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# Common Elements

*Each proposed remedial alternative will include the following actions as common elements:*

## Dual Phase Extraction (DPE)

An example DPE system showing a vapor/water separation tank, vacuum pump, vapor treatment unit, and groundwater storage tank.

- First step in the remediation process .
- Involves removal of soil gas, non-aqueous phase liquid (NAPL), and shallow impacted groundwater from beneath the concrete pad and in the shallow zone soils (depth of 10 to 15 ft).
- Intended to control construction worker exposure to NAPL and soil gas in the shallow sub- grade.

## Limited Excavation

Example excavation being performed at another site.

- Involves demolition of existing onsite buildings, removal of the concrete pads, and excavation of soils to a depth of **5 ft**.
- Removal of significant NAPL mass from the subsurface.
- Subsurface liquids will be pumped out of the excavation in order to minimize exposure to volatile compounds.

## Monitored Natural Attenuation (MNA)

Groundwater sampling from a monitoring well.

- Natural processes contribute to reduced contaminant concentrations in groundwater.
- MNA involves groundwater monitoring to track the effectiveness of natural processes to further reduce the low levels of contaminants-of-concern (COCs) that may remain after active remedial action(s).

## Offsite Hydraulic Control

Example groundwater treatment system at another site.

- Involves extraction of groundwater from areas downgradient of the Site.
- Downgradient wells to be placed west of 3rd Street.
- Intended to prevent the expansion of the groundwater plume.

## Institutional Controls

- Administrative actions established to maintain the long-term permanence of the remedy and to control future human exposure to COCs that may remain beneath the Site.
- Examples include deed restrictions and groundwater use restrictions.

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# Remedial Alternative 2 Deep Excavation and Enhanced Anaerobic Bioremediation

*In addition to the Common Elements, Remedial Alternative 2 would involve the following actions:*

**Deep Excavation**

Example excavation being performed at a site.

- To be performed in the source areas to a depth of **10 to 15 ft**
- Intended to remove the majority of the of NAPL mass.
- Removal of NAPL would eliminate the source of contaminants-of-concern (COCs).
- Subsurface liquids will be pumped out of the excavation in order to achieve the target excavation depth of 15 ft.

**Enhanced Anaerobic Bioremediation (EAB)**

Carbon substrate injection field set-up (cheese whey is used in this example)

- Involves subsurface injection of carbon substrate (electron donor) to induce biodegradation of chlorinated COCs by microorganisms.
- EAB would be used to target COCs remaining after deep excavation.
- Example electron donors include lactate, cheese whey, and emulsified vegetable oils.

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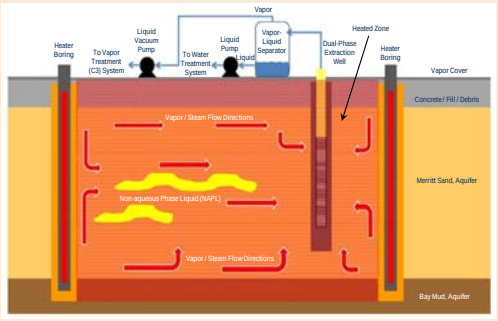
# Remedial Alternative 3
# *In-Situ* Thermal Remediation and Enhanced Anaerobic Bioremediation

*In addition to the Common Elements, Remedial Alternative 3 would involve the following actions:*

## *In-Situ* Thermal Remediation (ISTR)

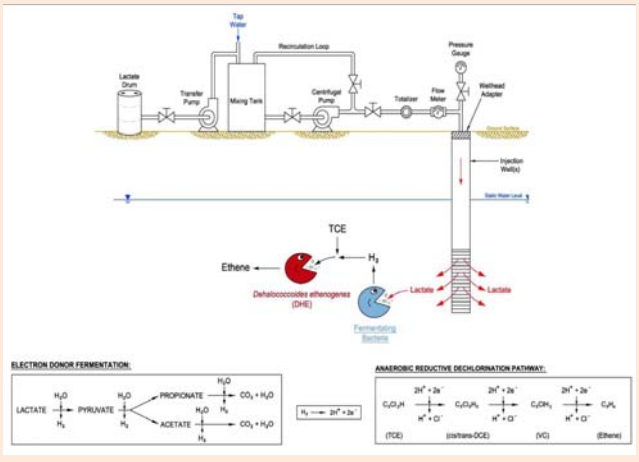

ISTR above-ground field set-up

- After **limited** excavation, ISTR would be performed in source areas.
- ISTR will volatilize the majority of chemicals-of-concern (COCs).
- Treatment depths would be from 5 to 55 feet bgs.
- Volatilized COCs would be extracted using dual-phase extraction wells, separated into liquid and vapor streams, and treated onsite.
- ISTR would operate for approximately one year.




**Schematic of ISTR mechanism of action**
**Reference: Heron, Gorm, *Thermal Treatment of Eight CVOC Source Zones to Near Nondetect Concentrations*, Groundwater Monitoring and Remediation, Vol. 29, No. 3, Summer 2009.**

## Enhanced Anaerobic Bioremediation (EAB)




- Involves subsurface injection of carbon substrate (electron donor) to induce biodegradation of chlorinated COCs by microorganisms.
- Intended to target low levels of COCs remaining following ISTR.
- Example electron donors include lactate, cheese whey, emulsified vegetable oils.

**Schematic of carbon substrate injection (lactate is used in this example)**

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# Remedial Alternative 4 Deep Excavation and Onsite Pump and Treat

*In addition to the Common Elements, Remedial Alternative 4 would involve the following actions:*

**Deep Excavation**

Example excavation being performed at another site.

