

APPENDIX A
REMEDY INVENTORY SHEETS

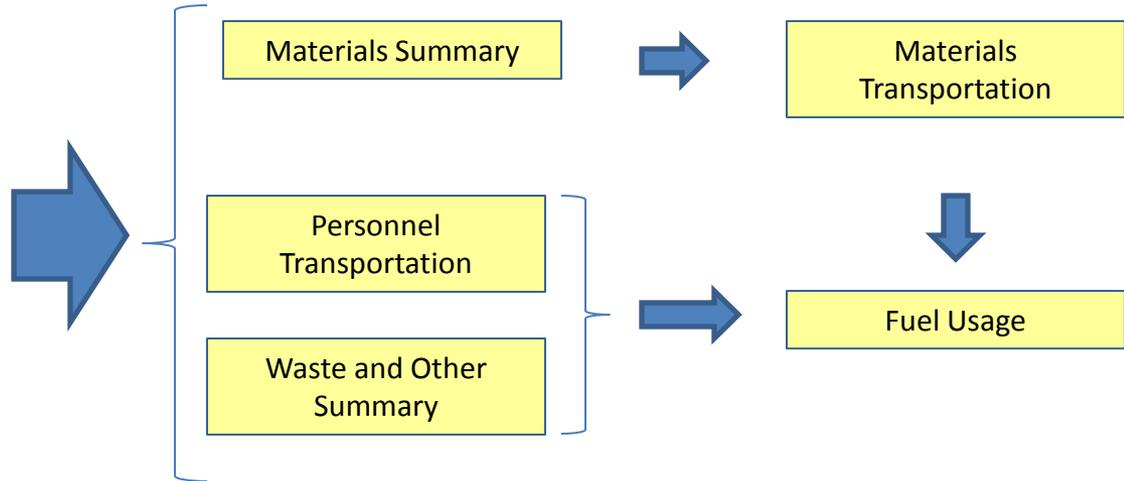
REMEDY INVENTORY SHEETS

The remedy information for each remedy alternative is entered into a set of spreadsheet modules that documents these remedy parameters and calculates the level of effort, fuel, electricity, water, and materials usage to implement the remedy. The set of spreadsheet modules is sufficiently flexible to use for other remedial alternatives or for other sites. Spreadsheet modules in the existing spreadsheet file are for site investigation, demolition, excavation, capping, extraction well installation, conveyance pipe installation, treatment plant construction, treatment plant operations and maintenance, injection well installation, bioremediation operations and maintenance, long-term monitoring, and decommissioning. In addition there are several summary tables at the end of the spreadsheet file that summarize information in the modules. Modules for additional activities can be added to the spreadsheet file as long as the summary tables at the end of the spreadsheet are linked to the new modules. Figure A-1 illustrates the organization of the typical spreadsheet file used for this study.

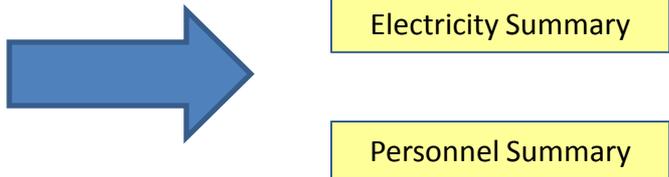
Figure A-1. Organization of Inventory Files

Activity-Specific Modules Used to Inventory Materials, Hours, Travel, and Equipment

- Site Investigation
- Demolition
- Excavation
- Capping
- Extraction Well Installation
- Conveyance Piping
- Treatment Plant Construction
- Treatment Plant O&M
- Injection Well Installation
- Bioremediation O&M
- Long-Term Monitoring
- Decommissioning
- ADDITIONAL MODULES TO BE ADDED AS NEEDED



Summary tabs that compile the information from the modules for export to the footprinting spreadsheets



**Remedy Conceptual Design and Assumptions:
 Alternative 2 - Hybrid P&T and Bioremediation Version 1**

Overview

This alternative uses a P&T system to contain a portion of the plume, uses bioremediation to address another portion of the plume, and uses targeted excavation to address the source area. Ground water extraction is achieved by a single above-ground self-priming pump that extracts groundwater from both new and existing extraction wells. Extracted groundwater is conveyed to a single treatment system housed in an existing building. The treatment process is based on an existing P&T system that has operated at the site. It includes air stripping, polishing with liquid phase GAC, and discharge of final effluent to the POTW. Air stripper off-gas is treated with vapor phase GAC. Bioremediation involves the injection of cheese whey and molasses. Excavation includes disposal of material off-site as hazardous waste back backfill with select fill.

General Assumptions Regarding Site Characteristics

The following assumptions have been made:

- The average concentration over the life-time of the P&T remedy is assumed to be 25% of average concentration reported in Table B-2 of the 2007 Statement of Basis Report. Only those compounds with concentrations over 1 mg/L in Table B-2 are considered.

Compound	25% of Table B-2 Concentration (ug/L)
1,2-dichloroethane	1,000
cis-1,2-dichloroethene	1,400
toluene	250
1,1,2-trichloroethane	300
trichloroethene	650
vinyl chloride	850
freon 113	300

- Groundwater is present at the site at a depth of approximately 5 feet below ground surface.
- A building or other infrastructure exists that can house the air stripper.
- Groundwater extraction and bioremediation occur in the hydrogeologic zones A, B, and C.
- Because intervals A, B, and C are already contaminated, wells in the B and C zones are note required to be double or triple cased, respectively

Key for Cell Shading

Blue	Is a calculated cell.
Green	Is a calculated cell referenced by one or more cells ithat are not in the immediate vicinity of the shaded cell
Red	Is a calculated or manual cell referenced by one or more of the summary sheets in the workbook
Yellow	Is a calculated cell that is exported from the spreadsheet for footprinting
	This outlined cell format is for manual input based on site/project specific information.
Gray	Is a default value for a general parameter that might be updated manually based on additional information

Assumptions Regarding Site Investigation

	Quantity by Project				Productivity by Project				Days of Equipment Use				Rig Mobs.		
	1	2	3	Units	1	2	3	Units	Units	1	2	3		Totals	
Direct Push Activities															
Total depth of pushing for grab samples (no coring or continuous logging)	1156	0	0	ft	120	0	0	ft/day	days	9.6	0	0	9.6	1	
Total depth of direct push coring with continuous soil logging	0	0	0	ft	0	0	0	ft/day	days	0	0	0	0	0	
Total depth of direct push cone penetrometer work	240	0	0	ft	120	0	0	ft/day	days	2	0	0	2	1	
Total depth of membrane interface probe (MIP) work	0	0	0	ft	0	0	0	ft/day	days	0	0	0	0	0	
													Total for Rig (50 HP)	11.6	2
Grout (5HP grout pump)	0.863187	0	0	cy	2	2	2	cy/day	days	0.4	0	0	0.4	N/A	
Test Pit Activities															
	Quantity				Productivity by Project				Days of Equipment Use						
	1	2	3	Units	1	2	3	Units	Units	1	2	3	Totals	Rig Mobs.	
Total test pit or trench volume (assume depth is 10 feet or less)	302	0	0	bcy	150	0	0	bcy/day	days	2	0	0	2	1	
Materials															
	Quantity				Conversion				Quantity of Materials						
	1	2	3	Units	1	2	3	Units	Units	1	2	3	Totals	Truckloads	
Steel for drums	10	0	0	drums	63	63	63	lbs/drum	lbs	630	0	0	630	1	
Cement grout (assumes 1.75-inch borehole for direct push)	0.86	0	0	cy	0.99	0.99	0.99	tons/cy	tons	0.85	0	0	0.85	0	
Pounds of plastic (LDPE) for sheeting	14400	0	0	sq. ft.	0.019	0.019	0.019	lbs/sq ft	lbs	274	0	0	274	0	
Potable water	500	0	0	gallons	N/A	N/A	N/A	N/A	gallons	500	0	0	500	0	
Waste															
	Volume Including Swell				Conversion				Quantity of Waste						
	1	2	3	Units	1	2	3	Units	Units	1	2	3	Totals	Truckloads	
Waste from direct-push (assumes 1.75-inch soil core) - 25% swell	0.89	0	0	lcy	1.5	1.5	1.5	tons/lcy	tons	1.335	0	0	1.34		
Waste from test pits - 25% swell	0	0	0	lcy	1.5	1.5	1.5	tons/lcy	tons	0	0	0	0		
Total soil waste									tons	1.335	0	0	1.34		
Weight of hazardous soil waste					100%	0%	0%	% of tot.	tons	1.335	0	0	1.34	1	
Weight of non-hazardous soil waste					0%	0%	0%	% of tot.	tons	0	0	0	0	0	
Time and Mobilizations															
									Labor and Mobilization						
									Units	1	2	3	Totals	Crew Mobs.	
Man-days required for oversight or field technicians									man-days	14	0	0	14	14	
Crew man-days for direct-push (2 person crews, a chemist can be added with the mobile lab option)									man-days	24	0	0	24	24	
Crew man-days for excavator and concrete (2 person crew)									man-days	4	0	0	4	4	
Fixed Laboratory Analysis															
	Samples				Cost Per Sample				Laboratory Analysis						
	1	2	3	Units	1	2	3	Units	Units	1	2	3	Totals		
Waste characterization	2	0	0	samples	\$700	\$0	\$0	\$/sample	\$	\$1,400	\$0	\$0	\$1,400		
Soil or sediment samples	323	60	0	samples	\$90	\$480	\$0	\$/sample	\$	\$29,070	\$28,800	\$0	\$57,870		
Water samples	5	0	0	samples	\$90	\$0	\$0	\$/sample	\$	\$450	\$0	\$0	\$450		
Vapor samples (cost related to analysis only, not cannister rental)	21	2	0	samples	\$0	\$250	\$0	\$/sample	\$	\$0	\$500	\$0	\$500		
													\$60,220		
Mobile Laboratory Analysis															
									Labor, Mobilization, & Equip. Use						
									Units	1	2	3	Totals	Mobs.	
Man-days									man-days	2	0	0	2	2	
Mobile lab days of use and mobilization									days	2	0	0	2	1	

Notes:

- Monitoring well installation can be modeled with the "extraction well" or "injection well" modules and sampling can be modeled with the LTM module
- "Projects" 1, 2, and 3 allow user to account for different productivity rates or sample costs based on different components of the investigation
- Total depth for grab samples determined as follows: 130 locations to 6 feet for soil grab samples, 21 locations to 6 feet for vapor samples and 5 locations to 50 feet for groundwater samples
- Productivity rates for direct-push include time for repositioning rig on each location and collecting samples
- Direct push rig assumed to be GeoProbe 6600 series or equivalent (e.g., approximately 50 HP)
- Test pit volumes include four 10'x10'x10' test pits for soils, four 10'x10'x10' test pits for the pond, and one trench that is 15 feet long by 5 feet deep by 2-feet long.
- Test pit productivity includes time for breaking through concrete, collecting soil samples, and backfilling test pits and trenches
- Test pits and trench assumed to be excavated with small excavator (100 HP with 1 cy bucket)
- Grouting to be accomplished with 5 HP grout pump at approximately 1 gpm
- Soils from test pits are temporarily stockpiled on 4-mil polyethylene sheeting (40'x40' per test pit and trench) and are used to back fill test pits
- Excavated/drilled soils assumed to swell 25%
- All waste assumed to be hazardous.
- Potable water used for mixing grout
- One consultant technician in the field overseeing contractors and collecting samples.
- Equipment to be mobilized once for the project
- Contractors and consultant to mobilize daily
- Direct push crew does borehole grouting
- Two waste characterization samples assumed (one for soil one for water)
- Soil/sediment samples represent expected minimum for investigation (multiple samples per location)
- Waste characterization sample analysis is \$700 per sample
- VOC analytical cost is \$90 per sample
- Project 2 analyses represent approximately 20% of the soil samples that are analyzed for SVOCs (\$150 per sample), Pesticides/PCBs (\$150 per sample), metals (\$130 per sample), and TPH (\$50 per sample)
- Project 2 vapor analyses represent 10% of vapor samples that are analyzed in off-site lab via TO-15. Project 1 vapor samples are analyzed with on-site instrumentation

Notes:

- Project 1 refers to removal of concrete associated with site investigation, and Project 2 refers to removal of concrete associated with excavation.
- Area of concrete removal for site investigation is based on eight 100 sq ft test pits, one 15x5 foot trench, and 130 borings that require one sq. ft. each of clearing.
- Area of concrete removal for excavation is based on an estimate 3,000 cy excavation that is 2 cy deep.
- Loose/broken concrete and asphalt assumed to have a density of 1.3 tons/cy (typical from Integrated Solid Waste Management, McGraw Hill, 1993).
- Loose general debris assumed to have a density of 1 ton per cubic yard (consistent with mixtures from Integrated Solid Waste Management, McGraw Hill, 1993)
- Productivity and crew for concrete removal is based on pavement demolition values provided by RS Means Building Construction Cost Data 2007, Reed Construction Data, Inc. 2006
- Handheld tools for concrete removal (per RSMeans) includes a 250 cfm air compressor, which would use a 70 HP diesel engine.
- Hydraulic hammer would use a 50HP small hoe or loader with a hammer.
- Debris moved with a 100 HP loader
- Two equipment mobilizations for Project 2 are 1) hydraulic hammer and 2) loader for loading debris
- Some values are rounded as appropriate

Assumptions Regarding Extraction Wells

Number of Extraction Wells and Extraction Rates

Aquifer	Depths (ft)	Existing	New	Total # of Wells	Total Depth (ft)	Total Extraction Rate (gpm)
Zone A	20	8	10	18	360	18
Zone B	50	2	8	10	500	10
Zone C	80	0	4	4	320	4
Total		10	22	32	1180	32

Well Depths and Drilling Times

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)	Time to Drill Each New Well (hrs)	Total Time to Drill Wells (hrs)
2-inch wells					
Zone A	10	20	200	4	40
Zone B	8	50	400	6	48
Zone C	4	80	320	8	32
Total	22		920		120
4-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0
6-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

Above table assumes single-cased wells.

The use of 2-inch extraction wells is assumed due to the large number of wells, the low yield for each well, and the use of an above ground pump instead of a submersible pump.

Well Construction Information			Units	Quantity by Well Size				
Well diameter			inches	2	4	6	Total	
Number of wells to install			#	22	0	0	22	
Borehole diameter			inches	6	8	10		
Total depth of all new wells			feet	920	0	0	920	
Total length of gravel/sand pack	10	ft/well	feet	220	0	0	220	
Total length of bentonite seal	2	ft/well	feet	44	0	0	44	
Total length of cement grout from bentonite to surface			feet	656	0	0	656	
Volume of drill cuttings			cy	6.7	0	0	6.7	
Volume of gravel/sand for sand pack			cy	1.4	0	0	1.4	
Volume of bentonite for seal			cy	0.3	0	0	0.3	
Volume of cement grout			cy	4.2	0	0	4.2	
Number of flush mount covers			#	0	0	0	0	
Number of steel 2'x2'x2' H2O rated manholes			#	22	0	0	22	
Number of concrete vaults 4'x4' with H2O steel doors			#	0	0	0	0	
Number of steel DOT rated 55-gallon drums for disposal			#	25	0	0	25	
Materials				Materials by Well Size				Truckloads
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	625.6			625.6	
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0	
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0	
Total mass of PVC			lbs				625.6	1
Total weight of gravel/sand	1.5	tons/cy	tons	2.1	0	0	2.1	1
Total dry weight of bentonite	0.19	tons/cy	tons	0.1	0	0	0.1	0
Total dry weight of cement grout	0.99	tons/cy	tons	4.2	0	0	4.2	1
Total potable water for grout	0.06	gal/lb	gals	536	0	0	536	0
Weight of steel for flush mount covers	32	lbs/unit	lbs	0	0	0	0	
Weight of steel for manholes	128	lbs/unit	lbs	2816	0	0	2816	
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0	
Total weight of steel for surface finish			lbs	2816	0	0	2816	1
Weight of concrete for flush mount covers	0.10	tons/unit	tons	0	0	0	0	
Weight of concrete for manholes	0	tons/unit	tons	0	0	0	0	
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0	
Total weight of concrete for surface finish			tons	0	0	0	0	0
Total steel for drums for disposal	63	lbs/drum	lbs	1575	0	0	1575	1
Waste				Waste by Well Size				Truckloads
Development water	100	gal/well	gallons	2200	0	0	2200	
Development water returned to aquifer	100	gal/well	gallons	2200	0	0	2200	
Water to POTW	0	gal/well	gallons	0	0	0	0	0
Total weight of drill cuttings & other waste	1.5	tons/cy	tons	10.1	0	0	10.1	
Weight of hazardous waste	100	% of total	tons	10.1	0	0	10.1	1
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0	0
Waste characterization (at \$700 per sample)			\$	1400	0	0	1400	
Time and Mobilizations				Equipment & Labor by Well Size				Mobs.
Rig-days of drilling (8-hour days) - 120 HP rig			rig-days	15	0	0	15	2
Small loader for handling cuttings			rig-days	0	0	0	0	0
Crew man-days for drilling (8-hour days, 3 man crew)			man-days	45	0	0	45	15
Days for oversight			days	8	0	0	8	8

Notes:

- All wells are single-cased wells.

- Surface finishing for each new well assumed to be a traffic rated 2'x2' manhole finished level with ground surface to provide access to well, piping, vacuum gage, and check valve.

- All wells to be constructed of schedule 40 PVC. Screen is assumed to be slotted PVC with approximately the same lb/ft as the casing.

- All waste to be containerized in steel drums for disposal as hazardous waste

- Absent other information, assume 10 cy of waste hauling per load if by roll-off/truck and 50 drums per load if containerized in drums

- Two rigs working simultaneously. One mobilization for each rig for entire project.

- Crew mobilizes daily in one light duty truck.

