Case Study

Gasoline Spill Remediation

Sears Gas Bar

Soil Vapour Extraction System, Prince George, BC

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Introduction

- **This presentation is focused on a case study outlining the remediation of a Sears former Service Station in Prince George, BC.**
- **Hydrocarbon contamination as a result of historic gasoline spills has had significant delays on the lease termination and redevelopment of the Site.**

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Background

- **Two gasoline spills occurred at the Site 20 years ago.**
- **The total loss of fuel was reported to be 36,800 L**
- **Based on the assessments to date, soil impacted with petroleum hydrocarbons remains at the site at a depth of 10 meters below grade.**

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Background, cont.

- **The Site is located within the boundaries of a shopping centre and Sears has been leasing it for 30 years.**
- **The shopping centre was sold and the new owner wants to redevelop the entire property.**
- **In order to obtain the required permits, the existing contamination needed to be remediated.**

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Site Description - Stratigraphy

- **The stratigraphy at the Site consists of:**
  - sand and gravel to 7 mbg
  - sandy silt from approximately 0.6 to 3.0 m in thickness
  - grey fine sand to the maximum depth investigated.
- **The sandy silt layer acted as a confining layer absorbing the gasoline from the spills.**

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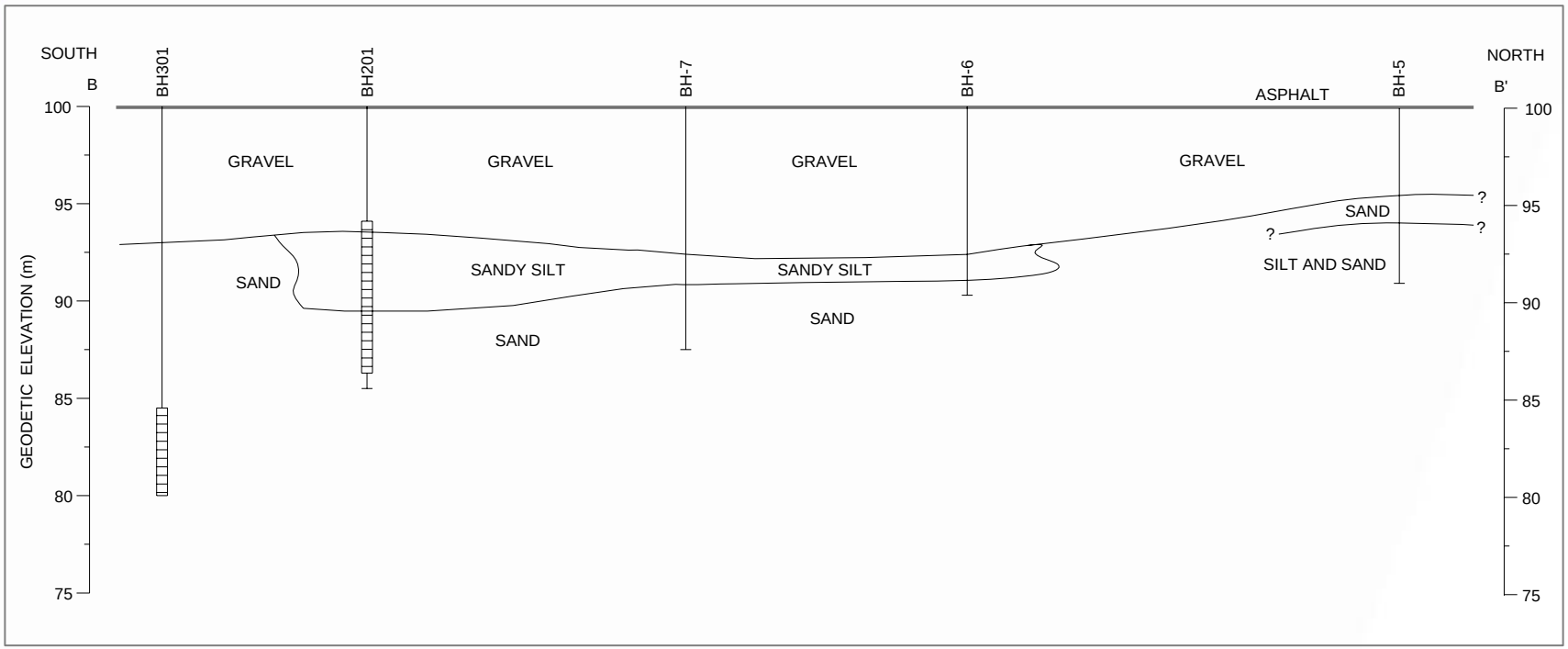
Stratigraphy, cont.



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Extent of Impacts

- **Two zones of contamination (ZOC) were identified:**
  - ZOC 1: Approximately 750 m^3 soil impacted with petroleum hydrocarbon above the Hazardous Waste Regulation was identified in the former Tank nest, with an approximate areal extent of 150 m^2
  - ZOC 2: Approximately 3000 m^3 of soil impacted above Commercial Land Use standards with an approximate areal extent of 1000 m^2

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Extent of Impacts, cont.

