Focused Feasibility Study

Frenchies' Fill-N-Food
Moxee, Washington

for
Washington State Department of Ecology

June 24, 2014

GeoEngineers
Earth Science + Technology

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File No. 0504-075-01

June 24, 2014

Prepared for:

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INTRODUCTION

This report presents the results of the focused feasibility study (FFS) conducted at the Frenchies' Fill-N-Food site located at 106 East Moxee Avenue in Moxee, Washington (herein referred to as "site"). Assessment activities conducted in 2012 and 2013 by GeoEngineers, Inc. (GeoEngineers) indicate gasoline-range petroleum hydrocarbons (GRPH) and associated volatile organic compounds (VOCs) are present in soil and groundwater at the site at concentrations greater than Washington State Model Toxics Control Act (MTCA) Method A cleanup levels. The approximate site location is presented on Vicinity Map, Figure 1.

This FFS presents potential remediation alternatives to advance the site to closure; summarizes the benefits, disadvantages and approximate costs associated with each remediation alternative; and recommends the preferred alternative based on the analysis.

SITE DESCRIPTION

Background

The site is located on two parcels (Parcel Nos. 42011 and 42542) and is bounded by East Moxee Avenue on the north, North Spokane Street on the east and South Rivard Road on the west. Two adjacent parcels to the south (Parcel Nos. 42543 and 42544) are occupied by a City Park. Two buildings are located within the site. The former Frenchies' Fill-N-Food building is situated within Parcel No. 42011 and currently is occupied by a restaurant and hair salon (herein designated the east building). A second commercial building (herein designated the west building) is located within Parcel No. 42542 and currently is occupied by a restaurant/arcade.

Two grassy areas exist within Parcel No. 42542 and the remainder of the project area is paved with asphalt, bounded by concrete sidewalks. Two buildings occupy additional space and have concrete entrances. The site is relatively level. The location of the site and the general layout is shown in Cleanup Level Exceedances - Soil, Figure 2.

The east portion of the project area (Parcel No. 42011) formerly operated as a gasoline station and auto service center until about 1994. During January 1994, Cayuse Environmental (Cayuse) and their excavation contractor removed three 4,000-gallon and one 6,000-gallon gasoline underground storage tanks (USTs) from the site. Four USTs removed near the south side of the building in 1994 reportedly were installed during the mid-1980s and replaced four existing gasoline USTs. The Cayuse report indicated approximately 1,800 cubic yards of petroleum-impacted soil were excavated during UST removal activities.

Soil samples collected during the 1994 tank removal contained gasoline-range petroleum hydrocarbon (GRPH) concentrations greater than MTCA Method A cleanup criteria. Groundwater was encountered about 10 feet below ground surface (depths in this report are referenced to ground surface unless otherwise noted) during tank removal activities. Laboratory results indicated a grab sample collected from groundwater accumulated in the excavation contained GRPH concentrations greater than MTCA Method A cleanup criteria.

Assessment Summary

GeoEngineers has performed the following subsurface assessment activities:

February 2012

- Advanced 12 direct-push soil borings (DP-1 through DP-12).
- Field screened continuous soil samples from each boring and submitted one soil sample from each boring for analytical testing.

September 2012

- Installed and developed four monitoring wells (MW-1 through MW-4).
- Field screened soil samples collected at approximately 5-foot-depth intervals from each well location and submitted one soil sample from each location for analytical testing.

January 2013

- Completed groundwater monitoring activities for MW-1 through MW-4.

April 2013

- Completed groundwater monitoring activities for MW-1 through MW-4.

August 2013

- Completed groundwater monitoring activities for MW-1 through MW-4.

November 2013

- Advanced 10 direct-push soil borings (DP-13 through DP-22).
- Field screened continuous soil samples from each boring and submitted one soil sample and one water sample from each boring for analytical testing.
- Installed and developed one monitoring well (MW-5), one soil vapor extraction well (SVE-1) and one air sparge well (AS-1).
- Submitted one soil sample from each of the wells for analytical testing.

December 2013

- Completed groundwater monitoring activities for MW-1 through MW-5.

February 2014

- Completed groundwater monitoring activities for MW-1 through MW-5.

March 2014

- Completed a Soil Vapor Extraction (SVE) and Air Sparge (AS) pilot test.

Additional soil and groundwater information for the site includes 12 in-situ soil samples and one water sample collected during tank removal activities in 1994. Three soil samples were collected from stockpiles at the time of the tank removal. The stockpiles (of which three soil samples were collected) reportedly were removed from the site sometime between completion of the tank removal and assessment activities in February 2012.

Geologic Setting

Observed native soil conditions generally consists of brown, fine sand with silt interbedded with silty fine to coarse sand. Trace gravel has also been observed at depths ranging from 1 to 20 feet.

Groundwater at the site, as measured during groundwater monitoring events, generally ranges from about 12 to 16 feet below ground surface (bgs). Groundwater appears to occur under unconfined (water table) conditions and previous drilling operations have indicated a capillary fringe exists between depths of approximately 9 to 12 feet bgs (up to 3 feet thick). Groundwater in the shallow aquifer underlying the project area generally flows towards the west.

Contaminants of Concern

Table 1 summarizes chemicals analyzed in soil and groundwater samples from previous assessment activities. Analytes detected in at least one soil sample at a concentration greater than the associated MTCA Method A unrestricted land use cleanup level are considered contaminants of concern (COC). In summary, soil COCs include GRPH, benzene, toluene, ethylbenzene and total xylenes (BTEX) and naphthalenes (1-methylnaphthalene, 2-methylnaphthalene and naphthalene). Groundwater COCs include GRPH, benzene, manganese and nitrate-nitrogen.

TABLE 1: SITE ANALYTES AND IDENTIFIED COCS (SOIL)

Soil			
Chemicals Analyzed	**Analyte Not Detected**	**Analyte less than MTCA Method A**	**Analyte greater than MTCA Method A (COC)**
GRPH			X
MTBE	X		
Benzene			X
Toluene			X
Ethylbenzene			X
Total Xylenes			X
1,2-Dichloroethane (EDC)	X		
1,2-Dibromoethane (EDB)	X		
Hexane		X	
1-Methylnaphthalene			X
2-Methylnaphthalene			X
Naphthalene			X
Lead		X	

TABLE 1 (CONTINUED): SITE ANALYTES AND IDENTIFIED COCS (GROUNDWATER)

Groundwater			
Chemicals Analyzed	**Analyte Not Detected**	**Analyte less than MTCA Method A**	**Analyte greater than MTCA Method A (COC)**
GRPH			X
MTBE	X		
Benzene			X
Toluene		X	
Ethylbenzene		X	
Total Xylenes		X	
1,2-Dichloroethane (EDC)		X	
1,2-Dibromoethane (EDB)	X		
Hexane		X	
1-Methylnaphthalene		X	
2-Methylnaphthalene		X	
Naphthalene		X	
Lead	X		
Methane		X	
Manganese			X
Nitrate-Nitrogen			X
Sulfate		X	
Alkalinity		X	

Contamination Extent

Based on the assessment results, soil contamination is present near the location of the former fuel dispensers and might extend under the nearby buildings. Soil samples with contaminant concentrations exceeding MTCA Method A cleanup levels were obtained from the following explorations:

- DP-2 (GRPH);
- DP-3 (GRPH, BTEX, Naphthalenes);
- DP-4 (GRPH, BTEX, Naphthalenes);
- DP-5 (GRPH, Benzene);
- DP-8 (GRPH, BTEX, Naphthalenes);
- DP-9 (GRPH);
- DP-10 (GRPH, Naphthalenes);

- DP-16 (GRPH, BTEX, Naphthalenes);
- DP-18 (GRPH);
- SVE-1 (GRPH, BTEX, Naphthalenes);
- AS-1 (GRPH, BTEX, Naphthalenes);
- MW-2 (GRPH, Benzene); and
- MW-3 (GRPH).

Contaminated soil samples were obtained from depths ranging between about 2.5 and 15 feet bgs. Results generally indicated the presence of contamination began at about 5 feet bgs in several borings: DP-2, DP-3, DP-8, DP-9, DP-10, DP-16 and SVE-1. In general, these borings are located directly north of the former Frenchies' Fill-N-Food building and near the former dispensers.

COCs have also been identified in groundwater at the site. Samples from the following monitoring wells have contained concentrations of COCs in excess of MTCA Method A cleanup levels:

- MW-2 (GRPH)
- MW-3 (GRPH, Benzene)

Groundwater samples from monitoring well MW-1 have also exceeded nitrate-nitrogen standards as established by 40CFR 19. Samples from monitoring wells MW-2, MW-3 and MW-4 have exceeded manganese MTCA Method B cleanup levels as calculated by Ecology's Cleanup Levels and Risk Calculations (CLARC) database. GRPH and benzene have not been detected in upgradient monitoring well MW-1 and downgradient monitoring wells MW-4 and MW-5. The approximate aerial extent of soil and groundwater contamination is shown in Figure 2 and Groundwater Elevations and Cleanup Level Exceedances Summary, Figure 3, respectively. Figure 2 also illustrates the area with vadose-zone soil contamination with the highest GRPH concentrations. This area is generally suspected to be the source of contamination at the site.

Based on the locations of samples with contaminant concentrations greater than MTCA Method A cleanup levels, it is possible contaminated soil and groundwater exist beneath the existing buildings, though this has not been confirmed.

Exposure Pathways

Petroleum-impacted soil is capped by the asphalt parking area. As a result, human and ecological direct contact with COCs is unlikely unless construction activities were to occur. Petroleum-impacted groundwater has not been detected in downgradient monitoring wells MW-4 and MW-5. Drinking supply wells are not present on the site and depth to groundwater is generally greater than 11 feet, therefore human or ecological ingestion or direct contact with contaminated groundwater is unlikely. The buildings on-site do not have basements.

A limited vapor intrusion Tier 1 assessment was completed for the site (GeoEngineers, 2014a). The limited assessment compared groundwater samples to vapor intrusion screening levels and Ecology guidance. Based upon the results, GeoEngineers determined VOCs are present in site groundwater at concentrations that could result in indoor air concentrations greater than MTCA Method B air cleanup levels. Indoor air monitoring conducted within the west building during a March 2014 AS pilot test did not indicate VOCs above detectable concentrations. Air monitoring was conducted using a photoionization detector (PID) and within the west building because it was closest to the AS well.

