APPENDIX A

REMEDY INVENTORY SHEETS

Travis AFB DP039 Footprinting Analysis Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Remedy Conceptual Design and Assumptions: Alternative A1 - Bioreactor

Overview

This remedy involves source area treatment of the DP039 site with a bioreactor. The remedy involves the construction of the bioreactor and installation of seven monitoring points. The remedy also involves operation, maintenance, and monitoring of the bioreactor for a 10-year period. The bioreactor is approximately 20 ft x 20 ft x 20 ft in size and is backfilled with a mixture of gravel, mulch, and iron pyrite. Vegetable oil and high fructose corn syrup were initially added to increase the total organic carbon content and foster anaerobic conditions for reductive dechlorination. Vegetable oil is added on an annual basis to maintain total organic carbon content. Water is extracted from the underlying aquifer with a solar powered pump and is infiltrated through the bioreactor. The seven new wells are sampled on a semi-annual basis.

Input for Bioreactor Construction

General Scope	Typical Scope Items	Useful Information
Installation of the bioreactor consists of excavating soil, filling the bioreactor pit, constructing the irrigation system	,	- Plastic liner assumed to be 20 ft x 20 ft by 40 mil with specific gravity of 0.94
and installing the solar pump		- 533 gallons of emulsified vegetable oil with assumed specific gravity of 0.97
		- 110 gallons of high fructose corn syrup addition with assumed specific gravity of 1.38
		- Density of sand and gravel assumed to be 1.5 tons per cubic yard
		- Photovoltaic system includes five 50 watt panels, control box, and Grundfos 11-SQF-2 pump (no
		inverter necessary)

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles* Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	4	1	8	32	1	33	Light-Duty Truck	Gasoline	33	15	2.2	establish soil stockpile area
work crew	4	1	8	32	1	33	Light-Duty Truck	Gasoline	33	15	2.2	remove and salvage wells EW563x39 and EW782x39
work crew	4	3	8	96	3	33	Light-Duty Truck	Gasoline	99	15	6.6	soil removal from bioreactor excavation
work crew	4	2	8	64	2	20	Light-Duty Truck	Gasoline	40	15	2.7	filling of bioreactor pit
work crew	3	1	8	24	2	33	Light-Duty Truck	Gasoline	66	15	4.4	irrigation system installation
work crew	1	1	8	8	1	33	Light-Duty Truck	Gasoline	33	15	2.2	solar pump installation

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Excavator (large)	396	0.57	Diesel	11.51172	4	46.04688	1	33	33	Diesel	7.2	4.6	John Deere 225C diesel used to remove wells EW563x39 and EW782x39
Excavator (large)	396	0.57	Diesel	11.51172	20	230.2344	0	20		Diesel	7.2		John Deere 225C diesel used to remove soil from bioreactor excavation
Excavator/hoe (small)	84	0.57	Diesel	2.44188	8	19.53504	1	20	20	Diesel	7.2	2.8	John Deere 310 diesel used to move soil in stockpile area
Dump truck		0.57	Diesel	0		0	12	0.2	2.4	Diesel	7.2	0.3	20-yd3 dump truck used to move 240 yd3 of clean soil to fenced area on-site
Excavator (large)	396	0.57	Diesel	11.51172	8	92.09376	0	33		Diesel	7.2		John Deere 225C diesel used to fill bioreactor pit
Excavator/hoe (small)	84	0.57	Diesel	2.44188	16	39.07008	0	33		Diesel	7.2		John Deere 310 diesel used to mix mulch
Excavator/hoe (small)	84	0.57	Diesel	2.44188	8	19.53504	0	33		Diesel	7.2		John Deere 310 diesel used for irrigation system installation

Electricity Usage

Equipment Type	HP	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
			Totals	0		0	



*Passenger miles per gallon for airplanes, buses, and trains

e	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles						
				of						
Material Type	Unit	Quantity	Trips	Transport	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes	
HDPE	lbs	78	1	1500	Truck Light Load (gptm)	Diesel	0.024	1.4	plastic liner material for stockpile area	
Gravel/sand/clay	tons	199.5	10	300	Truck C (15+ tons)	Diesel	5.92	50.7	133 cy of gravel used to fill bioreactor pit	
Other 2 - Mulch	су	133	9	270	Truck B (5-15 tons)	Diesel	7.2	37.5	133 cy of mulch used to fill bioreactor pit	
Emulsified vegetable oil	lbs	4,312	1	1000	Truck Light Load (gptm)	Diesel	0.024	51.7	vegetable oil used to fill bioreactor pit	
Steel	lbs	3,000	1	500	Truck A (< 5 tons)	Diesel	8.5	58.8	iron pyrite used to fill bioreactor pit	
HDPE	lbs	20	1	1500	Truck Light Load (gptm)	Diesel	0.024	0.4	surrogate for geotextile layer (polyester)	
PVC	lbs	95	1	500	Truck Light Load (gptm)	Diesel	0.024	0.6	pvc pipe for irrigation system	
Steel	lbs	22	1	500	Truck Light Load (gptm)	Diesel	0.024	0.1	Groundwater extraction pump	
Other 1 - PV system	W	250	1	1000	Truck Light Load (gptm)	Diesel	0.024	0.8	Photovoltaic system (250 watts)	
molasses	lbs	1266.012	1	500	Truck Light Load (gptm)	Diesel	0.024	7.6	surrogate for high fructose corn syrup	
			21	1070	Truck A (< 5 tons)	Diesel	8.5	125.9	empty one-way trips for specialty	
									or bulk delivery materials	
	Evel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (antm)									

e reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous	су								
Hazardous	су	7	1	520	Truck B (5-15 tons)	Diesel	7.2	72.2	Pb-contaminated soil from bioreactor
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)		
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)							
Discharge Location	Quantity	Activity or Notes					
Discharge to surface water							
Reinjected to aquifer							
Discharge to POTW							
Discharge to atmosphere							
Public Use							
Irrigation							
Industrial process water							
Other beneficial use							

Other								
Item	Quantity	Activity or Notes						
On-site HAP emissions								
On-site GHG emissions								
On-site GHG reductions								
On-site NOx reductions								
On-site SOx reductions								
On-site PM reductions								

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Laborator	v Analvsis
Laborator	<i>y /</i>

		Number	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			
SVOCs			
PCBs/Pesticides			
Metals	\$5	5	\$25
Other			
	Totals	5	25

soil samples analyzed for lead.

Input for Monitoring Well Installation

General Scope	Typical Scope Items
Installation of monitoring wells for bioreactor remedy.	
-3 shallow wells to 32 feet and 4 deep wells to 45 feet	
- wells are co-located in 8-inch borings	

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	3	3	8	72	3	50	Light-Duty Truck	Gasoline	150	15	10	installation of monitoring wells

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Drilling - medium rig (e.g., CME-	110	0.75	Diesel	4.2075	12	50.49	1	50	50	Diesel	7.2	6.9	Used to drill new wells, assume 4 hours per boring
Other	60	0.5	Diesel	1.53	6	9.18	1	50	50	Diesel	7.2	6.9	Forklift

Electricity Usage	•	•			1	1	
Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
			Totals	0		0	

Natural Gas Usage
Equipment Typ
Equipment Typ

Useful Information

e	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
PVC	lbs	187.68	1	500	Truck Light Load (gptm)	Diesel	0.024	1.1	from well install wksht
Gravel/sand/clay	tons	1.1	1	30	Truck Heavy Load (gptm)	Diesel	0.011	0.4	from well install wksht
Bentonite	tons	0.1	1	1000	Truck Heavy Load (gptm)	Diesel	0.011	1.1	from well install wksht
Cement	tons	0.6	1	30	Truck Heavy Load (gptm)	Diesel	0.011	0.2	from well install wksht
Steel	lbs	72	1	500	Truck Heavy Load (gptm)	Diesel	0.011	0.2	from well install wksht
Concrete	tons	1.0	1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	from well install wksht
Potable water	gals x 1000	0.103		0					from well install wksht, transported to site
									on drill rig support truck
			1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	empty return trip for concrete truck

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous	tons	3	1	1	Truck B (5-15 tons)	Diesel	7.2	0.1	drill cuttings and other waste
Hazardous	tons								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.103	water for mixing grout
Extracted GW #1 (1000 x gals)	0.21	well development
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

water usage from well installation worksheet

Fate of On-Site Water Usage (1000 x gals)							
Discharge Location	Quantity	Activity or Notes					
Discharge to surface water	0.21	water discharged to central groundwater treatment plant					
Reinjected to aquifer	0.103	returned to aquifer as grout					
Discharge to POTW							
Discharge to atmosphere							
Public Use							
Irrigation							
Industrial process water							
Other beneficial use							

Other

Utilei		
Item	Quantity	Activity or Notes
On-site HAP emissions		
On-site GHG emissions		
On-site GHG reductions		
On-site NOx reductions		
On-site SOx reductions		
On-site PM reductions		



Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Laborator	v Analysis
Laborator	7 7 11 41 9 51 5

		Number	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	0	0

Input for O&M

General Scope	Typical Scope Items	Useful Information
Annual emulsified vegetable oil addition		- Emulsified oil addition of 200 gallons per year, specific gravity of 0.97
Weekly O&M visits (5 minutes each)		
Two or more ORP checks per year conducted with O&M visits.		
All visits throughout 10-yr life of remedy.		

Labor, Mobilizations, Mileage, and Fuel

		Number of	Hours		Trine to	Roundtrip				Miles Der	Total Fuel	
Participant	Crew Size	Davs	Dav	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
O & M work crew	1	520	0.08	41.6	520	2	Light-Duty Truck	Gasoline	1040	15	69.3	Weekly O & M, 5 minutes per site visit (minor additional time for oil addition)

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

lectricity Usage							
Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
			Totals	0		0	

Natural Gas Usage
Equipmont Typ
Equipment Typ

		1				1	
)e	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

							-		
				Total Miles					
				Transporte					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Emulsified vegetable oil	lbs	16179.6	10	10000	Truck Light Load (gptm)	Diesel	0.024	194.2	annual ve

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								
Hazardous	tons								
Recyclable oil	tons								1
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)		
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)									
Discharge Location	Quantity	Activity or Notes							
Discharge to surface water									
Reinjected to aquifer									
Discharge to POTW									
Discharge to atmosphere									
Public Use									
Irrigation									
Industrial process water									
Other beneficial use									

Notes

Other								
Item	Quantity	Activity or Notes						
On-site HAP emissions								
On-site GHG emissions								
On-site GHG reductions								
On-site NOx reductions								
On-site SOx reductions								
On-site PM reductions								

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)	3497.5	
Other 1		
Other 2		

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative A1 - Bioreactor

Notes									
vegetable oil addition to bioreactor									

Laboratory Analysis			
		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			0
тос			0
Methane, Ethane, Ethene			0
Nitrate, Nitrite, Sulfate, Chloride			0
Alkalinity			0
Sulfide			0
Ferros iron by field kit			
Other			
Other			
Other			
	Totals	0	0

Input for O&M - Double the Amount of Emulsified Vegetable Oil

General Scope	Typical Scope Items
Annual emulsified vegetable oil addition	
Weekly O&M visits (5 minutes each)	
Two or more ORP checks per year conducted with O&M visits.	
All visits throughout 10-yr life of remedy.	

Labor, Mobilizations, Mileage, and Fuel

		Number of	Hours	Tetal Harris	Tainste	Roundtrip					Total Fuel	
Doutisinont	Crow Size	Number of	worked Per	Iotal Hours	l rips to	Willes to	Mada of Transport	Fuel Tures				Astivity or Notes
Participant	Crew Size	Days	Day	worked	Site	Sile	Wode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity of Notes
	-							-			-	
O & M work crew	1	520	0.08	41.6	520	2	Light-Duty Truck	Gasoline	1040	15	69.3	Weekly O & M, 5 minutes per site visit (minor additional time for oil addition)

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

Natural Gas Usage

lectricity Usage				1			,
Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
			Totals	0		0	Direct kWh information

Useful Information									
	- Emulsified oil addition of 200 gallons per year, specific gravity of 0.97								

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Matorials Us

iviateriais Usage									
				Total Miles					
				Transporte					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Emulsified vegetable oil	lbs	32359.2	10	10000	Truck Light Load (gptm)	Diesel	0.024	388.3	annual vegetable oil addition to bioreactor

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								
Hazardous	tons								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)		
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)									
Discharge Location	Quantity	Activity or Notes							
Discharge to surface water									
Reinjected to aquifer									
Discharge to POTW									
Discharge to atmosphere									
Public Use									
Irrigation									
Industrial process water									
Other beneficial use									

Other									
ltem	Quantity	Activity or Notes							
On-site HAP emissions									
On-site GHG emissions									
On-site GHG reductions									
On-site NOx reductions									
On-site SOx reductions									
On-site PM reductions									

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)	3497.5	
Other 1		
Other 2		

Green Remediation - Inventory of Energy, Mat	erial, Waste, and Other Remedy Aspects
	Alternative A1 - Bioreactor

		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			0
тос			0
Methane, Ethane, Ethene			0
Nitrate, Nitrite, Sulfate, Chloride			0
Alkalinity			0
Sulfide			0
Ferros iron by field kit			
Other			
Other			
Other			
	Totals	0	0



Notes

Input for Monitoring

General Scope	Typical Scope Items	Useful Information
Baseline monitoring plus 2 events per year thereafter for 10 years at 7 wells via low-flow sampling		- Polyethylene tubing weight of 0.08 pounds per foot

