Kennedy Jenks

November 21, 2023

Technical Memorandum

To: Mr. Dale Myers, Washington State Department of Ecology

From: Cayla Whiteside, Ryan Hultgren

Site: Circle K 1461, 2350 24th Avenue East, Seattle, Washington

Subject: Engineering Design Report Addendum, Contract C2100069
KJ 2196008.00

This Technical Memorandum presents Kennedy/Jenks Consultants, Inc.'s (Kennedy Jenks) addendum to the Engineering Design Report (EDR) referenced in the State of Washington, Department of Ecology (Ecology) Contract C2100069, Appendix C, Statement of Services, Task 2B Engineering Design Report, Item c. A final EDR report was submitted to Ecology on 10 December 2021 following comments provided by Ecology as part of this contract. The following addendum includes updated cost estimations for further comparison of cleanup alternatives.

The Circle K 1461 Site (site) is a former gasoline service station that operated from 1968 to 1990. The site is located at 2350 24th Avenue East in Seattle, Washington (Figure 1), on the southeastern corner of the intersection of 24th Avenue East and East McGraw Street. Four gasoline underground storage tanks (USTs), one pump island, one waste oil UST, and one heating oil UST were formerly located at the site (Figure 2). The site was redeveloped in 1990 and 1991, and two businesses currently operate at the site. The USTs were removed during redevelopment, and additional remedial and investigation actions were conducted at the site between 1989 and 2017. Residual petroleum hydrocarbons are present at the site in soil and groundwater. The primary contaminants of concern (COCs) in soil and groundwater are gasoline range organics (GRO) and benzene, toluene, ethylbenzene, and xylenes (BTEX).

The remedial alternative selected in the 2017 Remedial Investigation/Feasibility Study (RI/FS) and Cleanup Action Plan (CAP) was a combination of *in situ* bioremediation through a groundwater recirculation system with injection of bioaugmentation reagents for the treatment of groundwater and saturated soils, and a soil vapor extraction (SVE) system to address hydrocarbons in vadose zone soils, as well as the mitigation of potential vapor intrusion (VI). As part of the data gaps process and alternatives analysis completed during pre-design, an alternative process option of multiple phase extraction (MPE) coupled with *in situ* bioremediation was identified and chosen. Similar to SVE, MPE addresses residual hydrocarbon contamination of the vadose zone and can also be designed to protect against VI.

Comparison of Cleanup Alternatives

Both the remedial option detailed in the RI/FS and CAP (SVE and groundwater recirculation) and an MPE system would extract petroleum hydrocarbon-impacted soil vapor and groundwater from the subsurface for treatment, but they differ in the methods and level of vacuum applied to subsurface media. The primary difference is that with an MPE system, higher vacuums are induced and both groundwater and soil vapor are extracted through the same system.

The Existing Project Data Review and Design Data Gap Analysis (DGA) included as Appendix A to the EDR, included a discussion of previous remedial actions and pilot tests conducted at the site. A free product recovery, groundwater treatment, and vapor extraction system were installed at the site prior to 6 December 1989 by Chemical Processors, Inc., Environmental Services Division. Though SVE was a component of this system, operational details from this system are not expected to be representative of SVE conditions throughout the site as the former SVE system was installed within the UST excavation backfill.

Based on previous conversations with Ecology, an SVE pilot study was not able to be performed due to contracting and schedule issues. In lieu of performing a pilot study, an SVE system could be designed with the limited existing data but would need to utilize relatively conservative estimates of design parameters including, but not limited to, extraction well radius of influence (ROI), extraction vacuum and volumetric flow rate, and vapor mass loading. Groundwater is shallow across the site which limits the vacuum that can be applied without removal of significant volumes of water. A conservative approach for SVE system design would include installing additional extraction wells and associated subsurface piping and infrastructure for treating extracted vapor, resulting in increased system installation, operation, and maintenance costs.

The multiphase fluid recovery pilot test conducted in 2005 by Eco-Vac Services, Inc. of Woodstock, Georgia, provided data including vapor extraction rates, induced vacuum ROI, vapor mass loading, and total volumes of removed liquids, which can be used to design an MPE system for the site.

SVE with Groundwater Recirculation - Remedial Alternative 1 (RA1)

The SVE with groundwater recirculation component of the remedial design would begin with the construction of several onsite remediation wells (estimate of 17 new wells) to supplement existing multipurpose remediation/monitoring wells (estimate of 7 wells). The estimated 24 remediation wells and would be connected to the treatment system equipment. Twelve (12) of the wells would function as SVE wells and be connected via subsurface piping to above ground blower/vapor treatment equipment. The other twelve (12) wells would function as groundwater

recirculation injection/extraction wells and be connected via subsurface piping to the groundwater injection equipment. The number of wells is based on an estimated ROI of 30 feet.

The SVE component of the system would be operated for approximately 2 years, until evaluation of extracted vapor monitoring results indicates that the concentration of volatile petroleum hydrocarbons (measured as GRO and BTEX) in soil gas has declined appreciably, and the VI pathway is no longer a potentially complete exposure pathway. After initial operation of the SVE system and removal of adequate GRO and BTEX from soil that could partition into soil vapor, further operation of SVE system may be periodic (i.e., pulsed) to help optimize its performance.

Following operation of the SVE system, the groundwater recirculation phase of remediation would begin. The initial step includes injection of a low-concentration surfactant solution to increase petroleum hydrocarbon recovery rates. This step would be followed by injection and recirculation of a combination of extracted groundwater and amendments (i.e., a cultured bacteria consortium of petroleum-degrading bacteria and macronutrients) into the target cleanup area to stimulate biodegradation of GRO and BTEX in the saturated zone (including smear zone soils). Groundwater recirculation operation is estimated to take approximately 5 years.

Operation of the SVE system followed by groundwater recirculation is estimated to occur for a total of approximately 7 years.