- Consultant oversees two crews working simultaneously

Assumptions Regarding Conveyance Piping

Piping Features			Units	Quantity of 1-inch Pipe	Quantity of 2-inch Pipe	Quantity of 3-inch Pipe	Quantity of 4-inch Pipe	Quantity of 6-inch Pipe	Total	Truckloads & Mobs.
Mass of HDPE pipe per linear foot			lbs/ft	0.2	0.64	1.4	2.3	5.0		
Average distance between wells in same zone			feet	50	0	0	0	0		
Trench depth			feet	2	0	0	0	0		
Trench width			feet	0.5	0	0	0	0		
Total length of piping/trench (including drop tubes)			feet	3000	0	0	0	0		
<u>Materials</u>										
Trench bedding material and/or base course (sand/gravel)			cy	0	0	0	0	0	0	
Total mass of bedding material (sand/gravel)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Total mass of HDPE			lbs	600	0	0	0	0	600	1
<u>Waste</u>										
Off-site soil disposal (non-hazardous)			cy	0	0	0	0	0	0	
Off-site soil disposal (hazardous)			cy	0	0	0	0	0	0	
Off-site soil disposal (non-hazardous)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Off-site soil disposal (hazardous)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Trenching rate with backfill			feet/day	750	0	0	0	0		
Trenching equipment and time			days	4	0	0	0	0	4	1
Total crew man-days (1-person crew)			man-days	4	0	0	0	0	4	4
Days of oversight			days	4	0	0	0	0	4	4

Notes:

- All pipe assumed to be SDR-11 HDPE
- All piping to be 1-inch, directly from well to treatment plant
- Trenching accomplished with a 40 HP riding trencher, mobilized one time for the project.
- Native material used for bedding and backfill, no disposal required
- Up to 30-foot 1-inch SDR 11-HPDE drop tube in each well
- Individual fittings, valves, etc. are not considered

Assumptions Regarding Treatment Plant Construction

Extraction System Pumps and Treatment Plant Components

- Single 1 HP self-priming pump for groundwater extraction rated for 32 gpm at 25 feet of suction and 30 psi of discharge pressure
- One 0.5 HP process water transfer pump between the air stripper sump and the liquid phase GAC polishing units
- Building with less than 800 square feet of floor plan and natural ventilation
- Tray aerator with 4 trays rated for 200 cfm of flow and pressure drop of 20 inches of water - 5 HP blower
- Three 1,500-pound vapor phase GAC vessels in series (large units selected to reduce pressure drop to under 2 inches of water each) - with in-line pre-heater
- Three 3,000-pound liquid phase GAC vessels in series (large units selected to reduce pressure drop)
- Discharge to the POTW

Construction Parameters

Item	Unit	Quantity
Days required for construction	days	15
Man-days required for construction (3 person crew)	man-days	45
Mobilizations required for construction contractor	visits	15
Days required for oversight	man-days	15
Mobilizations required for oversight	visits	15

Notes:

- *Construction contractor includes local plumber and electrician to install air stripper, GAC units, and controls*

Primary Treatment Components

Item	Mass of Materials Integral to Primary Treatment Components				Materials for Building	
	Mass of Stainless Steel lbs	Mass of Steel lbs	Mass of HDPE lbs	Mass of PVC lbs	Mass of Concrete tons	Mass of Building and Reinforcing Steel lbs
Building and concrete reinforcing steel	0	0	0	0	0	0
Concrete foundation	0	0	0	0	0	0
Air stripper	1000	0	0	0	0	0
Liquid GAC units	0	5400	0	0	0	0
Vapor GAC units	0	2850	0	0	0	0
Total Mass	1000	8250	0	0	0	0
Truckloads for delivery	1	1	0	0	0	0

Notes:

- No building steel or concrete is required. Project assumes an existing building can house the system.
- Air stripper mass is based on Carbonair specifications for a STAT 80 stripper with 4 trays and QED 4.4
- Vapor GAC units are based on Carbonair specifications for three GPC 13R units.
- Liquid GAC units are based on Carbonair specifications for three PC20 units
- Fuel consumption for forklift to move equipment during treatment plant assembly is assumed to be negligible relative to the transportation of the equipment to the site.

Assumptions Regarding Treatment Plant O&M

General Operation Parameters

Item		Unit	Quantity
System Duration		years	30
System Flow Rate		gpm	32
Total Extraction for Duration of Remedy		gallons	504576000
<u>O&M Labor</u>			
Frequency of Operator Visits		visit/week	1
Total Operator Visits (one operator per visit)		man-days	1560
Frequency of plumber/electrician repairs		visit/year	4
Total plumber/electrician visits		man-days	120
Frequency of engineer/oversight visits		visit/year	4
Total engineer/oversight visits		man-days	120
<u>Discharge</u>			
Volume of treated water discharged to surface water	0%	of ext. water	gallons 0
Volume of treated water discharged to the POTW	100%	of ext. water	gallons 504576000
Volume of treated water reinjected	0%	of ext. water	gallons 0
Volume of treated water used beneficially	0%	of ext. water	gallons 0
<u>Sampling</u>			
Total process sampling over lifetime of remedy		samples	1440
Cost for sample analysis		\$/sample	\$90
Total cost for laboratory analysis		\$	\$129,600

- Process sampling includes monthly sampling of influent/effluent + duplicate + trip blank

Treatment Chemicals, Materials, and Waste

Item	Unit	Annual Quantity	Life-Cycle Quantity	Shipments per Year	Life-Cycle Shipments
<u>Adsorbants</u>					
- regenerated coal-based GAC	lbs	52200	1566000	20	600
- virgin coal-based GAC	lbs	0	0	0	0
- virgin coconut-based GAC	lbs	0	0	0	0
<u>Chemicals and Other Resources</u>					
- Potassium permanganate	lbs	0	0	0	0
- Hydrogen peroxide (50% solution, specific gravity =1.19)	lbs	0	0	0	0
- Polymer	lbs	0	0	0	0
- Sodium hydroxide (20% solution, specific gravity=1.22)	lbs	0	0	0	0
- Hydrochloric acid (30% solution, specific gravity = 1.18)	lbs	0	0	0	0
- Sequestering agent	lbs	0	0	0	0
- lime	lbs	0	0	0	0
- potable water	gallons	0	0	0	0
<u>Hazardous Waste</u>					
- filter cake solids	tons	0	0	0	0
- spent GAC for disposal	tons	0	0	0	0
- debris (spent bag filters, etc.)	tons	0	0	0	0
Total hazardous waste		0	0	0	0
<u>Non-Hazardous Waste</u>					
- filter cake solids	tons	0	0	0	0
- spent GAC for disposal	tons	0	0	0	0
- debris (spent bag filters, etc.)	tons	0	0	0	0
Total non-hazardous waste		0	0	0	0

Notes:

- Liquid GAC usage estimate uses process flow rate (same as extraction rate) and GAC influent concentrations determined by applying the Carbonair STAT.EXE software with the following assumptions: STAT 80 unit with 4 trays, air water ratio of 47:1 to represent 200 cfm of air to 32 gpm of water, air stripper influent concentrations equal to those on the overview tab of this file, air and water temperatures of 55 F, and no safety factor. GAC usage determined by applying GAC isotherms from USACE Adsorption Design Guide (No. 1110-1-2). Liquid GAC usage is estimated at 44,700 pounds per year.

- Vapor GAC usage estimate influent flow rate (32 gpm) and influent concentrations equal to those on the overview tab of this file to determine contaminant mass entering the treatment plant (approximately 500 pounds per year) and removal efficiency of the air stripper (varies by compound) determined by applying the Carbonair STAT.EXE software with the following assumptions: STAT 80 unit with 4 trays, air water ratio of 47:1 to represent 200 cfm of air to 32 gpm of water, air and water temperatures of 55 F, and no safety factor. GAC usage determined by using approximately 15 pounds of GAC per pound of contaminant, which is consistent with the GAC usage for cis-1,2-DCE at a concentration of approximately 10 ppmv (similar to the vapor concentration entering the GAC). Vapor GAC usage per year is approximately 7,500 pounds per year.

- Vinyl chloride is excluded from the vapor phase GAC estimates as it would not reasonably be treated by the GAC

Process Emissions

Compound Emitted	Percentage of Influent Mass Emitted through GAC	Emission Rate (lbs/day)	Emission Rate (lbs/yr)	Total Life-Cycle Emissions (lbs)	Global Warming Potential (lbs CO2e/lb)	Total CO2e* Emissions (lbs)
1,2-dichlorothane	0.9%	0.003	1	30	0	0
cis-1,2-dichloroethene	0.9%	0.005	2	60	0	0
toluene	0.9%	0.001	0	0	0	0
1,1,2-trichloroethane	0.9%	0.001	0	0	0	0
trichloroethene	0.9%	0.002	1	30	0	0
vinyl chloride	90.0%	0.294	107	3210	0	0
freon 113	0.9%	0.001	0	0	4800	0
Total greenhouse gas emissions (GHGs)						0
Total hazardous air pollutants (HAPs)		0.301	110	3300		

Notes:

- The percentage of influent mass emitted through the vapor GAC assumes that the air stripper transfers 90% of the influent mass to the air stripper off-gas and that the vapor phase GAC is 99% efficient for all compounds (except vinyl chloride, which has a 0% efficiency). Refer to the equation below.
- Freon-113 and cis-1,2-dichloroethene are not a HAPs.
- Greenhouse gas potential of freon 113 is the IPCC Second Assessment Report 100-year value.

$$M_e = C \times Q \times \frac{3.785L}{gal} \times \frac{1440min}{day} \times \frac{kg}{10^9} \times \frac{2.2lbs}{kg} \times \eta_a \times (1 - \eta_c)$$

where

Q = flow rate (gpm)

C = VOC concentration (ug / L)

η_a = air stripper efficiency (90%)

η_c = GAC efficiency (99%)

Assumptions Regarding Injection Well Installation

Number of Injection Wells

Aquifer	Depth	Existing	New	Total	Total Depth
Zone A	20	23	50	73	1460
Zone B	50	42	100	142	7100
Zone C	80	23	60	83	6640
Total		88	210	298	15200

Well Depths and Drilling Times

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)	Time Required to Drill Each New Well (hrs)	Total Time Required to Drill Wells (hrs)
2-inch Wells					
Zone A	50	20	1000	4	200
Zone B	100	50	5000	6	600
Zone C	60	80	4800	8	480
Total	210		10800		1280

4-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

6-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

Above table assumes single-cased wells.

Well Construction Information			Units	Quantity				
Well diameter			inches	2	4	6	Total	
Number of wells to install			#	210	0	0	210	
Borehole diameter			inches	6	8	10		
Total depth of all new wells			feet	10800	0	0	10800	
Total length of gravel/sand pack	10	ft/well	feet	2100	0	0	2100	
Total length of bentonite seal	2	ft/well	feet	420	0	0	420	
Total length of cement grout from bentonite to surface			feet	8280	0	0	8280	
Volume of drill cuttings			cy	78.5	0	0	78.5	
Volume of gravel/sand for sand pack			cy	13.6	0	0	13.6	
Volume of bentonite for seal			cy	2.7	0	0	2.7	
Volume of cement grout			cy	53.5	0	0	53.5	
Number of flush mount covers			#	210	0	0	210	
Number of steel 2'x2'x2' H20 rated manholes			#	0	0	0	0	
Number of concrete vaults 4'x4' with H20 steel doors			#	0	0	0	0	
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0	
Materials				Materials by Well Size				Truckloads
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	7344			7344	
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0	
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0	
Total mass of PVC							7344	2
Total weight of gravel/sand	1.5	tons/cy	tons	20.4	0	0	20.4	2
Total dry weight of bentonite	0.19	tons/cy	tons	0.5	0	0	0.5	0
Total dry weight of cement grout	0.99	tons/cy	tons	53	0	0	53	4
Total potable water for grout	0.06	gal/lb	gals	6766	0	0	6766	0
Weight of steel for flush mount covers	32	lbs/unit	lbs	6720	0	0	6720	
Weight of steel for manholes	128	lbs/unit	lbs	0	0	0	0	
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0	
Total weight of steel for surface finish			lbs	6720	0	0	6720	1
Weight of concrete for flush mount covers	0.10	tons/unit	tons	20	0	0	20.097	
Weight of concrete for manholes	0	tons/unit	tons	0	0	0	0	
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0	
Total weight of concrete for surface finish			tons	20	0	0	20.097	2
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0	0
Waste				Waste by Well Size				Truckloads
Development water	100	gal/well	gallons	21000	0	0	21000	
Development water returned to aquifer	100	gal/well	gallons	21000	0	0	21000	
Water to POTW	0	gal/well	gallons	0	0	0	0	0
Total weight of drill cuttings & other waste	1.5	tons/cy	tons	117.8	0	0	117.8	
Weight of hazardous waste	100	% of total	tons	117.8	0	0	117.8	8
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0	0
Waste characterization (at \$700 per sample)			\$	1400	0	0	1400	
Time and Mobilizations				Equipment & Labor by Well Size				Mobs.
Rig-days of drilling (8-hour days) - 120 HP rig			rig-days	160	0	0	160	8
Small loader for handling cuttings			rig-days	160	0	0	160	1
Crew man-days for drilling cuttings (8-hour days, 3 man crew)			man-days	480	0	0	480	160
Days for oversight			days	40	0	0	40	40

Notes:

- All wells are single-cased wells.

- Surface finishing for each new well assumed to be flush mount set in a 2-foot by 2-foot concrete pad similar to a monitoring well.

- All wells to be constructed of schedule 40 PVC. Screen is assumed to be slotted PVC with approximately the same lb/ft as the casing.

- All waste to be containerized in lined roll-off bins and trucked off-site as hazardous waste

- Absent other information, assume 10 cy of waste hauling per load by roll-off

- Four rigs working simultaneously. Two mobilizations for each rig for entire project, plus one small loader to handle cuttings mobilized once. Drill crew operates loader

- Crew mobilizes daily in one light duty truck.

- Consultant oversees four crews working simultaneously

Assumptions Regarding Bioremediation Operation

Bioremediation Features			Units	Injections	
Years of remedy operation			yrs	10	
Injection events per year			events/yr	4	
Days per event			days/event	14	
Total days per year			days/yr	56	
Total days over duration of remedy			days	560	
Total events over duration of remedy			events	40	
<u>Injection quantities</u>				Materials	Truckloads
Gallons of potable water	475	gal/well	total gal.	5662000	0
Gallons of extracted ground water	0	gal/well	total gal.	0	0
Gallons of cheese whey (approx. specific gravity of 1)	10	gal/well	total lbs.	994128	25
Gallons of molasses (approx. specific gravity of 1.45)	15	gal/well	total lbs.	2162228	54
Pounds of emulsified vegetable oil	0	lbs/well	total lbs.	0	0
				Electricity	
Injection pump electrical demand (2 at 1kW each)			kW	2	
Injection pump operation			hrs/day	8	
Injection pump electrical usage			kWh/yr	896	
Extraction pump electrical demand			kW	0	
Extraction pump operation			hrs/day	0	
Extraction pump electrical usage			kWh/yr	0	
Mixer electrical demand			kW	0	
Mixer operation			hrs/day	0	
Mixer electrical usage			kWh/yr	0	
Life-cycle electrical usage			kWh	8960	
				Labor & Equipment	Mobs.
Total consultant labor (3 person crew per day)			man-days	1680	560
Injection contractor equipment use and mobilization			days	0	0
Total contractor labor (3 person crew per day)			man-days	0	0

Notes:

- Injections to be completed by environmental consultant field personnel
- Absent other information, assume a maximum of 40,000 pounds per delivery by bulk
- Injection quantities based on pilot testing by facility consultant
- Although the first year of injections may be accomplished by a gasoline-powered pump (until electrical service is established at the facility), for simplicity, the full remedy duration is modeled with electrical pumps for bioinjections.
- Assume daily mobilization given proximity of consultant office to the site.

Assumptions Regarding Groundwater Sampling

LTM Component

- Comp. 1 = Bioremediation
- Comp. 2 = P&T and Surface Water
- Comp. 3 = Not used
- Comp. 4 = Not used

Item	Units	Comp. 1 Quantity	Comp. 2 Quantity	Comp. 3 Quantity	Comp. 4 Quantity	Total
Duration of LTM component	years	12	32			32
Number of wells sampled per year	wells	80	80			160
Wells sampled per day by a crew	wells	3	3			6
Crew-days per year	crew-days/yr	27	27	0	0	54
Crew mobilizations per year (4 minimum for qtrly sampling)	mobs./yr	4	4			8
Samples per year including QA samples	samples/yr	104	120			224
Total samples for component	samples	1248	3840	0	0	5088
Analysis cost per sample	\$/sample	\$300	\$90			
Total cost for analysis	\$	\$374,400	\$345,600	\$0	\$0	\$720,000
Total crew equipment days for component	equip-days	324	864	0	0	1188
Total crew man days for component	man-days	324	864	0	0	1188
Total mobilizations for component	trips	48	128	0	0	176
Purge water requiring off-site disposal	gallons	0	0			0
Drums required	drums	0	0	0	0	0
Steel required for drums	63 lbs/drum	0	0	0	0	0
Non-hazardous waste disposal (includes weight of drums)	tons	0	0			0
Hazardous waste disposal (includes weight of drums)	tons	0	0			0
Truckloads for drums	trips	0	0			0
Truckloads for non-hazardous waste	trips	0	0			0
Truckloads for hazardous waste	trips	0	0			0

Notes for long-term monitoring:

- Crew is defined by sets of equipment (i.e., one set of sampling equipment equals one crew)
- Dedicated pumps and tubing installed in each well
- Historic sampling programs have typically consisted of the following number of samples:
 - 1st quarter - 45 groundwater samples plus 4 surface water samples
 - 2nd quarter - 28 groundwater samples plus 4 surface water samples
 - 3rd quarter - 58 groundwater samples plus 4 surface water samples
 - 4th quarter - 28 groundwater samples plus 4 surface water samples
- All wells and surface water samples are analyzed for VOCs.
- Analyses for TOC, geochemistry, total iron, and dissolved gases have also been conducted in association with bioremediation
- For this alternative, assume 50% of the wells are sampled and analyzed for bioremediation parameters (including VOCs) and the other 50% are sampled and analyzed for VOCs only for monitoring the P&T system. As such, all wells are sampled and analyzed for VOCs and 80 wells are sampled and analyzed for bioremediation parameters. The surface water samples (16 per year) are analyzed for VOCs only.
- Analytical cost for VOCs is assumed to be approximately \$90 per sample. Analytical cost for bioremediation parameters is assumed to be \$90 for VOCs, \$25 for total organic carbon, \$55 for general chemistry, \$10 for iron, and \$120 for methane/ethane/ethen
- Assume QA samples add an additional 30% to the number of samples collected
- Assume no additional QA samples for surface water and no additional level of effort required.
- Assume bioremediation sampling is conducted for the duration of the bioremediation remedy plus 2 years
- Assume sampling associated with P&T is conducted for the duration of the P&T remedy plus 2 years.
- Assume all purge water can be placed in the top of the air stripper for on-site disposal
- Assume each sampling crew (one person with one set of equipment) can sample 3 wells per 10-hour day.
- Assume two crews (e.g., two technicians plus two sets of equipment) can mobilize in the same vehicle and that one mobilization is made for every 5 days of sampling.
- Purge water is generated at an average of 12,000 mL per sample (e.g., 3 gallons per sample)
- Years of sampling for components 1 and 2 overlap, resulting in 32 total years of monitoring
- For calculating waste disposal, assume 8.34 pounds per gallon of purge water, 2,000 pounds per ton, and 55 gallons per drum.

