



Phase Transfer Technology

FACT

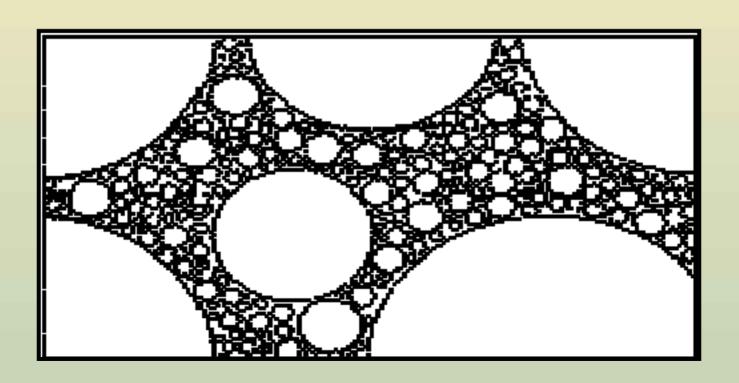
90 to 95 % of All Contaminants Are Absorbed To Particles In Soil, Bed Rock and Groundwater Aquifers

Contaminant Absorption
Limits Availability of Contaminants For
Remediation

Sorption is the #1 Reason Why Many In-situ and Ex-situ Remediation Project are Slow, Costly or Fail.

Sorption (Absorption and Adsorption) of Contamination in Soil Matrix

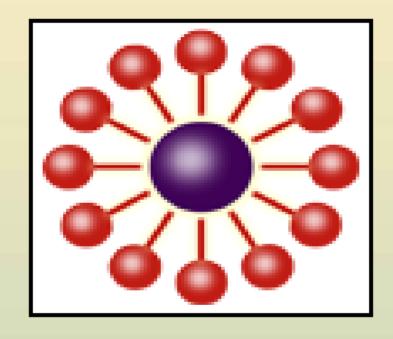
Soil & Water Remediation Must Address This To Be Successful.



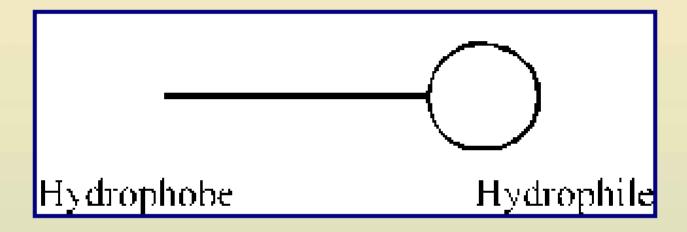
Ivey-sol® SER, SEB, SEO Technology

Presentation Overview:

- i) General Facts
- ii) How It Works (SAA Selectivity)
- iii) In-situ & Ex-situ Applications
- iv) NAPL Range (TPH, MTBE, PCB, PAH, TCE, PCE, Metals)
- v) Case Studies (In-situ, Ex-situ, and Commercial)
- vi) Questions & Answer Period
- vii) How To Contact Us



Micelle Encapsulated Oil Droplet Typical View of Surfactants



Surfactant Chemical Structure

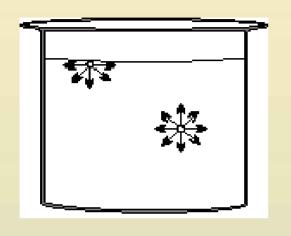
Hydrophilic (water loving) and Hydrophobic (water hating oil-liking) Groupings Allow For Surface Interaction
With Many Contaminants

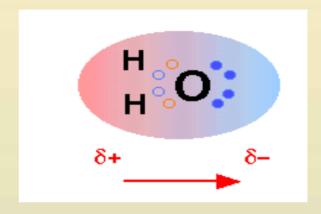
Classes Of Surfactants

- Anionic: They have one or more negatively (-) charged groupings. They have very good detergent ability and are commonly used as laundry detergent.
- <u>Cationic</u>: They have one or more positively (+) charged groupings. They typically have poor detergency, but are well suited for use as germicides, fabric softeners, and emulsifiers.
- Amphoteric: They contain both anionic and cationic groupings and have the characteristics of both anionic and cationic SAA. They work well at neutral pH and are found in products such as hair shampoo, skin cleaners, and carpet shampoo.
- Non-ionic: As their name implies, they have no ionic constituents or groupings. They are the largest single group of SAA and have a correspondingly wide range of chemical characteristics and application. Ivey-sol surfactant mixtures, are non-ionic and have the unique ability to selectively desorb contamination (LNAPL, DNAPL's, PAH, PCB, DCE, TCE, PCE), etc.

Ionic Surfactants make up >99% of the surfactant used around the world.

In this regard Ivey-sol is very unique.

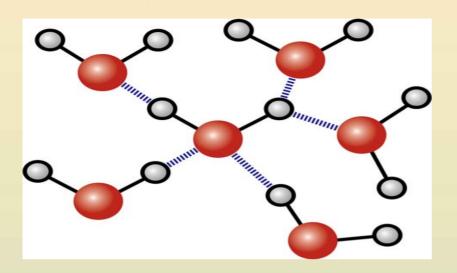


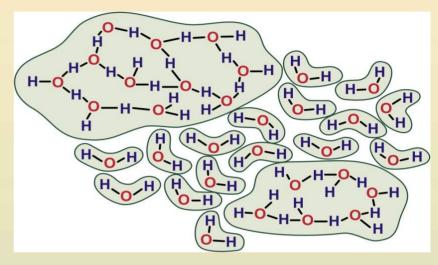


Surface Tension Forces Shown Pulling Water Together

Polar Water Molecule {Oxygen (ζ-) Hydrogen (ζ+)}

Surface Tension In Water: Is Caused By The Attractive Forces Between Neighbouring H₂O molecules. The oxygen (-) in one water molecule is attracted to the hydrogen (+) atoms in the neighbouring water molecules. Forming "Hydrogen-Bonding"





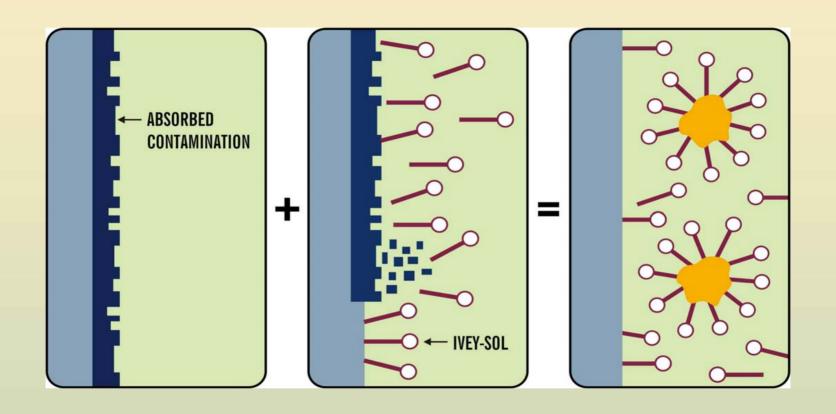
Hydrogen Bonding Between Polar Water Molecules (*in-blue*) Pulling Water Together Between Neighbouring H₂O.