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
well monitoring work crew	2	21	8	336	21	2	Light-Duty Truck	Gasoline	42	15	2.8	well monitoring crew (21 sampling events)
onsite water disposal					21	3.2	Light-Duty Truck	Gasoline	67.2	15	4.5	pickup truck for disposal of purged water to Central GW treatment plant
												labor for purge water disposal included in above items

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Generator	2	0.51	Gasoline	0.05814	220.5	12.81987							generator operating at 1.5 hours per well per event

Electricity Usage							
Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
			Totals	0		0	

		1				1	
)e	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles					
				Transporte					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
HDPE	lbs	40	1	1500	Truck Light Load (gptm)	Diesel	0.024	0.7	surrogate for 500 feet of tubing
Potable water	gals x 1000	0.21	1						surrogate for ice and distilled water
									carried in personnel vehicles
									Other items not included
									detergent (0.1 gallons per event)
									isopropyl alcohol (0.1 gal/event)
									nitrile or latex gloves (15 pairs per event)
									paper towels and plastic bags for storing
									glass or plastic sample bottles
					Fuel Use Rate reported in	miles per gallon	(mpg) and gallor	ns per ton-mile (a	iptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								15 pair
Hazardous	tons								deterg
Recyclable oil	tons								and < (
Hauled to POTW	tons								not inc
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.21	water noted above for ice and distilled water
Extracted GW #1 (1000 x gals)	0.699	21 sampling events, low flow sampling, 200ml/min for 1.5 hrs/well
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)												
Discharge Location	Quantity	Activity or Notes										
Discharge to surface water	0.699	discharge via central treatment plant										
Reinjected to aquifer												
Discharge to POTW	0.21	water for ice & distilled water to POTW by lab impact included										
Discharge to atmosphere		in laboratory conversion factors										
Public Use												
Irrigation												
Industrial process water												
Other beneficial use												

Other Item Quantity Activity or Notes On-site HAP emissions On-site GHG emissions On-site GHG reductions On-site NOx reductions On-site SOx reductions On-site PM reductions

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Inhorator	v Analysis
Luborutor	y Allulysis

		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	210	18900
ТОС	25	105	2625
Methane, Ethane, Ethene	90	210	18900
Nitrate, Nitrite, Sulfate, Chloride	25	168	4200
Alkalinity	25	168	4200
Sulfide	10	168	1680
Ferros iron by field kit			
Other			
Other			
Other			
	Totals	1029	50505

VOCs - 7 field samples, trip blank, duplicate sample, and rinsate blank (10 total) per event for 21 events.

TOC - 4 field samples plus duplicate per event for 21 events Others - 7 field samples plus duplicate per event for 21 events



irs nitrile or latex gloves, 17 gallons gent rinsate, 1 gallon isopropyl rinsate, 0.5 cy soild waste per event cluded in analysis

							Summary											
Level	1	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	
				-						-			-			<u> </u>		
																		ſ
		MW																ſ
Item	Bio Const	Installation	0&M	Monitoring														Total
Labor and Travel																		
Hours worked	256	72	41.6	336														705.6
Heavy equip. operating hours	64	18	0	220.5														302.5
Passenger trips to site	10	3	520	42														575
Passenger vehicle miles	304	150	1040	109.2														1603.2
Heavy equip. trips to site	14	2	0	0														16
Heavy equip. transport miles	55.4	100	0	0														155.4
Materials transport trips	48	7	10	2														67
Materials transport miles	8640	2120	10000	1500														22260
Waste transport trips	1	1	0	0														2
Waste transport miles	520	1	0	0														521
Energy																		
<u>On-site</u>																		
Gasoline (gallons)	0	0	0	12.81987														12.81987
E85 (gallons)	0	0	0	0														0
Diesel (gallons)	446.5152	59.67	0	0														506.1852
B20 (gallons)	0	0	0	0														0
Photovoltaic (MWh)	0	0	3.4975	0														3.4975
Other Renewable 1	0	0	0	0														0
Other Renewable 2	0	0	0	0														0
<u>Off-site</u>																		
Gasoline (gallons)	20.3	10	69.3	7.3														106.9
E85 (gallons)	0	0	0	0														0
Diesel (gallons)	415.4	23.9	194.2	0.7														634.2
B20 (gallons)	0	0	0	0														0
<u>Total Fuel</u>																		
Gasoline (gallons)	20.3	10	69.3	20.11987														119.71987
E85 (gallons)	0	0	0	0														0
Diesel (gallons)	861.9152	83.57	194.2	0.7														1140.3852
B20 (gallons)	0	0	0	0														0
Electricity Demand (kW)	0	0	0	0														0
Electricity Usage (MWh)	0	0	0	0														0
Natural gas usage (therms)	0	0	0	0														0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative A1 - Biorea

								Summary									<u> </u>	
Level		1	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0 0	
	-		I		1		1				1			1	T	1		_
Item		Rio Const	IVIW Installation	08.M	Monitoring													Total
Materials		BIO CONSC	instanation	Odivi	Wollitoling												+	Total
Asphalt	(tons)	0	0	0	0													0
Bentonite	(tons)	0	0.1	0	0													0.1
Borrow	(tons)	0	0	0	0													0
Cement	(tons)	0	0.58	0	0													0.58
Cheese whey	(lbs)	0	0	0	0													0
Concrete	(tons)	0	1	0	0													1
Emulsified vegetable oil	(lbs)	4311.8634	0	16179.6	0													20491.4634
GAC: regenerated	(lbs)	0	0	0	0													0
GAC: virgin coal-based	(lbs)	0	0	0	0													0
GAC: virgin coconut-based	(lbs)	0	0	0	0													0
Gravel/sand/clay	(tons)	199.5	1.1	0	0													200.6
HDPE	(lbs)	98	0	0	40													138
Hydrochloric acid (30%, SG = 1.18)	(lbs)	0	0	0	0													0
Hydrogen peroxide (50%, SG=1.19)	(lbs)	0	0	0	0													0
Hydroseed	(lbs)	0	0	0	0													0
Lime	(lbs)	0	0	0	0													0
Molasses	(lbs)	1266.012	0	0	0													1266.012
Nitrogen fertilizer	(lbs)	0	0	0	0												+	0
Other 1 - PV system	(W)	250	0	0	0													250
Other 2 - Mulch	(cy)	133	0	0	0						-							133
Other 3	()	0	0	0	0													0
Other 4	()	0	0	0	0											 	+ $+$	0
Other 5	() (lba)	0	0	0	0													0
Phosphorus lerunzer	(IDS)	0	0	0	0													0
Polymer Detable water	(auls)	0	0 102	0	0 21										-			0 313
Potassium permanganate	(gais x 1000)	0	0.105	0	0.21													0.313
	(lbs)	95.2	187.68	0	0													282.88
Sequestering agent	(lbs)	0	0	0	0													0
Sodium hydroxide (20%, SG=1,22)	(lbs)	0	0	0	0													0
Stainless steel	(lbs)	0	0	0	0													0
Steel	(lbs)	3022	72	0	0													3094
Trees: root balls	(each)	0	0	0	0													0
Trees: whips	(each)	0	0	0	0													0
· · · · · · · · · · · · · · · · · · ·																		
Waste																		
Non-hazardous		0	3	0	0													3
Hazardous		7	0	0	0													7
Recyclable oil		0	0	0	0													0
Hauled to POTW		0	0	0	0													0
For incineration		0	0	0	0													0
Water Use																		
Public water (1000 x gal.)		0	0.103	0	0.21													0.313
Extracted GW #1 (1000 x gals)		0	0.21	0	0.699													0.909
Extracted GW #2 (1000 x gals)		0	0	0	0													0
Surface water (1000 x gals)		0	0	0	0													0
Reclaimed water (1000 x gals)		0	0	0	0													0
Stormwater (1000 x gals)		0	0	0	0												+	0
							1							1	1	1		

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative A1 - Biorea

Summary																		
Level	1	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	
		1 1		1				I	I	ſ	1		Γ					
Item	Bio Const	MW Installation	O&M	Monitoring														Total
Water Discharge																		
Discharge to surface water	0	0.21	0	0.699														0.909
Reinjected to aquifer	0	0.103	0	0														0.103
Discharge to POTW	0	0	0	0.21														0.21
Discharge to atmosphere	0	0	0	0														0
Public Use	0	0	0	0														0
Irrigation	0	0	0	0														0
Industrial process water	0	0	0	0														0
Other beneficial use	0	0	0	0														0
Laboratory Analysis																		
Total samples	5	0	0	1029														1034
Total cost	25	0	0	50505														50530
Other																		
On-site HAP emissions	0	0	0	0														0
On-site GHG emissions	0	0	0	0														0
On-site GHG storage	0	0	0	0														0
On-site Nox reductions	0	0	0	0														0
On-site SOx reductions	0	0	0	0														0
On-site PM reductions	0	0	0	0														0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative A1 - Biorea

Lookup Table

Mode of Transport. For	Gasoline	E85	Diesel	B20
Personnel	mpg	mpg	mpg or pmpg	mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)

- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel

- Typical gasoline fuel efficiencies from from www.fueleconomy.gov

- E85 efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources

- Diesel car and truck efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources

- B20 car and truck efficiences based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and 127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov)

- Diesel airplane, bus, and train efficiences from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment	
Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov.

Fuel Type for	
Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057
5 . 1	

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Equipment Type	Default Load Factor	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considerd "other general industrial equipment".

Mode of Transport. For	rate
Materials	(mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

			Default	
			One-Way	Site-Specific
			Distance from	One-Way
			Source to Site	Distance
Materials	Units	Conv. to tons	(miles)	(miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	су	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

	Round-Trip Distance	
Waste Disposal Facility	(Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

New Wells and New Well Depths

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)
	2-Inch W	elis	
Zone A			0
Zone B			0
Zone C	0	0	0
Total	0		0
	4-inch w	ells	_
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0
	6-inch w	ells	
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0

Above table assumes single-cased wells.

	2-inch	4-inch	6-inch
Existing wells	0	0	

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative A1 - Bioreactor

Well Construction Inform	Units		Quantity by	Well Size			
Well diameter		inches	2	4	6	Total	
Number of wells to install			#	7	0	0	7
Borehole diameter		inches	6	8	10		
Total depth of all new boreholes		feet	45	135	0	180	
Total length of well casing PVC			feet	276	0	0	276
Total length of gravel/sand pack			feet	10	60	0	70
Total length of bentonite seal			feet	2	12	0	14
Total length of cement grout from bentonite to	surface		feet	33	63	0	96
Volume of drill cuttings			су	0.3	1.7	0	2
Volume of gravel/sand for sand pack			су	0.1	0.6	0	0.7
Volume of bentonite for seal			су	0	0.1	0	0.1
Volume of cement grout			су	0.2	0.6	0	0.8
Number of flush mount covers			#	1	3	0	4
Number of bollards at wells (4 per well)			#	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	
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	187.68			187.68
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				187.68
Total weight of gravel/sand	1.5	tons/cy	tons	0.15	0.9	0	1.05
Total dry weight of bentonite	0.92	tons/cy	tons	0	0.1	0	0.1
Total dry weight of cement grout	0.99	tons/cy	tons	0.2	0.6	0	0.8
Total potable water for grout	0.06	gal/lb	gals	26	77	0	103
Weight of steel for flush mount covers	18	lbs/unit	lbs	18	54	0	72
Weight of steel for bollards	50	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	18	54	0	72
Weight of concrete for flush mount covers	0.15	tons/unit	tons	0	0	0.0	0.58
Weight of concrete for bollards	0.019	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	0.58
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0
Total stain. steel for for extraction pump	13	lbs/pump	lbs	0	0	0	0
Waste					Waste by W	/ell Size	
Development water	30	gal/well	gallons	210	0	0	210
Development water returned to aquifer	0	gal/well	gallons	0	0	0	0
Water to POTW	0	gal/well	gallons	0	0	0	0
Total weight drill cuttings & other waste	1.5	tons/cy	tons	0.5	2.6	0	3.1
Weight of hazardous waste	0	% of total	tons	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0
Waste characterization at \$700 per sample)			\$	0	0	0	0

ksheet

Notes:

Three shallow wells (32 ft) co-located in 8-inch boring with a deep well (45 ft) plus one additional deep well.

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative A1 - Bioreactor

Travis AFB DP039 Footprinting Analysis Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Remedy Conceptual Design and Assumptions: Alternative A2 - Dual-Phase Extraction (DPE)

Overview

This remedy involves dual-phase extraction to capture and remediate the source area of the DP039 site. The groundwater is extracted at a rate of approximately 3 gpm and pumped to the central groundwater treatment plant (CGWTP) for treatment. Soil vapor is extracted by a centrally-located blower and treated by a centrally located treatment facility. The base case for treatment is UV/OX for groundwater treatment and thermal oxidation for soil vapors. An alternate case involves GAC treatment for groundwater treatment and GAC for extracted soil vapors. No additional process water sampling is required because sampling is already conducted for the CGWTP. Additional soil vapors are collected quarterly at several locations for the SVE system. Site-wide groundwater monitoring is analyzed separately as part of this footprint analysis. No additional groundwater monitoring beyond the site-wide sampling program is required for this remedy. Groundwater extraction is anticipated to operate for 20 years, soil vapor extraction for 10 years. The remedy infrastructure is already in place and does not require the installation of wells or equipment; therefore, the installation of these items is not included in this analysis.

