

# *Pleasures and Pitfalls of Pilot Studies*

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TAB/OSRTI/OLEM/EPA

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# *Disclaimer*

- *Honest effort to share experiences/memories*
- *Some clear as a bell/Some (a bit) murky*
- *Not necessarily a reflection of EPA policy*

# IMPORTANT NOTE

- Although some of the examples come from *'The Journal of Unfortunate Outcomes'*, this is NOT a 'glass-half empty presentation
- Properly *scoped, designed, funded and conducted* pilot studies are often a vital part of successful remedial efforts

# A Point About Lab Studies

- Conventional Wisdom – *“If it doesn’t work in the lab, it won’t work in the field.”*
- Well...Gen’l Rule N/A if (examples are NOT hypothetical):
  - you don’t control/monitor pH for a pH dependent technology
  - you don’t run the study long enough to see effects/results
  - you don’t prevent aeration during shipment of samples sent for anaerobic testing
  - ‘Spiking’ instead of using actual site soil/GW samples may be problematic
- Plug for BIOTRAPS® - Best of both Worlds
  - Actual field conditions at lower cost

# Doing Good Pilots is An Acquired Skill

- WHERE – Upradient, downgradient, sheet piled off in hot spot?
  - At heterogeneous sites even a properly-scoped pilot may not be in a ‘representative’ volume
- WHEN – The sooner the better, but some RODs w/ more established technologies specify pilots after remedy selection
- HOW – A single injection/heating point is NOT likely to be suitable
- WHO – Get good help, preferably with pilot experience
- WHY – Do not do a pilot to ‘check a box’/’fill a square’

*In the Beginning...*

# Fundamental Disagreement Over 'Ends and Means'

- Both in General and wrt Tech Innovation -

- Early days:
  - PRPs: *"No I can't. No I shouldn't"*
  - Fedl/State: *"Yes you can. Yes you should."*

# Receptivity to Innovation (or not)

- a) 'Early Adopters'
- b) 'Fast Followers'
- c) None of the Above



# The 'Annuity' Problem

- Existing Pump and Treat (P&T) and Soil Vapor Extraction (SVE) systems sometimes viewed as 'annuities' by some consultants
- Not clear what annual \$\$ pain point might result in reconsidering remedy

# TIO Mantra – *Faster, Better, Cheaper...*

- Pick Two
- Pick one (esp if trying to ‘restore resource’/meet 5ppb MCIs for TCE)
- New Tools Need to be A LOT better than existing tools
  - Incremental improvement not likely to overcome familiarity w/ status quo tools
- DIRTY SECRET: ‘Cheaper’ trumps ‘faster’, ‘better’ unless redevelopment is a driver – see ‘Speed Racer’ redev sites in Bos-Wash corridor

# \$64K Question Tech Xfer for TIO from Day 1

- Who is the primary client/customer/audience?
  - RPMs?
  - Consultants?
- Message/Content likely to vary depending

# \$32K Question – When to do the Tech Xfer?

- Personal View – *'Just in Time'*
- RPMs and their consultants are busy – Best time seems to be just as they are starting the Feasibility Study (FS) process

# Dem/Val vs Pilots – Important Distinction

- Dem/Val – Will it/Does It Work?
- Field Pilot – RIGHT purpose is to refine engineering design parameters
  - Generally NOT to make Go/No Go decisions
- BOTH INCREDIBLY IMPORTANT TO ASSIST TECHNOLOGY ON THE PATH TO(WARD) COMMERCIAL MATURITY/AVAILABILITY

# Excerpts from Gorm Heron of TRS

- **Portsmouth Gaseous Diffusion Plant, OH (2000)** – TCE in sand layer
  - Showed SEE in interbedded layer and importance of pressure cycling for TCE recovery
- **Beede Waste Oil, Plaistow, NH (2014)** – SEE injection pilot test
  - *Determined injection rates and well-spacing for full-scale*
- **Moss Pt, MS (2016)** –SEE injection pilot test
  - Proved injection rates and screen depths for full-scale