Water Clusters Can Form Form As A Result That Range In Size & Complexity

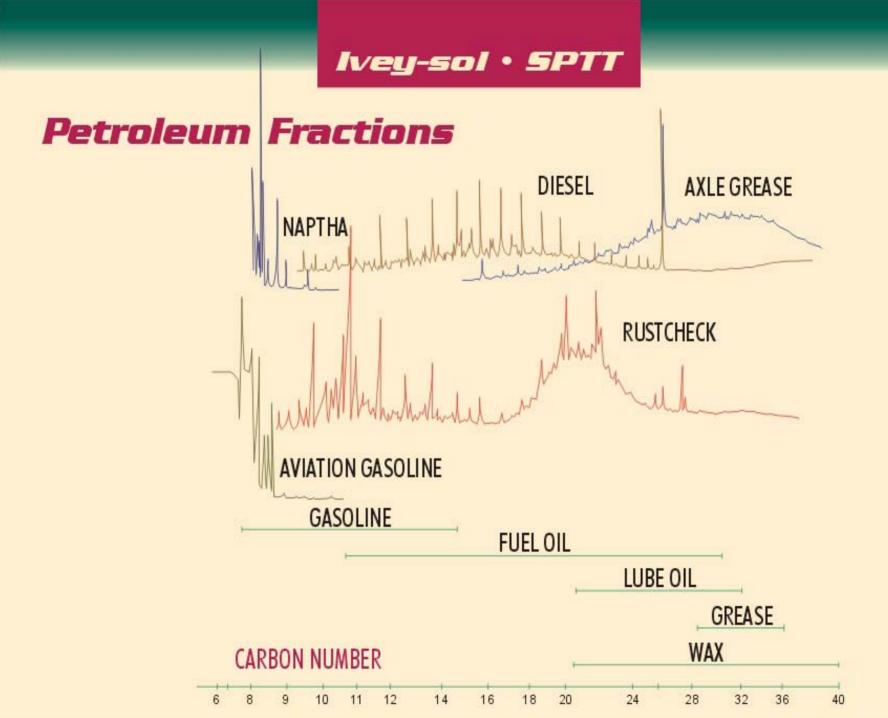
Hydrogen Bonding Is What Gives Rise To The Insolubility Of Non-Polar NAPL Compounds, And Why the Hydrophilic (*Water Liking*) End Of The Ivey-sol Molecules Are So Effective In Rendering The NAPL Compounds Miscible In Water.

Ivey-sol Lowers The Surface Tension of Water From 72 Dynes to <30 dynes

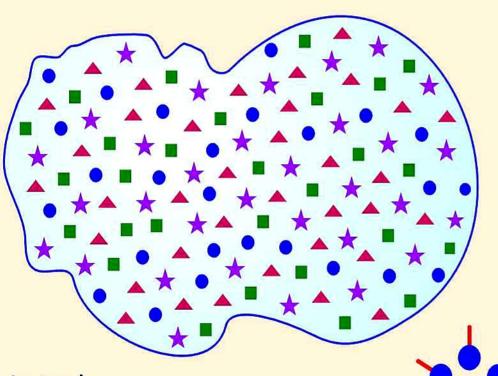
This increases the wetting ability of the water when present, making Ivey-sol® application possible in fine grain soils improving Water Permeability (K).



Ivey-sol Interaction With Oil On A Surface
With Partial Micelle Encapsulated of Oil Droplet
(Ivey-sol is Effective Below The CMC)



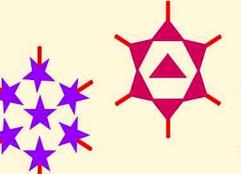
Selective Micelle Encapsulation of Contamination

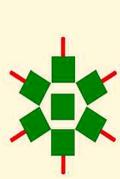


- Selective Micelle Formation
- Encapsulation and increased solubility
- Applicable for full LNAPL and PAH range
- Ivey-sol mixture is taylored to type/range of contamination being treated

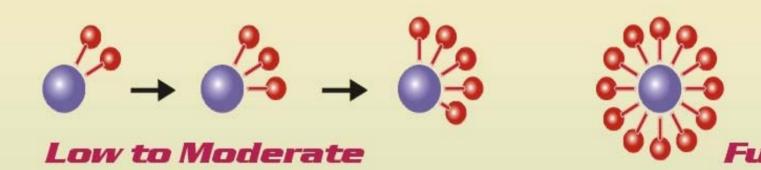
Legend:

- Aromatics
- Cyclic Alkanes
- **Alkanes**
- PAHs

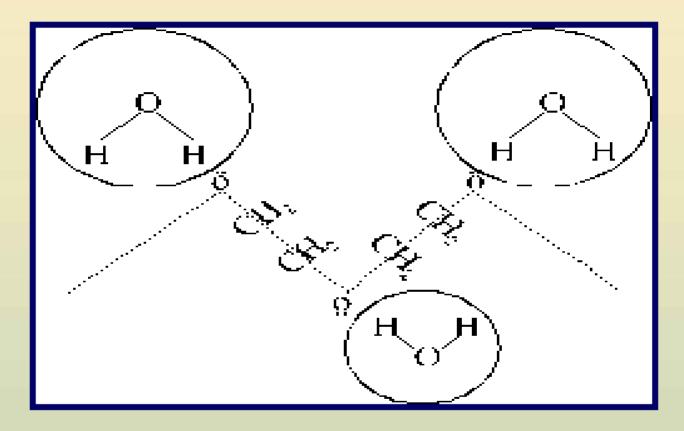




Encapsulation Effects



- Liberation of contamination can be effected with low to moderate encapsulation. Hence, low SPTT concentrations are effective.
- As partial encapsulation is predominant due to injection concentrations, no negative effects are realized at the treatment system (e.g., GAC, Air Stripping, Bio-Reactors, Membrane Separation, etc.)



Ivey-sol's Hydrophilic Interaction With Water (H_2O) Utilizing Hydrogen Bonding Effects To Aid Dissolving Contaminants in Water

Remediation By-Products

- **USEPA & Environment Canada Are Concerned About By-Products**By-Products Produced During Chemical & Biological Remediation.
- Chemical Reactions Are Not 100%! Hence They Giving Rise To The Formation of By-Products During Remediation.
- Chemical Oxidation and Reduction of Organic Contaminants

 Will Produce By-Products. (Often Unknown and/or Missed During Laboratory

 Analysis. The Old "Out of sight out of mind" Philosophy!)
- RISKS: Remediation By-Products Can Be More Toxic Than The Target Contamination. Example: The well published Biodegradation of TCE forming Vinyl Chloride, that was 15+ times more toxic than the original TCE contamination.

Ivey-sol does not alter the chemical structure of contaminants. Hence, no by-products formed averting by-product risks.

APPLICATION RANGE

LNAPL

Full LNAPL (F1,F2, F3, and F4) Range Including: BTEX, Gasoline, Diesel, Motor-Oil, Bunker-C, MTBE, PAH's, etc.

DNAPL

25 Fold (+) Increase In Solubility & Recovery Rate. This includes Compounds Like: PCE, PCB, TCE, TCA, CTC, TCM, PCP, & Various other Cl / Br Solvents

Heavy Metals

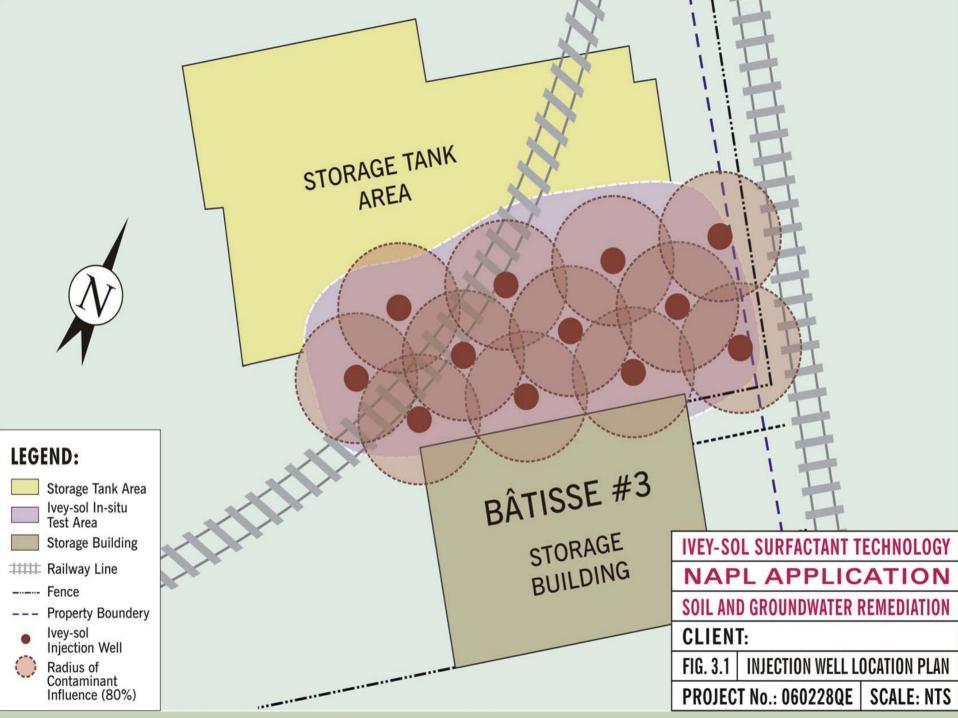
Transition metals, including organo-metalic complexes, and radio-active metals associated with NORMS.



