United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington, DC 20460

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May 1993

EPA

Seminar on Regional Considerations for Dense Nonaqueous Phase Liquids at Hazardous Waste Sites: Implementation and Enforcement Issues

Presentation Slide Hardcopy

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Table of Contents

Acronym List

ACL	Alternate Concentration Limits
AM	Action Memorandum
ARAR	Applicable or Relevant and Appropriate Requirements
DNAPL	Dense Nonaqueous Phase Liquids
EA	Environmental Assessments
EE/CA	Engineering Evaluation/Cost Analysis
EIS	Environmental Impact Statements
FS	Feasibility Study
GW	Ground Water
HSCD	Hazardous Site Control Division
LNAPL	Light Nonaqueous Phase Liquids
MCL	Maximum Contaminant Levels
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priority List
OE	Office of Enforcement
OERR	Office of Emergency and Remedial Response
ORD	Office of Research and Development
OSW	Office of Solid Waste
OSWER	Office of Solid Waste and Emergency Response
OWPE	Office of Waste Programs Enforcement
POC	Points of Compliance
PRP	Potentially Responsible Parties
RD/RA	Remedial Design/Remedial Action
RED	RCRA Enforcement Division
RI	Remedial Investigation
ROD	Record of Decision
SACM	Superfund Accelerated Cleanup Model
SAP	Sampling and Analysis Plan
SE	Site Evaluation
SOW	Statement of Work
TI	Technical Impracticability

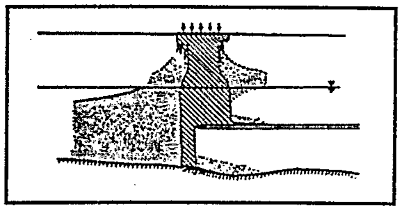
DNAPL Site Assessment Study

Randall W. Breeden
Geohydrologist
Hazardous Site Control Division
Office of Emergency and Remedial Response
U.S. Environmental Protection Agency, Washington, DC

Randall W. Breeden is a geohydrologist with the Hazardous Site Control Division of the Office of Emergency and Remedial Response (Superfund). He received a B.S. in soil science from Purdue University and an M.S.E.S. in water resources from Indiana University. His technical expertise is in the assessment of the design and operation of CERCLA and RCRA ground-water monitoring systems, characterization of subsurface hydrostratigraphy, and evaluation of field sampling and analysis programs. He has been a project manager for all aspects of field operations for site characterization efforts, and has performed technical evaluations of more than 40 ground-water monitoring and remediation systems.

Prior to joining EPA, Mr. Breeden was a vice president and senior project manager for a major environmental consulting firm where he provided support to private and public clients for ground-water remediation projects.

DNAPL Site Assessment Study



Randall W. Breeden
Office of Emergency and Remedial Response

Outline

1. Background
2. DNAPL Study Approach
3. Methods of Data Collection
4. DNAPL Study Results
5. Conclusions

Background

Reason for the study:

- Analysis of pump & treat technology
- Nineteen Case Study (1989)
- Twenty-Four Case Study (1991)
- Published reports

Background

Goal of this Study

Estimate pervasiveness of DNAPL contamination in subsurface at Superfund sites nationwide

Background

Purpose

Provide technical basis for evaluating ground-water remediation policy for Superfund program

Background

Possible Extent of DNAPLs

- **U.S. Solvent Production (in pounds):**
  - **15 billion — 1986**
  - **29 billion — 1990**
- **NPL Characterization Database:**
  - **85% of Superfund sites have ground-water contamination**
  - **Solvents reported as waste materials at 66% of sites**

Background

Possible Extent of DNAPLs
(Continued)

- **7 of the top 10 chemicals detected in ground water at 183 hazardous waste sites were DNAPL chemicals**

(Plumb and Pitchford, 1985)

Frequency of Detection of Most Common Organic Contaminants at Hazardous Waste Sites (USEPA, 10/17/91; and Plumb and Pitchford, 1985).