CLEANUP STANDARDS AND POINTS OF COMPLIANCE

Soil and groundwater cleanup levels are selected to protect human health and the environment. MTCA Method A cleanup levels will be used for soil and groundwater. Groundwater cleanup levels are based on drinking water protection. Soil cleanup levels are based on MTCA Method A unrestricted land use cleanup levels. Table 2 summarizes specific soil and groundwater cleanup levels for the contaminants of concern:

TABLE 2: MTCA METHOD A SOIL AND GROUNDWATER CLEANUP LEVELS

COC	Soil	Groundwater
Gasoline-Range Petroleum Hydrocarbons	30 mg/kg (cleanup level when benzene is present).	800 µg/L (cleanup level when benzene is present).
Benzene	0.03 mg/kg	5 µg/L
Toluene	7 mg/kg	1,000 µg/L
Ethylbenzene	6 mg/kg	700 µg/L
Xylenes	9 mg/kg	1,000 µg/L
Naphthalenes[1]	5 mg/kg	160 µg/L

Notes:

[1]Total value for naphthalene, 1-methylnaphthalene and 2-methylnaphthalene;

mg/kg = milligrams per kilogram;

µg/L = micrograms per liter.

Although manganese and nitrate were detected above the MCL in groundwater, they are not suspected to originate from the release from this Site. However, groundwater will continue to be monitored for these parameters to ensure protectiveness.

The point of compliance is the point (horizontal or vertical) where the established cleanup levels must be achieved. The standard soil and groundwater points of compliance will be observed for the remediation alternative selected. Per Chapter 173-340-720(8)(b) of the Washington Administrative Code (WAC), the standard groundwater point of compliance is from the "…uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the site." For the protection of groundwater, the soil point of compliance is the soils throughout the site (WAC 173-340-740[6][b]).

DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

General Categories of Remedial Actions

The general categories of remedial actions identified for the site include the following:

- No Action
- Institutional Controls

- In-situ Remediation
- Ex-situ Remediation

Primary Remedial Action Objectives (RAOs) are to mitigate human exposure to soil and groundwater contaminants by dermal contact, ingestion and inhalation. A secondary, although equally important, RAO is to prevent ecological receptors (plants and animals) from exposure to contaminants. The site will receive a "no further action" (NFA) designation and achieve regulatory site closure when RAOs are met.

Table 3 presents a summary and comparison of the general categories of response action alternatives identified for the site. Response action alternatives that were retained after the initial screening process were evaluated for the threshold requirements identified in WAC 173-340-360.

TABLE 3: SCREENING OF GENERAL REMEDIAL ACTIONS

General Response Action	Description	Screening Comments
No Action	No action	Current condition, no risk reduction.
Institutional Controls	Placement of access barriers, deed restriction	Does not accomplish remedial action objective as a stand-alone alternative. Might be used in conjunction with other alternatives.
In-situ Remediation	SVE, AS, Bioremediation, Chemical oxidation, Biosparging, Bioventing, Dual phase extraction	Eliminates on-site risk, permanent solution, low to high cost, regular maintenance required, remediation might require extended period of time.
Ex-Situ Remediation	Excavate and dispose of contaminated soil at a subtitle D landfill or construct on-site biopiles, landfarms or low temperature thermal desorption.	Eliminates on-site risk, permanent solution, high cost to shore excavation below water table, excavation safety next to an arterial and building is a concern. Impacted soil beneath the building left in place.

No Action

The no action alternative does not achieve the RAOs because it does not protect present and future public health, safety and welfare, and the environment. Therefore, this remedial alternative is eliminated from further consideration.

Institutional Controls

Institutional controls involve the placement of access barriers such as fencing and barricades to motorized and non-motorized travel, as well as withdrawal or restrictions on development of affected lands from future use (i.e., deed restrictions). The primary purpose of these controls is to minimize development and human activities on contaminated areas, provide incentive for final cleanup if inaccessible areas of the site become accessible, and provide protection to an implemented solution. The utilization of institutional controls does not, in itself, achieve the RAOs, but can protect the remedy that is implemented on site. The institutional controls alternative as a stand-alone alternative has been eliminated from further consideration, but the implementation of institutional controls in conjunction with in-situ and ex-situ remediation is considered.

In-Situ Remediation

In-situ remediation involves treating the soil and groundwater on site to reduce contaminants to concentrations that comply with established cleanup standards. In-situ soil remediation alternatives include SVE, multi-phase extraction (MPE), bioremediation and/or chemical oxidant applications. Groundwater remediation alternatives include AS, MPE, bioremediation and/or chemical oxidant injections. In-situ treatment provides a permanent solution if contaminant concentrations are permanently reduced to concentrations less than MTCA Method A cleanup levels in soil and groundwater. In-situ remediation can require several years to reduce the contaminant concentrations to less than MTCA cleanup levels depending on site conditions and the effectiveness of the treatment system.

Site conditions are expected to be conducive to in-situ soil and groundwater treatment technologies. Site soil generally consists of silty sands which are expected to have an appropriate permeability and allow for air and solution movement through the subsurface. Historic groundwater temperatures indicate favorable conditions for microbial action. Groundwater temperatures should generally be in between 10 and 45°C to promote biological processes. Limited ferrous iron is present on the site (less than 10 mg/L). If ferrous iron concentrations are greater than 10 mg/L the iron has a tendency to react with terminal electron acceptors (oxygen and nitrogen) introduced into the subsurface and could cause plugging in aquifer flow channels. Groundwater exists as an unconfined aquifer, which allows for more control when injecting or removing fluids from the subsurface. Site COCs are generally considered volatile and therefore in-situ technologies such as SVE, MPE or AS can migrate COCs from subsurface mediums and into a gaseous phase where they can be collected. Available nutrients and existing bacteria counts for the site are unknown.

Ex-Situ Remediation

Ex-situ remediation includes excavation of contaminated soil and either above-ground treatment or off-site disposal. Above-ground treatment technologies include biopiles, landfarming and low-temperature thermal desorption (LTTD). Off-site disposal consists of contaminated soil excavation and transport to an engineered, permitted landfill. Excavation and disposal provides the quickest permanent solution. However, because soil contamination extends to the groundwater interface (between 12 to 16 feet bgs) and possibly under buildings, excavation of petroleum-impacted soil to the groundwater interface would require extensive shoring systems near the property boundaries and buildings. Additionally, off-site disposal does not specifically address groundwater contamination except through removal of a continuing contaminant source. In-situ remediation techniques would likely be required in combination with source removal to remediate groundwater and contaminated soil left in place. Contaminated soil excavated from the site would likely be transported to Allied Waste's Roosevelt Regional Landfill in Roosevelt, Washington (80 miles from site), which is a Subtitle D facility.

Identification of Remedial Action Technologies

Initial remedial action alternatives were identified using the guidance document "How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites" (EPA, 2004). Site-specific information obtained during previous site assessments was used to screen remedial actions for the site. Each action was evaluated based on its ability to mitigate COCs identified in the site soil and groundwater to concentrations that facilitate the RAOs. The primary focus of the remediation alternatives is to remove the on-site source area for GRPH, BTEX and naphthalene.

Initial and detailed screening criteria for 12 technologies were reviewed and compared to site-specific information in order to narrow the alternatives and identify technologies that have the greatest chance of meeting MTCA cleanup standards. Table 4 provides site specific information used to evaluate remedial technology effectiveness. Tables 5 and 6 provide information on site-specific COCs.

TABLE 4: SITE CLEANUP INFORMATION SUMMARY

Parameter	Site Values
Soil Intrinsic Permeability	Silty fine to coarse sand (10-10 to 10-6 cm^2)[1]
Depth to Groundwater	Approximately 12-16 feet bgs (October 2012 To December 2013)[2]
Soil Moisture Content	Moist[3]
Presence of Low/Impermeable Layers	Not observed[3]
Heterotrophic Bacteria Count	Unknown
Soil pH	Unknown
Groundwater pH	6.72 – 8.08 su (October 2012 To December 2013)[2]
Available Nutrients (C:N:P Ratio)	Unknown
Groundwater Temperature	14.73 – 17.52 °C (October 2012 To December 2013)[2]
Maximum Groundwater TPH Concentrations	Maximum = 5.8 ppm (October 2012 To December 2013)[2]
Groundwater Heavy Metal Concentrations	Detectable lead was less than MTCA Method A cleanup levels[2]
Rainfall During Land Farming Season	Approximately 8 inches of annual precipitation[4]
Possibility of High Winds?	Yes
Soil Plasticity	Silty fine to coarse sand (assumed low)
Ferrous Iron Concentrations	Detected in MW-2 and MW-3 only. Values range from non-detectable to 1.6 mg/L (October 2012 To December 2013)[2]
Aquifer Type	Unconfined
Presence Of Free Product	None Observed
Soil Hydraulic Conductivity	Silty fine to coarse sand (10-5 To 10-1 cm/s)[5]
Is Significant Organic or Oxygen Demanding Material Present?	None observed[3]
Presence Of Subsurface Confined Spaces or Utilities?	Basements are not present. Subsurface utilities are expected.

Notes:

[1]Information provided by Exhibit II-4, (EPA 2004)
[2]As indicated by historical groundwater monitoring
[3]As indicated from site specific borings logs
[4]https://www.yakimacounty.us/about.asp
[5]Information provided by Exhibit X-5, (EPA 2004)

cm^2 = square centimeters
su = standard units
°C= Degrees Celsius
ppm = parts per million
mg/L = milligrams per liter

cm/s = centimeters per second

TABLE 5: COC VOLATILITY PROPERTIES

Compound	Boiling Points[1]	Henry's Law Constant[2]	Vapor Pressures[3]
Gasoline	40 to 225°C	NA	NA
Benzene	40 to 225°C	230 atm at 20°C	76 mm Hg at 20°C
Toluene	40 to 225°C	217 atm at 20°C	22 mm Hg at 20°C
Ethylbenzene	40 to 225°C	359 atm at 20°C	7 mm Hg at 20°C
Xylenes	40 to 225°C	266 atm at 20°C	6 mm Hg at 20°C
Naphthalene	40 to 225°C	72 atm at 20°C	0.5 mm Hg at 20°C

Notes:

[1]Information provided by Exhibit VII-7, (EPA 2004)
[2]Information provided by Exhibit VII-6, (EPA 2004)
[3]Information provided by Exhibit VII-8, (EPA 2004)

°C= Degrees Celsius
atm = Atmospheres
mm Hg = Millimeters of mercury

TABLE 6: COC SOLUBILITY PROPERTIES[1]

Compound	Molecular Weight (g/mol)	Solubility in water (g/L)	Organic Carbon Coefficient (Koc in mL/g)
Benzene	78	1.79	58
Toluene	92	0.53	130
Ethylbenzene	106	0.21	220
Xylenes	106	0.175	350
Naphthalene	128	0.031	950

Notes:

[1]Information provided by Exhibit XIII-9, (EPA 2004)
g/mol = Grams per mole;
g/L = Grams per liter;
Koc = Soil organic carbon-water partitioning coefficient
mL/g = milliliters per gram

Based on soil type, Table 4 suggests that site soils have a reduced permeability which could limit the use of certain remedial technologies. Another important aspect to consider is the presence of naphthalene as a site COC for soil. This compound has lower volatility properties as compared to other site COCs and remedial efforts dependent upon compound volatilization alone may not be easily achieved cleanup standards.