Fuel-oil - Bunker-C - Gasoline Dissolved In Water With Ivey-sol

PAH Soil Remediation

Parameters	Baseline	Ivey-sol 106	% Reduction
PAH'S	ppm	ppm	ppm
1-Methylnaphthalene	130	5	96.1%
2-Methylnaphthalene	220	6	97.3%
Acenaphthene	46	6.1	86.7%
Acenaphthylene	140	6.4	95.4%
Anthracene	190	19	90.0%
Benzo(a)anthracene	100	14	86.0%
Benzo(a)pyrene	74	9	87.8%
Benzo(b)fluoranthene	54	6.3	88.3%
Benzo(ghi)perylene	21	3.3	84.3%
Benzo(k)fluoranthene	54	6.3	88.3%
Chrysene	100	13	87.0%
Dibenzo(a,h)anthracene	9.6	1.2	87.5%
Fluoranthene	230	26	88.7%
Fluorene	190	12	93.7%
Indeno(1,2,3-cd)pyrene	35	4.5	87.1%
Naphthalene	560	9.7	98.3%
Perylene	20	1.6	92.0%
Phenanthrene	420	37	91.2%
Pyrene	170	19	88.8%



Treatment of Chlorinated Contaminated Fine Grain Soil

Chlorinated Compounds	Baseline Mg/kg	Treatment No. 1	Reduction (%)	Treatment No. 2	Reduction (%)	Total Reduction			
1,2-Dichlorobenzene	8,300,000	490,000	94%	56000	89%	99.33%			
1,3-Dichlorobenzene	1,100,000	45,000	96%	8100	82%	99.26%			
1,4-Dichlorobenzene	2,900,000	110,000	96%	14000	87%	99.52%			
	470.000	40.000	200/	450	00 000/	00.049/			
Chlorobenzene	170,000	12,000	93%	150	98.80%	99.91%			
Styrene	1200	74	94%	ND	>99.99%	>99.99%			
TCE	590	41	93%	ND	>99.99%	>99.99%			



Recent Research Has Confirmed *Ivey-sol* Increases The Controlled Solubility and Rate of *MTBE* Recovery From Soils, Bed Rock, and Groundwater

By > 740%

Reference: Dr. Davis Craft, University of Alberta (2004)

PCB's Ivey-sol Increases The Solubility of PCB's by > 900%

Based on Research and Development Work

Completed in 2005 by

Dr. David Craft (NRC) & George Ivey (Ivey International)

Surfactant Enhanced Oxidation (SEO)

- Ivey-sol Surfactants are applied to PCB contaminated soils to desorb PCBs
- Following de-sorption of PCB's a water soluble oxidizing chemical (Agent) is applied.
- PCB levels reduced to clean-up standards with some samples coming back Non-Detectable.
- When oxidizers are used alone, efficiency was < 35%.

Reference: 2005 Project Collaboration
Ivey International & National Environmental Contractor

FACT

90 to 95 % of All Contaminants Are Absorbed To Particles In Soil, Bed Rock and Groundwater Aquifers

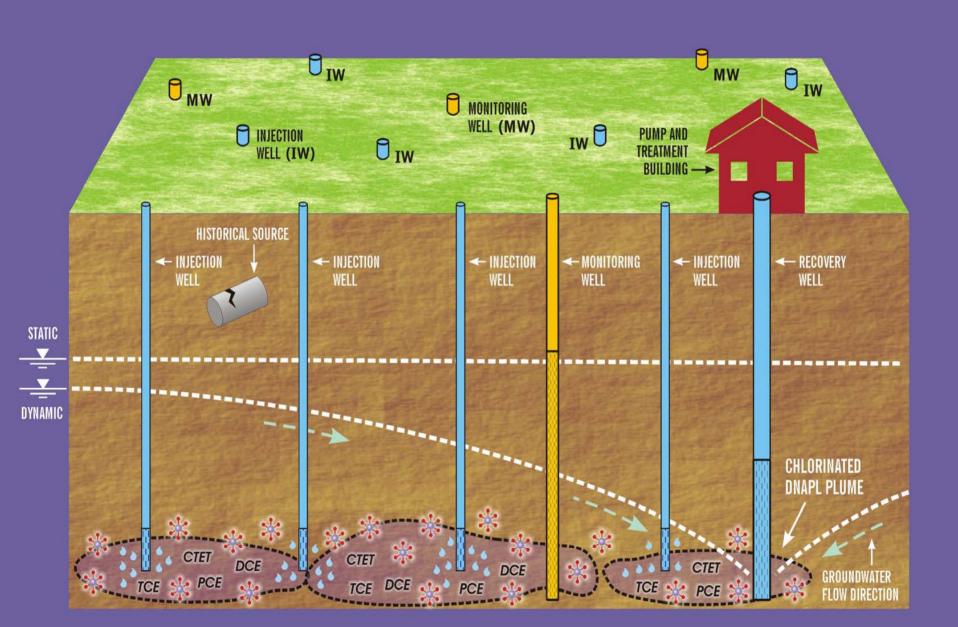
Sorption Limits 'Availability' of Contamination For

- Removal by <u>Pump and Treatment</u>;
- Availability for <u>Bioremediation</u>;
- Availability for <u>Oxidation and Reduction</u>

Ivey-sol Desorbs Contamination Improving Insitu and Ex-situ Remediation Methods

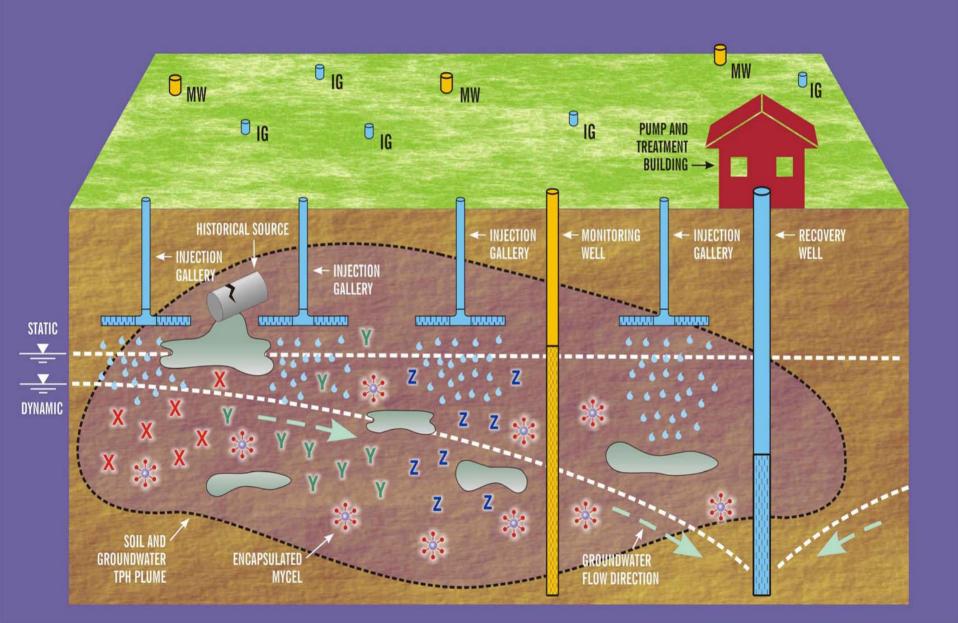
IN-SITU REMEDIATION

To design a good 'Remediation Action Plan' you need a good quality Phase II Site Investigation.



