



2003 AFCEE Technology Transfer Workshop

San Antonio, Texas

Promoting Readiness through Environmental Stewardship

Evolving Perspectives for Managing Releases of Recalcitrant Compounds

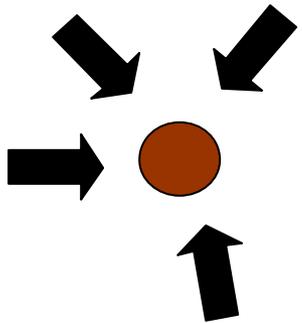
**Tom Sale
Colorado State University
February 25, 2003**



Air Force Real Property Agency



“Good Decision” initiatives



- National Research Council (NRC)

Committee on Source Removal

- USEPA DNAPL White Paper

EPA Advisory Panel

- American Petroleum Institute (API)

LNAPL Tool Box

- AFCEE

Source Zone Initiative / Technical Assistance to F.E. Warren AFB,
NAS Fort Worth and AFP 4

- Remediation Technologies Development Forum (RTDF)

NAPL Cleanup Alliance Decision Framework

- ESTCP

Decision Support System to Evaluate Effectiveness and Cost of Source
Zone Treatment

- USGS /Virginia Tech

Coupling of source removal strategies with MNA

- Others



Consensus on evolving perspectives?

More
Aggressive
Source
Depletion is
Needed
???

Too Often Our
Best Source
Depletion
Efforts do Little
to Alter Risk or
Life Cycle Cost
???

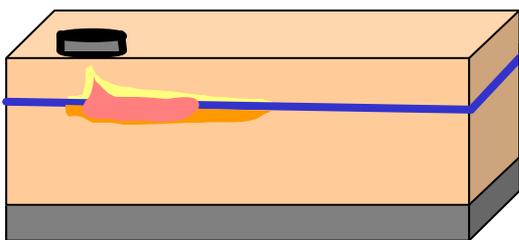


Challenge

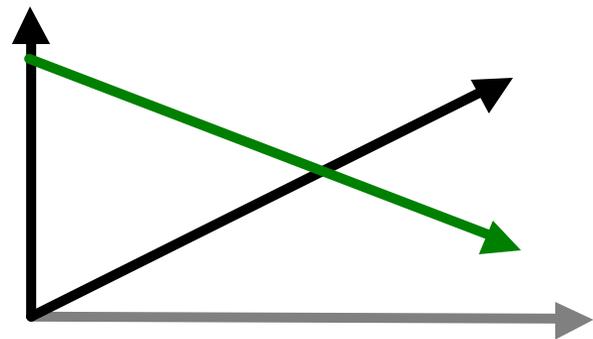
In spite of large investments, many sites have not achieved closure, unaccepted risks remain, and estimated costs to closure are large



Increased success yields greater environmental benefit and reduced life cycle costs



Environmental
Benefit
Life Cycle Cost

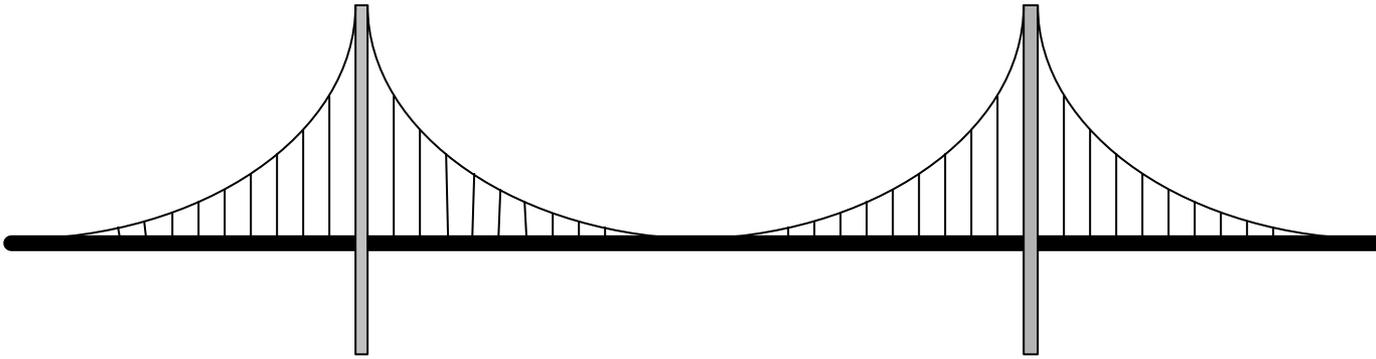


Frequency of success

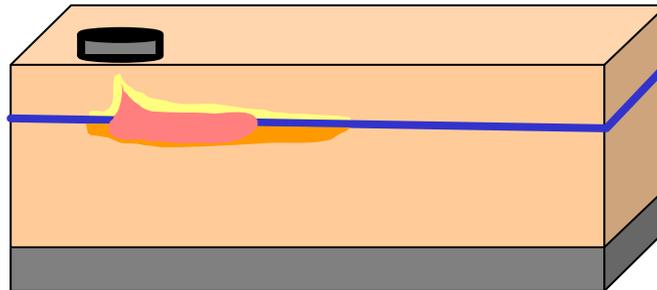


What is success?