Input for O&M - UV/OX & ThOx

General Scope	Typical Scope Items
Operate existing dual-phase extraction system for 20-years	- groundwater pumps assumed to be three 1/3 HP pumps operating a
- P&T operates for 20 years and SVE operates for 10 years	- vapor extraction assumed to be from a centrally, located blower to p
- extract water at average of 3 gpm total from three existing extraction wells	pressure associated with conveyance and treatment
- groundwater treatment assumed to be provided by Central Groundwater Treatment Plant (CGWTP) using UV/OX.	- thermal oxidizer assumed to be in centrally located area to treat oth
- vapor treatment assumed to be provided by existing thermal oxidizer	- hydrogen peroxide assumed to be added at 50 mg/L to 3 gpm of pro
- limited or no GAC expected for treatment given these other treatment options	

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles* Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
O&M technician	1	1040	4	4160	1040	33	Light-Duty Truck	Gasoline	34320	15	2288	routine weekly O&M checks

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

Electricity Usage

Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Pumps	1	30%	60%	0.5	175200	87600	pumps for extraction and conveyance
SVE blower	1	100%	70%	1.42857143	87600	125142.86	represents fraction of large blower
							used for vapor extraction
CGWTP						119200	actual electricity scaled by flow rate
Thermal oxidizer						731635.2	actual electricity scaled by flow rate
			Totals	1.92857143		1063578.1	

Natural Gas Usage

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
Thermal oxidizer						218649.6	for SVE component only
							for 10 years based on actual current
							usage
			Totals			218649.6	

Useful Information

at 30% of full load to extract and convey water provide vapor extraction at other locations. Assume 1 HP for extracting 40cfm at 80inches of water for vacuum and 20 inches of water for

her vapors. Based on actual data, gas usage is approximately 0.00104 therms per scf treated and electricity of 0.00348 kWh/scf ocess water

*Passenger miles per gallon for airplanes, buses, and trains

Matorials Us

viateriais Usage	-					•			
				Total Miles					
				of					
Material Type	Unit	Quantity	Trips	Transport	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Hydrogen peroxide (50%, SG=1.19)	lbs	26260.0272	1	500	Truck B (5-15 tons)	Diesel	7.2	69.4	hydrogen peroxide for UV/OX
									delivered in bulk for CGWTP
									assume one trip for amount used for
									DP039
			1	500	Truck A (< 5 tons)	Diesel	8.5	58.8	empty return trip
									UV/OX replacement lamps considered
									negligible contributor to footprint
									and not included in analysis
	•	•		· ·	Fuel Lise Rate reported in	miles ner gallon	(mpg) and gallor	s ner ton-mile (c	mtml

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous	су								
Hazardous	су								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)		
Extracted GW #1 (1000 x gals)	31536	extracted water
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)							
Discharge Location	Quantity	Activity or Notes					
Discharge to surface water	31536	to local creek by way of the CGWTP					
Reinjected to aquifer							
Discharge to POTW							
Discharge to atmosphere							
Public Use							
Irrigation							
Industrial process water							
Other beneficial use							

Other							
Item	Quantity	Activity or Notes					
On-site HAP emissions							
On-site GHG emissions							
On-site GHG reductions							
On-site NOx reductions							
On-site SOx reductions							
On-site PM reductions							

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Laboratory Analysis	ratory Analysis
---------------------	-----------------

		Number	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	320	28800
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	320	28800

Quarterly vapor samples at 8 locations for 10 years.

Input for O&M - GAC

General Scope	Typical Scope Items
Operate existing dual-phase extraction system for 20-years	- groundwater pumps assumed to be three 1/3 HP pumps operating a
- P&T operates for 20 years. SVE operates for 10 years	- vapor extraction assumed to be from a centrally, located blower to p
- extract water at average of 3 gpm total from three existing extraction wells	for pressure associated with conveyance and treatment
- groundwater treatment assumed to be provided by Central Groundwater Treatment Plant (CGWTP) using GAC	- GAC usage for extracted groundwater assumed to be approximatley
instead of UV/OX	- Liquid GAC usages based on average influent of 250 ug/L for TCE and
- vapor treatment assumed to be provided by GAC instead of thermal oxidizer	- Vapor GAC usage for SVE off-gas assumed to be approximately 10 lbs
	- Vapor GAC usage based on average TCE concentration of 1 ppmv and

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles* Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
O&M technician	1	1040	4	4160	1040	33	Light-Duty Truck	Gasoline	34320	15	2288	routine weekly O&M checks

Equipment Use, Mobilization, and Fuel Usage

				Gallons	-	Gallons				-	N A ¹	Gallons Fuel	
			Equip. Fuel	Fuel Used	Total Hours	Fuel Used		Roundtrip	I otal Willes	I ransport Fuel	willes per	Used for	
Equipment Type	HP	Load Factor	Туре	per Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

Electricity Usage

Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
Pumps	1	40%	60%	0.66666667	175200	116800	pumps for extraction and conveyance
SVE blower	1	100%	70%	1.42857143	87600	125142.86	represents fraction of large blower
							used for vapor extraction
CGWTP						0	no additional electricity required
Thermal oxidizer						0	no additional electricity required
			Totals	2.0952381		241942.86	

Natural Gas Usage
Equipment Type

Materials Usage

Useful Information

t 40% of full load to extract water, convey water, and pump through GAC provide vapor extraction at other locations. Assume 1 HP for extracting 40cfm at 80inches of water for vacuum and 20 inches of water

y 84 lbs of GAC per pound of TCE treate and 1000 lbs of GAC per pound of DCE treated 50 ug/L for DCE and isotherms from USACE DG 1110-1-2, 2001 s of GAC per pound of TCE and 50 pounds of GAC+H61 per pound of DCE treated average DCE concentration of 0.5 ppmv.

*Passenger miles per gallon for airplanes, buses, and trains

Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
		Totals				

Laboratory Analysis

					Input for O&M - GAC					
				Total Miles of						
Material Type	Unit	Quantity	Trips	Transport	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes	
GAC: regenerated	lbs	5514.60571	10	10000	Truck A (< 5 tons)	Diesel	8.5	1176.5	P&T GAC for TCE, 1 trip every 2 years	
GAC: regenerated	lbs	13130.0136		0	Truck A (< 5 tons)				P&T GAC for DCE, trips combined with above	
GAC: regenerated	lbs	714.768763		0	Truck A (< 5 tons)				SVE GAC for TCE, trips combined with above	
GAC: regenerated	lbs	1323.14065		0	Truck A (< 5 tons)				SVE GAC for DCE, trips combined with above	
			10	10000	Truck A (< 5 tons)	Diesel	8.5	1176.5	empty return trip	

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous	су								
Hazardous	су								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								
					antes aullense neuton m	:1.			

gptm = gallons per ton-mile

On-Site Water Usage								
Resource Type	Quantity	Use of Resource						
Public water (1000 x gals)								
Extracted GW #1 (1000 x gals)	31536	extracted water						
Extracted GW #2 (1000 x gals)								
Surface water (1000 x gals)								
Reclaimed water (1000 x gals)								
Stormwater (1000 x gals)								
Water table drawdown (ft)								

Discharge Location	Quantity	Activity or Notes	
Discharge to surface water	31536	to local creek by way of the CGWTP	
Reinjected to aquifer			
Discharge to POTW			
Discharge to atmosphere			
Public Use			
Irrigation			
Industrial process water			
Other beneficial use			

Other			
Item	Quantity	Activity or Notes	
On-site HAP emissions			
On-site GHG emissions			
On-site GHG reductions			
On-site NOx reductions			
On-site SOx reductions			
On-site PM reductions			

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative A2 - Dual-Phase Extraction (DPE)

		Number of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	320	28800
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	320	28800

Quarterly vapor samples at 8 locations for 10 years.

Input for O&M - GAC & Solar

General Scope	Typical Scope Items
Operate existing dual-phase extraction system for 20-years	- groundwater pumps assumed to be three 1/3 HP pumps operating a
- P&T operates for 20 years. SVE operates for 10 years	- vapor extraction assumed to be from a centrally, located blower to
- extract water at average of 3 gpm total from three existing extraction wells	pressure associated with conveyance and treatment
- groundwater treatment assumed to be provided by Central Groundwater Treatment Plant (CGWTP) using GAC	- GAC usage for extracted groundwater assumed to be approximatley
instead of UV/OX	- Liquid GAC usages based on average influent of 250 ug/L for TCE an
- vapor treatment assumed to be provided by GAC instead of thermal oxidizer	- Vapor GAC usage for SVE off-gas assumed to be approximately 10 lk
All electricity provided by PV system, assuming 1400 kWhs per year per installed kW (PVWATTS)	- Vapor GAC usage based on average TCE concentration of 1 ppmv ar

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	I otal Hours	I rips to	Miles to			I otal Miles	Miles* Per	I otal Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
O&M technician	1	1040	4	4160	1040	33	Light-Duty Truck	Gasoline	34320	15	2288	routine weekly O&M checks

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

Electricity Usage

				Electrical		Energy	
Equipment Type	HP	% Full Load	Efficiency	Rating (kW)	Hours Used	Used (kWh)	Notes
							All approximate 242,000 kWh
							provided by a 10kW PV system
							operationg over a 20-year period
							see materials section
							for materials
							see renewable section for
							on-site energy use
	-	-	Totals	0		0	

Equipment Typ

Natural Gas Usage

Useful Information

at 40% of full load to extract water, convey water, and pump through GAC provide vapor extraction at other locations. Assume 1 HP for extracting 40cfm at 80inches of water for vacuum and 20 inches of water for

y 84 lbs of GAC per pound of TCE treate and 1000 lbs of GAC per pound of DCE treated nd 50 ug/L for DCE and isotherms from USACE DG 1110-1-2, 2001 bs of GAC per pound of TCE and 50 pounds of GAc per pound of DCE treated nd average DCE concentration of 0.5 ppmv.

*Passenger miles per gallon for airplanes, buses, and trains

)e	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles					
Material Type	Unit	Quantity	Trips	or Transport	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
GAC: regenerated	lbs	5514.60571	10	10000	Truck A (< 5 tons)	Diesel	8.5	1176.5	P&T GAC for TCE, 1 trip every 2 years
GAC: regenerated	lbs	13130.0136		0	Truck A (< 5 tons)				P&T GAC for DCE, trips combined with above
GAC: regenerated	lbs	714.768763		0	Truck A (< 5 tons)				SVE GAC for TCE, trips combined with above
GAC: regenerated	lbs	1323.14065		0	Truck A (< 5 tons)				SVE GAC for DCE, trips combined with above
			10	10000	Truck A (< 5 tons)	Diesel	8.5	1176.5	empty return trips for GAC
Other 1 - PV system	W	10000	1	1000	Truck A (< 5 tons)	Diesel	8.5	117.6	PV delivery
			1	1000	Truck A (< 5 tons)	Diesel	8.5	117.6	empty return trip for PV delivery
					Fuel Use Rate reported in	miles per gallon	(mpg) and gallor	ns per ton-mile (g	ıptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	су								
Hazardous	су								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)		
Extracted GW #1 (1000 x gals)	31536	extracted water
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)						
Discharge Location	Quantity	Activity or Notes				
Discharge to surface water	31536	to local creek by way of the CGWTP				
Reinjected to aquifer						
Discharge to POTW						
Discharge to atmosphere						
Public Use						
Irrigation						
Industrial process water						
Other beneficial use						

Other			
Item	Quantity	Activity or Notes	
On-site HAP emissions			
On-site GHG emissions			
On-site GHG reductions			
On-site NOx reductions			
On-site SOx reductions			
On-site PM reductions			

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)	242000	estimated 242,000 kWh generated on-site over lifetime of remedy
Other 1		
Other 2		

Laborator	v Analysis
Luborator	y Anaiysis

		Number	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	320	28800
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	320	28800

Quarterly vapor samples at 8 locations for 10 years.