Assumptions Regarding Decommissioning

Well Decommissioning Information			Units	Quantity			
Well diameter			inches	2	4	6	Total
Number of wells to close			#	330	0	0	330
Total depth of wells			feet	16380	0	0	16380
Volume of cement grout			cy	13.2	0	0	13.2
Materials							
Total dry weight of cement grout	0.99	tons/cy	tons	13.1	0	0	13.1
Total potable water for grout	0.06	gal/lb	gals	1672	0	0	1672
Truckloads for deliveries			trips	2	0	0	2
Time and Mobilizations							
Crew days with one 5 HP grout pump			days	20	0	0	20
Crew man-days (3 person crew)			man-days	60	0	0	60
Number of rig mobilizations			trips	2	0	0	2
Number of crew mobilizations			trips	20	0	0	20
Oversight days			days	10	0	0	10
Number of consultant mobilizations			trips	10	0	0	10

Notes:

- Construction of all wells is assumed to be known and all wells assumed to be closed by tremie grouting with cement grout
- Consultant assumed to oversee two grouting crews working simultaneously
- Assumed that all cement grout can be shipped in one truckload
- Assume grouting takes approximately 15 minutes to set up at each point and that pumping rate is approximately 1 gpm

Assumptions Regarding Personnel & Equipment Transportation for Lifetime of Remedy

Item	Consultant Personnel (Oversight or Sampling)		Plant Operator		Construction Contractor		Driller		Total Trips	Total Miles
	trips	88	trips	88	trips	50	trips	100		
		miles RT		miles RT		miles RT		miles RT		
<i>Gasoline powered light duty trucks</i>										
- Site Investigation	14	1232	0	0	4	200	24	0	42	1432
- Demolition	9	792	0	0	16	800	0	0	25	1592
- Excavation	3	264	0	0	3	150	0	0	6	414
- Capping	7	616	0	0	9	450	0	0	16	1066
- Extraction well installation	8	704	0	0	0	0	15	1500	23	2204
- Conveyance piping	4	352	0	0	4	200	0	0	8	552
- Treatment plant construction	15	1320	0	0	15	750	0	0	30	2070
- Treatment plant O&M visits	120	10560	1560	137280	120	6000	0	0	1800	153840
- Injection well installation	40	3520	0	0	0	0	160	16000	200	19520
- Bioremediation O&M	560	49280	0	0	0	0	0	0	560	49280
- Groundwater LTM	176	15488	0	0	0	0	0	0	176	15488
- Decommissioning	10	880	0	0	0	0	20	2000	30	2880
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Light-Duty Truck Total	966	85008	1560	137280	171	8550	219	19500	2916	163170
<i>Gasoline powered passenger cars</i>										
- Site Investigation	0	0	0	0	0	0	0	0	0	0
- Demolition	0	0	0	0	0	0	0	0	0	0
- Excavation	0	0	0	0	0	0	0	0	0	0
- Capping	0	0	0	0	0	0	0	0	0	0
- Extraction well installation	0	0	0	0	0	0	0	0	0	0
- Conveyance piping	0	0	0	0	0	0	0	0	0	0
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	0	0	0	0	0	0	0	0	0	0
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	0	0	0	0	0	0	0	0	0	0
- Decommissioning	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Passenger Car Total	0	0	0	0	0	0	0	0	0	0
Gasoline Vehicle Total	966	85008	1560	137280	171	8550	219	19500	2916	163170

Item	Consultant Equipment		Operator Equipment		Construction Equipment		Drill Rig		Total Trips	Total Miles
	trips	88 miles RT	trips	88 miles RT	trips	50 miles RT	trips	100 miles RT		
<u>Diesel powered equipment transportation</u>										
- Site Investigation	0	0	0	0	1	50	3	300	4	350
- Demolition	0	0	0	0	2	100	0	0	2	100
- Excavation	0	0	0	0	3	150	0	0	3	150
- Capping	0	0	0	0	2	100	0	0	2	100
- Extraction well installation	0	0	0	0	0	0	2	200	2	200
- Conveyance piping	0	0	0	0	1	50	0	0	1	50
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	0	0	0	0	0	0	9	900	9	900
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	0	0	0	0	0	0	0	0	0	0
- Decommissioning	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Diesel Vehicle Total	0	0	0	0	9	450	14	1400	23	1850

Notes for personnel and equipment transport:

- Oversight consultant field personnel transportation is by light-duty truck. One vehicle per visit.
- Plant operator transportation is by light-duty truck. One vehicle per visit.
- Electrician, plumbing, light duty construction contractor transportation is by light-duty truck (including towing light equipment). One vehicle for crew per visit.
- Heavy duty construction contractor equipment transportation is by diesel powered truck.
- Contrator crew transportation is by light duty truck. One truck per crew.
- Driller transportation is mobilization of one heavy-duty diesel-powered vehicle. Driller transportation for grouting is by light duty truck.
- Mobile lab for investigation is assumed to reside at the same location as the drill rig

Item	One-Way Distance miles	Number of Trips																			Total Miles	
		Site Inv.	Demo.	Excav.	Capping	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.									Total Trips
PVC	500				0	1		0		2											3	1500
HDPE	500				0		1	0													1	500
Steel	500	1				1		1		1		0									4	2000
Stainless steel	500							1													1	500
Gravel/sand	50			375		1	0			2											378	18900
Bentonite (or clay)	50				0	0				0											0	0
Cement	50	0				1				4			2								7	350
Concrete	50				23	0		0		2											25	1250
Asphalt	50				0																0	0
LDPE	380	0																			0	0
Borrow	600			0	0																0	0
Potable water	0	0				0				0												
Non-haz. waste disposal	50	0	0	0		0	0		0	0		0									0	0
Haz. waste disposal	380	1	35	375		1	0		0	8		0									420	159600
Off-site recycling center	100		0																			0
GAC regeneration or virgin	600								600												600	360000
Treatment chemicals	500								0												0	0
Molasses	2400										54										54	129600
Cheese whey	752										25										25	18800
Emulsified vegetable oil	2800										0										0	0
Treatment plant equipment	2400							2													2	4800
																					0	0
																					0	0
																					0	0
																					0	0
																					0	0
																					0	0
Total Trips		2	35	750	23	5	1	4	600	19	79	0	2	0	1439							
Total Miles		880	13300	161250	1150	1480	500	5800	360000	4940	148400	0	100	0	697800							

Notes:
- Notes from above table apply

Fuel Usage Estimates for Lifetime of Remedy

Diesel Consumption	Load Factor	Days of Diesel Equipment Operation																			Total HP-hr	
		HP	Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>On-Site Consumption</u>																						
Small excavator (1 CY bucket)	0.57	100	2		0																912	
Medium excavator (1.5 CY bucket)	0.57	125			5.6																3192	
Large excavator (2 CY bucket)	0.57	150			0																0	
Small loader (1 CY bucket) or hoe low duty	0.25	50		6.7			0			160											16670	
Loader (2 CY bucket)	0.55	100		0.5	8.6																4004	
Dozer (100 HP)	0.55	100			3																1320	
Trencher (40 HP riding trencher)	0.75	40						4													960	
Direct-push drill rig	0.75	50	11.6								0										3480	
Drilling - medium rig (e.g., CME-55)	0.75	120					15			160											126000	
Drilling - large rig (e.g., CME-75)	0.75	175																			0	
Grout pump	0.5	5											20								400	
Mobile laboratory	0.5	5	2																		40	
Roller	0.56	130				0															0	
Grader	0.61	175				1															854	
Asphalt paver	0.62	130				0															0	
Concrete paving machine	0.53	100				1															424	
Rotary-screw air compressor (250 cfm)	0.48	70		1.9																	510.72	
Other																					0	
Other																					0	
Total HP-hrs			4432	1400.72	8296	1278	10800	960	0	0	131200	0	0	400	0	0	0	0	0	0	158767	
Diesel Usage (gal/HP-hr)	0.056																					
On-Site Diesel Consumption (gallons)			248.192	78.4403	464.576	71.568	604.8	53.76	0	0	7347.2	0	0	22.4	0	0	0	0	0	0	8891	
<u>Off-Site Consumption</u>	Conv. Factor	Units	Gallons of Diesel Based on Miles or Ton-Miles of Transport from Materials Transport Module																			Total
Bulk transport (e.g., materials, waste)	0.01	gal/ton-mi.	6.0376	1990.44	24187.5	174.6	54.1215	1.5	134.125	4698	529.799	29684.7	0	6.55	0	0	0	0	0	0	61467	
Heavy equipment mobilization	0.2	gal/mi.	70	20	30	20	40	10	0	0	180	0	0	0	0	0	0	0	0	0	370	
Total Off-Site Diesel Consumption (gallons)			76.0376	2010.44	24217.5	194.6	94.1215	11.5	134.125	4698	709.799	29684.7	0	6.55	0	0	0	0	0	0	61837	

- Notes:
- Diesel usage based engine efficiency of 33%, which is consistent with back-calculating usage from Road Construction Emissions Model Version 6.3.2, assuming 22.3 pounds of carbon dioxide per gallon of diesel.
 - Diesel usage for bulk transport is derived from www.nrel.gov/lci for materials transportation with a combination truck. The value of 0.01 gal/ton-mile translates to approximately 5 miles per gallon when hauling a 20-ton load.
 - Diesel usage for equipment transportation is based on average mileage of 5 miles per gallon when towing heavy equipment.
 - HP-hr calculation assumes 8-hour days
 - Oil, other maintenance fluids, and filters for vehicle/equipment maintenance is not included.

Gasoline Consumption	Load Factor	HP	Days of Gasoline Equipment Operation																			Total HP-hr
			Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>On-Site Consumption</u>																						
General equip. operation - gasoline	0.5	1																				0
Gen/comp. operation for sampling	0.5	1											1188									4752
Other																						0
Other																						0
Other																						0
Other																						0
Other																						0
Total HP-hrs			0	0	0	0	0	0	0	0	0	0	4752	0	0	0	0	0	0	0	0	4752
Gasoline Usage (gal/HP-hr)	0.05																					Total Gallons
On-Site Gasoline Consumption (gallons)			0	0	0	0	0	0	0	0	0	0	237.6	0	0	0	0	0	0	0	0	237.6
<u>Off-Site Consumption</u>																						
Conv. Factor	Units	Miles Driven with Gasoline Vehicle																			Total Miles	
		Per. transportation - light duty truck	Per. transportation - passenger car																			
0.1	gal/mi.	143.2	159.2	41.4	106.6	220.4	55.2	207	15384	1952	4928	1548.8	288	0	0	0	0	0	0	0	25034	
0.05	gal/mi.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Off-Site Gasoline Consumption (gallons)		143.2	159.2	41.4	106.6	220.4	55.2	207	15384	1952	4928	1548.8	288	0	0	0	0	0	0	0	25034	

Notes:

- Gasoline usage for general equipment based on engine efficiency of 33%, which is consistent with back-calculating usage from Road Construction Emissions Model Version 6.3.2, assuming 22.3 pounds of carbon dioxide per gallon of diesel.
- Gasoline usage for personnel transportation is calculated by multiplying the conversion factor times the miles calculated in the "personnel transportation" sheet
- HP-hr calculation assumes 8-hour days

Summary of On-Site Electricity Usage for Lifetime of Remedy

Item	Units	Electricity Usage (MWh)																			
		Site. Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								Total
Electricity	lbs			0					2164.17		8.96										2200

Notes:

Summary of Materials Usage for Lifetime of Remedy

Item	Units	Materials Usage																			Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>Construction Materials</u>																					
PVC	lbs				0	625.6		0		7344											8000
HDPE	lbs				0		600	0													600
Steel	lbs					4391		8250		6720		0									19400
Stainless steel	lbs							1000													1000
Gravel/sand	tons			5625		2.1				20.4											5648
Bentonite (or clay)	tons				0	0.1				0.5											1
Cement	tons	0.85				4.2				53		13.1									71
Concrete	tons				349.2	0		0		20.097											369
Asphalt	tons				0																0
LDPE	lbs	274																			274
Borrow	tons			0	0																0
Other																					0
Other																					0
<u>Water</u>																					
Potable water	gal. x 1000	0.5				0.536		0		6.766	5662	1.672									5671
Groundwater extracted	gal. x 1000			0		2.2		504576	21	0											504599
Water injected	gal. x 1000					2.2		0	21												23
Other	gal. x 1000																				0
<u>Treatment Materials</u>																					
Reactivated coal-based granular activated carbon	lbs							1566000													1566000
Virgin coal-based granular activated carbon	lbs							0													0
Virgin coconut based granular activated carbon	lbs							0													0
Other																					0
Other																					0
Other																					0
<u>Treatment Chemicals</u>																					
Potassium permanganate	lbs							0													0
Hydrogen peroxide (50% solution, specific gravity =1.19)	lbs							0													0
Polymer	lbs							0													0
Sodium hydroxide (20% solution, specific gravity=1.22)	lbs							0													0
Hydrochloric acid (30% solution, specific gravity = 1.18)	lbs							0													0
Sequestering agent	lbs							0													0
Lime	lbs																				0
Other																					0
Other																					0
Other																					0
<u>In-Situ Chemicals</u>																					
Molasses	lbs										2162228										2162200
Cheese whey	lbs										994128										994100
Emulsified vegetable oil	lbs										0										0
Other																					0
Other																					0
Other																					0

Notes:
 - All "total" quantities measured in lbs are rounded to the nearest 100 lbs.
 - All "total" quantities measured in tons are rounded to the nearest ton.
 - All "total" quantities measured in gallons are round to the nearest 1,000 gallons.

Summary of Waste Disposal, Services, and Other Emissions

Item	Units	Materials Usage																		Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.							
<i>Waste and Services</i>																				
POTW	gal. x 1000			0					504576											505000
Non-hazardous waste disposal	tons	0	0	0		0	0		0	0										0
Hazardous waste disposal	tons	1.34	523.8	5625		10.1	0		0	117.8										6280
Materials recycling	tons		0																	
Laboratory analysis	\$	60220		7100		1400			129600	1400		720000								919700
Other																				0
Other																				0
Other																				0
Other																				0
<i>Other</i>																				
On-site process emissions of HAPs	lbs								3300											3300
On-site process emissions of greenhouse gases	lbs-CO2e								0											0
On-site emissions of HAPs from soil	lbs																			0
Injected Carbon Compound (lbs of CO2)	lbs																			0
Other																				0
Other																				0
Other																				0
Other																				0

- Notes:
- Entries may include rounding
 - Waste rounded to the nearest 10 tons
 - Carbon sequestration from nutrient injections are not considered.

Personnel Summary

Item	Units	Man Days Worked																				Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.									
<u>Labor Category</u>																						
Oversight consultant	man-days	14	9	3	7	8	4	15	120	40	1680		10									1910
Treatment plant operator	man-days								1560													1560
Monitoring technician (LTM only)	man-days											1188										1188
Bioremediation injection field staff	man-days																					0
Driller	man-days	24				45				480			60									609
Electrician/plumber	man-days							45	120													165
Construction contractor	man-days	4	46	9	27		4															90
Other	man-days																					0
Other	man-days																					0
Other	man-days																					0
Total	man-days	42	55	12	34	53	8	60	1800	520	1680	1188	70	0	5522							

Notes:
 - 8-hour days assumed

**Remedy Conceptual Design and Assumptions:
 Alternative 3 - Bioremediation Version 1**

Overview

This alternative uses bioremediation to address the entire portion of the plume, and uses targeted excavation to address the source area. Bioremediation involves the injection of cheese whey and molasses through permanent injection wells. Excavation includes disposal of material off-site as hazardous waste back backfill with select fill.

General Assumptions Regarding Site Characteristics

The following assumptions have been made:

- The average concentration over the life-time of the P&T remedy is assumed to be 25% of average concentration reported in Table B-2 of the 2007 Statement of Basis Report. Only those compounds with concentrations over 1 mg/L in Table B-2 are considered.

