

# Rapid Remediation of Subsurface Organic Contaminants - a Contact Sport!

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President



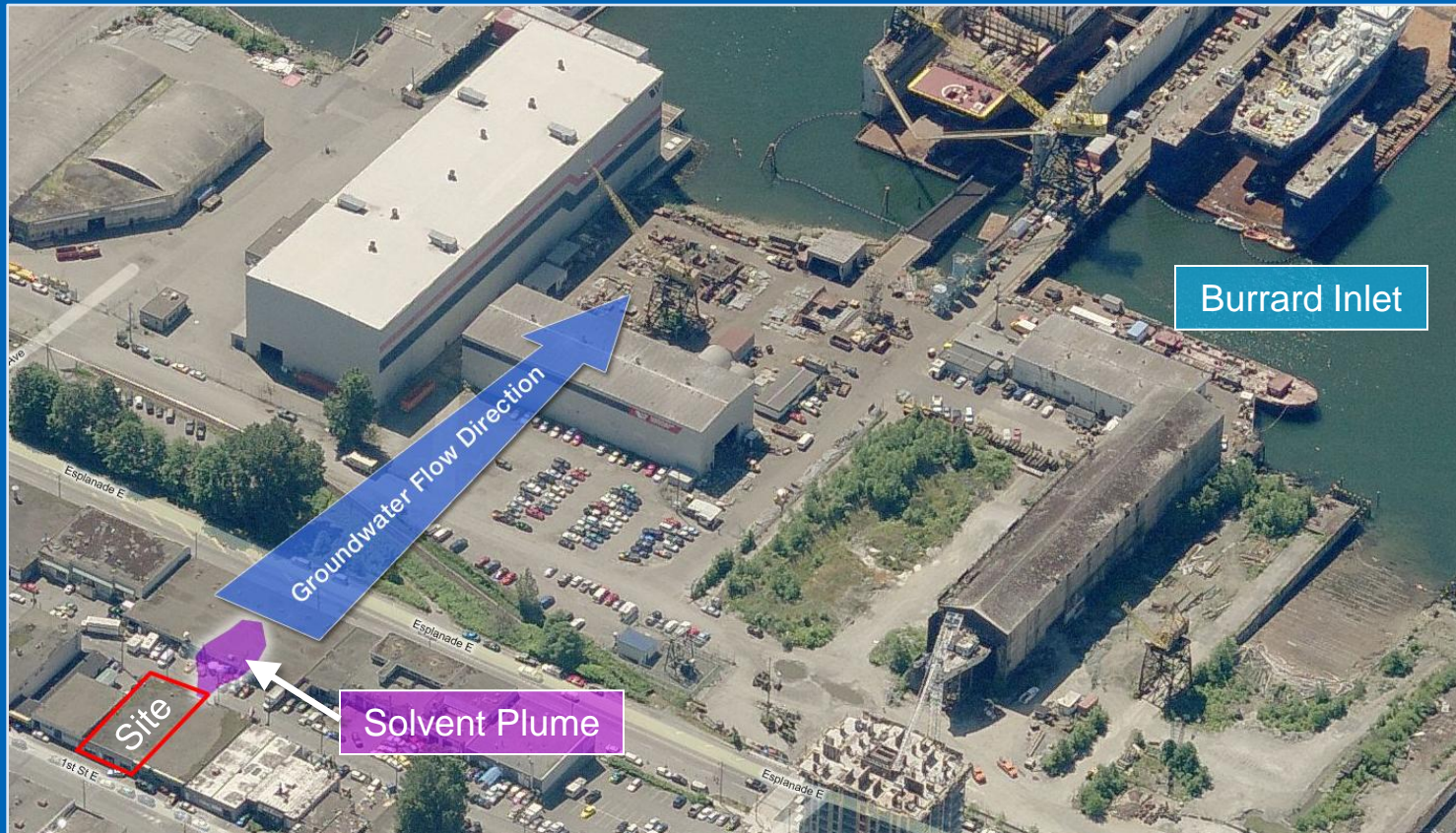
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Investigation - Remediation - Risk Assessment