MPE - Remedial Alternative 2 (RA2)

As part of the MPE system installation, a combination of vertical and slanted (angled) wells would be installed (estimate of 6 total wells) at locations identified as most likely to reduce the concentrations of the contaminants of concern. Several existing remediation/monitoring wells (estimate of 7) would also be connected to the treatment system equipment. Monitoring and potential mitigation of sub-slab vapor concentrations would be achieved by installing sub-slab depressurization wells and vapor monitoring points in and around the existing onsite structures. Soil vapor and extracted groundwater would be treated by carbon adsorption using granular activated carbon (GAC) with a provision for the use of a thermal oxidizer to treat vapors during the startup phase of the project. An ROI of 20 feet was estimated for vapor and an ROI of 30 feet was estimated for groundwater.

Groundwater initially extracted from the system is expected to be discharged after treatment with GAC to the sanitary sewer. Once groundwater concentrations become nearly asymptotic and carbon usage has stabilized, surfactants would be used to increase hydrocarbon recovery rates. A few months after surfactant treatment has begun, bioremediation treatment would be implemented. This includes treating recovered groundwater with GAC, and adding oxygen

and/or other electron acceptors, petroleum-degrading bacteria, and nutrients before reinjecting amended groundwater. MPE operation is expected to take approximately 5.5 years.

Cost Comparison

The design differences in the two remedial approaches discussed above produce differences in overall system costs, a main factor considered in the pre-design and design processes. Overall costs are influenced most heavily by components such as materials for extraction and injection well installations, groundwater amendments, and sampling effort. These differences are primarily driven by the difference in total number of remediation wells (24 wells for RA1 compared to 13 wells for RA2) and system operation time (7 years for RA1 versus 5.5 for RA2). Itemized cost estimate tables are presented in Attachments A and B. The following table provides a summary of the system construction cost, long-term operations and maintenance (O&M) costs, and total projected cost per remedial alternative.

	RA1 - SVE with Groundwater Recirculation	RA2 - MPE
System Construction Cost	$1,032,000	$813,200
Long-Term O&M Cost	$2,438,800	$2,381,500
Total Estimate*	$5,576,000	$5,146,000

*Total estimate includes construction report, O&M manuals, project coordination, and Washington state sales tax. Total estimate also includes the following scaling factors: Division 1 costs, contractor markup for subcontractors, contractor overhead and profit, estimate contingency, and escalation to the midpoint of construction.

The costs presented in this addendum include the following additions from the 2021 EDR: confirmation monitoring for both soil and groundwater, groundwater circulation system components and O&M (considered separately from SVE-related costs), and detailed planned reporting requirements and frequency.

The following line items were updated from the 2021 EDR to reflect current costs: remediation system operation costs (i.e., updated estimates for groundwater amendments), estimated effort and frequency for O&M activities, and sample quantity and lab analysis cost.

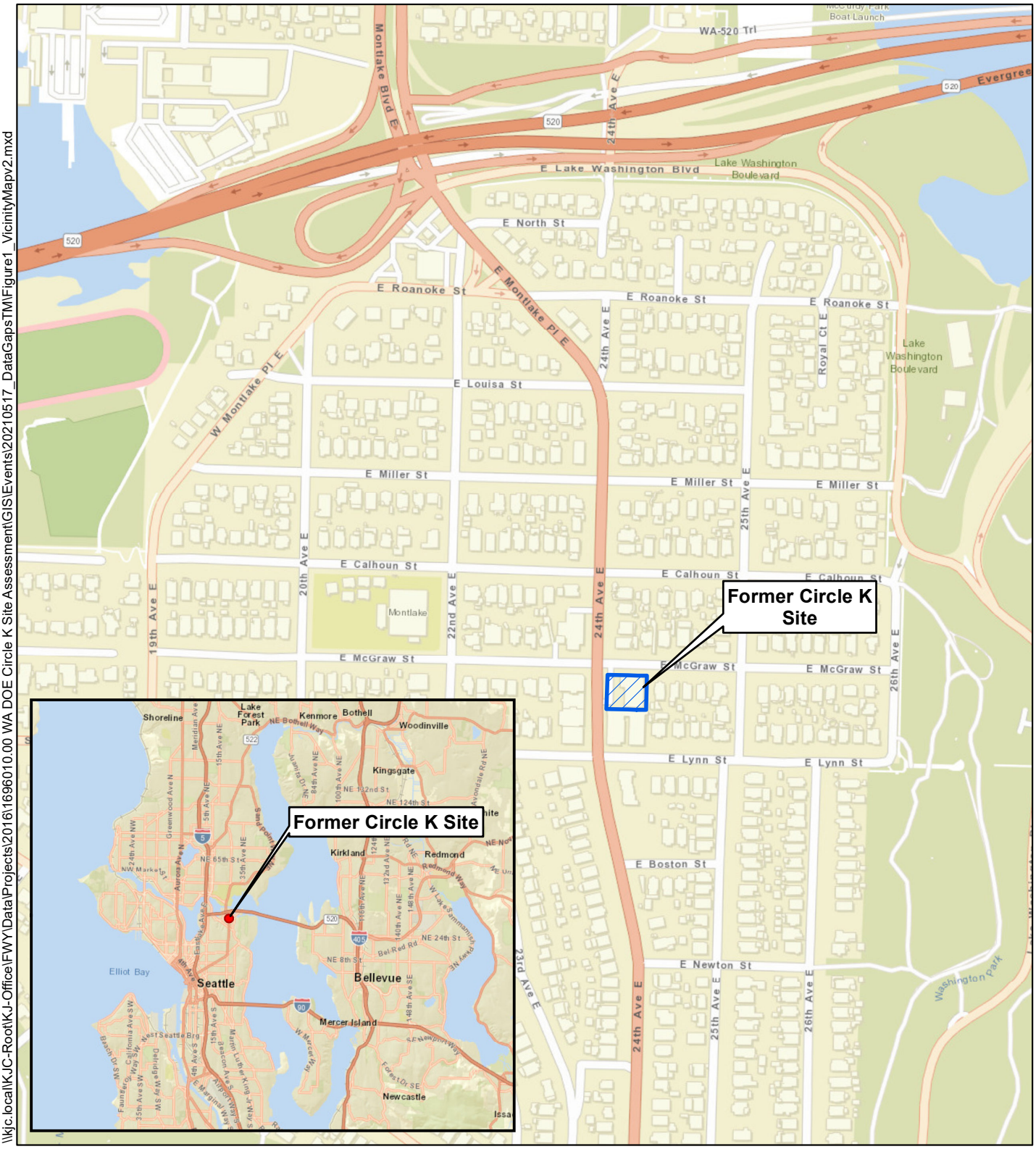
Alternatives Analysis and Chosen System

The alternatives analysis (Attachment C) conducted for the two systems indicates that MPE is the recommended alternative. The current benefit to cost ratio is greater for the installation of an MPE system, which has a lower probable cost by approximately $430,000. Factors including