- **ZOC 2 was identified within the sandy silt layer present at a depth of 7 mbg with an average thickness of 3 m.**

- **Approximately 7000 m^3 of clean sand and gravel overlie the impacted area.**

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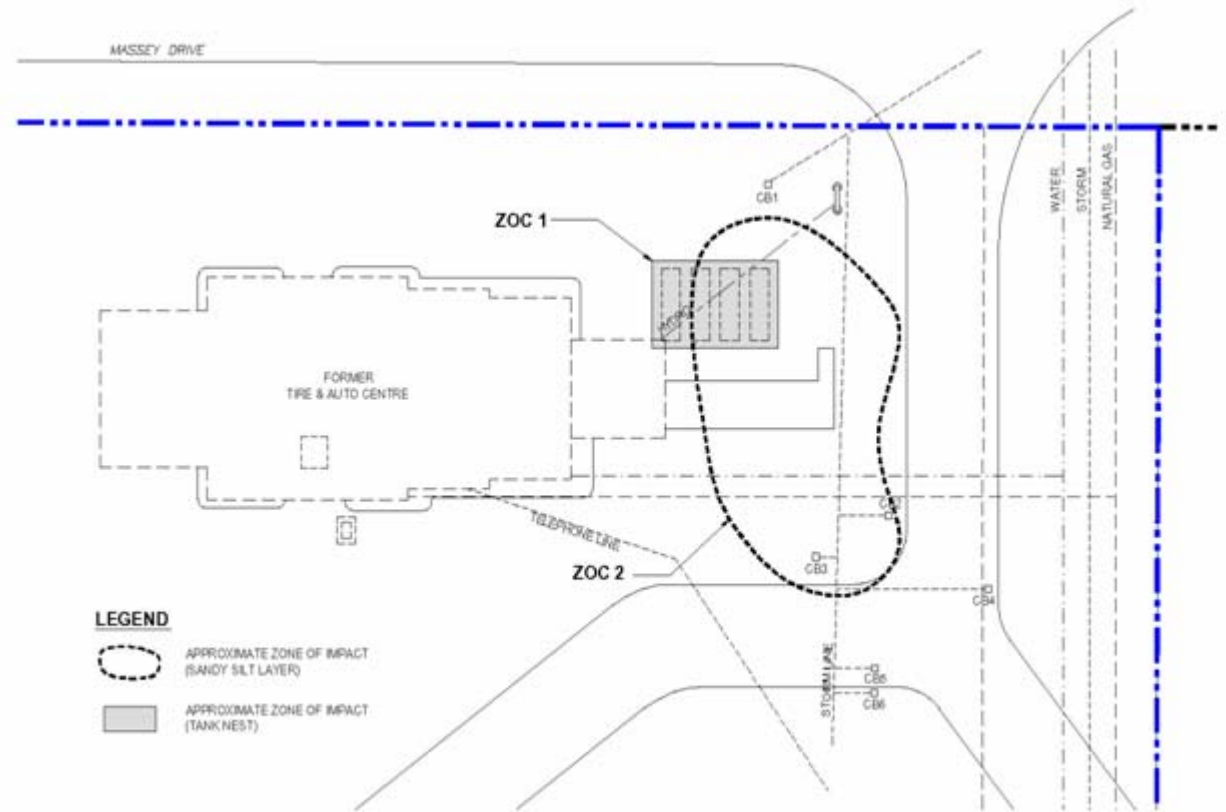
Extent of Impacts, cont.



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Remediation Options Evaluated

- **Risk Assessment**
- **Soil Excavation and Off-site Disposal**
- **In-situ Treatment**

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Risk Assessment Option

- **Most cost effective remedial strategy**
- **Not completed due to contractual agreements between Sears and the owner of the shopping centre.**

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Soil Excavation and Off-Site Disposal – ZOC 1

- **Selected remedial option for the UST nest contamination:**
  - Required to meet the BC Ministry of Environment (BC MOE) contaminant mass reduction program
  - Required to conduct the remedial option selected for ZOC 2

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Soil Excavation and Off-Site Disposal - ZOC 2

- Fastest way to remove contamination from the Site
- Based on the extent and depth of contamination, this option was not viable.

