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Draft – Issued for Regulatory Review

T E C H N I C A L M E M O R A N D U M

TO: Sunny Becker, Washington State Department of Ecology **DATE**: January 21, 2025

FROM: Thomas Cammarata, SoundEarth Strategies, Inc.

SUBJECT: Remedial Alternative – Plastic Sales and Services Site

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SoundEarth Strategies, Inc. (SoundEarth), on behalf of Lutheran Retirement Home of Greater Seattle (The Hearthstone), has developed a series of remedial alternatives to treat chlorinated volatile organic compounds (CVOCs) in the groundwater at the Plastic Sales and Services Site (the Site). In 2019, a groundwater remedy implemented at the Site consisted of the installation of 34 pairs of injection wells into the shallow and deep water-bearing zones beneath the Site. SoundEarth injected Electron Donor Solution-Extended Release (EDS-ER; emulsified vegetable oil) into each well to stimulate the biological degradation of CVOCs in the groundwater, a chemical process known as enhanced reductive dechlorination (ERD).

BACKGROUND

The 2019 groundwater treatment remedy successfully degraded tetrachloroethene (PCE) and trichloroethene (TCE) in the groundwater to concentrations below cleanup levels on a portion of the Site; however, cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC) concentrations increased substantially after 2019 and remained in the groundwater at concentrations well above cleanup levels. This condition can occur when the addition of the EDS-ER creates anaerobic conditions in the groundwater conducive to the degradation of PCE and TCE but sometimes not sufficiently anaerobic to degrade cis-1,2-DCE and VC. In response to the elevated residual CVOC concentrations in the groundwater at the Site and the presence of the CVOC plume in the 4th Avenue right-of-way (ROW), SoundEarth, with the approval of the Washington State Department of Ecology, performed a pilot test that included injecting EDS-ER combined with liquid zero-valent iron (ZVI) in selected injection wells. Results from the pilot show that introducing EDS-ER combined with liquid ZVI into the groundwater at the Site did not lead to the degradation of CVOCs. The results for the pilot test are presented in the Technical Memorandum regarding the Analysis of ZVI and EDS-ER Pilot Test Results – Plastic Sales and Service Site, dated January 16, 2025, and prepared by SoundEarth.

SITE DESCRIPTION

Under the Agreed Order No. DE 7084 dated September 14, 2009, the Site is defined as the extent of hazardous substances at 6870 Woodlawn Avenue Northeast (the former Dry Cleaner Property). In 2009, the Site was defined by the extent of contamination caused by the releases of hazardous substances at the former Dry Cleaner Property and included the following:

- The Dry Cleaner Building property
- The property adjoining the Dry Cleaner Building property to the north, located at 6869 Woodlawn Avenue Northeast

- The property adjoining the Dry Cleaner Building property to the south, located at 6565 4th Avenue Northeast
- The property adjoining the Dry Cleaner Building property to the west, located at 6850 Woodlawn Avenue Northeast
- Portions of the western alley and Woodlawn Avenue Northeast and 4th Avenue Northeast ROWs (Woodlawn Avenue ROW and 4th Avenue ROW, respectively)

A supplemental investigation performed at the Site in 2022 found that PCE and its degradation products were present in the groundwater beyond what was understood as the Site's extent in 2009. Based on the result from the supplemental investigation, as shown on Figure 1, the Site now includes the 4th Avenue ROW north of the intersection with the Woodlawn Avenue Northeast ROW. The current extent of groundwater contamination at the Site is shown on Figure 1.

REMEDIAL ALTERNATIVE ANALYSIS

Based on elevated CVOC concentrations in the shallow and deep water-bearing zones and the CVOC plume in the 4th Avenue ROW, SoundEarth has developed a series of remedial alternatives for the Site presented in Tables 1 and 2. The remedial alternative includes:

1) **Monitored Natural Attenuation**: Reliance on natural attenuation processes to degrade CVOCs.
2) **ERD**: Reliance on biostimulation stimulated by the introducing carbon substrate into the groundwater to modify existing geochemical and biological conditions in an aquifer to degrade CVOCs under anaerobic conditions.
3) **ERD (Biostimulation) and Bioaugmentation**: Reliance on EDR in combination with the microbes to accelerate the biodegradation process if the existing microbial population is not adequate to stimulate the degradation of CVOCs.
4) **Sodium Permanganate**: Reliance on a chemical oxidant to destroy the CVOCs in the groundwater. Sodium permanganate is an effective chemical oxidant to treat CVOCs in soil and groundwater.

