Combined remediation technologies for enhanced in-situ vapor, soil and groundwater LNAPL and DNAPL remediation

GEORGE (BUD) IVEY

PRESIDENT AND SENIOR REMEDIATION SPECIALIST, IVEY INTERNATIONAL INC.

25.09.2019

WWW.REMEDYSUMMIT.COM
Ivey International Inc. is an International Award Winning Remediation Technology Company.

Internationally known for the Ivey-sol® Surfactant Remediation Technology, & more recently, our DECON-IT® and Petro-Wipes® equipment and decontamination products.

Ivey-sol® Treats - Vapor Intrusion, Soil, Bedrock, and Groundwater Petroleum Hydrocarbon, Chlorinated Solvent, and Organometallic Contamination.

Our products are Guaranteed to Enhance Physical, Biological, and Chemical remediation technologies with synergistic enhancement to other technologies (1+1=3).

G. A. Ivey, B.Sc, CES, CESA, P.Chem, EP – Organic Chemistry, Geological Engineering, Masters Project Management, 30 Years Remediation Experience on >2500 Projects, >50 Countries...

**Combined Remediation Technologies For Enhanced Vapor, Soil and Groundwater LNAPL and DNAPL Remediation**
The growing concern regarding contaminant sorption, and their reduced ‘Availability’ for remediation, has been well cited in literature as demonstrated by the following quotation:

“During the past decade, much discussion has centered on the unavailability of absorbed compounds to soil microorganisms; it is generally now assumed that desorption and diffusion of bound contaminants to the aqueous phase is required for microbial degradation.”


Sorption Negatively Impacts performance of all Physical, Biological and Chemical Remediation!
Hydrophobic organic chemicals exhibit limited solubility in groundwater. As a result, the contaminants (Vapors, Dissolved, Sorbed, or NAPL) Phase Partition and sorb (i.e., absorb and adsorb) onto the soil or bedrock surfaces. This image shows how contaminant sorption limits their ‘Availability for Remediation’.
Contaminant Phase Partitioning (NAPL Formation) and Sorption - Limits Contaminant Availability For Remediation
Ivey-sol® mechanism is selective and works below the CMC

Increasing Physical, Biological and Chemical Availability For Enhanced Remediation
Biodegradable, pH Neutral, Non-toxic, Effect To Treat Broad Range of Contamination

(Peer Reviewed Journal Paper Available On Request Available)
PFOA & PFOS FREE
1,4 Dioxane Free
Dioxins & Furan Free
Non Detectable All USEPA Contaminants
To Understand ‘K’ - I Ask What Is Water?

It's not H₂O
Hydrogen Bonding
Water is actually a 3-dimensional ‘Cluster’ - With surface tension of 73 dynes. The cluster size limits water’s ability to move through finer soil geology. Ivey-sol can make clusters smaller (lower surface tension < 30 dynes) so moves through geology more easily.
Ivey-sol Reduces The Size of Water Cluster
(Lower Surface Tension from 73 Dynes to < 30 dynes)
For Fine Grain Soil Textures Applications Improving K
Over Coming Low K and Retardation
In Fine Grain Geology Allowing Access & Regress
Selective To Classes of Contaminants

Works below the CMC (No Emulsification)

Can Desorb: Sorbed, LNAPL, DNAPL, Globules/Ganglia

Lowers Water Surface Tension from 73 Dynes to < 30 Dynes (Gain Access Into Finer Grain Soil Textures)

Increasing Physical, Biological, Chemical ‘Availability’ For Enhanced In-situ & Ex-situ Remediation

Three Dimensional In-situ Animations Next

Journal Papers, Case Studies, Testimonials, Available On Request
Ivey-sol® Injection and Diffusion Radius
IVEY-SOL

Ivey-sol® Injection and Recovery Well

Groundwater Table
Surfactant Enhanced Recovery of Separate-Phase Petroleum Hydrocarbons
Sunnyside Yard, Queens, New York

Presented by:
Richard Mohlenhoff, P.E. (Amtrak)
Charlie McGuckin, P.E. (Roux Associates)
Site History