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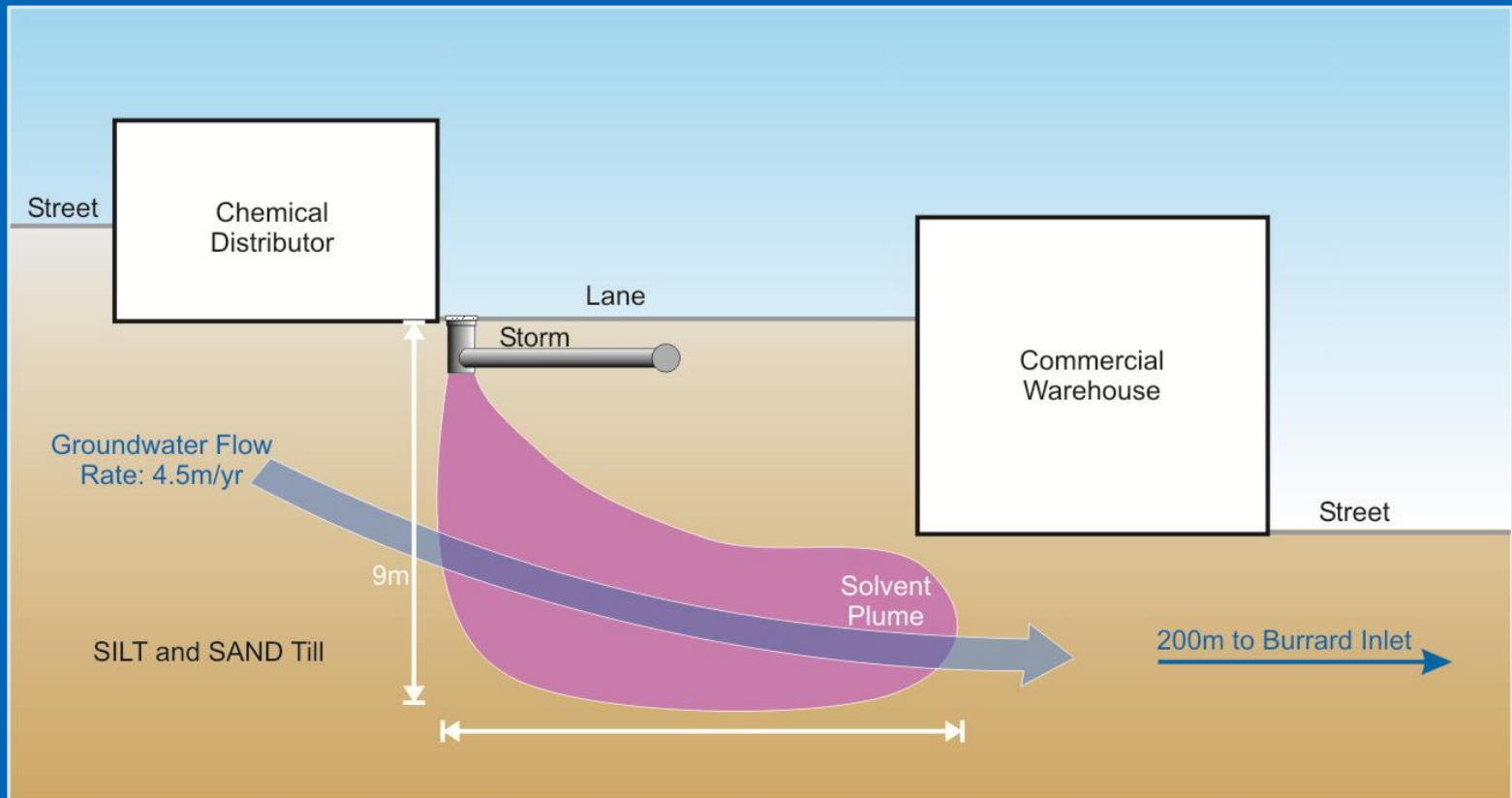
# Example 1 - Natural Contact

How do you transform a contaminated commercial site into a marketable property?



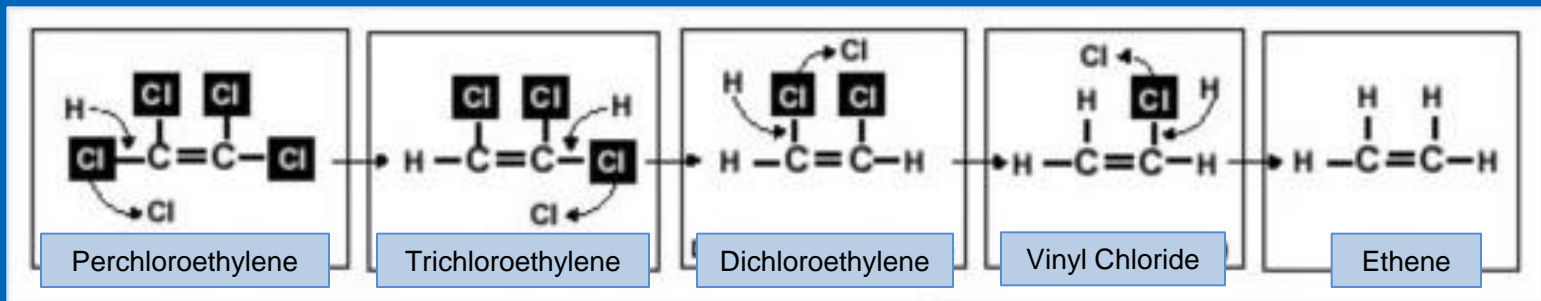
# Mechanism for Natural Contact

The groundwater gradient both created the plume and provided a natural mechanism for achieving contact with the contamination.