# TIO 'Cost and Performance' Reports – Somewhat of a Misnomer

- 100 or more – who's counting
- Cost information often/usually very problematic
- Small volumes generate inflated \$/cubic yard cost estimates
  - Mob/demob costs over a smaller volume
- Sometimes involves more PhDs than would be affordable for a full-scale deployment

# Partial Fix to Aversion to Innovation Problem

- **Risk Sharing – Superfund Reform Initiative 9**
- PRPs reluctant to try new technologies – having to ‘pay twice’ if innovative remedy failed
- If Innovative Remedy was not successful, EPA would repay PRPs up to 50% of the verified costs of the failed remedy to put toward the cost of the backup remedy
  - 6 or so projects/paid out on a couple
  - Not available to other federal agencies



# Superfund Innovative Technology Evaluation (S.I.T.E.) Program {R.I.P.}

- Statutorily- mandated tech eval program
- Joint collaboration between TIO and ORD
- \$7.5M Annual Budget
- Developer states claim(s)/Joint dev of deployment to assess claim(s)

# Remedial Technologies Development Forum (RTDF)

- Public-Private Partnership to Develop/Adopt Innovative Technologies of Mutual Interest
  - Idea was that Firms would be familiar w/ and have a sense of ownership-
  - ***Greatly simplifies the tech transfer function***
- Early Output – ‘Lasagna’ – Electro-Kinetics (E-K)
- E-K 1.0 – move contaminants to electrode – Problematic
  - *Subject of pay-out to PRPs under risk sharing for an As/Dioxin pilot project*
- E-K 2.0 – move oxidants/nutrients/micro-organisms to contaminants
  - Selected for use at Cristex Drum NPL site\*\*

# Early S.I.T.E. Program Challenges

- Difficulty Finding Sites\*
- Modest levels of funding/Vendor to bear costs of deployment\*
- Often/usually vendor's first field deployment
- Site characterization information often problematic
- Often ambiguous results – resulted in extended delay in report release

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\*Generally not a problem for SERDP/ESTCP

- SIDE NOTE: How many demo projects have taken place at Navy JAX?

# DOE Tech Dev

- EM-50 Developed
- EM-40 tasked w/ deployment
- Not always 'ready for prime time'
- EM-50 allowed PI to 'accompany' nascent tool
- Bill Heath developed Electrical Resistance Heating (ERH) at PNNL//Worked at Current Envl Solutions to refine/deploy the technology

# DOE – The ‘Hood Fire Incident’

- **In Situ Vitrification (ISV)** – Developed by Battelle to address Rad+VOCs
  - Classify RAD/destroy VOC
- Shroud to control possible off-gas
- Glass-splattering event due to ‘burps’ from buried drums - a major ‘Lesson Learned’
- Met w/ Battelle mgmt. to encourage them not to discard the technology
- Subsequent deployment at several NPL sites

# General Challenges in Remediation Tech Development

- May still be on the wrong side of the ‘Valley of Death’ even after Dem/Val
- New tools need to be ‘A Lot Better Than Existing Tools’
  - Incremental improvement not likely to overcome lack of familiarity
- Not always clear where a new tool fits in a world where Combined Remedies are needed