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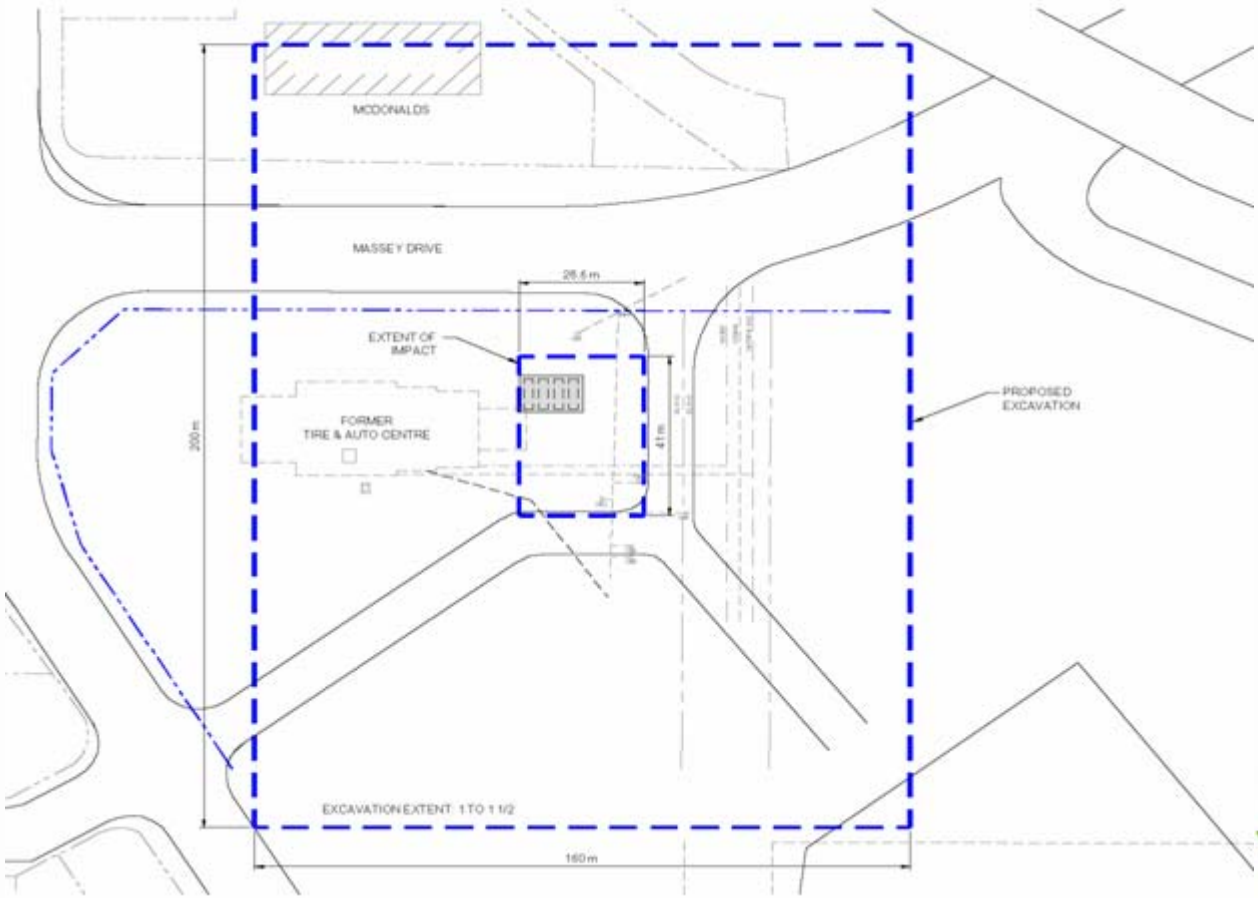
Soil Excavation and Off-Site Disposal – ZOC 2



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In-Situ Treatment

- **Soil Vapour Extraction System (SVE)**
  - Applying vacuum to the unsaturated zone
  - Removing petroleum hydrocarbons from the subsurface area
  - Treating extracted vapours at the surface

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Vertical SVE Pilot Test

- A pilot test was conducted using a vertical well network to evaluate effectiveness of this remediation option.
- Vertical wells were installed 2 m apart in the sandy silt zone

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Vertical SVE Pilot Test - Results

- Vacuum radius of influence was minimal to none.
- Approximate number of vertical wells that would be required: 440
- Option determined to be non cost-effective

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Horizontal Well Network

- Expected to provide a better radius of influence than vertical wells
- Increase contact area between well screen and impacted area
- Minimize number of wells required

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Implementation of Remedial Program

- ZOC 1 - Excavated to 5 mbg and soils transported off-site
- Excavation expanded to 10 mbg to conduct horizontal drilling program to remediate ZOC 2

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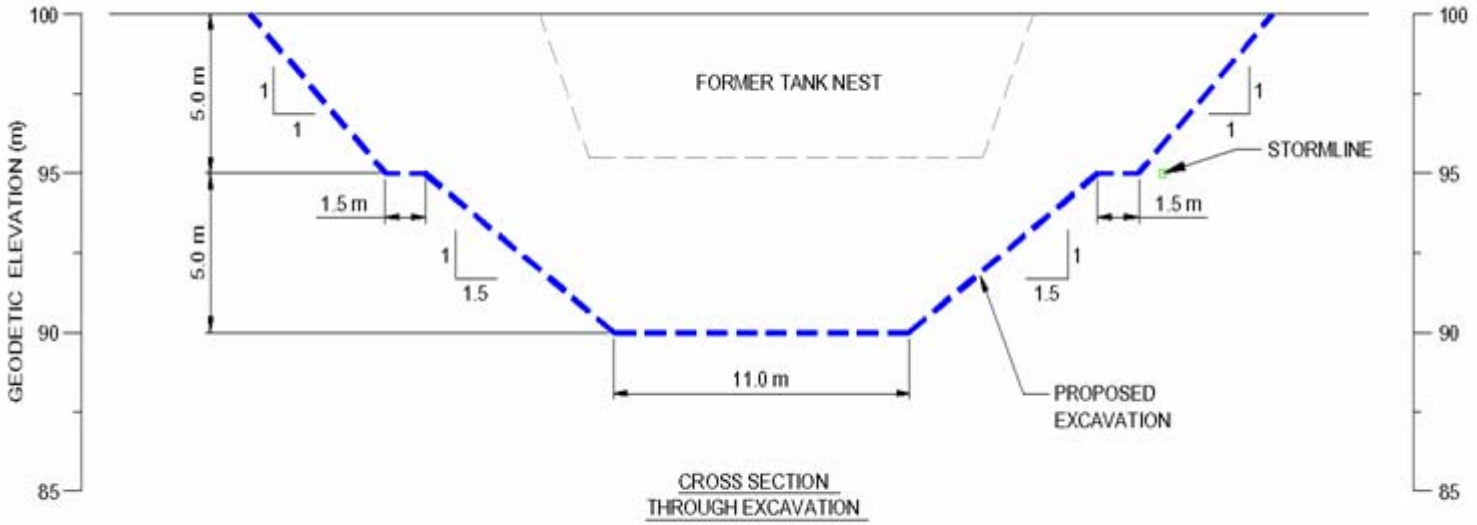
Excavation Dimensions