- Located in Sunnyside Yard, Queens, New York
- Over 100 years of service
- State Superfund Site
- Six Operable Units (OUs)
- 130 acre Site (52.6 Hectares)
- OU-3 LNAPL and PCB Plume
Dual Phase Vacuum Extraction (DPVE) System

June 2013
DPVE System Performance 2013 - 2015

Cumulative Product Recovery Over Time

- Total Product Recovered = 1,883 gallons
- 84% of recovery occurred within first 5 months
- Recovery nearing asymptotic conditions

(= 7118 L)
Ivey-sol® Surfactant Technology

• Composition
  • Selective non-ionic surfactant (Ivey-sol® 106)

• Applications
  • Desorbs and liberates LNAPL and/or sorbed petroleum hydrocarbons (not PCB’s)

• Mechanism
  • Makes the contaminants more miscible in the aqueous phase, increasing the physical-availability for enhanced MPE mass extraction
  • Selectively liberated petroleum without mobilizing PCB present in the soils.

• Additional Uses to enhance bioremediation and REDOX
Ivey-sol® Injection Areas (8 Wells)
Ivey-sol® Pilot Study Methods

1. Injection (gravity fed/geoprobe)
   • Experimented with surfactant to water ratios
   • Experimented with volumes and % of total mixtures

2. Extraction (DPVE system)
   • Removed at least 3x the injection volume (Usually 1 to <3)
   • Continued extraction until no surfactant was present (use field test kits)

3. Extract from injection point (push-pull) or nearby extraction well (sweep)
Free Product (LNAPL) Percent (%) Removal Following 3 Ivey-sol Pilot-Scale Applications

Percent Removal (%)

<table>
<thead>
<tr>
<th>High Vacuum Extraction Wells</th>
<th>Percent Removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-93</td>
<td>70</td>
</tr>
<tr>
<td>DP-23B</td>
<td>80</td>
</tr>
<tr>
<td>DP-2A</td>
<td>90</td>
</tr>
<tr>
<td>DP-17B</td>
<td>100</td>
</tr>
<tr>
<td>DP-27B</td>
<td>100</td>
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<tr>
<td>DP-35B</td>
<td>100</td>
</tr>
<tr>
<td>DP-36B</td>
<td>60</td>
</tr>
<tr>
<td>DP-37B</td>
<td>100</td>
</tr>
</tbody>
</table>
Conclusions

- LNAPL recovery was enhanced by the increase of LNAPL miscibility in groundwater;
- LNAPL was not observed in the extracted groundwater;
- Reduction of LNAPL thickness was usually observed within 24 hours of Ivey-sol® surfactant injection and persisted for several weeks or longer;
- Low concentration ratios of Ivey-sol® surfactant (1:25 to 1:50) were effective, while higher concentrations do not increase effectiveness (due to < CMC selectivity);
- No impact observed on wastewater treatment system performance; and
- Low injection volumes or injection rates were generally needed in OU-3 due to the low permeability soil conditions and high groundwater table.
Site Was Successfully Redeveloped Into High Speed Rail Building

Combining Ivey-sol Surfactants With Multi Phase Extraction (MPE) Significantly Improved LNAPL Remediation

Ivey-sol Was Later Used At Other OU Areas Site To Enhanced Bioremediation and Chemical REDOX Applications
Combining Ivey-sol Surfactants With Ex-situ Soil Washing Significantly Improved LNAPL and Sorbed Bunker-C #6 Remediation >50 Tonnes/Hour Rate Achieved.