# Advent of MNA c. 2000 – *Oh, No....*

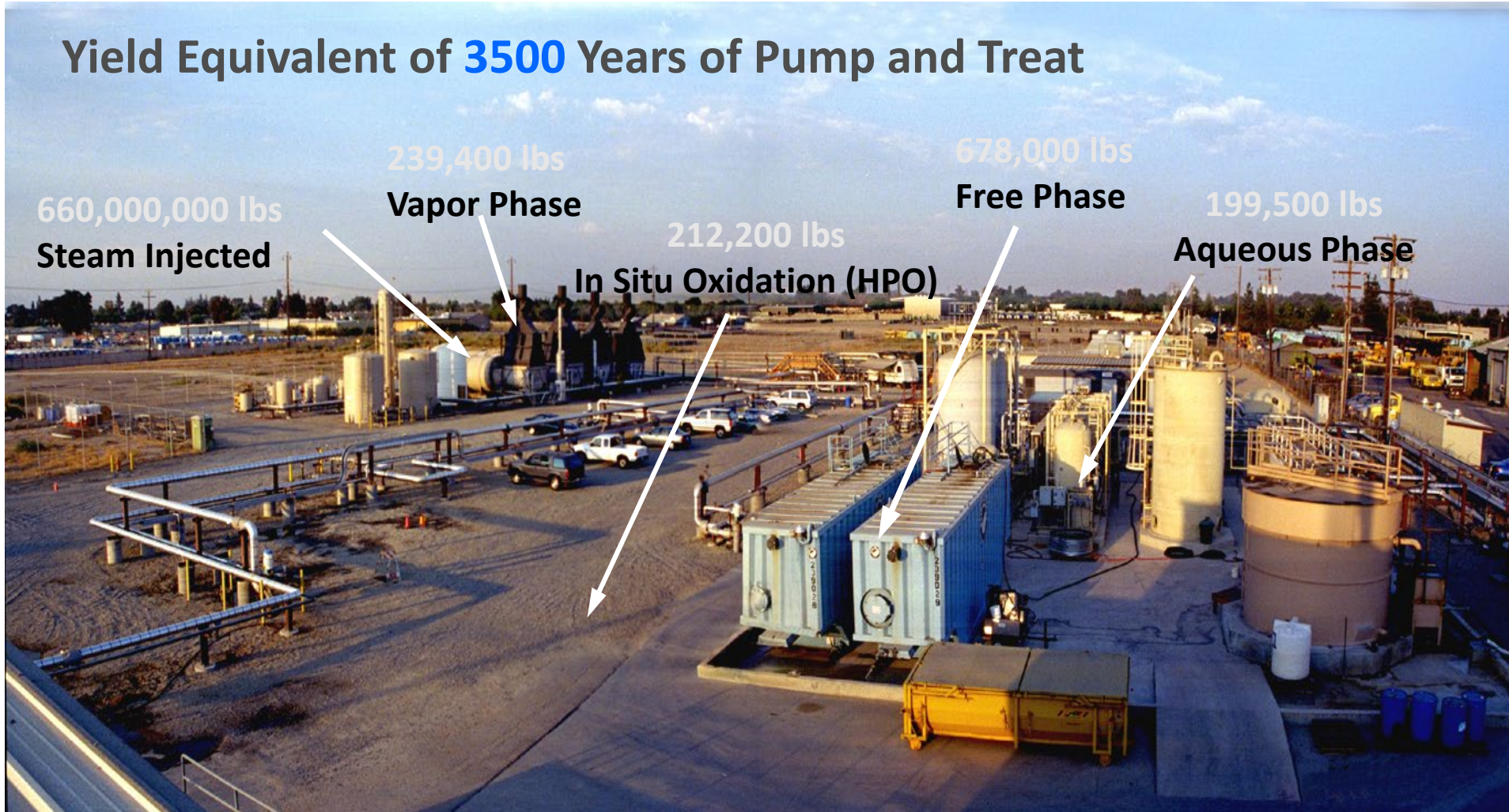
- Concern that advent of Monitored Natural Attenuation (MNA) would be the death knell of funding/interest in innovative technology development
- Turns out that due to limitations of even reasonably 'good' technologies, MNA may be innovation's best friend

# Steam Enhanced Extraction (SEE)

- Commercially available in the oil field – i.e., not ‘really’ new
- Adaptation for Remediation supported by NIEHS grant
  - Kent Udell, UC Berkeley, eternally grateful
- Selected for full-scale use by S Ca Edison at an NPL wood treater in Visalia, Ca – perhaps the most responsible PRP in history
- Recovered 1.3M # of creosote at a site recovering 10#week after 20 years of pump and treat (at a cost of \$1M/yr)



