9,113	9,823	4,256	28,541	112,486
UPR-100-N-20	13,000	16,700	19,120		1,090	5,000	54,910	8,237	8,878	3,846	25,796	101,667
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	13,000	16,700	19,120	-	1,090	5,000	57,066	8,560	9,227	3,997	26,809	105,660
UPR-100-N-21	12,730	16,420	17,620		530	5,000	52,300	7,845	8,456	3,663	24,570	96,835
XSITU-BIO							1,797	270	291	126	844	3,328
Total	12,730	16,420	17,620	-	530	5,000	54,097	8,115	8,747	3,789	25,414	100,163
UPR-100-N-22	13,080	16,970	20,070		1,430	5,000	56,550	8,483	9,144	3,961	26,567	104,704
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	13,080	16,970	20,070	-	1,430	5,000	58,706	8,806	9,493	4,112	27,580	108,696
UPR-100-N-23	13,020	16,970	19,680		1,170	5,000	55,840	8,376	9,029	3,911	26,233	103,389
XSITU-BIO							719	108	116	50	338	1,330
Total	13,020	16,970	19,680	-	1,170	5,000	56,559	8,484	9,145	3,961	26,571	104,720
UPR-100-N-24	13,150	16,970	20,540		1,590	5,000	57,250	8,588	9,257	4,010	26,895	106,000
XSITU-BIO							8,266	1,240	1,337	579	3,883	15,305
Total	13,150	16,970	20,540	-	1,590	5,000	65,516	9,827	10,594	4,589	30,779	121,305
UPR-100-N-36	12,680	16,420	17,620		530	5,000	52,250	7,838	8,448	3,660	24,547	96,742
XSITU-BIO							359	54	58	25	169	664
Total	12,680	16,420	17,620	-	530	5,000	52,609	7,891	8,506	3,685	24,715	97,407
UPR-100-N-43	13,150	16,970	20,220		1,590	5,000	56,930	8,540	9,205	3,988	26,745	105,407
XSITU-BIO							6,110	916	988	428	2,870	11,312
Total	13,150	16,970	20,220	-	1,590	5,000	63,040	9,456	10,193	4,416	29,615	116,720
100-N-3	15,030	27,260	52,230		14,320	5,000	113,840	17,076	18,407	7,974	53,481	210,777
XSITU-BIO							64,335	9,650	10,402	4,506	30,224	119,117
Total	15,030	27,260	52,230	-	14,320	5,000	178,175	26,726	28,809	12,480	83,705	329,894
100-N-12	12,300	16,150	17,030		110	5,000	50,590	7,589	8,180	3,544	23,767	93,669
XSITU-BIO							359	54	58	25	169	665
Total	12,300	16,150	17,030	-	110	5,000	50,949	7,643	8,238	3,569	23,935	94,333
100-N-35	12,820	16,420	18,050		660	5,000	52,950	7,943	8,561	3,709	24,875	98,038
XSITU-BIO							719	108	116	50	338	1,330
Total	12,820	16,420	18,050	-	660	5,000	53,669	8,050	8,677	3,759	25,213	99,369
100-N-36	12,550	16,150	17,030		180	5,000	50,910	7,637	8,232	3,566	23,917	94,261
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	12,550	16,150	17,030	-	180	5,000	53,066	7,960	8,581	3,717	24,930	98,253
124-N-2	13,510	33,990	20,750		2,790	5,000	76,040	11,406	12,295	5,326	35,723	140,790
XSITU-BIO							38,649	5,797	6,249	2,707	18,157	71,559
Total	13,510	33,990	20,750	-	2,790	5,000	114,689	17,203	18,544	8,033	53,880	212,349

Table 4.6. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Summary of Capping Costs

	Area %of	**Sub01**	**Sub02**	**Sub08**	**Sub20**	**Sub21**	**Subtotal w/o**	**PM/CM**	**Direct Distribs**	**G&A**	**Cntgcy**	**Total Cost**
Site ID	Total						PM/CM	15.00%	14.06%	5.34%	34%	
Unit#1Cap#1		242,000	6,918	211,765	193,308	18,236	672,227					
UPR-100-N-10	14.79%	35,792	1,023	31,320	28,590	2,697	99,422	14,913	16,076	6,964	46,708	184,083
UPR-100-N-39	85.21%	206,208	5,895	180,445	164,718	15,539	572,805	85,921	92,617	40,122	269,098	1,060,561
		242,000	6,918	211,765	193,308	18,236	672,227	100,834	108,692	47,086	315,805	1,244,644
Unit#1Cap#2		242,108	6,918	217,465	193,500	18,250	678,241					
UPR-100-N-29	0.92%	2,227	64	2,001	1,780	168	6,240	936	1,009	437	2,931	11,553
UPR-100-N-30	90.46%	219,011	6,258	196,719	175,040	16,509	613,537	92,031	99,203	42,975	288,233	1,135,978
UPR-100-N-32	8.62%	20,870	596	18,745	16,680	1,573	58,464	8,770	9,453	4,095	27,466	108,248
		242,108	6,918	217,465	193,500	18,250	678,241	101,736	109,665	47,507	318,631	1,255,779
Unit#4Cap#1		280,638	130,066	2,688,254	198,830	21,697	3,319,485					
UPR-100-N-4	0.18%	505	234	4,839	358	39	5,975	896	966	419	2,807	11,063
UPR-100-N-5	15.39%	43,190	20,017	413,722	30,600	3,339	510,869	76,630	82,602	35,783	240,001	945,886
UPR-100-N-6	0.41%	1,151	533	11,022	815	89	13,610	2,041	2,201	953	6,394	25,199
UPR-100-N-8	0.01%	28	13	269	20	2	332	50	54	23	156	615
UPR-100-N-25	0.23%	645	299	6,183	457	50	7,635	1,145	1,234	535	3,587	14,136
100-N-26	0.05%	140	65	1,344	99	11	1,660	249	268	116	780	3,073
124-N-4	83.73%	234,978	108,904	2,250,875	166,480	18,167	2,779,405	416,911	449,402	194,681	1,305,736	5,146,134
		280,638	130,066	2,688,254	198,830	21,697	3,319,485	497,923	536,728	232,511	1,559,460	6,146,106
Unit#4Cap#2		242,502	8,302	231,375	193,288	18,307	693,774					
UPR-100-N-9	98.26%	238,282	8,158	227,349	189,925	17,988	681,702	102,255	110,224	47,749	320,257	1,262,188
UPR-100-N-14	1.74%	4,220	144	4,026	3,363	319	12,072	1,811	1,952	846	5,671	22,351
		242,502	8,302	231,375	193,288	18,307	693,774	104,066	112,176	48,595	325,928	1,284,539
Unit#4Cap#3		242,195	6,918	211,877	193,306	18,279	672,575					
UPR-100-N-13	16.94%	41,028	1,172	35,892	32,746	3,096	113,934	17,090	18,422	7,980	53,525	210,952
UPR-100-N-26	83.06%	201,167	5,746	175,985	160,560	15,183	558,641	83,796	90,327	39,130	262,444	1,034,337
		242,195	6,918	211,877	193,306	18,279	672,575	100,886	108,749	47,110	315,969	1,245,289

Table 4.7. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Summary of Capping Costs

Site Name	Remove/Dispose	Capping	In Situ Solidification
CAP1-1			
UPR-100-N-10	95,391	653,884	157,016
UPR-100-N-39	99,297	3,767,236	415,600
Subtotal	194,688	4,421,120	572,616
CAP1-2			
UPR-100-N-29	100,630	41,563	158,467
UPR-100-N-30	112,776	4,086,761	349,849
UPR-100-N-32	101,908	389,430	173,568
Subtotal	315,314	4,517,754	681,884
CAP4-1			
UPR-100-N-4	97,464	83,646	192,295
UPR-100-N-5	218,961	7,151,720	651,238
UPR-100-N-6	104,056	190,527	217,955
UPR-100-N-8	95,391	4,647	157,016
UPR-100-N-25	97,779	106,881	202,532
100-N-26	101,593	23,235	163,047
124-N-4	766,864	38,909,260	1,388,214
Subtotal	1,482,108	46,469,916	2,972,297
CAP4-2			
UPR-100-N-9	104,307	4,672,424	345,617
UPR-100-N-14	95,409	82,740	158,496
Subtotal	199,716	4,755,164	504,113
CAP4-3			
UPR-100-N-13	88,873	749,331	181,321
UPR-100-N-26	99,908	3,674,112	252,221
Subtotal	188,781	4,423,443	433,542
Miscellaneous In Situ Solidification			
UPR-100-N-1	150,214		386,077
UPR-100-N-11	95,835		345,010
100-N-13	98,242		340,414
100-N-14	98,242		340,414
Subtotal	442,533		1,411,915
Total for Capping and Remove/Dispose	2,380,607	64,587,397	
Total for In Situ Solidification and Remove/Dispose	2,823,140		6,576,367

[a] Costs based on the modified CRCIA ranger/industrial exposure scenario
NA-Not Applicable

Table 4.8. 100-NR-1 CMS In Situ Bioremediation

Site ID	Total Site Volume (bcy)	Time Frame Years	Task Subtotals	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Contingency 34%		Total Cost
UPR-100-N-17									
Site Restoration	1,170		1,170	176	189	82	550		3,336
Construction	77,100		77,100	11,565	12,466	5,400	36,221	Capital	219,852
RACERO & M Cost	23,644	15.00	354,660	53,199	57,345	24,842	166,616	O&M	680,321
Total			$432,930	$64,940	$70,000	$30,324	$203,386		$903,510
UPR-100-N-42									
Site Restoration	2,190		2,190	329	354	153	1,029		6,245
Construction	78,365		78,365	11,755	12,671	5,489	36,815	Capital	223,460
RACERO & M Cost	23,644	15.00	354,660	53,199	57,345	24,842	166,616	O&M	680,321
Total			$435,215	$65,282	$70,370	$30,484	$204,460		$910,026

Table 4.9. 100-NR-1/2 CMS In Situ Solidification

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
UPR-100-N-1(rec)	4963	16835	24320	RACER Model Run					
RACER Fixed Cost	83,550			12,533	13,509	5,852	39,251	Capital	154,695
RACER Variable Cost	120,699			18,105	19,516	8,454	56,703	O&M	223,477
Soil Cover Cost	4,269			640	690	299	2,006	Cover	7,905
	204,249		-	31,278	33,715	14,606	97,960		386,077
UPR-100-N-5(rec)	8926	16835	24320	UPR-100-N-1(rec) Unit cost					
RACER Fixed Cost	83,550			12,533	13,509	5,852	39,251	Capital	154,695
RACER Variable Cost	217,078			32,562	35,099	15,205	101,981	O&M	401,926
Soil Cover Cost	9,385			1,408	1,518	657	4,409	Cover	17,377
	310,014		-	46,502	50,126	21,715	145,641		573,998
UPR-100-N-30(rec)	822	1,01285	1,26746	RACER Model Run					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	104,185			15,628	16,846	7,298	48,945	O&M	192,901
Soil Cover Cost	1,511			227	244	106	710	Cover	2,798
	187,441		-	28,343	30,552	13,235	88,768		349,849
UPR-100-N-6(rec)	264	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	33,461			5,019	5,410	2,344	15,720	O&M	61,954
Soil Cover Cost	1,000			150	162	70	470	Cover	1,851
	116,717		-	17,657	19,034	8,245	55,302		217,955
UPR-100-N-32(rec)	78	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	9,886			1,483	1,598	692	4,644	O&M	18,304
Soil Cover Cost	601			90	97	42	282	Cover	1,113
	93,142		-	14,061	15,157	6,566	44,040		173,568
100-N-26(rec)	33	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	4,183			627	676	293	1,965	O&M	7,744
Soil Cover Cost	622			93	101	44	292	Cover	1,152
	87,439		-	13,209	14,239	6,168	41,370		163,047
UPR-100-N-9(rec)	391	2,12834	2,61148	RACER Model Run					
RACER Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
RACER Variable Cost	102,109			15,316	16,510	7,152	47,970	O&M	189,057
Soil Cover Cost	1,339			201	217	94	629	Cover	2,480
	185,327		-	28,000	30,182	13,075	87,694		345,617
UPR-100-N-4(rec)	76	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	19,847			2,977	3,209	1,390	9,324	O&M	36,748
Soil Cover Cost	792			119	128	55	372	Cover	1,467
	103,065		-	15,579	16,793	7,275	48,791		192,295
UPR-100-N-8(rec)	04	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,045			157	169	73	491	O&M	1,934
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	84,263		-	12,721	13,712	5,940	39,840		157,016
UPR-100-N-10(rec)	04	2,12834	2,61148	UPR-100-N-9(rec)Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,045			157	169	73	491	O&M	1,934
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	84,263		-	12,721	13,712	5,940	39,840		157,016
UPR-100-N-14(rec)	07	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,828			274	296	128	859	O&M	3,385
Soil Cover Cost	557			84	90	39	262	Cover	1,031
	85,046		-	12,840	13,841	5,996	40,215		158,496
UPR-100-N-25(rec)	97	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Capital Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Fixed Cost	25,331			3,800	4,096	1,774	11,900	O&M	46,902
Variable Cost	837			126	135	59	393	Cover	1,550
Soil Cover Cost	108,549		-	16,408	17,687	7,662	51,389		202,532
UPR-100-N-26(rec)	199	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	51,969			7,795	8,403	3,640	24,414	O&M	96,221
Soil Cover Cost	1,037			156	168	73	487	Cover	1,920
	135,187		-	20,434	22,026	9,542	63,996		252,221
UPR-100-N-29(rec)	07	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
RACER Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
RACER Variable Cost	1,828			274	296	128	859	O&M	3,385
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	85,587		-	12,838	13,839	5,995	40,208		158,467
UPR-100-N-11(rec)	145	5,73869	7,01372	RACER Model Run					
RACER Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
RACER Variable Cost	101,699			15,255	16,444	7,123	47,777	O&M	188,298
Soil Cover Cost	1,428			214	231	100	671	Cover	2,645
	186,338		-	27,951	30,129	13,052	87,540		345,010

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
UPR-100-N-13(rec)	2	5,73869	7,01372	UPR-100-N-11(rec) Unit cost					
Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
Variable Cost	14,027			2,104	2,268	983	6,590	O&M	25,972
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	97,931		-	14,690	15,834	6,859	46,007		181,321
UPR-100-N-39(rec)	198	5,73869	7,01372	UPR-100-N-11(rec) Unit cost					
Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
Variable Cost	138,872			20,831	22,454	9,727	65,241	O&M	257,124
Soil Cover Cost	2,381			357	385	167	1,119	Cover	4,409
	224,464		-	33,670	36,294	15,722	105,451		415,600
124-N-4(rec)	48573	4380	10416	RACER Model Run					
RACER Fixed Cost	212,729			31,909	34,396	14,900	99,938	Capital	393,873
RACER Variable Cost	505,941			75,891	81,806	35,438	237,686	O&M	936,762
Soil Cover Cost	31,098			4,665	5,028	2,178	14,610	Cover	57,579
	749,768		-	112,465	121,230	52,517	352,233		1,388,214
100-N-14(rec)	53	15,29528	19,26396	RACER Model Run					
RACER Fixed Cost	81,065			12,160	13,107	5,678	38,083	Capital	150,094
RACER Variable Cost	102,099			15,315	16,508	7,151	47,965	O&M	189,039
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	183,164		-	27,578	29,728	12,878	86,374		340,414
100-N-13(rec)	53	15,29528	19,26396	100-N-14(rec) Unit cost					
Fixed Cost	81,065			12,160	13,107	5,678	38,083	Capital	150,094
Variable Cost	102,099			15,315	16,508	7,151	47,965	O&M	189,039
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	183,164		-	27,578	29,728	12,878	86,374		340,414