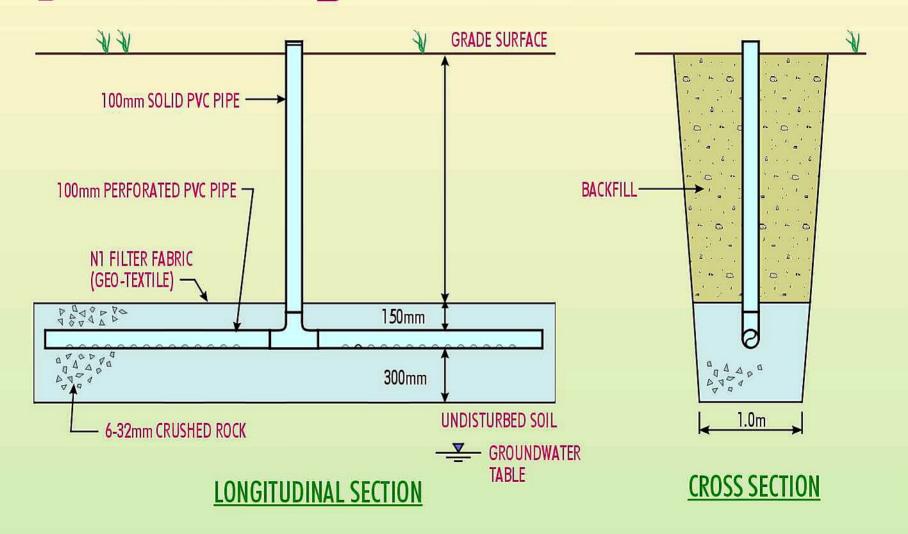
Injection Well Design PVC 100mm **Ground Surface** Ground/Surface **Access Cover Betonite Seal (if required)** (0.8 to 1m thickness) Solid 100mm (4 inch) PVC **Approximate Groundwater Table Elevation** Medium to coarse Silica Sand Screened 100mm PVC **Betonite Seal (if required) Not To Scale**

Standard
Injection Well
(IW)
Design

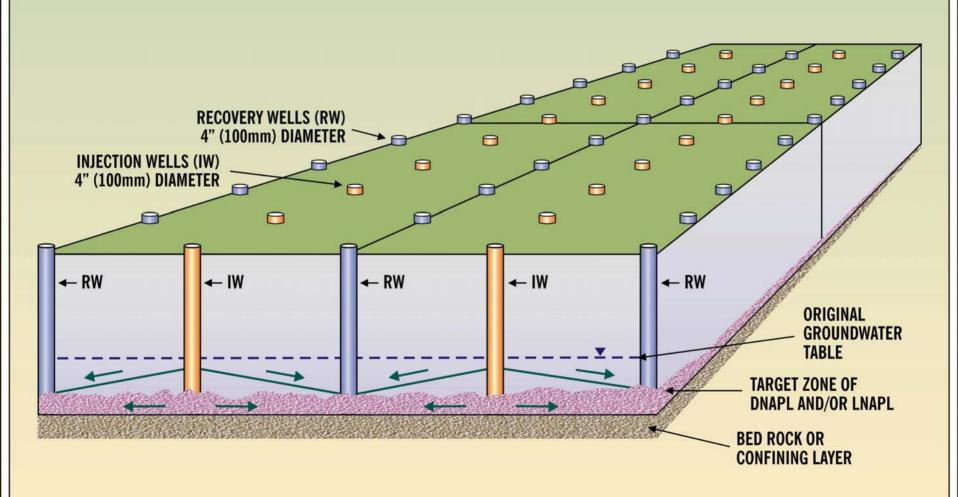


Ivey-sol

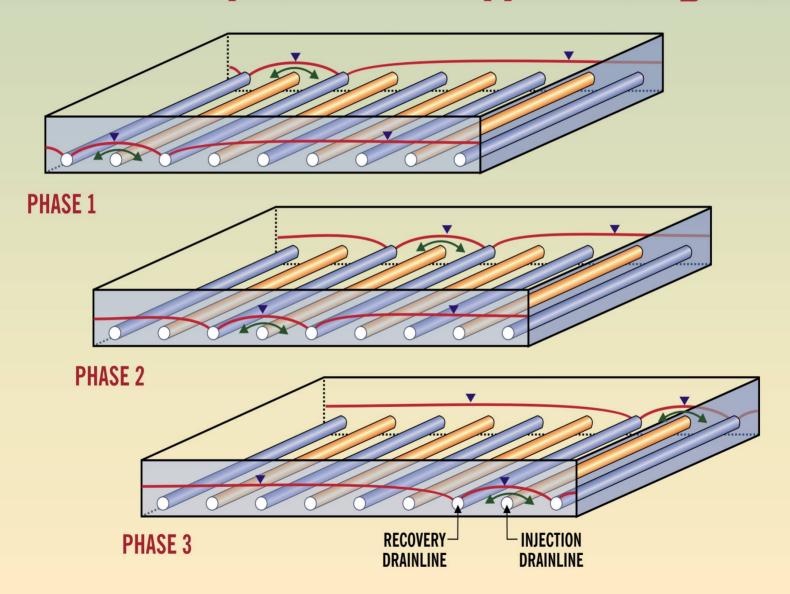
Injection Gallery (Basic Design)