Compound	25% of Table B-2 Concentration (ug/L)
1,2-dichloroethane	1,000
cis-1,2-dichloroethene	1,400
toluene	250
1,1,2-trichloroethane	300
trichloroethene	650
vinyl chloride	850
freon 113	300

- Groundwater is present at the site at a depth of approximately 5 feet below ground surface.
- Bioremediation occurs in the hydrogeologic zones A, B, and C.
- Because intervals A, B, and C are already contaminated, wells in the B and C zones are note required to be double or triple cased, respectively

Key for Cell Shading

Blue	Is a calculated cell.
Green	Is a calculated cell referenced by one or more cells ithat are not in the immediate vicinity of the shaded cell
Red	Is a calculated or manual cell referenced by one or more of the summary sheets in the workbook
Yellow	Is a calculated cell that is exported from the spreadsheet for footprinting
	This outlined cell format is for manual input based on site/project specific information.
Gray	Is a default value for a general parameter that might be updated manually based on additional information

Assumptions Regarding Site Investigation

	Quantity by Project				Productivity by Project				Days of Equipment Use				Rig Mobs.	
	1	2	3	Units	1	2	3	Units	Units	1	2	3		Totals
Direct Push Activities														
Total depth of pushing for grab samples (no coring or continuous logging)	1156	0	0	ft	120	0	0	ft/day	days	9.6	0	0	9.6	1
Total depth of direct push coring with continuous soil logging	0	0	0	ft	0	0	0	ft/day	days	0	0	0	0	0
Total depth of direct push cone penetrometer work	240	0	0	ft	120	0	0	ft/day	days	2	0	0	2	1
Total depth of membrane interface probe (MIP) work	0	0	0	ft	0	0	0	ft/day	days	0	0	0	0	0
										Total for Rig (50 HP)			11.6	2
Grout (5HP grout pump)	0.863187	0	0	cy	2	2	2	cy/day	days	0.4	0	0	0.4	N/A
Test Pit Activities														
Total test pit or trench volume (assume depth is 10 feet or less)	302	0	0	bcy	150	0	0	bcy/day	days	2	0	0	2	1
Materials														
Steel for drums	10	0	0	drums	63	63	63	lbs/drum	lbs	630	0	0	630	1
Cement grout (assumes 1.75-inch borehole for direct push)	0.86	0	0	cy	0.99	0.99	0.99	tons/cy	tons	0.85	0	0	0.85	0
Pounds of plastic (LDPE) for sheeting	14400	0	0	sq. ft.	0.019	0.019	0.019	lbs/sq ft	lbs	274	0	0	274	0
Potable water	500	0	0	gallons	N/A	N/A	N/A	N/A	gallons	500	0	0	500	0
Waste														
Waste from direct-push (assumes 1.75-inch soil core) - 25% swell	0.89	0	0	lcy	1.5	1.5	1.5	tons/lcy	tons	1.335	0	0	1.34	
Waste from test pits - 25% swell	0	0	0	lcy	1.5	1.5	1.5	tons/lcy	tons	0	0	0	0	
Total soil waste									tons	1.335	0	0	1.34	
Weight of hazardous soil waste					100%	0%	0%	% of tot.	tons	1.335	0	0	1.34	1
Weight of non-hazardous soil waste					0%	0%	0%	% of tot.	tons	0	0	0	0	0
Time and Mobilizations														
Man-days required for oversight or field technicians									Units	1	2	3	Totals	Crew Mobs.
Man-days required for oversight or field technicians									man-days	14	0	0	14	14
Crew man-days for direct-push (2 person crews, a chemist can be added with the mobile lab option)									man-days	24	0	0	24	24
Crew man-days for excavator and concrete (2 person crew)									man-days	4	0	0	4	4
Fixed Laboratory Analysis														
Waste characterization	2	0	0	samples	\$700	\$0	\$0	\$/sample	\$	\$1,400	\$0	\$0	\$1,400	
Soil or sediment samples	323	60	0	samples	\$90	\$480	\$0	\$/sample	\$	\$29,070	\$28,800	\$0	\$57,870	
Water samples	5	0	0	samples	\$90	\$0	\$0	\$/sample	\$	\$450	\$0	\$0	\$450	
Vapor samples (cost related to analysis only, not cannister rental)	21	2	0	samples	\$0	\$250	\$0	\$/sample	\$	\$0	\$500	\$0	\$500	
													\$60,220	
Mobile Laboratory Analysis														
Man-days									Units	1	2	3	Totals	Mobs.
Man-days									man-days	2	0	0	2	2
Mobile lab days of use and mobilization									days	2	0	0	2	1

Notes:

- Monitoring well installation can be modeled with the "extraction well" or "injection well" modules and sampling can be modeled with the LTM module
- "Projects" 1, 2, and 3 allow user to account for different productivity rates or sample costs based on different components of the investigation
- Total depth for grab samples determined as follows: 130 locations to 6 feet for soil grab samples, 21 locations to 6 feet for vapor samples and 5 locations to 50 feet for groundwater samples
- Productivity rates for direct-push include time for repositioning rig on each location and collecting samples
- Direct push rig assumed to be GeoProbe 6600 series or equivalent (e.g., approximately 50 HP)
- Test pit volumes include four 10'x10'x10' test pits for soils, four 10'x10'x10' test pits for the pond, and one trench that is 15 feet long by 5 feet deep by 2-feet long.
- Test pit productivity includes time for breaking through concrete, collecting soil samples, and backfilling test pits and trenches
- Test pits and trench assumed to be excavated with small excavator (100 HP with 1 cy bucket)
- Grouting to be accomplished with 5 HP grout pump at approximately 1 gpm
- Soils from test pits are temporarily stockpiled on 4-mil polyethylene sheeting (40'x40' per test pit and trench) and are used to back fill test pits
- Excavated/drilled soils assumed to swell 25%
- All waste assumed to be hazardous.
- Potable water used for mixing grout
- One consultant technician in the field overseeing contractors and collecting samples.
- Equipment to be mobilized once for the project
- Contractors and consultant to mobilize daily
- Direct push crew does borehole grouting
- Two waste characterization samples assumed (one for soil one for water)
- Soil/sediment samples represent expected minimum for investigation (multiple samples per location)
- Waste characterization sample analysis is \$700 per sample
- VOC analytical cost is \$90 per sample
- Project 2 analyses represent approximately 20% of the soil samples that are analyzed for SVOCs (\$150 per sample), Pesticides/PCBs (\$150 per sample), metals (\$130 per sample), and TPH (\$50 per sample)
- Project 2 vapor analyses represent 10% of vapor samples that are analyzed in off-site lab via TO-15. Project 1 vapor samples are analyzed with on-site instrumentation

Notes:

- Project 1 refers to removal of concrete associated with site investigation, and Project 2 refers to removal of concrete associated with excavation.
- Area of concrete removal for site investigation is based on eight 100 sq ft test pits, one 15x5 foot trench, and 130 borings that require one sq. ft. each of clearing.
- Area of concrete removal for excavation is based on an estimate 3,000 cy excavation that is 2 cy deep.
- Loose/broken concrete and asphalt assumed to have a density of 1.3 tons/cy (typical from Integrated Solid Waste Management, McGraw Hill, 1993).
- Loose general debris assumed to have a density of 1 ton per cubic yard (consistent with mixtures from Integrated Solid Waste Management, McGraw Hill, 1993)
- Productivity and crew for concrete removal is based on pavement demolition values provided by RS Means Building Construction Cost Data 2007, Reed Construction Data, Inc. 2006
- Handheld tools for concrete removal (per RSMeans) includes a 250 cfm air compressor, which would use a 70 HP diesel engine.
- Hydraulic hammer would use a 50HP small hoe or loader with a hammer.
- Debris moved with a 100 HP loader
- Two equipment mobilizations for Project 2 are 1) hydraulic hammer and 2) loader for loading debris
- Some values are rounded as appropriate

Assumptions Regarding Extraction Wells

Number of Extraction Wells and Extraction Rates

Aquifer	Depths (ft)	Existing	New	Total # of Wells	Total Depth (ft)	Total Extraction Rate (gpm)
Zone A	20	8	0	8	160	0
Zone B	50	2	0	2	100	0
Zone C	80	0	0	0	0	0
Total		10	0	10	260	0

Well Depths and Drilling Times

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)	Time to Drill Each New Well (hrs)	Total Time to Drill Wells (hrs)
2-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0
4-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0
6-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

Above table assumes single-cased wells.

The use of 2-inch extraction wells is assumed due to the large number of wells, the low yield for each well, and the use of an above ground pump instead of a submersible pump.

Well Construction Information			Units	Quantity by Well Size				
				2	4	6	Total	
Well diameter			inches	2	4	6	Total	
Number of wells to install			#	0	0	0	0	
Borehole diameter			inches	6	8	10		
Total depth of all new wells			feet	0	0	0	0	
Total length of gravel/sand pack	10	ft/well	feet	0	0	0	0	
Total length of bentonite seal	2	ft/well	feet	0	0	0	0	
Total length of cement grout from bentonite to surface			feet	0	0	0	0	
Volume of drill cuttings			cy	0	0	0	0	
Volume of gravel/sand for sand pack			cy	0	0	0	0	
Volume of bentonite for seal			cy	0	0	0	0	
Volume of cement grout			cy	0	0	0	0	
Number of flush mount covers			#	0	0	0	0	
Number of steel 2'x2'x2' H20 rated manholes			#	0	0	0	0	
Number of concrete vaults 4'x4' with H20 steel doors			#	0	0	0	0	
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0	
<u>Materials</u>				Materials by Well Size				Truckloads
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	0			0	
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0	
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0	
Total mass of PVC			lbs				0	0
Total weight of gravel/sand	1.5	tons/cy	tons	0	0	0	0	0
Total dry weight of bentonite	0.19	tons/cy	tons	0	0	0	0	0
Total dry weight of cement grout	0.99	tons/cy	tons	0	0	0	0	0
Total potable water for grout	0.06	gal/lb	gals	0	0	0	0	0
Weight of steel for flush mount covers	32	lbs/unit	lbs	0	0	0	0	
Weight of steel for manholes	128	lbs/unit	lbs	0	0	0	0	
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0	
Total weight of steel for surface finish			lbs	0	0	0	0	0
Weight of concrete for flush mount covers	0.10	tons/unit	tons	0	0	0	0	
Weight of concrete for manholes	0	tons/unit	tons	0	0	0	0	
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0	
Total weight of concrete for surface finish			tons	0	0	0	0	0
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0	0
<u>Waste</u>				Waste by Well Size				Truckloads
Development water	0	gal/well	gallons	0	0	0	0	
Development water returned to aquifer	0	gal/well	gallons	0	0	0	0	
Water to POTW	0	gal/well	gallons	0	0	0	0	0
Total weight of drill cuttings & other waste	0	tons/cy	tons	0	0	0	0	
Weight of hazardous waste	0	% of total	tons	0	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0	0
Waste characterization at \$700 per sample			\$	0	0	0	0	
<u>Time and Mobilizations</u>				Equipment & Labor by Well Size				Mobs.
Rig-days of drilling (8-hour days) - 120 HP rig			rig-days	0	0	0	0	0
Small loader for handling cuttings			rig-days	0	0	0	0	0
Crew man-days for drilling (8-hour days, 3 man crew)			man-days	0	0	0	0	0
Days for oversight			days	0	0	0	0	0

Assumptions Regarding Conveyance Piping

Piping Features			Units	Quantity of 1-inch Pipe	Quantity of 2-inch Pipe	Quantity of 3-inch Pipe	Quantity of 4-inch Pipe	Quantity of 6-inch Pipe	Total	Truckloads & Mobs.
Mass of HDPE pipe per linear foot			lbs/ft	0.2	0.64	1.4	2.3	5.0		
Average distance between wells in same zone			feet	0	0	0	0	0		
Trench depth			feet	0	0	0	0	0		
Trench width			feet	0	0	0	0	0		
Total length of piping/trench (including drop tubes)			feet	0	0	0	0	0		
<u>Materials</u>										
Trench bedding material and/or base course (sand/gravel)			cy	0	0	0	0	0	0	
Total mass of bedding material (sand/gravel)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Total mass of HDPE			lbs	0	0	0	0	0	0	0
<u>Waste</u>										
Off-site soil disposal (non-hazardous)			cy	0	0	0	0	0	0	
Off-site soil disposal (hazardous)			cy	0	0	0	0	0	0	
Off-site soil disposal (non-hazardous)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Off-site soil disposal (hazardous)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Trenching rate with backfill			feet/day	750	0	0	0	0		
Trenching equipment and time			days	0	0	0	0	0	0	0
Total crew man-days (1-person crew)			man-days	0	0	0	0	0	0	0
Days of oversight			days	0	0	0	0	0	0	0

Notes:

Assumptions Regarding Treatment Plant Construction

Extraction System Pumps and Treatment Plant Components

- Single 1 HP self-priming pump for groundwater extraction rated for 32 gpm at 25 feet of suction and 30 psi of discharge pressure
- One 0.5 HP process water transfer pump between the air stripper sump and the liquid phase GAC polishing units
- Building with less than 800 square feet of floor plan and natural ventilation
- Tray aerator with 4 trays rated for 200 cfm of flow and pressure drop of 20 inches of water - 5 HP blower
- Three 1,500-pound vapor phase GAC vessels in series (large units selected to reduce pressure drop to under 2 inches of water each) - with in-line pre-heater
- Three 3,000-pound liquid phase GAC vessels in series (large units selected to reduce pressure drop)
- Discharge to the POTW

Construction Parameters

Item	Unit	Quantity
Days required for construction	days	0
Man-days required for construction (3 person crew)	man-days	0
Mobilizations required for construction contractor	visits	0
Days required for oversight	man-days	0
Mobilizations required for oversight	visits	0

Notes:

- *Construction contractor includes local plumber and electrician to install air stripper, GAC units, and controls*

Primary Treatment Components

Item	Mass of Materials Integral to Primary Treatment Components				Materials for Building	
	Mass of Stainless Steel	Mass of Steel	Mass of HDPE	Mass of PVC	Mass of Concrete	Mass of Building and Reinforcing Steel
	lbs	lbs	lbs	lbs	tons	lbs
Building and concrete reinforcing steel	0	0	0	0	0	0
Concrete foundation	0	0	0	0	0	0
Air stripper	0	0	0	0	0	0
Liquid GAC units	0	0	0	0	0	0
Vapor GAC units	0	0	0	0	0	0
Total Mass	0	0	0	0	0	0
Truckloads for delivery	0	0	0	0	0	0

Notes:

Assumptions Regarding Treatment Plant O&M

General Operation Parameters

Item		Unit	Quantity
System Duration		years	0
System Flow Rate		gpm	0
Total Extraction for Duration of Remedy		gallons	0
<u>O&M Labor</u>			
Frequency of Operator Visits		visit/week	0
Total Operator Visits (one operator per visit)		man-days	0
Frequency of plumber/electrician repairs		visit/year	0
Total plumber/electrician visits		man-days	0
Frequency of engineer/oversight visits		visit/year	0
Total engineer/oversight visits		man-days	0
<u>Discharge</u>			
Volume of treated water discharged to surface water	0%	of ext. water	gallons 0
Volume of treated water discharged to the POTW	0%	of ext. water	gallons 0
Volume of treated water reinjected	0%	of ext. water	gallons 0
Volume of treated water used beneficially	0%	of ext. water	gallons 0
<u>Sampling</u>			
Total process sampling over lifetime of remedy		samples	0
Cost for sample analysis		\$/sample	\$90
Total cost for laboratory analysis		\$	\$0

- Process sampling includes monthly sampling of influent/effluent + duplicate + trip blank

Treatment Chemicals, Materials, and Waste

Item	Unit	Annual Quantity	Life-Cycle Quantity	Shipments per Year	Life-Cycle Shipments
<u>Adsorbants</u>					
- regenerated coal-based GAC	lbs	0	0	0	0
- virgin coal-based GAC	lbs	0	0	0	0
- virgin coconut-based GAC	lbs	0	0	0	0
<u>Chemicals and Other Resources</u>					
- Potassium permanganate	lbs	0	0	0	0
- Hydrogen peroxide (50% solution, specific gravity =1.19)	lbs	0	0	0	0
- Polymer	lbs	0	0	0	0
- Sodium hydroxide (20% solution, specific gravity=1.22)	lbs	0	0	0	0
- Hydrochloric acid (30% solution, specific gravity = 1.18)	lbs	0	0	0	0
- Sequestering agent	lbs	0	0	0	0
- lime	lbs	0	0	0	0
- potable water	gallons	0	0	0	0
<u>Hazardous Waste</u>					
- filter cake solids	tons	0	0	0	0
- spent GAC for disposal	tons	0	0	0	0
- debris (spent bag filters, etc.)	tons	0	0	0	0
Total hazardous waste		0	0	0	0
<u>Non-Hazardous Waste</u>					
- filter cake solids	tons	0	0	0	0
- spent GAC for disposal	tons	0	0	0	0
- debris (spent bag filters, etc.)	tons	0	0	0	0
Total non-hazardous waste		0	0	0	0

Notes:

Process Emissions

Compound Emitted	Percentage of Influent Mass Emitted through GAC	Emission Rate (lbs/day)	Emission Rate (lbs/yr)	Total Life-Cycle Emissions (lbs)	Global Warming Potential (lbs CO2e/lb)	Total CO2e* Emissions (lbs)
1,2-dichloroethane	0.0%	0	0	0	0	0
cis-1,2-dichloroethene	0.0%	0	0	0	0	0
toluene	0.0%	0	0	0	0	0
1,1,2-trichloroethane	0.0%	0	0	0	0	0
trichloroethene	0.0%	0	0	0	0	0
vinyl chloride	0.0%	0	0	0	0	0
freon 113	0.0%	0	0	0	4800	0
Total greenhouse gas emissions (GHGs)						0
Total hazardous air pollutants (HAPs)		0	0	0		

Notes:

$$M_e = C \times Q \times \frac{3.785L}{gal} \times \frac{1440min}{day} \times \frac{kg}{10^9} \times \frac{2.2lbs}{kg} \times \eta_a \times (1 - \eta_c)$$

where

Q = flow rate (gpm)

C = VOC concentration (ug / L)

η_a = air stripper efficiency (90%)

η_c = GAC efficiency (99%)

Assumptions Regarding Injection Well Installation

Number of Injection Wells

Aquifer	Depth	Existing	New	Total	Total Depth
Zone A	20	23	72	95	1900
Zone B	50	42	124	166	8300
Zone C	80	23	76	99	7920
Total		88	272	360	18120

Well Depths and Drilling Times

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)	Time Required to Drill Each New Well (hrs)	Total Time Required to Drill Wells (hrs)
2-inch Wells					
Zone A	72	20	1440	4	288
Zone B	124	50	6200	6	744
Zone C	76	80	6080	8	608
Total	272		13720		1640

4-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

6-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

Above table assumes single-cased wells.

