

# ISCO in Australia

What is the State of the Art?

Denton Mauldin, PE

Kleinfelder Australia Pty Ltd

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# Presentation Overview

- Why me and why present?
- The State-of-the-Art with ISCO
  - Bench- and Pilot-studies
  - IP
  - Analytical methods
  - Contaminant Mass
  - Oxidant Estimates
  - Activation
  - Direct Push vs Well
- ISCO Enhancements
  - Vapour Recovery
  - Injection Pressure
  - Surfactants/Solvents
- Case Studies

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# Why me?

- 19 years of ISCO experience in (10 - Australia 9 - US)
- I've made mistakes and almost made many
- Worked with global ISCO expert since 2001
- Some consultancies do not self-perform and/or their internal experts reside overseas

# Why present?

- Observations of failure and underperformance
- Gap regarding state of the art vs state-of-the-art
- Want to lift everyone's game from "Hulk Smash!"



# Learning State-of-the-Art Practices

Armed with negative knowledge I've come to understand the importance of:

- Bench- and Pilot-studies
- IP
- Modified analytical methods
- Accounting for NAPL and sorbed phase
- Oxidant dose nuances
- Pressure limits
- Activation, monitoring and re-activation
- Well considerations



State-of-the-Art Circa 1963

**Where are opportunities to unlearn?**

# Bench- and Pilot-Studies

- Important to use site soil and groundwater
- Identifies the most efficient dose (not always the highest)
- Pilot is used to fine-tune well spacing and ground truth activation approach



1 of 2 Solvent-Enhanced ISCO Bench-Trial Columns in the World

# Intellectual Property

- Fenton's Reagent (MECx)
- Sodium Persulfate (Peroxychem through Quantum Chemicals)
- Surfactant/Solvent/Co-solvents (EthicalChem/MECx)
- Proprietary Equipment (MECx others)
- Oxidant Estimates (MECx/Peroxychem/  
Carus/Regenisis/others)
- Recirculation Approaches (MECx)
- Activation Methods (MECx)
- Others...



# Analytical Methods

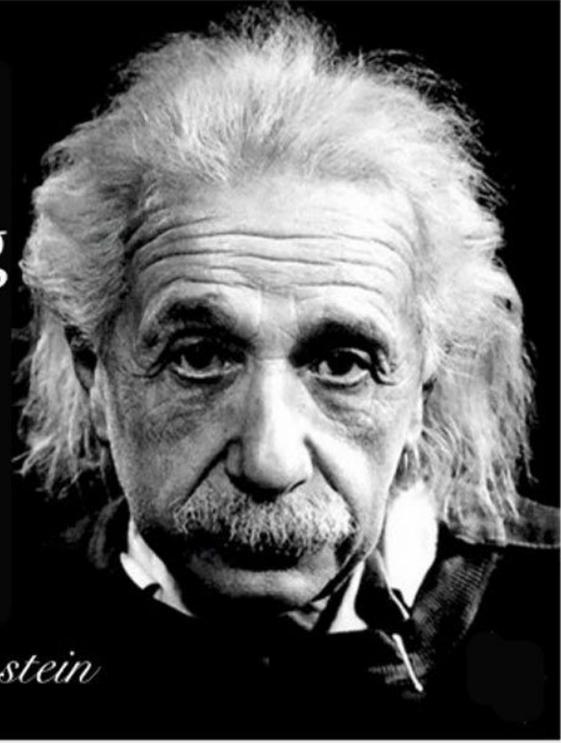
- Important for bench-scale (dosing) and assessing percent removal
- Dichloromethane (DCM)
  - Commonly used as extraction fluid for laboratory analysis
  - DCM dissolves contaminant (move into aqueous phase) instead of desorb contaminant mass
- Strong oxidisers (Fenton's) and ISCO enhancements (solvent) work better than DCM at desorption of contaminant mass
  - Leads to false perception that the process is "making" contamination

# Are you covering your mass?

- Where does mass reside?
  - Sorbed to soil
  - NAPL
- Hydrocarbons are dielectric
- Pump and Treat “on steroids”
- Reinjection is not the norm and is a potential example of insanity