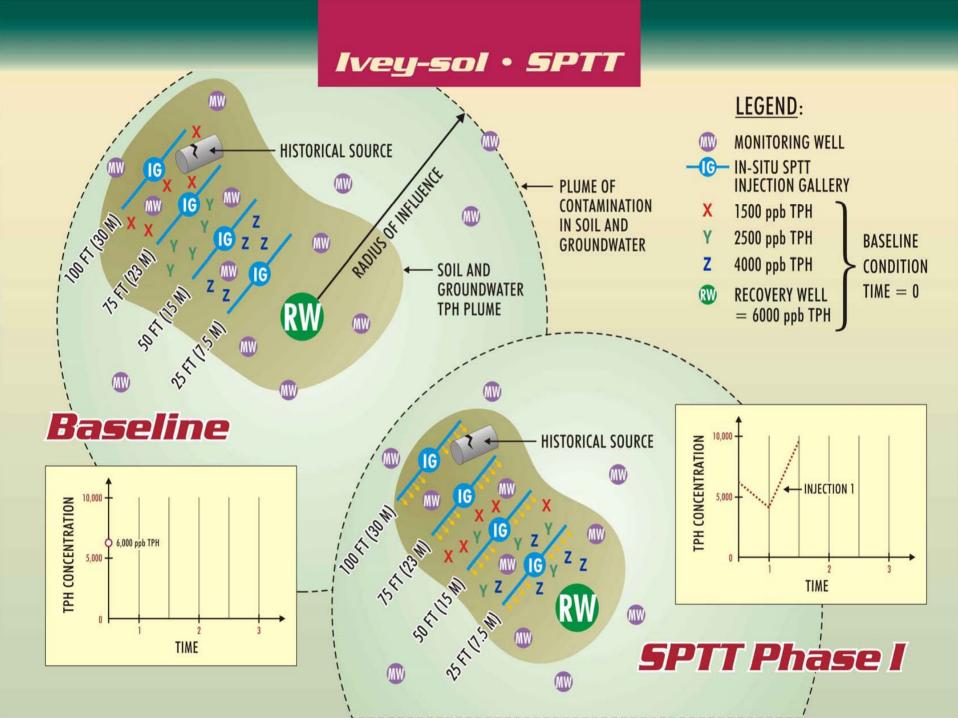


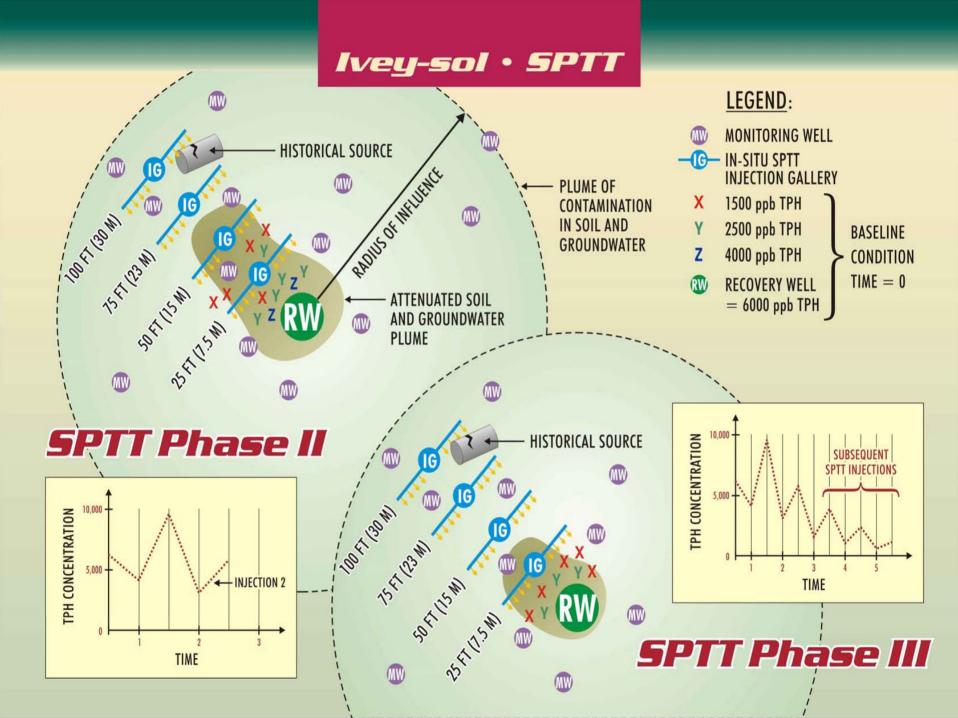
Conceptualization of Iveysol Surfactant Injection/Recovery System



Conceptualization of a Phased Modular Implementation Approach (Ivey-sol)





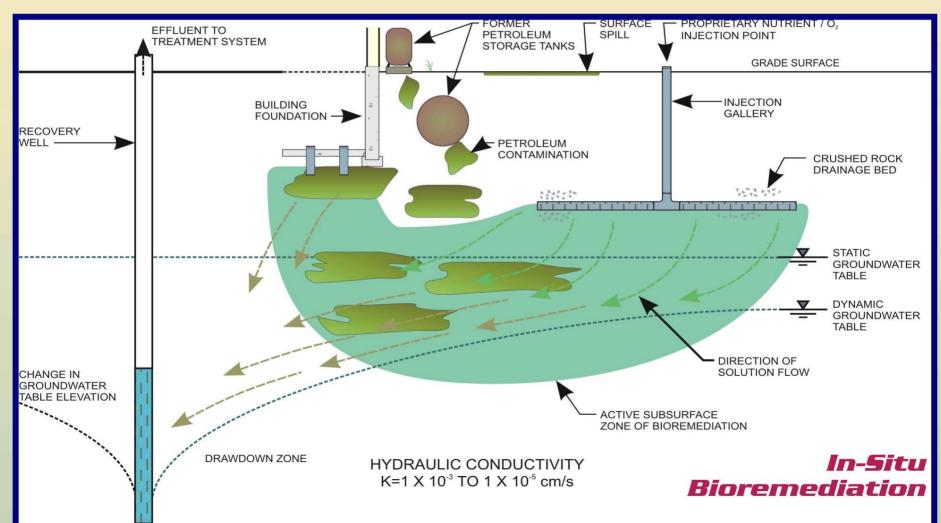


Individual conducting Ivey-sol Injections at an Injection Well (IW).

Introducing Ivey-sol mixture followed by water during injection process.



In-Situ SEB Surfactant Enhanced Bioremediation



EX-SITU REMEDIATION



Ex-Situ Soil Treatment Unit

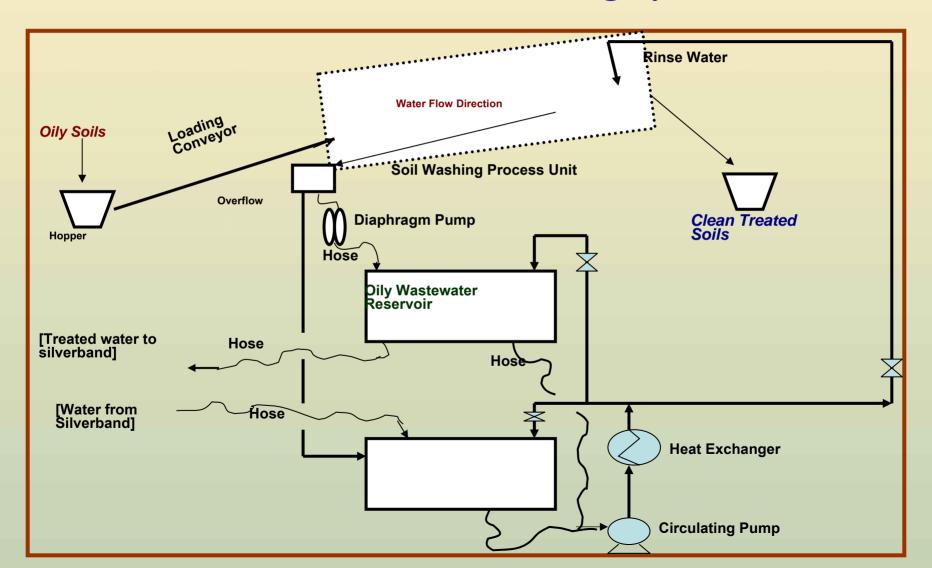
Small To Large Scale LNAPL & DNAPL

Soil Remediation

(Mobile 3 to 35 cubic yards units)



SER Ex-situ Soil Washing System



Alberta Canada Oil Refinery Site (>5000 Tons)

Contaminated soil with a baseline concentration of 40,000 ppm (4%). Ex-situ Ivey-sol Soil Washing SER Process achieved applicable soil remediation site objectives. Project data set provided below showing pre and post soil washing remediation results with time based sample analysis.

Soil Parameter	Base Line	5 Minutes	7 minutes	Reductions
CCME F1 C6-10 CCME F1 BTEX CCME F2 C10-16 CCME F3 C16-34 CCME F4 C34-50	72 ppm 71 ppm 417 ppm 13, 600 ppm 5,060 ppm	< 1 ppm < 1 ppm 35 ppm 1,600 ppm 512 ppm	< 1ppm < 1ppm 21 ppm 826 ppm 259 ppm	100% 100% 95% 94% 95%
CCME F4 C34-50+	13,000 ppm	571 ppm	290 ppm	98%

Note: CCME = Canadian Council of Ministers for the Environment. From CCME Soil and Water Clean-up Guideline Parameters.



Pre and Post Ivey-sol Treatment

Effective Removal of Heavy-end Hydrocarbons.