Ex-situ SER® Soil Washing 20,000 Tonnes of Bunker-C Soil
Ex-Situ SEB® Surfactant Enhanced Bioremediation

EX-SITU BIOREMEDIATION

- Agricultural Slage Plastic Cover Sheet
- 150 CFM Blower on Interval Timer
- 9 mil Vapor Barrier Liner
- 100mm PVC Perforated Pipe
Surfactant Enhanced Extraction to Expedite Remediation of Carbon Tetrachloride Source Zone at an Active Grain Elevator Facility

Eric Dulle, PE

April 2018
2018 Chlorinated Conference
Palm Springs, CA
SITE REMEDIATION PRESENTATION OVERVIEW

• Active Grain Elevator Facility - Kansas City, Kansas

• 80/20 Fumigant Mixture – Carbon Tetrachloride and Carbon Disulfide – Used in 70s and 80s
  (12.7 Million Kilograms of Fumigants used Nationally in 1978 alone)

• Leaks from AST Discovered in 90s – Groundwater and Soil Impacts

• Site Enters KDHE Voluntary Cleanup Program: 2000

• DPVE System Installation & Operation: Dec. 2007 to Current

• Surfactant Enhanced Extraction (SEE) Pilot Study: Spring 2015

• SEE Full-Scale: Fall 2016

• Observations Continued into 2018
DPVE PERFORMANCE – HYDRAULIC CONTROL AND CAPTURE

- Plume size and concentration reduction
  - Vapor-Phase Removal:
    - 9,100 pounds (690 gal. as CT) **(4178 L or 2608 L)**
  - Dissolved-Phase Removal:
    - 33 pounds (as CT) **(15 Kg)**
  - Groundwater Recovered/Treated:
    - 7.5 million gallons **(13,986,000 L)**
PILOT STUDY RESULTS

Test 1 and 2

• ‘Push-Pull®’ Tests at shallow monitoring wells

• Modest increase in mass removal observed
PILOT STUDY RESULTS

Test 3 and 4 (*Same Day*)

- Point-To-Point ‘Sweep’ Tests
- Influent groundwater concentrations (8,100 ug/L) highest ever recorded by over 50 percent
- Influent groundwater concentrations 4x greater than average
FULL-SCALE SEE

- August through November 2016
- 1000 L Ivey-sol® 106 Surfactant Formulation
  Mixed with conservative tracer for distribution observation
- Applied single well ‘Push-Pull®’ and multi-well Point-to-Point ‘Sweep’ Flushing Techniques
- Monitored recovery progress via real-time tracer testing and using the Ivey-sol® field surfactant test sheets

Aquafluor Meter: Measures intensity of fluorescence of tracer (rhodamine) that was mixed into Ivey-sol.
FULL-SCALE SEE

- Three (3) additional wells – K-MW-122 through 124 – Installed to facilitate surfactant delivery to the northern portion of the source area

- A total of 5 SEE phases were conducted to target the most heavily impacted portion of the source area
25% of the total mass recovered since 2007 was during the 12-month post-SEE period.

Influent groundwater concentrations up to 30,000 ug/L observed – 5x the highest concentrations ever observed during DPVE operations.
Before and After SEE Ivey-sol® Applications (3 Pilot + 5 Full Scale)
FULL-SCALE SEE RESULTS

- 98% CT Reduction in Source Area Shallow Monitoring Wells
  (CT comingled with shallow Diesel LNAPL)
  • K-MW-120S, 121S, 122 through 124
- 92% CT Reduction in Source Area DPVE wells
  • DPVE-3 and 4
- Significant reductions in LNAPL thickness
  • No measurable LNAPL in March 2018 (>99.99% removal)
- Tracer Conformed no spreading of plume by Ivey-sol applications
- Site Entered In Regulatory Closure Phase
- Estimated cost saving to client >$500,000 USD.

Great example of combined remediation technologies (Ivey-sol + MPE) to achieve rapid and cost effective LNAPL and DNAPL Remediation [1 + 1 = 3].
Ivey International Inc.
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info@iveyinternational.com
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Ivey-sol Surfactant Remediation Technology
Is Still Winning Innovation Awards, because
Ivey International realized…

1+1=3

…it was that simple.

Ivey International Inc. overcame the fundamental challenges to rapid cost effective site remediation of petroleum hydrocarbons, chlorinated solvents, and PFAS, by not only stepping out of the box, we redesigned it.