Excavation of contaminated soils was previously evaluated for the site (GeoEngineers, 2012b). Excavation would be required to dispose of material off-site or complete ex-situ remediation technologies such as off-site disposal and landfarming techniques. Remedial implementation costs for excavation and shoring alone were estimated at over $500,000 and therefore excavation of the source material was not considered as a remedial alternative because of the disproportionate cost to other available alternatives and likelihood that contamination would remain under nearby buildings and sidewalk.

After initial screening the following technologies were removed from consideration due to interpreted site-specific conditions:

- Biopiles – Biopiles involves heaping contaminated soils into piles and stimulating aerobic microbial activity within the soils through aeration and/or addition of minerals, nutrients and moisture. Space is limited and two operating businesses are present at the site. Excavation of the source material requires extensive shoring and contamination is likely present below buildings and under the side walk along East Moxee Avenue. These conditions are not favorable for this technology.
- Landfarming – Landfarming involves spreading excavated contaminated soils into a thin layer on the ground surface and stimulating aerobic microbial activity within the soils through aeration and/or addition of minerals, nutrients and moisture. These conditions are not favorable for this technology for the reasons listed above.
- Low Temperature Thermal Desorption – LTTD uses heat to physically separate petroleum hydrocarbons from excavated soils. These conditions are not favorable for this technology for the reasons listed above.
- Monitored Natural Attenuation (MNA) – MNA refers to the reliance on natural degradation processes to achieve site-specific RAOs within a time frame that is reasonable. MNA was eliminated as a primary treatment given that the contaminant mass is not expected to degrade within a reasonable period of time (10 years). Site contamination was discovered during the tank removal in 1994 and after nearly 20 years, site COC concentrations still remain greater than cleanup levels. MNA may be an appropriate technology after other remediation technologies have been implemented.

A detailed evaluation for the remaining technologies was completed as described below. The detailed evaluation generally follows the outline of the previously referenced remedial technology guidance document (EPA, 2004).

- SVE – SVE reduces contaminant concentrations of volatile constituents in petroleum products adsorbed to the soils in the vadose zone. Detailed evaluation of SVE for vadose zone remediation indicates that this could be a suitable technology for the site. The site intrinsic permeability is on the lower end of the SVE effectiveness. A pilot test conducted at the site for SVE indicated low to marginal success of this treatment technology because of an observed low radius of influence. The primary contaminants are gasoline-related which are typically easily volatilized. This technology was retained with reservations related to site soil permeability and low volatility of naphthalene.
- Bioventing – Bioventing is similar to SVE however bioventing generally promotes biodegradation as opposed to volatilization of site COCs by using lower air flow rates and might include the injection of air, oxygen and nutrients into the site soil. A detailed evaluation of bioventing indicated that this technology might not be appropriate to remediate contaminated site soil for the site. Bioventing primarily relies on aerobic processes to degrade petroleum products. Historic groundwater monitoring indicates that the site is generally anaerobic and overcoming the oxygen deficiency could be difficult. This technology ultimately was removed from further consideration, although it might be appropriate to implement after other technologies have reduced contaminant concentrations.
- AS – AS generally volatilizes constituents in petroleum products in the saturated zone through the use of air injection. In general, the primary contaminants are gasoline-related which are typically easily volatilized. The Henry's constant and vapor pressure for naphthalene is not favorable for AS, however naphthalene is a COC for soil only and therefore AS could be appropriate for groundwater. This technology was retained with reservations related to potential nearby confined spaces and the limited radius of influence identified in the pilot study.

- Biosparging – Biosparging is primarily effective to remediate contamination in saturated conditions. Biosparging is similar to air sparging however biosparging generally promotes biodegradation as opposed to volatilization of site COCs by using lower air flow rates and could include the injection of nutrients into groundwater. Although the site buildings do not contain basements, the proximity of the contamination to the roadway and presence of buildings on site indicates that confined spaces related to potential nearby sewer lines could be an issue. A detailed evaluation of biosparging indicated that this technology might not be appropriate to remediate contaminated site soils. Biosparging primarily relies on aerobic processes to degrade petroleum products. Historic groundwater monitoring indicates that the site is generally anaerobic and overcoming the oxygen deficiency could be difficult. This technology was removed from further consideration, although it might be appropriate to implement after other technologies have reduced contaminant concentrations.
- Dual-Phase Extraction (DPE) – DPE is generally a SVE system combined with pumping of groundwater to the surface for treatment or disposal. Detailed evaluation of DPE generally indicated favorable conditions for site conditions, with the exception of sorptive capacities of site COCs. DPE can be used to remediate COCs in both soil and groundwater. Higher organic carbon coefficients are not favorable for the removal of toluene, xylenes and naphthalene from the site-specific soils. This technology was eliminated because of: concerns regarding the effectiveness to remediate toluene, xylenes and naphthalene; slow aquifer recovery times observed during the pilot test; low radius of influence observed during pilot testing; lack of free product; and the anticipated expenses related to the treatment of groundwater pumped to the surface.
- Enhanced Aerobic Bioremediation – Enhanced aerobic bioremediation generally includes bioventing and biosparging and is dependent upon aerobic microbial activity to reduce contaminant concentrations. As mentioned above, low dissolved oxygen (DO) concentrations in site groundwater are not favorable for this technology and therefore it was eliminated from further consideration.
- In-situ Bioremediation – In-situ bioremediation is a technology that encourages growth and reproduction of indigenous microorganisms to enhance biodegradation of organic constituents. In-situ bioremediation can occur in oxidizing or reducing environments. A detailed evaluation of this technology indicates it could be an acceptable technology. To achieve site remediation goals, benzene will need to be reduced to less than 0.1 ppm and a TPH reduction of more than 95 percent could be required to reach MTCA Method A cleanup levels. This marginalizes the effectiveness of this technology on its own, however the technology was retained with reservations related to final cleanup goals and might be evaluated in combination with other treatment technologies such as SVE or chemical oxidation.
- In-Situ Chemical Oxidation (ISCO) – ISCO uses chemical contact and reactions with petroleum hydrocarbons to convert a hydrocarbon mass to carbon dioxide and water. Chemical oxidants include hydrogen peroxide, permanganate and ozone. Initial screening indicated that site utilities might be an issue for this technology. The full extent and location of site utilities is not fully defined. Use of chemical oxidation could impact nearby utilities from heat generation, VOC vapors, elevated oxygen levels and potential corrosion to buried metal utilities. In addition, the site oxidant demand is not fully defined; therefore, this technology was retained with reservations related to additional information required to evaluate existing site utilities and site specific oxidant demand.

The results of the above-detailed evaluation were used to develop three remedial alternatives for the site. The remedial alternatives generally represent a combination of treatment technologies. Treatment technologies used in combination with others generally provides added benefits to the remedial alternatives. For example, SVE can be used with other treatment technologies to mitigate concerns of vapor intrusion into confined spaces in close proximity to the site.

Description of Remedial Alternatives

General

Based on detailed screening, three remedial alternatives (Alternatives 1 through 3) were developed. The three selected remedial alternatives provide a range of permanent cleanup actions for contaminated soil and groundwater at the site (refer to Comparison of Remediation Options, Table 7). Each remedial alternative includes two years of quarterly groundwater monitoring. The proposed alternatives are:

- Alternative 1 – AS and SVE
- Alternative 2 – ISCO and bioremediation through lance injection and direct groundwater injection
- Alternative 3 – ISCO and bioremediation through infiltration trench and direct groundwater injection

Alternative 1 – AS and SVE

Alternative 1 generally consists of applying a vacuum to the vadose zone and injecting air into the saturated zone. Injection and extraction zones can be installed horizontally or vertically. Trenches excavated to place piping will be backfilled with imported fill and paved with hot-mix asphalt (HMA). Airflow rates can be adjusted and/or nutrients added to stimulate microbial degradation for the treatment alternative. An SVE/AS pilot test was completed for the site (GeoEngineers, 2014b). Based upon the results of the pilot test, approximately 11 SVE wells and 9 AS wells could be required.

The SVE pilot test indicated BTEX and total hydrocarbons (THC) vapor concentrations of 123 and 3,070 parts per million-volume, respectively, in air removed from the SVE well, which indicates that the SVE system will need to be treated using activated carbon. If vapor concentrations lead to breakthrough of the activated carbon relatively quickly, then other exhaust treatment alternatives will be considered, such as a catalytic oxidizer. For the purpose of this study, activated carbon treatment was assumed to estimate cost and maintenance requirements.

Vapor and groundwater sampling will be conducted during system operation to assess the system performance, modify the effectiveness of the treatment alternative and evaluate the carbon treatment efficiency. After vapor and groundwater samples indicate a reduction in COC concentrations consistent with remedial objectives, soil borings will be advanced to collect compliance samples.

Alternative 1 provides protection of human health and the environment as a permanent cleanup alternative. This alternative has the capability to remediate soil and groundwater inaccessible by excavation, such as beneath the building, depending on the radius of influence and location of extraction and injection wells. The estimated radius of influence from the pilot testing indicated that the radius of influence might not be sufficient to address the approximated extent of contamination under the buildings. The total estimated cost for Alternative 1 including design, implementation, monitoring and reporting is $631,800. Design and implementation costs are approximately $428,500 (without a 20 percent contingency).

Alternative 2 – ISCO and Bioremediation through Lance Injection and Direct Groundwater Injection

Alternative 2 consists of applying a chemical oxidant, microbes and nutrients through lance injection coupled with direct injection to groundwater. This technology primarily relies on chemical oxidation followed up by anaerobic respiration to remediate the subsurface. Approximately 100 lance injection points (1-inch-diameter and no greater than 10 feet deep) will be advanced in the interpreted zone of vadose contamination. Approximately 85 injection points will be located outside and 15 injection points will be performed inside the buildings. Lance injection points will be distributed in an approximate 7-foot center grid pattern and should be kept approximately 6 feet away from existing subsurface utilities. Approximately three new groundwater injection wells near the interpreted source area and upgradient will be installed to groundwater for a total of six injection wells. Lance injection points will be used to dose the vadose zone with oxidants, surfactants, nutrients and microbes to breakdown gasoline contamination in the soil. Injection wells will be used to dose groundwater with the same products.

The oxidant application will consist of NoviOx™ (chemical oxidant) followed by AM3™ (microbes), AnoxEA-aq™ (biological oxidants) and ReleaSE™ (surfactant) injected over a four day period. Upon completion of application, the lance injection points will be backfilled with bentonite and then covered with surface materials (grass, asphalt or concrete). Oxidant metabolism and groundwater re-equilibration with the soil matrix is expected to take about 180 to 365 days.

Bench scale testing should be conducted to evaluate the effectiveness of this technology. Bench scale testing would include collecting two to three contaminated water and soil samples in the field. Water samples would be obtained from existing monitoring wells and soil samples would be collected during installation of additional monitoring wells or independently using a drill rig. Portions of the samples would be sent in for a baseline COC analysis and the remaining sample would be subjected to the product sequence described above. After a set time, the soil and water would be analyzed for site COCs to determine the treatment effectiveness.