additional infrastructure and a longer operation timeline increase the probable cost of the SVE with groundwater recirculation alternative, causing it to be less practical than an MPE system.

Attachments:
Figure 1: Site Location and Vicinity Map
Figure 2: Historical Site Features and Monitoring Well Locations
Attachment A: Opinion of Probable Construction Cost Table– SVE System with Groundwater Recirculation
Attachment B: Opinion of Probable Construction Cost Table – MPE System
Attachment C: Alternatives Analysis of SVE + Groundwater Recirculation vs. MPE

Figures



\\kjc.local\KJC-Root\KJ-Office\FWY\Data\Projects\2016\1696010.00 WA DOE Circle K Site Assessment\GIS\Events\20210517_DataGapsTM\Figure1_VicinityMapv2.mxd

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors,

Legend

Site Location

N

0 200 400

Scale: Feet

Note:
1. All locations are approximate.

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Former Circle K Site
Seattle, Washington

Site Location and Vicinity Map

K/J 2196008*00

Figure 1

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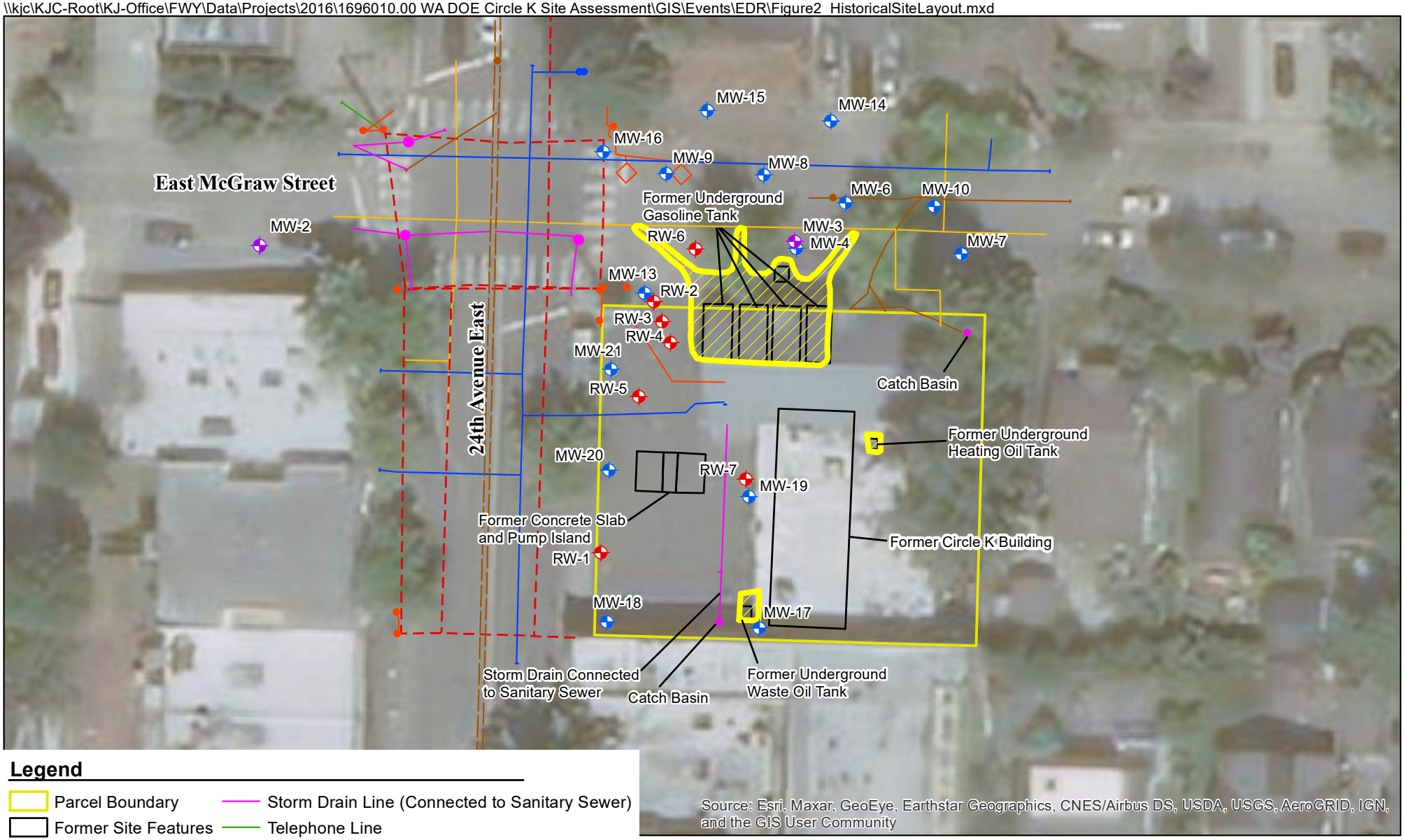

Legend

- Parcel Boundary
- Former Site Features
- Previous Excavations
- Monitoring Well
- Landau Well
- Multipurpose Wells
- Storm Drain Line (Connected to Sanitary Sewer)
- Telephone Line
- Power Line
- Gas Line
- Overhead Power Line
- Sanitary Sewer Line
- Water Line
- 90" RCP Sanitary Sewer Line

Notes:

1. All locations are approximate.
2. Sewer and water line locations are based on available site information and not appropriate for construction purposes.
3. Former feature locations georeferenced from *Report of Geotechnical Services Subsurface Contamination Study and Remedial Action Monitoring Circle K Facility 1461 Seattle, Washington*, dated 6 March 1990 by GeoEngineers.

