ARCADIS Design & Consultancy for natural and built assets

NORTHERN RIVERS WORKSHOP

Changing Remediation and Regulations

Rod Harwood | June 21ST, 2017





Incorporating Hyder

Presentation Contents

REMEDIATION

- 1987 | 1997 | 2007 | 2017
- EPA Changes
- Changes in Consultants – Local Vs. Global
- Career Paths – Have We Been Successful?
- The Future

1987-1997 Technologies Well Advanced
– 10 Years of Clean Up

Remediation History in Australia Pre-1997:

- 1987 - Separate phase recovery – active and passive
- 1989 - Soil vapour extraction
- 1989 - Above ground bioremediation – ex situ
- 1990 - Soil vapour extraction within “cone of depression”
- 1991 - Insitu peroxide injection for groundwater clean up
- 1994 - Air sparging, biosparging
- 1990s - Soil stabilisation – cement and other products
- 1990s - Cap and contain – large sites

Rapid Advancement from Overseas Experience

Establish Coarse Goals

- **Risk-based goals**
- **Regulatory established clean-up levels**
- **Establish goals for all environmental matrices and contaminants of concern**

  - Soil

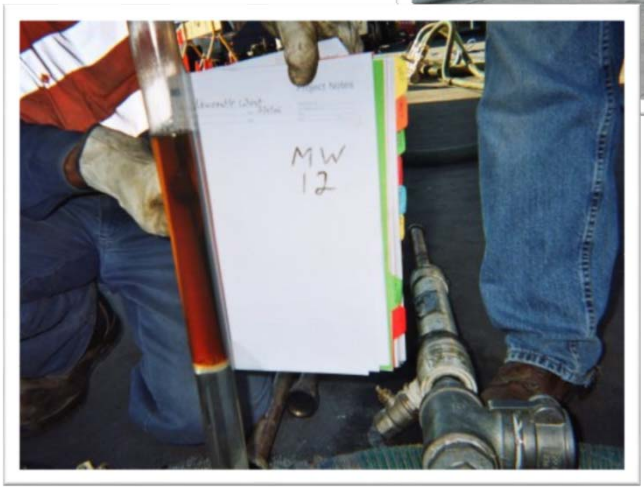
  - Groundwater

  - Surface water

  - Air

Separate Phase Recovery
– 80s and 90s

- Thought to be the solution in early 90s
- Driven by oil industry
- Did not consider all phases
- Gravity drainage solution
- Needed to be used with other technologies
- Why not dig it up?
- Active-two pump and passive



Bioremediation
– 80s to Today

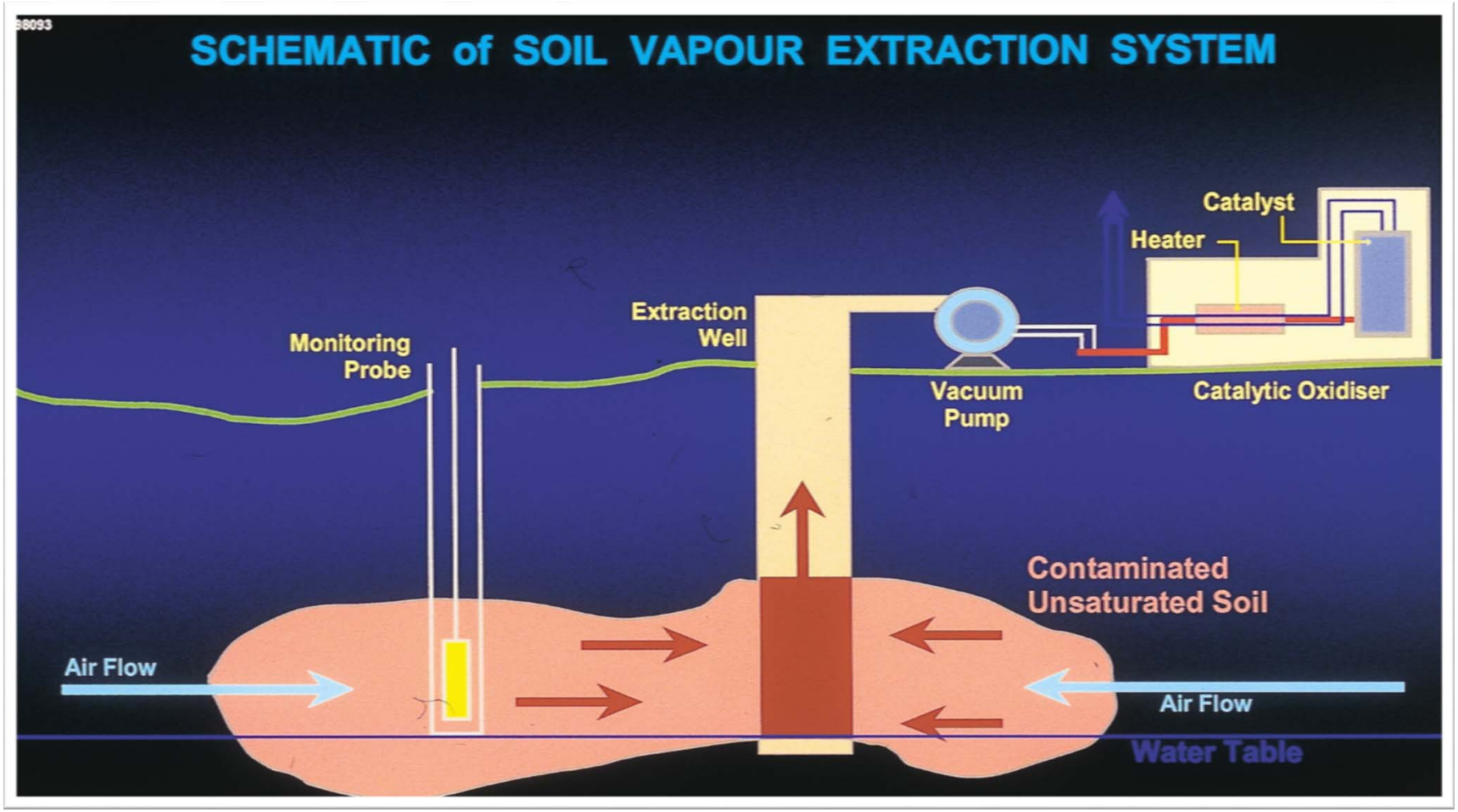
- Hydrocarbon driven in 1980s and 90s
- Attempts at coal tars in the early 90s
- Successful with creosotes and pesticides in 2000 with composting technology (thermophyllic)

Soil Vapour Extraction

1989 - Current

An extremely viable and inexpensive (less than $20/cubic metre of soil for large volumes) and also used in connection with dewatering activities to attack previously saturated ground.

