

Environmental Risk Assessment & Risk Management - a broader perspective





- **Every generation leaves behind its environmental footprint.**
- **In the past, it was all too common to....**



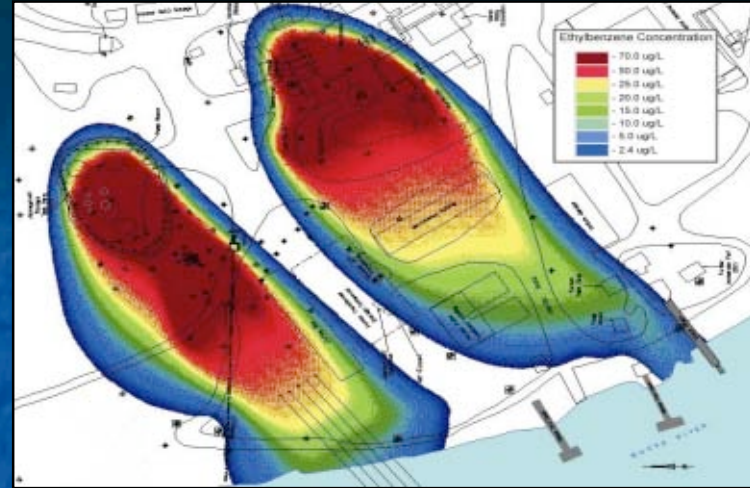
Dig a trench and bury the wastes...



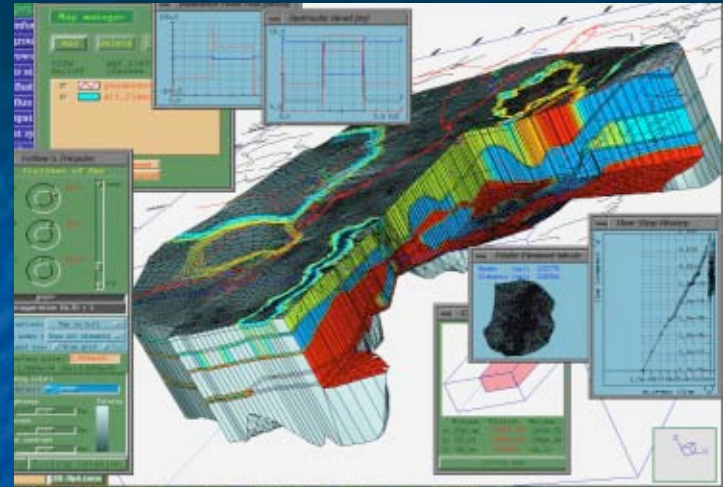
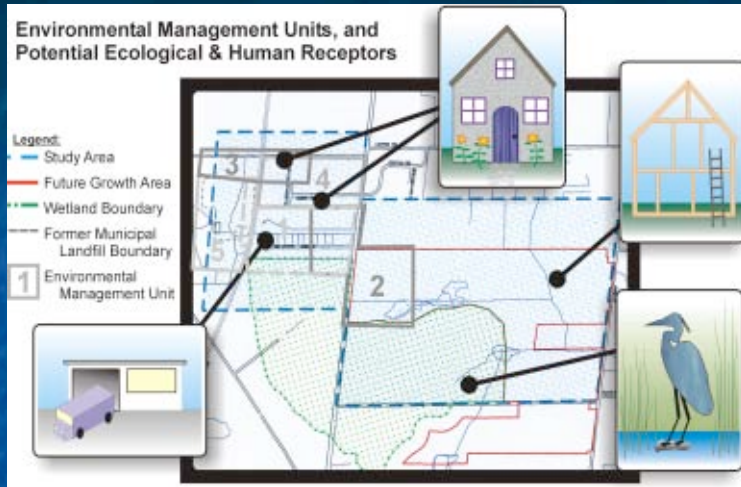
Detonate it...(optional)



Backfill...(then hope for FCSAP funding)



- **At the time, these were considered “normal practices”.**
- **However, we are only now understanding the magnitude and dimension of these impacts.**



- One of our “normal” practices is “risk management”.
- This will be part of our environmental footprint and our legacy to protect.