# Hydrocarbon Removed ~ 1,330,000 Lbs May 1997 to June 2000



# Field Pilots

- So easy to say, not necessarily so easy to do
- Too often not enough time/not enough \$\$ to do a proper pilot
  - Aphorism '*Never enough time to do it right, always enough time to do it over*' – N/A wrt pilots

# Pipe Clogged with Naphthalene – Wyckoff Steam Enhanced Extraction Pilot

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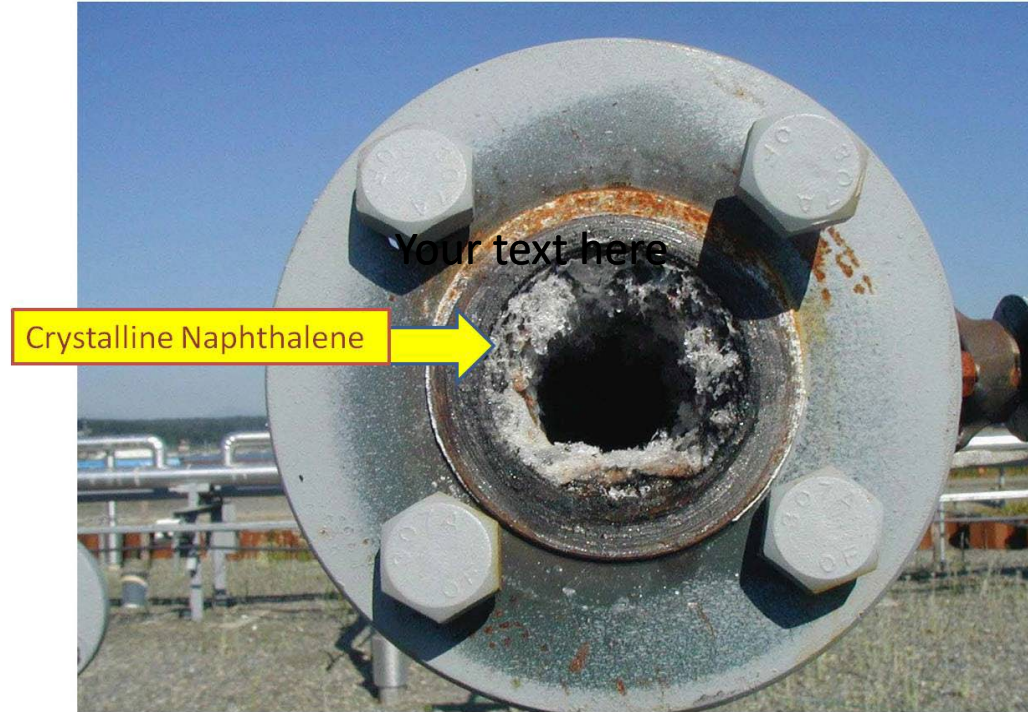


Figure B-5 Wyckoff Horizontal Vapor Recovery Pipe  
HV-4 Aboveground Piping

# How Should the SEE Pilot at Wyckoff Be Characterized?

- Recurring Existential Question: *Is it a **Technique** Problem or a **Technology** Problem?*
- *In any event, 'once and done'/no 'do overs' is the norm*

# Electric Power Research Institute ISCO Demo

- Expected arrival time of 'active ingredients' at downgradient sentinel well: **79 days**
- Actual arrival time of active ingredients at downgradient sentinel wells: **2 days** (NOT a typo)
- Preferential pathway/paleochannel – *Elvis has left the building...*
- Geology REALLY matters

# Recent Arcadis Soil Washing ESTCP Project in Alaska

- Overcome by early snow
- Full Stop – Important 3<sup>rd</sup> phase not conducted