Table 4.10. 100-N-46 Underground Fuel Storage Tank at HGP

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 26.0%	Home Off. 3.0%	S/C Fee 4.0%	B&O Tax 0.47%	Total Bid
Pre-Construction Activities	-	124	14,233	-	14,358	ERC Activities Include DD&G&A)				14,358
Prepare Site/ Mobilize	848	216	3,029	-	4,092	1,064	155	212	26	5,549
Removal Action	2,004	486	2,292	12,247	17,030	4,428	644	884	108	23,093
Restore Site	749	-	347	84	1,181	307	45	61	7	1,602
Tank Disposal	437	-	1,201	-	1,638	426	62	85	10	2,221
Removal Activity Closeout	-	-	1,920	-	1,920	ERC Activities (Include DD&G&A)				1,920
Subtotals:	$4,038	$826	$23,023	$12,332	$40,218	6,225	905	1,243	152	$48,743

	ERC Direct Distribs @18.09%			5,873
	(excludes ERC labor)			
Pre-Construction and Close out are performed with ERC Labor	ERC G&A @4.04		1,549	
Removal and site restoration work performed with Subcontractor (Building Trades) Labor.	(excludes ERC labor)			
Sample Analysis costs: Average ERC Cost for FY97 (Quanterra) (Inter office Memo Jan 15, 1997)	TOTAL:		56,165	
	Contingency @ 34%		19,096	
		TOTAL:	75,261	

Table 4.11. Rivershore Site Residential Scenario Remove/Dispose Summary

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 26.00%	Home Office 3.00%	S/C Fee 4.00%	B&O Tax 0.47%	Total Bid
Grout Wells	-	49	450	-	499	130	19	26	3	676
Excavate Site	107,489	92,794	285,981	577,095	1,063,359	276,473	40,195	55,201	6,746	1,441,974
Restore Site	197,503	266,706	113,099	42,830	620,137	161,236	23,441	32,193	3,934	840,941
Support Facilities	-	-	-	133,920	133,920	34,819	5,062	6,952	850	181,603
Mobilization/Demobilization	29,914	4,502	136,783	-	171,199	44,512	6,471	8,887	1,086	232,155
Subtotals:	334,905	364,052	536,312	753,844	1,989,114	517,170	75,189	103,259	12,618	2,697,349

Bond		25,962
Total Subcontractor Cost	SUBTOTAL:	2,723,311
PM/CM @15%		408,497
	SUBTOTAL:	3,131,808
Haul to ERDF and Disposal		3,447,990
	SUBTOTAL:	6,579,798
Assumptions:		
All excavation will take place above the water table.	Directdistribs@18.09%	1,190,285
Backfill material consists of clean natural fill material from the 100 BC Area.		
Riprap material above the water line is placed with a backhoe.	G&A@4.04%	313,911
Rip-rapmaterialwasassumedtoinclude4feetof+2ftmaterialrestingon2feetof12"minusmaterial.		
Existing wells will be grouted closed.	TOTAL:	8,083,995
Two new monitoring wells will be established through the clean cover material.		
Contractor markups are taken from the 300 FFFPE.	Contingency@34%	2,748,558
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.		
	TOTAL:	**10,832,553**

Table 4.12. Riversshore Site Modified CRCIA Ranger/Industrial Scenario Remove/Dispose Net Present Value

Calculation of Net Present Value annually escalated at 3.2% per year and discounted at 10% (7% plus 3.2%) per year for 300 years. The 3.2% is published by the U.S. Department of Energy (DOE) and is an average for 300 years, and the 7% Discount Rate was obtained from the U.S. Environmental Protection Agency (EPA) Hotline (800) 424-9346. The first year is not escalated or discounted.

The cash flow is made up of the following:

100 NR-1 & 100-NR-2 CMS rivershore site recreational scenario: remove/dispose alternative work must be repeated every 20 years.

				Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs				7%		1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
1	$9,738,935	$9,738,935	$9,738,935	1000	$9,738,935	100	$9,738,93500
2				1032		110	
3				1065		121	
4				1099		134	
5				1134		147	
6				1171		163	
7				1208		179	
8				1247		197	
9				1287		217	
10				1328		240	
11				1370		264	
12				1414		291	
13				1459		321	
14				1506		353	
15				1554		390	
16				1604		429	
17				1655		473	
18				1708		521	
19				1763		574	
20				1819		633	
21	$9,738,935	$9,738,935	$9,738,935	1878	$18,285,440	698	$2,621,03924
22				1938		769	
23				2000		847	
24				2064		934	
25				2130		1029	
26				2198		1134	
27				2268		1249	
28				2341		1377	
29				2416		1517	
30				2493		1672	
31				2573		1843	
32				2655		2031	
33				2740		2238	
34				2828		2466	
35				2918		2718	

				Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs				7%		1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
36				3012		2995	
37				3108		3300	
38				3207		3637	
39				3310		4008	
40				3416		4417	
41	$9,738,935	$9,738,935	$9,738,935	3525	$34,332,020	4867	$705,40020
42				3638		5363	
43				3754		5911	
44				3875		6513	
45				3999		7178	
46				4127		7910	
47				4259		8717	
48				4395		9606	
49				4536		10586	
50				4681		11665	
51				4830		12855	
52				4985		14166	
53				5145		15611	
54				5309		17204	
55				5479		18959	
56				5654		20892	
57				5835		23023	
58				6022		25372	
59				6215		27960	
60				6414		30812	
61	$9,738,935	$9,738,935	$9,738,935	6619	$64,460,446	33954	$189,84433
62				6831		37418	
63				7049		41234	
64				7275		45440	
65				7508		50075	
66				7748		55183	
67				7996		60811	
68				8252		67014	
69				8516		73850	
70				8788		81382	
71				9069		89683	
72				9360		98831	
73				9659		1,08912	
74				9968		1,20021	
75				10287		1,32263	
76				10616		1,45754	
77				10956		1,60621	
78				11307		1,77004	
79				11669		1,95058	
80				12042		2,14954	
81	$9,738,935	$9,738,935	$9,738,935	12427	$121,028,388	2,36880	$51,09280
82				12825		2,61041	

				Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs				7%		1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
83				13235		2,87667	
84				13659		3,17010	
85				14096		3,49345	
86				14547		3,84978	
87				15013		4,24245	
88				15493		4,67518	
89				15989		5,15205	
90				16500		5,67756	
91				17028		6,25667	
92				17573		6,89485	
93				18136		7,59813	
94				18716		8,37314	
95				19315		9,22720	
96				19933		10,16837	
97				20571		11,20555	
98				21229		12,34851	
99				21908		13,60806	
100				22609		14,99608	
101	$9,738,935	$9,738,935	$9,738,935	23333	$227,238,125	16,52568	$13,75060
102				24080		18,21130	
103				24850		20,06886	
104				25645		22,11588	
105				26466		24,37170	
106				27313		26,85761	
107				28187		29,59709	
108				29089		32,61599	
109				30020		35,94282	
110				30980		39,60899	
111				31972		43,64911	
112				32995		48,10132	
113				34051		53,00765	
114				35140		58,41443	
115				36265		64,37271	
116				37425		70,93872	
117				38623		78,17447	
118				39859		86,14827	
119				41134		94,93539	
120				42451		104,61880	
121	$9,738,935	$9,738,935	$9,738,935	43809	$426,653,333	115,28992	$3,70070
122				45211		127,04949	
123				46658		140,00854	
124				48151		154,28941	
125				49692		170,02693	
126				51282		187,36968	
127				52923		206,48139	
128				54616		227,54249	
129				56364		250,75182	

				Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs				7%		1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
130				58168		276,32851	
131				60029		304,51402	
132				61950		335,57445	
133				63932		369,80304	
134				65978		407,52295	
135				68089		449,09029	
136				70268		494,89750	
137				72517		545,37704	
138				74837		601,00550	
139				77232		662,30806	
140				79704		729,86349	
141	$9,738,935	$9,738,935	$9,738,935	82254	$801,067,455	804,30956	$99597
142				84886		886,34914	
143				87603		976,75675	
144				90406		1,076,38594	
145				93299		1,186,17730	
146				96284		1,307,16739	
147				99366		1,440,49846	
148				102545		1,587,42931	
149				105827		1,749,34710	
150				109213		1,927,78050	
151				112708		2,124,41411	
152				116315		2,341,10435	
153				120037		2,579,89699	
154				123878		2,843,04649	
155				127842		3,133,03723	
156				131933		3,452,60703	
157				136155		3,804,77294	
158				140512		4,192,85978	
159				145008		4,620,53148	
160				149648		5,091,82569	
161	$9,738,935	$9,738,935	$9,738,935	154437	$1,504,052,632	5,611,19191	$26805
162				159379		6,183,53349	
163				164479		6,814,25390	
164				169743		7,509,30780	
165				175174		8,275,25720	
166				180780		9,119,33343	
167				186565		10,049,50544	
168				192535		11,074,55499	
169				198696		12,204,15960	
170				205054		13,448,98388	
171				211616		14,820,78024	
172				218388		16,332,49982	
173				225376		17,998,41481	
174				232588		19,834,25312	
175				240031		21,857,34693	
176				247712		24,086,79632	

				Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs				7%		1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
177				255639		26,543,64955	
178				263819		29,251,10180	
179				272261		32,234,71418	
180				280974		35,522,65503	
181	$9,738,935	$9,738,935	$9,738,935	289965	$2,823,949,849	39,145,96584	$7214
182				299244		43,138,85436	
183				308820		47,539,01751	
184				318702		52,387,99729	
185				328900		57,731,57301	
186				339425		63,620,19346	
187				350287		70,109,45320	
188				361496		77,260,61742	
189				373064		85,141,20040	
190				385002		93,825,60284	
191				397322		103,395,81433	
192				410036		113,942,18739	
193				423157		125,564,29050	
194				436698		138,371,84814	
195				450673		152,485,77664	
196				465094		168,039,32586	
197				479977		185,179,33710	
198				495337		204,067,62949	
199				511187		224,882,52769	
200				527545		247,820,54552	
201	$9,738,935	$9,738,935	$9,738,935	544427	$5,302,136,760	273,098,24116	$1941
202				561848		300,954,26176	
203				579828		331,651,59646	
204				598382		365,480,05930	
205				617530		402,759,02534	
206				637291		443,840,44593	
207				657685		489,112,17141	
208				678730		539,001,61290	
209				700450		593,979,77741	
210				722864		654,565,71471	
211				745996		721,331,41761	
212				769868		794,907,22221	
213				794504		875,987,75887	
214				819928		965,338,51028	
215				846165		1,063,803,03833	
216				873243		1,172,310,94824	
217				901186		1,291,886,66496	
218				930024		1,423,659,10478	
219				959785		1,568,872,33347	
220				990498		1,728,897,31148	
221	$9,738,935	$9,738,935	$9,738,935	1022194	$9,955,082,680	1,905,244,83725	$523
222				1054904		2,099,579,81065	
223				1088661		2,313,736,95134	

				Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs				7%		1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
224				1123498		2,549,738,12038	
225				1159450		2,809,811,40865	
226				1196553		3,096,412,17234	
227				1234843		3,412,246,21392	
228				1274358		3,760,295,32773	
229				1315137		4,143,845,45116	
230				1357221		4,566,517,68718	
231				1400652		5,032,302,49128	
232				1445473		5,545,597,34539	
233				1491728		6,111,248,27461	
234				1539464		6,734,595,59863	
235				1588727		7,421,524,34968	
236				1639566		8,178,519,83335	
237				1692032		9,012,728,85635	
238				1746177		9,932,027,19970	
239				1802055		10,945,093,97407	
240				1859720		12,061,493,55943	
241	$9,738,935	$9,738,935	$9,738,935	1919231	$18,691,270,263	$13,291,765,90249	$141
242				1980647		14,647,526,02454	
243				2044028		16,141,573,67905	
244				2109436		17,788,014,19431	
245				2176938		19,602,391,64213	
246				2246600		21,601,835,58963	
247				2318492		23,805,222,81977	
248				2392683		26,233,355,54739	
249				2469249		28,909,157,81322	
250				2548265		31,857,891,91017	
251				2629810		35,107,396,88500	
252				2713964		38,688,351,36727	
253				2800810		42,634,563,20674	
254				2890436		46,983,288,65382	
255				2982930		51,775,584,09651	
256				3078384		57,056,693,67436	
257				3176892		62,876,476,42914	
258				3278553		69,289,877,02491	
259				3383467		76,357,444,48146	
260				3491738		84,145,903,81856	
261	$9,738,935	$9,738,935	$9,738,935	3603473	$35,093,991,210	92,728,786,00806	$038
262				3718784		102,187,122,18088	
263				3837785		112,610,208,64333	
264				3960595		124,096,449,92495	
265				4087334		136,754,287,81729	
266				4218128		150,703,225,17466	
267				4353108		166,074,954,14247	
268				4492408		183,014,599,46501	
269				4636165		201,682,088,61044	
270				4784522		222,253,661,64870	

				Rate		**Compounding Value**	**Total Net**
Discount Rate % (EPA) for 300 Yrs				7%		1102	**Present Worth**
Inflation Rate % (DOE) for 300 Yrs				32%		1032	13,325,126
Yr of O & M		**Total**	**Cash Flow in 1997 $**	**Compounded Escalation Factor**	**Compounded Escalated Costs**	**Compounded @ Discount Rate Factor**	**Net Present Discounted Worth**
Startup Capital Costs							
271				4937627		244,923,535,13687	
272				5095631		269,905,735,72083	
273				5258691		297,436,120,76435	
274				5426969		327,774,605,08232	
275				5600632		361,207,614,80071	
276				5779852		398,050,791,51039	
277				5964808		438,651,972,24445	
278				6155682		483,394,473,41338	
279				6352663		532,700,709,70154	
280				6555949		587,036,182,09110	
281	$9,738,935	$9,738,935	$9,738,935	6765739	$65,891,092,563	646,913,872,66439	$010
282				6982243		712,899,087,67616	
283				7205674		785,614,794,61913	
284				7436256		865,747,503,67028	
285				7674216		954,053,749,04465	
286				7919791		1,051,367,231,44720	
287				8173224		1,158,606,689,05482	
288				8434768		1,276,784,571,33841	
289				8704680		1,407,016,597,61493	
290				8983230		1,550,532,290,57165	
291				9270693		1,708,686,584,20996	
292				9567356		1,882,972,615,79938	
293				9873511		2,075,035,822,61091	
294				10189463		2,286,689,476,51723	
295				10515526		2,519,931,803,12198	
296				10852023		2,776,964,847,04043	
297				11199288		3,060,215,261,43855	
298				11557665		3,372,357,218,10528	
299				11927510		3,716,337,654,35202	
300				12309190		4,095,404,095,09593	
Total	$146,084,025	$146,084,025	$146,084,025		$140,964,380,098		$13,325,126