Well Construction Information			Units	Quantity				
Well diameter			inches	2	4	6	Total	
Number of wells to install			#	272	0	0	272	
Borehole diameter			inches	6	8	10		
Total depth of all new wells			feet	13720	0	0	13720	
Total length of gravel/sand pack	10	ft/well	feet	2720	0	0	2720	
Total length of bentonite seal	2	ft/well	feet	544	0	0	544	
Total length of cement grout from bentonite to surface			feet	10456	0	0	10456	
Volume of drill cuttings			cy	99.7	0	0	99.7	
Volume of gravel/sand for sand pack			cy	17.6	0	0	17.6	
Volume of bentonite for seal			cy	3.5	0	0	3.5	
Volume of cement grout			cy	67.6	0	0	67.6	
Number of flush mount covers			#	272	0	0	272	
Number of steel 2'x2'x2' H20 rated manholes			#	0	0	0	0	
Number of concrete vaults 4'x4' with H20 steel doors			#	0	0	0	0	
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0	
Materials				Materials by Well Size				Truckloads
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	9329.6			9329.6	
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0	
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0	
Total mass of PVC							9329.6	2
Total weight of gravel/sand	1.5	tons/cy	tons	26.4	0	0	26.4	2
Total dry weight of bentonite	0.19	tons/cy	tons	0.7	0	0	0.7	0
Total dry weight of cement grout	0.99	tons/cy	tons	66.9	0	0	66.9	6
Total potable water for grout	0.06	gal/lb	gals	8540	0	0	8540	0
Weight of steel for flush mount covers	32	lbs/unit	lbs	8704	0	0	8704	
Weight of steel for manholes	128	lbs/unit	lbs	0	0	0	0	
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0	
Total weight of steel for surface finish			lbs	8704	0	0	8704	1
Weight of concrete for flush mount covers	0.10	tons/unit	tons	26	0	0	26.0304	
Weight of concrete for manholes	0	tons/unit	tons	0	0	0	0	
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0	
Total weight of concrete for surface finish			tons	26	0	0	26.0304	3
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0	0
Waste				Waste by Well Size				Truckloads
Development water	100	gal/well	gallons	27200	0	0	27200	
Development water returned to aquifer	100	gal/well	gallons	27200	0	0	27200	
Water to POTW	0	gal/well	gallons	0	0	0	0	0
Total weight of drill cuttings & other waste	1.5	tons/cy	tons	149.6	0	0	149.6	
Weight of hazardous waste	100	% of total	tons	149.6	0	0	149.6	10
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0	0
Waste characterization at \$700 per sample			\$	1400	0	0	1400	
Time and Mobilizations				Equipment & Labor by Well Size				Mobs.
Rig-days of drilling (8-hour days) - 120 HP rig			rig-days	205	0	0	205	12
Small loader for handling cuttings			rig-days	205	0	0	205	3
Crew man-days for drilling cuttings (8-hour days, 3 man crew)			man-days	615	0	0	615	205
Days for oversight			days	52	0	0	52	52

Notes:

- All wells are single-cased wells.

- Surface finishing for each new well assumed to be flush mount set in a 2-foot by 2-foot concrete pad similar to a monitoring well.

- All wells to be constructed of schedule 40 PVC. Screen is assumed to be slotted PVC with approximately the same lb/ft as the casing.

- All waste to be containerized in lined roll-off bins and trucked off-site as hazardous waste

- Absent other information, assume 10 cy of waste hauling per load by roll-off

- Four rigs working simultaneously. Three mobilizations for each rig for entire project, plus one small loader to handle cuttings. Drill crew operates loader

- Crew mobilizes daily in one light duty truck.

- Consultant oversees four crews working simultaneously

Assumptions Regarding Bioremediation Operation

Bioremediation Features			Units	Injections	
Years of remedy operation			yrs	10	
Injection events per year			events/yr	4	
Days per event			days/event	21	
Total days per year			days/yr	84	
Total days over duration of remedy			days	840	
Total events over duration of remedy			events	40	
<u>Injection quantities</u>				Materials	Truckloads
Gallons of potable water	475	gal/well	total gal.	6840000	0
Gallons of extracted ground water	0	gal/well	total gal.	0	0
Gallons of cheese whey (approx. specific gravity of 1)	10	gal/well	total lbs.	1200960	30
Gallons of molasses (approx. specific gravity of 1.45)	15	gal/well	total lbs.	2612088	65
Pounds of emulsified vegetable oil	0	lbs/well	total lbs.	0	0
				Electricity	
Injection pump electrical demand (2 at 1kW each)			kW	2	
Injection pump operation			hrs/day	8	
Injection pump electrical usage			kWh/yr	1344	
Extraction pump electrical demand			kW	0	
Extraction pump operation			hrs/day	0	
Extraction pump electrical usage			kWh/yr	0	
Mixer electrical demand			kW	0	
Mixer operation			hrs/day	0	
Mixer electrical usage			kWh/yr	0	
Life-cycle electrical usage			kWh	13440	
				Labor & Equipment	Mobs.
Total consultant labor (3 person crew per day)			man-days	2520	840
Injection contractor equipment use and mobilization			days	0	0
Total contractor labor (3 person crew per day)			man-days	0	0

Notes:

- Injections to be completed by environmental consultant field personnel
- Absent other information, assume a maximum of 40,000 pounds per delivery by bulk
- Injection quantities based on pilot testing by facility consultant
- Although the first year of injections may be accomplished by a gasoline-powered pump (until electrical service is established at the facility), for simplicity, the full remedy duration is modeled with electrical pumps for bioinjections.
- Assume daily mobilization given proximity of consultant office to the site.

Assumptions Regarding Groundwater Sampling

LTM Component

- Comp. 1 = Bioremediation
- Comp. 2 = Surface Water
- Comp. 3 = Not used
- Comp. 4 = Not used

Item	Units	Comp. 1 Quantity	Comp. 2 Quantity	Comp. 3 Quantity	Comp. 4 Quantity	Total
Duration of LTM component	years	12	12			32
Number of wells sampled per year	wells	160	0			160
Wells sampled per day by a crew	wells	3	3			6
Crew-days per year	crew-days/yr	53	0	0	0	53
Crew mobilizations per year (4 minimum for qtrly sampling)	mobs./yr	4	4			8
Samples per year including QA samples	samples/yr	208	20			228
Total samples for component	samples	2496	240	0	0	2736
Analysis cost per sample	\$/sample	\$300	\$90			
Total cost for analysis	\$	\$748,800	\$21,600	\$0	\$0	\$770,400
Total crew equipment days for component	equip-days	636	0	0	0	636
Total crew man days for component	man-days	636	0	0	0	636
Total mobilizations for component	trips	48	48	0	0	96
Purge water requiring off-site disposal	gallons	5760	0			5760
Drums required	drums	105	0	0	0	105
Steel required for drums	63 lbs/drum lbs	6615	0	0	0	6615
Non-hazardous waste disposal (includes weight of drums)	tons	0	0			0
Hazardous waste disposal (includes weight of drums)	tons	28	0			28
Truckloads for drums	trips	12	0			12
Truckloads for non-hazardous waste	trips	0	0			0
Truckloads for hazardous waste	trips	48	0			48

Notes for long-term monitoring:

- Crew is defined by sets of equipment (i.e., one set of sampling equipment equals one crew)
- Dedicated pumps and tubing installed in each well
- Historic sampling programs have typically consisted of the following number of samples:
 - 1st quarter - 45 groundwater samples plus 4 surface water samples
 - 2nd quarter - 28 groundwater samples plus 4 surface water samples
 - 3rd quarter - 58 groundwater samples plus 4 surface water samples
 - 4th quarter - 28 groundwater samples plus 4 surface water samples
 - All wells and surface water samples are analyzed for VOCs.
 - Analyses for TOC, geochemistry, total iron, and dissolved gases have also been conducted in association with bioremediation
- For this alternative, assume all of the wells are sampled and analyzed for bioremediation parameters (including VOCs). The surface water samples (16 per year) are analyzed for VOCs only.
- Analytical cost for VOCs is assumed to be approximately \$90 per sample. Analytical cost for bioremediation parameters is assumed to be \$90 for VOCs, \$25 for total organic carbon, \$55 for general chemistry, \$10 for iron, and \$120 for methane/ethane/ethen
- Assume QA samples add an additional 30% to the number of samples collected
- Assume no additional QA samples for surface water and no additional level of effort required.
- Assume bioremediation sampling is conducted for the duration of the bioremediation remedy plus 2 years
- Assume sampling associated with P&T is conducted for the duration of the P&T remedy plus 2 years.
- Assume all purge water can be placed in the top of the air stripper for on-site disposal
- Assume each sampling crew (one person with one set of equipment) can sample 3 wells per 10-hour day.
- Assume two crews (e.g., two technicians plus two sets of equipment) can mobilize in the same vehicle and that one mobilization is made for every 5 days of sampling.
- Purge water is generated at an average of 12,000 mL per sample (e.g., 3 gallons per sample)
- Years of sampling for components 1 and 2 overlap, resulting in 12 total years of monitoring
- For calculating waste disposal, assume 8.34 pounds per gallon of purge water, 2,000 pounds per ton, and 55 gallons per drum.

Assumptions Regarding Decommissioning

Well Decommissioning Information			Units	Quantity			
Well diameter			inches	2	4	6	Total
Number of wells to close			#	370	0	0	370
Total depth of wells			feet	18380	0	0	18380
Volume of cement grout			cy	14.8	0	0	14.8
Materials							
Total dry weight of cement grout	0.99	tons/cy	tons	14.7	0	0	14.7
Total potable water for grout	0.06	gal/lb	gals	1877	0	0	1877
Truckloads for deliveries			trips	2	0	0	2
Time and Mobilizations							
Crew days with one 5 HP grout pump			days	20	0	0	20
Crew man-days (3 person crew)			man-days	60	0	0	60
Number of rig mobilizations			trips	2	0	0	2
Number of crew mobilizations			trips	20	0	0	20
Oversight days			days	10	0	0	10
Number of consultant mobilizations			trips	10	0	0	10

Notes:

- Construction of all wells is assumed to be known and all wells assumed to be closed by tremie grouting with cement grout
- Consultant assumed to oversee two grouting crews working simultaneously
- Assumed that all cement grout can be shipped in one truckload
- Assume grouting takes approximately 15 minutes to set up at each point and that pumping rate is approximately 1 gpm

Assumptions Regarding Personnel & Equipment Transportation for Lifetime of Remedy

Item	Consultant Personnel (Oversight or Sampling)		Plant Operator		Construction Contractor		Driller		Total Trips	Total Miles
	trips	88 miles RT	trips	88 miles RT	trips	50 miles RT	trips	100 miles RT		
<i>Gasoline powered light duty trucks</i>										
- Site Investigation	14	1232	0	0	4	200	24	0	42	1432
- Demolition	9	792	0	0	16	800	0	0	25	1592
- Excavation	3	264	0	0	3	150	0	0	6	414
- Capping	7	616	0	0	9	450	0	0	16	1066
- Extraction well installation	0	0	0	0	0	0	0	0	0	0
- Conveyance piping	0	0	0	0	0	0	0	0	0	0
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	52	4576	0	0	0	0	205	20500	257	25076
- Bioremediation O&M	840	73920	0	0	0	0	0	0	840	73920
- Groundwater LTM	96	8448	0	0	0	0	0	0	96	8448
- Decommissioning	10	880	0	0	0	0	20	2000	30	2880
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Light-Duty Truck Total	1031	90728	0	0	32	1600	249	22500	1312	114828
<i>Gasoline powered passenger cars</i>										
- Site Investigation	0	0	0	0	0	0	0	0	0	0
- Demolition	0	0	0	0	0	0	0	0	0	0
- Excavation	0	0	0	0	0	0	0	0	0	0
- Capping	0	0	0	0	0	0	0	0	0	0
- Extraction well installation	0	0	0	0	0	0	0	0	0	0
- Conveyance piping	0	0	0	0	0	0	0	0	0	0
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	0	0	0	0	0	0	0	0	0	0
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	0	0	0	0	0	0	0	0	0	0
- Decommissioning	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Passenger Car Total	0	0	0	0	0	0	0	0	0	0
Gasoline Vehicle Total	1031	90728	0	0	32	1600	249	22500	1312	114828

Item	Consultant Equipment		Operator Equipment		Construction Equipment		Drill Rig		Total Trips	Total Miles
	trips	88 miles RT	trips	88 miles RT	trips	50 miles RT	trips	100 miles RT		
<u>Diesel powered equipment transportation</u>										
- Site Investigation	0	0	0	0	1	50	3	300	4	350
- Demolition	0	0	0	0	2	100	0	0	2	100
- Excavation	0	0	0	0	3	150	0	0	3	150
- Capping	0	0	0	0	2	100	0	0	2	100
- Extraction well installation	0	0	0	0	0	0	0	0	0	0
- Conveyance piping	0	0	0	0	0	0	0	0	0	0
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	0	0	0	0	0	0	15	1500	15	1500
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	0	0	0	0	0	0	0	0	0	0
- Decommissioning	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Diesel Vehicle Total	0	0	0	0	8	400	18	1800	26	2200

Notes for personnel and equipment transport:

- Oversight consultant field personnel transportation is by light-duty truck. One vehicle per visit.
- Plant operator transportation is by light-duty truck. One vehicle per visit.
- Electrician, plumbing, light duty construction contractor transportation is by light-duty truck (including towing light equipment). One vehicle for crew per visit.
- Heavy duty construction contractor equipment transportation is by diesel powered truck.
- Contractor crew transportation is by light duty truck. One truck per crew.
- Driller transportation is mobilization of one heavy-duty diesel-powered vehicle. Driller transportation for grouting is by light duty truck.
- Mobile lab for investigation is assumed to reside at the same location as the drill rig

Item	One-Way Distance miles	Number of Trips																			Total Miles	
		Site Inv.	Demo.	Excav.	Capping	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.									Total Trips
PVC	500				0	0		0		2											2	1000
HDPE	500				0		0	0													0	0
Steel	500	1				0		0		1		12									14	7000
Stainless steel	500							0													0	0
Gravel/sand	50			375		0	0			2											377	18850
Bentonite (or clay)	50				0	0				0											0	0
Cement	50	0				0				6		2									8	400
Concrete	50				23	0		0		3											26	1300
Asphalt	50				0																0	0
LDPE	380	0																			0	0
Borrow	600			0	0																0	0
Potable water	0	0				0				0												
Non-haz. waste disposal	50	0	0	0		0	0		0	0		0									0	0
Haz. waste disposal	380	1	35	375		0	0		0	10		48									469	178220
Off-site recycling center	100		0																			0
GAC regeneration or virgin	600								0												0	0
Treatment chemicals	500								0												0	0
Molasses	2400											65									65	156000
Cheese whey	752											30									30	22560
Emulsified vegetable oil	2800											0									0	0
Treatment plant equipment	2400							0													0	0
																					0	0
																					0	0
																					0	0
																					0	0
																					0	0
																					0	0
Total Trips		2	35	750	23	0	0	0	0	24	95	60	2	0	896							
Total Miles		880	13300	161250	1150	0	0	0	0	5850	178560	24240	100	0	385330							

Notes:
- Notes from above table apply

Fuel Usage Estimates for Lifetime of Remedy

Diesel Consumption	Load Factor	Days of Diesel Equipment Operation																			Total HP-hr	
		HP	Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>On-Site Consumption</u>																						
Small excavator (1 CY bucket)	0.57	100	2		0																912	
Medium excavator (1.5 CY bucket)	0.57	125			5.6																3192	
Large excavator (2 CY bucket)	0.57	150			0																0	
Small loader (1 CY bucket) or hoe low duty	0.25	50		6.7			0			205											21170	
Loader (2 CY bucket)	0.55	100		0.5	8.6																4004	
Dozer (100 HP)	0.55	100			3																1320	
Trencher (40 HP riding trencher)	0.75	40						0													0	
Direct-push drill rig	0.75	50	11.6								0										3480	
Drilling - medium rig (e.g., CME-55)	0.75	120					0			205											147600	
Drilling - large rig (e.g., CME-75)	0.75	175																			0	
Grout pump	0.5	5											20								400	
Mobile laboratory	0.5	5	2																		40	
Roller	0.56	130				0															0	
Grader	0.61	175				1															854	
Asphalt paver	0.62	130				0															0	
Concrete paving machine	0.53	100				1															424	
Rotary-screw air compressor (250 cfm)	0.48	70		1.9																	510.72	
Other																					0	
Other																					0	
Total HP-hrs			4432	1400.72	8296	1278	0	0	0	0	168100	0	0	400	0	0	0	0	0	0	183907	
Diesel Usage (gal/HP-hr)	0.056																					
On-Site Diesel Consumption (gallons)			248.192	78.4403	464.576	71.568	0	0	0	0	9413.6	0	0	22.4	0	0	0	0	0	0	10299	
<u>Off-Site Consumption</u>	Conv. Factor	Units	Gallons of Diesel Based on Miles or Ton-Miles of Transport from Materials Transport Module																			Total
Bulk transport (e.g., materials, waste)	0.01	gal/ton-mi.	6.0376	1990.44	24187.5	174.6	0	0	0	0	673.579	35860.7	16.5375	7.35	0	0	0	0	0	0	62917	
Heavy equipment mobilization	0.2	gal/mi.	70	20	30	20	0	0	0	0	300	0	0	0	0	0	0	0	0	0	440	
Total Off-Site Diesel Consumption (gallons)			76.0376	2010.44	24217.5	194.6	0	0	0	0	973.579	35860.7	16.5375	7.35	0	0	0	0	0	0	63357	

- Notes:
- Diesel usage based engine efficiency of 33%, which is consistent with back-calculating usage from Road Construction Emissions Model Version 6.3.2, assuming 22.3 pounds of carbon dioxide per gallon of diesel.
 - Diesel usage for bulk transport is derived from www.nrel.gov/lci for materials transportation with a combination truck. The value of 0.01 gal/ton-mile translates to approximately 5 miles per gallon when hauling a 20-ton load.
 - Diesel usage for equipment transportation is based on average mileage of 5 miles per gallon when towing heavy equipment.
 - HP-hr calculation assumes 8-hour days
 - Oil, other maintenance fluids, and filters for vehicle/equipment maintenance is not included.

