



# Jacques Whitford

An Environment of Exceptional Solutions!

## SUSTAINABILITY IN REMEDIATION - ANALYSIS IN PETROLEUM HYDROCARBON REMEDIATION

Lesley Reid, M.Eng., P.Eng.

Jacques Whitford AXYS



FEDERAL CONTAMINATED SITES  
SITES CONTAMINÉS FÉDÉRAUX



NATIONAL WORKSHOP 2008 ATELIER NATIONAL

# Outline

- **INTRODUCTION**
- **BASELINE ASSUMPTIONS**
- **EX SITU**
- **IN SITU**
- **RISK ASSESSMENT**
- **DECISION MATRIX**
- **LEED®**

# Introduction

## Sustainability

- economic vitality
- environmental rejuvenation
- social enrichment

# Sustainability Considerations

- release of further contaminants during the remediation process
- petroleum hydrocarbon contamination present in the subsurface soils and groundwater
- identifying, delineating, remediating, and confirming conditions on the site

# ASSUMPTIONS (Sustainability)

- only total petroleum hydrocarbon (TPH)
- Ten boreholes (6-8m)
- plume measuring 5m x 10m x 2m
- at a uniform depth of 2m below overburden soils
- Soil 10,000 ppm TPH
- Groundwater 100,000 L 100 ppb TPH
- carbon dioxide only
- soils density 2,000 Kg/m<sup>3</sup>

# Reference

- emissions for fuels  
2.7 kg CO<sub>2</sub>/L
- Emission for electricity  
0.61 kg CO<sub>2</sub>/kWh
- Density TPH  
0.85 kg/L
- TPH CO<sub>2</sub>  
6,353 kg
- Attenuation  
80% ex situ and in situ  
50% risk assessment
- 5 km from the consultant office
- 10 km from the contractor's facilities
  - equipment storage,
  - ex situ treatment facilities
  - reinstatement material
  - analytical laboratory.

# Fuel Consumption Factors

Vehicle	Fuel Consumption	
	L/100km	L/hour
Prius Hybrid	5	
Camry Hybrid	7	
Float Truck	35	
Ford F250	27	
Volvo EC360B Excavator		25
Drill Rig		25
Dump Truck	35	25
Vacuum Truck	35	25
Sakai 400 Compactor	22	

# Baseline Investigation Quantities

Activity	Total
Mob/Demob - Daylighter and Operator	20 km
Mob/Demob Field Tech	30 km
Mob/Demob Supervisor	10 km
Mob/Demob Drill Operators	40 km
Mob/Demob Drill Rig	20 km
Operating Daylighter	5 hours
Operating Drill Rig	10 hours
Transporting Samples to the lab	40 km

# Carbon Check

From Source

6 353 Kg

From Baseline  
Assessment

1 500 Kg

# Ex Situ

- excavate and replace with clean fill
- overburden is removed by an excavator and stored on site
- dump truck haulage to an ex situ treatment facility
- returns with a load of reinstatement material
- fill is placed in the excavation in one metre lifts
- compacted with a vibratory roller
- Dewatering by vacuum truck while the excavation is open

# Ex Situ Remediation Quantities

Activity	Total
Mob/demob field tech	50 km
Mob/demob supervisor	10 km
Mob/demob excavator	20 km
Mob/demob excavator operator	100 km
Excavator operation	65 hours
Mob.demob dump truck	220 km

# Ex Situ Remediation Quantities (cont'd)

Activity	Total
Dump truck operation	20 hours
Mob/demob vac truck	60 km
Vacuum Truck operation	13 hours
Mob/demob compactor	20 m
Compactor operation	8 hours
Transport of samples to lab	60 km

# Carbon Check Ex Situ

From Source

80% - **5080 Kg**

From Confirmation of  
Remediation (10% of  
baseline)

**150 Kg**

From Baseline Assessment

**1 500 Kg**

Ex Situ Total

**13,000 Kg**

# In Situ

- vapour extraction system
- additional investigation to design the system 50% of the baseline
- source location for the vapour extraction system 500 km from the site.
- two years at 500,000 kWh per year.
- The water air sparged with 80% attenuation of the TPH (insignificant).
- confirmation of remediation 50% of baseline.

# In Situ Remediation Quantities

Activity	Total
Mob/demob Field Tech	240 km
Mob/demob supervisor	10 km
Mob/demob vapour extraction system	1000 km
Mob/demob drill operators	100 km
Mob/demob drill rig	20 km
Operation of drill rig	50 hours

# Carbon Check In Situ

From Source

- 80% - **5080 Kg**

From Baseline Assessment

**1 500 Kg**

From Design Assessment

**750 Kg**

From Confirmation of  
Remediaiton

**750 Kg**

From system operation

**600 000 Kg**

**In Situ Total**

**625 000Kg**

# Risk Assessment

- data from baseline investigation
- data from an additional detailed investigation
  - contaminants present
  - the receptors
  - the pathways
- assumption of no offsite migration

# Carbon Check Risk Assessment

From Source

- 50% - **3 275 Kg**

From Baseline Assessment

**1 500 Kg**

From Design Assessment

**1 500 Kg**

From Confirmation of  
Remediaiton

**150 Kg**

**Risk Assessment  
Total**

**6 200Kg**

# Decision Matrix

Remediation	CO <sub>2</sub>	Cost	Time
Ex situ	●●	\$\$\$	🕒
In situ	●●●	\$\$	🕒🕒
Risk Assessment	●	\$	🕒🕒🕒

## LEED Rating System and Addendum

### New Construction and Major Renovation

- Credit 3 for Sustainable Sites - Redevelopment of Contaminated Sites.
- One point for remediation as required by provincial programs for a site classified by the regulatory agency as a contaminated site.

## LEED Green Building Rating System

### Commercial Interiors

- Credit 1 for Sustainable Sites - Site Selection.
- One half point is available for a building located on a brownfield redevelopment, confirmed either through a CSA Z769 Phase II Environmental Site Assessment or the regulatory agency.

# References

Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program, Fuel and Energy Source Codes and Emission Coefficients*, <http://www.eia.doe.gov>

Bento et al., *Bioremediation of soil contaminated by diesel oil*, Brazilian Journal of Microbiology, vol.34, suppl. 1, November 2003.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, U.S. Environmental Protection Agency *Model Year 2008 Fuel Economy Guide*, DOE/EE-0321, [www.fueleconomy.gov](http://www.fueleconomy.gov)

Volvo Construction Equipment, *Case Study B-Series Excavators=Big Fuel Savings*, [www.volvoce.com](http://www.volvoce.com)

*Production and Cost Comparison Articulated Dump Truck vs. Pull Pans*, [www.pullpans.com](http://www.pullpans.com)

Canada Green Building Council, *LEED Green Building Rating System Rating System and Addendum for New Construction and Major Renovations, Version 1.0*, December 2004

Canada Green Building Council, *LEED Canada Green Building Rating System for Commercial Interiors, Version 1.0*, September 2006

U.S. Green Building Council, *LEED Green Building Rating System for Core and Shell Development, Version 2.0*, July 2006

Congress for New Urbanism, Natural Resources Defense Council and U.S. Green Building Council, *Pilot Version, LEED for Neighborhood Development Rating System*, February 2007