N

0 20 40

Scale: Feet

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Former Circle K Site
Seattle, Washington

Historical Site Features, Monitoring Wells and Soil Boring Locations

K/J 2196008*00

Figure 2

Attachment A

ATTACHMENT A

OPINION OF PROBABLE CONSTRUCTION COST

KENNEDY/JENKS CONSULTANTS, INC.

Project: Circle K 1461

Selected Alternative Soil Vapor Extraction (SVE) System with Groundwater Recirculation

Prepared By: CMW
Date Prepared: 11/21/2023
KJ Proj. No. 2196008*00

Current at ENR
Escalated to ENR
Months to Midpoint of Construct 16

Estimate Type:
- ☐ **Conceptual**
- ☒ **Preliminary (w/o plans)**
- ☐ **Design Development @** ____ **% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source and Notes
Preliminary Activities												
		Permitting										
	1	General Demolition/Grading/Construction	1	ls	10,000	10,000					10,000	
	2	Air Discharge	1	ls	0	0					0	
	3	Construction	1	ls	20,000	20,000					20,000	
	4	Sewer Discharge	1	ls	16,500	16,500					16,500	Sewer connection for water disposal.
	5	Electrical Permit	1	ls	1,000	1,000					1,000	No plans reviewed, less than 500 amps.
		SUBTOTAL									**47,500**	
SVE and Groundwater Recirculation System Construction												
	1	Mobilization/Demobilization	1	ls			64,437	64,437			64,437	8% of construction capital cost.
	2	Private Utility Locate	1	ls			2,000	2,000			2,000	
	3	Power Drop/Electrical - New	1	ls	5,000	5,000					5,000	For 200 amp power drop.
		New Extraction and Injection Well Installation	**17**	well								17 new wells. Connection to 7 existing wells. System comprised of 12 extraction and 12 injection wells.
	4	Mob/Demob Auger and Air-Knife	1	ls	5,000	5,000					5,000	Well install costs from Cascade Drilling Quote 9/10/20. For large rig and distant site, likely conservative.
	5	Auger and Support Truck and Air-Knife	10	day	4,500	45,000					45,000	Assumes 10 days to install 17 wells. $3,500/day Auger, $200/day support truck, $800/day Air-knife.
	6	Well Materials (screens)	340	feet	24	8,160					8,160	4" wells
	7	Vaults/Well Head Appurtenances	17	ea	675	11,475					11,475	Flush monuments and tie-ins to headers.
	8	Drums	87	drum	140	12,180					12,180	4 soil drums + 1 water drum per well + 2 decon drum. 55-gal DOT Drum for IDW
	9	Investigation-Derived Waste (IDW) Soil Transport and Disposal	68	drum	195	13,260					13,260	Soil cuttings
	10	Investigation-Derived Waste (IDW) Water Transport and Disposal	19	drum	185	3,515					3,515	Decontamination and development water
	11	Mob/Demob Development	1	ls	3,000	3,000					3,000	
	12	Development	17	ea	350	5,950					5,950	Estimate 2 hours per well
		Earthwork										
	13	Saw Cut existing pavement (4 to 6" depth)	2,160	lf			2	4,320			4,320	To connect 24 wells.
	14	Demo and Remove Existing Pavement (4" thickness)	720	sy			16	11,520			11,520	3' average width of trench.
	15	Haul and Dispose Pavement	157	ton	10	1,566	10	1,566			3,132	145 lb/cf density assumed.
	16	Excavation (landfill disposal)	960	cy			3	2,880			2,880	5' average depth of trench.
	17	Hauling Excavated Clean Material	1,620	ton	5	8,100	6	9,720			17,820	Hauling from site to landfill, 1.35 and 1.25 factors applied.
	18	Waste Profiling for Landfill Disposal	30	sample	35	1,050					1,050	Need to analyze for TPH, BTEX, Lead. Assumes 10 samples analyzed for 3 constituents.
	19	Landfill Disposal	1	ls	58,680	58,680					58,680	ACT Enviro: 20 RO bins for 10 days each for non-haz waste in Subtitle D landfill facility in Seattle.
	20	Imported Backfill (material and transport)	1,555	ton	25	38,880					38,880	Imported fill. Includes 20% compaction factor in quantity estimate.
	21	Placement and Compaction (imported fill)	1,152	cy			10	11,520			11,520	Includes 20% compaction factor
	22	CSBC Pavement Subgrade (6" thick)	720	sy	8	5,760	2	1,440			7,200	
	23	Asphalt Concrete Pavement (4" thick)	157	ton					100	15,660	15,660	
		Transfer System										
	24	Piping (Ex/Inj and SSD wells to treatment system)	2,592	lf	5	12,960					12,960	2" Schedule 80 PVC, same length as trenching with 20% increase
	25	Transfer Pumps	3	ea	665	1,995					1,995	From MSC direct. 230V, 3 Phase, 1 HP, Self Priming Cast Iron Centrifugal Pump
		Vapor Protection and Monitoring System										
	26	Sub-Slab Depressurization Wells	3	ea	500	1,500					1,500	3' wide, 6' long, 4' deep trench assumed. Replacement of paving.
	27	Manifold	1	ea	2,500	2,500					2,500	4" manifold with (3) 2" legs.
	28	Vapor Pins	4	ea	200	800					800	Vapor pins and estimate of installation cost.
		Vapor Treatment System										
	29	Catalytic Oxidizer	6	mo	3,900	23,400					23,400	Falmouth Electric Oxidizer, Quote via Gasho 6/25/21. $3,900/month for 3-6 months.
	32	Vapor GAC	2	ea	8,744	17,487					17,487	2000lb x 2. Quote from Evoqua 6/18/21. Shipping, tax not included.
	33	SVE Treatment Shed, Manifold, Blower, and appurtenances	1	ls	109,665	109,665					109,665	Includes shed, manifold, knockout tank, heat exchanger, pump, blower, control panel. Gasho quote, 6/25/21.
	36	Chain-Link Fence	40	LF	23	927	4	159	1	41	1,127	From RS Means data
		Groundwater Recirculation System										
	37	Surfactants	400	gal	50	20,000					20,000	Initial costs, $18000 + $2000 shipping. 2/23 quote from ETEC
	38	Nutrients & Bacteria (+electron acceptors)	1	ls	9,200	9,200					9,200	Initial costs, $9200, includes $650 S&H for all ETEC products. 2/23 quote from ETEC
	40	Super-Ox 10-C	1	ls	4,000	4,000					4,000	initial, 2/23 quote from ETEC
	41	Shipping (to and return)	1	ls	3,650	3,650					3,650	Initial shipping and demobilization of equipment ETEC quote 2/23 (initial equipment, demob, surfactant 6 mo.)
	42	Installation/set-up/training (5 days)	1	ls	10,000	10,000					10,000	Initial costs, ETEC 5 Year Proposal, 6/5/17.
	35	400 gal Storage Tank - Pre GAC Treatment	1	ea	512	512					512	From ntotank.com
	43	Liquid GAC	4	ea	500	2,000					2,000	
	44	Batch/Mixing Tank	1	ls	500	500					500	300 gal.
	45	Mixer, Injection Pump, Controls	1	ls	4,000	4,000					4,000	Based on installation of similar system.
	46	Groundwater Recovery Pumps	1	ls	50,000	50,000					50,000	Running electrical conduit and wire to each well, placing recovery pumps near the bottom of each well
	47	System Installation	65	day			4,000	260,000			260,000	Estimate of 13 weeks, 5 days/week.
	48	Consultant Labor	65	day			1,500	97,500			97,500	Engineer ($150/hr) at 10 hrs/day for system install
		SUBTOTAL									**984,435**	
										Preliminary Activities + SVE and Groundwater Recirculation System Construction	**1,032,000**	