Needs favourable permeability, vapour pressure and low soil moisture.



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VAPOUR EXTRACTABILITY OF SELECTED COMPOUNDS

COMPOUND	VAPOUR PRESSURE	MAXIMUM VAPOUR EXTRACTIBILITY (lb/day @ 100 scfm)
Benzene	28	1134
Toluene	9	430
Ethyl Benzene	4.3	236
Xylenes	3.0	165
Naphthalene	0.1	7
Methylene Chloride	198.9	8622
Chloroform	77	4782
1,1 DCA	89	4564
1, 2 DCA	32	1641
1, 1, 1 TCA	4.6	3154
TCE	28	1891
PCE	7.5	646
Chlorobenzene	3.8	221

Extractability assumes continuous vapour saturation, ignores moisture content.

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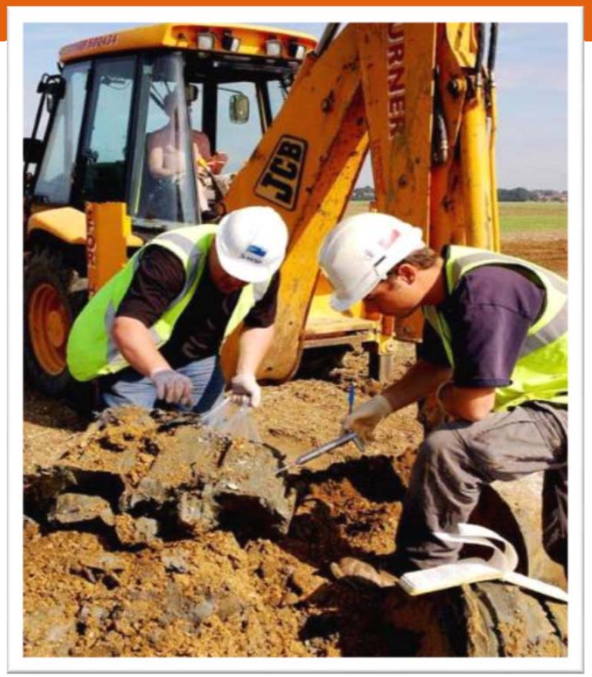
Air-Bio Sparging

Sparging became a very popular technology with issues such as changes to water table elevation and rebound being discussed in academic circles whiles practical sonsultants were solving problems.

Air is a more aggressive medium than water.

– Answer to “pump and treat” issues.



