Common Mistakes to Avoid when Treating Soil and Groundwater In-Situ

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PITFALL! TM

For those who remember … to learn from experience.

Source: Activision

Presentation Outline

- Value of In Situ Remediation Technologies
- 6 Common Mistakes
- About us
- Questions / Discussion

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So Brace yourself, we are moving in …

Source: Activision

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In Situ Treatment of Soil and Groundwater

- Pump and Treat
- Soil Vapour Extraction under vacuum with or without air/steam injection
- Chemical Oxidation In-situ//Ex-situ
- Chemical Reduction In-situ//Ex-situ
- Enhanced Bioremediation
- Soil Washing
- Reactive Barriers
- Thermal degradation

In Situ Treatment of Soil and Groundwater

- If properly designed and implemented :

↑ cost savings ↓ site disruption

Powerful Tools Alone OR Combined with Other Technologies:
e.g..
Site Specific Risk Assessment (SSRA)

- Drawbacks for these technologies are time and money.

State of the Technology

In Situ technologies have evolved significantly over the last two decades

- research and development
- laboratory testing
- innovative delivery and monitoring techniques
- sound pilot scale design and implementation
- experience implementing full scale remediation

Limitations

- In Situ Technologies must be used properly to be effective
- If limitations are not understood, likely to be misused = disappointing results

present most common pitfalls

Conditions for Selecting Chemical Oxidation

	Chemical Oxidation Applicability	Limitation / Disadvantages	Possible Alternative Options
Mobile NAPL	Probably not the best choice	High oxidant requirement ($)	Liquid Extraction Thermal degradation
Residual NAPL (higher than 10,000's mg/kg)	Yes, but difficult	High oxidant requirement ($)	Extraction with air/steam injection Thermal degradation
High conc. in soil/groundwater (10's – 10000's mg/kg)	Yes, good conditions	Normal considerations	Extraction with air/steam injection Bioremediation
Dissolved plume (< 1 mg/kg)	Yes, but could be costly	Higher cost due to SOD	Bioremediation, Reactive barriers

Source : ITRC 2004

NAPL: Non-Aqueous Phase Liquid

Pitfall # 1: Improper Site Characterization

- This is # 1 for a Reason !
- Often due to budget constraints, delineation can be lacking, particularly an understanding of depths & thicknesses of contaminated lenses particularly troublesome if DNAPLS may be present and/or in fractured bedrock situations

Possible solution:
Better characterization

- It is often wise to invest ***incrementally*** more of the project budget on drilling and on-site testing to have a much clearer picture of the soil horizons where treatments should be focused and the expected response to injections.

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Possible solution:
High resolution characterization

- Membrane Interface Probes (MIP) … for real time detection of volatile compounds at discrete depths and measure electrical conductivity (EC) for insight into soil types
- Laser Induced Fluorescence (LIF) … pin points the presence of longer chain hydrocarbon molecules
- Hydraulic Profiling Tool (HPT) … identifies hydraulic conductivity of zones for injection

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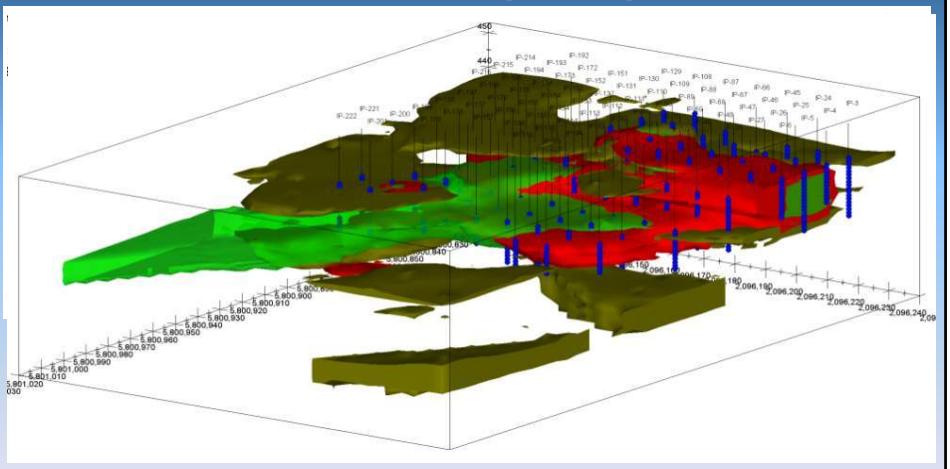
MIP 3D Imaging