Groundwater monitoring will be conducted 30 and 90 days after injection and will continue quarterly for 1 year to monitor remedial progress. After 1 year, remedial effectiveness will be evaluated and continued monitoring for the second year or the need for additional applications will be evaluated. Soil compliance samples will be collected after groundwater contaminant concentrations have decreased to less than MTCA Method A cleanup levels. The total estimated cost for Alternative 2 including design, implementation, monitoring and reporting is $392,940. Design and implementation costs are approximately $179,450 (without a 20 percent contingency). Costs were estimated assuming one application to the vadose zone and one application to groundwater would be required (total of two separate applications).

Alternative 2 provides protection of human health and the environment as a permanent cleanup alternative. This alternative has some capability to remediate soil and groundwater inaccessible by excavation, depending on the infiltration of the oxidants and access to buildings. Injection points can be installed from inside the buildings using this technology.

Alternative 3 – ISCO and Bioremediation through Infiltration Trench and Direct Groundwater Injection

Alternative 3 consists of installing infiltration gallery/injection wells and applying a chemical oxidant, microbes and nutrients. Alternative 3 is similar to Alternative 2 (chemical oxidation and anaerobic respiration), however the application method is different and Alternative 3 allows for more permanent infrastructure to remain in place if follow up applications are required. Shallow concentrated infiltration galleries will be installed in the interpreted zone of vadose contamination. Approximately three new groundwater injection wells near the interpreted source area and upgradient will be installed to groundwater for a total of six injection wells. Infiltration gallery locations will be backfilled with imported fill material and paved with HMA. Excess soil excavated from the infiltration galleries and soil not suitable for reuse as backfill, will be disposed at an appropriate facility as determined by conformational sampling.

Infiltration galleries will be used to dose the vadose zone with oxidants, surfactants, nutrients and microbes to breakdown gasoline contamination in the soil. Trenches should be located at least 6 feet away from existing subsurface utilities. Direct injection groundwater wells will be used to dose groundwater with the same products. A low concentration (3 to 5 percent) chemical oxidant (hydrogen peroxide) solution will be injected into the infiltration tranches and injection wells, followed by application of biological amendments. The biological amendments will consist of a TPH bacteria consortium (EXT-A2™), an enzyme accelerator (EZT-EA™) and a nutrient blend (CBN™). After injection, these products are expected to stimulate bioremediation at the site for three to six months. Injections will be repeated on a quarterly basis or as needed until contaminant concentrations have been reduced to less than MTCA Method A cleanup levels.

Bench scale testing should be conducted to evaluate the effectiveness of this technology. Bench scale testing would include collecting two to three contaminated water and soil samples in the field. Water samples would be obtained from existing monitoring wells and soil samples would be collected during installation of additional monitoring wells or independently using a drill rig. Portions of the samples would be sent in for a baseline COC analysis and the remaining sample would be subjected to the product sequence described above. After a set time, the soil and water would be analyzed for site COCs to determine the treatment effectiveness.

Groundwater monitoring will be conducted 30 and 90 days after injection and will continue quarterly for 1 year to monitor remedial progress. Soil compliance samples will be collected after groundwater contaminant concentrations have decreased to less than MTCA Method A cleanup levels. The total estimated cost for Alternative 3 including design, implementation, monitoring and reporting is $500,693. Design and implementation costs are approximately $269,244 (without a 20 percent contingency). Costs were estimated assuming four applications would be required.

Alternative 3 provides protection of human health and the environment as a permanent cleanup alternative. This alternative has some capability to remediate soil and groundwater inaccessible by excavation, depending on the infiltration of the products and allows for multiple applications to the vadose zone. This alternative could also be modified to include a water recirculation system to remove groundwater, amend it with ISCO and bioremediation products, and then infiltrate it back through the vadose zone and into the direct injection groundwater wells. Infiltration trenches can also be connected to fans and blowers in the future to modify the system for SVE or bioventing.

EVALUATION CRITERIA

This section presents a description of the threshold requirements for cleanup actions under MTCA and the additional criteria used in this FFS to evaluate the cleanup action alternatives.

Each remediation alternative was assessed relative to the MTCA requirements referenced below. A more detailed discussion of each requirement and its applicability to the remediation alternatives is discussed in "Evaluation Criteria."

- Threshold Requirements – WAC 173-340-360(a)
- Other Requirements – WAC 173-340-360(b)
- Disproportionate Cost Analysis (DCA) – WAC 173-340-360(e & f)

Threshold Requirements

Cleanup actions performed under MTCA must comply with several basic requirements. Cleanup action alternatives that do not comply with these criteria are not considered suitable cleanup actions. As provided in WAC 173-340-360(2)(a), the four threshold requirements for cleanup actions must:

- Protect human health and the environment;
- Comply with cleanup standards (WAC 173-340-700 through -760);
- Comply with applicable state and federal laws (WAC 173-340-710); and
- Provide for compliance monitoring (WAC 173-340-410 and WAC 173-340-720 through -760).

Protection of Human Health and the Environment

The results of cleanup actions performed under MTCA must ensure that both human health and the environment are protected.

Compliance with Cleanup Standards

Compliance with cleanup standards require, in part, that cleanup levels are met at the applicable points of compliance. If a remedial action does not comply with cleanup standards, the remedial action is an interim action, not a cleanup action. When a cleanup action involves containment of soils with hazardous substance concentrations exceeding cleanup levels at the point of compliance, the cleanup action may be determined to comply with cleanup standards, provided the requirements specified in WAC 173-340-740(6)(f) are met.

Cleanup alternatives must also comply with applicable or relevant and appropriate requirements (ARARS) in accordance with WAC 173-340-710. An evaluation of the ARARs potentially applicable to each remedial alternative was completed and is summarized in Summary of ARARs, Table 8. The remedial alternatives evaluated in this FFS comply with the intent of these laws and statutes and are protective of human health and the environment.

Compliance with Applicable State and Federal Laws

Cleanup actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710.

Provision for Compliance Monitoring

The cleanup action must allow for compliance monitoring in accordance with WAC 173-340-410. Compliance monitoring consists of protection monitoring, performance monitoring and confirmation monitoring. Protection monitoring is conducted to confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of a cleanup action. Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards and, if appropriate, remediation levels or other performance standards. Confirmation monitoring (groundwater and/or soil) is conducted to confirm the long-term effectiveness of the cleanup action once cleanup standards and, if appropriate, remediation levels or other performance standards have been attained.

Other MTCA Requirements

Under MTCA, when selecting from the alternatives that meet the minimum requirements described above, the alternatives shall be further evaluated against the following additional criteria:

Use permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]

MTCA requires that when selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]. MTCA specifies that the permanence of these qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a "disproportionate cost analysis" in accordance with WAC 173-340-360(3)(e). The criteria for conducting this analysis are described below.

Provide a reasonable restoration time frame [WAC 173-340-360(2)(b)(ii)]

In accordance with WAC 173-340-360(2)(b)(ii), MTCA places a preference on those cleanup action alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. MTCA includes a summary of factors to be considered in evaluating whether a cleanup action provides for a reasonable restoration time frame [WAC 173-340-360(4)(b)].

Consideration of public concerns [WAC 173-340-360(2)(b)(iii)]

Ecology will consider public comments submitted during the FFS process when making its preliminary selection of an appropriate cleanup action alternative. This preliminary selection is subject to further public review and comment when the proposed remedy is published in the draft cleanup action plan (CAP).

MTCA Disproportionate Cost Analysis

The MTCA disproportionate cost analysis (DCA) is used to evaluate which of the alternatives that meet the threshold requirements are permanent to the maximum extent practicable. This analysis involves comparing the costs and benefits of alternatives and selecting the alternative with incremental costs that are not disproportionate to the incremental benefits. The evaluation criteria for the disproportionate cost analysis are specified in WAC 173-340-360(2) and WAC 173-340-360(3), and include protectiveness, permanence, cost, long-term effectiveness, management of short-term risks, implementability and consideration of public concerns.

As outlined in WAC 173-340-360(3)(e), MTCA provides a methodology that uses the criteria below to determine whether the costs associated with each cleanup alternative are disproportionate relative to the incremental benefit of the alternative above the next lowest-cost alternative. The comparison of benefits relative to costs may be quantitative, but will often be qualitative. When possible for this FFS, quantitative factors were compared to costs for the alternatives evaluated, but many of the benefits associated with the criteria described below were necessarily evaluated qualitatively. Costs are disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental degree of benefits achieved by the other lower-cost alternative [WAC-173-340-360(e)(i)]. Where two or more alternatives are equal in benefits, Ecology selects the less costly alternative [WAC 173-340-360(e)(ii)(c)].

Each of the MTCA criteria used in the DCA is described below.

Protectiveness

The overall protectiveness of each alternative is evaluated based on several factors. First, the extent to which human health and the environment are protected and the degree to which overall risk at a site is reduced are considered. Both on-site and off-site risk reduction resulting from implementing the alternative are considered.

Permanence

MTCA specifies that when selecting a cleanup action alternative, preference shall be given to actions that are "permanent solutions to the maximum extent practicable." Evaluation criteria includes the degree to which the alternative permanently reduces the toxicity, mobility or mass of hazardous substances; the effectiveness of the alternative in destroying the hazardous substances; the reduction or elimination of hazardous substance releases and sources of releases; the degree of irreversibility of waste treatment processes; and the characteristics and quantity of treatment residuals generated.

Cost

The analysis of cleanup action alternative costs under MTCA includes costs associated with implementing an alternative including design, construction, long-term monitoring and institutional controls. Costs are intended to be comparable among different alternatives to assist in the overall analysis of relative costs and benefits of the alternatives. The costs to implement an alternative include the cost of construction, the net present value of any long-term costs and agency oversight costs. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs and the cost of maintaining institutional controls. Unit costs used to develop overall remediation costs for this FFS were derived using a combination of construction cost estimates solicited from applicable vendors and contractors; a review of actual costs incurred during similar applicable projects; and professional judgment.

Long-Term Effectiveness

Long-term effectiveness is a parameter that expresses the degree of certainty that the alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the cleanup action. The MTCA regulations contain a specific preference ranking for different types of technologies that will be considered as part of the comparative analysis. The ranking places the highest preference on technologies such as reuse/recycling, treatment, immobilization/solidification and disposal in an engineered, lined and monitored facility. Lower preference rankings are applied for technologies such as on-site isolation/containment with attendant engineered controls, and institutional controls and monitoring.

Management of Short-term Risks

Evaluation of this criterion considers the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry short-term risks such as potential mobilization of contaminants during construction or safety risks typical of large construction projects. Some short-term risks can be managed through best practices during project design and construction, while other risks are inherent to project alternatives and can offset the long-term benefits of an alternative.

Implementability

Implementability is an overall metric expressing the relative difficulty and uncertainty of implementing the cleanup action. Evaluation of implementability includes consideration of technical factors such as the availability of mature technologies and experienced contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting and completing the cleanup.