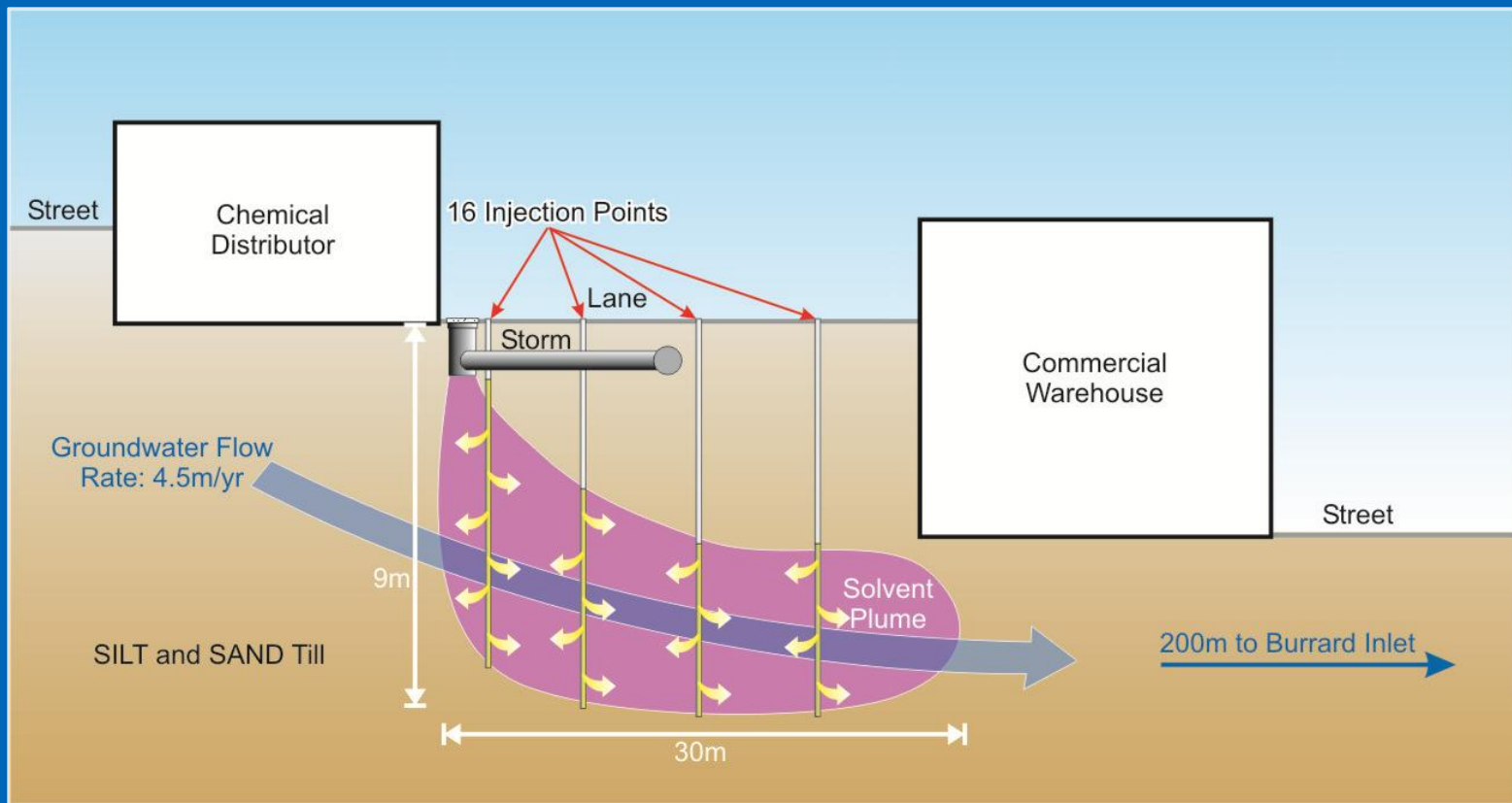
# What is HRC?

HRC® (Hydrogen Release Compound) is an electron donor material. It produces a controlled release of lactic acid upon contact with water. Microbes metabolize the lactic acid and generate hydrogen. Hydrogen is then used for anaerobic reductive de-chlorination.



# Injection Points

Injection locations were limited, forcing reliance on natural groundwater movement to make contact between HRC and the contamination.



# Concentrations

Remediation cost was \$150,000.

Contaminant	Aquatic Life Standards	Pre-Remediation Concentrations	Post-Remediation Concentrations	Time to Remediation
PCE (Perchloroethylene)	1,100 ppb	4,000 ppb	<100 ppb	7 months
TCE (Trichloroethylene)	200 ppb	1,500 ppb	<200 ppb	7 months
VC (Vinyl Chloride)	200 ppb	(700 ppb)	<200 ppb	26 months