RANKING BASED ON NUMBER OF SITES AT WHICH ORGANIC CONTAMINANT WAS DETECTED IN ANY MEDIUM (USEPA, 10/17/91)	ORGANIC CONTAMINANT	DNAPL?	PERCENTAGE OF 1300 SITES AT WHICH CONTAMINANT WAS DETECTED IN ANY MEDIUM (USEPA, 10/17/91)	RANKING BASED ON NUMBER OF SITES AT WHICH ORGANIC CONTAMINANT WAS DETECTED IN GROUNDWATER (PLUMB AND PITCHFORD, 1985)	PERCENTAGE OF 183 SITES AT WHICH CONTAMINANT WAS DETECTED IN GROUNDWATER (PLUMB AND PITCHFORD, 1985)
1	Toluene	No	60.5	2	31.15
2	Trichloroethene	Yes	57.3	1	34.43
3	Methylene Chloride	Yes	54.7	3	31.15
4	Benzene	No	53.2	7	27.32
5	Tetrachloroethene	Yes	51.8	4	31.15
6	Ethylbenzene	No	47.5	11	25.14
7	1,1,1-Trichloroethane	Yes	47.1	9	26.78
8	Chloroform	Yes	45.4	10	25.14
9	Xylenes	No	44.3	--	--
10	bis(2ethylhexyl) phthalate	No	41.8	6	28.42
11	Acetone	No	40.0	20	12.02
12	1,1-Dichloroethane	Yes	39.7	5	28.42
13	Phenol	No	39.4	14	19.13
14	trans-1,2-Dichloroethene	Yes	38.4	8	27.32
15	Napthalene	No	35.5	18	12.57
16	1,1-Dichloroethene	Yes	33.2	13	20.22
17	1,2-Dichloroethane	Yes	32.7	12	21.31
18	Vinyl Chloride	No	32.1	15	16.39
19	2-Butanone	No	31.8	--	--
20	Chlorobenzene	Yes	31.4	16	16.39
23	Dibutyl Phthalate	Yes	30.3	17	15.30
40	Chloroethane	No	18.1	19	12.57

DNAPL Study Approach

- Informal surveys indicate DNAPLs directly observed at <10% of Superfund sites nationwide.
- DNAPLs usually observed accidentally and not considered in many investigations.
- Study used *indirect indicators* of DNAPL presence from site history and field investigations.

Approach

Data Collection Strategy

- Consistent site information for comparative analysis
- Information from broad spectrum of sites, those with high & low DNAPL probability
- Enough detailed information on known DNAPL sites to test assumptions regarding indirect indicators

Approach

Data Analysis Strategy

- Develop system to estimate DNAPL probability at each site.
- Evaluate the usefulness of indirect indicators.

Approach

Data Analysis Strategy
(Continued)

- Evaluate relationship of:
  - site use type
  - site contamination
  - hydrogeological setting

  to the likelihood of DNAPL presence.
- Extrapolate results to entire group of Superfund sites.

Methods of Data Collection

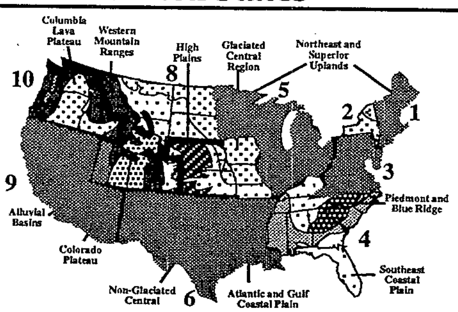
- Regions Selected: 1, 3, 5, 6, and 9
  - Geographic diversity
  - Range of geological settings
  - Range of site uses and contaminant types

Methods of Data Collection
(Continued)

- Site Selection within Region
  - Remedial investigation complete or equivalent amount of site data
  - Organic contamination of ground water
  - Site use profile representative of region

Hydrogeological Regions of the United States

Methods



From Heath, 1984

Number of Sites Evaluated

Methods

Region	*# of Sites Studied*	*# of Sites Evaluated*
1	84	79 (94%)
3	162	92 (57%)
5	266	74 (28%)
6	74	23 (31%)
9	126	42 (33%)
Total	712	310 (44%)