ATTACHMENT A

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Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source and Notes
Long-Term and Operations & Maintenance Costs												
	1	SVE System O&M (Labor and Instruments)	104	weeks	734	76,336	1,034	107,536	23	6,600	190,472	General contractor labor, equipment, replacement equipment, field measurements, system inspections, etc.
	2	Groundwater Recirculation System O&M (Labor & Instruments)	260	weeks	1,060	275,600	1,850	481,000			756,600	General contractor labor, equipment, replacement equipment, field measurements, system inspections, etc.
		Chemical Replacements										
	3	Vapor Carbon	13	event	7,000	91,000					91,000	Assumes non-hazardous disposal
	4	Liquid GAC Vessel	31	event	600	18,600					18,600	
	5	Bacteria & Nutrients	53	months	3,930	208,290					208,290	10/400 gal supply. Assumes injection starts after 3 months of operation. Includes S&H
	6	Super-Ox 10-C	59	months	4,000	236,000					236,000	Monthly rental cost, includes shipping ($200).
		Vapor Sampling and Chemical Analysis										
	7	Consultant Labor - Vapor Sampling	13	events			4,000	52,000			52,000	Startup, monthly for 6 months, then quarterly for 2 years
	8	VOCs	60	sample	200	12,000					12,000	Bi-monthly inf. and eff. vapor samples for VOCs. 6 events/year, 5 samples/event. $200/event.
	9	Investigation-Derived Condensate Water Handling/Disposal	2	events	1,500	3,000					3,000	1 disposal event per condensate removal event (annual)
		Groundwater Treatment Sampling and Chemical Analysis										
	10	Consultant Labor and Equipment - Treatment System	60	events	450		1,350	81,000			81,000	Monthly. Influent, midpoint, and effluent of each liquid GAC vessel train
	11	TPH-Gasoline	180	sample	63	11,340					11,340	
	12	BTEX	180	sample	80	14,400					14,400	
	13	Nitrate & Orthophosphate	10	sample	75	750					750	
		Compliance Groundwater Monitoring and Chemical Analysis										
	14	Consultant Labor and Equipment - Groundwater Monitoring	20	events			7,800	156,000			156,000	Quarterly
	15	TPH-Gasoline	480	sample	63	30,240					30,240	24 wells
	16	BTEX	480	sample	80	38,400					38,400	24 wells
	17	Nitrate & Orthophosphate	320	sample	75	24,000					24,000	16 wells
	18	Investigation-Derived Groundwater Handling/Disposal	20	events	1,500	30,000					30,000	Quarterly
		Confirmation Soil Sampling and Groundwater Monitoring and Chemical Analyses - Post Treatment System Shutdown										
	19	Consultant Labor and Equipment - Soil Sampling	1	events			6,800	6,800			6,800	Following remedial system operation, 8 temporary borings to 20 ft. for confirmation soil sampling
	20	TPH-Gasoline	23	sample	50	1,150					1,150	
	21	BTEX	23	sample	140	3,220					3,220	
	22	Consultant Labor and Equipment - Groundwater Sampling	10	events			7,800	78,000			78,000	2.5 years of quarterly monitoring
	23	TPH-Gasoline (Groundwater Samples)	160	sample	63	10,080					10,080	
	24	BTEX (Groundwater Samples)	160	sample	80	12,800					12,800	
	25	MNA Parameters (Groundwater Samples)	18	sample	300	5,400					5,400	
	26	Investigation-Derived Groundwater Handling/Disposal	10	events	1,500	15,000					15,000	
		Reporting										
	27	Monthly Progress Summary and Monthly Update Calls	114	report			500	57,000			57,000	Monthly for 7 yrs operation, 2.5 yrs confirmation monitoring
	28	Monthly Remedial Progress Evaluation Reports	6	report			3,750	22,500			22,500	Monthly for 6 months
	29	Quarterly Remedial Progress Evaluation Reports	26	report			6,000	156,000			156,000	
	30	Annual Remedial Progress Evaluation Reports	10	report			9,000	85,500			85,500	7 yrs operation, 2.5 yrs confirmation monitoring (10 reports)
	31	Quarterly EIM Data Uploads	26	report			1,200	31,200			31,200	
		SUBTOTAL									**2,438,742**	
Other												
	1	Construction Report	1	report	15,000	15,000					15,000	Includes as-built drawings. Based on contract amount.
	2	O&M Manuals (SVE System)	1	report	40,000	40,000					40,000	Based on contract amount.
	3	Project Coordination	7	years			6,000	42,000			42,000	
	4	Washington State Sales Tax	10.25%	per	106,611.80	10,928					10,928	10.25% of construction capital cost (materials) and chemical replacement costs (materials)
		SUBTOTAL									**107,928**	
		Subtotals				1,732,706		1,823,597		22,301	3,578,605	3,578,605
		Division 1 Costs	@	10%		173,271		182,360		2,230	357,860	
		Contractor Markup for Sub	@	10%						2,453	2,453	
		Contractor OH&P	@	15%		285,896		300,894			586,790	
		Estimate Contingency	@	20%							905,142	
		Escalate to Midpoint of Construct	@	2%							144,823	
		Estimated Bid Cost									5,575,673	
		Total Estimate									5,576,000	