PREFERRED REMEDIES

The preferred remedies for the shallow and deep water-bearing zones are ERD with bioaugmentation and sodium permanganate, respectively. Each preferred remedy focuses on treating groundwater at selected wells by degrading PCE and TCE source areas and inhibiting the formation of cis-1,2-DCE and VC. The goal for the shallow water-bearing zone is to degrade the source areas for PCE and TCE and create strongly reducing conditions in the groundwater that will degrade cis-1,2-DCE and VC and support microbial populations necessary to degrade CVOCs. The goal for the deep water-bearing zone is to degrade CVOCs using a strong oxidant, bypassing the formation and accumulation of cis-1,2-DCE and VC.

Attachments: Figure 1, Site Boundary Map
Table 1, Shallow Water-Bearing Zone CVOC Treatment Evaluation
Table 2, Deep Water-Bearing Zone CVOC Treatment Evaluation

FIGURE

1/3/2025

P:\0651 HEARTHSTONE\0651-002 HEARTHSTONE - WOODLAWN EAST\TECHNICAL\CAD\20241202024 PILOT TEST TECH MEMO\0651-002_2024_PP.DWG

LEGEND

- CATCH BASIN
- MANHOLE
- SHALLOW-ZONE MONITORING WELL
- DEEP-ZONE MONITORING WELL
- DEEP DEWATERING WELL
- SHALLOW INJECTION WELL
- DEEP INJECTION WELL
- DECOMMISSIONED WELL
- DIRECT-PUSH BORING (GEOENGINEERS 2004)
- DIRECT-PUSH BORING (GEOENGINEERS 2002/2003)
- DIRECT-PUSH BORING (FARALLON 2004)
- DIRECT-PUSH BORING (FARALLON 2006/2007)
- DIRECT-PUSH BORING (FARALLON 2010)
- DIRECT-PUSH BORING (SOUNDEARTH 2008)
- HOLLOW-STEM AUGER (SOUNDEARTH 2009)
- POST-ELECTRICAL RESISTANCE HEATING BORING LOCATION
- SW — STORMWATER LINE
- GAS — GAS LINE
- SS — SANITARY SEWER LINE
- W — WATER LINE
- OHP — OVERHEAD POWER LINE
- PROPERTY BOUNDARY LINE
- PARCEL BOUNDARY
- SITE BOUNDARY
- FD — FLOOR DRAIN
- UST — UNDERGROUND STORAGE TANK

NOTES:

1. FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010.

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6900 EAST GREEN LAKE WAY NORTH