Pitfall # 2: Not Testing Technology Specific Parameters

- The specific environment where the contaminants reside must be considered
- Based on experience, remedial goals, and site specific knowledge, a tailored set of data requirements can be generated in consultation with a reputable technology supplier
- qualify and quantify the selected reagents via bench scale lab … if it doesn't work in the lab it WON'T work in the field

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Possible solution:
Technology Specific Parameters

- Be armed with data checklist during Supplemental Phase II work

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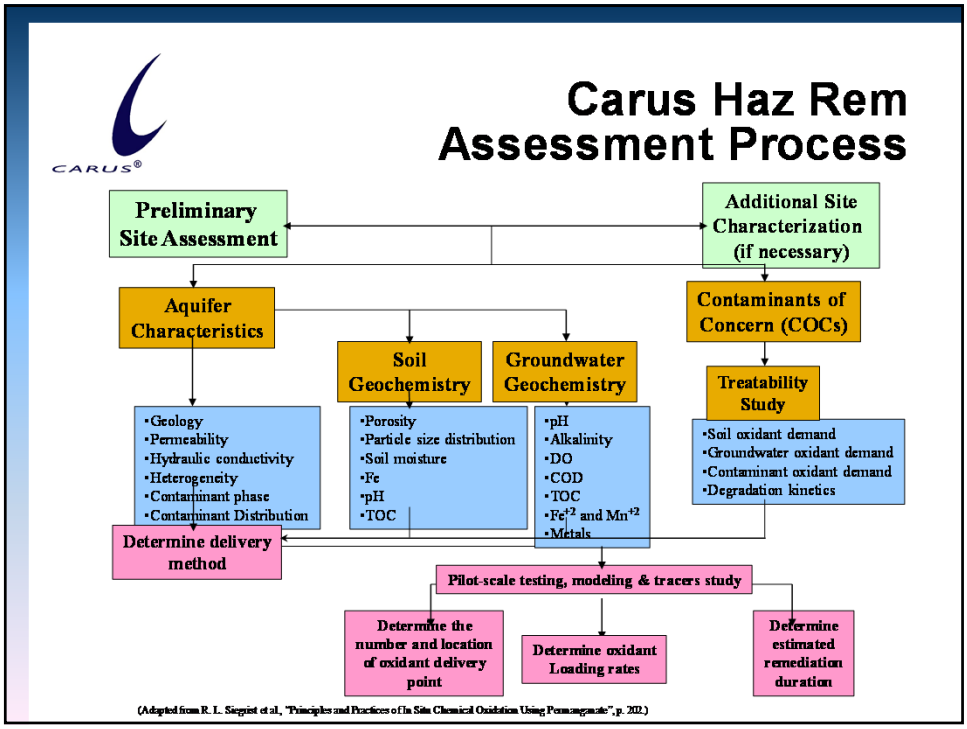

Technology Specific Parameters

- Soil Type, Density and Porosity
- Hydro-Geology: Water table level, Hydraulic gradient, hydraulic conductivity, effective porosity
- Contaminants type
- Presence/Description of underground infrastructure, building, Potable Water Wells, etc. near or above or below the impacted area

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Technology Specific Parameters

- Timeline for the remediation
- Soil Parameters: Natural oxidant demand (NOD), soil buffering capacity, fractional organic carbon (FOC)
- Geochemistry of Aquifer (Redox, pH, alkalinity, dissolved oxygen, TOC, manganese (total & dissolved), iron (total & dissolved), nitrate, nitrite, sulphate, sulphide)

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Pitfall # 3: Ruling-Out Technologies Too Early in the Remedial Design Phase

- We tend to have favourite approaches and biases
- Stick with what has worked in the past: Why fix what isn't broken?