Consideration of Public Concerns

The public involvement process under MTCA is used to identify potential public concerns regarding cleanup action alternatives. The extent to which an alternative addresses those concerns is considered as part of the evaluation process. This includes concerns raised by individuals, community groups, local governments, tribes, federal and state agencies, and other organizations that may have an interest in or knowledge of the site. In particular, public concerns for this site generally would be associated with environmental issues and cleanup action performance, which are addressed under other criteria such as protectiveness and permanence.

EVALUATION, COMPARISON AND RECOMMENDATION OF CLEANUP ALTERNATIVES

This section provides an evaluation and comparative analysis of cleanup action alternatives developed for the site. The alternatives are evaluated with respect to the MTCA evaluation criteria described above and then compared to each other relative to its expected performance under each criterion. The components of the three remedial alternatives are described above and summarized in Table 7. Detailed evaluation of the alternatives is presented in Evaluation of Cleanup Action Alternatives, Table 9, and the results of the evaluation are summarized in Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives, Table 10.

In order to evaluate reasonableness of costs, planning level estimates were developed for each remedial alternative. While in our judgment adequate for planning purposes, final cost estimates will depend on the specific final remedial design. Please note that: (1) the estimated costs for each alternative are considered to be within a margin of +/- 20 percent; (2) unit costs were derived from recent similar projects or from local vendors; (3) long-term monitoring and maintenance costs beyond 2 years are not included in the estimates; and (4) costs are based on 2014 dollars.

Figure 4 compares the DCA analysis total score and the estimated cost to implement each alternative. The DCA analysis is presented in Table 9 and summarized in Table 10. Estimated costs for each alternative are presented in: Alternative 1: Install Soil Vapor Extraction and Air Sparge Treatment System, Table 11; Alternative 2: ISCO and Bioremediation Through Lance Injection and Direct Groundwater Injection, Table 12; and Alternative 3: ISCO and Bioremediation Through Infiltration Trench and Direct Groundwater Injection, Table 13.

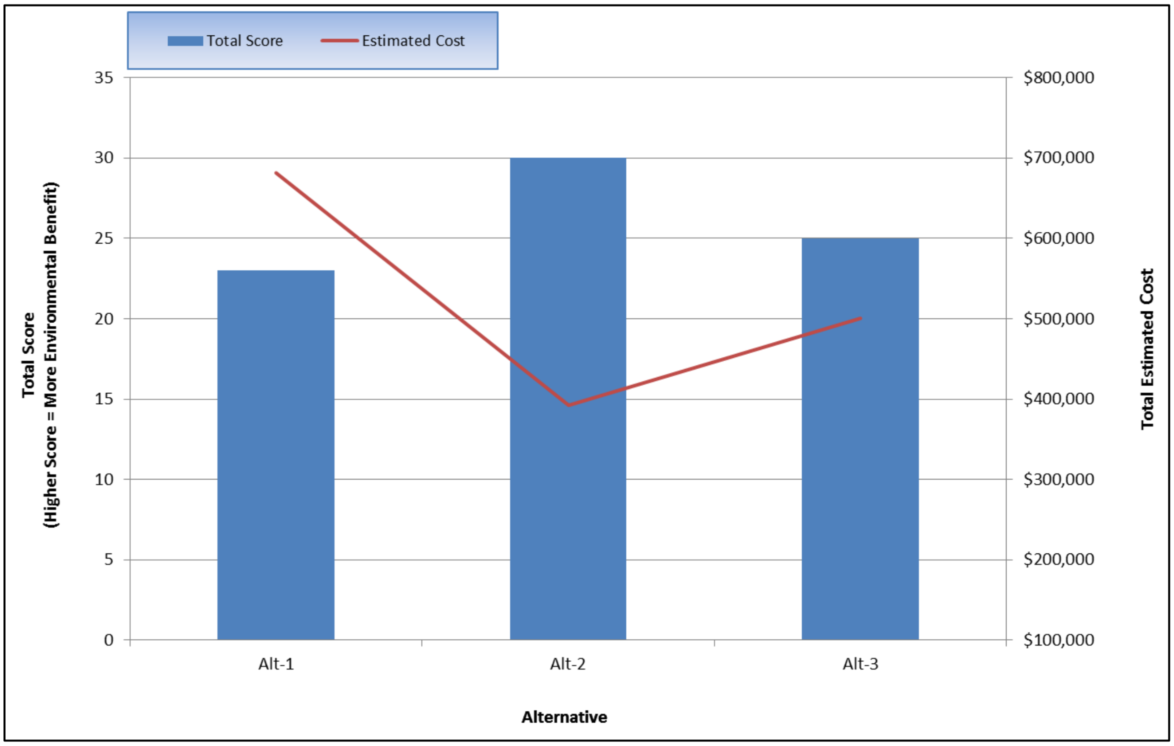

Figure 4: Disproportionate Cost Analysis Summary

Based on the Minimum Threshold, Other Criteria and Disproportionate Cost Analysis, remedial Alternative 2 is the preferred alternative. Alternative 1 had the highest costs and the lowest environmental benefits. Alternative 3 had less environmental benefit than Alternative 2, and the costs were higher. Alternative 2 requires minimal maintenance (unlike Alternative 1) because there is no active remediation system to operate and maintain. In compliance with MTCA [WAC 173-340-360(3)(e)(ii)(c)], Alternative 2 should be the preferred remedial alternative.

Alternative 2 provides both soil and groundwater remediation through ISCO and enhanced bioremediation. Like Alternative 3, chemical oxidants, bacteria and surfactants are injected in wells and infiltration galleries to dose both the vadose zone and groundwater. The primary difference between Alternatives 2 and 3 is the cost associated with installing more permanent infrastructure (infiltration galleries), application of products from within buildings and the assumption that Alternative 2 will be effective after one concentrated application to the vadose zone and a follow up application to the saturated zone.

Vapor production and intrusion during remedial efforts should be considered. Positive and negative pressure sub slab ventilation systems can be installed to assist with controlling vapor intrusion. Ventilation systems can utilize either active or passive system to assist with controlling vapor intrusion. A detailed evaluation of potential vapor production and intrusion as a result of the remedial action should be completed as part of the final remedial design.

REFERENCES

EPA, 1998. "Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA."

EPA, 2004. "How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers. EPA 510-B-95-007."

GeoEngineers, 2012a. "Soil Assessment, Frenchies' Fill-N-Food, Moxee, Washington." May 21, 2012.

GeoEngineers, 2012b. "Work Plan, Interim Action (Source Removal), Frenchies' Fill-N-Food, Moxee, Washington." December 21, 2012.

GeoEngineers, 2013a. "Soil and Groundwater Assessment, Frenchies' Fill-N-Food, Moxee, Washington." June 6, 2013.

GeoEngineers, 2013b. "Quarterly Groundwater Assessment, First Quarter 2013, Frenchies' Fill-N-Food, Moxee, Washington." June 7, 2013.

GeoEngineers, 2013c. "Quarterly Groundwater Assessment, Second Quarter 2013, Frenchies' Fill-N-Food, Moxee, Washington." December 12, 2013.

GeoEngineers, 2013d. "Quarterly Groundwater Assessment, Third Quarter 2013, Frenchies' Fill-N-Food, Moxee, Washington." December 12, 2013.

GeoEngineers, 2014a. "Data Gap investigation Report, Frenchies' Fill-N-Food, Moxee, Washington." April 3, 2014.

GeoEngineers, 2014b. " Soil Vapor Extraction and Air Sparge pilot Test Results." April 3, 2014.

GeoEngineers, 2014c. "Quarterly Groundwater Assessment, First Quarter 2014, Frenchies' Fill-N-Food, Moxee, Washington." June 13, 2014.

Model Toxics Control Act Cleanup Regulation Chapter 173-340 of the Washington Administrative Code, Revised November 2007.

TABLES

Table 7

Comparison of Remediation Options

Frenchies' Fill-N-Food

Moxee, Washington

Remedial Method	Conceptual Description	Benefits	Limitations	Relative Cost	Construction Feasibility	Duration of Installation	Duration of Treatment	Duration of O&M	Impacts to Future Development, Adjacent Land Uses	Recommended for Further Consideration
Alternative 1: Install a soil vapor extraction (SVE) and air sparge (AS) remediation system.	Install SVE extraction and AS injection wells. Design and construct remediation system. Collect performance vapor samples and optimize system operations after startup. SVE exhaust will be treated by activated carbon or catalytic oxidizer. Maintenance and exhaust monitoring will continue for the duration of the remediation system operation (estimated to be one year). Re-pave piping trenches. Groundwater monitoring for 2 years.	Permanent cleanup option with little to no long-term on-site liability. Some disturbance to site operations during pipe trench installation. Can be used under buildings. Readily available equipment and easy installation. Easily combined with other technologies. Requires no removal, storage or discharge considerations for groundwater.	High long-term costs for carbon exchange, performance sampling, and system operation and maintenance. Remediation time Might be longer when compared to other alternatives. Might require restrictive covenant if residual contamination remains under buildings and sidewalk. Might require air permits and UIC registration. Potential to induce contaminant migration. Possible vapor migration.	High	Easy to Moderate	One week to install SVE/AS wells. Four weeks to install piping, blower system, and treatment comound.	One year	1 year. Includes vapor treatment monitoring, carbon exchanges, systems restarts	Might leave impacted soil under buildings and sidewalk to the north.	**YES** - High MTCA Preference, However, expensive with limited radius of influence
Alternative 2: Lance application of chemical oxidants and microbes to vadose zone and direct injection into saturated zone.	Install approximately 100 vertical injection points (85 outside and 15 inside buildings). Injection points would be approximately one inch in diameter and installed to a depth no greater than 10 feet. Chemical oxidants and microbial/nutrient solutions NovIOX™, AnoxEA® AQ, ReleaSE-Dx ™ and AM3-S ™ would be sequentially applied to the vadose zone. Downward migration to the saturated zone is expected using this technology. An additional application to the saturated zone using 3 new wells and 3 existing wells is also included. Groundwater monitoring for 2 years.	Permanent cleanup option with little to no long-term on-site liability. Relatively easy implementation and little or no maintenance requirements. Rapid reduction of contaminants. VOC-off gas can be minimized through control of application rate and dosing concentrations. Can be combined with other technologies.	Might require multiple oxidant applications. Might require restrictive covenant if residual contamination remains under buildings and sidewalk. Might require UIC registration. Possible contaminant rebound. Plume Might be altered by treatment. Might cause aquifer clogging, Chemicals Might react with soil reducing effectiveness. Generally a single application with no allowance for future applications to vadose zone. Potential for VOC off-gassing. Will require vapor intrusion contingency planning.	Low	Easy	Two days to Install new injection wells. Five days per ISCO application.	Six to 12 months	Two days for 30 day and 90 day groundwater sampling events	Might leave impacted soil under buildings and sidewalk to the north.	**YES** - High MTCA preference, relatively easy to implement.
Alternative 3: Install infiltration galleries and injection wells and apply chemical oxidants and microbes.	Install infiltrations galleries at about 5 feet bgs in the contaminated area. Install approximately 3 injection wells to groundwater and utilize 3 existing wells. Apply an initial low-concentration oxidant dose (hydrogen peroxide) over a 1-3 day period. After the low concentration oxidant is applied, microbes, an enzyme accelerator (EZT-A2™and EZT-EA™) and nutrients (CBN™) will be applied over a two day period. Re-pave infiltration galleries. Bioremediation is anticipated to occur for 3- 6 months with the recommended program. Groundwater monitoring should be collected after 6 months to evaluate remedial efforts and additional dosage. Re-pave infiltration trenches. Groundwater monitoring for 2 years.	Permanent cleanup option with little to no long-term on-site liability. Some disturbance to site operations during trench installation. Can be used under buildings. Readily available equipment and easy installation. Easily combined with other technologies. Requires no removal, storage or discharge considerations for groundwater. Permanent cleanup option with little to no long-term on-site liability. Relatively easy implementation and little or no maintenance requirements. Rapid reduction of contaminants. VOC-off gas can be minimized through control of application rate and dosing concentrations. Provides infrastructure for future applications.	Might require multiple oxidant applications. Might require restrictive covenant if residual contamination remains under buildings and sidewalk. Will require UIC registration. Possible contaminant rebound. Plume Might be altered by treatment. Might cause aquifer clogging. Chemicals Might react with soil reducing effectiveness. Potential for VOC off-gassing. Will require vapor intrusion contingency planning.	Moderate	Easy to Moderate	Two weeks to Install trenches and new injection wells. Five days per ISCO application	Three to 12 months per application	Two days for 30 day and 90 day groundwater sampling events	Might leave impacted soil under buildings and sidewalk to the north.	**YES** - High MTCA preference, relatively easy to implement.