NORTH-ADJOINING PROPERTY
6869 WOODLAWN AVENUE NORTHEAST

6857 WOODLAWN AVENUE NORTHEAST

6900 WOODLAWN AVENUE NORTHEAST

SOUTH-ADJOINING PROPERTY
6565 4TH AVENUE NORTHEAST

HEARTHSTONE PROPERTY
6850 WOODLAWN AVENUE NORTHEAST

FORMER LAUNDRY PROPERTY

FORMER YASUKO PROPERTY

SINGLE-FAMILY LOT

APARTMENTS

FORMER STODDARD SOLVENT UST

FORMER UST FILL PORT

2ND AVENUE NORTHEAST

4TH AVENUE NORTHEAST

WOODLAWN AVENUE NORTHEAST

LATONA AVENUE NORTHEAST

WESTERN ALLEY

SoundEarth Strategies
WWW.SOUNDEARTHINC.COM

PLASTIC SALES & SERVICE SITE
6870 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON
SOUNDEARTH PROJECT #0651-002

FIGURE 1
SITE BOUNDARY MAP

TABLES

Table 1
Shallow Water-Bearing Zone CVOC Treatment Evaluation
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Technology	Description	Conceptual Approach	Advantages	Disadvantages
MNA	Reliance on natural attenuation processes to degrade CVOCs. Groundwater monitoring would be performed to evaluate the effectiveness of groundwater remediation (2019 and 2024 groundwater treatment), ensure natural attenuation processes are occurring, evaluate the stability of the CVOC plume, and confirm CVOCs are in compliance with groundwater cleanup levels.	Perform annual indoor air monitoring in the parking garage at 6884 Woodlawn Avenue Northeast (former Plastic Sales and Service Property), at 6900 East Green Lake Way North (at the intersection of 4th and Woodlawn ROWs), and in the Janke Building.	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	The longest restoration time is likely up to 30 years, given the reliance on natural attenuation processes.
		Collect groundwater samples from groundwater monitoring wells MW01 through MW03, MW05, MW06, MW15, MW19, MW21, MW24 through MW28, MW30, MW32, MW34, and MW36 for field parameter measurement and chemical analyses.	PCE and TCE has been remediated to the maximum extent practicable in the shallow water-bearing zone. PCE or TCE (parent CVOC compound) currently detected at concentrations above the groundwater cleanup level shallow water-bearing monitoring wells MW03, MW06, and MW28 at a maximum concentration of 8.5 µg/L.	
		Collect groundwater samples from injection wells IW08, IW16, IW21, IW31, IW33, IW57, IW59, and IW61 for field parameter measurement and chemical analyses.	cis-1,2-DCE and VC will continue to degrade via direct oxidation due to aerobic geochemical conditions (particularly in the 4th Avenue Northeast ROW).	
		Includes annual performance groundwater monitoring and sampling. Submit groundwater samples for CVOCs and natural attenuation parameter analyses.		
ERD (Biostimulation)	ERD is the process through which chlorine atoms attached to an organic compound are sequentially removed under anaerobic conditions. Application of ERD is comprised of biostimulation and sometimes bioaugmentation to modify existing geochemical and biological conditions in an aquifer to facilitate degradation of contaminants. Biostimulation refers to the introduction of an electron donor (carbon source) into the aquifer for stimulating microbial growth. The carbon source is used as food by native microbes, which in turn produce hydrogen through fermentation reactions. This process depletes the aquifer of dissolved oxygen and other electron accepters, including nitrate, sulfate, and ferric iron, which lowers the ORP, thereby creating the conditions for reductive dechlorination to occur.	Update the existing UIC registration with Ecology's UIC program.	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	Potential for incomplete reductive dechlorination (i.e., cis-1,2-DCE accumulation/VC stall), due to inability to establish sufficiently reduced conditions in the groundwater and/or absence of or stimulation of indigenous microbial consortium.
		Inject EVO into existing injection/monitoring wells in the shallow water-bearing zone (MW03, MW15, IW16, IW21, IW30, IW31, IW33, IW35, IW59, and IW61) to serve as carbon substrate.	PCE and TCE has been successfully degraded to cis-1,2-DCE and VC in the presence of EOS (2019 and 2024 groundwater treatment).	Potential for downgradient migration of generated cis-1,2-DCE and VC .
		Perform 1 year of quarterly performance groundwater monitoring to evaluate the effectiveness and longevity of the EVO; perform annual groundwater monitoring thereafter. Results will be evaluated using qualitative and statistical methods.	At sufficient loading/injection volume, the anaerobic zone may extend beyond the radius of influence of the edible oil itself, extending downgradient treatment (i.e., beneath the ROW).	Potential expansion of CVOC groundwater plume, requiring further downgradient investigation to define plume boundary.
ERD (Biostimulation) and Bioaugmentation	See ERD. Bioaugmentation refers to the introduction of microbes, which may be required to accelerate the acclimation and biodegradation process if the existing microbial population is not adequate at the onset of treatment. At many sites, microbes capable of dechlorinating cis-1,2-DCE and VC are not present in sufficient quantities resulting in a condition referred to as "cis-1,2-DCE and VC stall." In those cases, bioaugmentation can be used in combination with biostimulation to achieve the necessary conditions to overcome stall and promote complete reductive dechlorination.	Update the existing UIC registration with Ecology's UIC program.	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	If appropriate geochemical conditions are not established and/or microbial activity is not stimulated, there is the potential for incomplete reductive dechlorination, leading to downgradient migration of generated cis-1,2-DCE and VC and expansion of CVOC groundwater plume.
		Inject EVO into existing injection/monitoring wells in the shallow water-bearing zone (MW03, MW15, IW16, IW21, IW30, IW31, IW33, IW35, IW59, and IW61) to serve as carbon substrate.	PCE and TCE has been successfully degraded to cis-1,2-DCE and VC, in the presence of EOS (2019 and 2024 groundwater treatment).	
		Inject KB-1®, as manufactured by SiRem (or similar microbial consortium), into select existing injection/monitoring wells in the shallow water-bearing zone for introduction of a microbial culture that contains DHC, the group of microorganisms supportive of complete reductive dechlorination of chlorinated ethenes (PCE, TCE, cis-1,2-DCE, and VC) to non-toxic ethene.	At sufficient loading/injection volume, the anaerobic zone may extend beyond the radius of influence of the edible oil itself, extending downgradient treatment (i.e., beneath the ROW).	
		Perform 1 year of quarterly performance groundwater monitoring to evaluate the effectiveness and longevity of the EVO; perform annual groundwater monitoring thereafter. Results will be evaluated using qualitative and statistical methods.	If appropriate geochemical conditions are established, bioaugmentation with an enriched microbial consortium containing species of DHC may reduce the potential for incomplete reductive dechlorination.	