The way forward will be based on our viewpoint



"Everything that has been invented, has been invented"

Charles H. Duell

Commissioner US Office of Patents, 1899

"The more we study, the more we discover our ignorance"

Percy Byssle Shelley

1792-1822 British poet

Denotes activity

Denotes decision criteria

Problem Formulation
(defined from ESAs 2/3)

2. Historical information

4. EQC & SSTL

Data Analysis

3. Emerging Contaminants

Risk
Assessment

1. Receptors

5. Ecological Risk Assessments

Risk
Management

Remediation
Action



The "World is Flat"

Thomas Friedman, NY Times columnist



- **From a mechanical perspective, the earth is an interconnected network supported by the new digital age.**
- **From an environmental perspective, the earth is still a really big unknown place.**

The World of unknown Receptors

- As much as 97% of the world's plant and animal species may still wait to be discovered.
- 99% of flowering plants have never been tested for medicinal purposes. Plants cannot flee from predators, so they contrived chemical defences enriched in chemicals.
- We don't have the faintest idea the number of living things that are on the planet including the sensitive receptors in the North.
- Estimates of all living things range from 3 million to 200 million.

Reference: Edward O. Wilson. The Diversity of Life,
Harvard University Press.

Frogs with no lungs found in Indonesian wild



Globe and Mail, April 10, 2008
Michael Casey
Associate Press

Bangkok- A frog has been found in a remote part of Indonesia that has no lungs and breathes through its skin. These are about the most ancient and bizarre frogs you can get on the planet, said David Bickford, biologist, National University of Singapore....

Along with the lung less frog, Mr. Bickford said his team discovered two new lizard species and four other species of frogs during their two-month trip.

Many more discoveries to follow.

What is in a handful of soil?



- 10 billion bacteria
- 1 million plump yeasts
- Some 200,000 hairy little fungi-called moulds
- 10,000 protozoans
- Assorted rotifers, flatworms, roundworms and other creatures known collectively as cryptozoic

A large portion of all these will be unknown.

Reference: Bill Bryson, *A Short History of Nearly Everything*, 2004
Anchor Canada

Extracting the Past

- Similar to receptors, we face challenges to our work from a historical perspective.
- Our retrieval and evaluation of historical information is one of the fundamental building blocks of our environmental assessments and management.
- But collectively, we seem to suffer from some form of amnesia.