Gasoline Consumption	Load Factor	HP	Days of Gasoline Equipment Operation																			Total HP-hr
			Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>On-Site Consumption</u>																						
General equip. operation - gasoline	0.5	1																				0
Gen/comp. operation for sampling	0.5	1											636									2544
Other																						0
Other																						0
Other																						0
Other																						0
Other																						0
Total HP-hrs			0	0	0	0	0	0	0	0	0	0	2544	0	0	0	0	0	0	0	0	2544
Gasoline Usage (gal/HP-hr)	0.05																					Total Gallons
On-Site Gasoline Consumption (gallons)			0	0	0	0	0	0	0	0	0	0	127.2	0	0	0	0	0	0	0	0	127.2
<u>Off-Site Consumption</u>																						
	Conv. Factor	Units	Miles Driven with Gasoline Vehicle																			Total Miles
Per. transportation - light duty truck	0.1	gal/mi.	143.2	159.2	41.4	106.6	0	0	0	0	2507.6	7392	844.8	288	0	0	0	0	0	0	0	11483
Per. transportation - passenger car	0.05	gal/mi.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Off-Site Gasoline Consumption (gallons)			143.2	159.2	41.4	106.6	0	0	0	0	2507.6	7392	844.8	288	0	0	0	0	0	0	0	11483

Notes:

- Gasoline usage for general equipment based on engine efficiency of 33%, which is consistent with back-calculating usage from Road Construction Emissions Model Version 6.3.2, assuming 22.3 pounds of carbon dioxide per gallon of diesel.
- Gasoline usage for personnel transportation is calculated by multiplying the conversion factor times the miles calculated in the "personnel transportation" sheet
- HP-hr calculation assumes 8-hour days

Summary of On-Site Electricity Usage for Lifetime of Remedy

Item	Units	Electricity Usage (MWh)																			
		Site. Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								Total
Electricity	lbs			0					0		13.44										13

Notes:

Summary of Materials Usage for Lifetime of Remedy

Item	Units	Materials Usage																			Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>Construction Materials</u>																					
PVC	lbs				0	0		0		9329.6											9300
HDPE	lbs				0		0														0
Steel	lbs					0		0		8704		6615									15300
Stainless steel	lbs							0													0
Gravel/sand	tons			5625		0				26.4											5651
Bentonite (or clay)	tons				0	0				0.7											1
Cement	tons	0.85				0				66.9		14.7									82
Concrete	tons				349.2	0		0		26.0304											375
Asphalt	tons				0																0
LDPE	lbs	274																			274
Borrow	tons			0	0																0
Other																					0
Other																					0
<u>Water</u>																					
Potable water	gal. x 1000	0.5				0			0	8.54	6840	1.877									6851
Groundwater extracted	gal. x 1000			0		0			0	27.2	0										27
Water injected	gal. x 1000					0			0	27.2											27
Other	gal. x 1000																				0
<u>Treatment Materials</u>																					
Reactivated coal-based granular activated carbon	lbs								0												0
Virgin coal-based granular activated carbon	lbs								0												0
Virgin coconut based granular activated carbon	lbs								0												0
Other																					0
Other																					0
Other																					0
<u>Treatment Chemicals</u>																					
Potassium permanganate	lbs								0												0
Hydrogen peroxide (50% solution, specific gravity =1.19)	lbs								0												0
Polymer	lbs								0												0
Sodium hydroxide (20% solution, specific gravity=1.22)	lbs								0												0
Hydrochloric acid (30% solution, specific gravity = 1.18)	lbs								0												0
Sequestering agent	lbs								0												0
Lime	lbs								0												0
Other																					0
Other																					0
Other																					0
<u>In-Situ Chemicals</u>																					
Molasses	lbs										2612088										2612100
Cheese whey	lbs										1200960										1201000
Emulsified vegetable oil	lbs										0										0
Other																					0
Other																					0
Other																					0

Notes:
 - All "total" quantities measured in lbs are rounded to the nearest 100 lbs.
 - All "total" quantities measured in tons are rounded to the nearest ton.
 - All "total" quantities measured in gallons are round to the nearest 1,000 gallons.

Summary of Waste Disposal, Services, and Other Emissions

Item	Units	Materials Usage																		Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.							
<i>Waste and Services</i>																				
POTW	gal. x 1000			0					0											0
Non-hazardous waste disposal	tons	0	0	0		0	0		0	0										0
Hazardous waste disposal	tons	1.34	523.8	5625		0	0		0	149.6										6300
Materials recycling	tons		0																	
Laboratory analysis	\$	60220		7100		0			0	1400		770400								839100
Other																				0
Other																				0
Other																				0
Other																				0
<i>Other</i>																				
On-site process emissions of HAPs	lbs								0											0
On-site process emissions of greenhouse gases	lbs-CO2e								0											0
On-site emissions of HAPs from soil	lbs																			0
Injected Carbon Compound (lbs of CO2)	lbs																			0
Other																				0
Other																				0
Other																				0
Other																				0

- Notes:
- Entries may include rounding
 - Waste rounded to the nearest 10 tons
 - Carbon sequestration from nutrient injections are not considered.

Personnel Summary

Item	Units	Man Days Worked																				Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.									
<u>Labor Category</u>																						
Oversight consultant	man-days	14	9	3	7	0	0	0	0	52	2520		10									2615
Treatment plant operator	man-days								0													0
Monitoring technician (LTM only)	man-days											636										636
Bioremediation injection field staff	man-days																					0
Driller	man-days	24				0				615			60									699
Electrician/plumber	man-days							0	0													0
Construction contractor	man-days	4	46	9	27		0															86
Other	man-days																					0
Other	man-days																					0
Other	man-days																					0
Total	man-days	42	55	12	34	0	0	0	0	667	2520	636	70	0	4036							

Notes:
- 8-hour days assumed

**Remedy Conceptual Design and Assumptions:
 Alternative 4 - Pump and Treat Version 1**

Overview

This alternative uses a P&T system to contain the entire plume and targeted excavation to address the source area. Ground water extraction is achieved by several above-ground self-priming pump that extracts groundwater from both new and existing extraction wells. Extracted groundwater is conveyed to a single treatment system housed in an existing building. The treatment process includes air stripping, polishing with liquid phase GAC, and discharge of final effluent to the POTW. Air stripper off-gas is treated with vapor phase GAC. Excavation includes disposal of material off-site as hazardous waste back backfill with select fill.

General Assumptions Regarding Site Characteristics

The following assumptions have been made:

- The average concentration over the life-time of the P&T remedy is assumed to be 25% of average concentration reported in Table B-2 of the 2007 Statement of Basis Report. Only those compounds with concentrations over 1 mg/L in Table B-2 are considered.

Compound	25% of Table B-2 Concentration (ug/L)
1,2-dichloroethane	1,000
cis-1,2-dichloroethene	1,400
toluene	250
1,1,2-trichloroethane	300
trichloroethene	650
vinyl chloride	850
freon 113	300

- Groundwater is present at the site at a depth of approximately 5 feet below ground surface.
- A building or other infrastructure exists that can house the air stripper.
- Groundwater extraction occurs in the hydrogeologic zones A, B, and C.
- Because intervals A, B, and C are already contaminated, wells in the B and C zones are note required to be double or triple cased, respectively

Key for Cell Shading

Blue	Is a calculated cell.
Green	Is a calculated cell referenced by one or more cells ithat are not in the immediate vicinity of the shaded cell
Red	Is a calculated or manual cell referenced by one or more of the summary sheets in the workbook
Yellow	Is a calculated cell that is exported from the spreadsheet for footprinting
	This outlined cell format is for manual input based on site/project specific information.
Gray	Is a default value for a general parameter that might be updated manually based on additional information

Assumptions Regarding Site Investigation

	Quantity by Project				Productivity by Project				Days of Equipment Use				Rig Mobs.		
	1	2	3	Units	1	2	3	Units	Units	1	2	3		Totals	
Direct Push Activities															
Total depth of pushing for grab samples (no coring or continuous logging)	1156	0	0	ft	120	0	0	ft/day	days	9.6	0	0	9.6	1	
Total depth of direct push coring with continuous soil logging	0	0	0	ft	0	0	0	ft/day	days	0	0	0	0	0	
Total depth of direct push cone penetrometer work	240	0	0	ft	120	0	0	ft/day	days	2	0	0	2	1	
Total depth of membrane interface probe (MIP) work	0	0	0	ft	0	0	0	ft/day	days	0	0	0	0	0	
													Total for Rig (50 HP)	11.6	2
Grout (5HP grout pump)	0.863187	0	0	cy	2	2	2	cy/day	days	0.4	0	0	0.4	N/A	
Test Pit Activities															
Total test pit or trench volume (assume depth is 10 feet or less)	302	0	0	bcy	150	0	0	bcy/day	days	2	0	0	2	1	
Materials															
Steel for drums	10	0	0	drums	63	63	63	lbs/drum	lbs	630	0	0	630	1	
Cement grout (assumes 1.75-inch borehole for direct push)	0.86	0	0	cy	0.99	0.99	0.99	tons/cy	tons	0.85	0	0	0.85	0	
Pounds of plastic (LDPE) for sheeting	14400	0	0	sq. ft.	0.019	0.019	0.019	lbs/sq ft	lbs	274	0	0	274	0	
Potable water	500	0	0	gallons	N/A	N/A	N/A	N/A	gallons	500	0	0	500	0	
Waste															
Waste from direct-push (assumes 1.75-inch soil core) - 25% swell	0.89	0	0	lcy	1.5	1.5	1.5	tons/lcy	tons	1.335	0	0	1.34		
Waste from test pits - 25% swell	0	0	0	lcy	1.5	1.5	1.5	tons/lcy	tons	0	0	0	0		
Total soil waste									tons	1.335	0	0	1.34		
Weight of hazardous soil waste					100%	0%	0%	% of tot.	tons	1.335	0	0	1.34	1	
Weight of non-hazardous soil waste					0%	0%	0%	% of tot.	tons	0	0	0	0	0	
Time and Mobilizations															
Man-days required for oversight or field technicians									Units	1	2	3	Totals	Crew Mobs.	
Man-days required for oversight or field technicians									man-days	14	0	0	14	14	
Crew man-days for direct-push (2 person crews, a chemist can be added with the mobile lab option)									man-days	24	0	0	24	24	
Crew man-days for excavator and concrete (2 person crew)									man-days	4	0	0	4	4	
Fixed Laboratory Analysis															
Waste characterization	2	0	0	samples	\$700	\$0	\$0	\$/sample	\$	\$1,400	\$0	\$0	\$1,400		
Soil or sediment samples	323	60	0	samples	\$90	\$480	\$0	\$/sample	\$	\$29,070	\$28,800	\$0	\$57,870		
Water samples	5	0	0	samples	\$90	\$0	\$0	\$/sample	\$	\$450	\$0	\$0	\$450		
Vapor samples (cost related to analysis only, not cannister rental)	21	2	0	samples	\$0	\$250	\$0	\$/sample	\$	\$0	\$500	\$0	\$500		
													\$60,220		
Mobile Laboratory Analysis															
Man-days									Units	1	2	3	Totals	Mobs.	
Man-days									man-days	2	0	0	2	2	
Mobile lab days of use and mobilization									days	2	0	0	2	1	

Notes:

- Monitoring well installation can be modeled with the "extraction well" or "injection well" modules and sampling can be modeled with the LTM module
- "Projects" 1, 2, and 3 allow user to account for different productivity rates or sample costs based on different components of the investigation
- Total depth for grab samples determined as follows: 130 locations to 6 feet for soil grab samples, 21 locations to 6 feet for vapor samples and 5 locations to 50 feet for groundwater samples
- Productivity rates for direct-push include time for repositioning rig on each location and collecting samples
- Direct push rig assumed to be GeoProbe 6600 series or equivalent (e.g., approximately 50 HP)
- Test pit volumes include four 10'x10'x10' test pits for soils, four 10'x10'x10' test pits for the pond, and one trench that is 15 feet long by 5 feet deep by 2-feet long.
- Test pit productivity includes time for breaking through concrete, collecting soil samples, and backfilling test pits and trenches
- Test pits and trench assumed to be excavated with small excavator (100 HP with 1 cy bucket)
- Grouting to be accomplished with 5 HP grout pump at approximately 1 gpm
- Soils from test pits are temporarily stockpiled on 4-mil polyethylene sheeting (40'x40' per test pit and trench) and are used to back fill test pits
- Excavated/drilled soils assumed to swell 25%
- All waste assumed to be hazardous.
- Potable water used for mixing grout
- One consultant technician in the field overseeing contractors and collecting samples.
- Equipment to be mobilized once for the project
- Contractors and consultant to mobilize daily
- Direct push crew does borehole grouting
- Two waste characterization samples assumed (one for soil one for water)
- Soil/sediment samples represent expected minimum for investigation (multiple samples per location)
- Waste characterization sample analysis is \$700 per sample
- VOC analytical cost is \$90 per sample
- Project 2 analyses represent approximately 20% of the soil samples that are analyzed for SVOCs (\$150 per sample), Pesticides/PCBs (\$150 per sample), metals (\$130 per sample), and TPH (\$50 per sample)
- Project 2 vapor analyses represent 10% of vapor samples that are analyzed in off-site lab via TO-15. Project 1 vapor samples are analyzed with on-site instrumentation

Notes:

- Project 1 refers to removal of concrete associated with site investigation, and Project 2 refers to removal of concrete associated with excavation.
- Area of concrete removal for site investigation is based on eight 100 sq ft test pits, one 15x5 foot trench, and 130 borings that require one sq. ft. each of clearing.
- Area of concrete removal for excavation is based on an estimate 3,000 cy excavation that is 2 cy deep.
- Loose/broken concrete and asphalt assumed to have a density of 1.3 tons/cy (typical from Integrated Solid Waste Management, McGraw Hill, 1993).
- Loose general debris assumed to have a density of 1 ton per cubic yard (consistent with mixtures from Integrated Solid Waste Management, McGraw Hill, 1993)
- Productivity and crew for concrete removal is based on pavement demolition values provided by RS Means Building Construction Cost Data 2007, Reed Construction Data, Inc. 2006
- Handheld tools for concrete removal (per RSMeans) includes a 250 cfm air compressor, which would use a 70 HP diesel engine.
- Hydraulic hammer would use a 50HP small hoe or loader with a hammer.
- Debris moved with a 100 HP loader
- Two equipment mobilizations for Project 2 are 1) hydraulic hammer and 2) loader for loading debris
- Some values are rounded as appropriate

Assumptions Regarding Extraction Wells

Number of Extraction Wells and Extraction Rates

Aquifer	Depths (ft)	Existing	New	Total # of Wells	Total Depth (ft)	Total Extraction Rate (gpm)
Zone A	20	8	60	68	1360	68
Zone B	50	2	40	42	2100	42
Zone C	80	0	20	20	1600	20
Total		10	120	130	5060	130

Well Depths and Drilling Times

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)	Time to Drill Each New Well (hrs)	Total Time to Drill Wells (hrs)
2-inch wells					
Zone A	60	20	1200	4	240
Zone B	40	50	2000	6	240
Zone C	20	80	1600	8	160
Total	120		4800		640
4-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0
6-inch wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

Above table assumes single-cased wells.

The use of 2-inch extraction wells is assumed due to the large number of wells, the low yield for each well, and the use of an above ground pump instead of a submersible pump.

Well Construction Information			Units	Quantity by Well Size				
				2	4	6	Total	
Well diameter			inches	2	4	6	120	
Number of wells to install			#	120	0	0	120	
Borehole diameter			inches	6	8	10		
Total depth of all new wells			feet	4800	0	0	4800	
Total length of gravel/sand pack	10	ft/well	feet	1200	0	0	1200	
Total length of bentonite seal	2	ft/well	feet	240	0	0	240	
Total length of cement grout from bentonite to surface			feet	3360	0	0	3360	
Volume of drill cuttings			cy	34.9	0	0	34.9	
Volume of gravel/sand for sand pack			cy	7.8	0	0	7.8	
Volume of bentonite for seal			cy	1.6	0	0	1.6	
Volume of cement grout			cy	21.7	0	0	21.7	
Number of flush mount covers			#	0	0	0	0	
Number of steel 2'x2'x2' H2O rated manholes			#	120	0	0	120	
Number of concrete vaults 4'x4' with H2O steel doors			#	0	0	0	0	
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0	
<u>Materials</u>				<u>Materials by Well Size</u>				<u>Truckloads</u>
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	3264			3264	
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0	
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0	
Total mass of PVC			lbs				3264	1
Total weight of gravel/sand	1.5	tons/cy	tons	11.7	0	0	11.7	1
Total dry weight of bentonite	0.19	tons/cy	tons	0.3	0	0	0.3	0
Total dry weight of cement grout	0.99	tons/cy	tons	21.5	0	0	21.5	2
Total potable water for grout	0.06	gal/lb	gals	2745	0	0	2745	0
Weight of steel for flush mount covers	32	lbs/unit	lbs	0	0	0	0	
Weight of steel for manholes	128	lbs/unit	lbs	15360	0	0	15360	
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0	
Total weight of steel for surface finish			lbs	15360	0	0	15360	2
Weight of concrete for flush mount covers	0.10	tons/unit	tons	0	0	0	0	
Weight of concrete for manholes	0	tons/unit	tons	0	0	0	0	
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0	
Total weight of concrete for surface finish			tons	0	0	0	0	0
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0	0
<u>Waste</u>				<u>Waste by Well Size</u>				<u>Truckloads</u>
Development water	100	gal/well	gallons	12000	0	0	12000	
Development water returned to aquifer	100	gal/well	gallons	12000	0	0	12000	
Water to POTW	0	gal/well	gallons	0	0	0	0	0
Total weight of drill cuttings & other waste	1.5	tons/cy	tons	52.4	0	0	52.4	
Weight of hazardous waste	100	% of total	tons	52.4	0	0	52.4	4
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0	0
Waste characterization (at \$700 per sample)			\$	1400	0	0	1400	
<u>Time and Mobilizations</u>				<u>Equipment & Labor by Well Size</u>				<u>Mobs.</u>
Rig-days of drilling (8-hour days) - 120 HP rig			rig-days	80	0	0	80	4
Small loader for handling cuttings			rig-days	80	0	0	80	2
Crew man-days for drilling (8-hour days, 3 man crew)			man-days	240	0	0	240	80
Days for oversight			days	20	0	0	20	20

Notes:

- All wells are single-cased wells.