If you build a bridge you expect, without doubt, that it will bear traffic

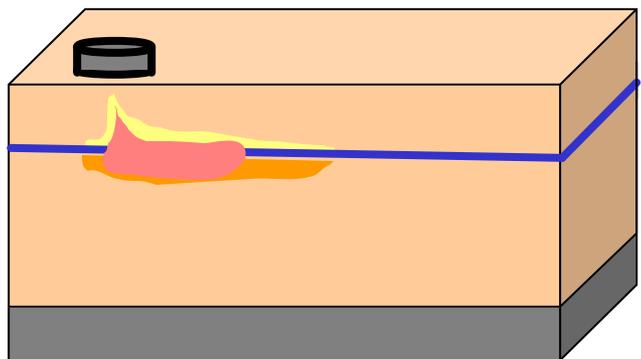


What should you expect if you implement a risk management measure?





Success



- **Significant risk reduction**
- **Reduced site care requirement**
- **Satisfying stakeholder expectations**

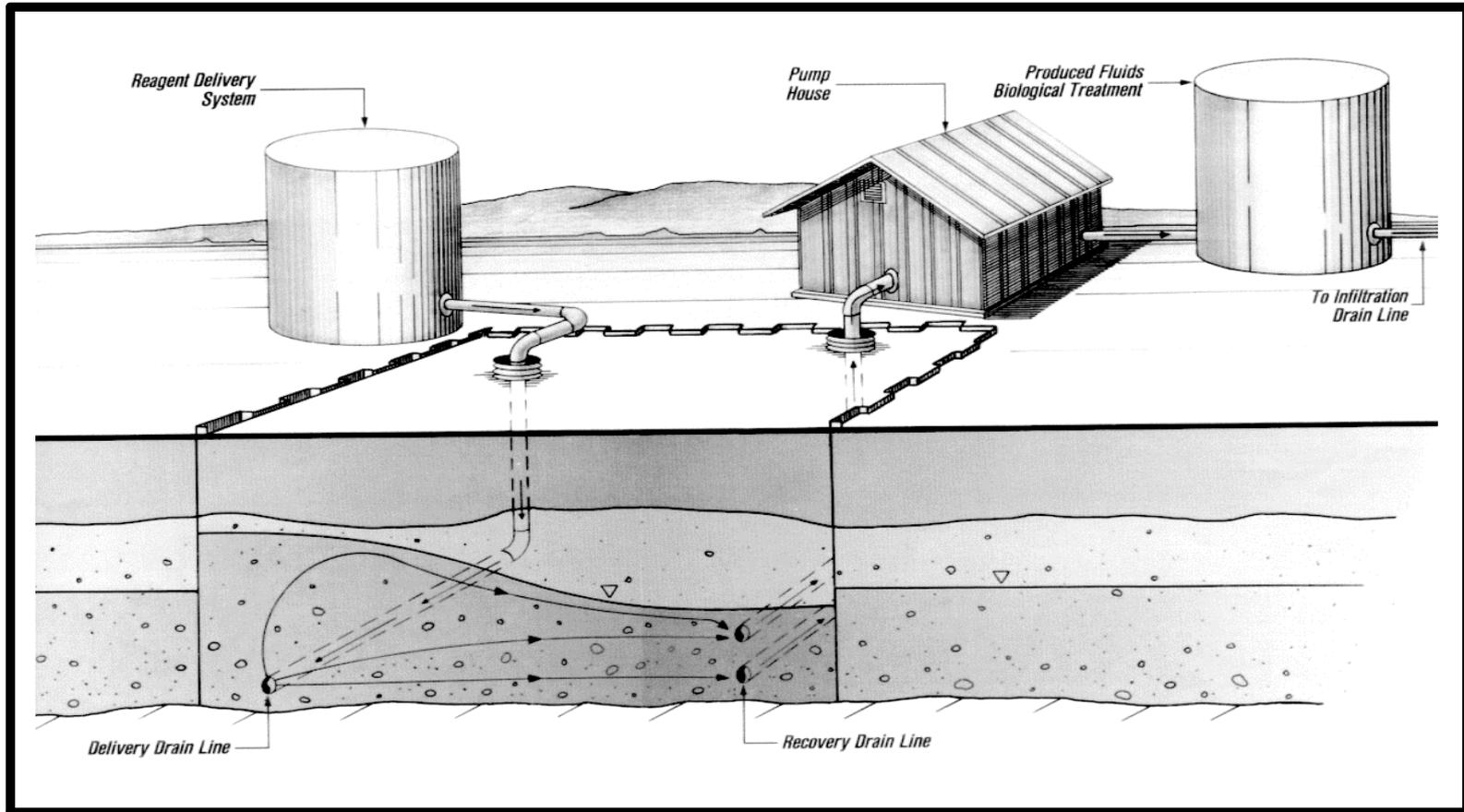


Common themes in “Good Decision” initiatives