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Excavation Dimensions

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Horizontal Drilling and Well Installation– ZOC 2

- Twenty four horizontal wells were installed at a depth ranging from 7 to 10 mbg
- Wells were drilled radially outward to intersect the sandy silt layer
- Challenge: Identify change in stratigraphy to prevent drilling though the sandy silt layer

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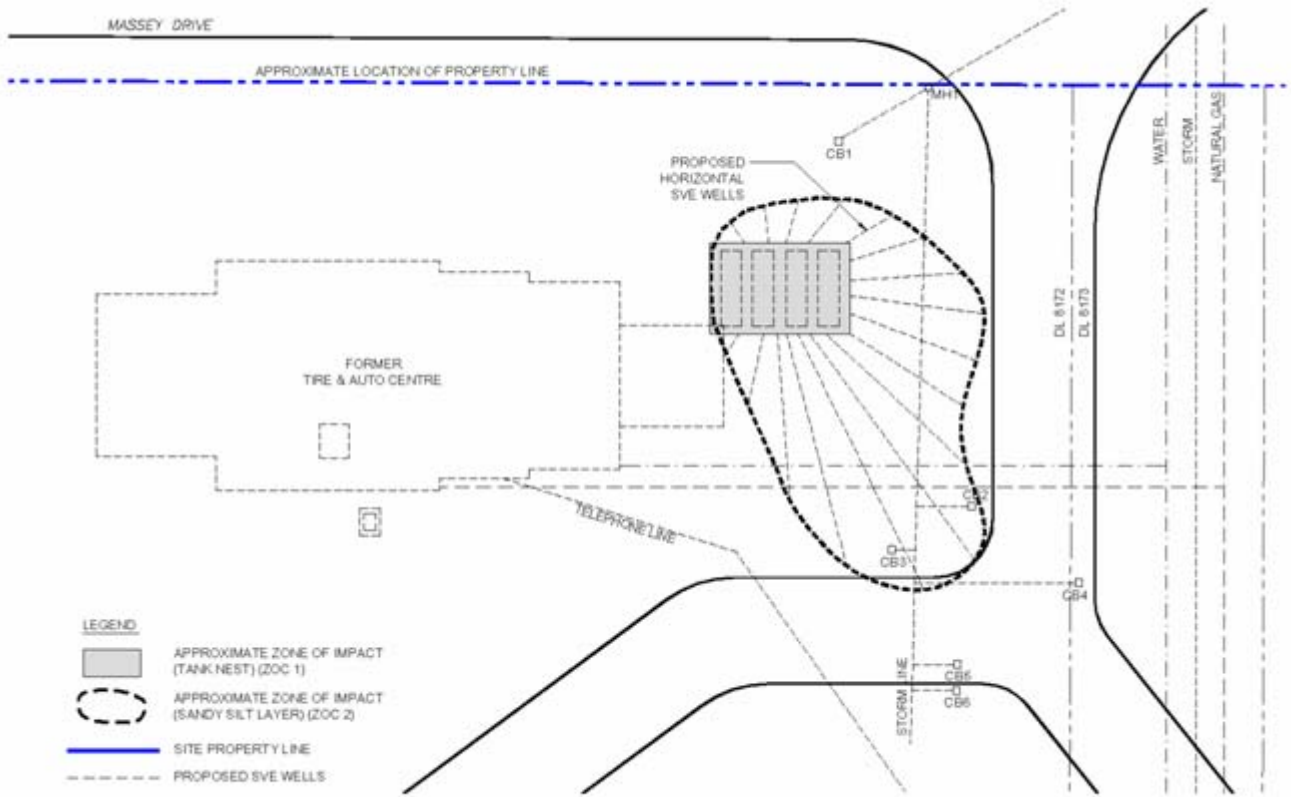
Horizontal Well Network



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Horizontal Well Network Completion

- Each well brought up to grade individually and was completed in 4 separate headers of 6 wells each

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Horizontal Well Network Pilot Test

- **A series of pilot tests were conducted in order to:**
  - determine the radius of influence
  - the size of equipment that would be required to run the SVE system

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Equipment Requirements

- **Based on the results from the pilot test the equipment required was:**
  - Two 350 to 500 scfm blowers to provide 10 to 15 inHg of vacuum,
  - Two 300 scfm catalytic oxidizers or two 2000 lb activated carbon vessels to treat the extracted vapours

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Carbon Vessels or Catalytic Oxidizers?