	Summary																	
Level	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
						-										<u> </u>		
Item	0&M -1	O&M -2	O&M -3															Total
Labor and Travel																		
Hours worked	4160	4160	4160															4160
Heavy equip. operating hours	0	0	0															0
Passenger trips to site	1040	1040	1040															1040
Passenger vehicle miles	34320	34320	34320															34320
Heavy equip. trips to site	0	0	0															0
Heavy equip. transport miles	0	0	0															0
Materials transport trips	2	20	22															2
Materials transport miles	1000	20000	22000															1000
Waste transport trips	0	0	0															0
Waste transport miles	0	0	0															0
Energy																		
<u>On-site</u>																		
Gasoline (gallons)	0	0	0															0
E85 (gallons)	0	0	0															0
Diesel (gallons)	0	0	0															0
B20 (gallons)	0	0	0															0
Photovoltaic (MWh)	0	0	242															0
Other Renewable 1	0	0	0															0
Other Renewable 2	0	0	0															0
<u>Off-site</u>																		
Gasoline (gallons)	2288	2288	2288															2288
E85 (gallons)	0	0	0															0
Diesel (gallons)	128.2	2353	2588.2															128.2
B20 (gallons)	0	0	0															0
														l				
<u>Total Fuel</u>																		
Gasoline (gallons)	2288	2288	2288															2288
E85 (gallons)	0	0	0															0
Diesel (gallons)	128.2	2353	2588.2															128.2
B20 (gallons)	0	0	0															0
Electricity Demand (kW)	1.928571429	2.095238095	0															1.928571429
Electricity Usage (MWh)	1063.578057	241.9428571	0															1063.578057
														J				
Natural gas usage (therms)	218649.6	0	0															218649.6

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative A2 - Dual-Phase Extraction (D

						-		Summary										
Level		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
	_			I		I	1							1				
ltem		0&M -1	O&M -2	O&M -3													+-+	Total
Materials	<i>(</i> ,)																	
Asphalt	(tons)	0	0	0														0
Bentonite	(tons)	0	0	0														0
Borrow	(tons)	0	0	0														0
Cement	(tons)	0	0	0													+	0
Cheese whey	(IDS)	0	0	0													+	0
	(tons)	0	0	0													+	0
Emulsified vegetable oil	(lbs)	0	0	0													+ $+$	0
GAC: regenerated	(lbs)	0	20682.52872	20682.52872													+ $+$ $+$	0
GAC: virgin coal-based	(IDS)	0	0	0													+	0
GAC: Virgin coconut-based	(IDS)	0	0	0													+	0
Gravel/sand/clay	(tons)	0	0	0													+	0
	(IDS)	0	0	0													+	0
Hydrochloric acid (30% , SG = 1.18)	(lbs)	0	0	0													+ $+$ $+$	0
Hydrogen peroxide (50%, SG=1.19)	(lbs)	26260.0272	0	0													+ $+$	26260.0272
Hydroseed	(lbs)	0	0	0													+ $+$	0
Lime	(IDS)	0	0	0													+	0
Molasses	(IDS)	0	0	0													+	0
Nitrogen fertilizer	(IDS)	0	0	0														0
Other 1 - PV system	(VV)	0	0	10000														0
Other 2 - Mulch	(cy)	0	0	0														0
Other 3	()	0	0	0														0
Other 4	()	0	0	0													+	0
Other 5 Describerus fortilizor	() (lbc)	0	0	0														0
Priosphorus lertilizer	(IDS)	0	0	0													+	0
Polymer Detable water	(IDS)	0	0	0													+	0
Polable water	(gais x 1000,	0	0	0													+	0
	(IDS)	0	0	0													+	0
FVC	(lbs)	0	0	0													+	0
Sequestering agent	(lbs)	0	0	0													+	0
Stainless steel	(lbs)	0	0	0														0
Stalless Steel	(lbs)	0	0	0														0
	(ibs)	0	0	0														0
Trees: whins	(each)	0	0	0														0
	(cucity	Ū		0														
Waste																		
Non-hazardous		0	0	0														0
Hazardous		0	0	0														0
Recyclable oil		0	0	0														0
Hauled to POTW		0	0	0														0
For incineration		0	0	0														0
		, , , , , , , , , , , , , , , , , , ,	•	, , , , , , , , , , , , , , , , , , ,														-
Water Use							1							1				1
Public water (1000 x gal.)		0	0	0														0
Extracted GW #1 (1000 x gals)		31536	31536	31536														31536
Extracted GW #2 (1000 x gals)		0	0	0														0
Surface water (1000 x gals)		0	0	0														0
Reclaimed water (1000 x gals)		0	0	0														0
Stormwater (1000 x gals)		0	0	0														0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative A2 - Dual-Phase Extraction (D

						Summary										
Level 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
																_
ltem O&M -1	O&M -2	O&M -3														Total
Water Discharge																
Discharge to surface water 31536	31536	31536														31536
Reinjected to aquifer 0	0	0														0
Discharge to POTW 0	0	0														0
Discharge to atmosphere 0	0	0														0
Public Use 0	0	0														0
Irrigation 0	0	0														0
Industrial process water 0	0	0														0
Other beneficial use 0	0	0														0
Laboratory Analysis																
Total samples 320	320	320														320
Total cost 28800	28800	28800														28800
Other																
On-site HAP emissions 0	0	0		1												0
On-site GHG emissions 0	0	0														0
On-site GHG storage 0	0	0														0
On-site Nox reductions 0	0	0														0
On-site SOx reductions 0	0	0														0
On-site PM reductions 0	0	0														0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative A2 - Dual-Phase Extraction (D

Mode of Transport. For	Gasoline	E85	Diesel	B20
Personnel	mpg	mpg	mpg or pmpg	mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)

- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel

- Typical gasoline fuel efficiencies from from www.fueleconomy.gov

- E85 efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources

- Diesel car and truck efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources

- B20 car and truck efficiences based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and

127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov)

- Diesel airplane, bus, and train efficiences from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment	
Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov.

Fuel Type for	
Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Loo	kup	Tab	le
LOOI	Nup	100	

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considerd "other general industrial equipment".

Mode of Transport. For	rate
Materials	(mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

			Default	
			One-Way	Site-Specific
			Distance from	One-Way
			Source to Site	Distance
Materials	Units	Conv. to tons	(miles)	(miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	су	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

	Round-Trip Distance	
Waste Disposal Facility	(Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

Travis AFB DP039 Footprinting Analysis Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Remedy Conceptual Design and Assumptions: Alternative B1 - Biobarrier

Overview

This remedy involves use of a biobarrier to prevent migration of the plume beyond the 500 ug/L VOC contour. The biobarrier is established by injecting emulsified vegetable oil into a line of 13 injection wells oriented perpendicular to groundwater flow. The injection wells are 65 feet deep with a 40-foot screened interval. The monitoring network includes six new monitoring well pairs and three injection wells monitored for VOCs and natural attenuation parameters. The six shallow monitoring wells are 30 feet deep and the six deep wells are 60 feet deep. Sampling will occur at the wells semi-annually for the first two years and annually thereafter. Approximately 25,000 pounds of emulsified vegetable oil was injected in the initial injection at a 10% by volume solution at a rate of 4 gpm per well. Approximately 33,000 gallons of water from a local hydrant will be used for blending, injection, and post injection flushing. The site team anticipates that the emulsified vegetable oil will provide adequate treatment for 3 to 5 years, but this length of effectiveness prior to maintenance injections is uncertain. For the purpose of this study, it is assumed that migration control with the biobarrier is required for 10 years with one repeat injection after 5 years.

Input for Monitoring Well Installation

General Scope	Typical Scope Items	Useful Information
- Installation of monitoring wells (2-inch PVC) and injection wells (4-inch PVC)		
- 6 monitoring wells to 30 ft bgs, 6 monitoring wells to 60 ft bgs, each with 10 ft screens		
- 13 injection wells to 65 ft bgs with 40 ft screens		
- wells installed via hollow stem auger, cuttings disposed of on-site as non-hazardous		

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	3	25	8	600	25	50	Light-Duty Truck	Gasoline	1250	15	83.3	personnel support truck for installation of monitoring wells, assume one well per day
oversight	1	25	8	200	25	33	Light-Duty Truck	Gasoline	825	15	55	

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	НР	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Drilling - medium rig (e.g., CME-	110	0.75	Diesel	4.2075	126	530.145	5	50	250	Diesel	7.2	34.7	Used to drill new wells, mobilized once per week
Skid-steer (small)	60	0.55	Diesel	1.683	25	42.075	5	50	250	Diesel	7.2	34.7	used for managing drill cuttings, mobilized once per week, towed behind diesel support truck

 Electricity Usage
 HP
 % Full Load
 Efficiency
 Rating (kW)
 Hours Used
 Energy
 Notes

 Image: Imag

Natural Gas Usage
Equipment Typ

vpe	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles					
Material Type	Unit	Quantity	Trins	d d	Mode of Transport	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
PVC	lbs	2057	1	500	Truck Light Load (gptm)	Diesel	0.024	12.3	from well install wksht
Gravel/sand/clay	tons	8.7	1	30	Truck Heavy Load (gptm)	Diesel	0.011	2.9	from well install wksht
Bentonite	tons	0.5	1	1000	Truck Heavy Load (gptm)	Diesel	0.011	5.5	from well install wksht
Cement	tons	5.5	1	30	Truck Heavy Load (gptm)	Diesel	0.011	1.8	from well install wksht
Steel	lbs	450	1	500	Truck Heavy Load (gptm)	Diesel	0.011	1.2	from well install wksht
Concrete	tons	3.625	1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	from well install wksht
Stainless steel	lbs	325	1	500	Truck Heavy Load (gptm)	Diesel	0.011	0.9	from well install wksht
Potable water	gals x 1000	0.7		0					from well install wksht, transported to
									site on support truck
			1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	empty return trip for concrete truck
					Fuel Use Rate reported in m	iles per gallon (r	npg) and gallons	per ton-mile (qp	tm)

Waste Generation												
Waste Type	Unit	Quantity	Round Trips	Total Miles Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes			
Non-hazardous	tons	22.3	2	2	Truck B (5-15 tons)	Diesel	7.2	0.3	drill cuttings and other waste			
Hazardous	tons											
Recyclable oil	tons											
Hauled to POTW	tons											
For incineration	tons											

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.7	mixing grout for well construction
Extracted GW #1 (1000 x gals)	0.75	well development
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Reinjected to aquifer
Discharge to POTW
Discharge to atmosphere
Public Use
Irrigation
Industrial process water
Other beneficial use

Discharge Location

Discharge to surface water

water usage from well installation worksheet

Other

Other		
ltem	Quantity	Activity or Notes
On-site HAP emissions		
On-site GHG emissions		
On-site GHG reductions		
On-site NOx reductions		
On-site SOx reductions		
On-site PM reductions		

On-Site Renewable Energy Generation Item

item	
Photovoltaic (kWh)	
Other 1	
Other 2	

Laborator	v Analysis
Eastrator	,

		Number	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	0	0

Activity or Notes
mixing grout for well construction
water discharged to central groundwater treatment plant

Quantity	Activity or Notes

Input for Biobarrier Injections

General Scope	Typical Scope Items
- inject 33,000 gallons of water plus 25,000 pounds of emulsified vegetable oil into 13 wells for initial event and	
one follow-up event at year 5 with same quantities of water and oil	
- use potable water from hydrants for injections	
- inject at 4 gpm per well	
- majority of power and mixing provided by pressure from hydrant	

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	3	39	8	936	39	33	Light-Duty Truck	Gasoline	1287	15	85.8	assume 1.5 days for each of the 13 wells for each event

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

 Electricity Usage
 HP
 % Full Load
 Efficiency
 Electrical Rating (kW)
 Energy
 Used (kWh)
 Notes

 Image: Image:

Natural Gas Usage
Equipment Typ

Useful Information

/pe	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

/ents
not

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous	tons								
Hazardous	tons								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource	
Public water (1000 x gals)	66	33,000 gallons per each of two events	
Extracted GW #1 (1000 x gals)			
Extracted GW #2 (1000 x gals)			
Surface water (1000 x gals)			
Reclaimed water (1000 x gals)			
Stormwater (1000 x gals)			
Water table drawdown (ft)			

Discharge Location	Quantity	Activity or Notes
Discharge to surface water		
Reinjected to aquifer	66	injected with emulsified vegetable oil
Discharge to POTW		
Discharge to atmosphere		
Public Use		
Irrigation		
Industrial process water		
Other beneficial use		

Discharge Location	Quantity	Activity or Notes									
Discharge to surface water											
Reinjected to aquifer	66	injected with emulsified vegetable oil									
Discharge to POTW											
Discharge to atmosphere											
Public Use											
Irrigation											
Industrial process water											
Other beneficial use											

Other									
ltem	Quantity	Activity or Notes							
On-site HAP emissions									
On-site GHG emissions									
On-site GHG reductions									
On-site NOx reductions									
On-site SOx reductions									
On-site PM reductions									

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Laboratory Analysis

		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	0	0

Input for Biobarrier Injections - Double the Number of Events

General Scope	Typical Scope Items
- inject 33,000 gallons of water plus 25,000 pounds of emulsified vegetable oil and water mixture into 13 wells for	
initial event and three follow-up events with same quantities of water and oil	
- use potable water from hydrants for injections	
- inject at 4 gpm per well	
- majority of power and mixing provided by pressure from hydrant	

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	3	78	8	1872	78	33	Light-Duty Truck	Gasoline	2574	15	171.6	assume 1.5 days for each of the 13 wells for each event

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes

 Electricity Usage
 HP
 % Full Load
 Efficiency
 Electrical Rating (kW)
 Energy
 Used (kWh)
 Notes

 Image: Image:

Natural Gas Usage
F . 1 F
Equipment Ty

Useful Information

/pe	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Emulsified vegetable oil	lbs	100000	4	4000	Truck B (5-15 tons)	Diesel	7.2	555.6	25,000 pounds per each of four events
			4	4000	Truck A (< 5 tons)	Diesel	8.5	470.6	empty return trips for oil delivery
Potable water	gals x 1000	132.0		0					provided on-site
									hoses, valves, fittings, gloves, etc. not
									included

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								
Hazardous	tons								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	132	33,000 gallons per each of four events
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)								
Discharge Location	Quantity	Activity or Notes						
Discharge to surface water								
Reinjected to aquifer	132	injected with emulsified vegetable oil						
Discharge to POTW								
Discharge to atmosphere								
Public Use								
Irrigation								
Industrial process water								
Other beneficial use								

Discharge Location	Quantity	Activity or Notes
Discharge to surface water		
Reinjected to aquifer	132	injected with emulsified vegetable oil
Discharge to POTW		
Discharge to atmosphere		
Public Use		
Irrigation		
Industrial process water		
Other beneficial use		