- **Developing attainable goal**
- **Recognizing technology limits**
- **Sufficient understanding of conditions and governing processes**
- **Prioritization of investments**
- ***A priori* analysis of benefits**
- **Tailoring solutions to sites**

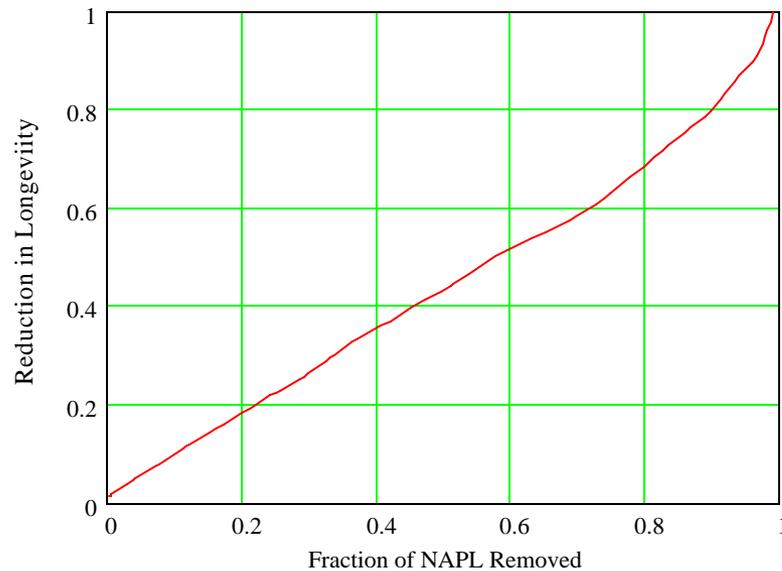
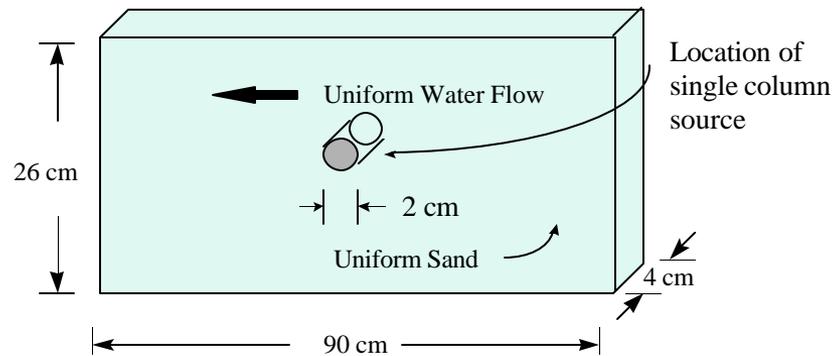
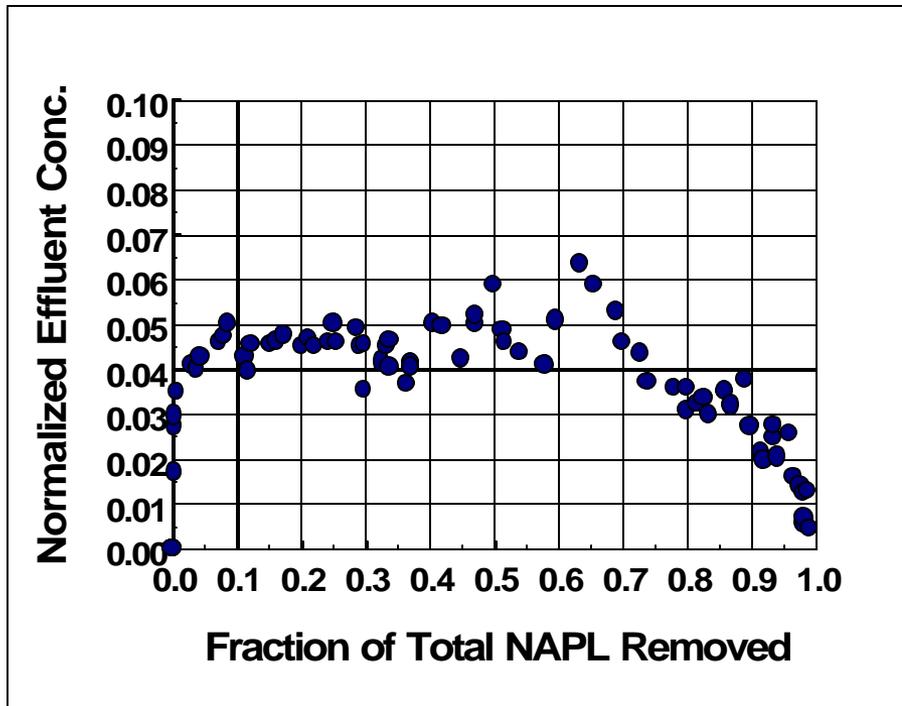