Table 1
Shallow Water-Bearing Zone CVOC Treatment Evaluation
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Technology	Description	Conceptual Approach	Advantages	Disadvantages
Sodium Permanganate	Permanganate has proven to be an effective chemical oxidant for the treatment of CVOCs (PCE, TCE, cis-1,2-DCE, and VC) in soil and groundwater. A solution of permanganate as a salt of either potassium or sodium is injected into the groundwater to chemically oxidize CVOCs. Liquid sodium-based permanganate can be injected at a higher concentration comparatively to solid potassium-based permanganate (i.e., requires mixing) due to solubility limits.	Secure a UIC registration with Ecology's UIC program (new registration given change in remediation amendment).	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	Health and safety concerns associated with the storage, handling and delivery of a chemical oxidant solution to the subsurface.
		Model the transport of sodium permanganate in the groundwater to estimate its travel time and distance or perform an injection in a non-critical area of the site and use empirical evidence to assess the travel time and distance.	Chemical oxidation does not sequentially degrade CVOC constituents like the ERD process (i.e., does not generate cis-1,2-DCE or VC).	Requires higher chemical oxidant loading due to presence of EOS (introduced during previous remedial efforts) and natural organics (i.e., low permeable silt).
		Inject sodium permanganate into existing injection wells in the shallow water-bearing zone (IW16, IW21, IW30, IW31, IW33, IW35, IW59, and IW61). Sodium permanganate would also be injected into shallow water-bearing zone monitoring wells MW03 and MW15; groundwater sample collection from these two monitoring wells would be completed when the chemical oxidant has been depleted.		Inherent to the sodium permanganate chemical oxidant, manganese will be detected at elevated concentrations following injections and may require months to years to attenuate to background levels.
		Perform bimonthly groundwater performance monitoring for 2 months (total of 4 events) at selected wells to monitor the migration of the oxidant, changes in geochemical parameters, and the efficacy of the treatment. Perform 1 year of quarterly performance groundwater monitoring and sampling for CVOCs; perform annual groundwater thereafter. Results will be evaluated using qualitative and statistical methods.		Potential for downgradient migration of injectate.

Acronyms:

µg/L = microgram per liter
cis-1,2-DCE = cis-1,2-dichloroethene
CVOC = chlorinated volatile organic compound
DHC = Dehalococcoides
Ecology = Washington State Department of Ecology
EOS = Emulsified Oil Substrate
ERD = enhanced reductive dechlorination
EVO = emulsified vegetable oil
MNA = monitored natural attenuation
ORP = oxidation-reduction potential
PCE = tetrachloroethene
ROW = right-of-way
TCE = trichloroethene
UIC = Underground Injection Control
VC = vinyl chloride
ZVI = zero-valent iron