Table 4.13. Rivershore Site Modified CRCIA Ranger/Industrial Scenario Remove/Dispose Summary

Item Description	Equipment	Materials	Labor	S/C	Subtotal	Field Distribs	Home Office	S/C Fee	B&O Tax	Total Bid
	$	$	$	$	Direct	26.00%	3.00%	4.00%	0.47%	**$**
Grout Wells	$-	$66	$450	$-	$516	$134	$19	$27	$3	$699
Excavate Site	$93,772	$80,955	$249,486	$533,273	$957,486	$248,946	$36,193	$49,705	$6,074	$1,298,404
Restore Site	$175,411	$266,706	$98,275	$42,830	$583,222	$151,638	$22,046	$30,276	$3,700	$790,881
Support Facilities	$-	$-	$-	$133,920	$133,920	$34,819	$5,062	$6,952	$850	$181,603
Mobilization/ Demobilization	$29,914	$4,502	$136,783	$-	$171,199	$44,512	$6,471	$8,887	$1,086	$232,155
Subtotals:	$299,097	$352,230	$484,993	$710,022	$1,846,342	$480,049	$69,792	$95,847	$11,713	$2,503,743
Bond										$24,626
Total Subcontractor Cost								Subtotal:		$2,528,369
PM/CM @ 15%										$379,255
								Subtotal:		$2,907,624
Haul to ERDF& Disposal										$3,007,900
								Subtotal:		$5,915,524

Assumptions:	Direct distribs @ 18.09%	$1,070,118
All excavation will take place above the water table.		
Backfill material consists of clean natural fill material from the 100 BC Area.	G&A @ 4.04%	$282,220
Riprap material above the waterline is placed with a backhoe.		
Rip-rap material was assumed to include 4 feet of +2ft material resting on 2 feet of 12 " minus material.	TOTAL:	$7,267,862
Existing wells will be grouted closed.		
Two new monitoring wells will be established through the clean cover material.	Contingency @ 34%	$2,471,073
Contractor markups are taken from the 300 FF FPE.		
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.	**TOTAL:**	**$9,738,935**

Table 4.14. Rivershore Site Residential Scenario Remove/Dispose Net Present Value

Calculation of Net Present Value annually escalated at 3.2 % per year and discounted at 10 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % is published by DOE and is an average for 300 years, and the 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

The cash flow is made up of the following:

100-NR-1 & 100-NR-2 CMS river shore site, residential scenario: remove/dispose alternative work must be repeated every 20 years

		Rate		Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs.		7%		1.102	Present Worth
Inflation Rate % (DOE) for 300 Yrs.		3.2%		1.032	14,821,449

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
1	10,832,553	10,832,553	10,832,553	1.000	10,832,553	1.00	10,832,553.00
2			-	1.032	-	1.10	
3			-	1.065	-	1.21	
4			-	1.099	-	1.34	
5			-	1.134	-	1.47	
6			-	1.171	-	1.63	
7			-	1.208	-	1.79	
8			-	1.247	-	1.97	
9			-	1.287	-	2.17	
10			-	1.328	-	2.40	
11			-	1.370	-	2.64	
12			-	1.414	-	2.91	
13			-	1.459	-	3.21	
14			-	1.506	-	3.53	
15			-	1.554	-	3.90	
16			-	1.604	-	4.29	
17			-	1.655	-	4.73	
18			-	1.708	-	5.21	
19			-	1.763	-	5.74	
20			-	1.819	-	6.33	
21	10,832,553	10,832,553	10,832,553	1.878	20,338,774	6.98	2,915,364.61
22			-	1.938	-	7.69	
23			-	2.000	-	8.47	
24			-	2.064	-	9.34	
25			-	2.130	-	10.29	
26			-	2.198	-	11.34	
27			-	2.268	-	12.49	
28			-	2.341	-	13.77	
29			-	2.416	-	15.17	
30			-	2.493	-	16.72	
31			-	2.573	-	18.43	
32			-	2.655	-	20.31	
33			-	2.740	-	22.38	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
34			-	2.828	-	24.66	
35			-	2.918	-	27.18	
36			-	3.012	-	29.95	
37			-	3.108	-	33.00	
38			-	3.207	-	36.37	
39			-	3.310	-	40.08	
40			-	3.416	-	44.17	
41	10,832,553	10,832,553	10,832,553	3.525	38,187,279	48.67	784,611.98
42			-	3.638	-	53.63	
43			-	3.754	-	59.11	
44			-	3.875	-	65.13	
45			-	3.999	-	71.78	
46			-	4.127	-	79.10	
47			-	4.259	-	87.17	
48			-	4.395	-	96.06	
49			-	4.536	-	105.86	
50			-	4.681	-	116.65	
51			-	4.830	-	128.55	
52			-	4.985	-	141.66	
53			-	5.145	-	156.11	
54			-	5.309	-	172.04	
55			-	5.479	-	189.59	
56			-	5.654	-	208.92	
57			-	5.835	-	230.23	
58			-	6.022	-	253.72	
59			-	6.215	-	279.60	
60			-	6.414	-	308.12	
61	10,832,553	10,832,553	10,832,553	6.619	71,698,928	339.54	211,162.59
62			-	6.831	-	374.18	
63			-	7.049	-	412.34	
64			-	7.275	-	454.40	
65			-	7.508	-	500.75	
66			-	7.748	-	551.83	
67			-	7.996	-	608.11	
68			-	8.252	-	670.14	
69			-	8.516	-	738.50	
70			-	8.788	-	813.82	
71			-	9.069	-	896.83	
72			-	9.360	-	988.31	
73			-	9.659	-	1,089.12	
74			-	9.968	-	1,200.21	
75			-	10.287	-	1,322.63	
76			-	10.616	-	1,457.54	
77			-	10.956	-	1,606.21	
78			-	11.307	-	1,770.04	
79			-	11.669	-	1,950.58	
80			-	12.042	-	2,149.54	
81	10,832,553	10,832,553	10,832,553	12.427	134,619,076	2,368.80	56,830.18

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
82			-	12.825	-	2,610.41	
83			-	13.235	-	2,876.67	
84			-	13.659	-	3,170.10	
85			-	14.096	-	3,493.45	
86			-	14.547	-	3,849.78	
87			-	15.013	-	4,242.45	
88			-	15.493	-	4,675.18	
89			-	15.989	-	5,152.05	
90			-	16.500	-	5,677.56	
91			-	17.028	-	6,256.67	
92			-	17.573	-	6,894.85	
93			-	18.136	-	7,598.13	
94			-	18.716	-	8,373.14	
95			-	19.315	-	9,227.20	
96			-	19.933	-	10,168.37	
97			-	20.571	-	11,205.55	
98			-	21.229	-	12,348.51	
99			-	21.908	-	13,608.06	
100			-	22.609	-	14,996.08	
101	10,832,553	10,832,553	10,832,553	23.333	252,755,463	16,525.68	15,294.70
102			-	24.080	-	18,211.30	
103			-	24.850	-	20,068.86	
104			-	25.645	-	22,115.88	
105			-	26.466	-	24,371.70	
106			-	27.313	-	26,857.61	
107			-	28.187	-	29,597.09	
108			-	29.089	-	32,615.99	
109			-	30.020	-	35,942.82	
110			-	30.980	-	39,608.99	
111			-	31.972	-	43,649.11	
112			-	32.995	-	48,101.32	
113			-	34.051	-	53,007.65	
114			-	35.140	-	58,414.43	
115			-	36.265	-	64,372.71	
116			-	37.425	-	70,938.72	
117			-	38.623	-	78,174.47	
118			-	39.859	-	86,148.27	
119			-	41.134	-	94,935.39	
120			-	42.451	-	104,618.80	
121	10,832,553	10,832,553	10,832,553	43.809	474,563,680	115,289.92	4,116.26
122			-	45.211	-	127,049.49	-
123			-	46.658	-	140,008.54	
124			-	48.151	-	154,289.41	
125			-	49.692	-	170,026.93	
126			-	51.282	-	187,369.68	
127			-	52.923	-	206,481.39	
128			-	54.616	-	227,542.49	
129			-	56.364	-	250,751.82	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
130			-	58.168	-	276,328.51	
131			-	60.029	-	304,514.02	
132			-	61.950	-	335,574.45	
133			-	63.932	-	369,803.04	
134			-	65.978	-	407,522.95	
135			-	68.089	-	449,090.29	
136			-	70.268	-	494,897.50	
137			-	72.517	-	545,377.04	
138			-	74.837	-	601,005.50	
139			-	77.232	-	662,308.06	
140			-	79.704	-	729,863.49	
141	10,832,553	10,832,553	10,832,553	82.254	891,022,033	804,309.56	1,107.81
142			-	84.886	-	886,349.14	
143			-	87.603	-	976,756.75	
144			-	90.406	-	1,076,385.94	
145			-	93.299	-	1,186,177.30	
146			-	96.284	-	1,307,167.39	
147			-	99.366	-	1,440,498.46	
148			-	102.545	-	1,587,429.31	
149			-	105.827	-	1,749,347.10	
150			-	109.213	-	1,927,780.50	
151			-	112.708	-	2,124,414.11	
152			-	116.315	-	2,341,104.35	
153			-	120.037	-	2,579,896.99	
154			-	123.878	-	2,843,046.49	
155			-	127.842	-	3,133,037.23	
156			-	131.933	-	3,452,607.03	
157			-	136.155	-	3,804,772.94	
158			-	140.512	-	4,192,859.78	
159			-	145.008	-	4,620,531.48	
160			-	149.648	-	5,091,825.69	
161	10,832,553	10,832,553	10,832,553	154.437	1,672,947,796	5,611,191.91	298.14
162			-	159.379	-	6,183,533.49	
163			-	164.479	-	6,814,253.90	
164			-	169.743	-	7,509,307.80	
165			-	175.174	-	8,275,257.20	
166			-	180.780	-	9,119,333.43	
167			-	186.565	-	10,049,505.44	
168			-	192.535	-	11,074,554.99	
169			-	198.696	-	12,204,159.60	
170			-	205.054	-	13,448,983.88	
171			-	211.616	-	14,820,780.24	
172			-	218.388	-	16,332,499.82	
173			-	225.376	-	17,998,414.81	
174			-	232.588	-	19,834,253.12	
175			-	240.031	-	21,857,346.93	
176			-	247.712	-	24,086,796.32	
177			-	255.639	-	26,543,649.55	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
178			-	263.819	-	29,251,101.80	
179			-	272.261	-	32,234,714.18	
180			-	280.974	-	35,522,655.03	
181	10,832,553	10,832,553	10,832,553	289.965	3,141,060,743	39,145,965.84	80.24
182			-	299.244	-	43,138,854.36	
183			-	308.820	-	47,539,017.51	
184			-	318.702	-	52,387,997.29	
185			-	328.900	-	57,731,573.01	
186			-	339.425	-	63,620,193.46	
187			-	350.287	-	70,109,453.20	
188			-	361.496	-	77,260,617.42	
189			-	373.064	-	85,141,200.40	
190			-	385.002	-	93,825,602.84	
191			-	397.322	-	103,395,814.33	
192			-	410.036	-	113,942,187.39	
193			-	423.157	-	125,564,290.50	
194			-	436.698	-	138,371,848.14	
195			-	450.673	-	152,485,776.64	
196			-	465.094	-	168,039,325.86	
197			-	479.977	-	185,179,337.10	
198			-	495.337	-	204,067,629.49	
199			-	511.187	-	224,882,527.69	
200			-	527.545	-	247,820,545.52	
201	10,832,553	10,832,553	10,832,553	544.427	5,897,531,657	273,098,241.16	21.59
202			-	561.848	-	300,954,261.76	
203			-	579.828	-	331,651,596.46	
204			-	598.382	-	365,480,059.30	
205			-	617.530	-	402,759,025.34	
206			-	637.291	-	443,840,445.93	
207			-	657.685	-	489,112,171.41	
208			-	678.730	-	539,001,612.90	
209			-	700.450	-	593,979,777.41	
210			-	722.864	-	654,565,714.71	
211			-	745.996	-	721,331,417.61	
212			-	769.868	-	794,907,222.21	
213			-	794.504	-	875,987,758.87	
214			-	819.928	-	965,338,510.28	
215			-	846.165	-	1,063,803,038.33	
216			-	873.243	-	1,172,310,948.24	
217			-	901.186	-	1,291,886,664.96	
218			-	930.024	-	1,423,659,104.78	
219			-	959.785	-	1,568,872,333.47	
220			-	990.498	-	1,728,897,311.48	
221	10,832,553	10,832,553	10,832,553	1022.194	11,072,972,635	1,905,244,837.25	5.81
222			-	1054.904	-	2,099,579,810.65	
223			-	1088.661	-	2,313,736,951.34	
224			-	1123.498	-	2,549,738,120.38	
225			-	1159.450	-	2,809,811,408.65	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
226			-	1196.553	-	3,096,412,172.34	
227			-	1234.843	-	3,412,246,213.92	
228			-	1274.358	-	3,760,295,327.73	
229			-	1315.137	-	4,143,845,451.16	
230			-	1357.221	-	4,566,517,687.18	
231			-	1400.652	-	5,032,302,491.28	
232			-	1445.473	-	5,545,597,345.39	
233			-	1491.728	-	6,111,248,274.61	
234			-	1539.464	-	6,734,595,598.63	
235			-	1588.727	-	7,421,524,349.68	
236			-	1639.566	-	8,178,519,833.35	
237			-	1692.032	-	9,012,728,856.35	
238			-	1746.177	-	9,932,027,199.70	
239			-	1802.055	-	10,945,093,974.07	
240			-	1859.720	-	12,061,493,559.43	
241	10,832,553	10,832,553	10,832,553	1919.231	20,790,176,315	13,291,765,902.49	1.56
242			-	1980.647	-	14,647,526,024.54	
243			-	2044.028	-	16,141,573,679.05	
244			-	2109.436	-	17,788,014,194.31	
245			-	2176.938	-	19,602,391,642.13	
246			-	2246.600	-	21,601,835,589.63	
247			-	2318.492	-	23,805,222,819.77	
248			-	2392.683	-	26,233,355,547.39	
249			-	2469.249	-	28,909,157,813.22	
250			-	2548.265	-	31,857,891,910.17	
251			-	2629.810	-	35,107,396,885.00	
252			-	2713.964	-	38,688,351,367.27	
253			-	2800.810	-	42,634,563,206.74	
254			-	2890.436	-	46,983,288,653.82	
255			-	2982.930	-	51,775,584,096.51	
256			-	3078.384	-	57,056,693,674.36	
257			-	3176.892	-	62,876,476,429.14	
258			-	3278.553	-	69,289,877,024.91	
259			-	3383.467	-	76,357,444,481.46	
260			-	3491.738	-	84,145,903,818.56	
261	10,832,553	10,832,553	10,832,553	3603.473	39,034,814,357	92,728,786,008.06	0.42
262			-	3718.784	-	102,187,122,180.88	
263			-	3837.785	-	112,610,208,643.33	
264			-	3960.595	-	124,096,449,924.95	
265			-	4087.334	-	136,754,287,817.29	
266			-	4218.128	-	150,703,225,174.66	
267			-	4353.108	-	166,074,954,142.47	
268			-	4492.408	-	183,014,599,465.01	
269			-	4636.165	-	201,682,088,610.44	
270			-	4784.522	-	222,253,661,648.70	
271			-	4937.627	-	244,923,535,136.87	
272			-	5095.631	-	269,905,735,720.83	
273			-	5258.691	-	297,436,120,764.35	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
274			-	5426.969	-	327,774,605,082.32	
275			-	5600.632	-	361,207,614,800.71	
276			-	5779.852	-	398,050,791,510.39	
277			-	5964.808	-	438,651,972,244.45	
278			-	6155.682	-	483,394,473,413.38	
279			-	6352.663	-	532,700,709,701.54	
280			-	6555.949	-	587,036,182,091.10	
281	10,832,553	10,832,553	10,832,553	6765.739	73,290,226,540	646,913,872,664.39	0.11
282			-	6982.243	-	712,899,087,676.16	
283			-	7205.674	-	785,614,794,619.13	
284			-	7436.256	-	865,747,503,670.28	
285			-	7674.216	-	954,053,749,044.65	
286			-	7919.791	-	1,051,367,231,447.20	
287			-	8173.224	-	1,158,606,689,054.82	
288			-	8434.768	-	1,276,784,571,338.41	
289			-	8704.680	-	1,407,016,597,614.93	
290			-	8983.230	-	1,550,532,290,571.65	
291			-	9270.693	-	1,708,686,584,209.96	
292			-	9567.356	-	1,882,972,615,799.38	
293			-	9873.511	-	2,075,035,822,610.91	
294			-	10189.463	-	2,286,689,476,517.23	
295			-	10515.526	-	2,519,931,803,121.98	
296			-	10852.023	-	2,776,964,847,040.43	
297			-	11199.288	-	3,060,215,261,438.55	
298			-	11557.665	-	3,372,357,218,105.28	
299			-	11927.510	-	3,716,337,654,352.02	
300			-	12309.190	-	4,095,404,095,095.93	
Total	$162,488,295	$162,488,295	$162,488,295		$156,793,747,830		$14,821,449