The dedicated support and the innovative minds of our employees, research partners and clients have allowed us to reach our corporate goal of being recognized as; “Today’s Environmental Solutions for a Better Tomorrow.”™

For more information about Ivey International’s Innovative Remediation Technologies, visit www.ivey-sol.com, call 1-800-246-2744, or email us at info@iveyinternational.com

Ivey-sol Surfactant Remediation Technology for treatment of petroleum hydrocarbon, chlorinated solvent, PFAS, and Organometallic impacted soil and groundwater

Free of Unwanted By-Products Including:
PFOA, PFOS, 1,4 Dioxane, Dioxin, Furan Free

Powering Site Remediation for Over 25 Years

2019 CV Best Environmental & Remediation Solutions Award
2019 EBJ Technology Merit Remediation Award
2018 CV Best Environmental Tech Development Company Award
2018 MISTIC Environmental Excellence Award
2011 Roy F. Weston Award Significant Contributions to Field of Industrial Waste Management
2011 MISTIC Environmental Excellence Award
2006 North American Frost & Sullivan Award for Technology Innovation
2006 Globe Award for Environmental Innovation and Application

Ivey International Inc.
Today’s environmental solutions for a better tomorrow

ivey-sol.com
Ivey-sol® Surfactant Technology is comprised of several patented and/or proprietary non-ionic surfactant formulations (biodegradable) that have the unique ability to selectively desorb sorbed (i.e., absorbed and/or adsorbed) contaminants and make free-product (NAPL) miscible in the aqueous phase for enhanced mass removal (see Mechanism). This includes the broad range of Light Non Aqueous Phase Liquids (LNAPL) like petroleum hydrocarbons (API >10), and the Dense Non Aqueous Phase Liquids (DNAPL) including chlorinated solvents (API <10). Ivey-sol® has also been used for the remediation of recalcitrant compounds within fine to coarse soil textures, marine sediments and fractured bedrock, and within the groundwater table and associated smear-zones and capillary zones, with favorable results.

Ivey-sol® desorbing contamination off the soil surfaces, or from NAPL (i.e. LNAPL and/or DNAPL) layers making them more ‘Available’ for in-situ or ex-situ remediation. The three (3) main Ivey-sol® application processes that were developed over two (2) decades for enhancing in-situ and ex-situ remediation of: Vapors/VOC, Soil/Bedrock (sorbed), and Groundwater (Dissolved, LNAPL, and Smear-Zone) COC site remediation, are outlined as follows:

**SER® SURFACTANT ENHANCED REMEDIATION**
In-situ and ex-situ application processes to liberate contaminants making them more ‘Chemically Available’ for chemical REDOX (i.e. Reduction or Oxidation or combined) by chemical agents.

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**SEC® SURFACTANT ENHANCED CHEMICALIZATION**
In-situ and ex-situ application processes to liberate contaminants making them more ‘Chemically Available’ for chemical REDOX (i.e. Reduction or Oxidation or combined) by chemical agents.

**CLIENT TESTIMONIALS**

“We completed an in-situ pilot-scale application of the Ivey-sol® surfactant technology at an industrial site with VC, DCE and TCE chlorinated contamination. We commenced site remediation with MPE with very good results, but eventually the rate of vapor, dissolved, and DNAPL phase mass recovery reduced over time. The introduction of Ivey-sol® significantly increased mass recovery of all phases, leading to our decision to go to full scale, pairing the MPE and Ivey-sol® technologies as an effective remediation strategy for the site.”

DENNIS TU, Executive Director Remediation

“We increased the TPH Mass Recovery Rate by 10x, removed TPH-d from vadose zone and lowered groundwater concentrations. Regulatory Agency agreed to a risk based closure if contamination levels continue to decrease” [site has since achieved regulatory closure]

GALEN KENOYER, Senior Hydrogeologist

“iivey-sol® has been proven highly effective at remediating both oil-based contaminated and chlorinated solvents in a variety of different soil types, ranging from sands to clays. Given the current need for innovative and cost-effective cleanup technologies, usage of iivey-sol® will significantly increase in the upcoming years.”