Notes:
1. Based on operation of SVE system with weekly O&M, monthly sampling for: 2.0 years
2. Recirculation system with weekly O&M, monthly sampling for: 5.0 years

Estimate Accuracy	
+30%	-20%

Estimated Range of Probable Cost		
+30%	Total Est.	-20%
$7,248,800	**$5,576,000**	**$4,460,800**

Preliminary Activities + System Construction Cost	$1,032,000
Long-Term O&M Cost	$2,438,800
Other Costs	$2,105,000
Total Estimate	**$5,576,000**

Attachment B

ATTACHMENT B

OPINION OF PROBABLE CONSTRUCTION COST

KENNEDY/JENKS CONSULTANTS, INC.

Project: Circle K 1461

Selected Alternative Multi-Phase Extraction (MPE) System

Prepared By: CMW
Date Prepared: 11/21/2023
KJ Proj. No. 2196008*00

Current at ENR
Escalated to ENR
Months to Midpoint of Construct 16

Estimate Type:
- ☐ **Conceptual**
- ☒ **Preliminary (w/o plans)**
- ☐ **Design Development @** ____ **% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source and Notes
Preliminary Activities												
		Permitting										
	1	General Demolition/Grading/Construction	1	ls	10,000	10,000					10,000	
	2	Air Discharge	1	ls	0	0					0	
	3	Construction	1	ls	20,000	20,000					20,000	
	4	Sewer Discharge	1	ls	16,500	16,500					16,500	
	5	Electrical Permit	1	ls	1,000	1,000					1,000	No plans reviewed, less than 500 amps.
		SUBTOTAL									**47,500**	
Multi-Phase Extraction System Construction												
	1	Mobilization/Demobilization	1	ls			53,507	53,507			53,507	8% of construction capital cost.
	2	Private Utility Locate	1	ls			2,000	2,000			2,000	
	3	Power Drop/Electrical - New	1	ls	5,000	5,000					5,000	For 200 amp power drop.
		Extraction and Injection Well Installation	**6**	well								3 new slant wells, 3 new vertical wells. Connection to 7 existing wells. Well install costs from driller quote 8/24/2022.
	4	Mob/Demob Auger and Air-Knife	1	ls	1,800	1,800					1,800	For HSA rig and distant site, likely conservative.
	5	Auger and Support Truck	3	day	4,500	13,500					13,500	Assumes 3 days to install 6 wells. $3,500/day Auger, $200/day support truck, $800/day Air-knife.
	6	Well Materials (screens)	120	feet	24	2,880					2,880	4" wells
	7	Vaults/Well Head Appurtenances	6	ea	675	4,050					4,050	Flush monuments and tie-ins to headers.
	8	Drums	30	drum	140	4,200					4,200	4 soil drums + 1 water drum per well + 1 decon drum. 55-gal DOT Drum for IDW
	9	Investigation-Derived Waste (IDW) Soil Transport and Disposal	24	drum	195	4,680					4,680	Soil cuttings
	10	Investigation-Derived Waste (IDW) Water Transport and Disposal	6	drum	185	1,110					1,110	Decontamination and development water
	11	Mob/Demob Development	1	ls	2,000	2,000					2,000	
	12	Development	6	ea	350	2,100					2,100	Estimate 2 hours per well
		Earthwork										
	13	Saw Cut existing pavement (4 to 6" depth)	1,170	lf			2	2,340			2,340	To connect 13 wells.
	14	Demo and Remove Existing Pavement (4" thickness)	390	sy			16	6,240			6,240	3' average width of trench.
	15	Haul and Dispose Pavement	85	ton	10	848	10	848			1,697	145 lb/cf density assumed.
	16	Excavation (landfill disposal)	520	cy			3	1,560			1,560	5' average depth of trench.
	17	Hauling Excavated Clean Material	878	ton	5	4,388	6	5,265			9,653	Hauling from site to landfill, 1.35 and 1.25 factors applied.
	18	Waste Profiling for Landfill Disposal	30	sample	35	1,050					1,050	Need to analyze for TPH, BTEX, Lead. Assumes 10 samples analyzed for 3 constituents.
	19	Landfill Disposal	1	ls	29,340	29,340					29,340	ACT Enviro: 10 RO bins for 10 days each for non-haz waste in Subtitle D landfill facility in Seattle.
	20	Imported Backfill (material and transport)	842	ton	25	21,060					21,060	Imported fill. Includes 20% compaction factor in quantity estimate.
	21	Placement and Compaction (imported fill)	624	cy			10	6,240			6,240	Includes 20% compaction factor
	22	CSBC Pavement Subgrade (6" thick)	390	sy	8	3,120	2	780			3,900	
	23	Asphalt Concrete Pavement (4" thick)	85	ton					100	8,483	8,483	
		Transfer System										
	24	Piping (Ex/Inj and SSD wells to treatment system)	1,404	lf	5	7,020					7,020	2" Schedule 80 PVC, same length as trenching with 20% FS
	25	Transfer Pumps	3	ea	665	1,995					1,995	From MSC direct. 230V, 3 Phase, 1 HP, Self Priming Cast Iron Centrifugal Pump
		Vapor Protection and Monitoring System										
	26	Sub-Slab Depressurization Wells	3	ea	500	1,500					1,500	3' wide, 6' long, 4' deep trench assumed. Replacement of paving.
	27	Manifold	1	ea	2,500	2,500					2,500	4" manifold with (3) 2" legs.
	28	Vapor Pins	4	ea	200	800					800	Vapor pins and estimate of installation cost.
		Treatment System										
	29	Catalytic Oxidizer	6	mo	3,900	23,400					23,400	Falmouth Electric Oxidizer, Quote via Gasho 4/5/22 for 3-6 mo. use
	31	Liquid GAC	4	ea	500	2,000					2,000	200 lb x 4. Quote from Evoqua 6/18/21. Shipping, tax not included.
	32	Vapor GAC	2	ea	8,744	17,487					17,487	2000lb x 2. Quote from Evoqua 6/18/21. Shipping, tax not included.
	33	MPE Treatment Shed, Manifold, Blower, and appurtenances	1	ls	109,665	109,665					109,665	Includes shed, manifold, knockout tank, heat exchanger, pump, blower, control panel. Gasho quote, 4/5/22.
	34	300 gal Storage Tank - Post GAC Treatment	1	ea	422	422					422	From tank-depot.com
	35	400 gal Storage Tank - Pre GAC Treatment	1	ea	512	512					512	From ntotank.com
	36	Chain-Link Fence	40	LF	23	927	4	159	1	41	1,127	From RS Means data
		Groundwater Recirculation System										
	37	Surfactants	400	gal	50	20,000					20,000	Initial costs, $18000/400 gal, no shipping. 2/23 quote from ETEC
	38	Bacteria + Nutrients	1	ls	9,200	9,200					9,200	Initial costs, $9200, no S&H. 2/23 quote from ETEC
	40	Super-Ox 10-C	1	ls	4,000	4,000					4,000	initial, 2/23 quote from ETEC
	41	Shipping (to and return)	1	ls	3,650	3,650					3,650	Initial shipping and demobilization of equipment ETEC quote 2/23 (initial equipment, demob, surfactant 6 mo.)
	42	Installation/set-up/training (5 days)	1	ls	10,000	10,000					10,000	Initial costs, ETEC 5 Year Proposal, 6/5/17.
	43	Batch/Mixing Tank	1	ls	500	500					500	300 gal.
	44	Mixer, Injection Pump, Controls	1	ls	4,000	4,000					4,000	Based on installation of similar system.
	45	System Installation	65	day			4,000	260,000			260,000	Estimate of 13 weeks, 5 days/week.
	46	Consultant Labor	65	day			1,500	97,500			97,500	Engineer ($150/hr) at 10 hrs/day for system install
		SUBTOTAL									**765,667**	
										Preliminary Activities + MPE System Construction	**813,200**	