Table 4.15. Rivershore Site Modified CRCIA Ranger/Industrial Cover Scenario Summary

Item	Equipment	Materials	Labor	S/C	Subtotal	Field Distribs	Home Office	S/C Fee	B&O Tax	Total Bid
Description					**Direct**	**2600%**	**300%**	**400%**	**047%**	
Grout Wells		590	899		1,489	387	56	77	9	2,019
Cover Construction	302,281	1,406,262	198,824	351,442	2,258,808	587,290	85,383	117,259	14,329	3,063,070
Support Facilities				45,036	45,036	11,709	1,702	2,338	286	61,071
Mobilization/ Demobilization	24,198	4,323	133,742		162,263	42,188	6,134	8,423	1,029	220,038
Subtotals:	326,479	1,411,174	333,466	396,478	2,467,596	641,575	93,275	128,098	15,654	3,346,198
Bond										30,439
									SUBTOTAL:	3,376,637
PM/CM @ 15%										506,496
									SUBTOTAL:	3,883,132

Assumptions:	Direct distribs @ 18.09%	$702,459
Cover material consists of clean natural fill material from the 100 BC Area.		
Riprap materials below the water line are placed from a barge in the river.	G&A @ 4.04%	$ 185,258
Riprap material above the waterline is placed with a backhoe.		
Rip-rap material was assumed to include 4 feet of +2ft material resting on 2 feet of 12 " minus material.	TOTAL:	$4,770,849
Existing wells will be grouted closed.		
Two new monitoring wells will be established through the clean cover material.	Contingency @ 34%	$1,622,089
Contractor markups are taken from the 300 FF FPE.		
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.	**TOTAL:**	**$6,392,937**

4.1.1 Attachment 1, MCACES Summary Report for the UPR-100-N-1 Site

100-N Area CMS MCACES Estimating Models Notes, Qualifications, & Assumptions, May 8, 1997

The Corrective Measures Study (CMS) used three of the generic MCACESERC baseline estimating models, including the Trench model, the Crib/French Drain model, and the Modified RCRA 'C' Barrier model.

The CMS includes 76 sites in the 100-N area. Sixteen of the 76 sites were covered by Five Modified RCRA 'C' Barriers (Caps). Differences between the CMS model estimates and the generic model estimates are as follows:

- Contingency of 34% was included in the CMS estimates.
- The HAMTC rates in the CMS estimates were updated to reflect the IOM entitled, *FY96 ERC All-in wage rates for BHI, THI, HAMTC, Building Trades by resource Code, and Field Support Heavy Equipment Pool Rates*, dated October 18, 1996 (CCN#038622).
- RA Production rates in the CMS estimates for soil excavation are about 93% of the rates in the RA baseline models, which were updated after the CMS runs were completed.
- The ERC adders in the CMS estimate are 14.06% (DD) and 5.34% (G&A) as opposed to the 1997 adders, which are 18.09% (DD) and 4.04% (G&A). The DD and G&A rates were updated after the CMS runs.
- PM/CM cost in the CMS estimates was calculated by applying 15% to the project direct cost.
- Transportation and disposal costs are included in the CMS estimates based on ERDF experience.

4.1.1.1 Extract from the RD/RA Baseline Cost Estimates Notes, Qualifications, & Assumptions 1997

EXHIBIT 6 - MODEL ASSUMPTIONS

1.0 GENERAL

1.1 Background

In June 1993, RL tasked the U.S. Army Corps of Engineers, Walla Walla District with the preparation of pre-conceptual baseline estimates for RD/RA for a number of solid waste management units (SWMUs) at the Hanford Site. The purpose of the effort waste assist the Richland ER Project in baseline planning for FY94 through FY2000. The FY95-97 baseline efforts by BHI represents a continued refinement of the Remedial Action Estimating system initiated at the beginning of FY94. The estimates are considered preconceptual. Significant Remedial Action work began in 1996 and lessons learned will reflect in the models in mid 1997.

1.2 Methodology

Ten (10) RA estimating models were created by the USACE using MCACES Gold for the FY94 Baseline. The models were based on the type of site and there mediation approach. They reflect how work is performed at the Hanford Site interns of division of workscope performed by onsite and offsite contractors, labor rates, and contractor markups. Six (6) models were revised and used for the BL95 and eight (8) for BL97. The additional two models used in the BL97 were the site closure model and the Modified RCRA C Barrier model. (See 2.11 for model list).

The MCACES models are used to create baseline cost estimates for each waste site or group of waste sites requiring remediation. Subproject estimates are then created using EXCEL Spreadsheets to rollup the MCACES site remedial action model estimates by operable unit and Subproject.

1.3 Operable Unit and Waste Site Summary

A total of 1233 waste sites were estimated in the BL 97 using MCACES generic RA and Barrier models as per the *Richland Environmental Restoration Project Baseline, Volume 2: Fiscal Year 1997 Baseline Cost Summary.*

2.0 Cost Estimate Development

2.1 Cost Estimate Breakdown Structure

MCACES Gold allows up to six levels of titling hierarchy to organize cost estimate details. The cost estimate breakdown structure was developed from the U.S. Army Corps of Engineers HTRWWBS and modified for remediation work at Hanford. The following is an example of the breakdown structure used:

Level 0:	1.4.10.1.1.5.1.2.4	100-BC-1 Trench 116-B-1
Level 1:	08	Solids Collection & Containment
Level 2:	08.01	Excavation
Level 3:	08.01.03	Contaminated Soil
Level 4:	08.01.03.01	Excavate/Load Contaminated Soil
Level 5:		Cost Details
Level 6:		not used and availabl*e*

2.2 Contractor Markups

Contractor markups were included for work performed by subcontractors to BHI. The models calculate Program Management and Construction Management by multiplying FTE's per functional group times the project duration. The ERC adders are then applied to total direct costs in the model.

2.3 Sales Tax

An 8.0% Washington State sales tax is applied to all materials.

2.4 Contingency

The models include a contingency calculation. A more refined calculation maybe used in the baseline.

The FY 97 baseline contingency analysis was performed by project area. The analysis resulted in contingency rates of 15.7% for the 100 area, 30% for the 200 area, and 15.6% for the 300 area. These rates were applied to the BL 97 estimates outside of the MCACES models.

2.5 Price Level

The pricing level used in the MCACES models is:

Labor-ERC Labor Rate *BHFY96-HanfordAll-inWageRate1995*.

Equipment-*BHI-93EE, Eq. Rates EP-1110-1-8, Aug.1993*

2.7 Escalation

Escalation is applied outside of the MCACES models.

2.8 Labor Rates

A Labor Rate database was created for all classifications to be used on the Hanford ERC Project. The rates reflect the ERC average wage rates issued on December 20, 1996 (CCN#040990). The database includes the labor resource categories and organizational codes, and reflects payroll additives and an average of 4% overtime. BHI's direct distributable and general indirect costs are applied at the bottom line in the models. The baseline database recomputes these costs using current approved rates.

2.9 Equipment

Equipment pricing data is based on an extract from the latest USACE equipment price book (EP1110-8, Aug 93) which is the basis for the MCACES Version 5.30 equipment rate database. The rates are equivalent to an owner ship rate, and include depreciation, maintenance, fuel, and repairs. These rates were judged adequate for present day costs.

2.10 Crews

The MCACES crew database, although available, was not used in these MCACES models.

2.11 List of Models

The following estimating models were developed based on type of waste site, size, and remediation approach:

1. Burial Ground (Small, Medium to Large)
2. Crib/French drain(Small, Medium, & Large)
3. Trench (Small, Medium, & Large)
4. Septic Tank
5. Below grade structure (Small & Medium)
6. Reactor Area Piping (Large)
7. Retention Basin (Large)
8. Site Closure (Created in 1996)
9. Modified RCRA 'C' Barrier (Created in 1996 from 1995 crew up estimates)

A model size categories area follows.

Small-<or=4,356SF Medium-4,357SFto87, 120SF Large->87,120SF

Separate models for each size were developed in 1996 to accommodate different productivity rates, crew sizes, and equipment types.

2.12 Summary of Model Input Parameters

Major cost drivers or "parameters" form the basis for each model. The major quantity inputs necessary to support the parameter calculations areas follows:

A. EXCAVATION MODELS:
   1. Length, width, and depth of waste site in linear feet (lf)
   2. Non-contaminated, contaminated, and demolition waste volume in bank cubic feet (bcf)
   3. Percent of Transition Soil

B. Modified RCRA 'C' Barrier Model:
   1. Barrier surface area in square feet.

3.0 Notes and Assumptions

3.1 Excavation Models

1. Remediation technology is excavation and disposal.
2. The model calculations include excavation, sampling, monitoring of the excavation, backfill, and site restoration.
3. All contaminated material was assumed to below level waste (LLW).
4. LLW samples were taken every 200L CY excavated for field monitoring and every 1,078 SF of bottom area for closure samples.
5. All LLW samples will be analyzed on site; an additional 5% for QA/QC samples will be analyzed offsite.
6. Material will be loaded into 20 cubic yard (cy) containers. Containers will be filled to approximately 15 LCY due to load restrictions on the total combined weight of the tractor, trailer, and filled container on the highways (40tons).
7. The transport and disposal rate per cubic yard was calculated by the ERDF Subproject based on actual ERDF costs. These costs are not applied in the MCACES models.
8. Appropriate contractor markups were added in the MCACES models.
9. Estimates include QA/Safety and Health Physics (HP) oversight by the ERC team.
10. Key estimate planning quantities and notes are included under each title level with in each estimate.

3.2 RCRA 'C' Barrier Models

1. Remediation technology is to cover the contaminated area with a soil barrier approved under RCRA guidelines.
2. Appropriate contractor markups were added in the MCACES models.
3. Estimates include QA/Safety and Health Physics (HP) oversight by the ERC team.
4. Key estimate planning quantities and notes are included under a title level with in each estimate.

4.0 MCACES Model Details

The MCACES models for excavation take 11 input quantities and calculate 25 additional quantities, which are used to price all resources required to setup, sample, excavate, and restore each waste site. These estimates are grouped on the baseline spreadsheets into operable units for each Subproject where contingency is applied. The MCACES models estimate to the base cost, plus subcontractor adders and BHI markups and computed in the ACCESS Baseline Database.

The basic input parameters include the following:

1. Non-contaminated Soil Volume in bcf
2. Contaminated Soil in bcf
3. Demolition Waste in bcf
4. Top Excavation Length in lf
5. Top Excavation Width in lf
6. Bottom Area in sf
7. Number of Groundwater Protection Samples (Small sites <10,000 sf-3 ea.; Medium sites 10,000 to 100,000 sf-21 ea.; and Large sites>100,000-60ea.)
8. Transition Zone Soil percentage
9. Hauling distance for Borrow in miles
10. Hauling distance for demolition waste in miles (not used)
11. Hauling distance for contaminated soil in miles (not used)

The models also include the following fixed values, which are used to calculate and/or convert additional quantities, and resource requirements (labor and equipment types and hours).

RA Models

1. Soils well factor-15%
2. Demolition wastes well factor - 60%
3. Non-contaminated soil excavation rate

   Small-56LCY/Hr (with exception of Burial Ground, which is 77 LCY/Hr)

   Medium-112LCY/Hr (with exception of Burial Ground, which is 154 LCY/Hr for Medium To Large)

   Large-224 LCY/Hr
4. Transition soil excavation rate

   Small-28 LCY/Hr (with exception of Burial Ground, which is 30 LCY/Hr)

   Medium-56 LCY/Hr (with exception of Burial Ground, which is 60 LCY/Hr for Medium To Large)

   Large-112 LCY/Hr
5. Contaminated soil excavation rate

   Small-37 LCY/Hr (with exception of Burial Ground, which is 20 LCY/Hr)

   Medium-70 LCY/Hr (with exception of Burial Ground, which is 40 LCY/Hr for Medium To Large)

   Large-140 LCY/Hr
6. Demolition waste excavation rate-12 LCY/Hr(with exception of 16 LCY/Hr for the Retention Basin model)
7. Sample analysis cost for on-site mobile lab-400.00/Sample
8. Sample analysis cost for off-site laboratory-2,000/Sample

RCRA 'C' Barrier Model

1. Load/Haul Soils & Other Materials-120LCY/Hr
2. Place Asphalt

   (Base course)-65 SY/Hr

   (Permeable Layer)-57.5 LCY/Hr

3. Spread/Compact Soils-120 LCY/Hr
4. Spread/Compact Sand/Gravel-105 LCY/Hr
5. Place Perimeter Berm Backfill-60 LCY/Hr

With these inputs, MCACES determines how much of each resource is needed for each operation estimated in the model. These resource quantities are then priced according to the rate tables provided with MCACES. The subcontractor markups on the labor and material, and the Owner markups were applied within MCACES models. The MCACES models estimate all costs with the exception of escalation and contingency.