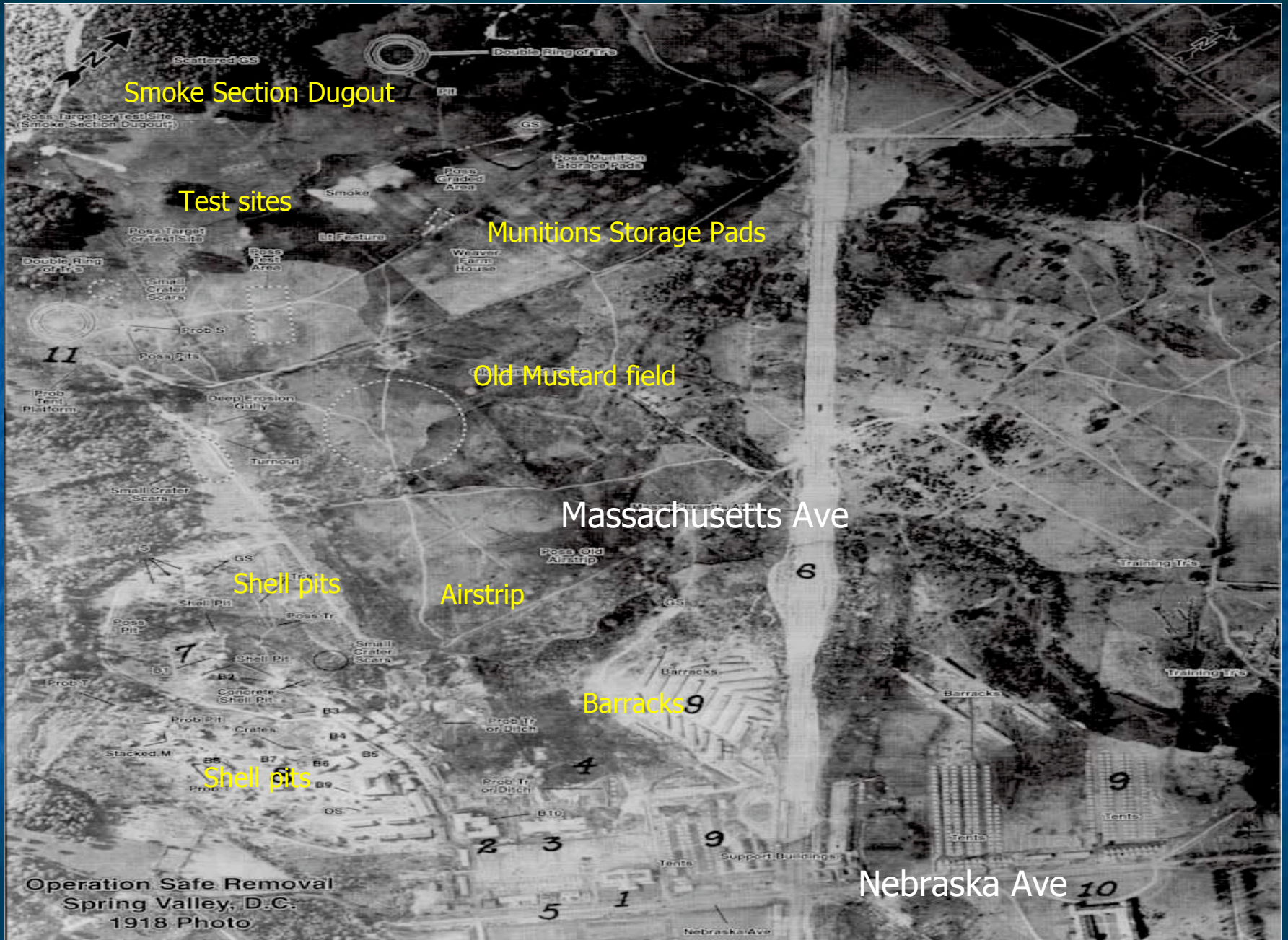
- Historically, in the Canadian North, significant projects have been completed including:
 - Alaska Highway
 - Canol project oil-pipeline
 - RCAF operations and airfield construction
 - Loran navigational systems
 - Uranium transportation route
 - DEW line

In many cases, the historical documentation for a number of these sites would be considered poor.

Spring Valley, Washington DC

Formerly Used Defence Site – USACE

- During World War I (WWI), 1917-18, the Spring Valley area was used by the U.S. Government to manufacture and test chemical agents, and munitions, including Mustard, Lewisite, and Adamsite agents, irritants, and smokes.
- The site employed over 1200 chemists and engineers with 700 technicians.
- There was extensive testing of 54 different toxic substances, some in open air and trenches.



Smoke Section Dugout

Test sites

Munitions Storage Pads

Old Mustard field

Massachusetts Ave

Shell pits

Airstrip

Barracks

Shell pits

Operation Safe Removal
Spring Valley, D.C.:
1918 Photo

Nebraska Ave

Spring Valley, Washington DC

Formerly Used Defence Site – USACE

- Demobilization of the site followed immediately after the end of the war in November 1918. It was there, then it was gone (buried!).
- No information management system or monitoring was maintained.
- Soon thereafter, Spring Valley was developed as a residential neighbourhood known for its large homes and tree-lined streets.



It was not until the early 1990s, that identified buried munitions, explosives and chemical warfare material (MEC/CWM) were found in the Spring Valley neighbourhood.