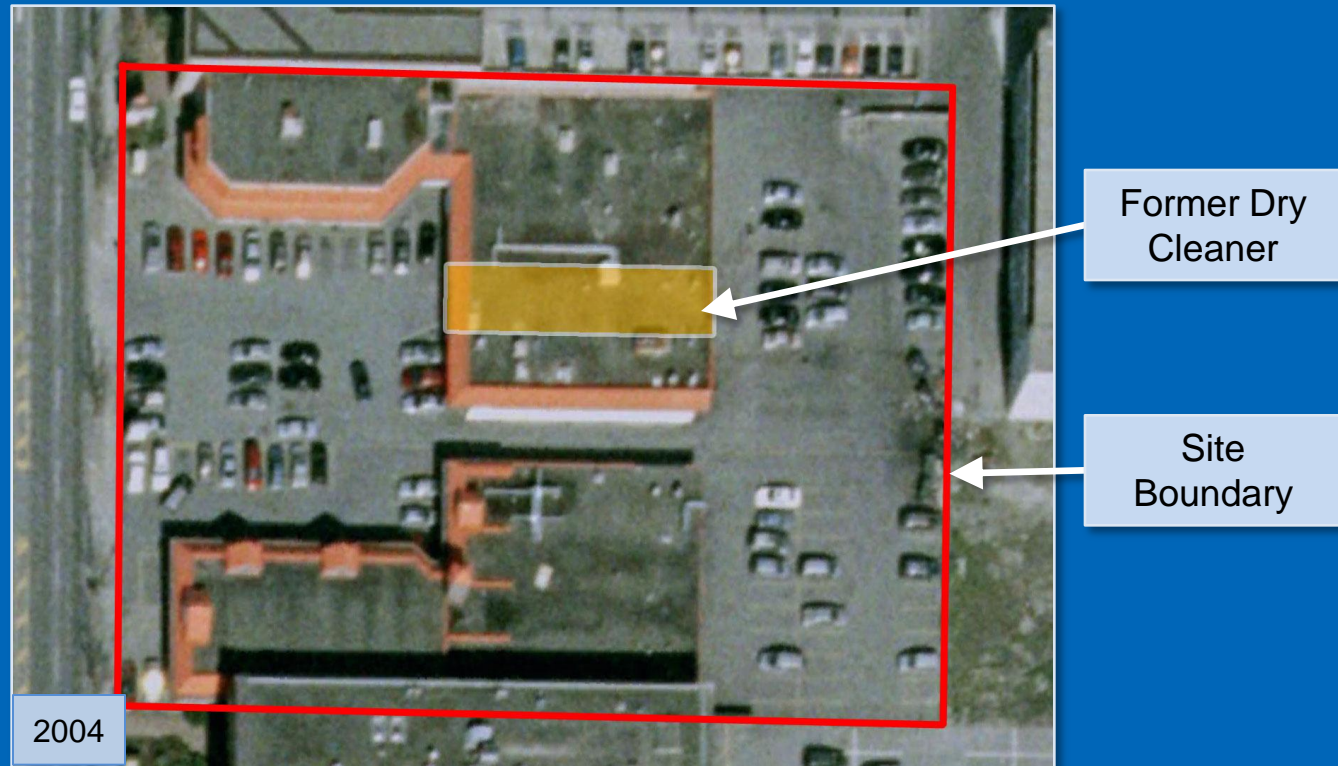
# Example 2 – Forced Contact

How do you transform a Brownfield into a profitable new development?