Other			On-Site Renewable Ene
Item	Quantity	Activity or Notes	ltem
On-site HAP emissions			Photovoltaic (kWh)
On-site GHG emissions			Other 1
On-site GHG reductions			Other 2
On-site NOx reductions			
On-site SOx reductions			
On-site PM reductions			

Green Remediation - Inventory of Energy,	Material, Waste,	and Other Remedy Aspects
		Alternative B1 - Biobarrier

Laborator	v Analvsis
	,

		Number	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	0	0



Renewable Energy Generation

Quantity	Activity or Notes

Input for Monitoring

General Scope	Typical Scope Items
- Baseline monitoring plus 2 events per year for two years and 1 event per year thereafter for 9 more years	
- sampling at 12 monitoring wells and 3 injection wells with low-flow sampling	
- purge water discharged to central groundwater treatment plant	

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
well monitoring work crew	2	42	8	672	42	2	Light-Duty Truck	Gasoline	84	15	5.6	well monitoring crew (14 sampling events, three days per event)

Equipment Use, Mobilization, and Fuel Usage

	-			Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Generator	2	0.51	Gasoline	0.05814	315	18.3141							generator operating at 1.5 hours per well per event

Natural Gas Usage

Electricity Usage	1					1	
Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
	-		Totals	0		0	

Useful Information
- Polyethylene tubing weight of 0.08 pounds per foot

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles Transporte					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
HDPE	lbs	40	1	1500	Truck Light Load (gptm)	Diesel	0.024	0.7	surrogate for 500 feet of tubing
Potable water	gals x 1000	280	1	30	Truck Light Load (gptm)	Diesel	0.024	840.7	surrogate for ice and distilled wa
									Other items not included
									detergent (0.1 gallons per event
									isopropyl alcohol (0.1 gal/event)
									nitrile or latex gloves (15 pairs p
									paper towels and plastic bags fo
									glass or plastic sample bottles

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								nitrile
Hazardous	tons								isopro
Recyclable oil	tons								event
Hauled to POTW	tons								not inc
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.28	water for ice and distilled water
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)	0.999	14 sampling events, low flow sampling, 200ml/min for 1.5 hrs/well
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Discharge Location	Quantity	Activity or Notes
Discharge to surface water		
Reinjected to aquifer		
Discharge to POTW	0.999	discharged to Central GW Treatment Plant
Discharge to atmosphere		0.28 from ice & distilled water also to POTW but accounted for in lab
Public Use		conversion factors
Irrigation		
Industrial process water		
Other beneficial use		

Other			
Item	Quantity	Activity or Notes	
On-site HAP emissions			
On-site GHG emissions			
On-site GHG reductions			
On-site NOx reductions			
On-site SOx reductions			
On-site PM reductions			

On-Site Renewable Energy Generation

ltem	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Laborator	Analysis
Lubbrutory	Allulysis

		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	252	22680
ТОС	25	224	5600
Methane, Ethane, Ethene	90	224	20160
Nitrate, Nitrite, Sulfate, Chloride	25	224	5600
Alkalinity	25	224	5600
Sulfide	10	224	2240
Ferros iron by field kit			
Other			
Other			
Other			
	Totals	1372	61880

VOCs - 15 field samples, trip blank, duplicate sample, and rinsate blank (18 total) per event for 14 events.

Others - 15 field samples, one duplicate sample (16 total) for 14 events





or latex gloves, detergent rinsate, ppyl rinsate, and < 0.5 cy soild waste per

cluded in analysis

	Summary																	
Level	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Well																	ſ
Item	Installation	Injections	Monitoring	Injections (2)														Total
Labor and Travel																		
Hours worked	800	936	672	1872														2408
Heavy equip. operating hours	151	0	315	0														466
Passenger trips to site	50	39	42	78														131
Passenger vehicle miles	2075	1287	84	2574														3446
Heavy equip. trips to site	10	0	0	0														10
Heavy equip. transport miles	500	0	0	0														500
Materials transport trips	8	4	2	8														14
Materials transport miles	2620	4000	1530	8000														8150
Waste transport trips	2	0	0	0														2
Waste transport miles	2	0	0	0														2
Energy																		
<u>On-site</u>																		
Gasoline (gallons)	0	0	18.3141	0														18.3141
E85 (gallons)	0	0	0	0														0
Diesel (gallons)	572.22	0	0	0														572.22
B20 (gallons)	0	0	0	0														0
Photovoltaic (MWh)	0	0	0	0														0
Other Renewable 1	0	0	0	0														0
Other Renewable 2	0	0	0	0														0
<u>Off-site</u>																		
Gasoline (gallons)	138.3	85.8	5.6	171.6														229.7
E85 (gallons)	0	0	0	0														0
Diesel (gallons)	101.3	513.1	841.4	1026.2														1455.8
B20 (gallons)	0	0	0	0														0
Total Fuel																		
Gasoline (gallons)	138.3	85.8	23.9141	171.6														248.0141
E85 (gallons)	0	0	0	0														0
Diesel (gallons)	673.52	513.1	841.4	1026.2														2028.02
B20 (gallons)	0	0	0	0														0
Electricity Demand (kW)	0	0	0	0														0
Electricity Usage (MWh)	0	0	0	0														0
Natural gas usage (therms)	0	0	0	0														0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative B1 - Biobar

				-			-	Summary									<u> </u>	
Level		1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
														1		1		_
		Well																
Item		Installation	Injections	Monitoring	Injections (2)													Total
Materials	(topo)	0	0	0	0													0
Asphalt	(tons)	0	0	0	0													0
Berrow	(tons)	0.5	0	0	0													0.5
Comont	(tons)	5.5	0	0	0													
Change where	(lbs)	0	0	0	0													5.5
Concrete	(tons)	3 625	0	0	0													3 625
Emulsified vegetable oil	(lbs)	0	50000	0	100000													50000
GAC: regenerated	(lbs)	0	0	0	0													0
GAC: virgin coal-based	(lbs)	0	0	0	0													0
GAC: virgin coconut-based	(lbs)	0	0	0	0													0
Gravel/sand/clav	(tons)	8.7	0	0	0													8.7
HDPE	(lbs)	0	0	40	0													40
Hydrochloric acid (30%, SG = 1.18)	(lbs)	0	0	0	0													0
Hydrogen peroxide (50%, SG=1.19)	(lbs)	0	0	0	0													0
Hydroseed	(lbs)	0	0	0	0													0
Lime	(lbs)	0	0	0	0													0
Molasses	(lbs)	0	0	0	0													0
Nitrogen fertilizer	(lbs)	0	0	0	0													0
Other 1 - PV system	(W)	0	0	0	0													0
Other 2 - Mulch	(су)	0	0	0	0													0
Other 3	()	0	0	0	0													0
Other 4	()	0	0	0	0													0
Other 5	()	0	0	0	0													0
Phosphorus fertilizer	(lbs)	0	0	0	0													0
Polymer	(lbs)	0	0	0	0													0
Potable water	(gals x 1000)	0.7	66	280	132													346.7
Potassium permanganate	(lbs)	0	0	0	0													0
PVC	(lbs)	2057	0	0	0													2057
Sequestering agent	(lbs)	0	0	0	0													0
Sodium hydroxide (20%, SG=1.22)	(lbs)	0	0	0	0													0
Stainless steel	(lbs)	325	0	0	0													325
Steel	(IDS)	450	0	0	0													450
Trees: root balls	(each)	0	0	0	0													0
	(each)	0	0	U	0													0
Wasta																		
Non-bazardous		22.3	0	0	0													22.3
Hazardous		0	0	0	0													0
Becyclable oil		0	0	0	0													0
Hauled to POTW		0	0	0	0													0
For incineration		0	0	0	0													0
		-		-	-													-
Water Use																		
Public water (1000 x gal.)		0.7	66	0.28	132													66.98
Extracted GW #1 (1000 x gals)		0.75	0	0	0													0.75
Extracted GW #2 (1000 x gals)		0	0	0.998678996	0													0.998678996
Surface water (1000 x gals)		0	0	0	0													0
Reclaimed water (1000 x gals)		0	0	0	0													0
Stormwater (1000 x gals)		0	0	0	0													0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative B1 - Biobar

Image	Summary																	
Image Number Number </th <th>Level</th> <th>1</th> <th>2</th> <th>3</th> <th>0</th> <th>0 (</th> <th>)</th>	Level	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0 ()
IntenIntentIntentIntentIntentIntentIntentIntentIntentIntentIntentIntentWate charage		Well																-
Water scheme Discharge bound Discharge bound Reingeted to quiferIndI	Item	Installation	Injections	Monitoring	Injections (2)													Total
Discharge to surface water00 <td>Water Discharge</td> <td></td>	Water Discharge																	
Reinject do quifer0.766013200 <t< td=""><td>Discharge to surface water</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0</td></t<>	Discharge to surface water	0	0	0	0													0
Dacharge b OTW0.0	Reinjected to aquifer	0.7	66	0	132													66.7
Decknappede000	Discharge to POTW	0.75	0	0.998678996	0													1.748678996
Public Use0.0 <td>Discharge to atmosphere</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td></td> <td>0</td>	Discharge to atmosphere	0	0	0	0													0
Iringation00	Public Use	0	0	0	0													0
Industrial process water00<	Irrigation	0	0	0	0													0
Other beneficial use000	Industrial process water	0	0	0	0													0
Image: Constraint of the state of the sta	Other beneficial use	0	0	0	0													0
Labordy AnalysisMMM <td></td>																		
Total samples00137200001372013721372Total cost00618800618800666	Laboratory Analysis																	
Total cost00618800000061880CherImage: Construction of the cons	Total samples	0	0	1372	0													1372
d_{1} d_{2} <	Total cost	0	0	61880	0													61880
Other																		
On-site HAP emissions00	Other																	
On-site GHG emissions00	On-site HAP emissions	0	0	0	0													0
On-site GHG storage000<	On-site GHG emissions	0	0	0	0													0
On-site Nox reductions 0 0 0 0 0 0 0 0 0 0 0 On-site Sox reductions 0 <td< td=""><td>On-site GHG storage</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0</td></td<>	On-site GHG storage	0	0	0	0													0
On-site SOX reductions 0 <td>On-site Nox reductions</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td></td> <td>0</td>	On-site Nox reductions	0	0	0	0													0
On-site PM reductions 0	On-site SOx reductions	0	0	0	0													0
	On-site PM reductions	0	0	0	0													0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative B1 - Biobar

Mode of Transport. For	Gasoline	E85	Diesel	B20
Personnel	mpg	mpg	mpg or pmpg	mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)

- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel

- Typical gasoline fuel efficiencies from from www.fueleconomy.gov

- E85 efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), *Climate Leaders Direct Emissions from Mobile Sources*

- Diesel car and truck efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources

- B20 car and truck efficiences based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and

127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov)

- Diesel airplane, bus, and train efficiences from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment	
Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov.

Fuel Type for	Gals, ner HP-hr
BZU	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Equipment Typ
halt paver
khoe
crete paving machine
er (large)
er (small)
ing - direct push
ing - large rig (e.g., CME-75)
ing - medium rig (e.g., CME-55)
np truck
avator (large)
avator (medium)
avator/hoe (small)
erator
der
ut numn

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considerd "other general industrial equipment".

Mode of Transport. For	rate
Materials	(mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = *miles per gallon*, *gptm* = *gallons per ton-mile*

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

Lookup Table

			Default	
			One-Way	One-Way Site
			Distance from	Specific
			Source to Site	Distance
Materials	Units	Conv. to tons	(miles)	(miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	су	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

	Round-Trip Distance	
Waste Disposal Facility	(Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

New Wells and New Well Depths

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)
	2-Inch W	ells	
Zone A	6	30	180
Zone B	6	60	360
Zone C	0	0	0
Total	12		540
	4-inch w	ells	
Zone A	0	0	0
Zone B	13	65	845
Zone C	0	0	0
Total	13		845
	6-inch w	ells	
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0

Above table assumes single-cased wells.