ATTACHMENT B

Kennedy Jenks

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Labor $/Unit	Labor Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source and Notes
Long-Term and Operations & Maintenance Costs												5.5 years of operation
	1	MPE System O&M (Labor and Instruments)	286	weeks	1,331	380,553	1,581	452,037	23	6,600	839,190	General contractor labor, equipment, replacement equipment, activated carbon changeout, etc.
		Chemical Replacements										
	2	Liquid Carbon	34	event	600	20,400	1,042.00				20,400	Assumes non-hazardous disposal. Replacement every 6 weeks for first 6 months, quarterly after that.
	3	Vapor Carbon	31	event	7,000	217,000					217,000	Assumes non-hazardous disposal. Replacement every 6 weeks for first 6 months, quarterly after that.
	4	Bacteria + Nutrients	47	months	3,930	184,710					184,710	10/400 gal supply. Assumes phase 3 starts after 6 months of recirc. operation.
	5	Super-Ox 10-C	47	months	4,000	188,000					188,000	Monthly rental cost
		Vapor Sampling and Chemical Analysis										
	6	Consultant Labor - Vapor Sampling	26	events	500	13,000	1,500	39,000			52,000	Startup, monthly for 6 months, then quarterly for 2 years, then semi-annual during system operation
	7	MPE System VOCs Chemical Analyses	145	sample	200	29,000					29,000	Bi-monthly inf. and eff. vapor samples for VOCs. 6 events/year, 5 samples/event. $200/event.
	8	Investigation-Derived Condensate Water Handling/Disposal	5	event	1,500	7,500					7,500	1 disposal event per condensate removal event (annual)
		Groundwater Treatment Sampling and Chemical Analysis										
	9	Consultant Labor and Equipment - Treatment System	66	events	450	29,700	1,350	89,100			118,800	Monthly. Influent, midpoint, and effluent of each liquid GAC vessel train
	10	TPH-Gasoline	198	sample	63	12,474					12,474	
	11	BTEX	198	sample	80	15,840					15,840	
	12	Nitrate & Orthophosphate	10	sample	75	750					750	
		Compliance Groundwater Monitoring and Chemical Analysis										
	13	Consultant Labor and Equipment - Groundwater Monitoring	22	events			7,800	171,600			171,600	Quarterly
	14	TPH-Gasoline	264	sample	63	16,632					16,632	12 wells
	15	BTEX	264	sample	80	21,120					21,120	12 wells
	16	Nitrate & Orthophosphate	176	sample	75	13,200					13,200	8 wells
	17	Investigation-Derived Groundwater Handling/Disposal	22	events	1,500	33,000					33,000	Quarterly
		Confirmation Soil Sampling and Groundwater Monitoring and Chemical Analyses - Post Treatment System Shutdown										
	18	Consultant Labor and Equipment - Soil Sampling	1	events			6,800	6,800			6,800	Following remedial system operation, 8 temporary borings to 20 ft. for confirmation soil sampling
	19	TPH-Gasoline	23	sample	50	1,150					1,150	
	20	BTEX	23	sample	140	3,220					3,220	
	21	Consultant Labor and Equipment - Groundwater Sampling	10	events			7,800	78,000			78,000	2.5 years of quarterly monitoring
	22	TPH-Gasoline (Groundwater Samples)	160	sample	63	10,080					10,080	
	23	BTEX (Groundwater Samples)	160	sample	80	12,800					12,800	
	24	MNA Parameters (Groundwater Samples)	18	sample	300	5,400					5,400	
	25	Investigation-Derived Groundwater Handling/Disposal	10	events	1,500	15,000					15,000	
		Reporting										
	26	Monthly Progress Summary and Monthly Update Calls	96	report			500	48,000			48,000	Monthly for 5.5 yrs operation, 2.5 yrs confirmation monitoring
	27	Monthly Remedial Progress Evaluation Reports	4	report			3,750	15,000			15,000	Start of each operation phase
	28	Quarterly Remedial Progress Evaluation Reports	24	report			6,000	144,000			144,000	
	29	Annual Remedial Progress Evaluation Reports	8	report			9,000	72,000			72,000	5.5 yrs operation, 2.5 yrs confirmation monitoring (8 reports)
	30	Quarterly EIM Data Uploads	24	report			1,200	28,800			28,800	
		SUBTOTAL									**2,381,466**	
Other												
	1	Construction Report	1	report	15,000	15,000					15,000	Includes as-built drawings. Based on contract amount.
	2	O&M Manuals (MPE System)	1	report	50,000	50,000					50,000	Based on contract amount.
	3	Project Coordination	5.5	years			6,000	33,000			33,000	
	4	Washington State Sales Tax	10.1%	per	94,012.22	9,495					9,495	10.1% of construction capital cost (materials) and chemical replacement costs (materials)
		SUBTOTAL									**107,495**	
		Subtotals				1,673,228		1,613,776		15,124	3,302,128	
		Division 1 Costs	@	10%		167,323		161,378		1,512	330,213	
		Contractor Markup for Sub	@	10%						1,664	1,664	
		Contractor OH&P	@	15%		276,083		266,273			542,356	
		Estimate Contingency	@	20%							835,272	
		Escalate to Midpoint of Construct	@	2%							133,644	
		Estimated Bid Cost									5,145,276	
		Total Estimate									5,146,000	