Information Collected

Methods

Standardized survey format based on EPA Fact Sheet

- Site History Information
  - Historical site use and industrial or waste disposal practices
  - Substances and chemicals on site historically
  - Known releases of nonaqueous chemicals

Methods

Information Collected
(Continued)

- **Site Contamination Information**
  - Observations of NAPLs
  - Concentrations of DNAPL-related compounds in ground water
  - Patterns of ground-water contamination suggesting subsurface, nonaqueous source

Methods

Information Collected
(Continued)

- **Geological Information**
  - Depth to water table
  - Depth to bedrock
  - Detailed descriptions of unconsolidated materials and bedrock

DNAPL Study Results

Ground-Water Contamination Profile

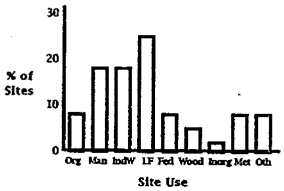
	# Sites in Regions 1, 3, 5, 6, & 9	*# Sites Evaluated*
No organic contaminants in ground water	77	0 (0%)
Organic contamination of ground water with no direct observation of DNAPL	591	270 (46%)
DNAPL observed below water table	44	40 (90%)
Totals	712	310 (44%)

Results

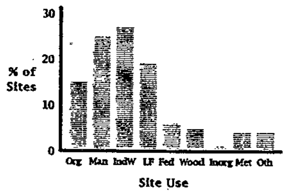
Site Use Profile

How representative are sites studied?

Site use in Regions 1, 3, 5, 6, and 9



Site use for sites studied



Results

DNAPL Indications from Site History

	# Sites	% Sites
Industrial facilities associated with use or disposal of DNAPLs	198	64%
DNAPL-related *substances and chemicals* (>5 drums/yr)	233	75%
Operations and industrial and waste management practices with likelihood of DNAPL release	281	90%

Results

Site History

(Continued)

	# Sites	% Sites
Known releases of DNAPLs	191	62%
Known releases of DNAPLs in *nonaqueous form*	124	40%

Results

Site History Ranking Method

Likelihood of subsurface DNAPL:

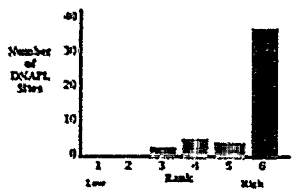
HIGH ↕ LOW

6	Known releases of DNAPL substances or chemicals in a nonaqueous form
5	
4	Combinations of positive indicators
3	
2	No known DNAPL-related practices, substances and chemicals, or releases
1	

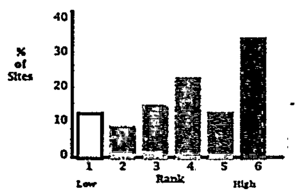
Results

Site History Ranking

A. Known DNAPL Sites (40)



B. Remaining Sites (270)



Results

Summary of Findings from Site History Information

- Ranking system adequately predicts high probability of DNAPL release for known DNAPL sites
- Based on site history information, about 80% of sites have medium to high probability of DNAPL release

Results

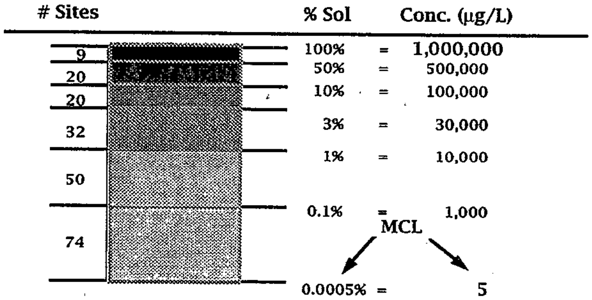
DNAPL Indications from Ground-Water Data

Maximum concentrations of DNAPL chemicals in ground water expressed as percentage of their solubilities might be more indicative of problem.