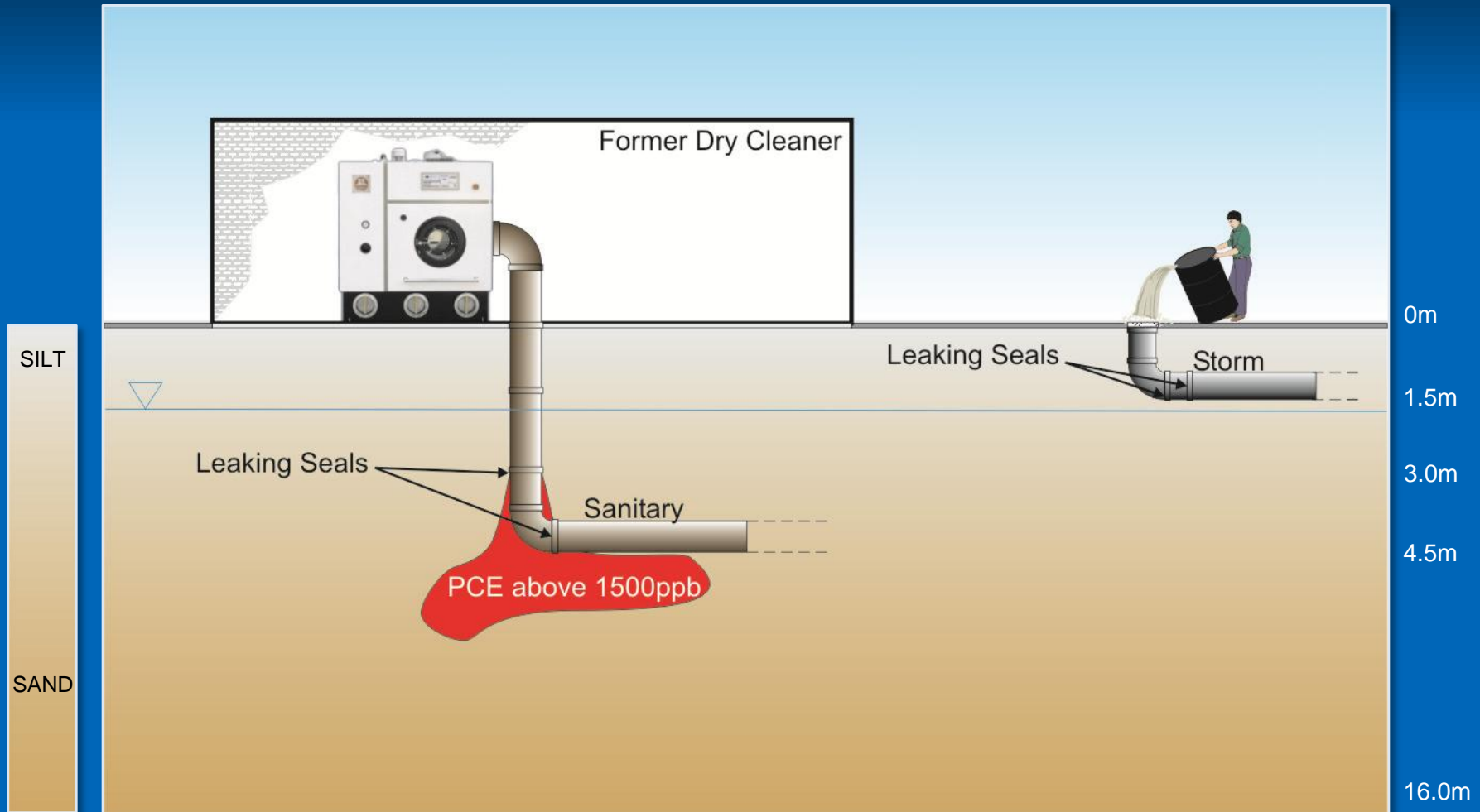
# The Site

Strip mall with Dry Cleaner.





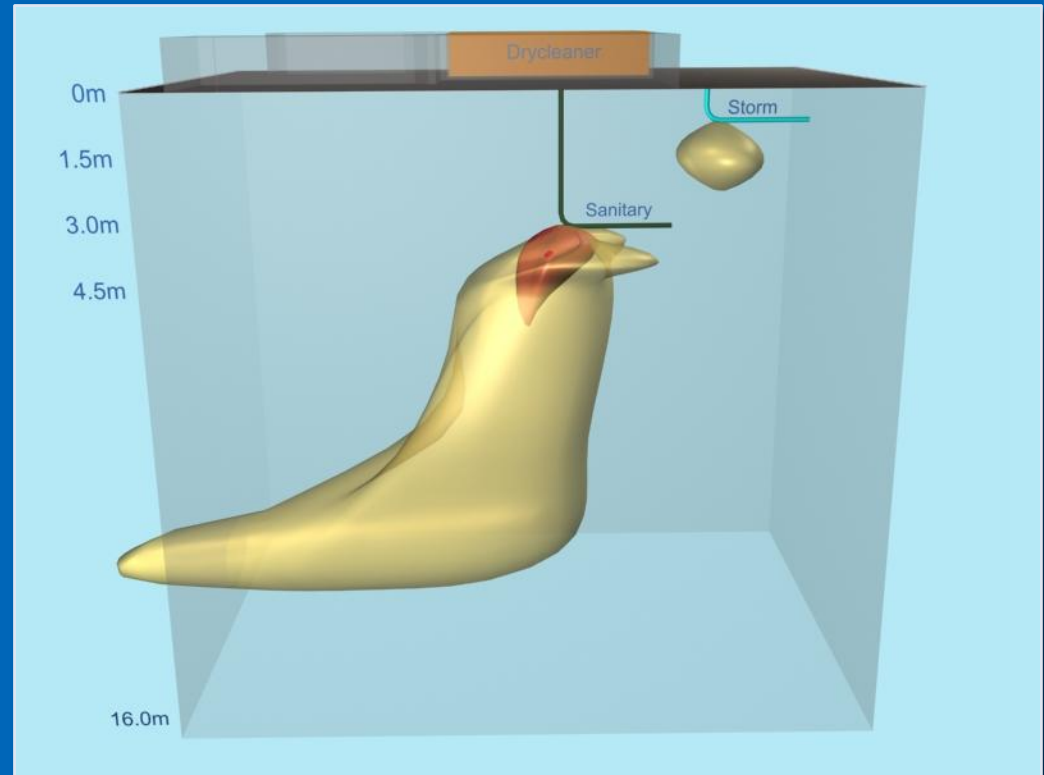
# The Source



# Regulatory Issues

Introduction of Drinking Water standards in three (3) months will dramatically increase the size of the contaminant plume.

Contaminant		Standards < Feb. 1, 2011	Standards > Feb. 1, 2011
PCE	Soil	50 ppm	50 ppm
	G'water	1,500 ppb	30 ppb
TCE	Soil	50 ppm	0.015 ppm
	G'water	11,000 ppb	5 ppb