Ex-Situ Soil Treatment Sydney Australia



Ex-situ Soil Treatment SEO & SEB















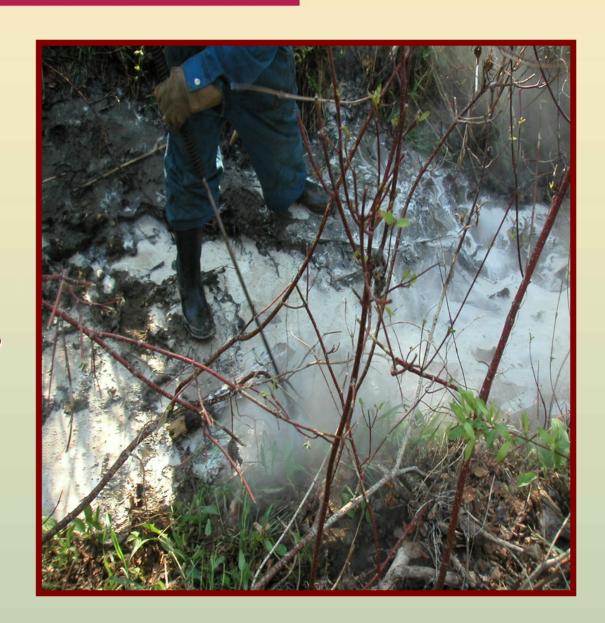


Tank Cleaning Applications
Before & After Ivey-sol® Cleaning

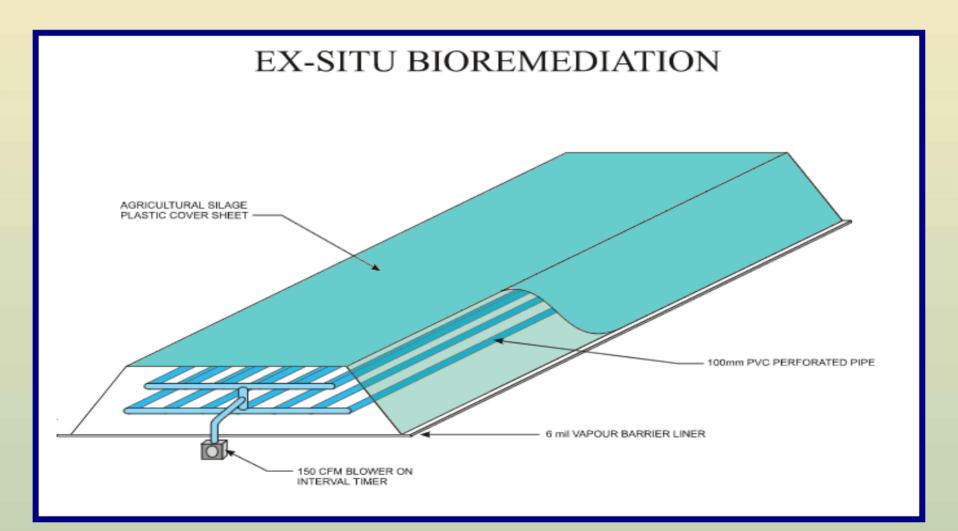
Stream and Shoreline Spill Clean-up With (Ivey-sol ®).

Application via highpressure spray to liberate hydrocarbons from stream-bed sand, rock and vegetation.

Removal of dissolved wastes from localized area via Vacuum suction hose.



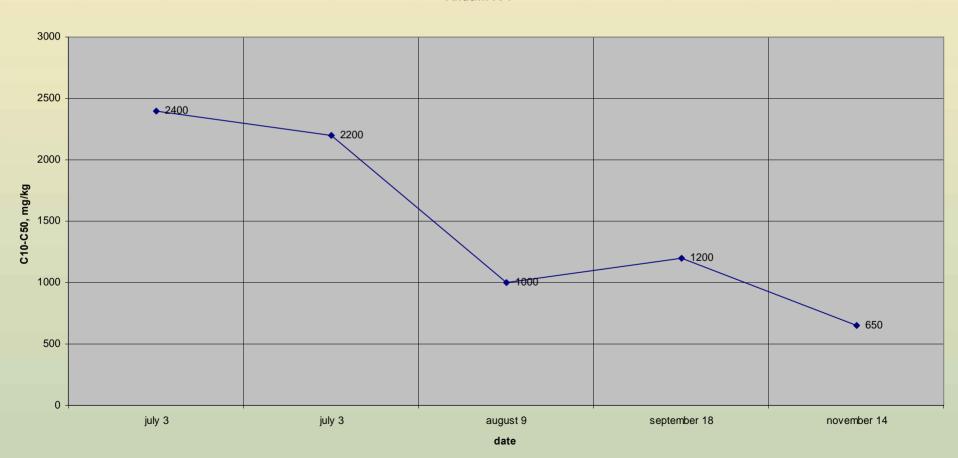
Ex-Situ SEB Surfactant Enhanced Bioremediation (F3 &F4)



SEB Ex-situ Soil Remediation Project

Quebec, Canada

Andain A-1



SEB Fine Grain F3 & F4 Remediation









Range Of Applications

- ► Surfactant Enhanced Remediation (SER)
- ► Surfactant Enhanced Bioremediation (SEB)
- **►** Surfactant Enhanced Oxidation (SEO)
- **▶** Off-shore Oil-spill Dispersant

Other Application:

- ► Oil Recovery (From Oil-Sands)
- ► Tank Cleaning
- ► NORM Treatment
- ► Oil Stain Removal (Parking Areas)
- **▶** Degreaser

Case Study Monroe, Connecticut, USA

PRESENTED BY:

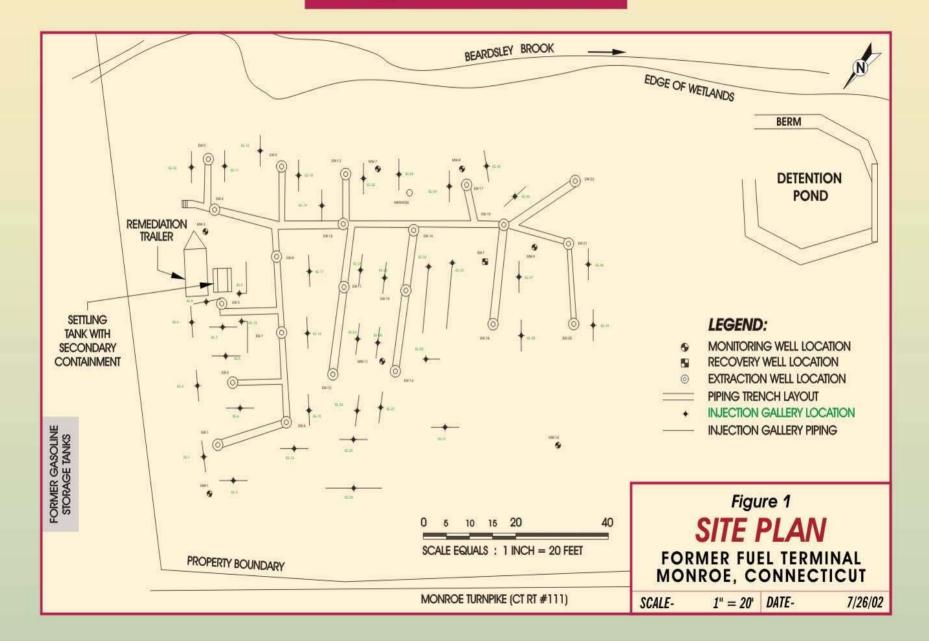
George A. Ivey

SENIOR ENVIRONMENTAL SCIENTIST, IVEY INTERNATIONAL INC.

Fuel Terminal

Monroe, Connecticut, USA

- Former heating oil terminal from the mid-1950's to the late 1970's
- No. 2 fuel oil was stored at the site
- Multiple releases occurred over time
- Site and surrounding area are wetlands, with the former terminal area elevated with fill material for commercial use
- Irregular fill consisting of sand, silt, gravel and boulders with some timbers and metal buried throughout the site
- Sensitive receptors are adjacent stream and down-gradient potable wells
- Whigh vacuum (dual phase) extraction system in use at the site since late 1999
- Selective Phase Transfer Technology (SPTT) system installed in May 2002
- Monthly SPTT injections commenced in May 2002