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Erroneous Assumptions:

'chemical oxidants can't be used in the vicinity of utilities'

'stoichiometric requirements follow 1st Order Reactions'

'treatment will take too long'

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Pitfall # 4: Failing to Make Contact or the Distribution Challenge

- Contaminant degradation occurs in the aqueous phase
- Selection of treatment solutions offering the proper kinetics will ensure the materials persist and remain active as contaminants and treatment solutions alike diffuse, desorbs, and flow within the subsurface

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Possible solution: Making Contact and understanding distribution

- Pilot scale work can verify that injections are reaching the proper zones in sufficient quantities
- Validate the distribution and dilution amendment in the subsurface aquifer (both qualitatively *and* quantitatively) through the use of an ***INERT*** tracer ***PRIOR*** to using treatment solutions

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Formula for Contact

Radius of Influence (ROI)	=	**Injectable** Porosity + Advection & Dispersion
Reagent persistence required Rxns	>	Residence time for the chemical + Time required to achieve the ROI

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Pitfall # 5: Not Measuring and Controlling Pressure and Flow when injecting

- establish baseline P & Q to avoid inadvertent fracturing /uncontrolled distribution
- injection P gradually ramped up to determine optimal

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Rule Of Thumb For Injection Wells

P_{Imax} = DTI * 0.5PSI
(includes safety factor)

DTI = Depth To Target Interval

Source: Remediation Hydraulics – Payne, Quinnan, Potter - CRC Press

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Rule Of Thumb For Direct Push Points

P_{Imax} = DPT_p +(DTI * 0.5PSI)
(includes safety factor)

DTI = Depth To Target Interval

DPT_p = Direct Push Compaction Factor (0 to 75 PSI, dependent on soil type)

Source: Remediation Hydraulics – Payne, Quinnan, Potter - CRC Press

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Rules Of Thumb For Injection Volumes

- In the saturated zone, typically 20-80% of the effective pore volume should be targeted to ensure contact and distribution of the amendment
- FMC-: With Direct Push in the saturated zone – target max of 15% PV per event to avoid plume displacement
- In the vadose zone, 2 to 5 pore volumes should be targeted (contaminants and amendments must be brought together in the aqueous phase)

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Pitfall # 6: : Failing to Assess Post Injection Performance

- Remediation Feedback Loop :
- Document injection pressures, locations, solution volumes & mass injected and resulting concentrations of additives in the groundwater/soil matrix
- assessing distribution (field parameters, tracers) and confirming the stability & residence time of treatment solutions

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Pitfall # 6: Failing to Assess Post Injection Performance

- soil and/or groundwater quality monitored
- groundwater data useful to predict when soil should be sampled
- High Resolution Characterization tools (MIP, LIF, HPT) will provide very good soils data
- injection program - adjusted & optimized based on the results of detailed monitoring

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Summary

- When well designed, implemented, and monitored, on-site treatment technologies are very attractive alternatives for site remediation
- A synergy exists between the tools
- This synergy extends to the coupling of treatment technologies with other remedial approaches including dig & haul and SSRA

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About Chemco

- Canadian Company founded in 1988
- Production and warehouse facilities in Quebec and throughout Canada.
- **Sectors of activity**
  - Industrial and Municipal Waste Water
  - Contaminated Soil and Groundwater
  - Air, Odours and Atmospheric Emissions
  - Process Water
- **Products:** coagulants, flocculants, nutrients, bacterial preparations strains, oxidants, catalysts, oxygen and hydrogen release compounds, odour control agents
- **Services:** technical support, product selection, product supply and sourcing, logistics, laboratories, design, and staff training.

Our Expertise, Products and Services

- **Training and Education:** technical transfer session, health and safety training;
- **Consulting and Technology Site Assessment:** technology support and selection (chemical oxidation and reduction, co solvent-surfactant soil washing and enhanced bioremediation);
- **Products supply, logistic, storage and implementation**: nutrients, bacterial preparations strains, oxidants, reducing agents, catalysts, oxygen and hydrogen release compounds, co solvent-surfactant blends
- **Laboratory Services and Analysis**: Groundwater Parameter Analysis, Tracer Study, Soil and Groundwater Oxidant Demand Evaluation (SOD), Bench Scale Treatability testing in saturated and unsaturated conditions.

Our Expertise, Products and Services

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We remain available to assist you with:

- Screening
- Design
- Laboratory Service
- Product Supply & Logistics,
- Equipment,
- Implementation
- Monitoring

for your next on-site remediation project

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Questions are Welcome!

Acknowledgements:
FMC Environmental
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For more information please contact:

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