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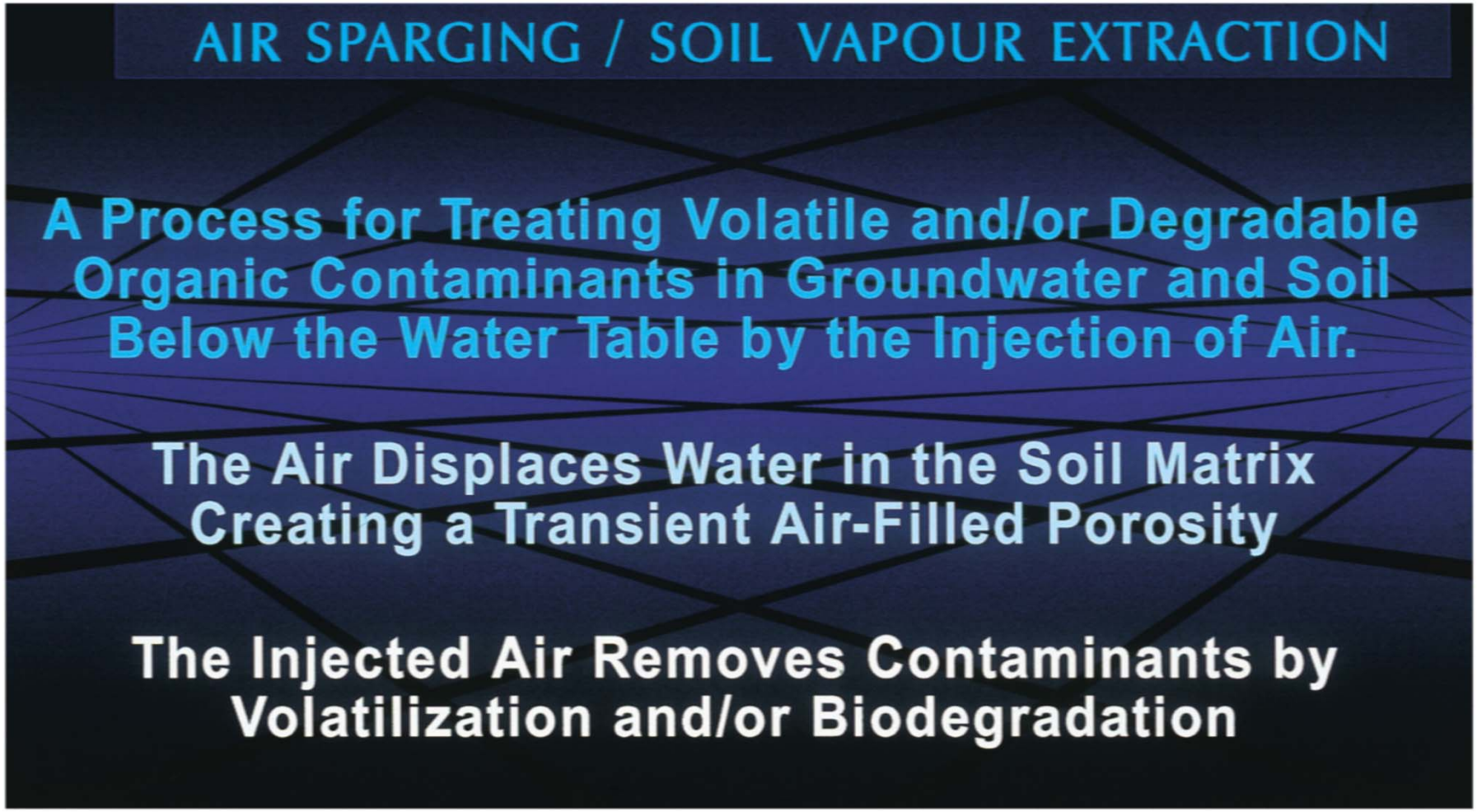
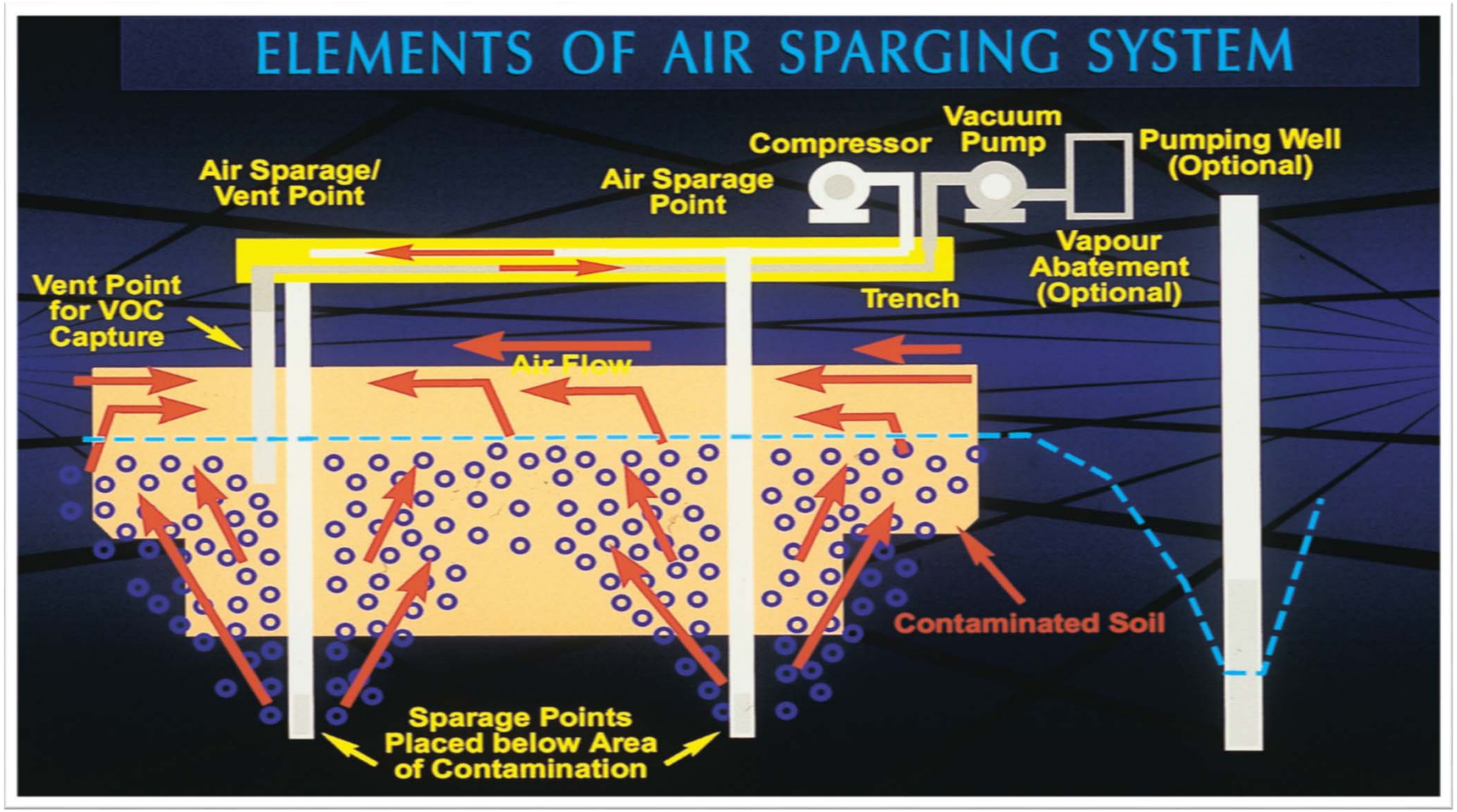
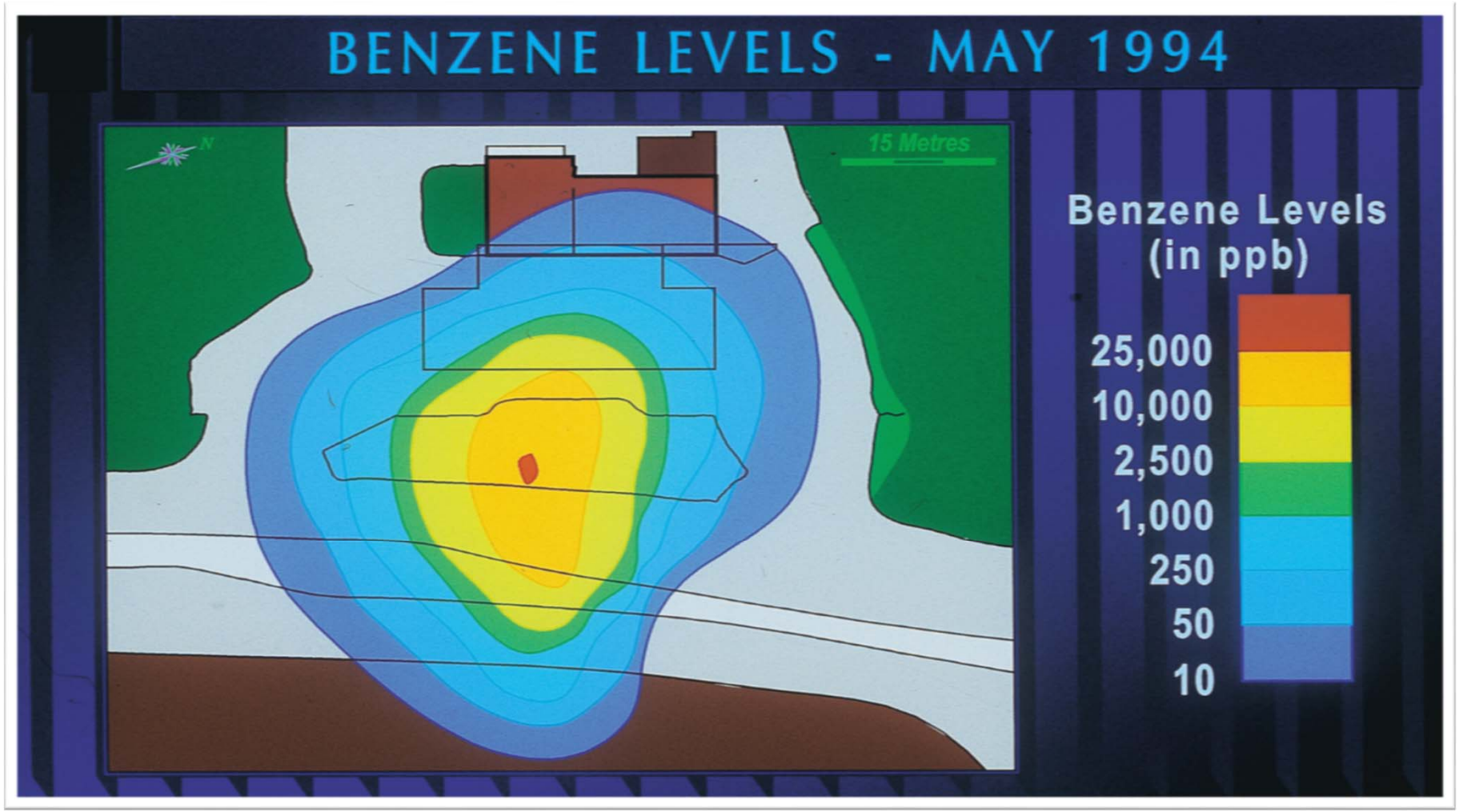
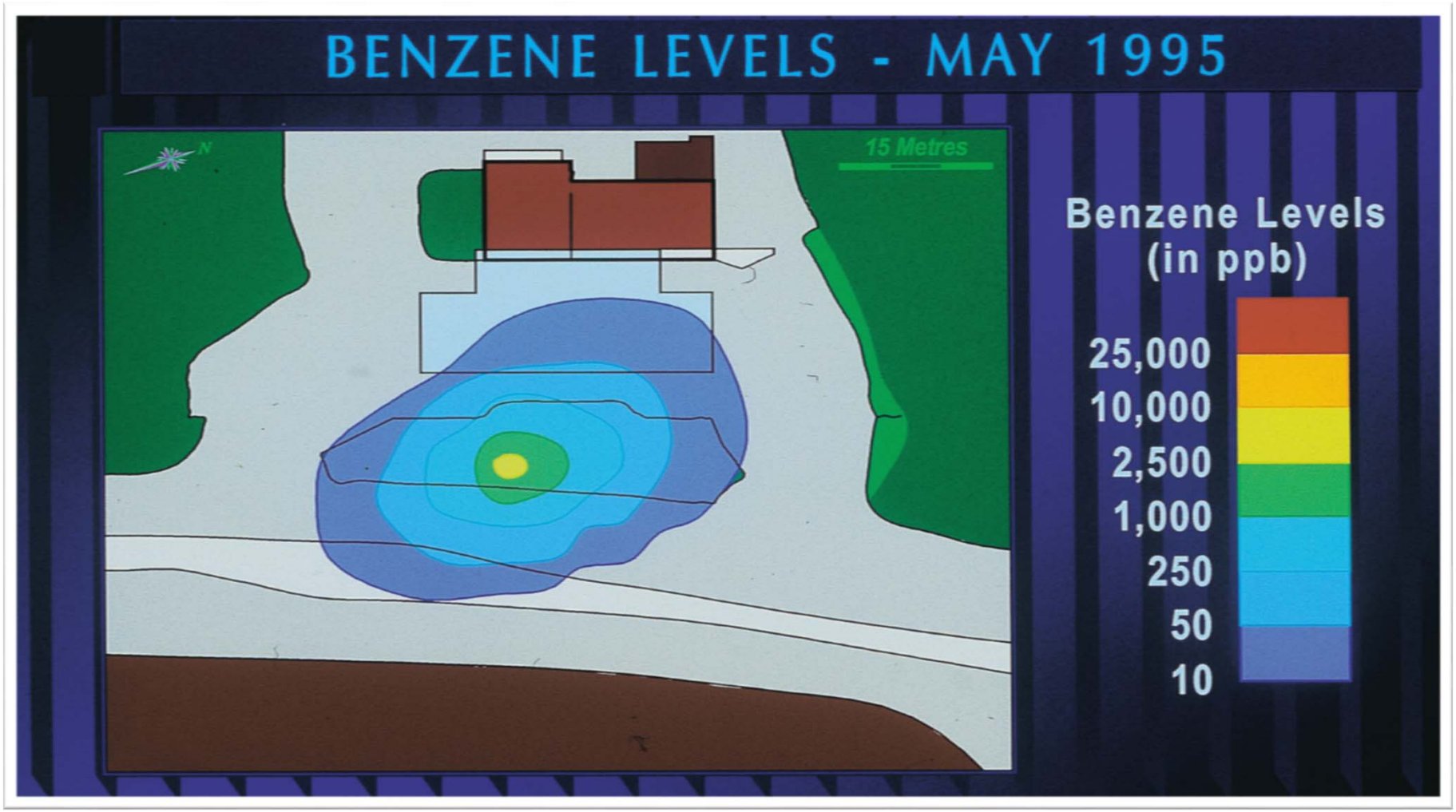