Table 8
Summary of ARARs
Frenchies' Fill-N-Food
Moxee, Washington

ARAR	Regulated Activity	Alternative 1	Alternative 2	Alternative 3	Evaluation
Yakima County Codes					
Municipal Code 12.10	Stormwater Management Regulations	Does Not Apply	Does Not Apply	Does Not Apply	Less than one acre of distrubance is anticipated
Municipal Code 6.28	Noise Control	Applies	Applies	Applies	Construction actions will meet the requirements of this chapter.
Washington State					
Yakima Clean Air Agency	Emissions	Applies	Does Not Apply	Applies	Notice of Construction required for new potential emission sources.
Washington Administrative Code 173-400	Emissions	Applies	Does Not Apply	Applies	Regulates potential air pollution. Administrated through Yakima Clean Air Agency
Washington Administrative Code 173-460	Emissions	Applies	Does Not Apply	Applies	New source emmissions standards
Washington Administrative Code 173-201A	Water Quality Standards for Surface Waters	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Washington Administrative Code 173-218	Underground Injection Controls	Applies	Applies	Applies	Injection wells used for remediation wells receiving fluids intended to clean up, treat or prevent subsurface contamination are Class V injection wells. WAC definition of fluid includes semi-solid, liquid, sludge, gas or any other form or state.
Washington Administrative Code 173-303	Dangerous Waste Management	Does Not Apply	Does Not Apply	Does Not Apply	It is unlikely impacted soil and/or groundwater will designate as a dangerous waste.
Washington Administrative Code 173-340	Toxic Waste Cleanup (MTCA)	Applies	Applies	Applies	The remedial action will be conducted under MTCA. Remedial alternatives will comply with MTCA regulations.
Washington Administrative Code 197-11 and 173-802	State Environmental Policy Act	Applies	Applies	Applies	A SEPA review is required for projects with potential significant environmental impacts.
RCW 90.48	Water Pollution Control (Construction Stormwater Permit)	Does Not Apply	Does Not Apply	Does Not Apply	A Stormwater Pollution Prevention Plan (SWPPP) is required for the applicable remediation alternatives.
Washington Administrative Code 173-160	Construction and Maintenance of Wells	Applies	Applies	Applies	Requirements are applicable to construction of monitoring wells and soil borings
Washington Administrative Code 173-216	State Waste Discharge Program	Applies	Applies	Applies	Applies to the injection of fluids into the subsurface
Washington Administrative Code 173-162	Rules and Regulations Governing the Licensing of Well Contractors and Operators	Applies	Applies	Applies	The regulation establishes training standards for well contractors and operators
Federal Regulations					
Title 40 Code of Federal Regulations 131	Water Quality Standards (National Toxics Rule)	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 141	Drinking Water Regulations	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 143	National Secondary Drinking Water Standards	Applies	Applies	Applies	MTCA requires these be considered in establishing cleanup levels.
Title 40 Code of Federal Regulations 260-268	Hazardous Waste (RCRA)	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 33 of United States Code, Chapter 26	Water Pollution Control (Clean Water Act)	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 50	Clean Air Act	Applies	Does Not Apply	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 58	Ambient Air Quality Monitoring	Applies	Does Not Apply	Applies	MTCA requires cleanup actions comply with applicable regulations.

Table 9

Evaluation of Cleanup Action Alternatives

Frenchies' Fill-N-Food

Moxee, Washington

Alternative Numbers	Alternative 1	Alternative 2	Alternative 3
Alternative Descriptions	Alternative 1: Install a soil vapor extraction (SVE) and air sparge (AS) remediation system.	Alternative 2: Lance application of chemical oxidants and microbes to vadose zone and direct injection into saturated zone.	Alternative 3: Install infiltration galleries and injection wells and apply chemical oxidants and microbes.
	Install SVE extraction and AS injection wells. Design and construct remediation system. Collect performance vapor samples and optimize system operations after startup. SVE exhaust will be treated by activated carbon or catalytic oxidizer. Maintenance and exhaust monitoring will continue for the duration of the remediation system operation (estimated to be one year). Re-pave piping trenches. Groundwater monitoring for 2 years.	Install approximately 100 vertical injection points (85 outside and 15 inside buildings). Injection points would be approximately one inch in diameter and installed to a depth no greater than 10 feet. Chemical oxidants and microbial/nutrient solutions NovIOX™, AnoxEA® AQ, ReleaSE-Dx ™ and AM3-S ™ would be sequentially applied to the vadose zone. Downward migration to the saturated zone is expected using this technology. An additional application to the saturated zone using 3 new wells and 3 existing wells is also included. Groundwater monitoring for 2 years.	Install infiltrations galleries at about 5 feet bgs in the contaminated area. Install approximately 3 injection wells to groundwater and utilize 3 existing wells. Apply an initial low-concentration oxidant dose (hydrogen peroxide) over a 1-3 day period. After the low concentration oxidant is applied, microbes, an enzyme accelerator (EZT-A2™and EZT-EA™) and nutrients (CBN™) will be applied over a two day period. Re-pave infiltration galleries. Bioremediation is anticipated to occur for 3- 6 months with the recommended program. Groundwater monitoring should be collected after 6 months to evaluate remedial efforts and additional dosage. Re-pave infiltration trenches. Groundwater monitoring for 2 years.
Approximate Volume of Contaminated Soil Removed (cubic yards)	45 (trench spoils from pipe installation. Might be reusable as trench backfill).	Negligible (spoils from lance injections).	100 (spoils from infiltration galleries installation. Might be reusable as backfill).
Alternative Ranking Under MTCA			
1. Compliance with MTCA Threshold			
Protection of Human Health and the Environment	Yes- Alternative will protect human health and the environment	Yes - Alternative will protect human health and the environment.	Yes - Alternative will protect human health and the environment.

Alternative Numbers	Alternative 1		Alternative 2		Alternative 3	
Compliance with Cleanup Standards	Yes - impacted soil and groundwater will be remediated in-place.		Yes - impacted soil and groundwater will be remediated in-place. Might leave impacted soil under building and below sidewalk to the north.		Yes - impacted soil and groundwater will be remediated in-place. Might leave impacted soil under building and below sidewalk to the north.	
Compliance with Applicable State and Federal Regulations	Yes - Alternative complies with applicable state and federal regulations		Yes - Alternative complies with applicable state and federal regulations		Yes - Alternative complies with applicable state and federal regulations	
Provision for Compliance Monitoring	Yes - Alternative includes provision for compliance monitoring (i.e., vapor and groundwater sampling during system operation and soil sampling after remedial actions).		Yes - Alternative includes provision for compliance monitoring (i.e. groundwater monitoring and soil sampling after remedial actions).		Yes - Alternative includes provision for compliance monitoring (i.e. groundwater monitoring and soil sampling after remedial actions).	
2. Restoration Time Frame						
	Initial remediation timeframe is moderate (estimated at 1 year, might be longer depending on effectiveness of the remediation). Groundwater monitoring expected for 2 years.		Initial remediation timeframe is relatively short (estimated at about 6-12 months, might be longer depending on effectiveness of the remediation). Groundwater monitoring expected for 2 years.		Initial remediation timeframe is moderate (estimated at about 12 months, might be longer depending on effectiveness of the remediation). Groundwater monitoring expected for 2 years.	
3. Disproportionate Cost Analysis - Relative Benefits Ranking[1]		**Score**		**Score**		**Score**
Protectiveness	Moderate level of protection. SVE and AS radius of influence likely will extend beneath the building, but may not reach the full extent of interpreted extents of vadose and groundwater contamination.	3	Highest level of protection, Soil and groundwater remediation by oxidant application. Oxidant infiltration may remediate impacted soil and groundwater beneath the building. May not achieve Method A cleanup standards for soil and groundwater.	5	High level of protectiveness, Soil and groundwater remediation by oxidant application. Oxidant infiltration may remediate impacted soil and groundwater beneath the building. May not achieve Method A cleanup standards for soil and groundwater.	4
Permanence	Achieves high level of permanence. SVE/AS permanently reduces contaminant concentrations in soil and groundwater. Some contamination may remain under the buildings.	4	Achieves moderately high level of permanence. Chemical oxidant injections permanently reduce contaminant concentration in soil and groundwater.	4	Achieves high level of permanence. Chemical oxidant injections reduce contaminant concentration in soil and groundwater. Soil remaining under building may lead to recontamination.	3

Alternative Numbers	Alternative 1		Alternative 2		Alternative 3	
Long-Term Effectiveness	Permanently remediates soil and groundwater to concentrations to less than MTCA Method A cleanup levels.	4	Permanently remediates soil and groundwater to concentrations to less than MTCA Method A cleanup levels. Oxidant infiltration might not effectively remediate contaminated soil located beneath the building. Potential contaminant rebound.	3	Permanently remediates soil and groundwater to concentrations to less than MTCA Method A cleanup levels. Potential contaminant rebound.	3
Management of Short-Term Risks	Moderate short-term risks associated with operation and maintenance of the treatment system and air emissions.	3	Low short -term risks associated with installation of injection points and handling of remediation products. May impact site subsurface utilities.	4	Moderate short -term risks associated with trench installation and injection of remediation products. May impact site subsurface utilities.	3
Technical and Administrative Implementability	Implementable, technically possible. Pilot test indicated 15 foot radius of influence for SVE. Requires regular maintenance and performance sampling during the operation of the system. Carbon treatment likely required to treat exhaust and carbon requires exchange. Likely permitting requirements to discharge SVE exhaust.	3	Implementable, technically feasible. No long term maintenance. UIC regulations apply. Possibility to perform injections inside buildings. May require additional injections.	5	Implementable, technically feasible. UIC regulations apply. Requires regular maintenance and performance sampling. UIC regulations apply.	4
Consideration of Public Concerns	Public acceptance of this alternative is likely because contaminated soil is remediated. Potential public concerns regarding treatment system noise and exhaust.	3	Public acceptance of this alternative is likely because contaminated soil is remediated. Minimal disruption to the site.	4	Public acceptance of this alternative is likely because contaminated soil is remediated. Minimal disruption to the site.	4
4. Cost	$ 681,800.00	3	$ 392,940.00	5	$ 500,692.80	4
Total Score		23		30		25

Notes

[1]Alternatives were scored using a scale of 1 to 5 with a score of 1 being the least amount of benefits provided by the alternative and a score of 5 being the most amount of benefits provided by the alternative.