Table 2
Deep Water-Bearing Zone CVOC Treatment Evaluation
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Technology	Description	Conceptual Approach	Advantages	Disadvantages
MNA	Reliance on natural attenuation processes to degrade CVOCs. Groundwater monitoring would be performed to evaluate the effectiveness of groundwater remediation (2019 and 2024 groundwater treatment), ensure natural attenuation processes are occurring, evaluate the stability of the CVOC plume, and confirm CVOCs are in compliance with groundwater cleanup levels.	Perform annual indoor air monitoring in the parking garage at 6884 Woodlawn Avenue Northeast (former Plastic Sales and Service Property), at 6900 East Green Lake Way North (at the intersection of 4th and Woodlawn ROWs), and in the Janke Building.	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	PCE and/or TCE (parent compounds) currently detected at concentrations significantly above the groundwater cleanup level in groundwater monitoring wells MW09, MW10, and MW35, warranting further deep water-bearing zone treatment.
		Collect groundwater samples from groundwater monitoring wells MW08 through MW11, MW13, MW22, MW29, MW31, MW33, MW35, and MW37 for field parameter measurement and chemical analyses.		cis-1,2-DCE and VC currently detected at elevated concentrations significantly above the groundwater cleanup level in groundwater monitoring wells MW31 and injection wells IW15, IW22, IW32, IW34, IW36 and IW38, warranting further deep water-bearing zone treatment.
		Collect groundwater samples from injection wells IW07, IW15, IW22, IW32, IW34, and IW60 for field parameter measurement and chemical analyses.		Longest restoration timeframe (decades), given reliance on natural attenuation processes.
		Includes annual performance groundwater monitoring and sampling. Submit groundwater samples for CVOCs and natural attenuation parameter analyses.		
ERD (Biostimulation)	ERD is the process through which chlorine atoms attached to an organic compound are sequentially removed under anaerobic conditions. Application of ERD is comprised of biostimulation and sometimes bioaugmentation to modify existing geochemical and biological conditions in an aquifer to facilitate degradation of contaminants. Biostimulation refers to the introduction of an electron donor (carbon source) into the aquifer for stimulating microbial growth. The carbon source is used as food by native microbes, which in turn produce hydrogen through fermentation reactions. This process depletes the aquifer of dissolved oxygen and other electron accepters including nitrate, sulfate, and ferric iron, which lowers the ORP, thereby creating the conditions for reductive dechlorination to occur.	Update the existing UIC registration with Ecology's UIC program.	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	Potential for incomplete reductive dechlorination (i.e., cis-1,2-DCE accumulation/VC stall), due to inability to establish appropriate geochemical chemical conditions and/or absence of or stimulation of indigenous microbial consortium.
		Install three new injection wells in the vicinity of 2021 deep water-bearing zone borings DZ-B02 and DZ-B03 (to the northeast of existing monitoring well MW31) in the 4th Avenue Northeast ROW to supplement the injection well network.	In the presence of EVO (2019 and 2024 groundwater treatment), PCE and TCE (parent compounds) have been degraded to cis-1,2-DCE and VC; however, PCE and/or TCE still detected at concentrations significantly above the groundwater cleanup levels in groundwater monitoring wells MW09, MW10, and MW35.	Potential for downgradient migration of generated cis-1,2-DCE and VC, specifically in the vicintiy of downgradient deep water-bearing zone monitoring well MW35 (i.e., CVOCs have not been detected above the method reporting limit or cleanup levels in deep water-bearing zone monitoring wells MW33 and MW37, located to the north and south of MW35, respectively).
		Inject EVO into existing injection/monitoring wells (MW09, MW10, IW15, IW22, IW29, IW32, IW34, IW36, and IW38) and the three newly installed injection wells in the deep water-bearing zone.	At sufficient loading/injection volume, the anaerobic zone may extend beyond the radius of influence of the edible oil itself, extending downgradient treatment (i.e., beneath the ROW).	Potential expansion of CVOC groundwater plume, require further downgradient investigation to define plume boundary (particularly in the vicinity of deep water-bearing zone monitoring well MW35).
		Perform 1 year of quarterly performance groundwater monitoring to evaluate the effectiveness and longevity of the EVO; perform annual groundwater monitoring thereafter. Results will be evaluated using qualitative and statistical methods.		