- Catalytic oxidizers
  - require less maintenance and are more reliable than activated carbon
  - no risk of breakthrough
  - high initial capital cost
- Activated Carbon
  - low initial capital cost
  - Initial savings offset by high cost in operation and disposal of used carbon

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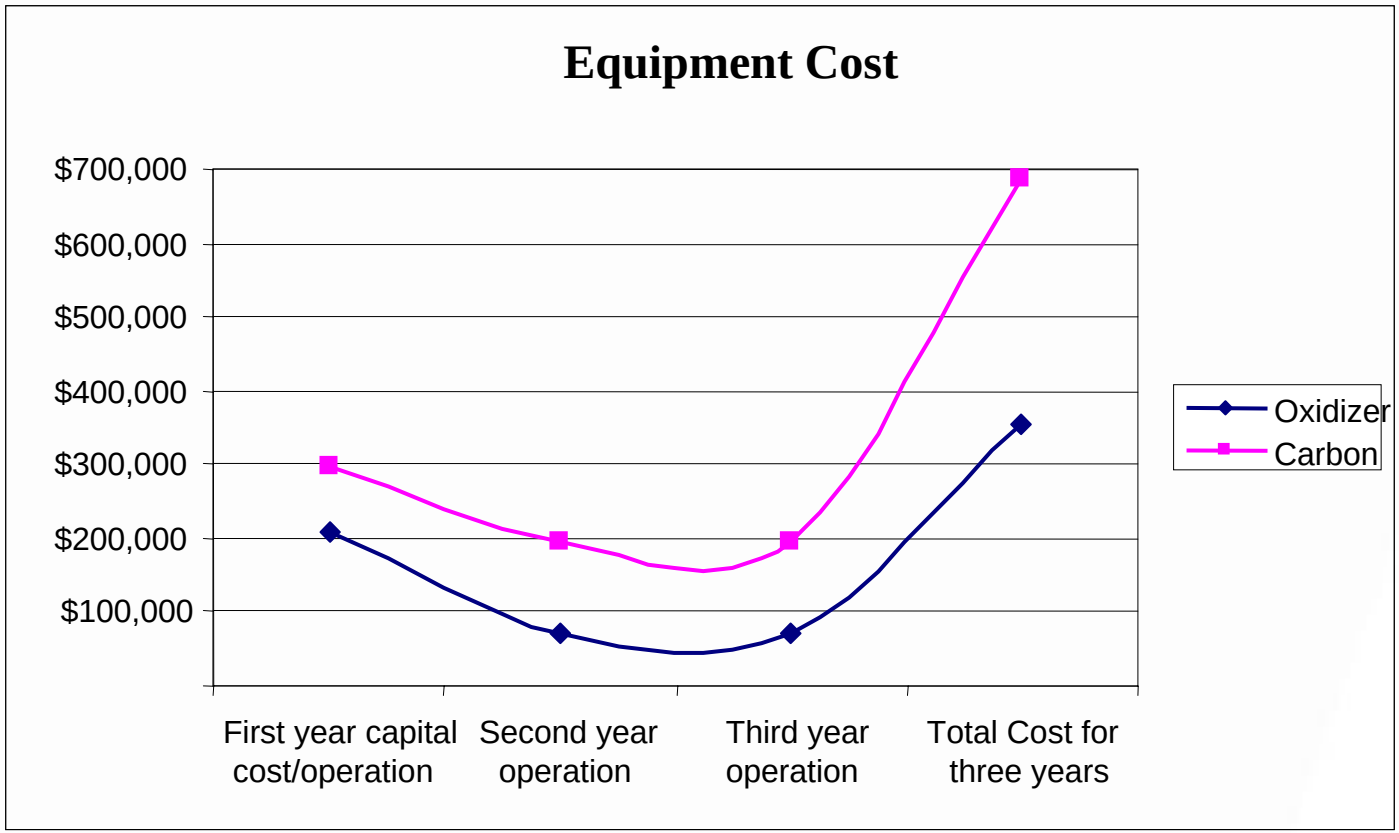
Cost Analysis



Note: Carbon consumption was estimated assuming extraction levels would decrease to 100 ppm after the first year of operations

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System Installation

- The final system consisted of:
  - One knock-out drum
  - Two 40 HP, 350 scfm vacuum blowers
  - Two silencers
  - Two 45 amp, 460 V, 300 scfm catalytic oxidizers