Table 10

Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives

Frenchies' Fill-N-Food

Moxee, Washington

	Alternative 1: Install a soil vapor extraction (SVE) and air sparge (AS) remediation system.	Alternative 2: Lance application of chemical oxidants and microbes to vadose zone and direct injection into saturated zone.	Alternative 3: Install infiltration galleries and injection wells and apply chemical oxidants and microbes.
Alternative Ranking Under MTCA			
1. Compliance with MTCA Threshold Criteria[1]	**Yes**	**Yes**	**Yes**
2. Restoration Time Frame	Initial remediation timeframe is moderate (estimated at 1 year, might be longer depending on effectiveness of the remediation). Groundwater monitoring expected for 2 years.	Initial remediation timeframe is relatively short (estimated at about 6-12 months, might be longer depending on effectiveness of the remediation). Groundwater monitoring expected for 2 years.	Initial remediation timeframe is moderate (estimated at about 12 months, might be longer depending on effectiveness of the remediation). Groundwater monitoring expected for 2 years.
3. Disproportionate Cost Analysis Relative Benefits Ranking			
Protectiveness	3	5	4
Permanence	4	4	3
Cost[2]	3	5	4
Long-Term Effectiveness	4	3	3
Management of Short-Term Risks	3	4	3
Technical and Administrative Implementability	3	5	4
Consideration of Public Concerns	3	4	4
Total of Scores	**23**	**30**	**25**
4. Disproportionate Cost Analysis			
	$681,800	**$392,940**	**$500,693**
Costs Disproportionate to Incremental Benefits	Yes	No	No
Restrictive Covenant	Building footprint	Building footprint	Building footprint
Practicability of Remedy	Practicable	Practicable	Practicable
Remedy Permanent to Maximum Extent Practicable	Yes-permanent remedy	Yes-permanent remedy	Yes-permanent remedy
Overall Alternative Ranking	**3rd**	**1st**	**2nd**

Notes:

[1]WAC 173-340-360(2)(a)

[2]Low cost is a benefit.

Table 11

Alternative 1: Install Soil Vapor Extraction and Air Sparge Treatment System

Frenchies' Fill-N-Food
Moxee, Washington

Scope Item	Unit	Unit Cost[1]	Quantity	Extended
Design Costs				
Permitting/Design/Regulatory Oversight				
Permitting[2]	lump	$5,000.00	1	$5,000
Design, work plan and procurement	lump	$30,000.00	1	$30,000
Regulatory oversight costs	lump	$10,000.00	1	$10,000
			Task Sub-Total	**$45,000**
Implementation Costs				
Remediation System Installations and Construction Field Oversight				
Construction monitoring/oversight	day	$1,500.00	15	$22,500
Install SVE/AS wells	lump	$40,000.00	1	$40,000
Purchase and install SVE/AS treatment system (includes trenching, piping, soil disposal, backfill, trench and equipment purchase)[3]	lump	$250,000.00	1	$250,000
Treatment System Operation and Maintenance				
Weekly operation visits (1 month)	day	$1,500.00	4	$6,000
Bi-monthly operation visits (2 month)	day	$1,500.00	4	$6,000
Monthly visits (9 months)	day	$1,500.00	9	$13,500
Unplanned visits (system shutdowns and maintenance)	day	$1,500.00	10	$15,000
Vapor performance samples (one inlet and one outlet sample per planned visit)	ea	$250.00	34	$8,500
Carbon exchange	lump	$12,000.00	1	$12,000
Quarterly O&M reporting	event	$2,500.00	4	$10,000
			Task Sub-Total	**$383,500**
Monitoring and Reporting Costs				
Groundwater Monitoring (2 Years)				
8 quarters groundwater monitoring (quarterly)[4]	event	$6,000.00	8	$48,000
IDW Disposal and knockout tank water disposal (bi-annually)	event	$2,500.00	4	$10,000
Compliance Monitoring and Reporting				
Advance soil borings and collect compliance samples	lump	$20,000.00	1	$20,000
Remedial action report	lump	$20,000.00	1	$20,000
			Task Sub-Total	**$98,000**
Contingency				
	Total Estimated Costs for Alternative 1			**$526,500**
Contingency	20%	$526,500.00	1	$105,300
Vapor Intrusion Mitigation	lump	$50,000.00	1	$50,000
Total Estimated Costs including Contingency - Alternative 1				**$681,800**

Notes:

[1]Unit costs derived from either recent similar project experience or estimates from local vendors. Estimated costs are considered to be within a margin of +/- 20 percent.

[2]Permitting for this alternative might include air discharge permits and SEPA review.

[3]Assumes trench spoils will be disposed at Roosevelt Regional Landfill located near Roosevelt, Washington.

[4]Actual sampling duration will depend on when groundwater cleanup levels are achieved.

ea = each unit; lump = lump sum estimate

Table 12

Alternative 2: ISCO and Bioremediation Through Lance Injection and Direct Groundwater Injection

Frenchies' Fill-N-Food
Moxee, Washington

Scope Item	Unit	Unit Cost[1]	Quantity	Extended
Design Costs				
Permitting/Design/Regulatory Oversight				
Permitting[2]	lump	$5,000.00	1	$5,000
Design, work plan and procurement	lump	$25,000.00	1	$25,000
Regulatory oversight costs	lump	$15,000.00	1	$15,000
Bench Scale Testing	lump	$10,000.00	1	$10,000
			Task Sub-Total	**$55,000**
Implementation Costs				
Injection Well Installation				
Install Injection Wells	lump	$20,000.00	1	$20,000
Construction monitoring/oversight	day	$1,500.00	3	$4,500
(Assumes one application to groundwater and one to vadose zone)[3]				
Purchase NoviOX	gallons	$200.00	23	$4,600
Purchase AnoxEA-Aq	lbs	$4.00	8,000	$32,000
Purchase ReleaSE	lump	$415.00	2	$830
Purchase AM3	lump	$200.00	2	$400
Delivery	lump	$560.00	2	$1,120
Sales Tax	lump	$1,500.00	2	$3,000
Perform Lance Injections	lump	$35,000.00	1	$35,000
Perform Groundwater Injections	lump	$8,000.00	1	$8,000
Performance Monitoring and Reporting	lump	$15,000.00	1	$15,000
			Task Sub-Total	**$124,450**
Monitoring and Reporting Costs				
Restoration and Groundwater Monitoring (2 Years)				
8 Quarters Groundwater Monitoring (Quarterly)[4]	event	$6,000.00	8	$48,000
IDW Disposal (bi-annually)	event	$2,500.00	4	$10,000
Compliance Sampling and Reporting				
Compliance Sampling	lump	$20,000.00	1	$20,000
Remedial action report	lump	$20,000.00	1	$20,000
			Task Sub-Total	**$98,000**
Contingency				
		Total Estimated Costs for Alternative 2		**$277,450**
Vapor Intrusion Mitigation	lump	$50,000.00	1	$50,000
Contingency	20%	$327,450.00	1	$65,490
		Total Estimated Costs including Contingency - Alternative 2		**$392,940**

Notes:

[1]Unit costs derived from either recent similar project experience or estimates from local vendors. Estimated costs are considered to be within a margin of +/- 20 percent.

[2]Permitting for this alternative might include a SEPA review and underground injection control (UIC) registration.

[3]Discussions with vendor indicates one application may be sufficient to remediate vadose zone.

[4]Actual sampling duration will depend on when groundwater cleanup levels are achieved.

lbs = pounds; lump = lump sum estimate

Table 13

Alternative 3: ISCO and Bioremediation Through Infiltration Trench and Direct Groundwater Injection

Frenchies' Fill-N-Food
Moxee, Washington

Scope Item	Unit	Unit Cost[1]	Quantity	Extended
Design Costs				
Permitting/Design/Regulatory Oversight				
Permitting[2]	lump	$5,000.00	1	$5,000
Design, work plan and procurement	lump	$25,000.00	1	$25,000
Regulatory oversight costs	lump	$22,000.00	1	$22,000
Bench Scale Testing	lump	$10,000.00	1	$10,000
			Task Sub-Total	**$62,000**
Implementation Costs				
Infiltration Gallery and Injection Well Installation				
and backfill)[3]	lump	$25,000.00	1	$25,000
Install Injection Wells	lump	$20,000.00	1	$20,000
Construction monitoring/oversight	day	$1,500.00	7	$10,500
Purchase and Application of Chemical Oxidants (assumes four applications)				
ETEC Injection Trailer Rental	day	$1,000.00	5	$5,000
Hydrogen Peroxide	gallons	$20.00	300	$6,000
PetroBac Product Bundle	gallons	$100.00	50	$5,000
CBN Nutrients	lbs	$3.00	1,000	$3,000
Product Shipping	lump	$950.00	1	$950
Apply Oxidants to Injection Wells and Infiltration Galleries	lump	$11,500.00	1	$11,500
Sales Tax	lump	$2,736.00	1	$2,736
Performance Monitoring and Reporting	lump	$15,000.00	1	$15,000
			Task Sub-Total	**$207,244**
Monitoring and Reporting Costs				
Maintenance and Monitoring (2 Years)				
8 quarters groundwater monitoring (quarterly)[4]	event	$6,000.00	8	$48,000
IDW Disposal (bi-annually)	event	$2,500.00	4	$10,000
Reporting and Compliance Monitoring				
Compliance Monitoring	lump	$20,000.00	1	$20,000
Remedial action report	lump	$20,000.00	1	$20,000
			Task Sub-Total	**$98,000**
Contingency				
	Total Estimated Costs for Alternative 3			**$367,244**
Vapor Intrusion Mitigation	lump	$50,000.00	1	$50,000
Contingency	20%	$417,244.00	1	$83,449
Total Estimated Costs including Contingency - Alternative 3				**$500,693**

Notes:

[1]Unit costs derived from either recent similar project experience or estimates from local vendors. Estimated costs are considered to be within a margin of +/- 20 percent.