# Technical Issues

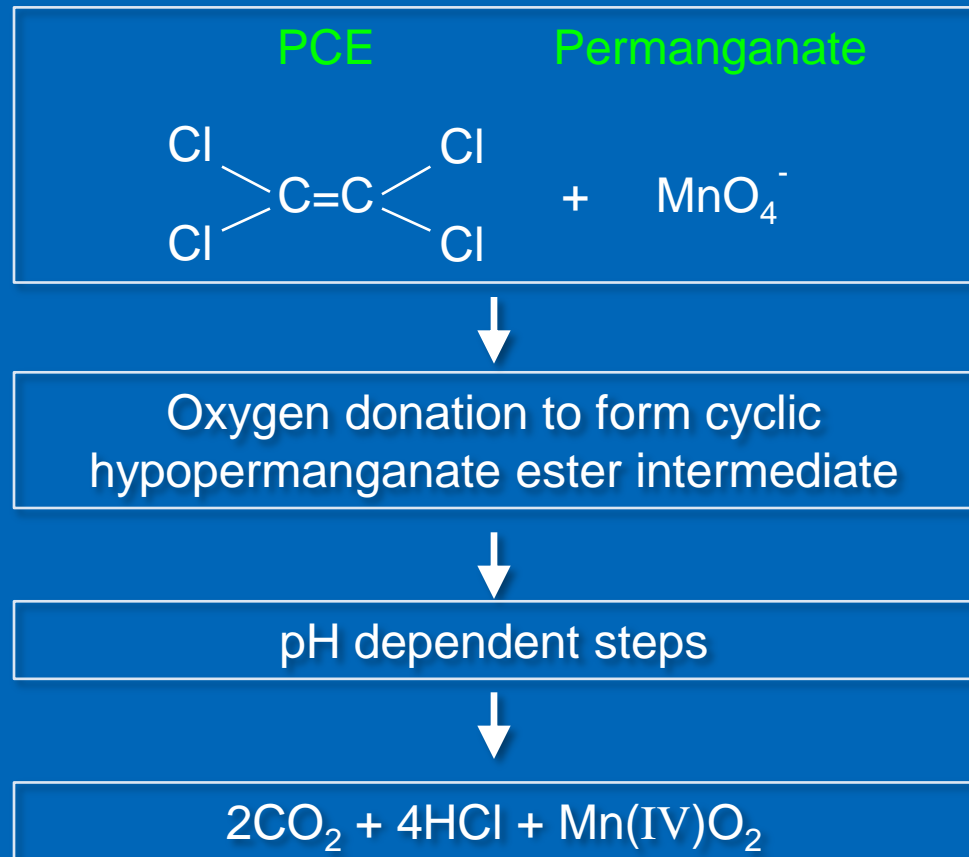
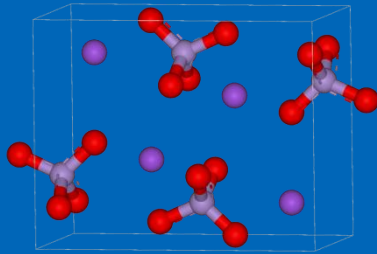
## Obstacles to numerical remediation in only three months

- Excavation is extremely limited due to high groundwater table and floodplain soils which can easily collapse as a sinkhole when dewatering.
- Flat groundwater gradient resulting in a flow rate of 1.5m/yr, means unsuitable natural delivery system for the injectant.
- Need fast-acting injectant