	2-inch	4-inch	6-inch
Existing wells	0	0	0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B1 - Biobarrier

Waste

Development water

Weight of hazardous waste

Weight of non-hazardous waste

Water to POTW

Development water returned to aquifer

Total weight drill cuttings & other waste

Waste characterization at \$700 per sample)

Well Installation Worksheet Well Construction Information Units **Quantity by Well Size** Well diameter inches Total 2 4 6 Number of wells to install # 12 13 0 25 Borehole diameter 10 inches 8 6 Total depth of all new boreholes 540 845 0 1385 feet 845 Total length of PVC feet 540 0 1385 120 520 640 Total length of gravel/sand pack feet 0 24 26 50 Total length of bentonite seal feet 0 Total length of cement grout from bentonite to surface feet 396 299 0 695 3.9 10.9 14.8 Volume of drill cuttings 0 су Volume of gravel/sand for sand pack 0.8 5 5.8 су 0 Volume of bentonite for seal 0.2 0.3 0.5 су 0 Volume of cement grout су 2.6 2.9 0 5.5 Number of flush mount covers 12 13 25 # 0 Number of bollards at wells (4 per well) 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 367.2 Total mass of 2-inch PVC 0.68 lbs/ft 367.2 lbs 1690 2.0 Total mass of 4-inch PVC lbs/ft lbs 1690 Total mass of 6-inch PVC 3.5 lbs/ft lbs 0 0 2057.2 Total mass of PVC lbs Total weight of gravel/sand 1.5 tons/cy tons 1.2 7.5 0 8.7 0.92 0.2 0.3 0.5 Total dry weight of bentonite tons/cy tons 0 0.99 2.6 2.9 5.5 Total dry weight of cement grout tons/cy tons 0 0.06 332 370 702 Total potable water for grout 0 gal/lb gals Weight of steel for flush mount covers 18 lbs 216 234 0 450 lbs/unit Weight of steel for bollards 50 lbs/unit lbs 0 0 0 0 291 Weight of steel vault doors lbs/unit lbs 0 0 0 0 216 234 450 Total weight of steel for surface finish lbs 0 0.15 Weight of concrete for flush mount covers tons/unit tons 2 2 0.0 3.625 0.019 Weight of concrete for bollards tons/unit 0 0 0 tons 0 Weight of concrete for vaults 4.7 0 tons/unit 0 0 0 tons 3.625 Total weight of concrete for surface finish tons 2 2 0 Total steel for drums for disposal 63 lbs/drum lbs 0 0 0 0 Total stain. steel for for extraction pump 13 lbs/pump lbs 156 169 0 325

30

0

0

1.5

0

0

gal/well

gal/well

gal/well

tons/cy

% of total

% of total

gallons

gallons

gallons

tons

tons

tons

\$

360

0

0

5.9

0

0

0

Waste by Well Size

0

0

0

0

0

0

0

390

0

0

16.4

0

0

0

750

0

0

22.3

0

0

0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B1 - Biobarrier

Travis AFB DP039 Footprinting Analysis Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Remedy Conceptual Design and Assumptions: Alternative B2 - Permeable Reactive Barrier (PRB)

Overview

This remedy involves use of a permeable reactive barrier (PRB) to prevent migration of the plume beyond the 500 ug/L VOC contour. The PRB is established by high pressuring jetting of zero valent iron, guar gum, acetic acid, and water into formation to 60 feet deep in 50 locations. The size is based on extrapolating from the pilot permeable reactive barrier to a size comparable to the installed biobarrier. Materials use and construction is based on scaling the pilot values from 24 to 50 columns for the appropriate size and 50 feet to 60 feet for the appropriate depth. Based on this scaling factor a total of 758 tons of zero valent iron is used. Injection is conducted at a lift rate of 1 foot per minute (60 minutes for the full well depth), and two passes are made at each hole. The first pass includes water, guar gum, acetic acid, and air, the second pass includes water, guar gum, acetic acid, and zero valent iron. Injections are conducted at 120 gpm. Guar gum is used at a rate of 40 pounds per 1,000 gallons of water, and acetic acid is used at a rate of 24 pounds per 1,000 gallons of water.

It is assumed that the wall will last for 10 years and that this coincides with the duration that migration control is required. A senstivity analyis can be conducted for reinstalling the wall a single time by multipling all results by 2. Because this technology and the biobarrier technology are both based on passive treatment through a reactive zone, the monitoring program for the PRB is assumed to be the same as that for the biobarrier.

Input for Monitoring Well Installation

General Scope	Typical Scope Items	Useful Information
- Installation of monitoring wells (2-inch PVC)		
- 6 monitoring wells to 30 ft bgs, 6 monitoring wells to 60 ft bgs, each with 10 ft screens		
- wells installed via hollow stem auger, cuttings disposed of on-site as non-hazardous		

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	3	12	8	288	12	50	Light-Duty Truck	Gasoline	600	15	40	personnel support truck for installation of monitoring wells, assume one well per day
oversight	1	12	8	96	12	33	Light-Duty Truck	Gasoline	396	15	26.4	

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	НР	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Drilling - medium rig (e.g., CME-	110	0.75	Diesel	4.2075	48	201.96	2	50	100	Diesel	7.2	13.9	Used to drill new wells, mobilized twice
Skid-steer (small)	60	0.55	Diesel	1.683	12	20.196	2	50	100	Diesel	7.2	13.9	used for managing drill cuttings, mobilized twice towed behind diesel support truck

 Electricity Usage

 Equipment Type
 HP
 % Full Load
 Efficiency
 Rating (kW)
 Hours Used
 Energy
 Notes

 Image: Image:

Natural Gas Usage
Equipment Typ

/pe	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles Transporte								Number of	
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes	Parameter and Notes	Unit Cost	Samples	Total Cost
PVC	lbs	367	1	500	Truck Light Load (gptm)	Diesel	0.024	2.2	from well install wksht	VOCs			
Gravel/sand/clay	tons	1.2	1	30	Truck Heavy Load (gptm)	Diesel	0.011	0.4	from well install wksht	SVOCs			
Bentonite	tons	0.2	1	1000	Truck Heavy Load (gptm)	Diesel	0.011	2.2	from well install wksht	PCBs/Pesticides			
Cement	tons	2.6	1	30	Truck Heavy Load (gptm)	Diesel	0.011	0.9	from well install wksht	Metals			
Steel	lbs	216	1	500	Truck Heavy Load (gptm)	Diesel	0.011	0.6	from well install wksht	Other			
Concrete	tons	1.7	1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	from well install wksht	Other			
Potable water	gals x 1000	0.332		0					from well install wksht, brought on support	Other			
									truck	Other			
										Other			
										Other			
											Totals	0	0
			1	30	Truck A (< 5 tons)	Diesel	8.5	3.5	empty return trip for concrete truck				

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons	5.9	1	1	Truck B (5-15 tons)	Diesel	7.2	0.1	drill c
Hazardous	tons								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.332	water for mixing grout
Extracted GW #1 (1000 x gals)	0.36	well development
Extracted GW #2 (1000 x gals)		
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1	LOOO x gals)	
Discharge Location	Quantity	Activity or Notes
Discharge to surface water	0.36	water discharged to central groundwater treatment plant
Reinjected to aquifer	0.332	returned to aquifer as grout
Discharge to POTW		
Discharge to atmosphere		
Public Use		
Irrigation		
Industrial process water		
Other beneficial use		

water usage from well installation worksheet

Other	Other										
Item	Quantity	Activity or Notes									
On-site HAP emissions											
On-site GHG emissions											
On-site GHG reductions											
On-site NOx reductions											
On-site SOx reductions											
On-site PM reductions											

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B2 - Permeable Reactive Barrier (PRB)

Inhorator	v Analysis
Luborator	7 711019313



Input for Monitoring Well Installation

General Scope	Typical Scope Items	Useful Information
- install 50 jetted columns to 60 feet below ground surface		- grout pump HP based on Soilmec unit of suitable capacity (274 HP)
- 758 tons of zero valent iron		- compressed air HP based on calculated value from www. Engineeringtoolbox.com
- injection at 120 gpm at 5800 psi for 2 passes at each well		- water assumed to come from local fire hydrant
- use compressed air for first pass only at 200 cfm at 200 psi		
- guar gum usage of 40 lbs/1000 gallons of water, acetic acid usage of 24 lbs/1000 gallons of water		
- 275,000 gallons of liquified spoils deposited in on-site spoils pit to reinfiltrate		

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
work crew	3	20	8	480	20	10	Light-Duty Truck	Gasoline	200	15	13.3	3 injections/day plus time for set up and breakdown, travel between site and hotel
work crew	1				1	500	Heavy-Duty Truck	Gasoline	500	10	50	initial travel to site for specialty contractor, towing some equipment

Equipment Use, Mobilization, and Fuel Usage

				Gallons Fuel		Gallons						Gallons Fuel	
			Equip. Fuel	Used per	Total Hours	Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Drilling - large rig (e.g., CME-75)	175	0.75	Diesel	6.69375	80	535.5	1	500	500	Diesel	7.2	69.4	drill rig, assume 4 hours of operation per day
Grout pump	274	1	Diesel	13.974	100	1397.4	1	500	500	Diesel	7.2	69.4	grout pump and hopper,2 hours per hole based on lift rate of 1 ft/min and two passes
Excavator (medium)	125	0.57	Diesel	3.63375	32	116.28	1	33	33	Diesel	7.2	4.6	four days of excavator for digging and covering spoils pit
Other	60	1	Diesel	3.06	50	153							air compressor operating 1 hour per hole (one pass only), 200 cfm and 200psi (towed to site)

Natural Gas Usage

Electricity Usage

Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
			Totals	0		0	

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B2 - Permeable Reactive Barrier (PRB)

Equipment Type	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles					
				Transporte					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Steel	lbs	1516000	40	20000	Truck C (15+ tons)	Diesel	5.92	3378.4	surrogat
Other 3 - acetic acid	lbs	17280	1	500	Truck B (5-15 tons)	Diesel	7.2	69.4	
Other 4 - guar gum	lbs	28800	1	500	Truck B (5-15 tons)	Diesel	7.2	69.4	
Potable water	gals x 1000	720.0		0					provided
									hoses, va
									included
			42	21000	Truck A (< 5 tons)	Diesel	8.5	2470.6	empty re

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	Notes
Non-hazardous	tons								
Hazardous	tons								
Recyclable oil	tons								
Hauled to POTW	tons								
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource	
Public water (1000 x gals)	720	120 gpm for 120 minutes per hole for 50 holes	
Extracted GW #1 (1000 x gals)			
Extracted GW #2 (1000 x gals)			
Surface water (1000 x gals)			
Reclaimed water (1000 x gals)			
Stormwater (1000 x gals)			
Water table drawdown (ft)			

Discharge Location	Quantity	Activity or Notes
Discharge to surface water		
Reinjected to aquifer	720	injected as part of wall construction
Discharge to POTW		
Discharge to atmosphere		
Public Use		
Irrigation		
Industrial process water		
Other beneficial use		

Other				C
ltem	Quantity	Activity or Notes		ŀ
On-site HAP emissions				F
On-site GHG emissions				C
On-site GHG reductions				C
On-site NOx reductions				
On-site SOx reductions				
On-site PM reductions				

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B2 - Permeable Reactive Barrier (PRB)

Laboratory	Anal	vsis
Laboratory	All Mil	y 313

Notos
Notes
ogate for zero valent iron
vided on-site
es, valves, fittings, gloves, etc. not
Jded
oty return trips
· ·

		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs			
SVOCs			
PCBs/Pesticides			
Metals			
Other			
	Totals	0	0

gals)

Input for Monitoring

General Scope	Typical Scope Items
- Baseline monitoring plus 2 events per year for two years and 1 event per year thereafter for 9 more years	
- sampling at 12 monitoring wells and 3 injection wells with low-flow sampling	
 purge water discharged to central groundwater treatment plant 	

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
well monitoring work crew	2	42	8	672	42	2	Light-Duty Truck	Gasoline	84	15	5.6	well monitoring crew (14 sampling events, three days per event)

Equipment Use, Mobilization, and Fuel Usage

			Equip. Fuel	Gallons Fuel Used per	Total Hours	Gallons Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Gallons Fuel Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Generator	2	0.51	Gasoline	0.05814	315	18.3141							generator operating at 1.5 hours per well per event

lectricity Usage				Flootricol		Francis	
Equipment Type	НР	% Full Load	Efficiency	Rating (kW)	Hours Used	Energy Used (kWh)	Notes
							Equipment with kW rating
							Equipment with kW rating
							Direct kWh information
			Totals	0		0	

Natu	ral Gas Usage
	Equipment Typ

Useful Information
- Polyethylene tubing weight of 0.08 pounds per foot

)e	Heat Load (btu/hr)	Power Rating (btu/hr)	Effiency	Total Hours Used	Btus Required	Total Therms Used	Notes
			Totals				

Materials Usage

				Total Miles Transporte					
Material Type	Unit	Quantity	Trips	d	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
HDPE	lbs	40	1	1500	Truck Light Load (gptm)	Diesel	0.024	0.7	surrog
Potable water	gals x 1000	0.28	1	30	Truck Light Load (gptm)	Diesel	0.024	0.8	surrog
									Other
									deter
									isopro
									nitrile
									paper
									glass o

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								nitrile
Hazardous	tons								isopro
Recyclable oil	tons								event
Hauled to POTW	tons								not inc
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.28	ice and distilled water
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)	0.998679	14 sampling events, low flow sampling, 200ml/min for 1.5 hrs/well
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Discharge Location	Quantity	Activity or Notes
Discharge to surface water		
Reinjected to aquifer		
Discharge to POTW	0.998678996	discharged to Central GW Treatment Plant
Discharge to atmosphere		0.28 for ice & distilled water also discharged to POTW by lab but
Public Use		considered in lab conversion factors
Irrigation		
Industrial process water		
Other beneficial use		

Other								
Item	Quantity	Activity or Notes						
On-site HAP emissions								
On-site GHG emissions								
On-site GHG reductions								
On-site NOx reductions								
On-site SOx reductions								
On-site PM reductions								

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	252	22680
ТОС	25	224	5600
Methane, Ethane, Ethene	90	224	20160
Nitrate, Nitrite, Sulfate, Chloride	25	224	5600
Alkalinity	25	224	5600
Sulfide	10	224	2240
Ferros iron by field kit			
Other			
Other			
Other			
	Totals	1372	61880

VOCs - 15 field samples, trip blank, duplicate sample, and rinsate blank (18 total) per event for 14 events.