- To be performed in the source areas to a depth of **10 to 15 ft.**
- Intended to remove the majority of the of NAPL mass.
- Removal of NAPL would eliminate the source of contaminants-of-concern (COCs).
- Subsurface liquids will be pumped out of the excavation in order to achieve the target excavation depth of 15 ft.

**Onsite Pump and Treat**


Example groundwater treatment system at another site.

- Involves groundwater extraction from onsite wells.
- Goals are to establish hydraulic control (i.e., prevent offsite migration) and to remove COC mass.
- Groundwater treatment would be performed at an onsite location.
- To be performed over the long-term.

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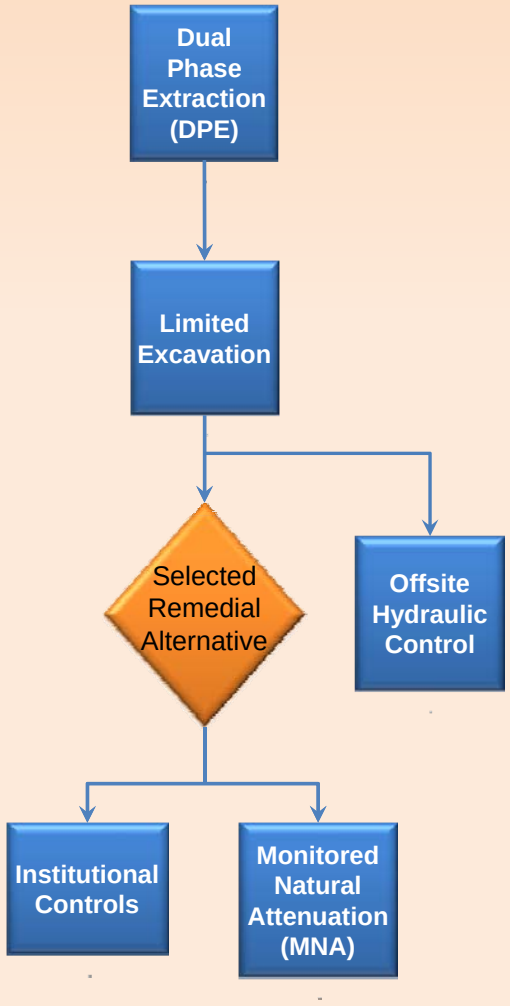
# Sequencing of Remedial Actions




**Purpose**

***DPE*** would extract and remove non-aqueous phase liquid (NAPL), impacted shallow groundwater, and soil vapor beneath the concrete pad to control construction worker exposure to chemicals-of-concern (COCs).

***Limited Excavation*** would remove NAPL and other contaminants residing in the top five feet of soil.

***Offsite Hydraulic Control*** would prevent migration of contaminated groundwater offsite and expansion of the groundwater plume.

***Selected Remedial Alternative*** would remove the majority of the contaminant source.

***Institutional Controls*** would maintain the long-term permanence of the remedy and control future human exposure to COCs beneath the Site

***MNA*** would allow monitoring of natural attenuation of the remaining low levels of COCs.

***Remedial Alternatives Under Consideration***

**Remedial Alternative 2**:
Deep Excavation and Enhanced Anaerobic Bioremediation (EAB)

**Remedial Alternative 3**:
*In-situ* Thermal Remediation (ISTR) and EAB

**Remedial Alternative 4**:
Deep Excavation and Onsite Pump and Treat

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# Vapor and Groundwater Treatment Systems

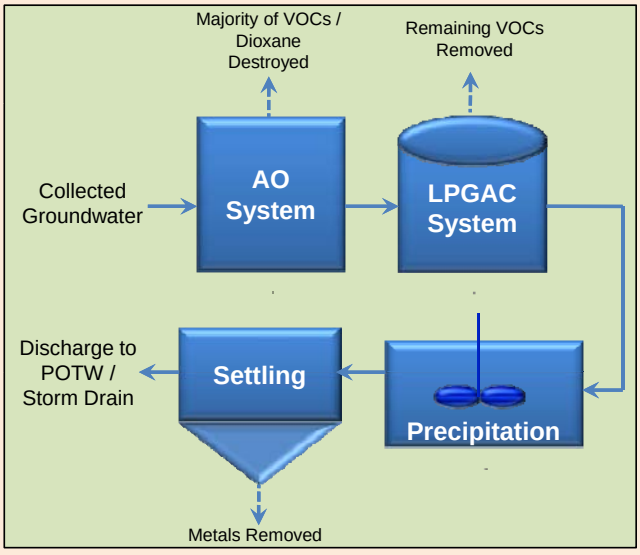
*Treatment of vapors collected from DPE and treatment of groundwater collected from DPE / offsite hydraulic control / onsite pumping*

**Vapor Treatment**

**Example C3 System (left) and VPGAC Vessels with treated vapor emission stack (right).**

- Treatment with Cryogenic Cooling and Compression (C3) System and vapor-phase granular activated carbon (VPGAC) prior to discharge to the atmosphere
- Vapor cooled and condensed and then collected for off site disposal.
- Achieves 99% recovery of VOCs in vapor stream as condensed liquid. Remaining 1% of VOCs in vapor stream treated with VPGAC (polishing step).

**Groundwater Treatment**




**Groundwater Treatment System Treatment Train**

- Treatment of all liquids collected during DPE and onsite &offsite groundwater pumping.
- Advanced oxidation (AO) system to remove majority of the VOCs and 1,4-dioxane.
- Liquid-phase granular activated carbon (LPGAC) system to remove VOCs that may remain after AO treatment.
- Precipitation /settling process to remove metals from the liquid stream.