Assess

Design

Implement



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Biogenie

Site Remediation Solutions

Large Scale Sulfolane-Impacted Soil Remediation at a Gas Plant

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Site Remediation Solutions

Site History

- Large sour gas plant in central Alberta
- Operational from the 1960's to present
 - natural gas, ethane, butane, propane, and CO₂
- Former operation involved Sulfinol[®] process
 - included process facilities, sump, and sulphur pit which were all dismantled prior to the project
- Sulfinol[®] process resulted in soil and groundwater contamination
- 2005 client wanted to address the source area



Sulfinol[®] Process

- Process used since the 1960's
- Removal of H₂S and other corrosive gases from natural gas streams
- Sulfinol utilizes sulfolane and diisoproanolamine (DIPA)
- Sulfolane is toxic, non-volatile, and water soluble



Sulfolane











Remedial Objectives

Soil Quality Guidelines

Parameter	Guideline	Unit	Exposure Pathway
Salinity and Metals			
Electrical Conductivity	4	(dS/cm)	Commercial/Industrial Land Use ¹
Sodium Adsorption Ratio	12		Commercial/Industrial Land Use ¹
pH	6.0 - 8.0		Industrial Land Use ²
Arsenic	12	mg/kg	Industrial Land Use ²
Nickel	50	mg/kg	Industrial Land Use ²
Hexavalent Chromium	1.4	mg/kg	Industrial Land Use ²
Sulphur and Sulfolane			
Elemental Sulphur	500	mg/kg	All Land Uses ³
Sulfolane	2.3	mg/kg	Protection of Potable Groundwater ⁴

1. Salt Contamination Assessment and Remediation Guidelines (Alberta Environment, 2001)

Canadian Environmental Quality Guidelines (CCME, 1999)

2. 3. Guidelines for the Remediation and Disposal of Sulphur Contaminated Solid Wastes (Alberta Environment, 1996)

4. Soil and Water Quality Guidelines for Sulfolane and Diisopropanolamine (DIPA): Environmental and Human Health (CAPP, 2001)



Additional Site Assessment

Objectives:

- Additional site assessment to better delineate the sulfolane and sulphur plume, as well as metals
- Better understand the two main contaminants in relation to specific site characteristics
- Select the best technology and remediation strategy





Findings of ESA

- Sulfolane impacted soil volume of 12,100 m³
- Metals impacted soil volume of 275 m³
 - As, Cr⁶⁺, and Ni
- Elemental sulphur impacted soil volume of 6,200 m³
- Groundwater impacts with sulfolane



Site Specific Challenges

- Plant operation concerns (safety)
 - numerous overhead, surface, and underground structures
- Large volume of impacted material
- Limited space available on site
- Several types of contaminants
- Volume of soil was not completely delineated
- Time to perform the overall work
- Treatment performance (pay-per-performance) risk involved



Sulfolane Remediation Strategy

- 1. *In situ* biotreatment of 12,100 m³ of sulfolane-impacted soil
 - installation of subsurface aeration system
 - addition of nutrient amendments
 - periodic soil tilling
 - monitoring of equipment and soil conditions
 - third party groundwater monitoring
- 2. Segregation of off-site disposal of 275 m³ of impacted soil with metals



Advantages

- 1. Soil treatment to below sulfolane detection limit
- 2. Improved groundwater quality
- 3. Maximize space available
- 4. Minimize soil handling
- 5. Minimize use of landfill and backfill
- 6. Increased safety from decreasing truck traffic near the plant
- 7. Control of physical and biological parameters
- 8. Short timeframe for treatment





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Sulfolane Remediation Results

Sulfolane Concentration

Initial maximum Initial minimum Initial mean 755 mg/kg 6.5 mg/kg 138 mg/kg

Final concentration

<2 mg/kg

Total treatment time was 6 months



Sulfolane Concentration

Sulfolane Concentration in Soil Over Time



Sulphur Remediation Strategy

- *In situ* chemical stabilization of 6,200 m³ of sulphurimpacted soil
 - addition of "zero grind" limestone at a ratio of 3.2 mg/kg limestone : 1 mg/kg sulphur
- Elemental sulphur concentrations ranged from 200 mg/kg to 28,000 mg/kg



Advantages

- 1. Minimize use of landfill and backfill
- 2. Maximize space available
- 3. Increased safety by decreasing truck traffic near the plant











Project Results

Overall:

- Safety: no recordable incidents
- Quality: all remedial objectives achieved
- Cost: within the original budget and less than alternative methods
- Time: completed in 6 months (expected 8 months)

100% of the objectives were achieved