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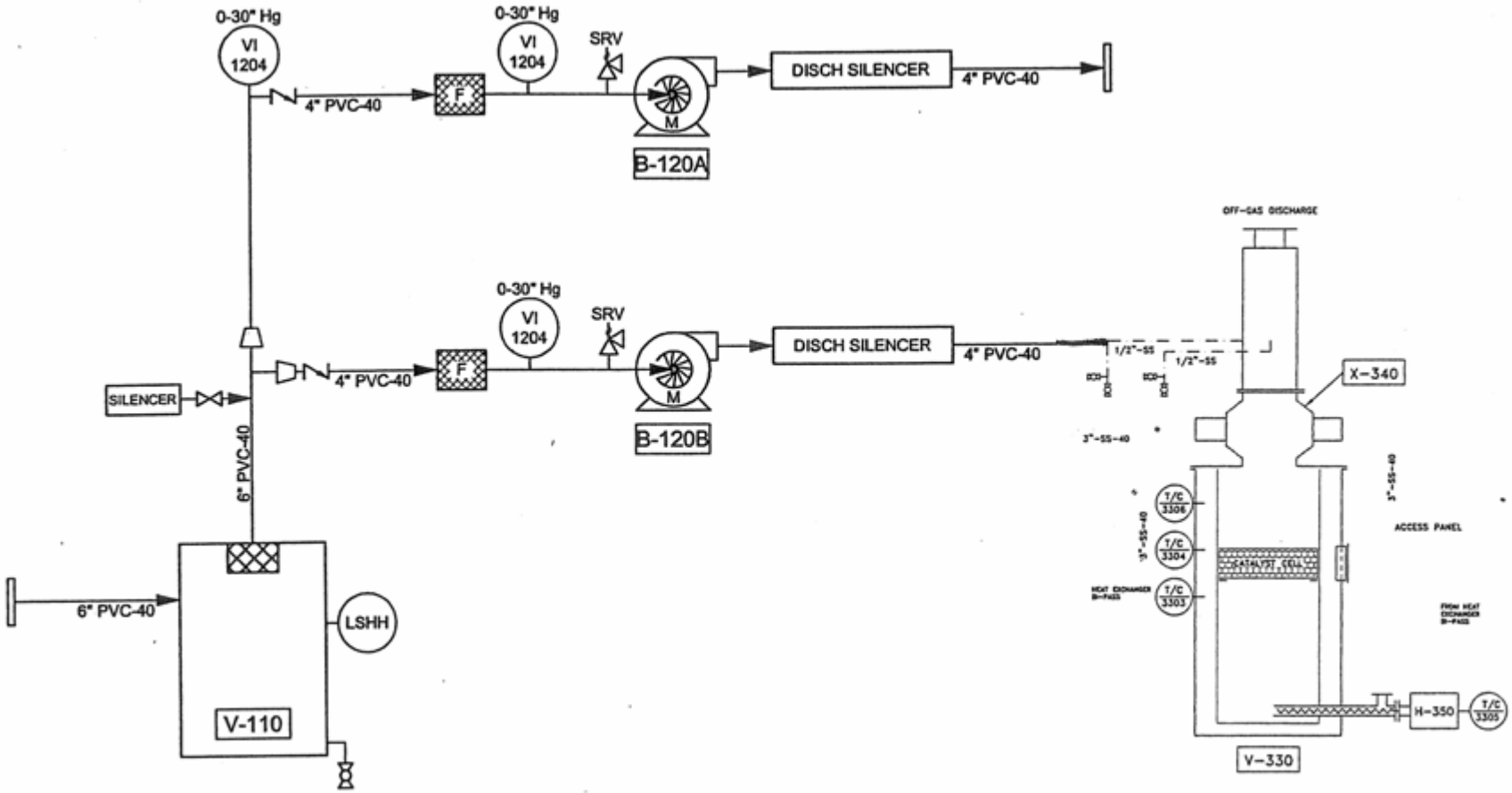
System Schematic Diagram



SVE System

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System Operation Requirements

- Start up of the system requirements:
  - Open one well at a time to prevent overloading the oxidizers- maximum capacity 25%LEL
  - Maintain minimum catalyst temperature of 500^{o}F
  - Maintain maximum vacuum at the blowers of 16 inHg