Innovative Cap and Contain Solutions

AGL Oyster Cove and Mortlake

AGL retains ownership of coal tars within the cap.

– Residents only own top 1m of clean land.

Technology Options - 1997-2007

- ANZECC 92 embodies Risk Assessment, but Govt and Stakeholders reluctant to embrace
- ANZECC 2000 embraces the Receiving Water, but we are still reluctant to apply it
- ANZECC 2000 promotes Direct Toxicity Assessment, but we are still cautious
- Monitored Natural Attenuation
- Acceptance of Robust Statistical Approaches
- Risk Assessment
- Groundwater Guidelines and Emergence of CUTEP

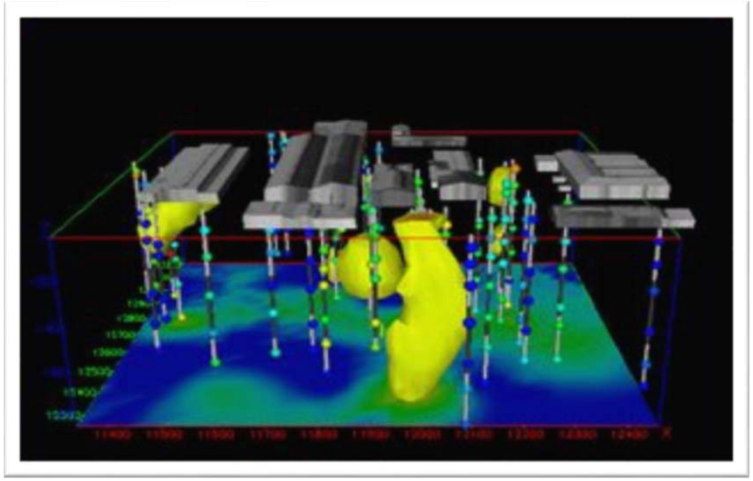
Movement away from clean up to a more strategic risk management approach in the first 7 years with a re-emergence of insitu clean up over the last three years.