TCE @ 20 mg/l = 2% solubility (Sol = 1,000 mg/L)
PCE @ 20 mg/l = 13% solubility (Sol = 150 mg/L)

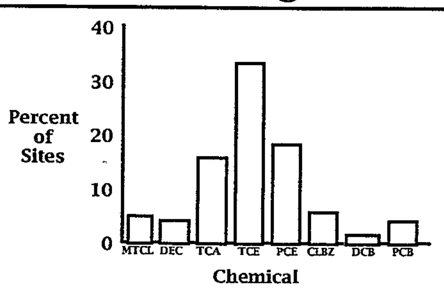
Results

Percentage Solubilities Observed for TCE



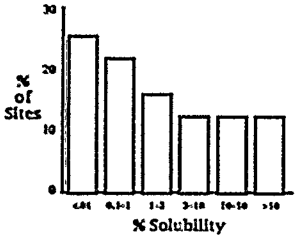
Results

DNAPL Chemicals Observed at Highest Percentage Solubility



Results

Ranges of Maximum Percent Solubilities for DNAPL Chemical in Ground Water



Maximum % Sol Sites	# Sites	%
>1%	161	60
>10%	74	27
>50%	37	14

Results

Ground-Water Contamination Ranking Method

Likelihood of subsurface DNAPL: VERY HIGH ↔ HIGH ↔ MED ↔ LOW

Concentrations of DNAPL chemicals:

6	One @ >50% sol. or Two @ >25% sol. or Three @ > 15% sol.
5	
4	
3	One @ 1–3% sol. or Two @ 0.5–1.5% sol. or Three @ 0.3–1% sol.
2	
1	No DNAPL chemicals or <0.1% sol.

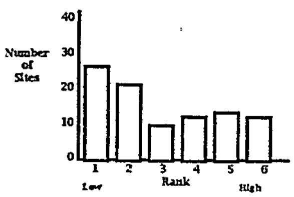
Results

Ground-Water Contamination Ranking

A. Known DNAPL Sites (40)

- All receive the highest ground-water contamination rank (6)

B. Remaining Sites (270)



Results

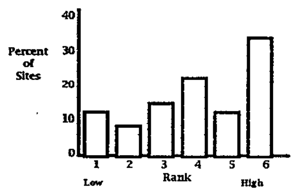
Summary of Findings from Ground-Water Data

- Most useful indicator is maximum percentage solubility of DNAPL chemicals detected in ground water.
- Based on ground-water concentration data, ~60% have medium to very high probability of DNAPL.

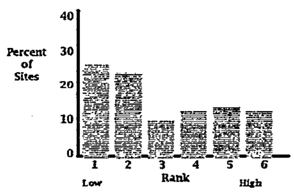
Results

Comparison of Ranking Factors

A. Site History Rank



B. Ground-Water Contamination Rank



Results

Combining the Site History & Ground-Water Contamination Ranks

Site Hist Rank	Ground-Water Contam Rank 6	5	4	3	2	1
6	Hi	Hi	Hi	Med	Med	Med
5	Hi	Hi	Hi	Med	Med	Lo
4	Hi	Hi	Med	Med	Lo	Lo
3	Hi	Hi	Med	Med	Lo	Lo
2	Hi	Hi	Med	Med	Lo	Lo
1	Hi	Hi	Med	Med	Lo	Lo

Results

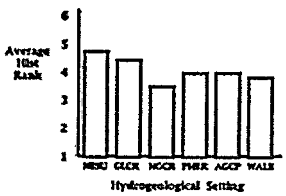
Summary of Combined Ranks

Likelihood of Subsurface DNAPL	Number of Sites	Percent of Sites
Definite	40	13%
High	109	35%
Medium	66	21%
Low	95	31%

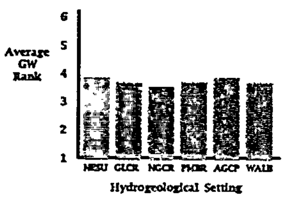
Results

Relationship of Hydrogeological Setting to Likelihood of Subsurface DNAPL

A. Site History Rank



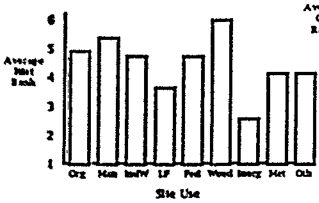
B. Ground-Water Contamination Rank



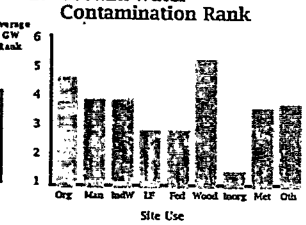
Results

Relationship of Site Use to Likelihood of Subsurface DNAPL

A. Site History Rank



B. Ground-Water Contamination Rank



Effect of Hydrogeological Setting

Results

- No distinguishable difference in DNAPL likelihood based on geological setting
- Implication: if DNAPLs are suspected based on site history, their presence should be investigated in all cases, regardless of geological setting