4.1.2 Attachment 3, Model Assumptions for RACER-Ex Situ Bioremediation

Land Farming (Ex Situ)

Ex situ bioremediation – 1 and farming, is a process for treating contaminated soil that requires excavation and movement to a treatment cell. The contaminated soil is spread in a thin layer over an area to enhance volatilization, aeration, -biodegradation, and photolysis. This model estimates costs to construct and operate a lined treatment cell and enhance the biodegradation process. The model provides options to stimulate growth of indigenous bacteria (biostimulation) or to cultivate and add bacteria to the site (bioaugmentation).

State and local regulations often impact the location, design, and operation of a land farming treatment cell. The model assumes that the cell is located on the same property as the contaminated soil and is enclosed by a berm and covered. The model also assumes that the soil will be tilled at least once a week.

The following topics are available for the Land Farming (Ex Situ) model:

<u>Technical Help</u>

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References

<u>System Help</u>

- Button Bar
- Model Processing

Required Parameters

Required parameters are the minimum amount of information required to generate a cost estimate. There are no defaults as the values are site-specific. A reasonable cost estimate can be generated from the required parameters. The required parameters include:

- Total Volume of Soil Treated
- Volume of Soil Per Batch
- Number of Temporary Holding Areas
- Temporary Holding Area Size
- Treatment Duration per Batch
- Safety Level

Total Volume of Soil Treated

This is the total ex situ volume (in loose cubic yards) of the contaminated soil to be treated. Bank or in situ soil swells approximate) 110% to 130% when excavated.
Assuming a swell factor of 1.3 (130%), a one-acre area would be needed to land farm 2500 loose cubic yards (1900.bank cubic yards) of soil 18 inches deep.

For this reason, it may be more desirable to treat larger volumes of soil in a series of successive batches rather than construct a treatment bed large-enough to treat all of the soil at one time. The valid range is 100 to 99,999 loose cubic yards.

Volume of Soil per Batch

This is the ex situ volume (in loose cubic yards) of the contaminated soil that will be treated at one time. The volume of soil per batch determines the size of the treatment cell, setup parameters, amount of tilling, quantity of nutrients, and cell parameters applicable to the site. Therefore, the largest volume of soil to be treated at one time should be entered at this parameter. In most cases, the optimum volume of soil per batch is between 1,000 and 2,000 loose cubic yards. Larger volumes would require excessively large treatment beds. The model determines the number of batches by dividing the total volume of soil treated by the volume of soil per batch, and the model will not allow any combination of input, which causes the number of batches to exceed 90. The valid range is 100 to 10,000 loose cubic yards. The volume of soil per batch cannot be less than the total volume of contaminated soil.

The primary cost driver in an ex situ land farming application is the construction of the treatment bed. Therefore, treating soil in a series of successive batches rather than treating all of the soil at one time will reduce the overall cost of treatment. In determining the total volume the optimum volume of soil per batch, the user may wish to run several different scenarios and observe the costs for each scenario.

Number of Temporary Holding Areas

The scheduling and coordination of ex situ soil remediation projects often require the contaminated soil to be temporarily stockpiled adjacent to the treatment bed. Contaminated stockpiles should be placed in lined holding areas and covered with plastic. The number of temporary holding areas should correspond to the maximum number of stockpiles, which will be present at any one time. The temporary holding area in this model is lined with a 40-mil PVC liner and is surrounded by a 1.5-foot high berm to prevent surface water intrusion. For each holding area, the model includes one pump and one holding tank for collection and containment of accumulated rainwater or leachate. The valid range is 0 to 99 areas.

Temporary Holding Area Size - If the number of temporary holding areas is one (1) or more, this parameter is used to specify the size of each holding area. The model assumes that all holding areas are the same size. Assuming a stockpile height of eight (8) feet and a soil angle of repose of 34 degrees will yield a conservative estimate for the holding area size required for a given volume of contaminated soil. The valid range is 100 to 999,999 square feet.

Treatment Duration per Batch

The treatment duration is the total time that each batch will be in the bioremediation cell. Treatment time can be estimated from information obtained in the bench and pilot studies. The duration is dependent upon the application rates of nutrients, moisture, pH, and microorganisms, as well as the specific contamination and concentration of the contaminant. Climate and soil type also significantly impact the treatment duration. Biodegradation occurs at much slower rates in colder climates. Also, soils having high clay contents require considerably longer treatment duration than sandy soils. The user should consider the climate and the soil type when determining the treatment duration. The amount of nutrients, moisture, pH, and cultured bacteria are important but can be controlled. Total treatment duration is determined by multiplying the treatment duration per batch by the number of batches. The duration for a single treatment is usually between 8 and 20 weeks; however, longer durations are not uncommon. The valid range is 1 to 104 weeks.

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by the Occupational Safety and Health OSHA, 29 CFR Part 1910.| The four levels are designated as A, B, C, and D where "A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of-safety 1evels and associated requirements is 1ocated- in the On-Line Help for Safety Levels.

Secondary Parameters

A reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, the secondary parameters can be used to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameter sets are:

- Treatment Cell
- Maintenance

Treatment Cell

The treatment cell parameters are listed and described below.

- Cell Area
- Depth of Contaminated Soil
- Sire of French Drain
- Containment Cover
- Sump Pump Capacity
- Sump Pump Quantity

Cell Area – The model defaults to a square treatment cell. The default surface area of the remediation cell will be calculated in square yards based on two factors: the volume of soil to be treated and the depth of soil placed in the remediation cell. The valid range is 1 to 193,600 square yards. It is important to note that this model uses ex situ or loose soil volume measurements. Quantity estimates based on bank (in situ) volumes must be converted to loose volume by multiplying by the appropriate swell factor.

Depth of Contaminated Soil in the Cell – The depth of contaminated soil in the biodegradation cell depends on the capability of the aerating plow, for this model 1 to 18 inches. The depth of the soil will affect the size of the containment cell, the equipment used, and possibly the duration. The default depth is 12 inches. The valid range is 1 to 18 inches. Note: A six-inch minimum soil depth is recommended. An 18 inch depth, if soil conditions allow, will minimize the required treatment cell area, which will reduce costs.

It is important to note that the cell area and depth of contaminated soil are interrelated. If one of these parameters is changed, the model will automatically re-calculate the other based on the volume of soil per batch.

Size of French Drain – The model includes a French drain for leachate collection. The leachate flows (via gravity) to a low end of the bermed area and is pumped from there. Leachate is pumped back onto the soil for continued remediation. Options for 1eachate holding tanks are available at the assembly level. Costs for leachate treatment and disposal are not included in this model. The default French drain size is 18' x 18'. At sites with predominate dry seasons, leachate collection systems may not be required, as evapotranspiration and periodic covering of the land farm will control excess saturation.

Options:

- 12' x 12"
- 18'x18'
- 24' x 24"
- None

Containment Cover – A containment cover is recommended and is required in some states. A cover forms a barrier over the cell area to limit moisture infiltration into and out of the contaminated soil. The default is to include a cover, with 135-pound tear strength, fiberglass reinforced plastic sheet being the default cover.

Sump Pump Capacity – The default sump pump is a 75 gpm installed sump pump. The model assumes that electrical service is available at the site. Portable, gasoline powered water pumps are also available.

Note: Provisions must be made to remove excess rainwater in the cell. For cost estimating purposes, the water truck used to sprinkle the soil can be used as a pumper truck to remove water to a treatment facility or holding tank.

Options:

- 75 gpm installed
- 100 gpm installed
- 6,000 gph portable gasoline powered
- 8;000 gph portable gasoline powered o 10,000 gpm portable gasoline powered

Sump Pump Quantity – This is the quantity of pumps required. The model defaults to one 75-gpm pump. This parameter may be set to zero if no pumps are required. The valid range is 0 to 99 pumps.

Maintenance

The maintenance parameters are listed and described below.

- Tilling Frequency
- Number of Passes Per Day
- Microorganisms
- Watering Frequency
- Fertilizing Frequency

Tilling Frequency – The tilling frequency affects the amount of aeration. The- model assumes that a D3 dozer with a tiller will be used to till the soil. The default tilling frequency1st 44 days, per month, which equates to one day per week (days per-week, days per month/4.33; rounded up-to the nearest whole number). The-model assumes that the dozer wi11 remain on-site for-the entire project duration if the tilling frequency is greater than two (2) days per week and the time required for each day of tilling is greater than 4 hours. Otherwise, the model assumes that the doter will be removed from the site at the conclusion of each day of tilling. The dozer is assumed to be decontaminated prior to leaving the site. The valid range is 0 to 7 days per week.

Number of Passes Per Day – This is the number of times during each day of tilling that the tiller will pass through the soil. The default is two (2) passes per day. If the tilling frequency (number of days per month of tilling) is decreased, then the number of passes should be increased. The number of passes per day directly impacts the number of hours required for each day of tilling. The number of hours required for each day of tilling depends on the cell area, number of passes per day, and the tillage productivity of the dozer. The model defaults to a minimum of 4 hours of dozer rental for each day of tilling. This 4-hour minimum is assumed to account for equipment mobilization. The valid range is 1 to 10 passes per day.

Microorganisms – Bacteria may be cultured and added to the contaminated soil. Since addition of bacteria is not common in bioremediation, as enhancement of existing bacteria, the default is not to add microorganisms. If microorganisms are added, application rates are 50 pounds per 1,000 cubic yards initially and 25 pounds per 1,000 cubic yards on a monthly basis thereafter.

Watering Frequency - The watering frequency specifies the number of times per month that water is applied to the contaminated area to retain consistent moisture content.
Maintenance of soil moisture is vital during excessive dry periods, particularly at sites in low humidity areas. On the other hand, high humidity or excessive rainfall may reduce or eliminate the requirement for watering. The model assumes that the soil moisture content of new soil put into the remediation cell is less than 80%. If the soil becomes too wet, additional plowing to enhance evaporation may be required. Also, in climates where rainfall exceeds the evaporation rate, excessive watering will result in increased amounts of leachate requiring treatment and disposal. The default watering frequency is 4 times per month, which equates to once per week. The model assumes that a water truck will be used. However, a sprinkler system is available at the assembly level. The valid range is 0 to 99 times per month.

Fertilizing Frequency – Nutrients can be added with the water. The addition of nutrients for the microorganisms, primarily in the form of nitrogen and phosphorus, along with the oxygen from soil tilling, are critical to good growth. The nutrient mix will vary from site to site, with the optimum mix determined through pilot studies and geochemical evaluations of the site. However, a default has been determined based on actual field cases. The default is 0.5 pounds of 20:20:20 fertilizer per cubic yard of contaminant. The default fertilizing frequency is once per month. The valid range is 0 to 400 times per-month.

Date 11/04/96
Time 11:57

PROJECT SUMMARY REPORT

10ON CMS
HANFORD
Pasco Washington WA
JA LAPIERRE / B BENNETT
11/04/96

Category	Amount
PA/SI	
Site Assessment	8
Studies	0
Remedial Design	0
RA Capital	22,166
Site Work	0
Sampling and Analysis	0
RA Professional Labor	0
Subcontractor Overhead & Profit	3,584
General Conditions	10,189
Studies/Professional Labor Overhead	0
Prime Contractor Home Office	0
Subtotal	$35,939
Prime Contractor	
Profit - (Fee) (0.00%)	0
RA Operations and Maintenance	0
0&M Service Contract	
Overhead, Tax & Profit	0
Subtotal	$35,939
Escalation	2,120
Total Contract Costs	$38,059
Contingencies (0.00%)	0
Project Management (0. 00%)	0
Total Project Costs	$38,059

********** END OF REPORT *********

This System Intended for Government Use Only

Date 11/04/96

Time 11:48

PROJECT SUMMARY REPORT

10ON CMS, RUN 2
Pasco Washington WA
JAL & BRB
11/04/96

Category	**Amount**
PA/SI	
Site Assessment	0
Studies	0
Remedial Design	0
RA Capital	24,199
Site Work	0
Sampling and Analysis	0
RA Professional Labor	0
Subcontractor Overhead & Profit	3,870
General Conditions	10,580
Studies/Professional Labor Overhead	0
Prime Contractor Home Office	0
Subtotal	$38,649
Prime Contractor	
Profit - (Fee) (0.00%)	0
RA Operations and Maintenance	0
0&M Service Contract	
Overhead, Tax & Profit	0
Subtotal	$38,649
Escalation	2,280
Total Contract Costs	$40,929
Contingencies (0.00%)	0
Project Management (0. 00%)	0
Total Project Costs	$40,929

********** END OF REPORT *********

This System Intended For Government Use Only

Date 11/04/96 Page 1
Time 12:06

PROJECT SUMMARY REPORT

100N, CMS RUN 3
RUN 3
Pasco Washington WA
JAL & BRB
11/04/96

Category	Amount
PA/SI	0
Site Assessment	0
Studies	0
Remedial Design	0
RA Capital	42,741
Site Work	0
Sampling and Analysis	0
RA Professional Labor	0
Subcontractor Overhead & Profit	6,552
General Conditions	15,042
Studies/Professional Labor Overhead	0
Prime Contractor Home Office	0
Subtotal	$64,335
Prime Contractor	0
Profit - (Fee) (0.00%)	0
RA Operations and Maintenance	0
0&M Service Contract	
Overhead, Tax & Profit	0
Subtotal	$64,335
Escalation	3,796
Total Contract Costs	$
Contingencies (0.00%)	0
Project Management (0. 00%)	0
Total Project Costs	$68,131

********** END OF REPORT *********

This System Intended For Government Use Only

4.1.3 Attachment 4, Model Assumptions for RACER-In Situ Bioremediation

In Situ Biodegradation (Bioventing)

Bioventing can be particularly effective for removing volatile contaminants muse they are highly susceptible to physical removal. Bioventing has been developed and applied by the petroleum industry to remediate fuel-contaminated sites. This model assumes that the contaminants of concern are petroleum hydrocarbons.

One of the main advantages of aerobic biodegradation of petroleum hydrocarbon contaminants over other techniques is that the contaminants are completely destroyed, as the byproducts axe primarily carbon dioxide, water, and biomass. Biodegradation avoids generating hazardous byproducts and additional waste streams.

The following topics are available for the In Situ Biodegradation (Bioventing) model:

Technical Help

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References
- Tables
- Algorithms

System Help

- Button Bar
- Model Processing

General Information

Situ biodegradation involves microbial transformation of organic contaminants to affect cleanup of soils, groundwater, and/or other contaminated media. Biodegradation of organics in soil/groundwater systems is a natural process by which indigenous microorganisms obtain energy and/or carbon through the metabolism of organic contaminants. Various designations are used to describe essentially the same remediation technology:

- In Situ Biodegradation
- In Situ Bioremediation
- In Situ Bioreclamation
- Enhanced Bioreclamation
- Bioremediation or Biodegradation

All of these designations refer to processes where contaminants are degraded by in-place biological processes.

One means of performing in situ biodegradation is through soil venting. Soil venting, also called bioventing, is similar to soil vapor extraction (see the Soil Vapor Extraction model)' except that with bioventing, in situ biodegradation is stimulated intentionally. This process utilizes one or more vacuum extraction wells screened outside the contaminated zone to direct oxygen from the surface through the subsurface. Extracted air can be pulled directly through soil pores from the atmosphere or supplied by one or more injection wells.