Technical Remediation Solutions

Technology Selection Evaluation Process

- Applicability
- Permissibility
- Present value cost
- Treatment time

Lime enrichment and composting degrades hydrocarbons

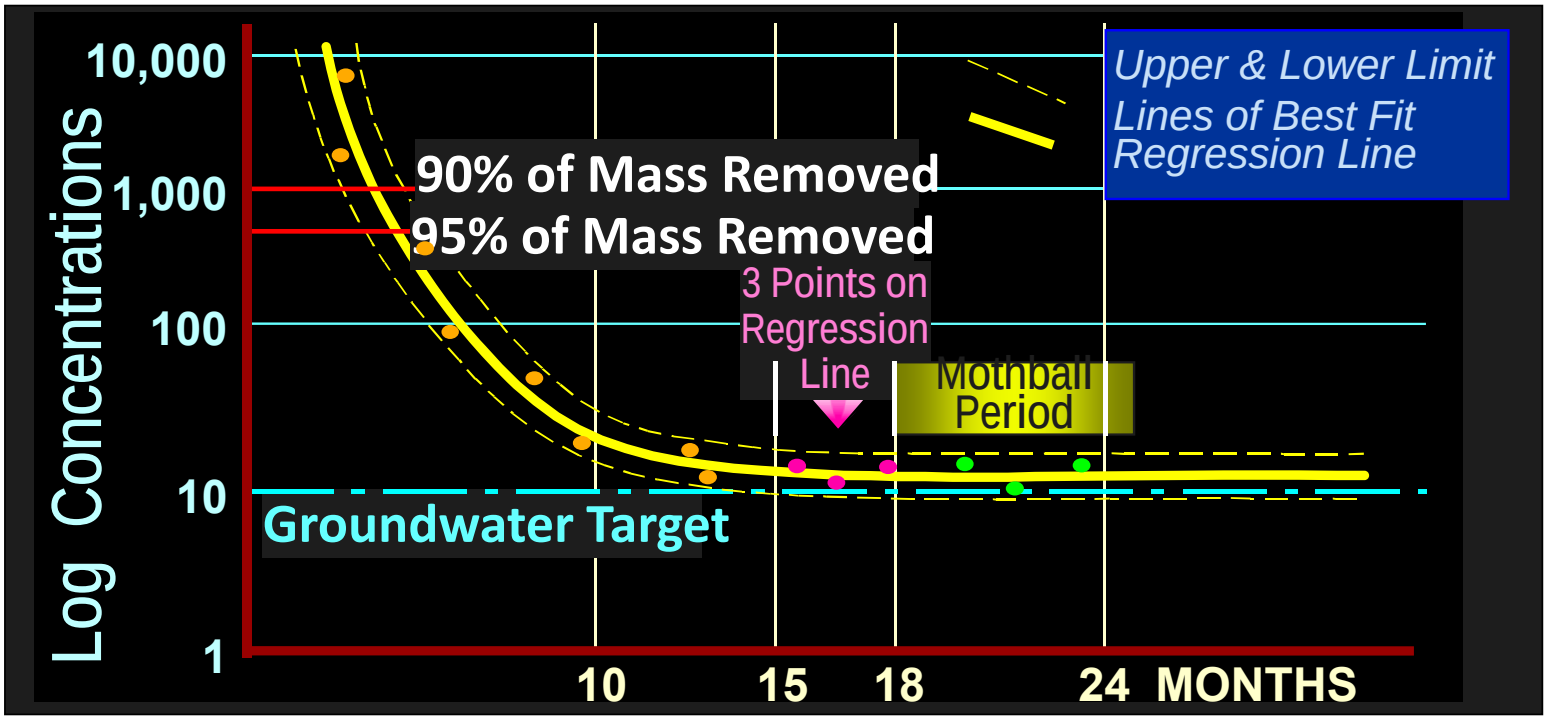


Geostatistical packages utilising kreigging, now used to predict confidence of data and determine clean-up volumes

CUTEP

Rigorous Process

- Milestones
- Best Available Technology
- Targets Vs Thresholds
- Cost Effective
- Recognising Assymptotic Remediation
- Mothballing



Reinvented and New Technology Solutions
1997-2007

Greater Focus on Metal Clean Up in Groundwater and Chlorinated Clean Up and DNAPL Assessment Techniques

- Thermal Desorption
- Multi Phase Extraction
- Chemical Oxidation
- Composting Bioremediation
- Funnel and Gate
- Injection of Reductants for Metals

Thermal Desorption

Direct or Indirect
Strict Permitting
Monitoring

Internationally was popular in the US in the early 1990s, since hydrocarbons were a hazardous waste in most States - inability to move to landfill. Technology now applied at Rhodes Peninsular to remove recalcitrant organics.

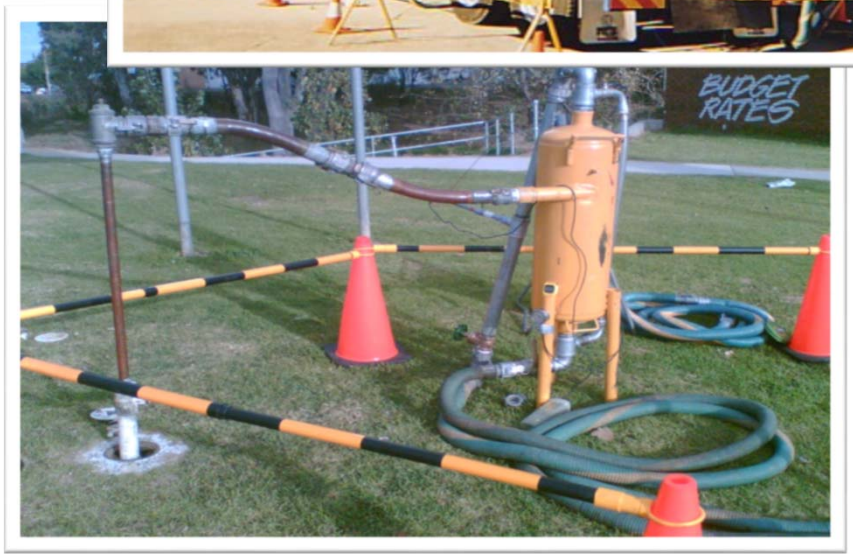
Soil Treatment

- 350 to 500°C soil temperature
- ITD and DTD outcomes similar
- <1ppm for individual SVOCs

Multiphase Extraction

Reinvented-formerly considered applicable in relatively low permeability soils K less than 1m/day – now successful in high permeability sites

- Attacks both the separate phase, vadose zone and dissolved phase in one application.
- Strong ability to prove effectiveness with trials.
- Now adopted by oil industry as one of the technologies of choice.
- Can use mobile or specific designed systems.