(Heath)

Site Use Findings

Results

- Uses with a higher likelihood of subsurface DNAPL:
  - Wood treatment
  - Organic chemical production
  - General manufacturing
  - Industrial waste disposal

Site Use Findings *(Continued)*

Results

- Uses with a lower likelihood of subsurface DNAPL:
  - Combination landfills
  - Primary metals industry/mining
  - Inorganic chemical production

Site Use Findings *(Continued)*

Results

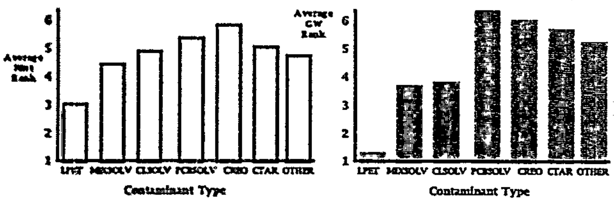
- Uses for which site use relationship is not clear from our study:
  - Federal facilities (high based on site history and low based on ground water data)

Relationship of Contaminant Type to Likelihood of Subsurface DNAPL

Results

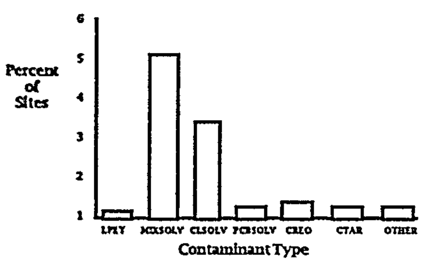
A. Site History Rank

B. Ground-Water Contamination Rank



Distribution of Contaminant Type

Results



Results

Summary for Site Contaminant Type

- Creosote, Coal Tar, and PCB Sites:
  - Small proportion of sites in Superfund
  - Easily linked with specific site uses
  - High likelihood of subsurface DNAPL
  - Relatively small impact in terms of volume of subsurface contaminated

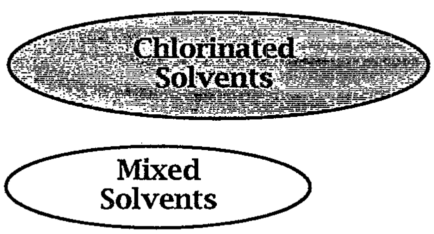
Results

Summary for Site Contaminant Type *(Continued)*

- Chlorinated Solvent & Mixed Solvent Sites:
  - Majority of sites in Superfund
  - Associated with wide range of site uses
  - Range in likelihood of subsurface DNAPL
  - Relatively large impact in terms of volume of subsurface contaminated

Results

Average Plume Dimensions by Contaminant Type



Chlorinated Solvents: L = 4,500 ft, W = 1,500 ft, D = 92 ft

Mixed Solvents: L = 2,800 ft, W = 1,000 ft, D = 70 ft

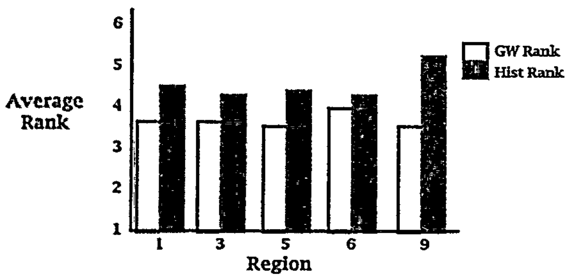
Results

Average Plume Dimensions by Contaminant Type *(Continued)*

Creosote Coal tar	L = 1,500 ft W = 1,200 ft D = 26 ft
PCB	L = 600 ft W = 250 ft D = 20 ft

Results

Regional Distribution of DNAPL Probability



Results

Estimated Scope of the DNAPL Problem

Extrapolation to 712 NPL sites in Regions 1, 3, 5, 6, & 9.