Sawmill Bay, NT



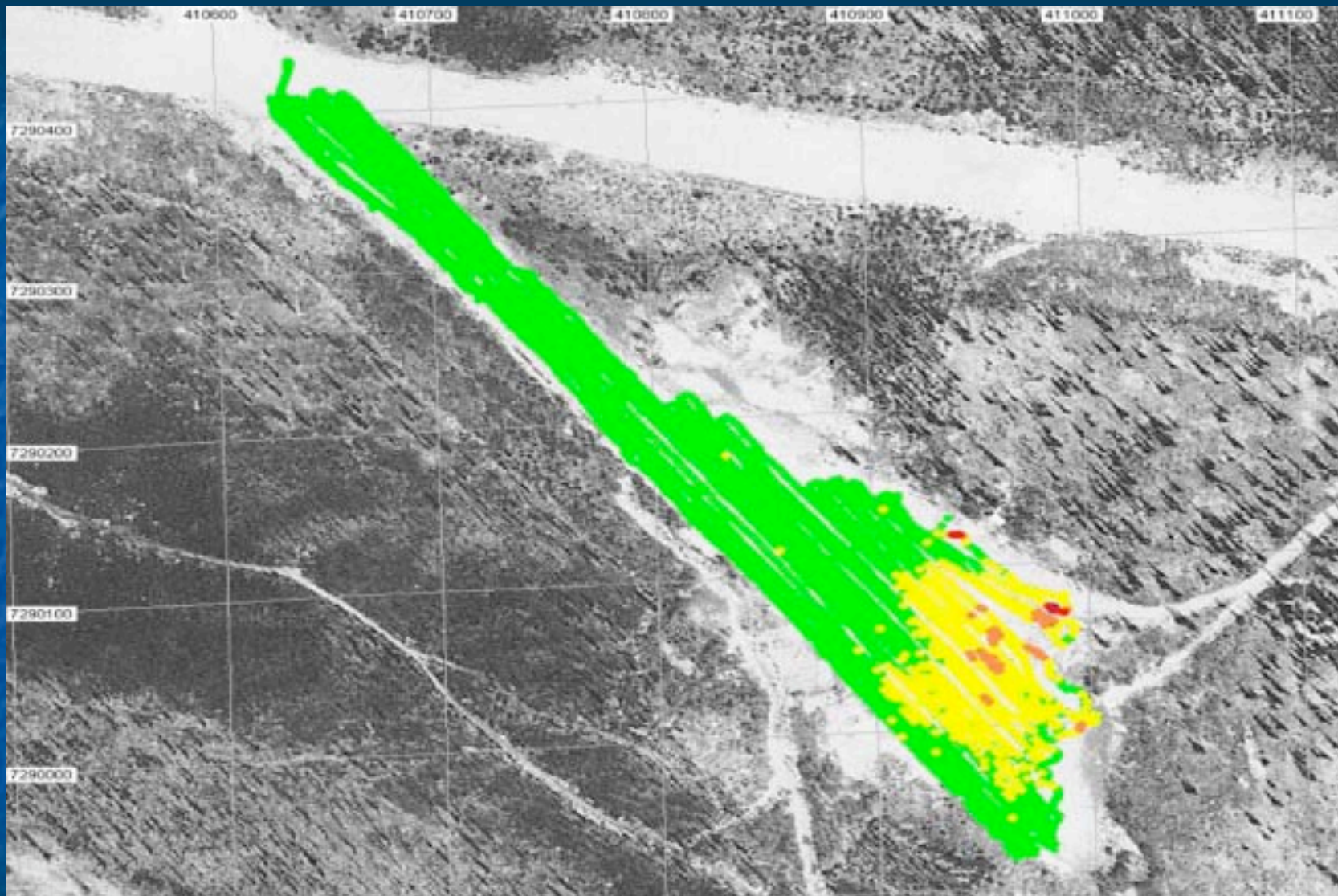
- Sawmill Bay site has had a varied history since the 1930s including:
 - timber sawmills- (30s-40s)
 - barging and as an airfield for the trans-shipment of uranium ore from Port Radium mine –(40s to 60s)
 - air fields and bases camp for RCAF operations (late 40s to 50s)
 - Loran navigation system- (50s)
 - a staging area for the construction of the DEW Line (50s) and
 - a fishing lodge late (50s to present- abandoned).
- Its varied history has left areas impacted with uranium ore, metals, PHCs, landfills and dumps, barrel caches and buildings in disrepair....much is unknown.