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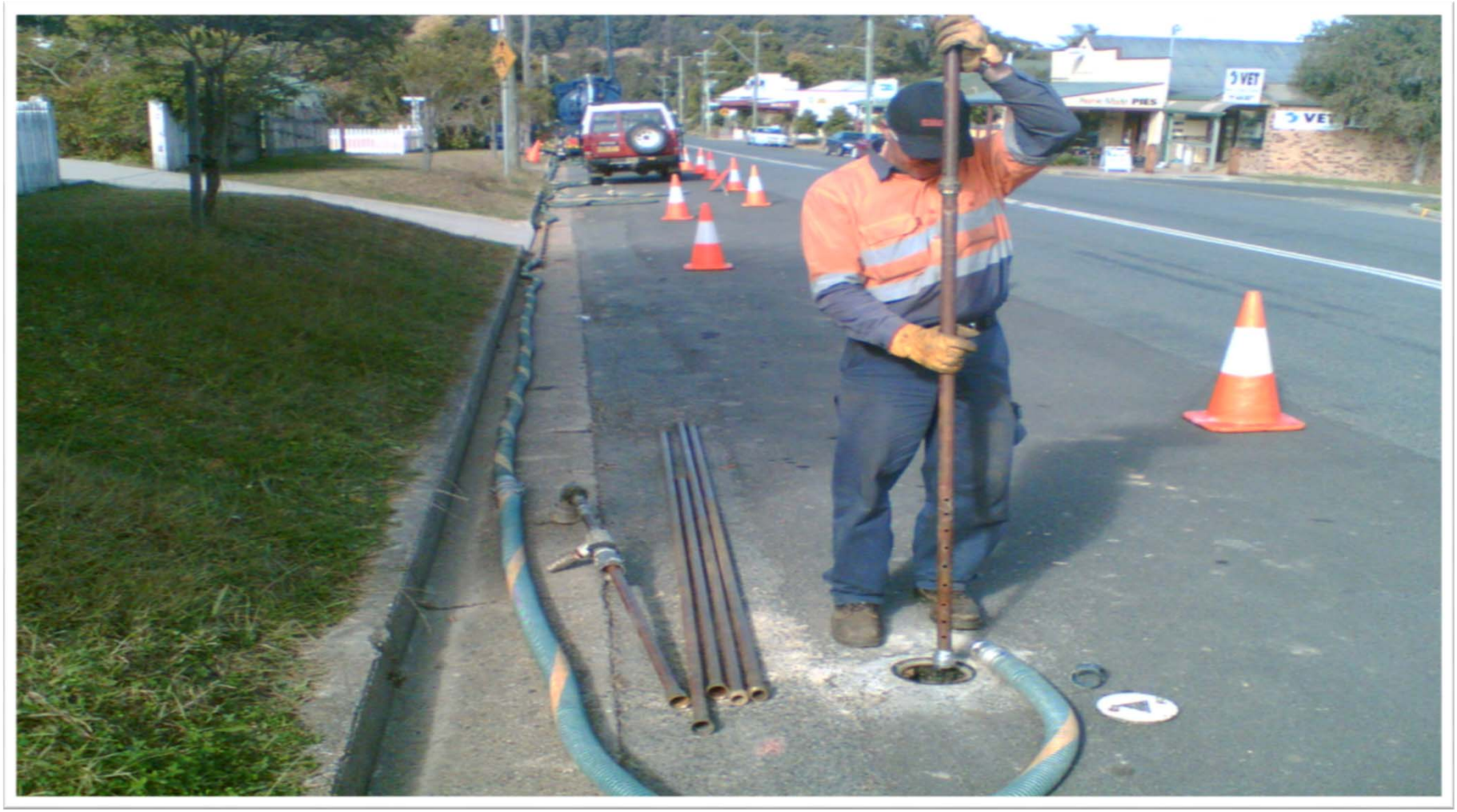

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Mobile Pilot Testing - Multiphase Extraction

- Use of a Spout-VAC type Truck, purpose designed for handling flammable liquids and other dangerous goods for smaller short-term (1-day to 2-month) pilot trials/events. Or locations where access is limited.
- Utilisation of existing monitoring well network supplemented with purpose designed extraction wells.
- Gather required data (ROI, flow rates and trend) to allow client to make informed decision on way forward.
- Eg: permanent MPE system for long-term operation (2 months - 4years). System may include water / vapour treatment and possible power generation (if financially viable).

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Continued Monitoring Effectiveness of System

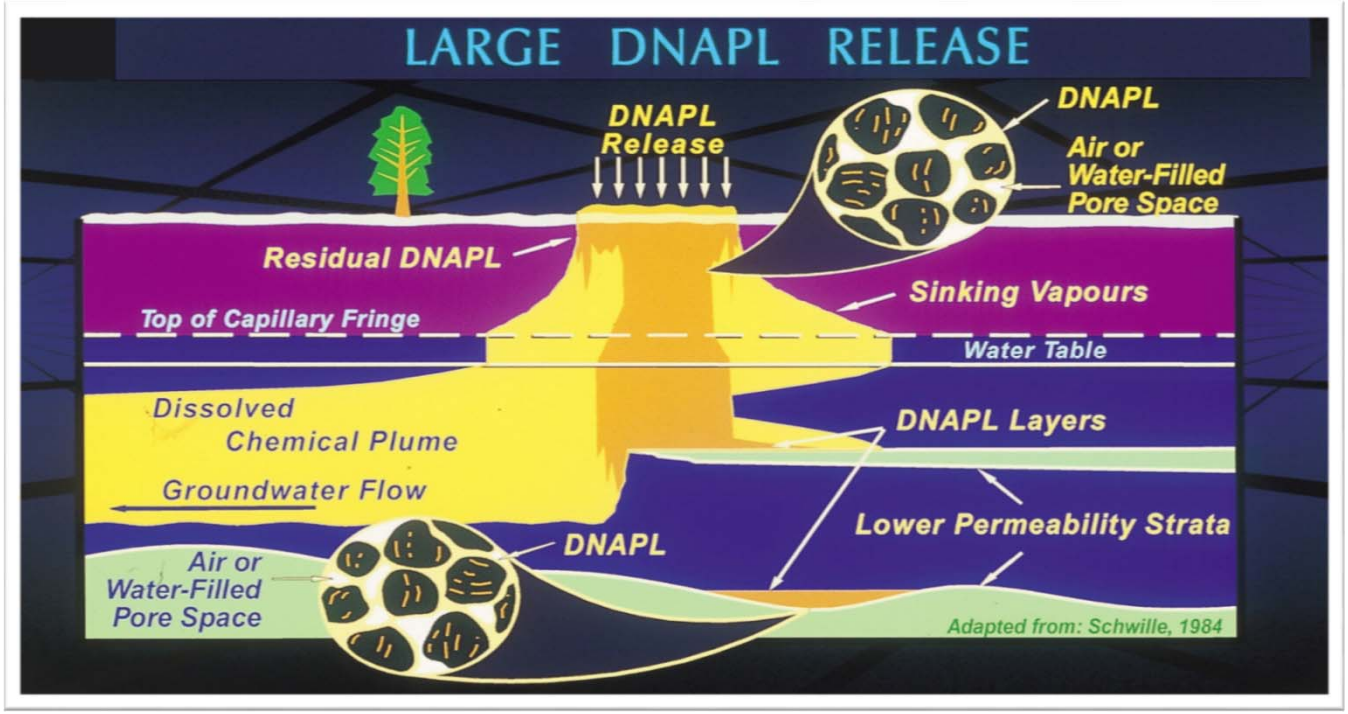
During any system operation you must monitor and adjust performance:

- water flow rates
- vapor flow rates
- vacuum response
- water level response
- concentration data – both groundwater and vapor
- amount of total fluids removed
- calculation of amount of product recovered

This has been the most common reason for system failure.

Chemical Oxidation

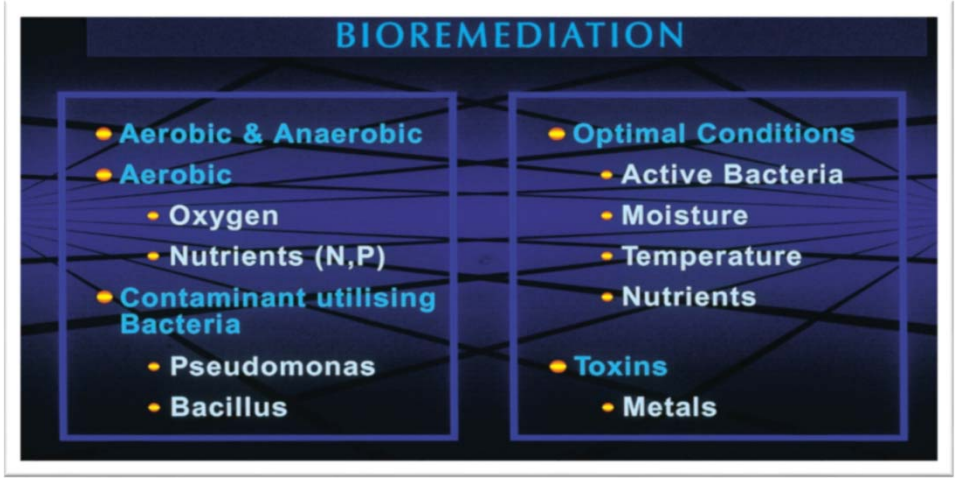
Used to break double bonds in chlorinated solvents in groundwater and also in soils – TCE, DCE coal tars. Vinyl chloride needs to be addressed aerobically.

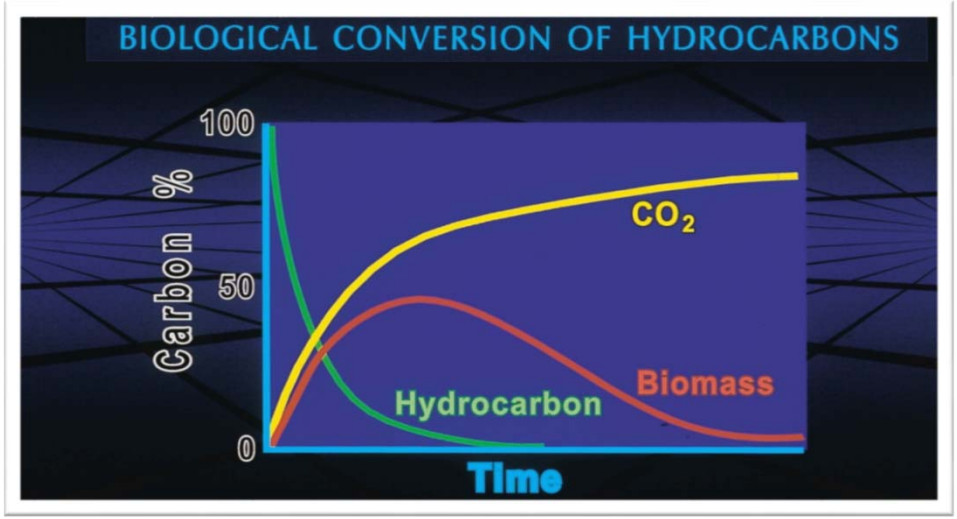


Composting Exsitu

Bioremediation

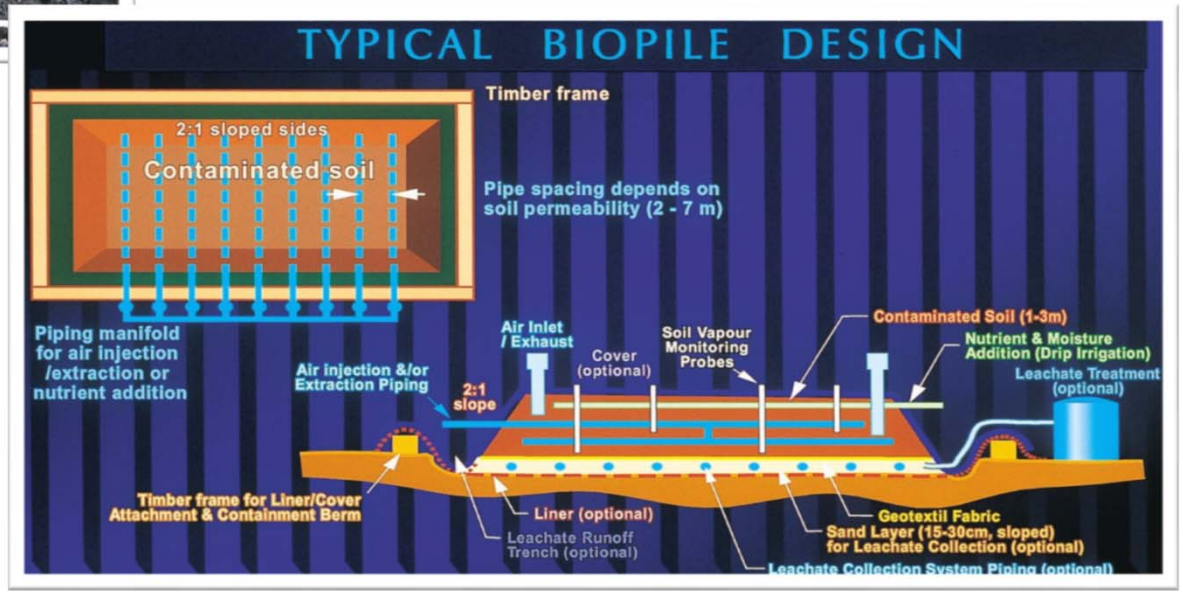
This technology has produced excellent results for pesticides, PCPs and coal tars by creating a chemical thermophyllic process which destroys the contaminants at temperatures much higher than standard biological temperatures.