When is source mass depletion warranted?



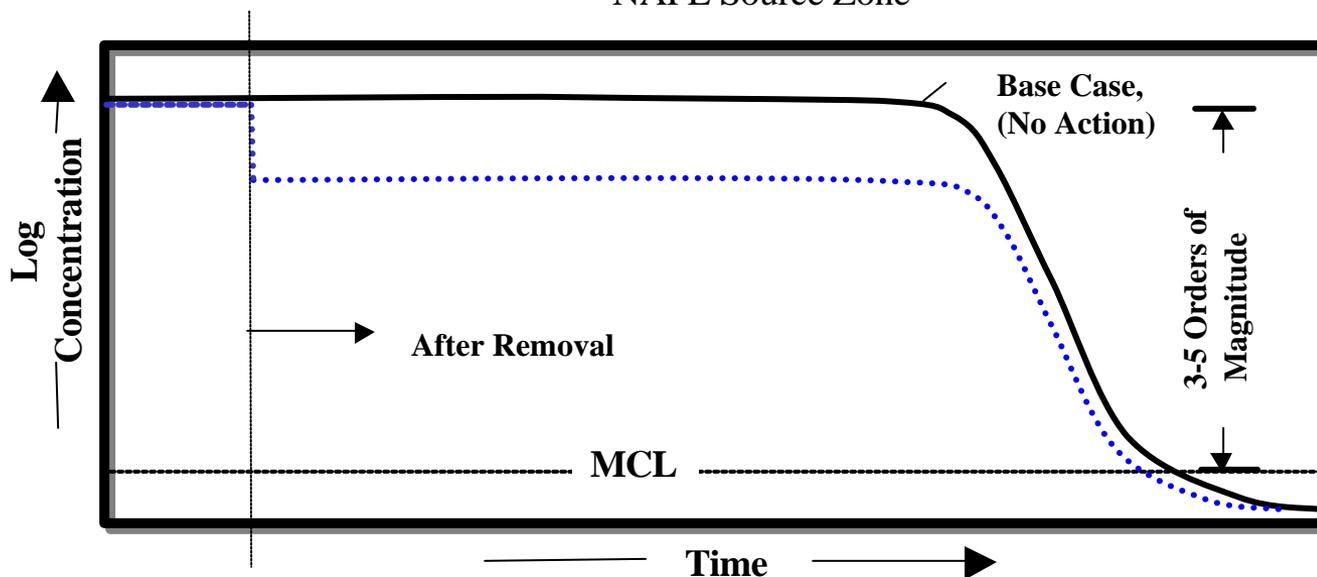
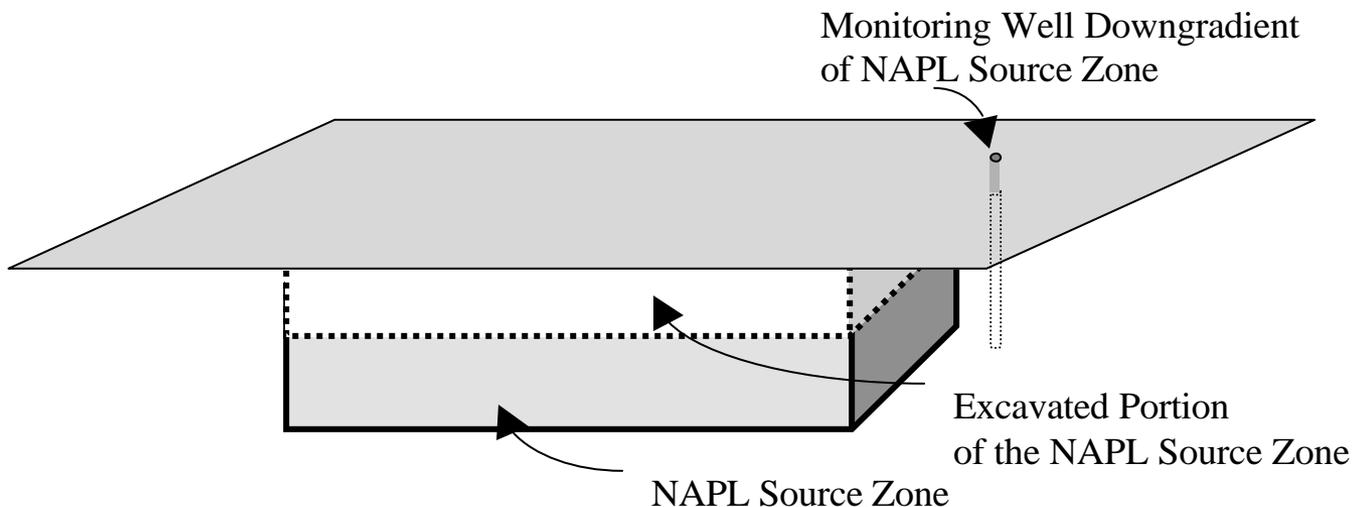