- Surface finishing for each new well assumed to be a traffic rated 2'x2' manhole finished level with ground surface to provide access to well, piping, vacuum gage, and check valve.

- All wells to be constructed of schedule 40 PVC. Screen is assumed to be slotted PVC with approximately the same lb/ft as the casing.

- All waste to be containerized in roll-off for disposal as hazardous waste

- Absent other information, assume 10 cy of waste hauling per load if by roll-off/truck and 50 drums per load if containerized in drums

- Four rigs working simultaneously. One mobilization for each rig for entire project.

- Crew mobilizes daily in one light duty truck.

- Consultant oversees four crews working simultaneously

Assumptions Regarding Conveyance Piping

Piping Features			Units	Quantity of 1-inch Pipe	Quantity of 2-inch Pipe	Quantity of 3-inch Pipe	Quantity of 4-inch Pipe	Quantity of 6-inch Pipe	Total	Truckloads & Mobs.
Mass of HDPE pipe per linear foot			lbs/ft	0.2	0.64	1.4	2.3	5.0		
Average distance between wells in same zone			feet	50	0	50	0	0		
Trench depth			feet	2	0	2	0	0		
Trench width			feet	0.5	0	0.5	0	0		
Total length of piping/trench (including drop tubes)			feet	3000	0	1000	0	0		
<u>Materials</u>										
Trench bedding material and/or base course (sand/gravel)			cy	0	0	0	0	0	0	
Total mass of bedding material (sand/gravel)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Total mass of HDPE			lbs	600	0	1400	0	0	2000	1
<u>Waste</u>										
Off-site soil disposal (non-hazardous)			cy	0	0	0	0	0	0	
Off-site soil disposal (hazardous)			cy	0	0	0	0	0	0	
Off-site soil disposal (non-hazardous)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Off-site soil disposal (hazardous)	1.5	tons/cy	tons	0	0	0	0	0	0	0
Trenching rate with backfill			feet/day	750	0	750	0	0		
Trenching equipment and time			days	4	0	1.3	0	0	6	1
Total crew man-days (1-person crew)			man-days	4	0	2	0	0	6	6
Days of oversight			days	4	0	2	0	0	6	8

Notes:

- All pipe assumed to be SDR-11 HDPE
- 1-inch piping from each well to 3-inch common header
- Trenching accomplished with a 40 HP riding trencher, mobilized one time for the project.
- Native material used for bedding and backfill, no disposal required
- Up to 30-foot 1-inch SDR 11-HPDE drop tube in each well
- Individual fittings, valves, etc. are not considered

Assumptions Regarding Treatment Plant Construction

Extraction System Pumps and Treatment Plant Components

- Four 1 HP self-priming pumps for groundwater extraction each rated for 32 gpm at 25 feet of suction and 30 psi of discharge pressure
- One 3 HP process water transfer pump between the air stripper sump and the liquid phase GAC polishing units
- Building with less than 1,000 square feet of floor plan and natural ventilation
- Tray aerator with 4 trays rated for 800 to 900 cfm of flow and pressure drop of 20 inches of water - 10 HP blower
- Three 10,000-pound vapor phase GAC vessels in series (large units selected to reduce pressure drop) - with in-line pre-heater
- Three 10,000-pound liquid phase GAC vessels in series (large units selected to reduce pressure drop)
- Discharge to the POTW

Construction Parameters

Item	Unit	Quantity
Days required for construction	days	20
Man-days required for construction (3 person crew)	man-days	60
Mobilizations required for construction contractor	visits	20
Days required for oversight	man-days	20
Mobilizations required for oversight	visits	20

Notes:

- Construction contractor includes local plumber and electrician to install air stripper, GAC units, and controls

Primary Treatment Components

Item	Mass of Materials Integral to Primary Treatment Components				Materials for Building	
	Mass of Stainless Steel	Mass of Steel	Mass of HDPE	Mass of PVC	Mass of Concrete	Mass of Building and Reinforcing Steel
	lbs	lbs	lbs	lbs	tons	lbs
Building and concrete reinforcing steel	0	0	0	0	0	0
Concrete foundation	0	0	0	0	0	0
Air stripper	2100	0	0	0	0	0
Liquid GAC units	0	24000	0	0	0	0
Vapor GAC units	0	17550	0	0	0	0
Total Mass	2100	41550	0	0	0	0
Truckloads for delivery	1	1	0	0	0	0

Notes:

- No building steel or concrete is required. Project assumes an existing building can house the system.
- Air stripper mass is based on Carbonair specifications for a STAT 180 stripper with 4 trays and QED 24.4
- Vapor GAC units are based on Carbonair specifications for three GPC 70units.
- Liquid GAC units are based on Carbonair specifications for three PC50 units
- Fuel consumption for forklift to move equipment during treatment plant assembly is assumed to be negligible relative to the transportation of the equipment to the site.

Assumptions Regarding Treatment Plant O&M

General Operation Parameters

Item		Unit	Quantity
System Duration		years	40
System Flow Rate		gpm	130
Total Extraction for Duration of Remedy		gallons	2733120000
<u>O&M Labor</u>			
Frequency of Operator Visits		visit/week	1
Total Operator Visits (one operator per visit)		man-days	2080
Frequency of plumber/electrician repairs		visit/year	4
Total plumber/electrician visits		man-days	160
Frequency of engineer/oversight visits		visit/year	4
Total engineer/oversight visits		man-days	160
<u>Discharge</u>			
Volume of treated water discharged to surface water	0%	of ext. water	gallons 0
Volume of treated water discharged to the POTW	100%	of ext. water	gallons 2733120000
Volume of treated water reinjected	0%	of ext. water	gallons 0
Volume of treated water used beneficially	0%	of ext. water	gallons 0
<u>Sampling</u>			
Total process sampling over lifetime of remedy		samples	1920
Cost for sample analysis		\$/sample	\$90
Total cost for laboratory analysis		\$	\$172,800

- Process sampling includes monthly sampling of influent/effluent + duplicate + trip blank

Treatment Chemicals, Materials, and Waste

Item	Unit	Annual Quantity	Life-Cycle Quantity	Shipments per Year	Life-Cycle Shipments
<u>Adsorbants</u>					
- regenerated coal-based GAC	lbs	209000	8360000	21	840
- virgin coal-based GAC	lbs	0	0	0	0
- virgin coconut-based GAC	lbs	0	0	0	0
<u>Chemicals and Other Resources</u>					
- Potassium permanganate	lbs	0	0	0	0
- Hydrogen peroxide (50% solution, specific gravity =1.19)	lbs	0	0	0	0
- Polymer	lbs	0	0	0	0
- Sodium hydroxide (20% solution, specific gravity=1.22)	lbs	0	0	0	0
- Hydrochloric acid (30% solution, specific gravity = 1.18)	lbs	0	0	0	0
- Sequestering agent	lbs	0	0	0	0
- lime	lbs	0	0	0	0
- potable water	gallons	0	0	0	0
<u>Hazardous Waste</u>					
- filter cake solids	tons	0	0	0	0
- spent GAC for disposal	tons	0	0	0	0
- debris (spent bag filters, etc.)	tons	0	0	0	0
Total hazardous waste		0	0	0	0
<u>Non-Hazardous Waste</u>					
- filter cake solids	tons	0	0	0	0
- spent GAC for disposal	tons	0	0	0	0
- debris (spent bag filters, etc.)	tons	0	0	0	0
Total non-hazardous waste		0	0	0	0

Notes:

- Liquid GAC usage estimate uses process flow rate (same as extraction rate) and GAC influent concentrations determined by applying the Carbonair STAT.EXE software with the following assumptions: STAT 180 unit with 4 trays, air water ratio of 47:1 to represent 800 to 900 cfm of air to 130 gpm of water, air stripper influent concentrations equal to those on the overview tab of this file, air and water temperatures of 55 F, and no safety factor. GAC usage determined by applying GAC isotherms from USACE Adsorption Design Guide (No. 1110-1-2). Liquid GAC usage is estimated at 179,000 pounds per year.

- Vapor GAC usage estimate influent flow rate (130 gpm) and influent concentrations equal to those on the overview tab of this file to determine contaminant mass entering the treatment plant (approximately 2,000 pounds per year) and removal efficiency of the air stripper (varies by compound) determined by applying the Carbonair STAT.EXE software with the following assumptions: STAT 180 unit with 4 trays, air water ratio of 47:1 to represent 800 to 900 cfm of air to 130 gpm of water, air and water temperatures of 55 F, and no safety factor. GAC usage determined by using approximately 15 pounds of GAC per pound of contaminant, which is consistent with the GAC usage for cis-1,2-DCE at a concentration of approximately 10 ppmv (similar to the vapor concentration entering the GAC). Vapor GAC usage per year is approximately 30,000 pounds per year.

- Vinyl chloride is excluded from the vapor phase GAC estimates as it would not reasonably be treated by the GAC

Process Emissions

Compound Emitted	Percentage of Influent Mass Emitted through GAC	Emission Rate (lbs/day)	Emission Rate (lbs/yr)	Total Life-Cycle Emissions (lbs)	Global Warming Potential (lbs CO2e/lb)	Total CO2e* Emissions (lbs)
1,2-dichloroethane	0.9%	0.014	5	200	0	0
cis-1,2-dichloroethene	0.9%	0.02	7	280	0	0
toluene	0.9%	0.004	1	40	0	0
1,1,2-trichloroethane	0.9%	0.004	1	40	0	0
trichloroethene	0.9%	0.009	3	120	0	0
vinyl chloride	90.0%	1.192	435	17400	0	0
freon 113	0.9%	0.004	1	40	4800	192000
Total greenhouse gas emissions (GHGs)						192000
Total hazardous air pollutants (HAPs)		1.223	446	17840		

Notes:

- The percentage of influent mass emitted through the vapor GAC assumes that the air stripper transfers 90% of the influent mass to the air stripper off-gas and that the vapor phase GAC is 99% efficient for all compounds (except vinyl chloride, which has a 0% efficiency). Refer to the equation below.
- Freon-113 and cis-1,2-dichloroethene are not a HAPs.
- Greenhouse gas potential of freon 113 is the IPCC Second Assessment Report 100-year value.

$$M_e = C \times Q \times \frac{3.785L}{gal} \times \frac{1440min}{day} \times \frac{kg}{10^9} \times \frac{2.2lbs}{kg} \times \eta_a \times (1 - \eta_c)$$

where

Q = flow rate (gpm)

C = VOC concentration (ug / L)

η_a = air stripper efficiency (90%)

η_c = GAC efficiency (99%)

Assumptions Regarding Injection Well Installation

Number of Injection Wells

Aquifer	Depth	Existing	New	Total	Total Depth
Zone A	0	23	0	23	0
Zone B	0	42	0	42	0
Zone C	0	23	0	23	0
Total		88	0	88	0

Well Depths and Drilling Times

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)	Time Required to Drill Each New Well (hrs)	Total Time Required to Drill Wells (hrs)
2-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

4-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

6-inch Wells					
Zone A	0	0	0	4	0
Zone B	0	0	0	6	0
Zone C	0	0	0	8	0
Total	0		0		0

Above table assumes single-cased wells.

Well Construction Information			Units	Quantity				
Well diameter			inches	2	4	6	Total	
Number of wells to install			#	0	0	0	0	
Borehole diameter			inches	6	8	10		
Total depth of all new wells			feet	0	0	0	0	
Total length of gravel/sand pack	10	ft/well	feet	0	0	0	0	
Total length of bentonite seal	2	ft/well	feet	0	0	0	0	
Total length of cement grout from bentonite to surface			feet	0	0	0	0	
Volume of drill cuttings			cy	0	0	0	0	
Volume of gravel/sand for sand pack			cy	0	0	0	0	
Volume of bentonite for seal			cy	0	0	0	0	
Volume of cement grout			cy	0	0	0	0	
Number of flush mount covers			#	0	0	0	0	
Number of steel 2'x2'x2' H20 rated manholes			#	0	0	0	0	
Number of concrete vaults 4'x4' with H20 steel doors			#	0	0	0	0	
Number of steel DOT rated 55-gallon drums for disposal			#	0	0	0	0	
Materials				Materials by Well Size				Truckloads
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	0			0	
Total mass of 4-inch PVC	2.0	lbs/ft	lbs		0		0	
Total mass of 6-inch PVC	3.5	lbs/ft	lbs			0	0	
Total mass of PVC							0	0
Total weight of gravel/sand	1.5	tons/cy	tons	0	0	0	0	0
Total dry weight of bentonite	0.19	tons/cy	tons	0	0	0	0	0
Total dry weight of cement grout	0.99	tons/cy	tons	0	0	0	0	0
Total potable water for grout	0.06	gal/lb	gals	0	0	0	0	0
Weight of steel for flush mount covers	32	lbs/unit	lbs	0	0	0	0	
Weight of steel for manholes	128	lbs/unit	lbs	0	0	0	0	
Weight of steel vault doors	291	lbs/unit	lbs	0	0	0	0	
Total weight of steel for surface finish			lbs	0	0	0	0	0
Weight of concrete for flush mount covers	0.10	tons/unit	tons	0	0	0	0	
Weight of concrete for manholes	0	tons/unit	tons	0	0	0	0	
Weight of concrete for vaults	4.7	tons/unit	tons	0	0	0	0	
Total weight of concrete for surface finish			tons	0	0	0	0	0
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0	0
Waste				Waste by Well Size				Truckloads
Development water	100	gal/well	gallons	0	0	0	0	
Development water returned to aquifer	100	gal/well	gallons	0	0	0	0	
Water to POTW	0	gal/well	gallons	0	0	0	0	0
Total weight of drill cuttings & other waste	1.5	tons/cy	tons	0	0	0	0	
Weight of hazardous waste	100	% of total	tons	0	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0	0
Waste characterization (at \$700 per sample)			\$	0	0	0	0	
Time and Mobilizations				Equipment & Labor by Well Size				Mobs.
Rig-days of drilling (8-hour days) - 120 HP rig			rig-days	0	0	0	0	0
Small loader for handling cuttings			rig-days	0	0	0	0	0
Crew man-days for drilling cuttings (8-hour days, 3 man crew)			man-days	0	0	0	0	0
Days for oversight			days	0	0	0	0	0

Assumptions Regarding Bioremediation Operation

Bioremediation Features			Units	Injections	
Years of remedy operation			yrs	0	
Injection events per year			events/yr	0	
Days per event			days/event	0	
Total days per year			days/yr	0	
Total days over duration of remedy			days	0	
Total events over duration of remedy			events	0	
<u>Injection quantities</u>				Materials	Truckloads
Gallons of potable water	0	gal/well	total gal.	0	0
Gallons of extracted ground water	0	gal/well	total gal.	0	0
Gallons of cheese whey (approx. specific gravity of 1)	0	gal/well	total lbs.	0	0
Gallons of molasses (approx. specific gravity of 1.45)	0	gal/well	total lbs.	0	0
Pounds of emulsified vegetable oil	0	lbs/well	total lbs.	0	0
				Electricity	
Injection pump electrical demand (2 at 1kW each)			kW	0	
Injection pump operation			hrs/day	0	
Injection pump electrical usage			kWh/yr	0	
Extraction pump electrical demand			kW	0	
Extraction pump operation			hrs/day	0	
Extraction pump electrical usage			kWh/yr	0	
Mixer electrical demand			kW	0	
Mixer operation			hrs/day	0	
Mixer electrical usage			kWh/yr	0	
Life-cycle electrical usage			kWh	0	
				Labor & Equipment	Mobs.
Total consultant labor (3 person crew per day)			man-days	0	0
Injection contractor equipment use and mobilization			days	0	0
Total contractor labor (3 person crew per day)			man-days	0	0

Notes:

- Injections to be completed by environmental consultant field personnel
- Absent other information, assume a maximum of 40,000 pounds per delivery by bulk
- Injection quantities based on pilot testing by facility consultant
- Although the first year of injections may be accomplished by a gasoline-powered pump (until electrical service is established at the facility), for simplicity, the full remedy
- Assume daily mobilization given proximity of consultant office to the site.