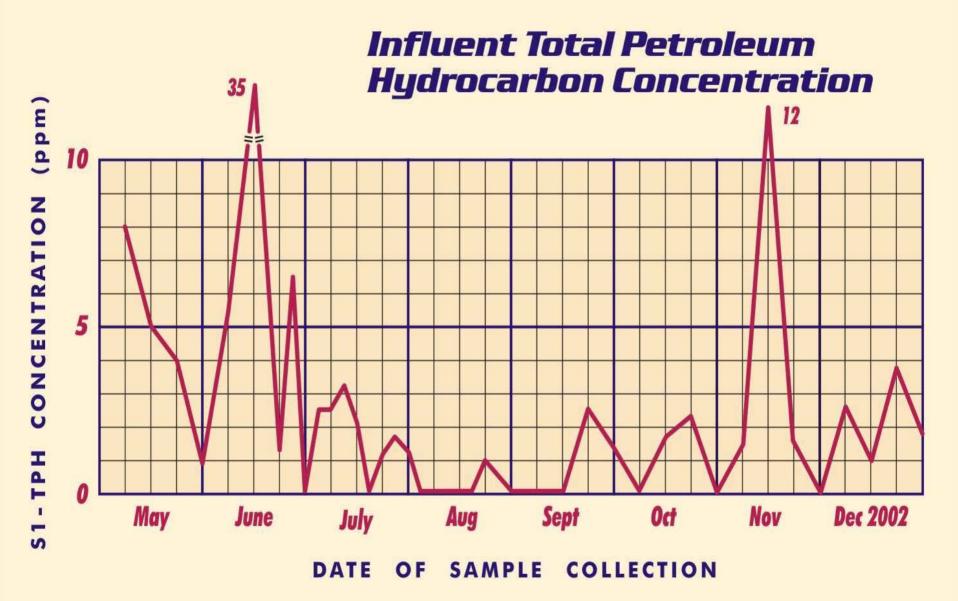
Fuel Terminal

Monroe, Connecticut, USA



Fuel Terminal





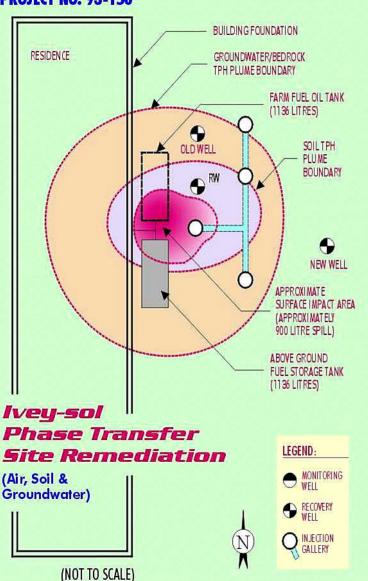
Fuel Terminal

Monroe, Connecticut, USA

- **Mass Recovery = Flow Rate x Concentration**
- Mass Recovery (pounds per day) = gallons per minute (gpm) x mg/l X 0.012
- \gg 3.785 l/gal x 1 lb/454,000 mg x 1440 minutes/day = 0.012
- Mass Recovery prior to the injection period is based on an average influent concentration of 0.75 mg/l
- 8 gpm x .075 mg/l x 0.012 = 0.072 lbs/day = 3.269×10^4 mg/day (prior to SPTT use)
- Mass Recovery during the injection period is based on a concentration average calculated using the post injection peak concentrations of 3.07 mg/l
- 8 gpm x 3.07 mg/l x 0.012 = 0.29472 lbs/day = 13.38×10^4 mg/day (during SPTT use)
- Pre vs. post injection mass removal rates show an increase of 409.3%

Ivey-sol

PROJECT NO. 93-156



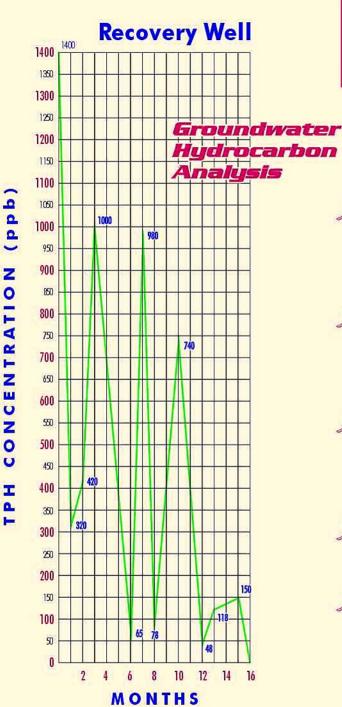
Case Study I

- Approximately 900 L (200 gal) fuel oil spill at the above ground storage tank
- Drinking water well and bedrock-aquifer were contaminated at 1400 ppb TPH
- Classified as a Sensitive Site by the Department of Environment with a 10 ppb TPH groundwater clean-up objective



lvey-sol





Ivey Environmental Services installed a pump & treat system at the recovery well

Several Ivey-sol injection galleries were designed and installed

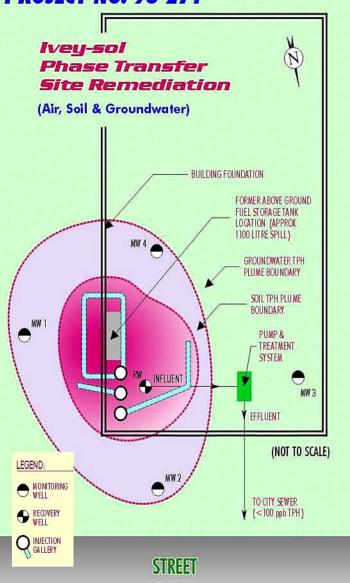
The site was successfully cleaned up to under 10 ppb in less than 18 months

The client estimates the savings at > \$50,000

The Department of the Environment decommissioned the site

Ivey-sol

PROJECT NO. 98-271



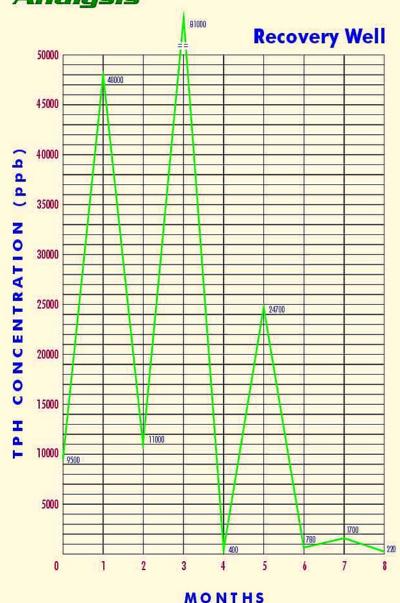
Case Study II

- Approximately 1100 L (240 gal) fuel oil spill from an above ground storage tank
- The water table was contaminated at 9500 ppb TPH; the soil under the building was saturated with free product
- Classified as a Non-sensitive Site by the Department of Environment, with clean-up objectives of 1000 ppb TPH for groundwater and 100 ppm TPH for soil

Case Study II

Groundwater Hydrocarbon Analysis







Ivey Environmental Services designed and installed a recovery well and a pump & treat system within the building basement



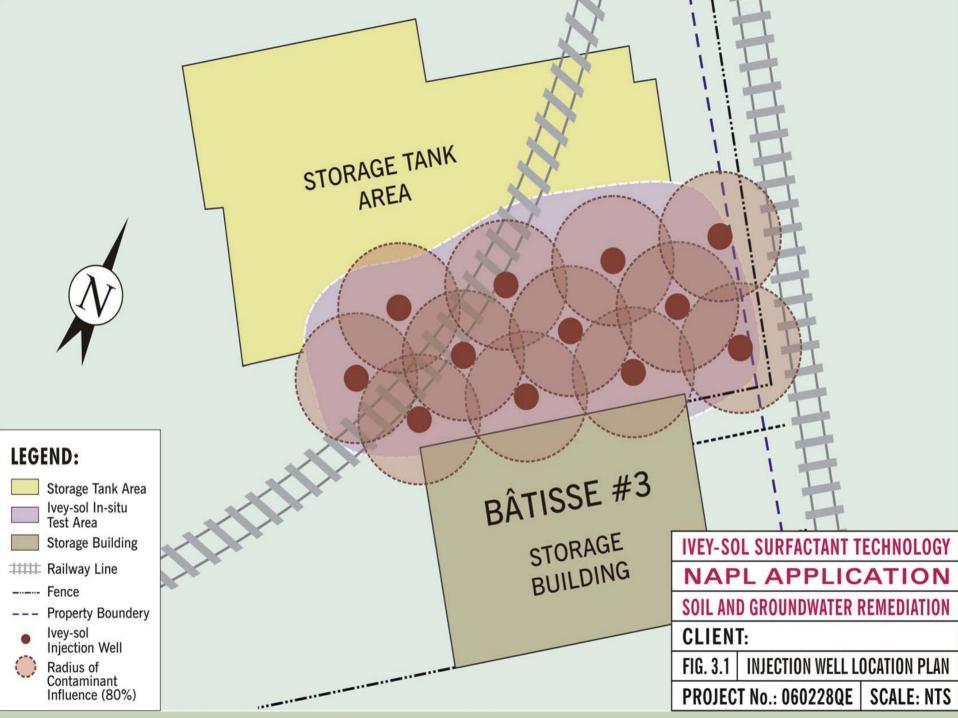
Several Ivey-sol injection galleries were designed and installed in the vicinity of structurally sensitive foundation footings