This procedure physically removes volatile organic compounds (VOCs) in the soil gas and establishes a contaminant gradient between the solid/liquid and gas phases, thereby allowing continuous removal as contaminants redistribute into the gas phase. Pulling air through the subsurface also provides oxygen that can be used as an electron acceptor in aerobic biodegradation of organics. This oxygen, in combination with moisture, nutrients, and possibly microorganisms supplied by either sprinkler systems or infiltration trenches/galleries, stimulates in situ biodegradation of organic Contaminants.

Bioventing can be used in saturated soil columns the groundwater table is lowered to expose more of the contaminated layer. Air injected into the subsurface is drawn through the contaminated zone to stimulate biodegradation and physically strip volatile contaminants. Water and nutrients are provided via infiltration.

Growth factors, which affect the rate of microbial degradation, include:

- Soil Moisture
- Oxygen Requirements
- Soil pH
- Soil Nutrients
- Soil Temperature

Soil Moisture

Moisture control may take the form of supplemental water to the site (irrigation), removal of excess water (drainage, well points), or other methods (e.g., soil additives). Also, the addition of vegetation to a site will increase evapotranspiration of water and, therefore, assists in retarding the downward migration of water (e.g., leaching). When natural precipitation is insufficient to maintain soil moisture within an optimal range for microbial activity, irrigation may be necessary. Water can be applied by standard irrigation methods (e.g., sub-irrigation or sprinkler irrigation) in the case of shallow contamination not exceeding 10 feet. In the case of deep soil contamination, injection wells may be installed for injection of water with or without nutrients and microbial culture. The ease of controlling moisture depends on how easily water is controlled at the site and on the availability of a suitable water source (e.g., transport distance, drilling of new wells, availability, and cost of energy for pumping). Controls to manage the run-on and runoff at the site are necessary to prevent drainage end erosion problems. Costs for erosion control and runoff can be modeled using the Site Work and Utilities module of the RACER System.

Oxygen Requirements

Aerobic degradation is the most attractive of the processes for microbial transformation of petroleum hydrocarbon contaminants because it proceeds at a more rapid rate and does not produce the noxious byproducts associated with anaerobic decomposition. For petroleum hydrocarbons, approximately 3.5 pounds of oxygen are required per pound of hydrocarbon. For bioventing, however the critical factor is making sure that the vacuum wells are keeping the subsurface aerated. Passive injection vents allow a path for air to be pulled through the subsurface.

Soil pH

Depending on the nature of the hazardous waste components contaminating the soil, it may be advantageous to optimize the soil pH for a particular segment of the microbial community because both microbial structure and activity are affected by the soil pH. Near neutral pH values are most conducive to microbial functioning in general with a range of 7.0 to 8.5 considered acceptable. For this model, it will be assumed that the pH does not need adjusting.

Soil Nutrients

As in the case of all living organisms, indigenous microbial populations must have specific inorganic nutrients (e.g., nitrogen. phosphorus, potassium. calcium, magnesium. etc.) and a carbon and energy source to survive.

The nutrients necessary to stimulate in situ biodegradation in the subsurface should be studied and defined in a pilot study. Carbon, nitrogen, and Phosphorus amendments to the soil can be added at variable rates depending on microorganism requirements. Standard agricultural methods are used-to add nutrients to the soil. Sufficient nitrogen and phosphorus must be reapplied to ensure that these nutrients do not limit the microbial and metabolic activity.

Soil Temperature

Soil temperature is one of the most important factors controlling microbiological activity and the rate of decomposition of organic contaminants. It also influences the rate of volatilization of compounds from the soil. Optimal growth of microbial populations responsible for biodearadation of petroleum products occurs between 20 and 35° C. Because of the insulating properties of plant cover, vegetation plays a significant role in soil temperature. Bare soil unprotected from the sun's direct rays becomes very warm during the hottest part of the day; it also loses its heat rapidly during colder seasons. A well vegetated soil does not become as warm as a bare soil during the summer, and the vegetation acts as an insulator to reduce heat loss from the soil in the winter.

Required Parameters

Required parameters are the minimum amount of information necessary to generate a cost estimate. There are no defaults as the parameter values are specific. A reasonable cost estimate can be generated using only the required parameters. The required parameters include:

- Installation
  - Average Depth to Top of Screen (Vertical Installation)
  - Trench Depth (Horizontal Installation)
  - Screen Length (Vertical and Horizontal Installation)
- Soil Type
- Area of Contaminated Soil
- VEPs
- Blowers
- Startup Period
- O&M Period
- Safety Level

Installation

Installation refers to the type of installation, either vertical or horizontal vapor extraction point (VEP) installation.

Options:

- Vertical
- Horizontal

If vertical installation is selected, the user must provide the average depth to the top of screen, which is used to cost drilling and construction materials. The valid range is 6 to 999 feet. If horizontal installation is selected, the user must provide the trench depth, which is used to cost trenching and construction materials. The valid range is 3 to 30 feet.

The user must also provide the screen length. In the vertical bioventing system, the screen length is designed to span the vertical extent of soil contamination. The total depth of the vertical bioventing well is the sum of the depth to the top of the screen and screen length. However, the total depth of vertical VEP may not exceed 999 feet.

In the horizontal installation, the screen length is designed to remediate effectively the entire site. The screen length is based on the radius of influence of the vapor extraction well and area of contaminated soil. The valid range for horizontal screen length is 1 to 999 feet.

Soil Type

The soil properties greatly affect the design of the in situ bioremediation system. The primary controlling soil parameter is soil permeability. Permeability should be sufficient to permit adequate flow of air through the contaminated matrix. The radius of influence of applied vacuum at the vapor extraction point extends over a greater distance in soils with higher permeability. The soil permeability directly relates to the soil particle size. This model classifies soil types into four groups based on particle size. Table 1 shows the range of soil permeability for different soil types.

Options

- Silty Clay, Clay
- Mixed Sandy, Silty, Clayey Soils
- Primarily Sand
- Sand and Gravel

Area of Contaminated Soil

The area of contaminated soil is the appropriate areal extent of the contamination to be remediated by bioremediation. The valid range is 1 to 1,000,000 square feet. This roughly correlates to a rectangular impact zone of 23 acres or 1,000 ft x 1,000 ft. Typically, a site with an impact area as great as this would be addressed in stages or divided into smaller areas and addressed as independent cells. If this is the case. it is advisable to execute multiple runs of the model to account for each cell.

VEPs

The number of VPs are calculated based on the default well spacing, a secondary parameter, using the equations shown in Algorithm 1. The number of VEPS cannot be directly changed on this screen. However, they may be changed at the VEP Design parameters by changing the default VEP spacing or by directly changing the number of VEPs.

Blowers

Represents the default quantity of blowers, which is determined from the secondary parameter, total flow rate (Q). The quantity of blowers cannot be directly changed on this screen. However, the quantity and type of blowers may be changed by editing the VEP Design parameters.

Startup Period

The total treatment duration is divided into startup and O&M. The coats associated with the startup period (e.g. equipment acquisition, installation and optimization) are considered capital costs, and the O&M costs are identified separately. This parameter may be used to identify the startup period (e.g., equipment procurement, installation, and optimization) or it may cover the entire treatment period. The unit of measure for the startup period is weeks'. The valid range for this model is 4 to 999 weeks.

O&M Period

The O&M period may be 0 to 999 months. (Reference Startup Period above) safety Level.

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSIDA in 29 CFR Part 1910. The four levels are designated as A. B, C, and D; where "A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of safety levels and associated requirements is located in the On-Line Help for Safety Levels.

Secondary Parameters

Reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, secondary parameters can be added to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameters are divided into the following four categories:

- VEP Design
- Drill Vertical*
- Trench Horizontal**
- Soil Additives

*These parameters are only available when the type of VEP installation is vertical

**These parameters are only available when the type of VEP installation is horizontal.

VEP Design

The parameters for the design of the bioventing extraction system include:

- VEP Spacing
- Number of VEPs
- Gas Flow Rate
- Total Flow Rate
- Quantity of Blowers
- Type of Blower

VEP Spacing - The design of vapor extraction systems depends primarily on the soil type. The model defaults quantities to the design parameters based on the required parameter. soil type. Since the radius of influence depends on the soil type, the VEPS spacing, number of VEPs, gas flow rate, and blower specifications also depend on the soil type, The model design parameters for different soil types are based on data obtained from CAM RILL soil vapor extraction projects. Table 2 shows the default values for VEP spacing and gas flow rate.

In bioventing, the purpose of vapor extraction is not to cause volatilization of organic compounds, but merely to provide sufficient vacuum to cause the infiltration of ambient air (due to the development of a pressure gradient) into the subsurface soils to promote biorespiration. Therefore, it is not advisable to apply high vacuum at the vapor extraction well because it would cause volatilization of organic compounds, thus, requiring treatment of the extracted subsurface vapors.

Number of VEPs - The number of VEPS are calculated based on well spacing using the equations shown in Algorithm 1. The number of VEPS may be changed directly by the user, or they may be calculated based on the -VEP spacing.

Gas Flow Rate - The gas flow rate is used in the calculation for total flow rate (Q), which determines the default quantity of blowers. Q is calculated from the equation shown in Algorithm 2. The valid range is .01 to 99.99.

Total Flow Rate - The total flow rate, as calculated by the model, is displayed to provide the user with off-gas treatment quantities, which can be input into other models such as carbon adsorption - gas, etc. This field cannot be edited and is displayed for information purposes only.

Quantity of Blowers - The user may change the default quantity of blower6 directly, or have the modal calculate the quantity of blowers. Table 3 shows the model defaults for type of blower and quantity of blowers. The valid range is 1 to 99 blowers.

Note: Because the quantity of blowers is determined from the total flow rate, if the user changes the default VEP spacing (which determines the number of VEPs, also used in the calculation of total flow rate) or changes the gas flow rate (also used in the calculation of total flow rate) and wants to use the default quantity of blowers, the user must re-calculate by clicking the Calculate push button.

Type of Blowers - The user is given the option of the four blowers provided below. Table 3 shows the model defaults for type of blower and quantity of blowers.

Options

- 98 SCAM. I HP
- 127 SUM. 1.5 9P
- 160 SCPM. 2 HP
- 280 SC t. S HP

Drill Vertical

The parameters for drilling vertical VEPs are listed and described below.

- Diameter
- Construction Material
- Drilling Method
- Soil Sample Collection
- Drum Drill Cuttings

Diameter - The modal defaults to 2" diameter vertical VEPS. However, an option of 4" diameter vertical VEPs is al.50 available in the model. The VEP diameter affects the diameter of borehole and cost of construction material and drill cutting containment (drumming).

Options

- 2 inch
- 4 inch

Construction Material - Vertical VEPs are typically constructed of either PVC or stainless steel screen and casing. Primary selection considerations are cost and material compatibility with the contaminant.

Options

- PVC - Schedule 40
- PVC - Schedule 80
- Stainless Steel

The model defaults to Schedule 40 PVC for the construction of all vertical VEPS less than 85 feet deep. However, when the depth of the vertical VEPs is greater than 85 feet, the model defaults to Schedule 80 PVC material.

Drilling Method – The vertical VEPs can be installed using a variety of vertical drilling techniques, depending on site hydrogeology and desired depth of the borehole. The three vertical drilling techniques included in this model are:

- Hollow Stem Auger
- Water/Mud Rotary
- Air Rotary

The model defaults to hollow 6tem auger for 2-inch and 4-inch diameter vertical VEP installation when the well depth is less than 150 feet below ground surface (bgs).

The water/mud rotary method is the model default for drilling when the VEP depth is greater than 150 feet bgs. Air rotary drilling is also available a6 an option. It is assumed that drilling is in an unconsolidated formation. If the subsurface is consolidated, then the user should use water/mud rotary or air rotary rather than hollow stem augers even for depths less than 150 feet bgs. Table 4 gives the diameter of borehole for the different drilling methods.

All connection piping is assumed to be above ground installation. The Piping model should be run if below ground piping is desired. The amount of connection piping defaulted is the radius of influence times the number of VEPS. The amount of manifold pipe will be defaulted at half the length of the connection piping, and is the same material as the connection pipe. A pressure gauge and other piping appurtenances will be defaulted as well. The connection and manifold pipe size defaults for vertical VEPs are shown in Table 5.

Soil Sample Collection - Sample collection during borehole advancement allows characterization of the geology beneath the site and definition of the magnitude and extent of contaminants in the vadose zone. According to the IRP Statement of Work 1991. Soil samples shall be collected every five feet or at each change in lithology, whichever is less for lithologic description. Drill cuttings can be collected as the borehole is advanced for general geologic information. Discrete samples are collected in unconsolidated sediment using a variety of methods including split spoon, Shelby tubes, and the California brass ring.

The model defaults to collection of soil samples with a split spoon sampler with standard penetration tests at five-foot intervals during borehole advancement. Samples are screened with an organic vapor analyzer (OVA) for volatile organics and described for the lithologic log by the geologist supervising drilling.

If laboratory analysis is desired, the user must decide how many soil samples and what type of analysis will be required. The user must then add these soil analyses to the Sampling and Analysis model.

Drum Drill cuttings - The drill cuttings are generally placed in 55-gallon drums and stored until disposal options have been evaluated. The model default is to include drill cuttings containment.

The professional labor hours spent in the field supervising the installation of the vertical VEPs are passed to the RA Professional Labor model. The model makes the following assumptions for staff hydrogeologist hours related to vertical VEP installation:

- If sample collection is included, VEPs are drilled at a rate of 20 feet per hour, plus 2 hours per well for well completion. Total labor hours are for drilling supervision by a staff hydrogeologist.
- If sample collection is not included, VEPs are drilled at a rate of 40 feet per hour, plus 2 hours per well for well completion. Total labor hours are for drilling supervision by a staff hydrogeologist.

Decontamination procedures for the VEPs screen, riser, and caps as well as decontamination of drilling tools (e.g., hollow stem augers) will be conducted prior to and between each borehole/well installation. Procedures consist of steam cleaning with a high-pressure steam-generating pressure washer and detergent, in accordance with AFCEE requirements.

Decontamination procedures for split spoon samplers, bailers, and hand augers were also based on AFCEE requirements and consist of:

- Clean with tap water and detergent using a brush.
- Rinse thoroughly with tap water.
- Rinse with deionized water.
- Rinse twice with pesticide-grade isopropanol.
- Rinse with organic-free deionized water.
- Allow to air dry.

Monitoring wells art usually installed on the periphery of the soil contaminant plume. Monitoring wells are not included in this model, but may be estimated by using the Monitoring model.

Trench Horizontal

Horizontal installation involves excavating a narrow trench and installing a screened or perforated pipe at a common elevation. The model defaults to a horizontal installation method depending on the depth of installation. The model defaults to the use of chain trencher when the depth of installation is less than or equal to 4 feet. The crawler mounted, hydraulic excavator is defaulted when the depth of installation is greater than 4 feet but less than or equal to 20 feet. The Horizontal Dewatering Systems, Inc (IWSI) proprietary method (Patent *4927292) will be defaulted for depths of installation between 21 and 30 feet. The model does not consider the need for cave-in protection when installing bioventing systems in trenches exceeding l0 feet. Additional controls such as a trench box, well points, sheeting, or side sloping maybe required due to soil conditions. If this is the case, refer to the Site Work and Utilities models.