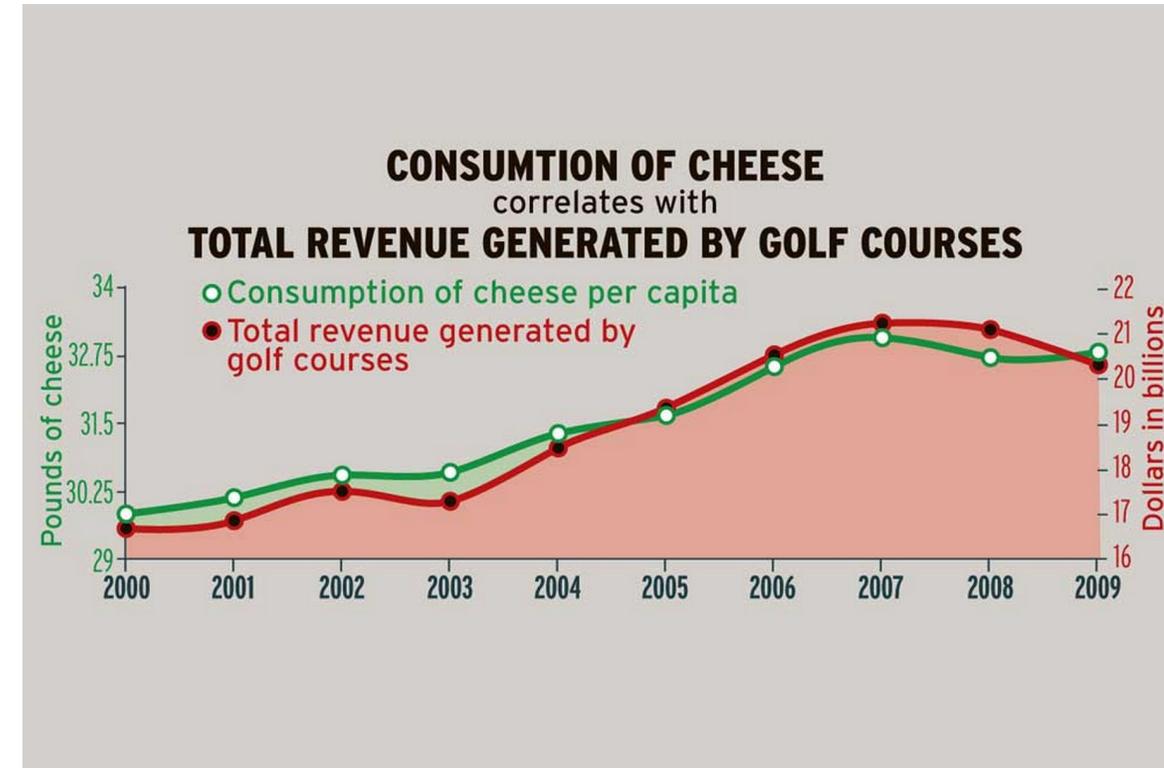
**Insanity:**  
doing the same thing  
over and over again  
and expecting  
different results.

*- Albert Einstein*



# Oxidant Estimates

- Comparing to supplier estimates
- Upper dose limit of oxidant
- Proprietary models
- Adjustments when using enhancements
- Activation estimates need to be done too



# Activation and Re-activation

- Synergy with multiple activations ( $H_2O_2$ , Fe, heat and high pH)
- Caution against “pre-activated” mixes
- Watch for conversion of liquid to gas
- Opportunity lost when oxidant remains in the subsurface without activation
- Re-activation a sign of not over activating
- Be ready to re-activate in the field

# Direct Push vs Permanent Wells

- Direct push doesn't allow for recirculation
- Permanent wells allow for multi-purpose use (injection and extraction)
- Seals are important with H<sub>2</sub>O<sub>2</sub>



# ISCO Enhancements

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# Vapour Recovery

- Addresses off-gassing – critical for use of Hydrogen Peroxide
- H<sub>2</sub>O<sub>2</sub> solution will expand 200 times (L to V)



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# Recirculation

- Improves contact between solvent/oxidant/activator and contaminant
- Controls migration of contaminants
- Prevents over-pressurisation of formation
- Improves monitoring



# Feeling the Pressure

- With as little as 60 kPA the overburden pressure soil can be exceeded and the formation is altered
- Blocks formation
- Creates stress channels
- In the case of H<sub>2</sub>O<sub>2</sub> increases the threat of rapid decomposition (rapid conversion of liquid to vapour)
- Over-pressurisation is the first sign of negative knowledge