The site was successfully cleaned up to 220 ppb in eight months



The Department of the Environment decommissioned the site











Ex-situ Case Study

Waste Oil Refinery Site Heavy-ends Soil Contamination

Baseline : 40,580 ppm

Client Objective: <3 %

Ivey-sol Metal Remediation

Metal	Baseline	Treated
Pb	203 ppm	n.d.
Cu	42 ppm	n.d.
Al	3,950 ppm	n.d.
Ar	1.5 ррт	n.d.
Fe	8,720 ppm	n.d.
Ca	91,400 ppm	n.d.
Cr	11 ppm	n.d.
Mn	42 ppm	n.d.
Hg	0.07 ppm	n.d.
Na	195 ррт	n.d.
Ti	199 ррт	n.d.
Zn	366 ррт	n.d.
* *	parts per million n.d. = nor ble not extractable metals in s	



Pre and Post Ivey-sol Treatment

Effective Removal of Heavy-end Hydrocarbons.

Other Applications (Slide Examples)

- Tank Cleaning
- Shore Line Clean-up
- Frac-Sand Treatment (Oil & Gas Well Waste)
- Oil Recovery

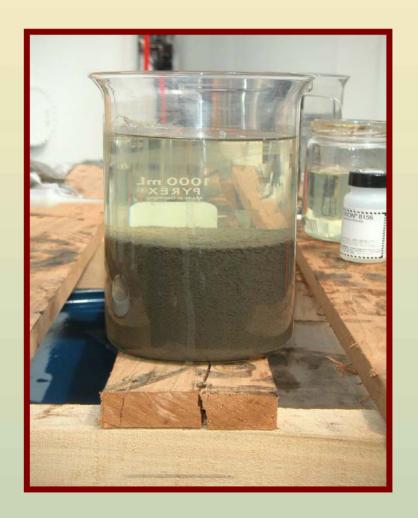
Oil & Gas Well Frac-Sand Waste Treatment (Ivey-sol®)

Sample From Alberta, Western Canada



Oil Recovery Potential

- Coagulants & Flocculants were used to precipitate the petroleum from the post treated water
- Upper water layer is clarified and available for re-use.
- Hence water use is less a limiting an issue as a result.
- Passing the precipitate through a Filter-press would allow for the recovery of the target hydrocarbons. These may be of economic value.



Dispersants tend to reduce the long term impacts of an Oil Spills.

By dispersing and lessening the concentration of oil in the water column can make the oil more available for natural biodegradation

Surfactant Enhanced Biodegradation



Department of Transportation & Communications HEADQUARTERS PHILIPPINE COAST GUARD (PUNONG HIMPILAN TANOD BAYBAYIN NG PILIPINAS) 139 25th Street, Port Arca 1018 Manila



Accreditation Certificate

PCG-07-06-038

NUMBER

This Certificate is issued to

Silahis Marketing Corporation

manufacturer/distributor of

IVEY-SOL OIL DISPERSANT

with business address at

3RD Flr. LPL Bldg., 215 Sen Gil Puyat Ave., Makati City

Upon completion of all requirements for

Accreditation for Oil Spill Dispersant

Issued this 20th day of June 2007 Pursuant to Republic Act 5173, PD 600 as amended by PD 979 and MARPOL related regulations

HPCG Memo Circular No 04-2005 dated 14 October 2005

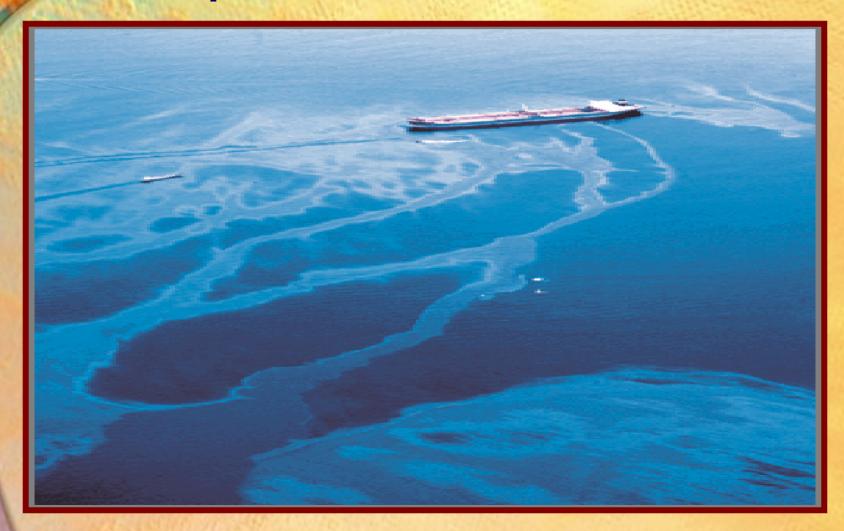
This certificate unless cancelled, suspended, or revoked shall continue to be in effect until

19 June 2010

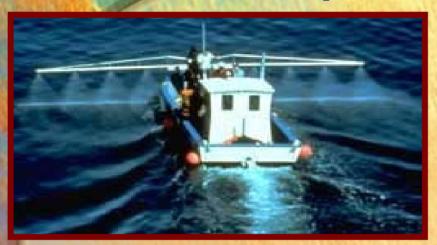
ADM PCG A Commandant, PCG

NOT VALID WITHOUT OFFICIAL SEAL

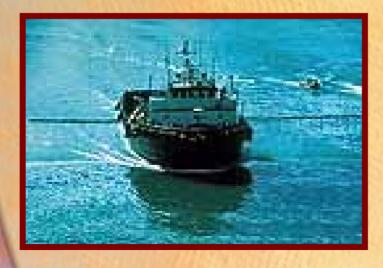
Oil Spill As Viewed From The Air



Dispersant Applications

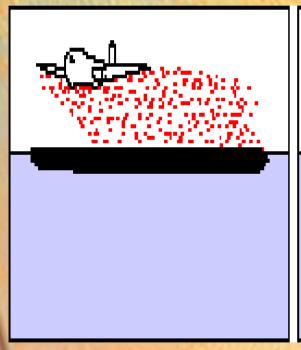


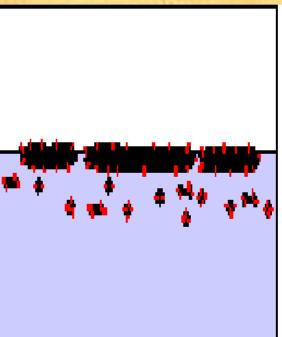


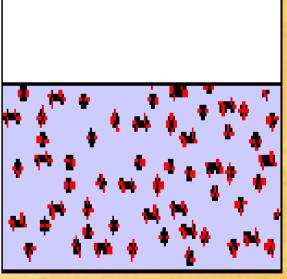




Mechanism Aerial Dispersion







To Be Effective, dispersants must be applied within a short 'Window of Opportunity' following a spill.



Taken From Plane
1- Day After Dispersant
Application (Very Effective)

Taken From Plane Just After Dispersant Application (*Time Zero*)



Before and After Dispersant Shore Line Clean-up



1989 - Exxon Valdez 40,000 tons of oil spilled



Copy of Technical Paper Available At Our Booth Following Presentation

lvey International Inc.

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