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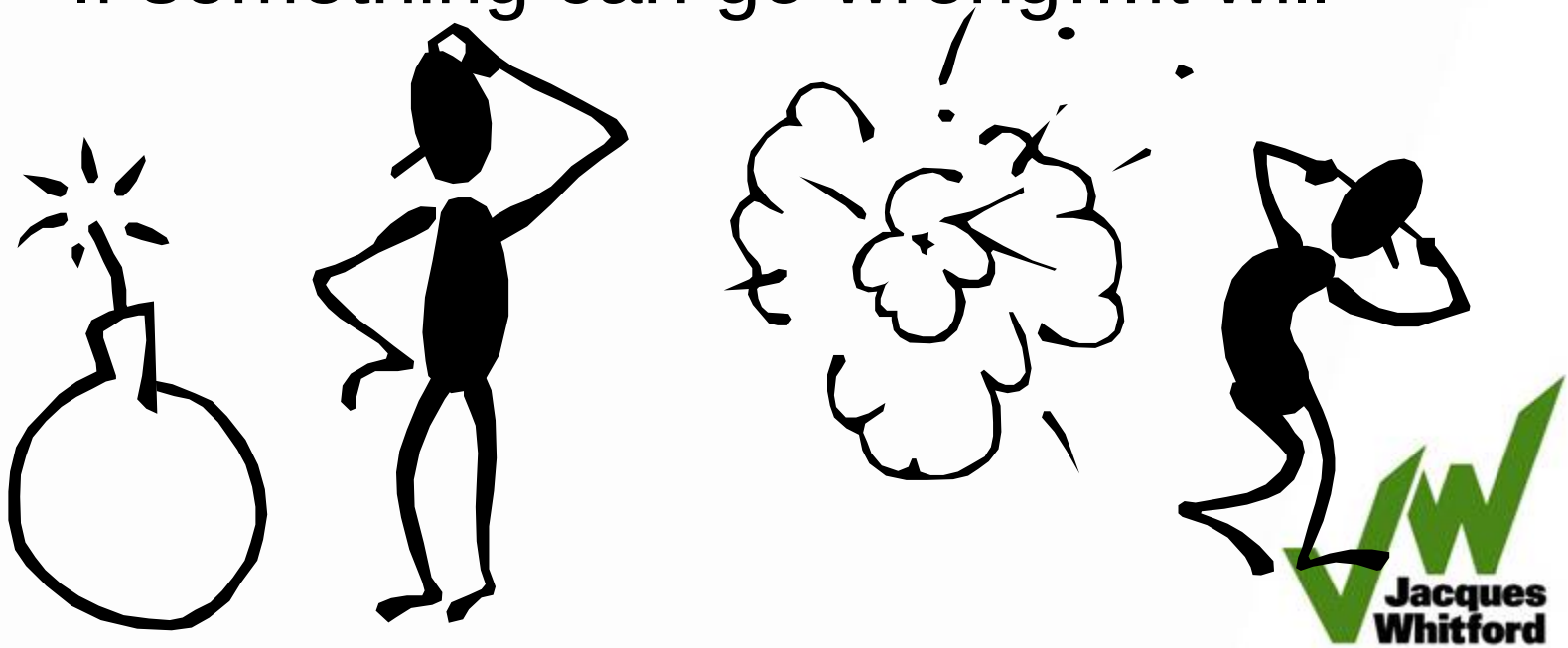
System Start Up - Challenges

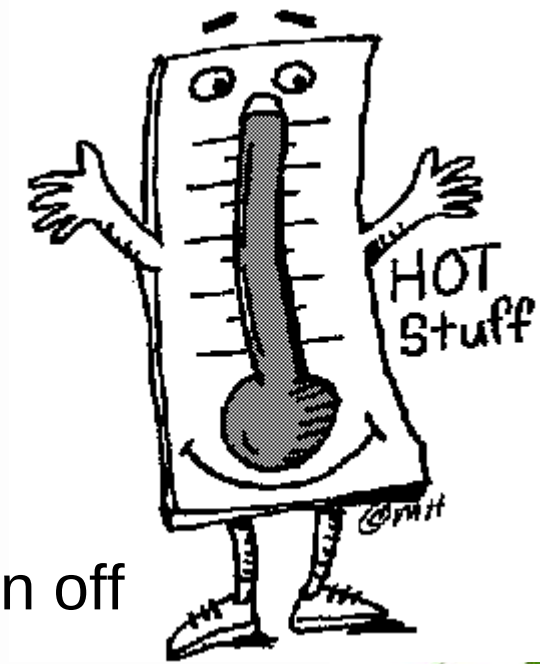
MURPHY'S LAW

If something can go wrong…it will



Challenges….1

- After the start up of the system, several challenges were encountered:
  - Maintaining vacuum from the blowers between 10 and 15 inHg,
  - Keeping minimum temperature required at the oxidizers.
  - Cycling of the vacuum blowers causing them to overheat and turn off



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Solution

- A butterfly valve was installed to control the vacuum in the system
  - The new valve would control the mixture of dilution air and vapours from the soils, maximizing the extraction levels but maintaining the minimum vacuum required

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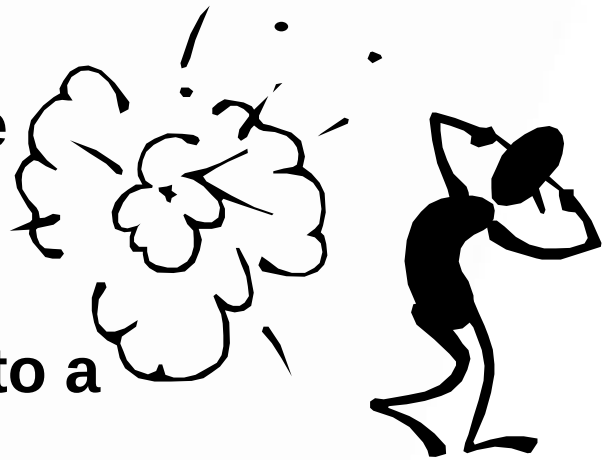
Challenges…2

- One month after start up of the system, one of the vacuum blowers (Side A) had to be completely replaced due to a failure with the bearings.
- A month later, the other blower (Side B) had to be replaced due to a broken shaft



Challenges…3

- **A month after the blower from side B was completely replaced, the bearings had to be replaced…again**

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Solution

- **It was determined that the metal platform that supported the system was not even, creating vibrations on the blowers and making them go off alignment**

…the system has been running constantly since….