Others - 15 field samples, one duplicate sample (16 total) for 14 events



Notes



or latex gloves, detergent rinsate, ppyl rinsate, and < 0.5 cy soild waste per

cluded in analysis

					_		Summary											
Level	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
					_													
														1	1			
	Well													1	1			
Item	Installation	construction	Monitoring												1			Total
Labor and Travel															1			
Hours worked	384	480	672															1536
Heavy equip. operating hours	60	262	315															637
Passenger trips to site	24	21	42															87
Passenger vehicle miles	996	700	84															1780
Heavy equip. trips to site	4	3	0															7
Heavy equip. transport miles	200	1033	0															1233
Materials transport trips	7	84	2															93
Materials transport miles	2120	42000	1530															45650
Waste transport trips	1	0	0															1
Waste transport miles	1	0	0															1
															I			
Energy															L			
<u>On-site</u>															L			
Gasoline (gallons)	0	0	18.3141															18.3141
E85 (gallons)	0	0	0															0
Diesel (gallons)	222.156	2202.18	0															2424.336
B20 (gallons)	0	0	0															0
Photovoltaic (MWh)	0	0	0															0
Other Renewable 1	0	0	0															0
Other Renewable 2	0	0	0															0
															L			
<u>Off-site</u>															L			
Gasoline (gallons)	66.4	63.3	5.6															135.3
E85 (gallons)	0	0	0															0
Diesel (gallons)	41.2	6131.2	1.5															6173.9
B20 (gallons)	0	0	0													\square		0
															L			
<u>Total Fuel</u>															ļ			
Gasoline (gallons)	66.4	63.3	23.9141															153.6141
E85 (gallons)	0	0	0													+		0
Diesel (gallons)	263.356	8333.38	1.5													+		8598.236
B20 (gallons)	0	0	0													\square		0
														′				
Electricity Demand (kW)	0	0	0															0
Electricity Usage (MWh)	0	0	0													+		0
														ļ'	L	\perp		
Natural gas usage (therms)	0	0	0													\square		0
															1			

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative B2 - Permeable Reactive Barrier (P

								Summary										
Level		1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
			I	1														
		Well																
ltem		Installation	construction	Monitoring													+-+-	Total
Materials	(1)	0	0	0														-
Asphalt	(tons)	0	0	0														0
Berrow	(tons)	0.2	0	0													+	0.2
Bollow	(tons)	26	0	0													+	26
Cheese whey	(lbs)	2.0	0	0														2.0
Concrete	(tons)	17	0	0														17
Emulsified vegetable oil	(lbs)	0	0	0														0
GAC: regenerated	(lbs)	0	0	0														0
GAC: virgin coal-based	(lbs)	0	0	0														0
GAC: virgin coconut-based	(lbs)	0	0	0														0
Gravel/sand/clav	(tons)	1.2	0	0														1.2
HDPE	(lbs)	0	0	40														40
Hydrochloric acid (30%, SG = 1.18)	(lbs)	0	0	0														0
Hydrogen peroxide (50%, SG=1.19)	(lbs)	0	0	0														0
Hydroseed	(lbs)	0	0	0														0
Lime	(lbs)	0	0	0														0
Molasses	(lbs)	0	0	0														0
Nitrogen fertilizer	(lbs)	0	0	0														0
Other 1 - PV system	(W)	0	0	0														0
Other 2 - Mulch	(су)	0	0	0														0
Other 3 - acetic acid	(lbs)	0	17280	0														17280
Other 4 - guar gum	(lbs)	0	28800	0														28800
Other 5	()	0	0	0														0
Phosphorus fertilizer	(lbs)	0	0	0														0
Polymer	(lbs)	0	0	0														0
Potable water	(gals x 1000)	0.332	720	0.28														720.612
Potassium permanganate	(lbs)	0	0	0													+	0
PVC	(lbs)	367	0	0														367
Sequestering agent	(lbs)	0	0	0														0
Sodium hydroxide (20%, SG=1.22)	(Ibs)	0	0	0													+	0
Stainless steel	(IDS)	0	0	0														0
	(IDS)	216	1516000	0														1516216
Trees: root balls	(each)	0	0	0													+	0
	(eacil)	0	0	0														0
Waste																	+	
Non-bazardous		5.9	0	0														59
Hazardous		0	0	0														0
Recyclable oil		0	0	0														0
Hauled to POTW		0	0	0														0
For incineration		0	0	0														0
Water Use																		
Public water (1000 x gal.)		0.332	720	0.28														720.612
Extracted GW #1 (1000 x gals)		0.36	0	0														0.36
Extracted GW #2 (1000 x gals)		0	0	0.998678996														0.998678996
Surface water (1000 x gals)		0	0	0														0
Reclaimed water (1000 x gals)		0	0	0														0
Stormwater (1000 x gals)		0	0	0														0
				1														

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative B2 - Permeable Reactive Barrier (P

Image								Summary										
Image Number of the second secon	Level	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
Image Marcial				1				1						1		1		-
IntendInten		Well																
Water splaceWater splace </th <th>Item</th> <th>Installation</th> <th>construction</th> <th>Monitoring</th> <th></th> <th>Total</th>	Item	Installation	construction	Monitoring														Total
Discharge to surface water0.6000 </td <td>Water Discharge</td> <td></td>	Water Discharge																	
Reine do quíer0.327200<	Discharge to surface water	0.36	0	0														0.36
Dacharge b OTW000<	Reinjected to aquifer	0.332	720	0														720.332
Decknappede000	Discharge to POTW	0	0	0.998678996														0.998678996
Public UseOO	Discharge to atmosphere	0	0	0														0
Irigation00<	Public Use	0	0	0														0
Industrial process water00<	Irrigation	0	0	0														0
Other beneficial use000	Industrial process water	0	0	0														0
Image: Constraint of the state of the sta	Other beneficial use	0	0	0														0
Labordary AnalysisMMM </td <td></td>																		
Total samples001372000013720013721372Total cost000618800000618800	Laboratory Analysis																	
Total cost0061880<	Total samples	0	0	1372														1372
Image: Constraint of the system of the sy	Total cost	0	0	61880														61880
Other																		
On-site HAP emissions00	Other																	
On-site GHG emissions00	On-site HAP emissions	0	0	0														0
On-site GHG storage000<	On-site GHG emissions	0	0	0														0
On-site Nox reductions 0 0 0 0 0 0 0 0 0 0 0 On-site Sox reductions 0 <td< td=""><td>On-site GHG storage</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0</td></td<>	On-site GHG storage	0	0	0														0
On-site SOX reductions 0 <td>On-site Nox reductions</td> <td>0</td> <td>0</td> <td>0</td> <td></td> <td>0</td>	On-site Nox reductions	0	0	0														0
On-site PM reductions 0	On-site SOx reductions	0	0	0														0
	On-site PM reductions	0	0	0														0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative B2 - Permeable Reactive Barrier (P

Mode of Transport. For	Gasoline	E85	Diesel	B20
Personnel	mpg	mpg	mpg or pmpg	mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)

- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel

- Typical gasoline fuel efficiencies from from www.fueleconomy.gov

- E85 efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), *Climate Leaders Direct Emissions from Mobile Sources*

- Diesel car and truck efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources

- B20 car and truck efficiences based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and

127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov)

- Diesel airplane, bus, and train efficiences from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment	
Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov.

Fuel Type for	
Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	

Т

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considerd "other general industrial equipment".

Mode of Transport. For	rate
Materials	(mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

Lookup Table

			Default	
				One Way Site
			Distance from	Creating
			Distance from	Distance
Materiala	Linite	Conv. to tono	source to site	
Materials	Units	Conv. to tons	(miles)	(miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	су	0.54	0	30
Other 3 - acetic acid	lbs	0.0005	0	500
Other 4 - guar gum	lbs	0.0005	0	500
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

	Round-Trip Distance	
Waste Disposal Facility	(Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		

New Wells and New Well Depths

Aquifer	Number of New Wells	Depth of New Wells (ft)	Total Depth for New Wells (ft)
	2-inch w	ells	
Zone A	6	30	180
Zone B	6	60	360
Zone C	0	0	0
Total	12		540
	4-inch w	ells	_
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0
	6-inch w	ells	
Zone A	0	0	0
Zone B	0	0	0
Zone C	0	0	0
Total	0		0

Above table assumes single-cased wells.

	2-inch	4-inch	6-inch
Existing wells	0	0	0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B2 - Permeable Reactive Barrier (PRB)

Well Installation Worksheet

Well Construction Inform	nation	Units		Quantity by V	Well Size		
Well diameter		inches	2	4	6	Total	
Number of wells to install		#	12	0	0	12	
Borehole diameter		inches	6	8	10		
Total depth of all new boreholes		feet	540	0	0	540	
Total length of PVC			feet	540	0	0	540
Total length of gravel/sand pack			feet	120	0	0	120
Total length of bentonite seal			feet	24	0	0	24
Total length of cement grout from bentonite to	surface		feet	396	0	0	396
Volume of drill cuttings			су	3.9	0	0	3.9
Volume of gravel/sand for sand pack			су	0.8	0	0	0.8
Volume of bentonite for seal			су	0.2	0	0	0.2
Volume of cement grout			су	2.6	0	0	2.6
Number of flush mount covers			#	12	0	0	12
Number of bollards at wells (4 per well)			#	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	
Total mass of 2-inch PVC	0.68	lbs/ft	lbs	367.2			367.2
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				367.2
Total weight of gravel/sand	1.5	tons/cy	tons	1.2	0	0	1.2
Total dry weight of bentonite	0.92	tons/cy	tons	0.2	0	0	0.2
Total dry weight of cement grout	0.99	tons/cy	tons	2.6	0	0	2.6
Total potable water for grout	0.06	gal/lb	gals	332	0	0	332
Weight of steel for flush mount covers	18	lbs/unit	lbs	216	0	0	216
Weight of steel for bollards	50	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	216	0	0	216
Weight of concrete for flush mount covers	0.15	tons/unit	tons	2	0	0.0	1.74
Weight of concrete for bollards	0.019	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	2	0	0	1.74
Total steel for drums for disposal	63	lbs/drum	lbs	0	0	0	0
Total stain. steel for for extraction pump	0	lbs/pump	lbs	0	0	0	0
<u>Waste</u>				Waste by W	/ell Size		
Development water	30	gallons	360	0	0	360	
Development water returned to aquifer	0	gallons	0	0	0	0	
Water to POTW	0	gallons	0	0	0	0	
Total weight drill cuttings & other waste	1.5	tons/cy	tons	5.9	0	0	5.9
Weight of hazardous waste	0	% of total	tons	0	0	0	0
Weight of non-hazardous waste	0	% of total	tons	0	0	0	0
Waste characterization at \$700 per sample)			\$	0	0	0	0

Notes:

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Alternative B2 - Permeable Reactive Barrier (PRB)

Travis AFB DP039 Footprinting Analysis Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspects Remedy Conceptual Design and Assumptions: Alternative M - Long-term Monitoring

Overview

This monitoring program represents the component of the site-wide groundwater monitoring that is conducted at the DP039 location, and is the same for all remedy options. Additional performance monitoring may be conducted as part of the individual remedial options.

THIS IS NOT A MONITORED NATURAL ATTENUATION ALTERNATIVE. RATHER, IT IS THE LONG-TERM MONITORING THAT OCCURS AT THE SITE IN ASSOCIATION WITH THE VARIOUS ONGOING ACTIVE REMEDIES.

Input for Monitoring

General Scope	Typical Scope Items	
Monitor 26 wells semi-annually for water levels for 20 years		
Monitor 16 wells annually and 5 wells semi-annually for VOCs via low-flow sampling for 20 years		

Labor, Mobilizations, Mileage, and Fuel

			Hours			Roundtrip						
		Number of	Worked Per	Total Hours	Trips to	Miles to			Total Miles	Miles Per	Total Fuel	
Participant	Crew Size	Days	Day	Worked	Site	Site	Mode of Transport.	Fuel Type	Traveled	Gallon	Used	Activity or Notes
Sampling technician	2	100	10	2000	100	33	Light-Duty Truck	Gasoline	3300	15	220	based on approximately 5 wells sampled per day for two-person crew
												(includes time to conduct water level measurements)

Equipment Use, Mobilization, and Fuel Usage

			Equip. Fuel	Gallons Fuel Used per	Total Hours	Gallons Fuel Used		Roundtrip	Total Miles	Transport Fuel	Miles per	Gallons Fuel Used for	
Equipment Type	HP	Load Factor	Туре	Hour	Operated	On-Site	Trips to Site	Miles to Site	Transported	Туре	Gallon	Transport.	Activity or Notes
Generator	4	0.51	Gasoline	0.11628	780	90.6984							two 2HP generators operated 1.5-hours per sample, transported to site in truck

Electricity Usage							-	Natural Gas Usage
Equipment Type	НР	% Full Load	Efficiency	Electrical Rating (kW)	Hours Used	Energy Used (kWh)	Notes	Equipment Typ
							Equipment with kW rating	
							Equipment with kW rating	
							Direct kWh information	
			Totals	0		0		

Natural Gas Usage
Equipment Typ

Useful Information											

		Dower Dating		Total Hours	Dhua		
	пеат гоао	Power Rating		Total Hours	Blus	rotal merms	
e	(btu/hr)	(btu/hr)	Effiency	Used	Required	Used	Notes
			Totals				