Type A Behavior



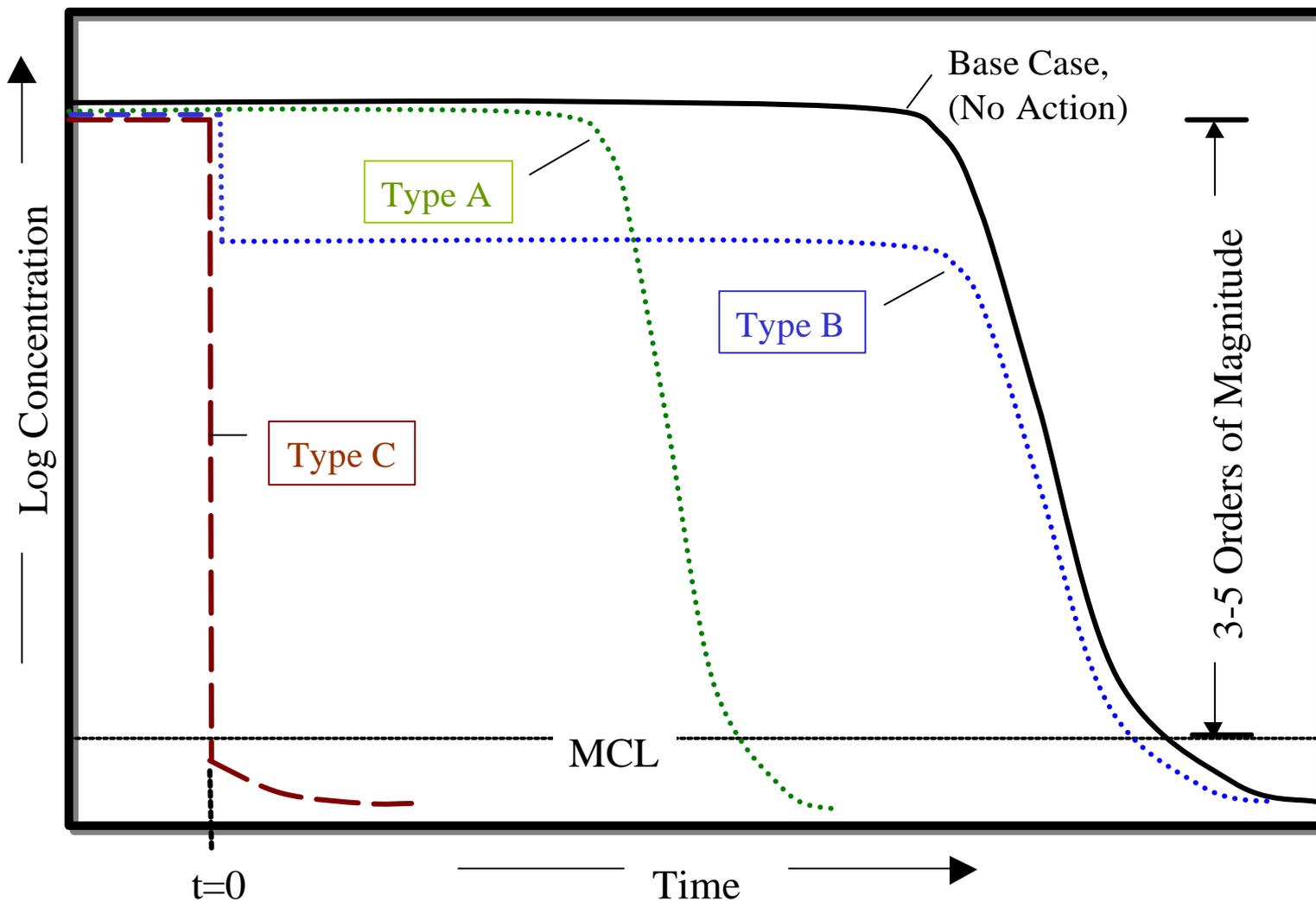


Type B Behavior



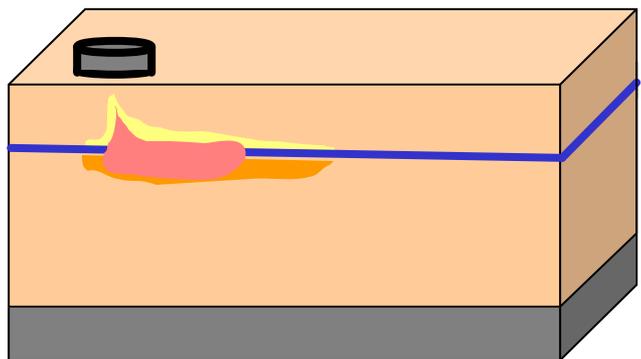


A Priori analysis - emissions prediction





What are the benefits of source depletion ?



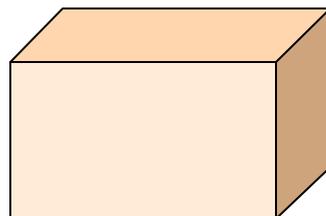
- Reduced potential for NAPL migration (**Type A**)
- Reduced source longevity (**Type A**)
- Enhanced plume attenuation due to reduced loading (**Type B**)
- Reduced loading to receptors (e.g. a well or stream) (**Type B**)
- Near-term attainment of maximum contaminant levels (MCLs) in source zone (**Type C**)



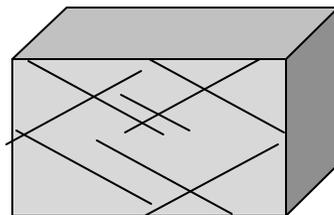
How does geology control potential for success?

Primary Representative Geologic Elements

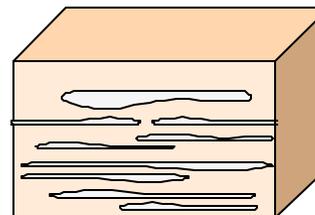
Granular Media with Low Heterogeneity
(e.g. eolian sands)



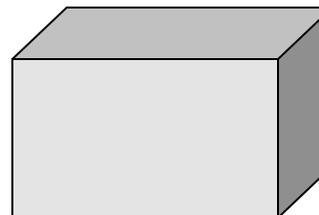
Fracture Media with Low Matrix Porosity
(e.g. crystalline rock)



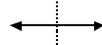
Granular Media With Moderate to High Heterogeneity
(e.g. deltaic deposition)



Fracture Media with High Matrix Porosity
(e.g. limestone or sandstone)