The HDSI proprietary method uses specialized equipment to drill a 14-inch wide hole to set a vertical PVC blank pipe. After drilling, the machine digs in either a forward or backward direction to create a horizontal VEP. As it digs, a high-density polyethylene (HDPE) perforated pipe is laid horizontally. The pipe is simultaneously covered with a filter pack and connected to the vertical PVC pipe.

Note that the trenching methods do not permit collection of discrete soil samples for laboratory analysis. Therefore, the soil sample collection option is not provided for horizontal VEPs installation.

All connection piping is assumed to be aboveground installation. The piping model should be run if below ground piping is desired. The amount of connection piping defaulted is the radius of influence times the number of VEPs. The amount of manifold pipe will be defaulted at half the length of the connection piping and is the same material as the connection pipe. A pressure gauge and other piping appurtenances will be defaulted as well.

The model defaults to 2-inch and 4-inch diameter schedule 40 PVC connection and manifold pipe, respectively when a 2-inch diameter screen pipe is specified. The model defaults to 4-inch and +-inch diameter schedule 40 PVC connection and manifold pipe, respectively when a 4-inch diameter screen pipe is specified, and C-inch and 8-inch diameter schedule 40 PVC connection and manifold pipe. Respectively when a C-inch diameter screen pipe is specified.

The parameters for horizontal installation are listed and described below.

- VEP Diameter
- Contaminant of Trench Cutting

VEP Diameter - The model defaults to 2” diameter horizontal VEPs for depths of installation less than or equal to 10 feet. However, an option of 4" diameter horizontal VEPs is also available in the model.

When the installation depth is greater than 20 feet, the model defaults to installation of horizontal VEPs by the HDSI proprietary method; therefore, the construction materials cannot be edited. Per this construction method, a choice of 4-inch or C-inch diameter perforated HDFE horizontal pipe is available for installation. The model defaults to 4-inch diameter horizontal VEPS for depths of installation greater than 10 feet.

Containment of Trench Cutting - The trench cuttings can be placed in 55-gallon drums and stored until disposal options have been evaluated. If containment is included, this option will be coated. Otherwise, it is assumed that the waste soil is backfilled into the trench to be treated, along with the in situ contaminated soil. The model default is not to include containment of trench cuttings.

Another alternative that is not included in this model would be stockpiling tie waste soil at a location near the bioventing area.

The amount of waste soil to be drummed using the HDSI proprietary method is less than that drummed using conventional excavating equipment. This is due to the minimal disturbance of subsurface soil when using the IWSI method.

The professional labor hours spent in the field supervising the installation of the horizontal VEPS are included with the VEP installation costs. The model makes the following assumptions for staff hydrogeologist hours related to horizontal VEP installation:

- 45 minutes for vertical blank PVC pipe installation of a staff hydrogeologist per VEP.
- 1 minute per 2 feet of horizontal screen section, installation of a staff hydrogeologist per VEP.
- 1.5 hours for loading, moving, and setting up on site.

Decontamination, procedures for the VEP screen, riser, and caps, as well as decontamination of trenching tools, will be conducted prior to and between each VEP installation. Procedures consist of steam cleaning with a high-pressure steam-generating pressure washer and detergent, in accordance with AFCEE requirements.

Monitoring wells are usually Installed= the periphery of the soil contaminant plume. Monitoring wells are not included in this model, but may be estimated by using the Monitoring model.

Soil Additives

The soil additives parameters are Listed and described below.

- Watering
- Nutrients
- Microorganisms

Watering – Moisture and nutrients will generally be delivered to the soil by one of the three methods: spray irrigation (sprinkler system), infiltration gallery, or injection wells. This model assumes that if the watering Qztion is selected, a sprinkler will be wed. The model default is to include watering. The Infiltration Gallery or Injection Wells models may be used to estimate costs for the other options.

Nutrients – The most basic bioremediation processes involve the addition of oxygen and appropriate nutrients, typically nitrogen and phosphorus. The optimum nutrient mix must be determined by laboratory growth studies and geochemical evaluations of the site: however, a default has been determined for a rough estimate of nutrients and quantities. If nutrients are selected, the default is a nitrogen/ phosphorus/potassium (20:20:20) pulverized fertilizer, at an application of Boo lbs/acre. The model default is to include nutrients.

Microorganisms – When naturally occurring microorganisms are few in number or are absent, or when rapid cleanup is desired, acclimated organic matter may be added to the soil to be treated. The acclimated organic matter supplies organisms capable of initiating the degradation process. For this model, it will be assumed that microorganisms will not be added to the subsurface. The applications for the microorganisms, if chosen, will be 0.5 lb bioculture per gallon of water. The monthly application is estimated to be 25 lbs of bacteria per 1.000 cubic yards of waste. This corresponds to 200 gallons of water and bioculture per month per 1.000 cubic yards of contaminated soil.

4.1.4 Attachment 5, Model Assumptions for RACER-In Situ Solidification

In Situ Solidification

Solidification/Stabilization (S/S) is a treatment technology in which chemical agents are mixed with waste to make use of complex chemical and physical actions to improve physical properties and reduce contaminant solubility, toxicity, and/or mobility. S/S is a viable treatment for contaminated materials when the constituents cannot be treated, recovered, or destroyed by other methods because of technical or economical limitations.

The In Situ model does not include excavation, transportation, or disposal of solidified material. Solidification of in-drum waste is not addressed with this model- This model assumes that the site is fully accessible by heavy equipment (e.g., 100-ton crane, large earth moving equipment. etc.). It is also assumed that the site has been properly characterized prior to use of the In Situ Solidification model.

The following topics are available for the In Situ Solidification model:

Technical Help

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References
- Tables

System Help

- Button Bar
- Model Processing

To solidification, a reagent is added to transform a liquid, sludge, sediment, roil into a Solid form. Solidification may immobilize the contaminants within the crystalline structure of the solidified material thus reducing the contaminant leaching potential: although this varies depending upon waste, soil, and reagent characteristics. In stabilization, a reagent is added to transform the material so that the hazardous constituents are in the least mobile or toxic form. Solidification is a physical treatment, whereas, stabilization is a chemical treatment. Compatibilities of common reagents with various waste components are shown in Table 1.

A bench-scale laboratory program is usually performed to determine the type and amount of the S/S reagent required to satisfy the regulatory treatment objectives.

S/S is generally most effective for inorganic compounds and radionuclides. Solidification/stabilization is generally effective on certain contaminants, or contaminant groups: volatile and non-volatile metals (with some exceptions, anionic complexes of metals such as chromium, selenium, arsenic, cyanides, strong acids, oxidizing agents, and reducing agents); other inorganics, polychlorinated biphenyls (PCBs), and radionuclides. Treatment of some semivolatile compounds has been documented using S/S, although treatment of volatile organic compounds (VOCs) is currently the focus of research and debate.

This technology can be performed using a variety of equipment. Several methods include Open Pit/Trench/Area Mixing, in Situ/In Drum Mixing, and Ex Situ treatment in a mixing unit. The Open Pit/Trench/Area mixing method requires a reagent to be dumped on top of the waste and mixed with conventional earth saving and earth handling equipment. The In Situ/In Drum method requires a specialized or patented piece of equipment (usually a hollow stem auger or multiple auger rig) that injects and mixes reagent into the waste in place and can be used at depths up to 120 feet below grade. The Ex Situ method requires excavation, conveyance, or pumping of a contaminated medium into a mixing unit where a reagent is added. Treatment would be processed through a pugmill (mixing apparatus). The process modeled herein is the In Situ process using crane-mounted mixing augers. The Ex Situ process may be estimated using the Solidification/Stabilization model.

In most instances, the solidified material can be left in place and capped. However, local and state regulations should be reviewed to evaluate provisions for in-place disposal of solidified material. In Situ S/S eliminates the higher costs and additional hazards associated with excavation, handling and transport of hazardous materials associated with On-Site treatment and/or off-site disposal. In cases where the solidified material cannot be left in place, disposal options should be evaluated prior to technology selection. If land filling is the disposal option of choice, then the effectiveness of the S/S technology to meet the requirements of the Land Disposal Restrictions (LDRs) under the Resource Conservation and Recovery Act (RCRA) should be evaluated prior to proceeding. If the waste contains PCBs, then the waste disposal is regulated by the Toxic Substance Control Act (TSCF).

EPA guidelines recommend a minimum unconfined compressive strength (TTCS) of 50 pounds per square inch (psi) for treated waste that is disposed in landfill with no free liquids phase. For In Situ applications, strength should be adequate to serve the anticipated future uses of the site.

The total cost for this remediation technology will vary depending upon the chemical and physical characteristics of the waste, the site characteristics, and the treatment requirements.

Required parameters are the minimum amount of information required to generate cost estimate. There are no defaults as the values are site-specific. A reasonable cost estimate can be generated from the required parameters. The required parameters include:

- Type of Waste
- Total Volume of Waste*
- Depth of Bore*
- Boring Surface Area*
- Soil Type
- Safety Level

* Note: The user must enter two of these three required parameters. The remaining value is then calculated by the two entered values. The entered values must not allow the calculated value to exceed its valid range.

Type of Waste

The selections for type of waste are solid or sludge. It is assumed that the sludge is pumpable. The type of waste will affect the S/S mix design. It is assumed in the model that the waste is suitable for the S/S process. Waste with high concentrations of organics and other miscellaneous materials (i.e., oil and grease, loess, peat, highly plastic clays) may inhibit the effectiveness of this technology.

Options

- Solid
- Sludge

Total Volume of Waste

The volume of the waste is specified in cubic yards. The volume will be converted to weight since ratios using weight comparisons are most commonly used. The valid range is 1 to 9,999,999 cubic yards. Sludges can be converted from gallons to cubic yards by multiplying the number of gallons by 0.005.

Depth of Bore

This parameter reflects the depth of the contaminated waste to be treated. The depth of waste to be solidified drives the size of the equipment used for treatment. The valid range is 1 to 120 feet.

Boring Surface Area

This is the surface area affected by the boring for the solidification/stabilization process. The boring surface area drives the number of borings required. The valid range is 1 to 9,999,999 square feet.

1 Type

The soil type will affect the size of the boring equipment.

Options

- Silty Clay, Clay
- Mixed Sandy, Silty, Clayey Soils
- Primarily Sand

- Sand & Gravel

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSHA in 29 CFR Part 1910. The four levels are designated as A, B, C, and D; where

'"A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of safety levels and associated requirements is located in the On-Line Help for Safety Levels.

Secondary Parameters

The secondary parameters are listed and described below.

A reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, the secondary parameters can used to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameter sets are:

- Secondary
- Additives

Secondary

The secondary parameters are listed and described below.

- Initial Moisture Content
- Density of Waste
- Auger Diameter

Initial Moisture Content – The initial moisture content varies depending upon the waste medium. The moisture content will aid in determining the mix design for the waste and additives. The default moisture contents are shown in Table 2. The valid range for solid waste is 0 to 30%. For sludge waste, the valid range is 31 to 70%.

Density of Waste – The density of waste is specific to the waste medium and will be presented in pounds per cubic foot (pcf). This will provide information necessary to calculate the mix design and volume expansion encountered after the solidified waste has cured. The unit weight can be adjusted to the field conditions of the waste. The default waste densities are shown in Table 3. The-valid range for solid waste is 60 to 200 pcf. For sludge waste, the valid range is 40 to 200 pcf.

Auger Diameter – The auger diameter refers to the diameter of the boring bit. The auger diameter will default based on soil type and depth of boring. The auger diameter will determine the number of borings required.

Additives

The additives parameters are listed and described below.

- Chemical Additive Ratios
- Calculate Volume of Treated Waste

Chemical Additive Ratios – There are many chemical additives that can be used effectively in the S/S process. However, additive ratios axe highly waste specific and should be determined by beach and pilot testing. The chemical additive ratio defaults provided in this model are rudimentary and are provided only to obtain estimated chemical additive costs. A more precise estimate can be provided upon completion of beach and pilot testing.

This parameter group may include such chemicals as: water, proprietary chemical binders, Portland cement, fly ash, cement kiln dust, hydrated lime, asphalt, bitumen, polyolefins, epoxy, urea formaldehyde, activated carbon, modified Clay, pumice, blast furnace slag, polycrylares, and polyacrylamides. Mix ratios will be defaulted based on the required parameter input and standard S/S mix designs.

The default additives will include water, proprietary chemical binder, fly ash, kiln dust, and Portland cement. The mix proportions will be weight based and contingent upon the initial moisture. Content and unit weight of the waste. Table 4 provides a list of the default weight of additive to waste ratios Table 5 provides a summary of specific gravity and weight for both chemical additives and waste streams. These defaults are estimated based on information obtained from the EPA SITE program, and conversations with consultants and vendors.

Calculate Volume of Treated Waste - This is a locked field that will display the amount of waste after treatment and curing has been completed. This is displayed for informational purposes only. In general the volume of the treated waste will increase based on the amount of chemical additive that has been added for treatment. This increase in volume will raise the ground surface of the site over the aerial limits of the untreated waste if the treated material is left in place. The-site would require grading end capping based on its future use. If the treated material were to be disposed of in a landfill, the total volume of the treated waste would indicate the amount that is to be disposed of either in a Subtitle "C" (hazardous) or Subtitle "D" (non-hazardous) landfill depending upon the outcome of the Toxicity Characteristic Leaching Procedure (TCLP) analytical results. Groundwater monitoring adjacent to the solidified material may be required and should be estimated using the Monitoring model. Well installation can be estimated using the Groundwater Monitoring Wells model.

4.2 Cost Estimates for Groundwater Alternatives

4.2.1 Costs – Alternative 2

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 2

Calculation of Net Present Worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2% (7% plus 3.2%) per year for 300 years. The 3.2% annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7% Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

START-UP CAPITAL COSTS (IN 1997 DOLLARS) IS $63,358

NET PRESENT WORTH OF OPERATIONS & MAINTENANCE AND FUTURE CAPITAL

COSTS FOR 100-NR-2 CMS ALTERNATIVE # 2 IS $699,468

The cash flow is made up of the following:

1. Install Signs Along the River @ 5,076 every 20 Years. Start at year one.
2. Sample Sr-90 to River @ 5,687/yr. for 300 Yrs. Capital Well Replacement Costs of $48,557 every 20 Yrs.
3. Monitor Tritium to River $11,270/yr for 15Yrs.
4. Sample Sr-90 in Aquifer @ 13,893/yr for 300 Yrs. Capital Well Replacement Costs of $291,408 every 20 Yrs.
5. Sample Other Contaminants @ $8,314/yr. for 100 Yrs. Capital Well Replacement Costs of $58,282 every 25 Yrs.

The total inosculated capital costs is $5,068,784

The total inosculated operating cost is $6,874,535

The average annual in osculated operating cost is $6,874,535/300 YRS. = $22,915

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 300 years.