Site Layout





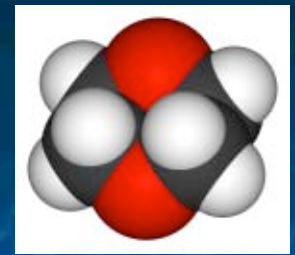
Tourist photos and Traditional Knowledge saved the day



Emerging Contaminants

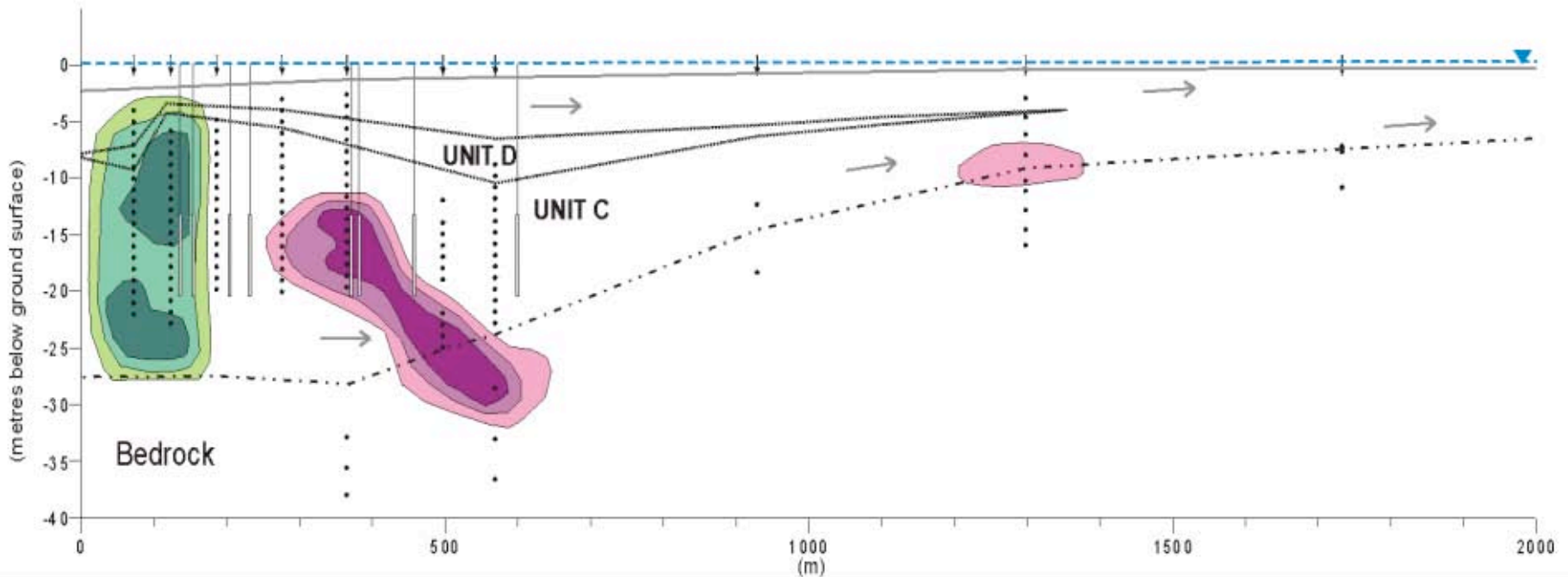
- Emerging contaminants are chemicals that are
 - presently unregulated,
 - can have unknown or not fully understood effects on health and the environment and
 - have public and/or regulatory interests.
- Examples
 - 1,4 Dioxane
 - Pharmaceuticals and Personal Care Products (PPCP)

1,4 Dioxane



- Used in paints, cosmetics, shampoos, hair lotions, soaps, deodorants, and is a stabilizer and corrosion inhibitor with other chlorinated solvents.
- It is likely that every significant chlorinated solvent plume (TCE, PCE, TCA) is co-existing with a 1,4 dioxane plume.
- Probable human carcinogen; does not adsorb and highly resistant to abiotic and biotic transformations.
- A solvent to water (dissolves water) and travels at the same velocity as groundwater.

1,4 Dioxane vs TCE plume



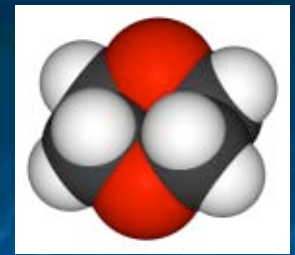
TCE concentrations:

- Above treatment objective (50 $\mu\text{g/L}$)
- 10 $\mu\text{g/L}$
- 1 $\mu\text{g/L}$

1,4-dioxane concentrations:

- Above treatment objective (66.5 $\mu\text{g/L}$)
- 30 $\mu\text{g/L}$
- 15 $\mu\text{g/L}$