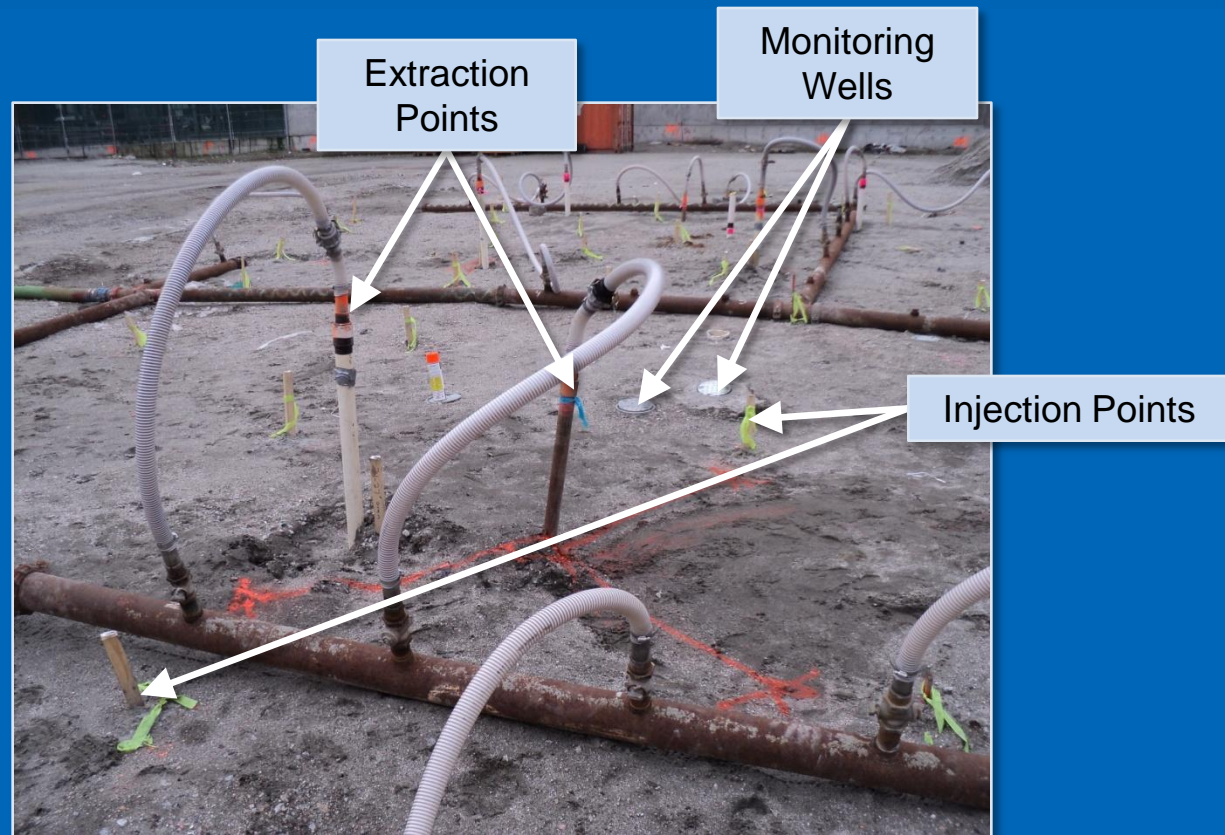
# Fast Acting Injectant

Potassium permanganate ( $\text{KMnO}_4$ ) is a powerful oxidant.



# Fast Contact Mechanism

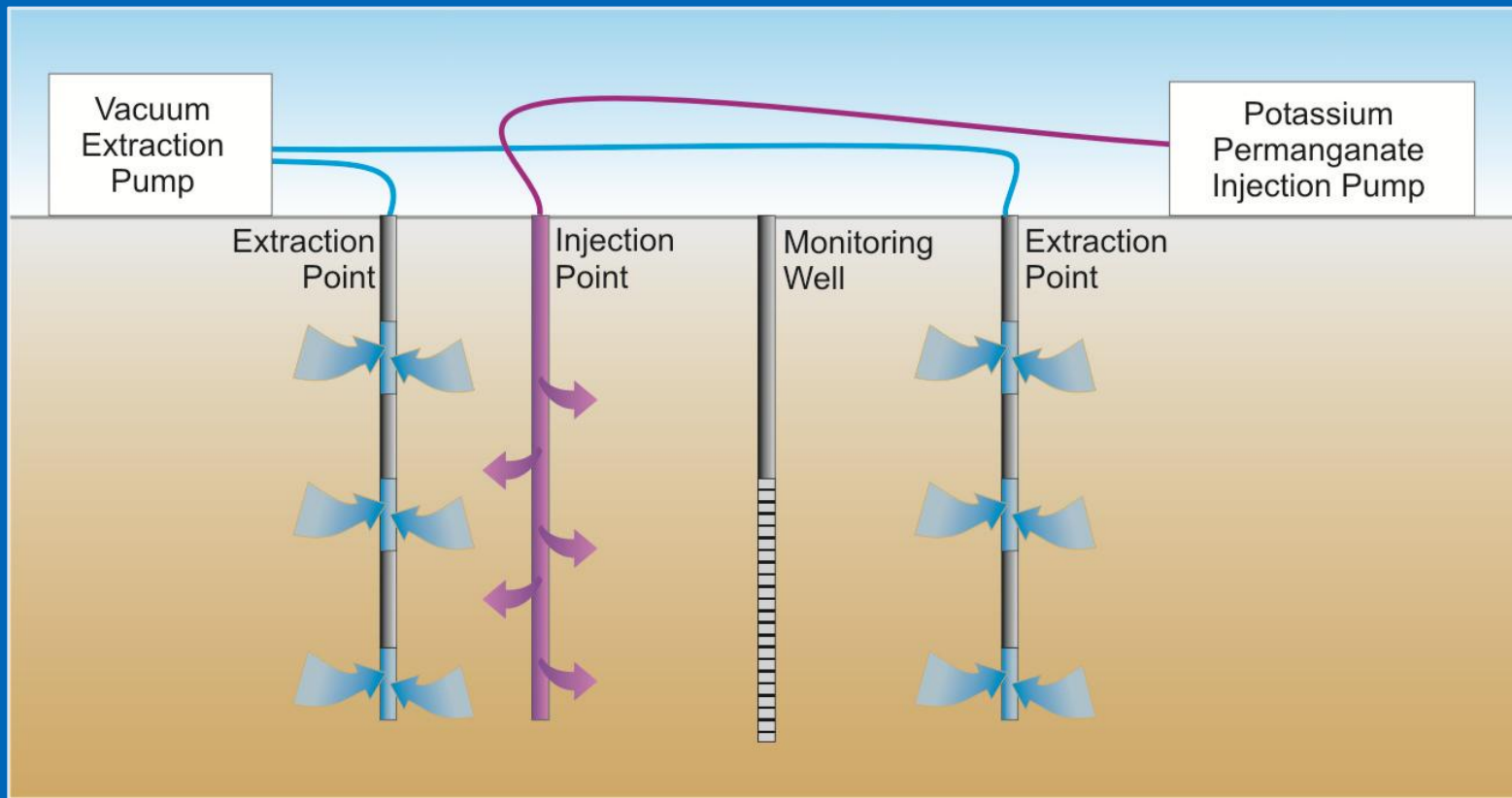
Accelerate groundwater flow by combining extraction and injection.