Composting can be provided by wood, mushrooms green waste and readily available organic material.

Conventional bioremediation ineffective due to die off of bacteria at temperatures ranging to 40^{O}c.



Addition of Reductants and Buffering Capacity to Groundwater to Precipitate Metals

- New focus on groundwater clean-up even though soils may be acceptable for land use.
- Modelling both for fate and transport and geochemical stability.
- Reductants include calcium polysulphide and nano iron and buffering will be specific for contaminant mix.

Used in many sites including copper, chrome arsenic contaminants at Timber sites and other sites impacted by metals.

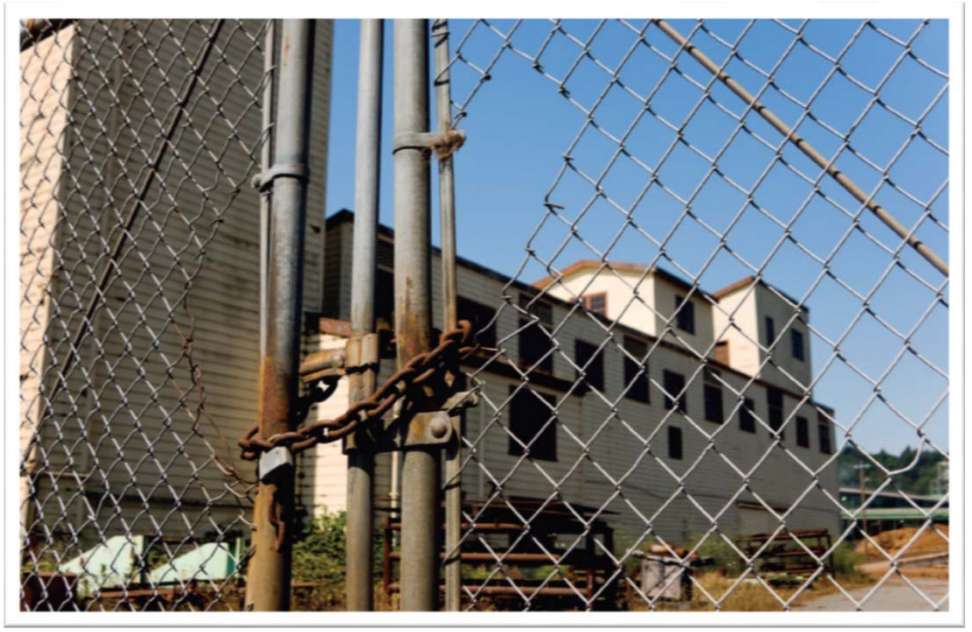
New Regulatory Solutions and Issues 2017

NEPM Framework and Risk Driven Remediation

- Dermal exposure Replaced by Vapour
- NEPM (2013)
- Risk Assessments
- Emerging Contaminants
  - PFAS
  - 1,4 Dioxane

New Regulatory Pressure 2017

- Wider Role for Auditors
- JRPP
- More Skills-more Reliance on Support Teams
  - Vapour Risk
  - Planners
  - Health and Safety



Global Technology Changes 2007-2017

- Large Plume Clean Up-Enhanced Insitu Bioremediation-Ethanol, Fentons Solution
- Chromium Biodegradation
- Rapid Assessment Tools
- Automated Data Analysis
- Field Decisions to Provide Cost Effective Solutions

Global Technology Changes 2007-2017

- Organic Treatment Heat Advances
  - Boiling TCE and PCE in groundwater
  - STAR-smoldering of DNAPL tars
  - Electrokinetic enhanced ISCO

Global Technology Changes 2007-2017

- Petroleum Solutions
  - LNAPL Transmissivity
  - Geometry of Plume Change
  - Stable Plume
  - Acceptable Vapours
  - CUTEP

EPA Issues and Benefits

- NEPM provides National Framework
- Suitably Qualified Professionals
- Practical view of risk assessment
- Successful release of guidelines
- PFAS –more issues than solutions but practical approach-start at the end and go back to source

Practical and Solutions Focused

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Emergence of Global Companies and Large Australian Groups

Changes to Consultants

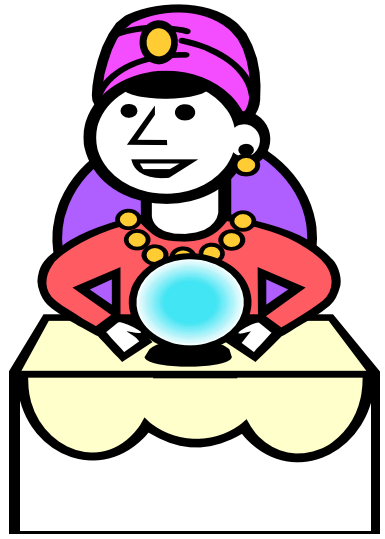
- 1997 Three Global Players - URS ,GTI, Golder
- 2007 - Global Players - URS, ERM, HLA, Golder, Maunsell / ENSR, WSP, Environ
- Local Players Become More Dominant - Coffey, GHD, Expansion.JBSG
- Smaller number of Small players - But is size important?
- Segmentation of market continues, but players are shifting - oil industry still dominant, but property developers and overseas M&A activity creates consultancies that do not feed on the local market.

Career Paths

- 1997 – poor retention of 5-10 year people - employer market, lifestyle balance not appropriate for new generation.
- 2007 – poor retention, employee market, growth hampered by saturated Australian market, balanced lifestyle now a pre-requisite for employment.
- 2017 – retention at mid level, mature market.

The Future

- Create a sustainable working environment that is profitable - allows employees to have a balanced lifestyle.
- EIAUST/NZ encourage senior consultants to mentor younger members to move it to the next stage.
- Create passion for change and advancement.
- Encourage training, academic courses and standing.



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