BRUCE TUNNICLIFFE, President

“An EU military site the UTCHEM model was able to simulate the Pilot SEAR and that injected fluids were contained within the pilot application area. Further, the simulations estimated an approximate 1000 % increase in jet-fuel mass recovery with the application of the iivey-sol® surfactant technology, compared to water injections without iivey-sol®. The model also showed that the mass process for mass removal during SEAR was production of a micro-emulsion.”

SOREN RYGGAARD LENSCHOW, Project Manager

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Surfactant Enhanced Recovery of Separate-Phase Petroleum Hydrocarbons
Super Fund Site – Sunnyside Yard, Queens, New York City, USA
Paper ID: 22600 / Topic: TH5c / Author: George Ivey, Ivey International Inc.

**SITE HISTORY**

**DUAL PHASE VACUUM EXTRACTION (DPVE) SYSTEM LAYOUT**

**RESULTS AND CONCLUSIONS**

- **SPH (LNAPL) % Mass Removal**
  - Conclusions
    - SPH (LNAPL) mass removal was not applied to the area to increase the amount of groundwater that can be collected from the site.
    - The percentage of groundwater removal at the site was not determined.
    - The performance of the groundwater treatment system (SPH) was not evaluated.
    - The removal of SPH (LNAPL) mass was not assessed within the site.
    - Total area of soil removed with SPH (LNAPL) mass was not estimated.
    - Use of surfactant for removing SPH (LNAPL) mass was not evaluated.

- **Pilot Study Methods**
  - The percentage of groundwater removal at the site was not determined.
  - The performance of the groundwater treatment system (SPH) was not evaluated.
  - Use of surfactant for removing SPH (LNAPL) mass was not evaluated.
  - Total area of soil removed with SPH (LNAPL) mass was not estimated.

**Surfactant Technology**

- Ivey-sol® Surfactant Technology
  - Water mixed with Surfactant
  - Water mixed with Surfactant
  - DPVE System Performance

**REMEDIATION**

**SURFACTANT TECHNOLOGY ENHANCES REMEDIATION AT CONTAMINATED GRAIN ELEVATOR SITE**

By Eric Dulle and George ‘Bud’ Ivey

Grain elevators are an enduring symbol of agricultural tradition. Unfortunately, they present environmental problems, due to a legacy of the agricultural industry’s use of synthetic chemicals to help grow, store, and transport food. Since the 1970s, for example, grain producers have used fumigants containing chemicals such as carbon tetrachloride (CT) to protect stored grains from fungus and rats. Fumigants were typically stored in above-ground storage tanks at grain elevator sites, ready for use as needed. As professionals in the remediation industry well know, where there are storage tanks, there are leaks, and where there are leaks, there is the potential for soil and groundwater contamination. Such contamination is the reality at most, if not all, grain elevator sites.

During the 1970s and 1980s, the owner/operator of a still-active grain intake facility had regularly applied 80/20 grain fumigant (i.e., 80% CT and 20% carbon disulfide), as was common during that era. The fumigant compound was stored in an above-ground storage tank on the property before its removal in the 1990s. The site entered into a voluntary cleanup and property redevelopment program in 2000, following soil and groundwater detection of fumigant constituents of concern (COCs). These were primarily CT, but also carbon disulfide, chloroform, and methylene chloride. Groundwater impacts extended about 122 m downgradient from the site (the “source area”).

To remediate the site, Burns & McDonnell Engineering Company, the consulting engineer for the project, recommended the installation of a dual-phase extraction (DPE) system. It has been operating since 2007.

Remediation options at the site were significantly limited due to access constraints associated with ongoing facility operations, a steep grade change from the access point to the source area, active mainline railroad tracks, and...
other utilities and structures throughout the impacted area. Nonetheless, the remediation team was able to successfully and safely install the DPE system, including eight extraction wells, within the source area.

Over the period from 2007 to 2014, the system achieved significant contaminant mass reduction, removing over 4,130 kg of COCs in the vapour and dissolved phases. About 28.5 million litres of groundwater were recovered and treated during this time period.