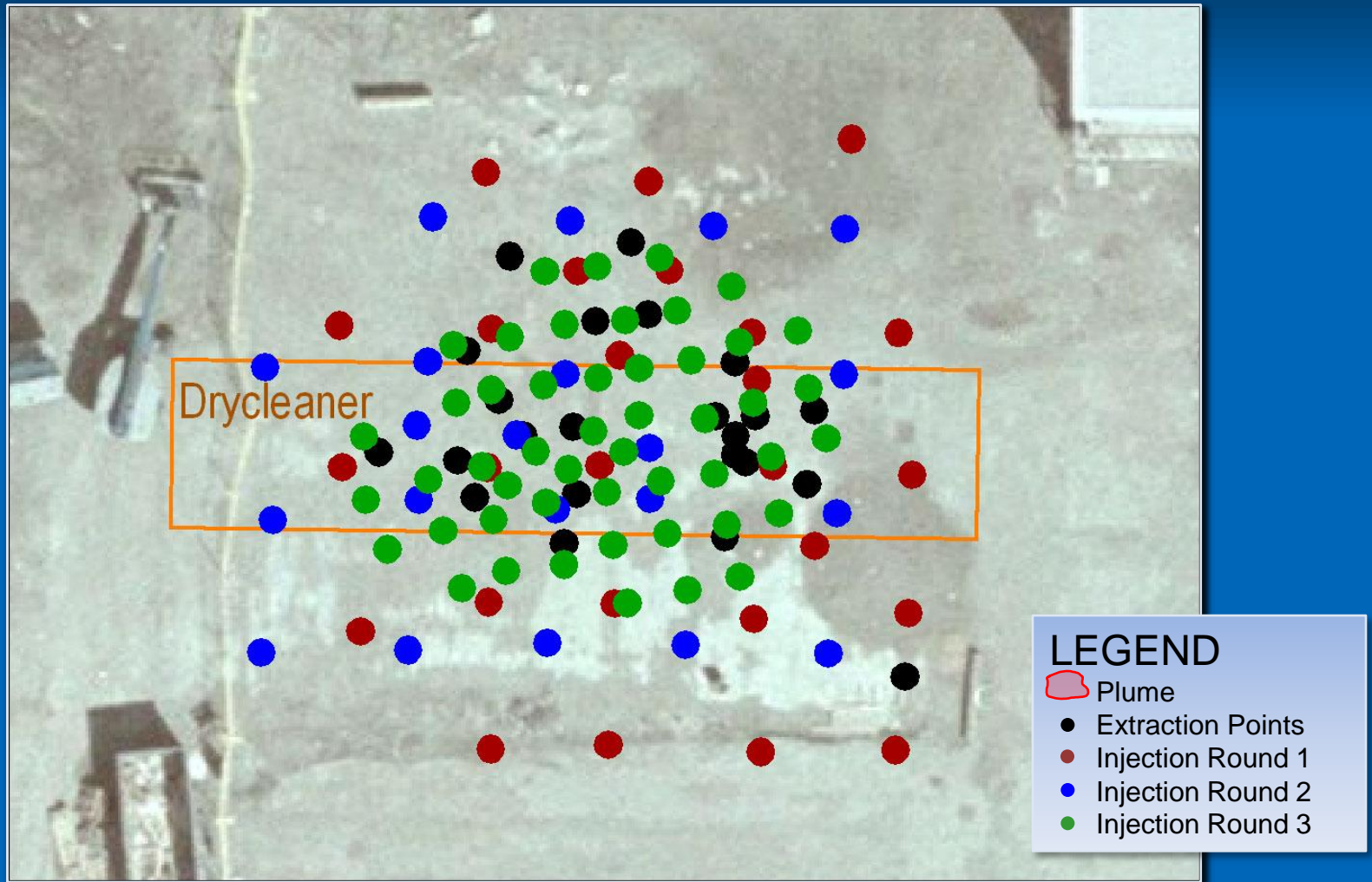


# Forced Delivery System

The concept is simple. Execution requires precision.



# Injection Series



# Concentrations

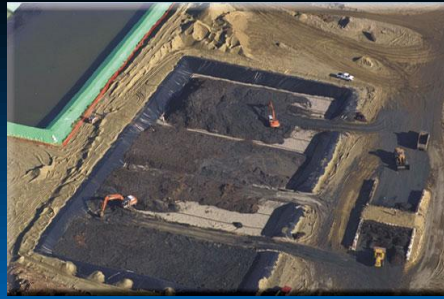
Remediation cost was \$850,000.

Contaminant	DNAPL Standards	Pre-Remediation Concentrations	Post-Remediation Concentrations	Time to Remediation
<b>PCE</b> (Perchloroethylene)	1,500 ppb	41,000 ppb	<600 ppb	3 months
<b>TCE</b> (Trichloroethylene)	11,000 ppb	78,000 ppb	<940 ppb	3 months





Landfill,  
Burnaby



Bulk Fuel Storage,  
North Vancouver



Works Yard,  
Nelson



Service Station,  
Vancouver



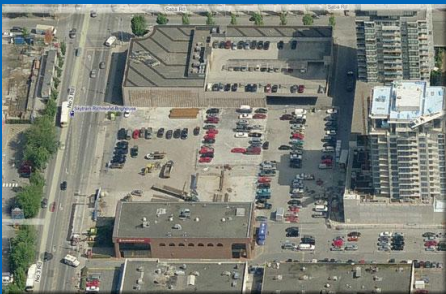
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# Degradation Sequence of PCE

BH406 VOC Concentration vs. Time