Source = NAPL

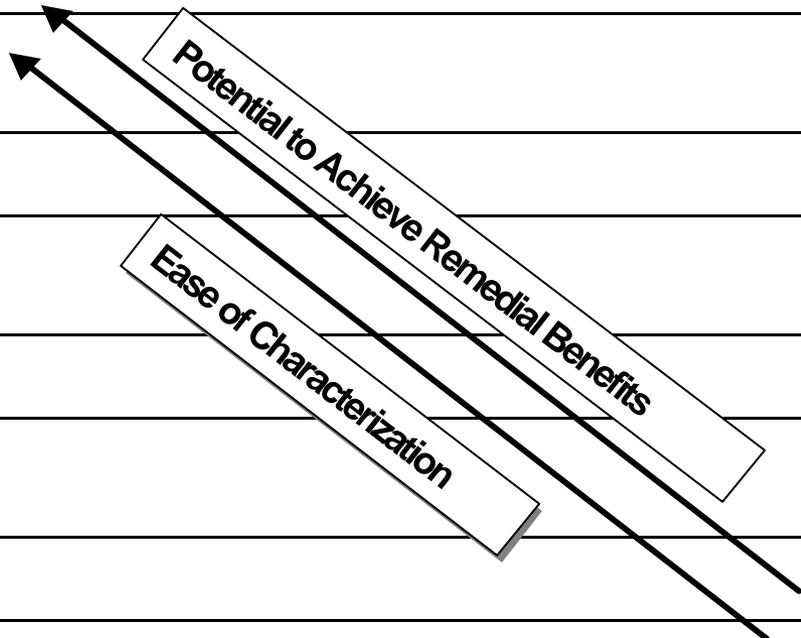


Source = NAPL and Matrix Diffusion



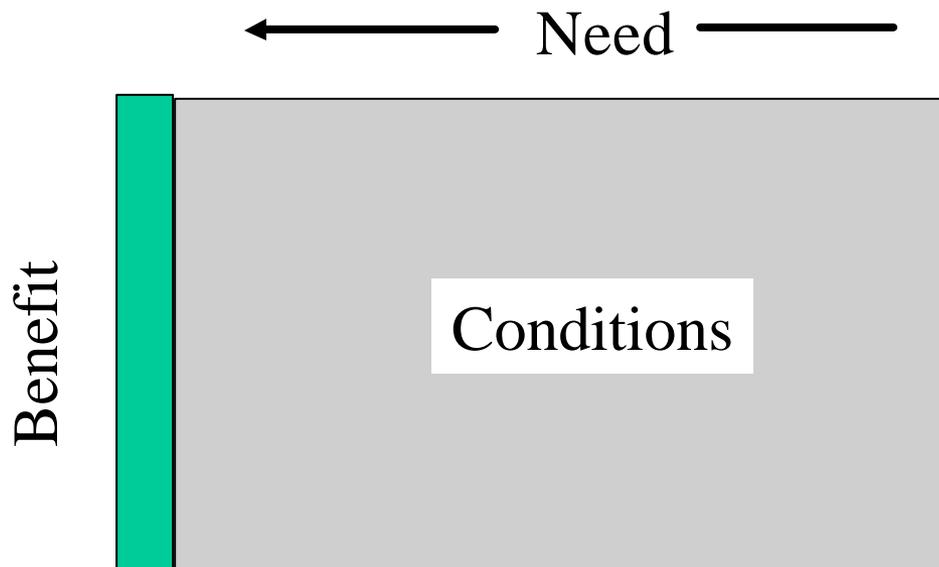
Factors that control potential for success

			Anthropogenic Factors	
			_____ Size of Release-Site →	
			_____ Degree of Surface Interference →	
Geologic Factors	Granular Porous Media w/ Low Heterogeneity (e.g. Beach and, eolian deposits)	Suspended DNAPL Zones		
		Basal DNAPL Zones		
	Granular Porous Media w/ High Heterogeneity (e.g. Deltaic, glacial, and alluvial fan deposits)	Suspended DNAPL Zones		
		Suspended DNAPL Zones		
	Fractured Rock w/ High Matix Porosity (e.g. Limestone shale, sandstone)	Integrated Frac. Network		
		Independent Frac. Network		
	Fractured Rock w/ Low Matrix Porosity (e.g. Crystalline rock)	Integrated Frac. Network		
		Independent Frac. Network		





Need for source depletion as a function of conditions and desired benefits



Draft – Developed by Chuck Newell and Tom Sale for the
EPA Orlando DNAPL Meeting 2/2002