Table 2
Deep Water-Bearing Zone CVOC Treatment Evaluation
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Technology	Description	Conceptual Approach	Advantages	Disadvantages
ERD (Biostimulation) and Bioaugmentation	See ERD. Bioaugmentation refers to the introduction of microbes, which may be required to accelerate the acclimation and biodegradation process if the existing microbial population is not adequate at the onset of treatment. At many sites, microbes capable of dechlorinating cis-1,2-DCE and VC are not present in sufficient quantities resulting in a condition referred to as "cis-1,2-DCE and VC stall." In those cases, bioaugmentation can be used in combination with biostimulation to achieve the necessary conditions to overcome stall and promote complete reductive dechlorination.	Update the existing UIC registration with Ecology's UIC program.	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	If appropriate geochemical conditions are not established and/or microbial activity is not stimulated, there is the potential for incomplete reductive dechlorination, leading to downgradient migration of generated cis-1,2-DCE and VC and expansion of CVOC groundwater plume (particularly in the vicinity of deep water-bearing zone monitoring well MW35).
		Install three new injection wells in the vicinity of 2021 deep water-bearing zone borings DZ-B02 and DZ-B03 (to the northeast of existing monitoring well MW31) in the 4th Avenue Northeast ROW to supplement the injection well network.	At sufficient loading/injection volume, the anaerobic zone may extend beyond the radius of influence of the edible oil itself, extending downgradient treatment (i.e., beneath the ROW).	
		Inject EVO into existing injection/monitoring wells (MW09, MW10, IW15, IW22, IW29, IW32, IW34, IW36, and IW38) and the three newly installed injection wells in the deep water-bearing zone.	If appropriate geochemical conditions are established, bioaugmentation with an enriched microbial consortium containing species of DHC may reduce the potential for incomplete reductive dechlorination.	
		Inject KB-1®, as manufactured by SiRem (or similar microbial consortium), into select existing injection/monitoring wells and newly installed injections wells in the deep water-bearing zone for introduction of a microbial culture that contains DHC, the group of microorganisms supportive of complete reductive dechlorination of chlorinated ethenes (PCE, TCE, cis-1,2-DCE, and VC) to non-toxic ethene.		
		Perform 1 year of quarterly performance groundwater monitoring to evaluate the effectiveness and longevity of the EVO; perform annual groundwater monitoring thereafter. Results will be evaluated using qualitative and statistical methods.		
Sodium Permanganate	Permanganate has proven to be an effective chemical oxidant for the treatment of CVOCs (PCE, TCE, cis-1,2-DCE, and VC) in soil and groundwater. A solution of permanganate as a salt of either potassium or sodium is injected into the groundwater to chemically oxidize CVOCs. Liquid sodium-based permanganate can be injected at a higher concentration comparatively to solid potassium-based permanganate (i.e., requires mixing) due to solubility limits.	Secure a UIC registration with Ecology's UIC program (new registration given change in remediation amendment).	The vapor intrusion pathway has been demonstrated incomplete through two sub-slab soil gas and indoor air sampling events at the Janke Property.	Health and safety concerns associated with the storage, handling and delivery of a chemical oxidant solution to the subsurface.
		Install three new injection wells in the vicinity of 2021 deep water-bearing zone borings DZ-B02 and DZ-B03 (to the northeast of existing monitoring well MW31) in the 4th Avenue Northeast ROW to supplement the injection well network.	Chemical oxidation does not sequentially degrade CVOC constituents like the ERD process (i.e., does not generate cis-1,2-DCE or VC).	Requires high chemical oxidant loading due to presence of EVO (introduced during previous remedial efforts).
		Model the transport of sodium permanganate in the groundwater to estimate its travel time and distance or perform an injection in a non-critical area of the site and use empirical evidence to assess the travel time and distance.		Inherent to the sodium permanganate chemical oxidant, manganese will be detected at elevated concentrations following injections and may require months to years to attenuate to background levels.
		Inject sodium permanganate into existing injection wells (IW15, IW22, IW29, IW32, IW34, IW36, and IW38) and the three newly installed injection wells in the deep water-bearing zone. Sodium permanganate would also be injected into deep water-bearing zone monitoring wells MW09 and MW10; groundwater sample collection from these two monitoring wells would be completed when the chemical oxidant has been depleted.		Potential for downgradient migration of injectate.
		Perform bimonthly groundwater performance monitoring for 2 months (total of 4 events) at selected wells to monitor the migration of the oxidant, changes in geochemical parameters, and the efficacy of the treatment. Perform 1 year of quarterly performance groundwater monitoring and sampling for CVOCs; peform annual groundwater thereafter. Results will be evaluated using qualitative and statistical methods.		

Acronyms:

cis-1,2-DCE = cis-1,2-dichloroethene
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TCE = trichloroethene
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