Evaluations of DPE performance in 2014 found that, while the system had succeeded in removing a very large amount of mass and significantly reducing the lateral extent of the source area, a subset of source-area extraction wells continued to exhibit elevated (i.e., source-level) COC concentrations in groundwater. The system had dramatically reduced source mass and prevented migration of the plume as intended, but a remnant, highly concentrated source still required remediation.

As a result, an additional investigation was conducted using high-resolution site characterization techniques to assess the nature and extent of residual COC mass in the source area. The investigation results indicated significant sorbed-phase COC mass, generally limited to the shallow, sandy interval of an area bound by the DPE wells exhibiting elevated COC concentrations. Historical light non-aqueous phase liquid (LNAPL) heavily impacted extraction wells, within the source area.

COCs was also identified. Burns & McDonnell used the data generated by the investigation to evaluate alternatives for expediting the source-area remediation and maximizing the effectiveness of the DPE system. During the course of evaluating alternatives, a presentation at a remediation industry conference, describing a project with similar site conditions, led Burns & McDonnell to believe that surfactant-enhanced extraction (SEE) would be a viable option. The company also had a previous relationship with surfactant technology developer Ivey International Inc. (Ivey) in a separate petroleum remediation project.

Based on these factors, Burns & McDonnell decided to conduct a SEE pilot study in 2015 using the Ivey-sol 106 (CD) surfactant formulation, which was specially designed to treat chlorinated solvents at the site. If the pilot study yielded positive results, a full-scale project would follow.

Ivey-sol 106 SEI surfactant products are non-toxic and biodegradable, so they do not persist in the environment after application, which can be continued over time...

verified with Ivey-sol field test kits and by three USEPA laboratory test methods. Indeed, because they are non-toxic to bacteria, they can also give a boost to natural attenuation. They have some disadvantages that careful application can overcome. For example, their effectiveness may be diminished if the mixtures freeze during storage, and their deployment may suppress volatile organic compounds, making them less detectable by standard, handheld vapour meters.

For the pilot study at the grain elevator site, which was conducted in April and May of 2015, Ivey-sol surfactant technology was deployed in single-well "push-pull" tests and multiwell "point-and-to-point" tests at two DPE site locations and two groundwater monitoring wells. Burns & McDonnell was able to use the existing DPE and well infrastructure to implement the surfactant injection and product recovery, thus minimizing intrusive activities and cost. Groundwater was encountered at approximately 2.1 m - 2.4 m below ground surface. The lithology within the targeted source zone generally consisted of well-sorted, loose, silty sand to silt with depths ranging from 2.1 m - 5.2 m below ground surface, underlain by a silty clay. Ivey have found that their surfactant products are effective in site conditions with more varied and complex structures, including coarse-grained, fine-grained, and higher silty and clay-content soils.

For surfactant system optimization, Ivey-sol surfactant enhanced with water in a 1% - 2% solution, which was gravity-fed into two monitoring wells and two DPE wells to achieve a targeted injection diffusion radius and then allowed to remain in the formation for 2 weeks. The study demonstrated that the surfactant-enhanced DPE system recovered more than 20% of the total mass that the DPE system had recovered over the previous 10 years. In addition, recovered groundwa-ter concentrations up to 30,000 micrograms per liter (µg/L), more than five times (500%) the highest concentrations ever observed during DPE operations, were observed during the DPE operation monitoring period.

Overall, the full-scale SEE test achieved 98% CT reduction in the source area, shallow monitoring wells and 92% reduction in source area DPE wells.

Ivey-sol can make carbon tetrachloride molecules miscible without emulsifying the constituents of concern, thereby increasing their availability for remediation, while not impacting the performance of wastewater treatment systems.

Eric Dulle is with Burns & McDonnell. Email: ealodie@burnsmcm.com. George "Tud" Ivey is with Ivey International. Email: budivey@iveyinternational.com
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Conclusions
- SPH (LNAPL) mass recovery was measured to be lower than the SPH recovery that was predicted by modeling techniques.
- Poor performance was attributed to the permeability of the surrounding geologic formations.
- The model suggested that the contaminant plume was not adequately sampled.