Notes: 1. Based on operation of MPE system with weekly O&M, monthly sampling for: 5.5 years

Estimate Accuracy	
+30%	-20%

Estimated Range of Probable Cost		
+30%	Total Est.	-20%
$6,689,800	**$5,146,000**	**$4,116,800**

Preliminary Activities and System Construction Cost	$813,200
Long-Term O&M Cost	$2,381,500
Other Costs	$1,950,700
Total Estimate	**$5,146,000**

Attachment C

Attachment C: Alternatives Analysis of SVE + Groundwater Recirculation vs. MPE

Circle K 1461
Washington State Department of Ecology

		ALTERNATIVE 1 SVE (plus Groundwater Recirculation)	ALTERNATIVE 2 MPE
Restoration Timeframe	**15%**	**6** Ability to change flow paths may decrease amount of concentration rebound. Recirculation system expected to run for approximately 5 years, SVE system for approximately 2 years.	**6** Higher vacuums may lead to faster/easier cleanup of soils in the vadose zone. System expected to run for 5 years.
O&M	**15%**	**7** SVE plus groundwater recirculation would have slightly more infrastructure than MPE due to the potential for additional pumps or wells needed. However, operationally, the recirculation system could allow for more flexibility in how the system would operate (e.g. which wells to inject into, changing flow paths). O&M on just the recirculation system would last longer than on the SVE system, simplifying O&M after SVE shutdown.	**6** MPE has less infrastructure. However, dealing with both water and vapor in one system could lead to additional mechanical issues compared to one system for groundwater and one for SVE. Less concerned about how much water would be collected through the system since that is a feature of the system. O&M is only on one system (and blower) so is made simpler. Recirculation would still be included in this alternative to allow flexibility in how the system would operate (e.g. which wells to inject into, changing flow paths), but slightly fewer wells would mean less flexibility in operation.
Protectiveness	**15%**	**6** Both systems equally protective of VI and would reduce contaminant concentrations at the site.	**6** Both systems equally protective of VI and would reduce contaminant concentrations at the site.
Permanence	**15%**	**8** Ability to change flow paths may decrease amount of concentration rebound.	**7** Higher vacuums may lead to faster/easier cleanup of soils in the vadose zone.
Long-Term Effectiveness	**10%**	**7** Once contaminant mass is removed, effect is permanent.	**8** MPE may be more effective in unsaturated soils. Once contaminant mass is removed, effect is permanent.
Short-Term Risks	**10%**	**7** Remediation worker risk due to potential contact with impacted media during installation, operation, and maintenance. Moderate degree of risk to workers (contact with impacted media) and minimal risk to the community and environment (discharge of treated air and water).	**7** Remediation worker risk due to potential contact with impacted media during installation, operation, and maintenance. Moderate degree of risk to workers (contact with impacted media) and minimal risk to the community and environment (discharge of treated air and water).
Implementability/ Constructability	**15%**	**7** Installation between the systems would be similar, but may be slightly more complicated with SVE because of the access needed during implementation (due to number of wells).	**8** Installation between the systems would be similar, but may be slightly easier with MPE due to fewer wells being needed and less infrastructure (fewer pumps).
Public Concerns	**5%**	**5**	**5**
Total Weighted Benefits		**6.8**	**6.7**
Estimated Cost (millions)		**$5.58**	**$5.15**
Benefit/Cost Ratio		**1.2**	**1.3**
			MPE is the recommended alternative.

Notes:
Alternatives are ranked on a scale of 1 to 10 based on how each alternative satisfies the listed criteria (1 = does not meet criteria, 10 = meets criteria completely).