# One of the First S.I.T.E. Demonstrations

- Chemical Stabilization
- Vendor's first field deployment
- Rainy season in Portland Or, flooded roads, detours to get to site
- Vendor personnel did not add sufficient water to the mix

# S.I.T.E Demonstration –Long Beach, Ca.

- In Situ Steam Injection/Soil Blending w/ Augur
  - Developer's first field deployment
  - Mixed results (at best)
- Message from developer:
  - *"Jim, I know it didn't go so well, but NOW I know how to do it."*



# LAST S.I.T.E. Demonstration – Ashland, Wisc

- Former Manufactured Gas Plant (MGP)
- Cool-Ox ISCO Technology – Non exothermic
- Only had enough funding for one Cool-Ox Application
- Assured by PRPs consultant that area selected was only ‘moderately’ contaminated
- Ended up injection into a holder – ‘mother lode’/’weapons grade’ PAH levels
- No way to assess treatment performance

# Ashland, Wisc – cont.

- Secondary Objective: Ascertain increased PAH recovery rates over 'baseline'
- Turned out that the existing 3-well passive recovery system was not operating properly
- Not entirely clear whether the enhanced recovery was due to the Cool-Ox injection or refurbishment of the existing passive recovery system
- -----
- Did I mention that we also had 'daylighting'?
- Did I mention that it was REALLY cold?

# Mass Flux – Classic Example of the (Rocky) Road to Commercial Acceptance

- PFMs developed by U of Fla to improve understanding of fate and transport of subsurface contamination
- TIO funded early deployment at a Marine Corps base in the SE – funding constrained - Alas
  - Ideal - Line of properly spaced PFMs orthogonal to centerline of plume
  - Actual – Pick and choose among existing monitoring wells

# Mass Flux – cont.

- Premature effort to replace MCL's w/ Mass Flux as Compliance Metric
- Best use is as information to design and monitor remedy
- Acceptance hampered by fact that consultants don't know what to 'do' with the output – No place to put it in the 'models'
- Some reluctance to do Mass Flux properly
  - PRP's proposed to do 2 flux meters across a 400' landfill boundary
- European firm bringing new energy to the tool
- Regenesis considers mass flux an important metric in deployment of PlumeStop – Colloidal Activated Carbon injection

# The 'Not(Quite) Ready for Prime Time' Problem – Other Sectors

- Release of 'Beta' version software w/ lots of bugs
  - Customers work out the bugs
- F-22 Rollout
  - HUNDREDS of problems still to be worked out
  - TCTOs – some major – issued through life of project
- Don't get me started on 'Cost Overruns'

# Springfield Interchange – aka ‘The Mixing Bowl’



# Springfield Interchange Price Tag Rises 45%

- By **Alan Sipress – Washington Post**
  - June 15, 2000
- The cost of replacing the Springfield interchange, already the most expensive highway project ever undertaken in the Washington region, has ballooned by 45 percent and now exceeds **\$500 million**, Virginia officials said yesterday.
- **NOTE: Final cost for this above-ground project > \$700m**

# LA -> SF Bullet Train

- In 2008, when voters approved a bond to help build the railroad, the authority estimated that the system would cost **\$33 billion**.
- The 2022 business plan estimates that the full, 500-mile high-speed system between Los Angeles and San Francisco will cost as much as **\$105 billion ...**



# Closing Thoughts

- If you only have resources to do a single injection point, don't bother
- For Dem/Val projects involving vendor's first field deployment, consider need for contingencies/second chances/do overs
- For field pilots as part of remedy decision – deployment should be to refine engineering design parameters NOT to make a go/no go
- Be aware that site characterization may be problematic – budget for some verification

# Closing Thoughts

- Consider if there might be some way(s) to make grant application processes more hospitable
  - Application/Selection Process can be a gauntlet, esp for small(er) technology developers
  - Several examples over the years of researchers doing interesting work, but by the time we contacted them, they had given up.

# Questions

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