Assumptions Regarding Groundwater Sampling

LTM Component

- Comp. 1 = P&T and Surface Water
- Comp. 2 = Not used
- Comp. 3 = Not used
- Comp. 4 = Not used

Item	Units	Comp. 1 Quantity	Comp. 2 Quantity	Comp. 3 Quantity	Comp. 4 Quantity	Total
Duration of LTM component	years	42	0			42
Number of wells sampled per year	wells	160	0			160
Wells sampled per day by a crew	wells	3	3			6
Crew-days per year	crew-days/yr	53	0	0	0	53
Crew mobilizations per year (4 minimum for qtrly sampling)	mobs./yr	4	0			4
Samples per year including QA samples	samples/yr	228	0			228
Total samples for component	samples	9576	0	0	0	9576
Analysis cost per sample	\$/sample	\$90	\$0			
Total cost for analysis	\$	\$861,840	\$0	\$0	\$0	\$861,840
Total crew equipment days for component	equip-days	2226	0	0	0	2226
Total crew man days for component	man-days	2226	0	0	0	2226
Total mobilizations for component	trips	168	0	0	0	168
Purge water requiring off-site disposal	gallons	0	0			0
Drums required	drums	0	0	0	0	0
Steel required for drums	63 lbs/drum lbs	0	0	0	0	0
Non-hazardous waste disposal (includes weight of drums)	tons	0	0			0
Hazardous waste disposal (includes weight of drums)	tons	0	0			0
Truckloads for drums	trips	0	0			0
Truckloads for non-hazardous waste	trips	0	0			0
Truckloads for hazardous waste	trips	0	0			0

Notes for long-term monitoring:

- Crew is defined by sets of equipment (i.e., one set of sampling equipment equals one crew)
- Dedicated pumps and tubing installed in each well
- Historic sampling programs have typically consisted of the following number of samples:
 - 1st quarter - 45 groundwater samples plus 4 surface water samples
 - 2nd quarter - 28 groundwater samples plus 4 surface water samples
 - 3rd quarter - 58 groundwater samples plus 4 surface water samples
 - 4th quarter - 28 groundwater samples plus 4 surface water samples
- All wells and surface water samples are analyzed for VOCs.
- Analyses for TOC, geochemistry, total iron, and dissolved gases have also been conducted in association with bioremediation
- For this alternative, assume 50% of the wells are sampled and analyzed for bioremediation parameters (including VOCs) and the other 50% are sampled and analyzed for VOCs only for monitoring the P&T system. As such, all wells are sampled and analyzed for VOCs and 80 wells are sampled and analyzed for bioremediation parameters. The surface water samples (16 per year) are analyzed for VOCs only.
- Analytical cost for VOCs is assumed to be approximately \$90 per sample. Analytical cost for bioremediation parameters is assumed to be \$90 for VOCs, \$25 for total organic carbon, \$55 for general chemistry, \$10 for iron, and \$120 for methane/ethane/ethen
- Assume QA samples add an additional 30% to the number of samples collected
- Assume no additional QA samples for surface water and no additional level of effort required.
- Assume bioremediation sampling is conducted for the duration of the bioremediation remedy plus 2 years
- Assume sampling associated with P&T is conducted for the duration of the P&T remedy plus 2 years.
- Assume all purge water can be placed in the top of the air stripper for on-site disposal
- Assume each sampling crew (one person with one set of equipment) can sample 3 wells per 10-hour day.
- Assume two crews (e.g., two technicians plus two sets of equipment) can mobilize in the same vehicle and that one mobilization is made for every 5 days of sampling.
- Purge water is generated at an average of 12,000 mL per sample (e.g., 3 gallons per sample)
- Years of sampling for components 1 and 2 overlap, resulting in 32 total years of monitoring
- For calculating waste disposal, assume 8.34 pounds per gallon of purge water, 2,000 pounds per ton, and 55 gallons per drum.

Assumptions Regarding Decommissioning

Well Decommissioning Information			Units	Quantity			
Well diameter			inches	2	4	6	Total
Number of wells to close			#	218	0	0	218
Total depth of wells			feet	5060	0	0	5060
Volume of cement grout			cy	4.1	0	0	4.1
<u>Materials</u>							
Total dry weight of cement grout	0.99	tons/cy	tons	4.1	0	0	4.1
Total potable water for grout	0.06	gal/lb	gals	523	0	0	523
Truckloads for deliveries			trips	1	0	0	1
<u>Time and Mobilizations</u>							
Crew days with one 5 HP grout pump			days	20	0	0	20
Crew man-days (3 person crew)			man-days	60	0	0	60
Number of rig mobilizations			trips	2	0	0	2
Number of crew mobilizations			trips	20	0	0	20
Oversight days			days	10	0	0	10
Number of consultant mobilizations			trips	10	0	0	10

Notes:

- Construction of all wells is assumed to be known and all wells assumed to be closed by tremie grouting with cement grout
- Consultant assumed to oversee two grouting crews working simultaneously
- Assumed that all cement grout can be shipped in one truckload
- Assume grouting takes approximately 15 minutes to set up at each point and that pumping rate is approximately 1 gpm

Assumptions Regarding Personnel & Equipment Transportation for Lifetime of Remedy

Item	Consultant Personnel (Oversight or Sampling)		Plant Operator		Construction Contractor		Driller		Total Trips	Total Miles
	trips	88 miles RT	trips	88 miles RT	trips	50 miles RT	trips	100 miles RT		
<i>Gasoline powered light duty trucks</i>										
- Site Investigation	14	1232	0	0	4	200	24	0	42	1432
- Demolition	9	792	0	0	16	800	0	0	25	1592
- Excavation	3	264	0	0	3	150	0	0	6	414
- Capping	7	616	0	0	9	450	0	0	16	1066
- Extraction well installation	20	1760	0	0	0	0	80	8000	100	9760
- Conveyance piping	8	704	0	0	6	300	0	0	14	1004
- Treatment plant construction	20	1760	0	0	20	1000	0	0	40	2760
- Treatment plant O&M visits	160	14080	2080	183040	160	8000	0	0	2400	205120
- Injection well installation	0	0	0	0	0	0	0	0	0	0
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	168	14784	0	0	0	0	0	0	168	14784
- Decommissioning	10	880	0	0	0	0	20	2000	30	2880
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Light-Duty Truck Total	419	36872	2080	183040	218	10900	124	10000	2841	240812
<i>Gasoline powered passenger cars</i>										
- Site Investigation	0	0	0	0	0	0	0	0	0	0
- Demolition	0	0	0	0	0	0	0	0	0	0
- Excavation	0	0	0	0	0	0	0	0	0	0
- Capping	0	0	0	0	0	0	0	0	0	0
- Extraction well installation	0	0	0	0	0	0	0	0	0	0
- Conveyance piping	0	0	0	0	0	0	0	0	0	0
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	0	0	0	0	0	0	0	0	0	0
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	0	0	0	0	0	0	0	0	0	0
- Decommissioning	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Passenger Car Total	0	0	0	0	0	0	0	0	0	0
Gasoline Vehicle Total	419	36872	2080	183040	218	10900	124	10000	2841	240812

Item	Consultant Equipment		Operator Equipment		Construction Equipment		Drill Rig		Total Trips	Total Miles
	trips	88 miles RT	trips	88 miles RT	trips	50 miles RT	trips	100 miles RT		
<u>Diesel powered equipment transportation</u>										
- Site Investigation	0	0	0	0	1	50	3	300	4	350
- Demolition	0	0	0	0	2	100	0	0	2	100
- Excavation	0	0	0	0	3	150	0	0	3	150
- Capping	0	0	0	0	2	100	0	0	2	100
- Extraction well installation	0	0	0	0	0	0	4	400	4	400
- Conveyance piping	0	0	0	0	1	50	0	0	1	50
- Treatment plant construction	0	0	0	0	0	0	0	0	0	0
- Treatment plant O&M visits	0	0	0	0	0	0	0	0	0	0
- Injection well installation	0	0	0	0	0	0	0	0	0	0
- Bioremediation O&M	0	0	0	0	0	0	0	0	0	0
- Groundwater LTM	0	0	0	0	0	0	0	0	0	0
- Decommissioning	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Diesel Vehicle Total	0	0	0	0	9	450	7	700	16	1150

Notes for personnel and equipment transport:

- Oversight consultant field personnel transportation is by light-duty truck. One vehicle per visit.
- Plant operator transportation is by light-duty truck. One vehicle per visit.
- Electrician, plumbing, light duty construction contractor transportation is by light-duty truck (including towing light equipment). One vehicle for crew per visit.
- Heavy duty construction contractor equipment transportation is by diesel powered truck.
- Contractor crew transportation is by light duty truck. One truck per crew.
- Driller transportation is mobilization of one heavy-duty diesel-powered vehicle. Driller transportation for grouting is by light duty truck.
- Mobile lab for investigation is assumed to reside at the same location as the drill rig

Item	One-Way Distance miles	Number of Trips																			Total Miles	
		Site Inv.	Demo.	Excav.	Capping	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.									Total Trips
PVC	500				0	1		0		0											1	500
HDPE	500				0		1	0													1	500
Steel	500	1				2		1		0		0									4	2000
Stainless steel	500							1													1	500
Gravel/sand	50			375		1	0			0											376	18800
Bentonite (or clay)	50				0	0				0											0	0
Cement	50	0				2				0			1								3	150
Concrete	50				23	0		0		0											23	1150
Asphalt	50				0																0	0
LDPE	380	0																			0	0
Borrow	600			0	0																0	0
Potable water	0	0				0				0												
Non-haz. waste disposal	50	0	0	0		0	0		0	0		0									0	0
Haz. waste disposal	380	1	35	375		4	0		0	0		0									415	157700
Off-site recycling center	100		0																			0
GAC regeneration or virgin	600								840												840	504000
Treatment chemicals	500								0												0	0
Molasses	2400										0										0	0
Cheese whey	752										0										0	0
Emulsified vegetable oil	2800										0										0	0
Treatment plant equipment	2400							2													2	4800
																					0	0
																					0	0
																					0	0
																					0	0
																					0	0
																					0	0
Total Trips		2	35	750	23	10	1	4	840	0	0	0	1	0	1664							
Total Miles		880	13300	161250	1150	3170	500	5800	504000	0	0	0	50	0	690100							

Notes:
- Notes from above table apply

Fuel Usage Estimates for Lifetime of Remedy

Diesel Consumption	Load Factor	Days of Diesel Equipment Operation																			Total HP-hr	
		HP	Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>On-Site Consumption</u>																						
Small excavator (1 CY bucket)	0.57	100	2		0																912	
Medium excavator (1.5 CY bucket)	0.57	125			5.6																3192	
Large excavator (2 CY bucket)	0.57	150			0																0	
Small loader (1 CY bucket) or hoe low duty	0.25	50		6.7			80			0											8670	
Loader (2 CY bucket)	0.55	100		0.5	8.6																4004	
Dozer (100 HP)	0.55	100			3																1320	
Trencher (40 HP riding trencher)	0.75	40						6													1440	
Direct-push drill rig	0.75	50	11.6								0										3480	
Drilling - medium rig (e.g., CME-55)	0.75	120					80			0											57600	
Drilling - large rig (e.g., CME-75)	0.75	175																			0	
Grout pump	0.5	5												20							400	
Mobile laboratory	0.5	5	2																		40	
Roller	0.56	130				0															0	
Grader	0.61	175				1															854	
Asphalt paver	0.62	130				0															0	
Concrete paving machine	0.53	100				1															424	
Rotary-screw air compressor (250 cfm)	0.48	70		1.9																	510.72	
Other																					0	
Other																					0	
Total HP-hrs			4432	1400.72	8296	1278	65600	1440	0	0	0	0	0	400	0	0	0	0	0	0	82846.7	
Diesel Usage (gal/HP-hr)	0.056																					
On-Site Diesel Consumption (gallons)			248.192	78.4403	464.576	71.568	3673.6	80.64	0	0	0	0	0	22.4	0	0	0	0	0	0	4639	
<u>Off-Site Consumption</u>	Conv. Factor	Units	Gallons of Diesel Based on Miles or Ton-Miles of Transport from Materials Transport Module																			Total
Bulk transport (e.g., materials, waste)	0.01	gal/ton-mi.	6.0376	1990.44	24187.5	174.6	262.43	5	632.925	25080	0	0	0	2.05	0	0	0	0	0	0	52341	
Heavy equipment mobilization	0.2	gal/mi.	70	20	30	20	80	10	0	0	0	0	0	0	0	0	0	0	0	0	230	
Total Off-Site Diesel Consumption (gallons)			76.0376	2010.44	24217.5	194.6	342.43	15	632.925	25080	0	0	0	2.05	0	0	0	0	0	0	52571	

- Notes:
- Diesel usage based engine efficiency of 33%, which is consistent with back-calculating usage from Road Construction Emissions Model Version 6.3.2, assuming 22.3 pounds of carbon dioxide per gallon of diesel.
 - Diesel usage for bulk transport is derived from www.nrel.gov/lci for materials transportation with a combination truck. The value of 0.01 gal/ton-mile translates to approximately 5 miles per gallon when hauling a 20-ton load.
 - Diesel usage for equipment transportation is based on average mileage of 5 miles per gallon when towing heavy equipment.
 - HP-hr calculation assumes 8-hour days
 - Oil, other maintenance fluids, and filters for vehicle/equipment maintenance is not included.

Gasoline Consumption	Load Factor	HP	Days of Gasoline Equipment Operation																			Total HP-hr
			Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>On-Site Consumption</u>																						
General equip. operation - gasoline	0.5	1																				0
Gen/comp. operation for sampling	0.5	1											2226									8904
Other																						0
Other																						0
Other																						0
Other																						0
Other																						0
Total HP-hrs			0	0	0	0	0	0	0	0	0	0	8904	0	0	0	0	0	0	0	0	8904
Gasoline Usage (gal/HP-hr)	0.05																					Total Gallons
On-Site Gasoline Consumption (gallons)			0	0	0	0	0	0	0	0	0	0	445.2	0	0	0	0	0	0	0	0	445.2
<u>Off-Site Consumption</u>																						
	Conv. Factor	Units	Miles Driven with Gasoline Vehicle																			Total Miles
Per. transportation - light duty truck	0.1	gal/mi.	143.2	159.2	41.4	106.6	976	100.4	276	20512	0	0	1478.4	288	0	0	0	0	0	0	0	24081
Per. transportation - passenger car	0.05	gal/mi.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Off-Site Gasoline Consumption (gallons)			143.2	159.2	41.4	106.6	976	100.4	276	20512	0	0	1478.4	288	0	0	0	0	0	0	0	24081

Notes:

- Gasoline usage for general equipment based on engine efficiency of 33%, which is consistent with back-calculating usage from Road Construction Emissions Model Version 6.3.2, assuming 22.3 pounds of carbon dioxide per gallon of diesel.
- Gasoline usage for personnel transportation is calculated by multiplying the conversion factor times the miles calculated in the "personnel transportation" sheet
- HP-hr calculation assumes 8-hour days

Summary of On-Site Electricity Usage for Lifetime of Remedy

Item	Units	Electricity Usage (MWh)																			Total
		Site. Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
Electricity	lbs			0					7619.44		0										7600

Notes:

Summary of Materials Usage for Lifetime of Remedy

Item	Units	Materials Usage																			Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.								
<u>Construction Materials</u>																					
PVC	lbs				0	3264		0		0											3300
HDPE	lbs				0		2000	0													2000
Steel	lbs					15360		41550		0		0									56900
Stainless steel	lbs							2100													2100
Gravel/sand	tons			5625		11.7				0											5637
Bentonite (or clay)	tons				0	0.3				0											0
Cement	tons	0.85				21.5				0			4.1								26
Concrete	tons				349.2	0		0		0											349
Asphalt	tons				0																0
LDPE	lbs	274																			274
Borrow	tons			0	0																0
Other																					0
Other																					0
<u>Water</u>																					
Potable water	gal. x 1000	0.5				2.745			0	0	0		0.523								4
Groundwater extracted	gal. x 1000			0		12			2733120	0	0										2733132
Water injected	gal. x 1000					12			0	0											12
Other	gal. x 1000																				0
<u>Treatment Materials</u>																					
Reactivated coal-based granular activated carbon	lbs								8360000												8360000
Virgin coal-based granular activated carbon	lbs								0												0
Virgin coconut based granular activated carbon	lbs								0												0
Other																					0
Other																					0
Other																					0
<u>Treatment Chemicals</u>																					
Potassium permanganate	lbs								0												0
Hydrogen peroxide (50% solution, specific gravity =1.19)	lbs								0												0
Polymer	lbs								0												0
Sodium hydroxide (20% solution, specific gravity=1.22)	lbs								0												0
Hydrochloric acid (30% solution, specific gravity = 1.18)	lbs								0												0
Sequestering agent	lbs								0												0
Lime	lbs																				0
Other																					0
Other																					0
Other																					0
<u>In-Situ Chemicals</u>																					
Molasses	lbs										0										0
Cheese whey	lbs										0										0
Emulsified vegetable oil	lbs										0										0
Other																					0
Other																					0
Other																					0

Notes:
 - All "total" quantities measured in lbs are rounded to the nearest 100 lbs.
 - All "total" quantities measured in tons are rounded to the nearest ton.
 - All "total" quantities measured in gallons are round to the nearest 1,000 gallons.

Summary of Waste Disposal, Services, and Other Emissions

Item	Units	Materials Usage																		Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.							
<i>Waste and Services</i>																				
POTW	gal. x 1000			0					2733120											2733000
Non-hazardous waste disposal	tons	0	0	0		0	0		0	0										0
Hazardous waste disposal	tons	1.34	523.8	5625		52.4	0		0	0										6200
Materials recycling	tons		0																	
Laboratory analysis	\$	60220		7100		1400			172800	0		861840								1103400
Other																				0
Other																				0
Other																				0
Other																				0
<i>Other</i>																				
On-site process emissions of HAPs	lbs								17840											17800
On-site process emissions of greenhouse gases	lbs-CO2e								192000											192000
On-site emissions of HAPs from soil	lbs																			0
Injected Carbon Compound (lbs of CO2)	lbs																			0
Other																				0
Other																				0
Other																				0
Other																				0

- Notes:
- Entries may include rounding
 - Waste rounded to the nearest 10 tons
 - Carbon sequestration from nutrient injections are not considered.

Personnel Summary

Item	Units	Man Days Worked																				Total
		Site Inv.	Demo.	Excav.	Cap.	EW Install.	Piping	TP Const.	TP O&M	IW Install.	Bio.	LTM	Decom.									
<u>Labor Category</u>																						
Oversight consultant	man-days	14	9	3	7	20	6	20	160	0	0		10									249
Treatment plant operator	man-days								2080													2080
Monitoring technician (LTM only)	man-days											2226										2226
Bioremediation injection field staff	man-days																					0
Driller	man-days	24				240				0			60									324
Electrician/plumber	man-days							60	160													220
Construction contractor	man-days	4	46	9	27		6															92
Other	man-days																					0
Other	man-days																					0
Other	man-days																					0
Total	man-days	42	55	12	34	260	12	80	2400	0	0	2226	70	0	5191							

Notes:
 - 8-hour days assumed