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Status of the System to Date

- The system is operating at a constant catalytic temperature,
- The vacuum in both blowers remains at 12 inHg
- All the horizontal wells are open
- The dilution valve is fully closed

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Mass Extracted to Date

- An estimate of 22,250 L of product have been remediated with the SVE System
- Approximately 60% of the released gasoline has been removed after 14 months of operation

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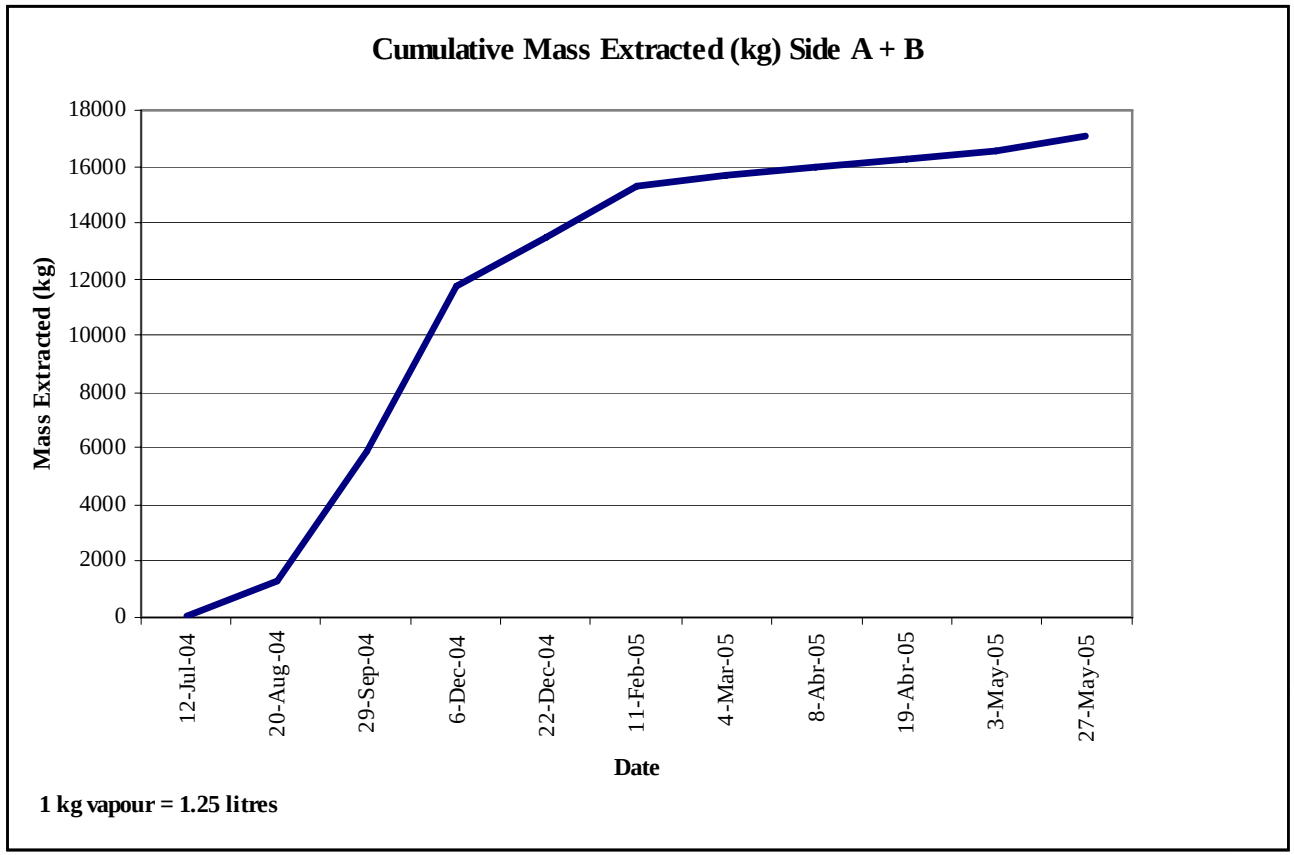
Mass Extracted to Date



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Efficiency

- The system is operating at about a 50% higher efficiency than originally anticipated
- Currently, the system is operating at 1%LEL, which represents a removal of approximately 10 L of gasoline per day

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Next Steps

- Potential for rebound effects
  - Turn system off for a period of 4 weeks to evaluate the potential of gasoline accumulation in the well network
  - Collect air samples and vapour readings to assess the amount of contamination remaining in the soil

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Next Steps, cont.

- Bioventing
  - Reverse the blowers to inject air into the subsurface to provide a constant supply of fresh air and promote biodegradation of the remaining petroleum hydrocarbon impacts

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QUESTIONS

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