DNAPL REMEDIAL BENEFITS ¹	<u>MORE NEED</u> FOR SOURCE DEPLETION 		<u>LESS NEED</u> FOR SOURCE DEPLETION 
Reduce potential for DNAPL migration as separate phase	1a. Expanding mobile DNAPL Zone (probably rare at chlorinated solvent sites) ² <i>(containment addresses this problem too)</i>	1b. Free-Phase DNAPL present but stable in stratigraphic traps	1c. Immobile, residual DNAPL Zone
Reduce source longevity and reduce long-term management requirements	2a. High life-cycle containment cost (for example, containment Net Present Value (NPV) >> cost of remediation) 3a. Low reliability of containment system 4a. High resource value that cannot be used due to DNAPL (for example, sole-source aquifer OR Well Yield > 144,000 gpd with TDS < 3000 mg/L) ³ 5a. High probability of a meaningful reduction in time to reach MCLs (for example, small sites with low complexity)	2b. Moderate life-cycle containment cost 3b. Moderate reliability of containment system 4b. Moderate resource value 5b. Moderate probability of a significant reduction in time to MCLs	2c. Low life-cycle containment cost (for example, containment Net Present Value (NPV) << cost of remediation) 3c. High reliability of containment system 4c. Low resource value (for example, resource not being used AND either Total Dissolved Solids > 10,000 mg/L or Well Yield < 150 gpd) ⁴ 5c. Low probability of meaningful reduction in time to reach MCLs (for example, large releases at complex sites)
Near-term enhanced natural attenuation due to reduced dissolved phase loading	6a. Expanding dissolved phase plume (source loading > assimilative capacity) <i>(containment addresses this problem too)</i>	6b. Stable dissolved phase plume (source loading ~ assimilative capacity)	6c. Shrinking dissolved phase plume (source loading < assimilative capacity)
Near-term reductions in dissolved phase loading to receptors (e.g., a well or a stream)	7a. Receptor impacted now or impacted soon (for example, < 2 years travel time) ⁵ <i>(containment addresses this problem too)</i>	7b. Potential longer-term risk to receptor (for example, >2 years travel time)	7c. No risk to receptors now or in the future
Near-term attainment of MCLs	8a. Need for rapid cleanup (for example, impending property transfer)	8b. Limited need for rapid cleanup	8c. No near-term need for cleanup (for example, no risk, no users of resource)
Intangibles	9a. Desire for active remedy; desire to test new technologies; desire to reduce stewardship burden on future generations.	9b. Neutral on intangible issues.	9c. Desire for low-impact remedy; desire to use proven technologies; desire to not expend financial resources for limited benefit.

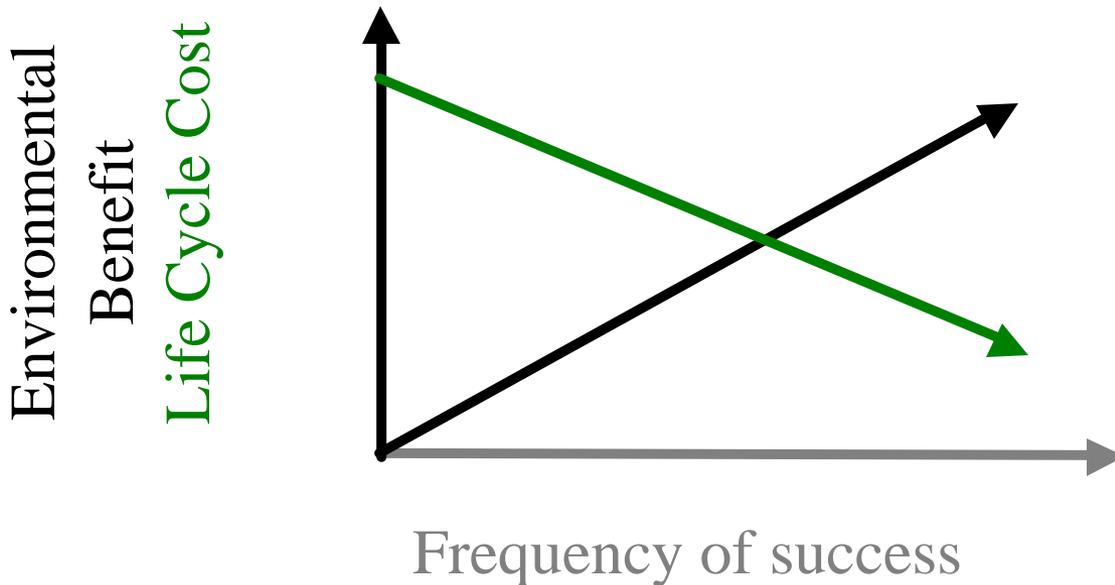


Retrospection – Reasons things don't always work out

- **Unrealistic goals**
- **Unrecognized technology limits**
- **Flawed source or problem definition**
- **Chasing nonexistent problem**
- **Doing things solely to meet expectations for action**
- **Doing what others do**



Increased success results in greater environment benefit and lower life cycle costs



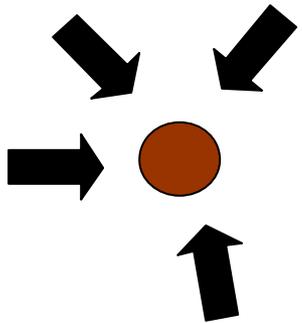


Path forward?

- Long Term - Follow the progress of ongoing “good decision” initiatives
- Near Term - Optimize potential for success by:
 - Establishing goals that are attainable and beneficial
 - Understanding the condition specific limitation of technologies
 - Prioritizing source depletion actions based on potential for success and attainable benefits
 - Build consensus among stakeholders as to benefits and costs



Convergence



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