[2]Permitting for this alternative might include SEPA review and underground injection control (UIC) registration.

[3]Assumes infiltration gallery trench spoils will be disposed at Roosevelt Regional Landfill located near Roosevelt, Washington.

[4]Actual sampling duration will depend on when groundwater cleanup levels are achieved.

lbs = pounds; lump = lump sum estimate

FIGURES

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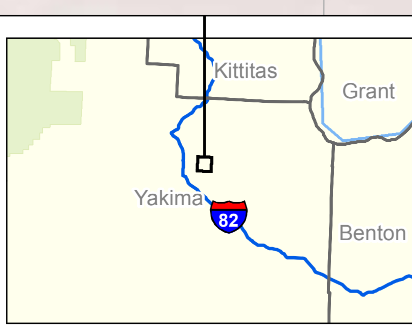

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Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Sources: ESRI Data & Maps, Street Maps 2008.
Projection: NAD 1983, UTM Zone 10 North.

Vicinity Map

Frenchies' Fill-N-Food
Moxee, Washington

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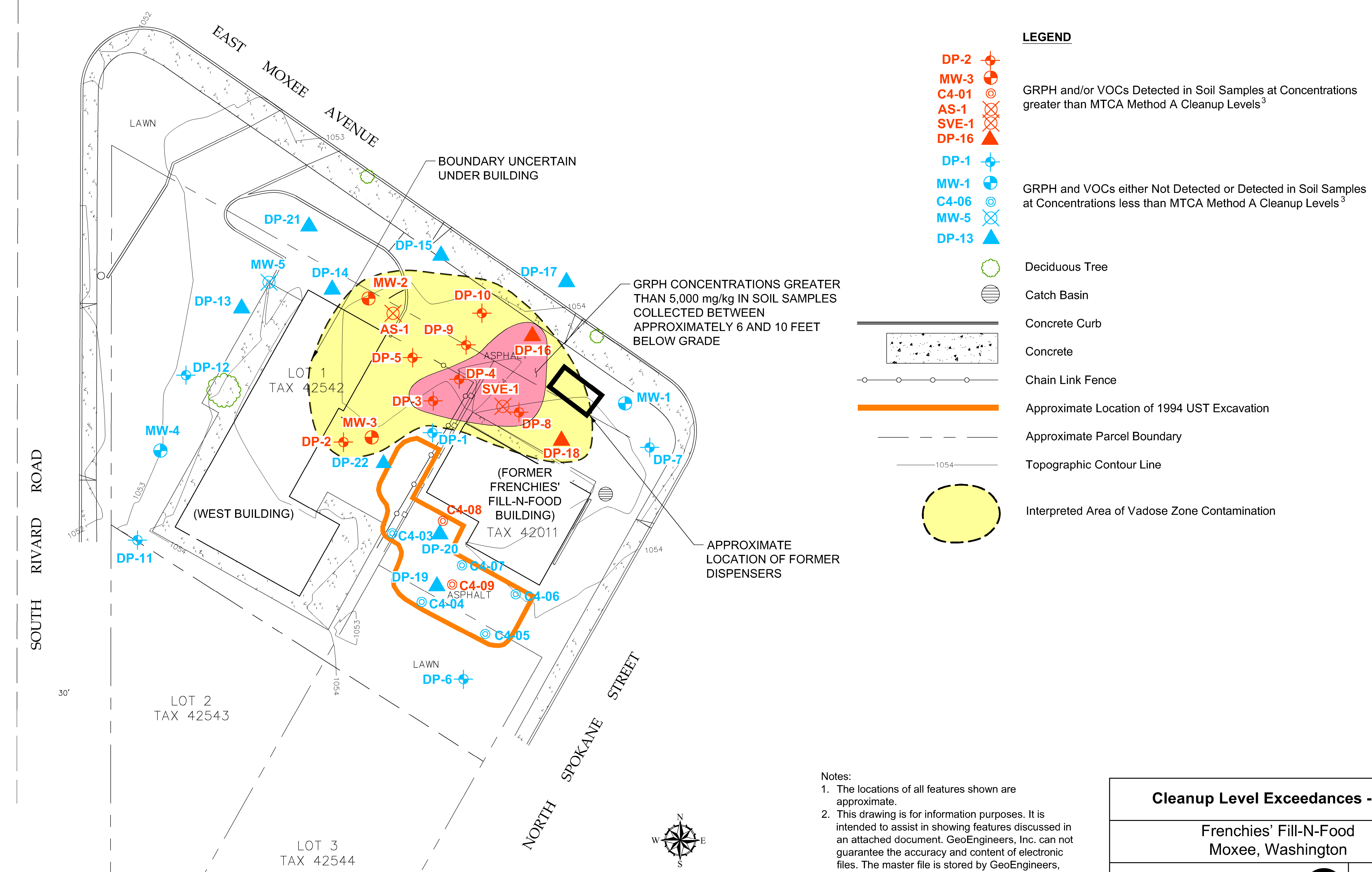
Figure 1

Office: SPO Path: W:\Spokane\Projects\0\0504075\01\GIS\MXD\050407501_F1_VicinityMap.mxd Map Revised: 2/19/2014 CRC



Notes:
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Cleanup Level Exceedances - Soil

Frenchies' Fill-N-Food
Moxee, Washington

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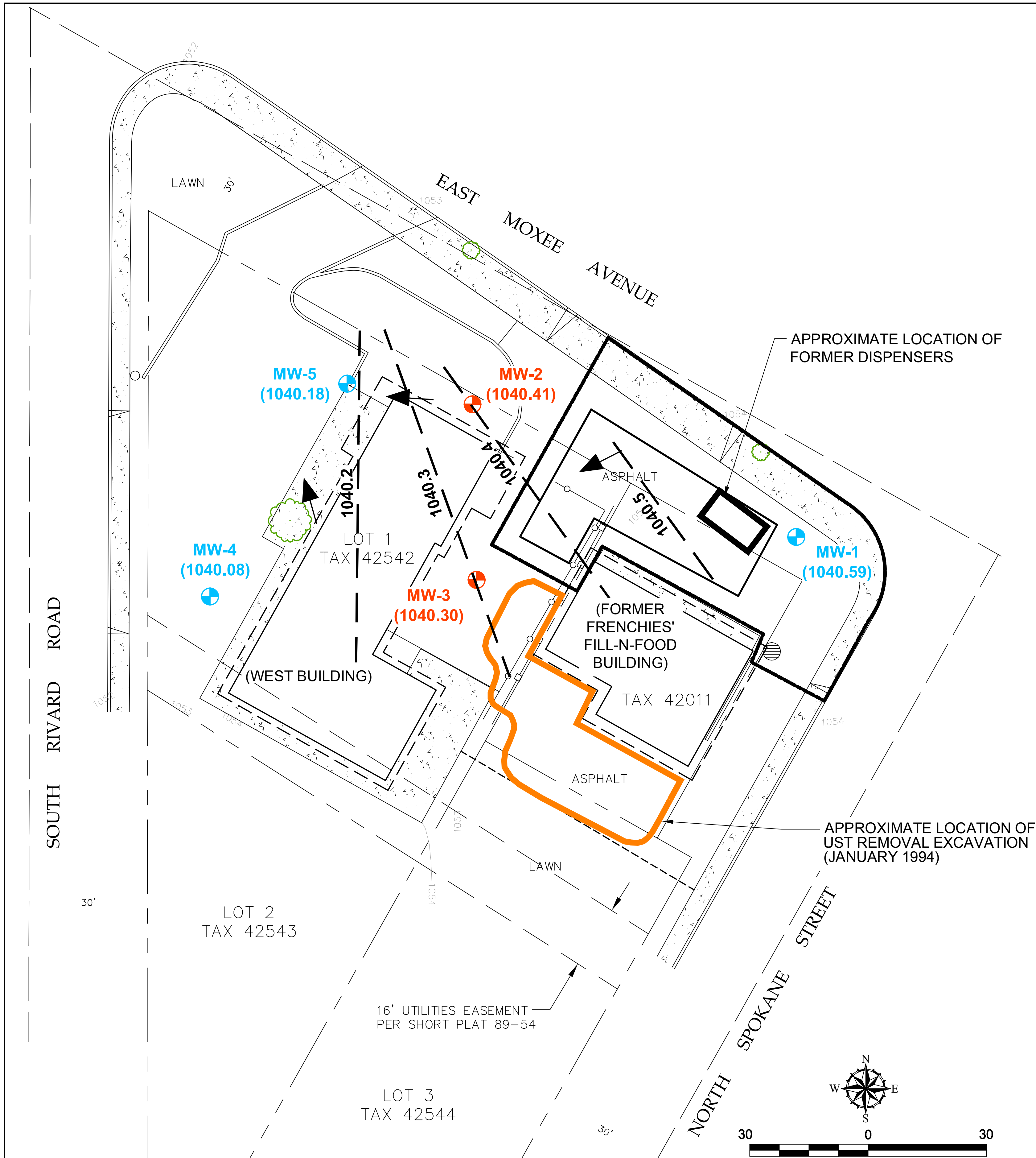
Figure 2

Reference: Base drawing adapted from survey provided by T,D & H Engineering Consultants, November 2012.

OFFICE: SPO Dwg name: W:\Spokane\Projects\0\0504075\01\CAD\Task 200\050407501_T200_F2.dwg User: mhirsch Plot time: May-08-14 @ 6:15am



Reference: Base drawing adapted from survey provided by T,D & H Engineering Consultants, November 2012.

Legend

(1041.31) MW-1	Approximate Groundwater Monitoring Well Location and Groundwater Elevation on 2/27/14
	GRPH and/or VOCs Either Not Detected or Detected at Concentrations Less Than MTCA Method A Cleanup Levels in Groundwater Sample(s)
	GRPH and/or VOCs Detected at Concentrations Greater Than MTCA Method A in Groundwater Sample(s)
1040.2	Approximate Groundwater Elevation Contour (0.2-foot contour interval)
	Interpreted Groundwater Flow Direction
	Deciduous Tree
	Catch Basin
	Concrete Curb
	Concrete
	Edge of Asphalt
	Roof Line
	Chain Link Fence
	Guard Rail
	Approximate Location of 1994 UST Excavation
	Approximate Right-of-way (ROW)
	Approximate Parcel Boundary
1054	Topographic Contour Line

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Groundwater elevations are referenced to the North American Vertical Datum of 1988 (NAVD 83)

Groundwater Elevations and Cleanup Level Exceedances Summary

Frenchies' Fill-N-Food
Moxee, Washington

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Figure 3

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