Materials Usage

Material Type	Unit	Quantity	Trins	Total Miles Transporte	Mode of Transport	Fuel Type	Fuel Use Rate	Total Fuel Lise	
Potable water		0.52	11103	ů		rucriype	Tuer ose nate	Total Tuel Ose	surrogates
	gais x 1000	0.52		0					1 gallon ng
									I ganon pe
									Assume us
									Other item
									detergent
									isopropyl a
									nitrile or la
									paper tow
									glass or pla

Fuel Use Rate reported in miles per gallon (mpg) and gallons per ton-mile (gptm)

Waste Generation

				Total Miles					
Waste Type	Unit	Quantity	Round Trips	Transport.	Mode of Transport.	Fuel Type	Fuel Use Rate	Total Fuel Use	
Non-hazardous	tons								nitrile
Hazardous	tons								isopro
Recyclable oil	tons								event
Hauled to POTW	tons								not inc
For incineration	tons								

gptm = gallons per ton-mile

On-Site Water Usage

Resource Type	Quantity	Use of Resource
Public water (1000 x gals)	0.52	
Extracted GW #1 (1000 x gals)		
Extracted GW #2 (1000 x gals)	2.5	20 sampling events, low flow sampling, 200ml/min for 1.5 hrs/well
Surface water (1000 x gals)		
Reclaimed water (1000 x gals)		
Stormwater (1000 x gals)		
Water table drawdown (ft)		

Fate of On-Site Water Usage (1000 x gals)											
Discharge Location	Quantity	Activity or Notes									
Discharge to surface water	2.5	to surface water via central treatment plant									
Reinjected to aquifer											
Discharge to POTW		0.52 for ice and water discharged to POTW by lab but considered in									
Discharge to atmosphere		lab conversion factors									
Public Use											
Irrigation											
Industrial process water											
Other beneficial use											

Other			
Item	Quantity	Activity or Notes	
On-site HAP emissions			
On-site GHG emissions			
On-site GHG reductions			
On-site NOx reductions			
On-site SOx reductions			
On-site PM reductions			

On-Site Renewable Energy Generation

Item	Quantity	Activity or Notes
Photovoltaic (kWh)		
Other 1		
Other 2		

Notes
gate for ice and decon water
on per well, carried in technician truck
ne use of dedicated tubing/pumps
items not included
gent (0.1 gallons per event)
pyl alcohol (0.1 gal/event)
or latex gloves (15 pairs per event)
towels and plastic bags for storing
or plastic sample bottles

Laboratory Analysis			
		Number	
		of	
Parameter and Notes	Unit Cost	Samples	Total Cost
VOCs	90	720	64800
тос			
Methane, Ethane, Ethene			
Nitrate, Nitrite, Sulfate, Chloride			
Alkalinity			
Sulfide			
Ferros iron by field kit			
Other			
Other			
Other			
	Totals	720	64800

One event of 21 field samples (16+5) plus 5 trip blanks, field blank, and duplicate. Another event with 5 samples plus 1 trip blank plus duplicate plus field blank.

Notes

or latex gloves, detergent rinsate, ppyl rinsate, and < 0.5 cy soild waste per

cluded in analysis

							Summary										
Level	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																	,
Item	Monitoring																Total
Labor and Travel																	
Hours worked	2000																2000
Heavy equip. operating hours	780																780
Passenger trips to site	100																100
Passenger vehicle miles	3300																3300
Heavy equip. trips to site	0																0
Heavy equip. transport miles	0																0
Materials transport trips	0																0
Materials transport miles	0																0
Waste transport trips	0																0
Waste transport miles	0																0
Energy																	
<u>On-site</u>																	
Gasoline (gallons)	90.6984																90.6984
E85 (gallons)	0																0
Diesel (gallons)	0																0
B20 (gallons)	0																0
Photovoltaic (MWh)	0																0
Other Renewable 1	0																0
Other Renewable 2	0																0
<u>Off-site</u>																	
Gasoline (gallons)	220																220
E85 (gallons)	0																0
Diesel (gallons)	0																0
B20 (gallons)	0																0
Total Fuel																	
Gasoline (gallons)	310.6984																310.6984
E85 (gallons)	0																0
Diesel (gallons)	0																0
B20 (gallons)	0																0
Electricity Demand (kW)	0																0
Electricity Usage (MWh)	0																0
Natural gas usage (therms)	0																0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative M - Long-term Monitor

	Summary																	
Level		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
				-						-				-				
Item		Monitoring																Total
Materials																		
Asphalt	(tons)	0																0
Bentonite	(tons)	0																0
Borrow	(tons)	0																0
Cement	(tons)	0																0
Cheese whey	(lbs)	0																0
Concrete	(tons)	0																0
Emulsified vegetable oil	(lbs)	0																0
GAC: regenerated	(lbs)	0																0
GAC: virgin coal-based	(lbs)	0		_														0
GAC: virgin coconut-based	(lbs)	0		_														0
Gravel/sand/clay	(tons)	0		_														0
HDPE	(lbs)	0																0
Hydrochloric acid (30%, SG = 1.18)	(lbs)	0																0
Hydrogen peroxide (50%, SG=1.19)	(lbs)	0		_														0
Hydroseed	(lbs)	0		_														0
Lime	(lbs)	0		_														0
Molasses	(lbs)	0		_														0
Nitrogen fertilizer	(lbs)	0																0
Other 1 - PV system	(W)	0																0
Other 2 - Mulch	(cy)	0																0
Other 3	()	0																0
Other 4	()	0		_														0
Other 5	()	0		_														0
Phosphorus fertilizer	(lbs)	0																0
Polymer	(lbs)	0																0
Potable water	(gals x 1000)	0.52																0.52
Potassium permanganate	(lbs)	0		_														0
PVC	(lbs)	0		_														0
Sequestering agent	(lbs)	0		_														0
Sodium hydroxide (20%, SG=1.22)	(lbs)	0																0
Stainless steel	(lbs)	0																0
Steel	(lbs)	0																0
Trees: root balls	(each)	0		_														0
Trees: whips	(each)	0																0
Waste		-																
Non-hazardous		0		-									-	-				0
Hazardous		0																0
Recyclable oil		0		-									-					0
Hauled to POTW		0		_									-					0
For incineration		0																0
														+			+ $+$	
water Use																		
Public water (1000 x gal.)		0.52																0.52
Extracted GW #1 (1000 x gals)		0																0
Extracted GW #2 (1000 x gals)		2.5																2.5
Surface water (1000 x gals)		0																0
Reclaimed water (1000 x gals)		0																0
Stormwater (1000 x gals)		0																0
															1			

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative M - Long-term Monitor

Summary																	
Level	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0	
			1	T	1	1	1	T			1	Г	1	1	1	<u> </u>	_
ltem	Monitoring																Total
Water Discharge																	
Discharge to surface water	2.5																2.5
Reinjected to aquifer	0																0
Discharge to POTW	0																0
Discharge to atmosphere	0																0
Public Use	0																0
Irrigation	0																0
Industrial process water	0																0
Other beneficial use	0																0
Laboratory Analysis																	
Total samples	720																720
Total cost	64800																64800
Other																	
On-site HAP emissions	0																0
On-site GHG emissions	0																0
On-site GHG storage	0																0
On-site Nov reductions	0																0
On-site SOx reductions	0																0
On-site PM reductions	0																0

Green Remediation - Inventory of Energy, Material, Waste, and Other Remedy Aspe Alternative M - Long-term Monitor

Mode of Transport. For	Gasoline	E85	Diesel	B20
Personnel	mpg	mpg	mpg or pmpg	mpg
Airplane	ERROR	ERROR	44.7	ERROR
Bus	ERROR	ERROR	95.6	ERROR
Car	20	14.6	22.3	20.6
Heavy-Duty Truck	10	7.3	11.2	10.3
Light-Duty Truck	15	10.95	16.7	15.4
Train	ERROR	ERROR	59.1	ERROR
Vehicle (other)	NO DATA	NO DATA	NO DATA	NO DATA

- Fuel usage for buses, airplanes, and trains are for passenger miles per gallon (pmpg)

- Airplane/jet fuel calculated as diesel for simplicity and due to similarities between kerosene and diesel

- Typical gasoline fuel efficiencies from from www.fueleconomy.gov

- E85 efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 3.539 for (ethanol), Climate Leaders Direct Emissions from Mobile Sources

- Diesel car and truck efficiences based on higher heating values (mmBtu per barrel) of 5.218 mmBtu (gasoline) and 5.825 for (diesel), Climate Leaders Direct Emissions from Mobile Sources

- B20 car and truck efficiences based on higher heating values of 5.825 mmBtu per barrel (diesel, Climate Leaders) and

127,960 btu per gallon (biodiesel, Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov)

- Diesel airplane, bus, and train efficiences from converting average CO2 emissions Climate Leaders from Commuting, Business Travel and Product Transport to diesel usage assuming 22.5 lbs of CO2 per gallon of diesel.

Fuel Type for Equipment	
Transport	mpg
B20	7.09
Diesel	7.2

B20 efficiency based on higher heating value of 127,960 btu per gallon for biodiesel (Alternative Fuels & Advanced Vehicles Data Center, www.afdc.energy.gov.

Fuel Type for	
Equip. Use	Gals. per HP-hr
B20	0.052
Diesel	0.051
E85	0.078
Gasoline	0.057

Fuel consumption based on thermal efficiency of 36% for diesel and 38% for gasoline.

Loo	kup	Tab	le

Equipment Type	Default Load	Typical HP
Asphalt paver	0.62	
Backhoe	0.57	
Concrete paving machine	0.53	
Dozer (large)	0.55	
Dozer (small)	0.55	
Drilling - direct push	0.75	
Drilling - large rig (e.g., CME-75)	0.75	
Drilling - medium rig (e.g., CME-55)	0.75	
Dump truck	0.57	
Excavator (large)	0.57	
Excavator (medium)	0.57	
Excavator/hoe (small)	0.57	
Generator	0.51	
Grader	0.61	
Grout pump	0.51	
Hydroseeder	0.62	
Integrated tool carrier	0.43	
Loader	0.55	
Loader (small)	0.55	
Mobile laboratory	0.5	
Mowers	0.6	
Other	0.5	
Riding trencher	0.75	
Roller	0.56	
Rotary-screw air compressor (250 cfm)	0.48	
Skid-steer (small)	0.55	
Telescopic handler	0.43	
Tractor mower	0.6	
Water truck	0.57	
Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2		

Default equipment loads obtained from Road Construction Emissions Model Version 6.3.2, Sacramento Air Quality Management District. Generators and grout pumps considerd "other general industrial equipment".

Mode of Transport. For rate	
Materials	(mpg or gptm)
Train (gptm)	0.0024
Truck A (< 5 tons)	8.5
Truck B (5-15 tons)	7.2
Truck C (15+ tons)	5.92
Truck Heavy Load (gptm)	0.011
Truck Light Load (gptm)	0.024

mpg = miles per gallon, gptm = gallons per ton-mile

Rail fuel usage from Climate Leaders, Direct Emissions from Mobile Sources Truck usages from Climate Leaders, Direct Emissions from Mobil Sources and Effects of Payload on the Fuel Consumption of Trucks, Dept. for Transportation (Great Britain), December 2007. Truck heavy load based on Truck C carrying 15 tons. Truck light load based on Truck A carrying 5 tons.

			Default	
			One-Way	One-Way Site
			Distance from	Specific
			Source to Site	Distance
Materials	Units	Conv. to tons	(miles)	(miles)
Asphalt	tons	1	30	
Bentonite	tons	1	1000	
Borrow	tons	1	30	
Cement	tons	1	30	
Cheese whey	lbs	0.0005	1000	
Concrete	tons	1	30	
Emulsified vegetable oil	lbs	0.0005	1000	
GAC: regenerated	lbs	0.0005	1000	
GAC: virgin coal-based	lbs	0.0005	1000	
GAC: virgin coconut-based	lbs	0.0005	1000	
Gravel/sand/clay	tons	1	30	
HDPE	lbs	0.0005	1,500	
Hydrochloric acid (30%, SG = 1.18)	lbs	0.0005	500	
Hydrogen peroxide (50%, SG=1.19)	lbs	0.0005	500	
Hydroseed	lbs	0.0005	500	
Lime	lbs	0.0005	500	
Molasses	lbs	0.0005	500	
Nitrogen fertilizer	lbs	0.0005	500	
Other 1 - PV system	W	0.000125	0	1000
Other 2 - Mulch	су	0.54	0	30
Other 3			0	
Other 4			0	
Other 5			0	
Phosphorus fertilizer	lbs	0.0005	500	
Polymer	lbs	0.0005	1000	
Potable water	gals x 1000	4.17	30	
Potassium permanganate	lbs	0.0005	1400	
PVC	lbs	0.0005	500	
Sequestering agent	lbs	0.0005	1000	
Sodium hydroxide (20%, SG=1.22)	lbs	0.0005	500	
Stainless steel	lbs	0.0005	500	
Steel	lbs	0.0005	500	
Trees: root balls	each	NA	500	
Trees: whips	each	NA	1000	

Miles are one-way miles. In most cases a empty initial or return trip needs to be added.

Miles should be from manufacturer to supplier to site.

	Round-Trip Distance	
Waste Disposal Facility	(Miles)	Name or Type of Facility
Non-hazardous - Local landfill	1	On-site stockpile
Hazardous	520	Clean Harbors Buttonwillow, California
Recyclable Oil		
Hauled to POTW		
For incineration		