Pilot Study Methods
- The pilot study was conducted using a three-phase extraction process.
- The process involved the injection of a surfactant solution into the subsurface to reduce the interfacial tension between the LNAPL and the water.
- The LNAPL was then extracted using a vacuum system.
- The process was monitored using various analytical techniques, including GC-MS and FTIR.

Ivey-sol® Surfactant Technology

DPVE System Performance

Surfactant Technology Enhances Remediation
At Contaminated Grain Elevator Site

By Eric Dulle and George ‘Bud’ Ivey

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In-situ and ex-situ application processes to liberate contaminants making them more ‘Chemically Available’ for chemical REDOX (i.e. Reduction or Oxidation or combined) by chemical agents.

**CLIENT TESTIMONIALS**

"We completed an in-situ pilot-scale application of the Ivey-sol® surfactant technology at an industrial site with VC, DCE and TCE chlorinated contamination. We commenced site remediation with MPE with very good results, but eventually the rate of vapor, dissolved, and DNAPL phase mass recovery reduced over time. The introduction of Ivey-sol® significantly increased mass recovery of all phases, leading to our decision to go to full scale, pairing the MPE and Ivey-sol® technologies as an effective remediation strategy for the site."

DENNIS TU, Executive Director Remediation

"We increased the TPH Mass Recovery Rate by 10x, removed TPH-d from vadose zone and lowered groundwater concentrations. Regulatory Agency agreed to a risk based closure if contamination levels continue to decrease" [site has since achieved regulatory closure]

GALEN KENOYER, Senior Hydrogeologist
CHRIS D’SIA, Senior Project Manager

"Ivey-sol® has been proven highly effective at remediating both oil-based contamination and chlorinated solvents in a variety of different soil types, ranging from sands to clays. Given the current need for innovative and cost-effective cleanup technologies, usage of Ivey-sol® will significantly increase in the upcoming years."

BRUCE TUNNICLIFFE, President

"At an EU military site the UTCHEM model was able to simulate the Pilot SEAR and that injected fluids were contained within the pilot application area. Further, the simulations estimated an approximate 1000 % increase in jet-fuel oil mass recovery with the application of the Ivey-sol® surfactant technology, compared to water injections without Ivey-sol®. The model also showed that the main process for mass removal during SEAR was production of a micro-emulsion."

SOREN RYGAARD LENSCHOW, Project Manager

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Ivey-sol Surfactant Remediation Technology
Is Still Winning Innovation Awards, because
Ivey International realized…

1+1=3

…it was that simple.

Ivey International Inc. overcame the fundamental challenges to rapid cost effective site remediation of petroleum hydrocarbons, chlorinated solvents, and PFAS, by not only stepping out of the box, we redesigned it.

The dedicated support and the innovative minds of our employees, research partners and clients have allowed us to reach our corporate goal of being recognized as, “Today’s Environmental Solutions for a Better Tomorrow.”™

For more information about Ivey International’s Innovative Remediation Technologies, visit www.ivey-sol.com, call 1-800-246-2744, or email us at info@iveyinternational.com

Ivey-sol Surfactant Remediation Technology for treatment of petroleum hydrocarbon, chlorinated solvent, PFAS, and Organometallic impacted soil and groundwater

Free of Unwanted By-Products Including:
PFOA, PFOS, 1,4 Dioxane, Dioxin, Furan Free

Powering Site Remediation for Over 25 Years

2019 CV Best Environmental & Remediation Solutions Award
2018 EBJ Technology Merit Remediation Award
2018 CV Best Environmental Tech Development Company Award
2011 MISTIC Environmental Excellence Award
2011 Roy F. Weston Award Significant Contributions to Field of Industrial Waste Management
2006 North American Frost & Sullivan Award for Technology Innovation
2006 Globe Award for Environmental Innovation and Application

Ivey International Inc.
Today’s environmental solutions for a better tomorrow

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