1,4 Dioxane



- In the US, 1,4 dioxane has been recently discovered at hundreds of contaminated sites.
- Records of Decision have been overturned based on the presence of 1,4 dioxane.
- Problem: conventional groundwater remediation treatment including carbon treatment and air stripping are not effective.
- Effective treatments are ultraviolet light and chemical oxidation.
- Numerous public water supply wells in the US have been shut down.
- Ontario MOE - PWQO of 30 ug/L; Health Canada -draft

Pharmaceuticals and Personal Care Products (PPCP)



- Prescription and therapeutic drugs, veterinary drugs, fragrances, and cosmetics, as well as antibiotics and growth natural and synthetic hormones used with livestock.
- Up to 90 % of oral drugs can pass through humans unchanged, thus many of these drugs enter the environment through human and livestock waste.
- Volume released to the environment per year is on the same as level as pesticides.

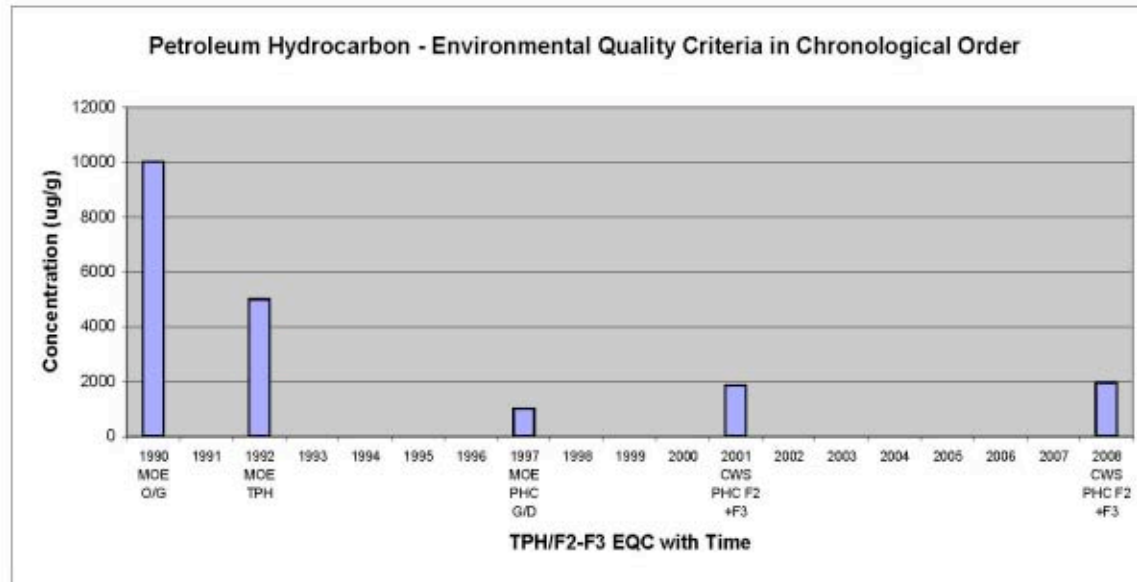
PPCP- not the conventional contaminant



- The effects of PPCPs are different from conventional contaminants.
- Drugs are purposefully designed to interact with cellular receptors at low concentrations and to elicit specific biological effects.
- Effects on aquatic life are a major concern. Exposure risks for aquatic organisms are much larger than those for humans. Aquatic organisms have:
 - continual exposures
 - multi-generational exposures
 - exposure to higher concentrations of PPCPs in untreated water
 - possible low dose effects
- Around the world, changes in fish, amphibians and other organisms have been noted.

Evolution of the Environmental Quality Criteria (EQC) & Role of the SSTL

- EQCs have evolved only recently from “analytical detection or background limits” to “toxicity based”.
- Advancing into Tiered Generic approach using pathway specific criteria.
- More Confidence in our approach.



- 1 1990 MOE - Guidelines for the Decommissioning and Cleanup of Sites in Ontario, 1990 Table A-2 Industrial /Commercial Landuse Coarse grained soil.
- 2 1992 MOE - Interim Guidelines for the Remediation of Petroleum Contamination at Operating Retail and Private Fuel Outlets in Ontario Low Site Sensitivity.
- 3 1997 MOE - Guideline for Use At Contaminated Sites in Ontario Table B Industrial /Commercial Landuse Coarse grained soil, non-potable coarse grained.
- 4 2001 CWS - Tier 1 Industrial /Commercial Landuse Coarse grained surface soil non-potable groundwater condition.
- 5 2008 CWS - Tier 1 Industrial /Commercial Landuse Coarse grained surface soil non-potable groundwater condition.