# Surfactants/Solvents

- Requires IP consideration
- Surfactants dissolve sorbed contaminants and can exacerbate dissolved plume
- Some surfactants and solvents can polymerise (turn to goo) – need to limit concentrations
- Solvent will desorb contaminant mass and liberate NAPL
- Use of solvents is akin to multi-phase extraction prior to ISCO (1/3 the cost)

# Summary

Concern	Signs of "Hulk Smash"	State-of-the-Art Practitioner
IP	What does "IP" stand for?	Considers IP
Contaminant Mass	Why am I "creating" mass? "Reinjection is the norm"	Modify methods to suite application
NAPL	No APLs  	Considers and addresses NAPL-indicative concentrations or NAPL prior to ISCO
Oxidant Estimates	Need more chemical	Considers source of estimate and upper dose limits
Activation	1 Activation 1 Method	Activates and reactivates with multiple methods
Enhancements	Why enhance?	Considers multiple enhancements
Well Design	Direct Push	Multi-purpose well



# Case Studies

- Perth
- Sydney

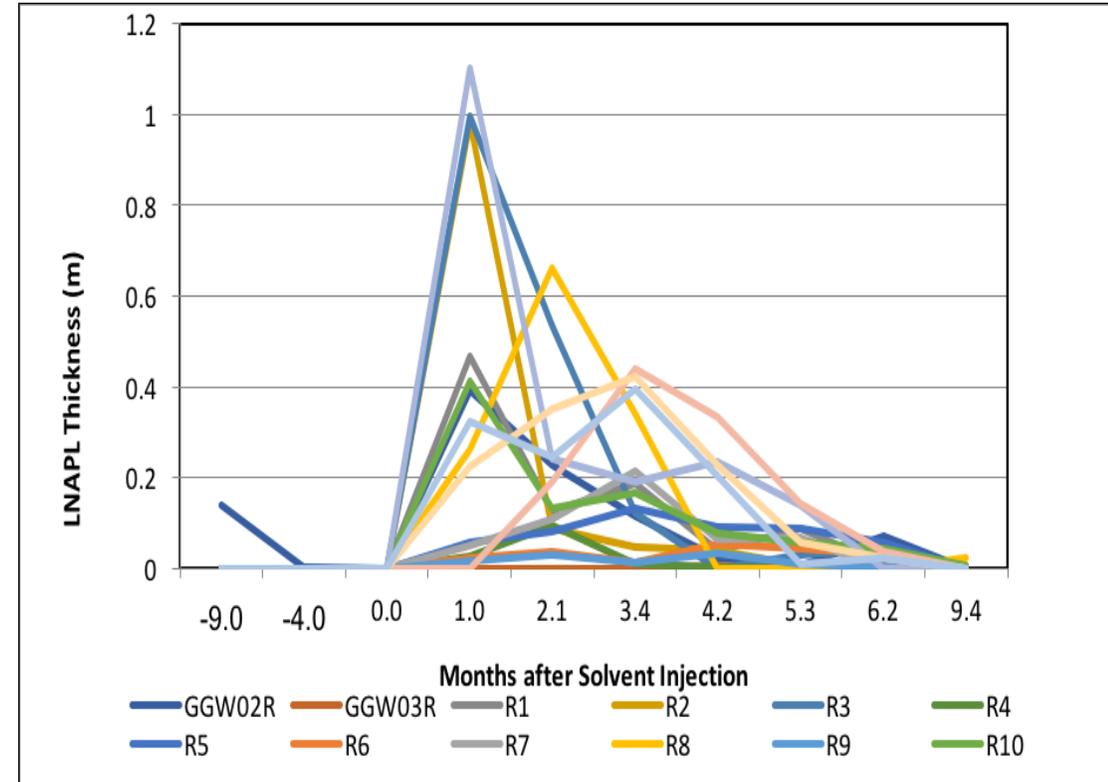
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# Perth WA

- Original scope included shoring and excavation
- Liberated LNAPL
  - Increased occurrence of LNAPL from **1/19** to **15/19** of wells
  - Increased LNAPL thickness **4,800%**
- 4 tonnes of mass removed
- Achieved 99% Mass Removal Efficiency



- Implemented catalysed hydrogen peroxide with iron- and alkaline-activated sodium persulfate ISCO
- Liberated and removed LNAPL
- Met risk-based criteria with **one** injection
- 100% Reduction of LNAPL
- 93% Reduction of dissolved Benzene
- 90% Reduction of TRH (C<sub>6</sub>-C<sub>10</sub> and C<sub>10</sub>-C<sub>40</sub>)



Questions?

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