4.2.2 Costs – Alternative 3

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 3

Calculation of Net Present Worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $8,240,697

Net present worth of operations & maintenance and future capital costs for 100-NR-2 cms alternative #3 is $1,021,528

The cash flow is made up of the following:

1. Install Clino Wall at the River 1 st yr. @ 8,182,415. This is all Capital cost with no Yearly O&M.
2. Sample Sr-90 to River at Clino Wall @ 19,389/Yr. for 300 Yrs. Capital Well Replacement Costs of $321,218 Every 20 Yrs.
3. Monitor Tritium to River $11,270/yr for 15 Yrs.
4. Sample Sr-90 in Aquifer @ $13,893/Yr. for 300 Yrs. Capital Well Replacement Costs of $291,408 Every 20 Yrs.
5. Sample Other Contaminants @ 8,314/yr for 100Yrs. Capital Replacement Well Costs of $58,282 Every 25 Yrs.

The total unescalated capital costs is $16,992,315

The total unescalated operating cost is $10,985,030

The average annual unescalated operating cost is $10,985,030 /300 yrs. = $36,617

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 300 years.

4.2.3 Costs – Alternative 4

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 4

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 270 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 270 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $1,754,609

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative # 4 is $12,491,105

The cash flow is made up of the following:

1. Pump & Treat to 200 gpm, O&M @ $674,185/yr for 270 years. Plant & well construct & replacement @ 1, 20, & 50 yrs.
2. Monitor Tritium to River $11,270/yr. for 15 Yrs.
3. Sample Sr-90 in Aquifer @ $30,923/Yr. for 270 Yrs. Capital Well Replacement Costs of $524,535 Every 20 Yrs.
4. Sample Other Contaminants @ $8,314/yr for 100 Yrs. Capital Well Replacement Costs of $58,282 Every 25 Yrs.
5. Monitor Water Levels @ 7,046/yr for 270 Yrs. Capital Well Replacement Costs of $194,228 Every 50 Yrs.

The total unescalated capital costs is $38,160,277

The total unescalated operating cost is $193,282,168

The average annual unescalated operating cost is $193,282,168 /270yrs. = $715,860

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 270 years.

4.2.4 Costs – Alternative 5

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 5

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 270years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 270 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $4,580,204

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative #5 is $34,585,404

The cash flow is made up of the following:

1. Pump & Treat to 200 gpm, O&M @ $674,185/yr for 270 years. Plant & well construct & replacement @ $1,20 & 50 yrs.
2. Maintain Tritium Hydraulic Control $l2,175/yr. for 15 Yrs. Capital well costs $115,796 at day one.
3. Sample Sr-90 in Aquifer @ $30,923/yr for 270 Yrs. Capital Well Replacement Costs of $524,535 Every 20 Yrs.
4. Sample Other Contaminants @ $8,314/yr for 100 Yrs. Capital Well Replacement Costs of $58,282 Every 25 Yrs.
5. Monitor Water Levels @ $7,046/yr for 270 Yrs. C Capital Well Replacement Costs of $194,228 Every 50 Yrs.
6. Others Pump & Treat to 200 gpm, O&M @ $1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20 & 50 yrs. intervals

The total unescalated capital costs is $50,409,080

The total unescalated operating cost is $315,188,703

The average annual unescalated operating cost is $315,188,703 /270yrs. = $1,167,366

The actual average yearly operating costs will vary since projects requiring O&M run for $15,90,100, & 270 years.

4.2.5 Costs – Alternative 6

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 6

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $20,389,389

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative #6 is $36,269,137

The cash flow is made up of the following:

1. Pump & Treat to 135 gpm, O&M @ $589,180/yr for 270 years. Plant & well construct & replacement @ 1, 20, & 50 years.
2. Maintain Tritium Hydraulic Control 11,270/yr for 15 years.
3. Sample Sr-90 in Aquifer @ 21,580/yr for 270 years. Capital Well Replacement Costs of 349,630 Every 20 years.
4. Sample Other Contaminants @ 8,314/yr for 100 years. Capital Well Replacement Costs of 58,282 Every 25 years.
5. Monitor Water Levels @ 7,046/yr for 270 years. Capital Well Replacement Costs of 194,228 Every 50 years.
6. Others Pump & Treat to 200 gpm, O&M @ 1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20, & 50 yrs. intervals
7. Install Freeze Wall at the River. O&M 212,463/yr for 300 years. Capital Installation Costs 1st year 16,463,096.

The total unescalated capital costs is $56,753,369

The total unescalated operating cost is $353,590,138

The average annual unescalated operating cost is $353,590,138/ 300yrs. = $1,178,634.

The actual average yearly operating costs will vary since projects requiring O&M run for 15, 90, 100, 270 & 300 years.

4.2.6 Costs – Alternative 7

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 7

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 100 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 100 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $22,416,808

Net present worth of operations & maintenance and future capital costs for 100-nr-2 cms alternative # 7 is $114,113,817

The cash flow is made up of the following:

1. Pump & Treat to 250 gpm, O&M @ 4,966,263/yr for 20 years. Original Capital Cost $2,048,414
2. Maintain Tritium Hydraulic Control 2175/yr for 15 years. New Well Capital Costs $115,796
3. Sample Sr-90 in Aquifer @ 13,519/yr for 20 years.
4. Sample Other Contaminants @ 8,314/yr for 100 years. Capital Well Replacement Costs of 58,282 every 25 years.
5. Monitor Water Levels @ 10,404/yr for 100 years. Capital Well Replacement Costs of $294,740 @ 50 years.
6. Others Pump & Treat to 200 gpm, O&M @ 1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20, & 50 yrs. intervals
7. Install Soil Flushing. O&M 2,953,284/yr for 20 yr. Capital Installation Costs 1st. year $8,708,080.
8. Install Sheet Piling Wall Original Capital Cost $8,776,437. Remove in 20 years @1,077,752

The total unescalated capital costs is $32,309,602

The total unescalated operating cost is $283,686,469

The average annual unescalated operating cost is $283,686,469138/ 100yrs. = $2,836,864.

The actual average yearly operating costs will vary since projects requiring O&M run for 152,090,100 years.

4.3 Groundwater Alternatives Descriptions 100-NR-1/100-NR-2 CMS

4.3.1 Alternative 1: No Action

Physical Features

None

Notes

- National Contingency Plan requires evaluation of the No Action alternative.
- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.
- Nitrate load to the Columbia River from the N-Area is very small in comparison to the load from irrigation return flows.

Associated Activities

- No cleanup activities at all.
- No institutional controls after DOE releases the property in 2018.

Consequences

- Tritium conc. in to river exceeds MCL for next 10-15 years.
- Tritium conc. in aquifer exceeds MCL for next 25 years.
- Strontium conc. into river exceeds MCL for next 270 years.
- Strontium conc. in aquifer exceeds MCL for next 300 years.
- Other contaminants in aquifer will exceed MCLs for few to 90 years.
- Manganese conc. into river may exceed MCL sat future date for few years.
- Contaminant conc. into river could change without being detected.

4.3.2 Alternative 2: Institutional Controls

NR-1/NR-2CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

Physical Features

- Monitoring wells.
- Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years.
- Strontium- 9 wells, sample rate varies, test for Sr-90, for 300 years.
- Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years.
- Signs along river.

Notes

- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.

Associated Activities

- Access controls on river shoreline along N-Springs.
- Controls on GW use for 300 years.
- Limits on irrigation in the general area.
- Monitoring for 300 years.
- Regulatory acceptance of institutional controls.

Consequences

- No use of unconfined aquifer allowed for 300 years.
- Must maintain monitoring, institutional controls, etc. for 300 years.
- Risk to ecological receptors along river may occur due to strontium.
- Changing groundwater conditions would be detected by monitoring.
- Tritium and strontium would continue to flow into the Columbia River.

Also:

- Tritium conc. into river exceeds MCL for next 10-15 years.
- Tritium conc. in aquifer exceeds MCL for next 25 years.
- Strontium conc. into river exceeds MCL for next 270 years.
- Strontium conc. in aquifer exceeds MCL for next 300 years.
- Other contaminants in aquifer will exceed MCLs for few to 90 years.
- Manganese conc. in to river may exceed MCL sat future date for few years.

4.3.3 Alternative 3: Permeable Wall and Institutional Controls

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
(IC for tritium to river and all COCs in aquifer)
August 5, 1996

Physical Features

- Permeable barrier, 2000 ft. long (for strontium) (top of barrier wall at least 10 ft below ground surface).
- Monitoring wells.
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 2 wells plus 40 sample tubes impermeable wall, sample rate varies, test for Sr-90, for 300 yrs.
  Strontium- 5 wells, once every 2 yrs, test for Sr-90, for 300years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
- Signs along river

Notes

- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.
- Nitrate load to the Columbia River from the N-Area is very small in comparison to the load from irrigation return flows.
- Permeable wall operates passively; little O&M required.

Associated Activities

- Land use controls for area containing permeable wall.
- Monitoring for permeable barrier integrity for 300 years.
- Institutional controls on GW use for 300 years.
- Institutional controls along river for 15 years, for tritium.
- (assume other COCs pose no risk to river)
- Monitoring north and south of permeable wall for groundwater quality going in to river.
- Regulatory acceptance of institutional controls.

Consequences

- No use of unconfined aquifer allowed for 300 years.
- Must maintain monitoring and institutional controls for 300 years.
- Permeable wall reduces risk to ecological receptors along river that is due to strontium.

Also:

- Tritium conc. into river exceeds MCL for next 10-15 years.
- Tritium conc. in aquifer exceeds MCL for next 25 years.
- Strontium conc. into river will be less than MCL.
- Strontium conc. in aquifer exceeds MCL for next 300 years.
- Other contaminants in aquifer will exceed MCLs for few to 90 years.
- Manganese conc. into river may exceed MCL sat future date for few years.

4.3.4 Alternative 4: Hydraulic Controls and Pump and Treat for Strontium, Institutional Controls for Tritium to River and Other COCs in Aquifer

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

Physical Features

- Sr-90Hyd.Control and P&T:
  9 extraction wells, 5 of 9 new
  3 injection wells, 1 of 3 new
  1 Treat Plant expand existing plant)
  Pumping rate- 15 gpm for 9 extraction wells
- Monitoring wells along river
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 270 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench

Notes

- Hydraulic controls for Sr-90 will partly control tritium to river

Associated Activities

- Institutional controls on GW for 270 years.
- Institutional controls of land use where wells and treatment plant are located.
- Monitor groundwater for 270 years.
- O&M of treatment plant for 270 years.
- O&M of wells and pipelines for 270 years.
- Regulatory acceptance of institutional controls rather than significant expense of remediation.
- Treatment plant residuals disposed at ERDF.

Consequences

- No use of unconfined aquifer allowed for 270 years.
- Must maintain monitoring and institutional controls for 270 years.
- Contaminants north and south of Sr-90 plume would continue going into the river.
- Tritium conc. into river exceeds MCL for next 10-15 years.
- Tritium conc. in aquifer exceeds MCL for next 25 years.
- Strontium conc. into river will be less than MCL.
- Strontium conc. in aquifer exceeds MCL for next 270 years.
- Other contaminants in aquifer will exceed MCLs for few to 90 years.
- Manganese conc. into river may exceed MCL sat future date for few years.

4.3.5 Alternative 5: Hydraulic Controls for Tritium and Strontium to River Pump and Treat Strontium and Other COCs in Aquifer

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

Physical Features

- Sr-90 Hyd. Control and P&T
  9 extraction wells, 5 of 9 new
  3 injection wells, 1 of 3 new
  1 Treat. Plant (expand existing plant and modify for nitrate treat.)
  Pumping rate-six well sat 15 gpm
  three well sat 20 gpm
- Tritium-Hyd. Control
  2 extraction wells, both new
  0 injection wells (use new Sr-90 well)
  0 Treat. Plant
- "Others"-P&T
  8 extraction wells, 4 of 8 new
  3 injection wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 300 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench (Sr and NO3)
- Treatment facility NE of 1324-N for "Others"

Notes

- Hydraulic controls for Sr-90 will partly control tritium to river
- Pump and treat for "Others" will retard their migration to the river

Associated Activities

- Institutional controls on GW for 270 years
- Institutional controls of land use where wells and treatment plant are located
- Monitor groundwater for 270 years
- O&M of wells, pipelines, & treatment plant for strontium for 270 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

Consequences

- No use of unconfined aquifer for 270 years
- Must maintain wells, piping systems, and treatment plant for strontium for 270 years
- Wells, piping systems, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Contaminant migration south of Sr-90 plume would be retarded by the pump and treat actions, so river will be protected
- Tritium conc. in aquifer exceeds MCL for next 25 years

- Strontium conc. in to river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few years

4.3.6 Alternative 6: Impermeable Barrier for Strontium, Institutional Controls for Tritium, Pump and Treat All Groundwater COCs

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

Physical Features

- Sr-90-P&T
  6 extraction wells, 4 of 6 new
  3-injection wells, 1 of 3 new
  1 Treat. Plant (expand existing plant and modify to treat nitrate)
- "Others"-P&T 8 extraction wells, 4 of 8 new
  3-injection wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 270 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench (Sr and NO3)
- Treatment facility NE of 1324-N for "Others"

Notes

- Impermeable barrier for Sr-90 will partly control tritium to river
- Columbia River tritium concentrations near Richland water intake are higher than at the N-Springs area. Health risks under current conditions are acceptable to the City of Richland and the Regulators.

Associated Activities

- Institutional controls on GW for 270 years
- Institutional controls of land use where impermeable barrier, wells and treatment plants are located
- Monitor groundwater for 270 years
- O&M of wells, pipelines, & treatment plant for strontium for 270 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

Consequences

- No use of unconfined aquifer for 270 years
- Must maintain wells, piping systems, and treatment plant for strontium for 270 years
- Wells, piping systems, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Contaminants north and south of Sr-90 plume would continue going into the river.
- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years

4.3.7 Alternative 7: Impermeable Barrier for Strontium to River, Impermeable Barrier and Hydraulic Controls for Tritium to River, Soil Flushing for Strontium in the Aquifer, Pump and Treat for Other COCs in Aquifer

100-NR-1/NR-2 CMS Groundwater Alternatives – Descriptions
(May 11, 1997)

Physical Features

- Tritium-Hyd .Control
  2 extraction wells, both new
  0 Treat. Plant
- Soil Flushing
  9 extraction wells, 8 new
  1 Treat. Plant (expand existing plant and modified to treat nitrate)
  3 injection wells, 1 new
- Others-P&T 8 extraction wells, 4 of 8 new
  3 injections wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 20 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench
- Treatment facility NE of 1324-N for "Others"
- Operate a sheet pile barrier for 20 years and remove

Notes

- Impermeable barrier and hydraulic controls will control strontium and tritium to river
- Pump and treat for "Others" will retard their migration to the river

Associated Activities

- Institutional controls on groundwater for 100 years
- Institutional controls of land use where well sand treatment plant are located
- Monitor groundwater for 100 years
- O&M of wells, pipelines, & treatment plant for strontium for 20 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

Consequences

- No use of unconfined aquifer for 100 years
- Must maintain wells, piping systems, and treatment plant for strontium for 20 years
- Wells, piping system, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
  - Strontium conc. in aquifer exceeds MCL for next 20 years
  - Other contaminants in aquifer will exceed MCLs for few years

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