EQCs – Ecological Receptors

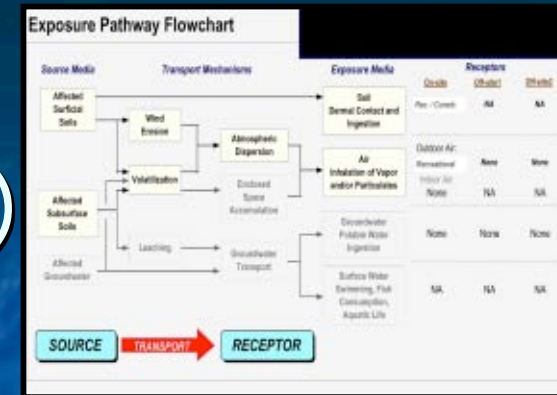
- Can be challenging for ecological receptors:
 - Lack of sediment or eco-quality guidelines for many chemical parameters.
 - Unaware of the sensitivity of receptors – especially in the arctic.



Role of the Site Specific Target Level (SSTL)

- SSTLs are specific output from Ecological Risk Assessments.
- EQCs are static and based on policy and science.
 - MOE 2004 standards based on 1996 guidelines...
- SSTLs are at the leading edge (real time) of science (TRVs, bioavailability).

Site Specific Target Level (SSTL)



- But there is a disconnect between the EQC (static) and SSTL (active).
- This disconnect represents challenges:
 - to risk management plans and
 - to stakeholder buy-in.
- What receptors are the SSTLs trying to protect (the earthworm, vole, hare, muskrat, fox, caribou).

Reality Check

SOIL / WATER PARTITIONING

$$C_W = \left(\frac{C_S}{K_{oc} F_{oc}} \right)^{1/n}$$

C_W = Concentration of Contaminant in water (mg/L)

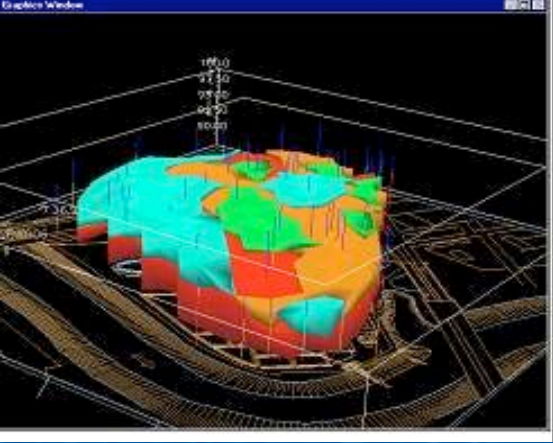
C_S = Concentration of Contaminant in soil (mg/kg)

N = Dependent on contaminant – (0.7 – 1.1)

F_{oc} = Fraction of organic content

Contaminant	CCME C/I Soil EQC (mg/kg)	Water Concentration in Equilibrium with CCME Soil Criteria (mg/L)
Benzene	Old EQC 5	2.5 mg/L
	New EQC 0.030	0.015 mg/L

$n=1$, $F_{oc} = 0.02$, $K_{oc} = 100$ L/Kg



Ecological Risk Assessments



- Best described as mix of science and professional judgement
- Faced with many unknowns:
 - Biomagnification and food chain issues
 - Multiple low dose contaminant effects
 - Receptor sensitivities and behaviour
- Outcomes can be very sensitive to data input and assumptions:
 - Bioavailability
 - TRVs
 - Statistical data, Field data, Modelling data

Take Home Message



- Risk Management is a **powerful tool** and provides a great deal of protection for many ecologically sensitive sites.
- For now and into the foreseeable future, we must rely on a “**weight of evidence**” approach.
- In time, with reflection, we will **understand** our environmental footprint...

My Risk Management Mantra

***We can't always get what we want,
but if we try sometimes, we just might find
we'll get what we need.***

The Rolling Stones

Thank-you

Welcome to Session D

Environmental Risk Assessment & Risk Management