Known DNAPL sites	5%	60%
High (very likely)	35%	
Medium (warrant further investigation	20%	
Low DNAPL likelihood	30%	40%
No organics in ground water	10%	

Conclusions

- Potential for subsurface DNAPL will be consideration at majority of Superfund sites.
- May have underestimated DNAPL potential because data not specific to DNAPLs.

Conclusions *(Continued)*

- Future research efforts should focus on chlorinated solvent and mixed solvent sites, as these constitute the majority of Superfund sites and present the greatest challenge with respect to site characterization and remediation.

Ground-Water Remediation Policy Directive and Superfund Accelerated Cleanup Model (SACM) Discussion

Kenneth A. Lovelace
Environmental Engineer
Hazardous Site Control Division
Office of Emergency and Remedial Response
U.S. Environmental Protection Agency, Washington, DC

Kenneth A. Lovelace is an environmental engineer with Superfund's Hazardous Site Control Division. He received a B.S. in geology from the University of California, Davis, and an M.S. in civil engineering from Colorado State University.

Mr. Lovelace has more than 14 years of professional experience in hydrology, as a consultant and as a senior engineer for an oil pipeline company. His primary area of responsibility at EPA is developing national policy for characterization, cleanup, and management of ground-water contamination at hazardous waste sites.

Ground-Water Remediation Policy Directive and SACM Discussion

Kenneth A. Lovelace, P.E., P.G.
Office of Emergency and Remedial Response

Ground-Water Remediation Policy Directive

- Background
- Site Investigation
- DNAPL Characterization
- Early Actions
- Remedy Design

Background

- Ground-water contamination is present at:
  - 85% of Superfund National Priority List (NPL) sites
  - 50% of permitted RCRA land disposal facilities

Background *(Continued)*

- Subsurface NAPLs, especially DNAPLs, will significantly impact ground-water remediation
  - Are long-term sources of contaminants
  - Control of sources needed to achieve cleanup standards

Background *(Continued)*

- OSWER Policy Directive, May 27, 1992
- "Considerations in Ground-Water Remediation at Superfund Sites and RCRA Facilities - Update"
- Affects CERCLA Remedial Action, RCRA Corrective Action

Site Investigation

- Evaluate likelihood of NAPL occurrence *early*
  - Use DNAPL fact sheet
  - Historical and existing field data
  - During pre-remedial work, if possible
  - Needed for planning site investigation

Site Investigation *(Continued)*

- If NAPLs likely, further characterization should:
  - Suggest areas where LNAPLs or DNAPLs might be present
  - Confirm NAPL presence
  - Estimate NAPL extent, to extent possible

Site Investigation *(Continued)*

- Why is characterization needed?
  - Define sources of contaminants
  - Estimate flow paths and travel time
  - Identify possible remedial strategies

DNAPL Characterization

- Locate geologic DNAPL traps
  - Topographic valleys in bedrock surface
  - Traps formed by geologic features
- Focus efforts on DNAPL accumulations
  - More likely to be found
  - Depends on site conditions, exploration methods

DNAPL Characterization
(Continued)

- Locating DNAPL in small discontinuities is very difficult
- Caution should be exercised
- Can be combined with other investigation efforts

Early Actions

- Actions initiated before remedial investigation (RI) is completed. Removal or remedial actions.
- Focus of early actions is to:
  - Reduce site risks
  - Prevent exposure to contaminants
  - Minimize further migration
  - Control sources

Early Actions *(Continued)*

- Directive recommends
  - Early plume containment
  - Early extraction of free-phase NAPLs

Early Actions *(Continued)*

- Why are these actions important?
  - Protect surrounding aquifer
  - Protect wells or ecological resources
  - Free-phase is mobile fraction and is extractable
  - Much more effective to remove NAPL sources

Remedy Design

- Actions should be implemented in a *phased approach*
- Information gained from earlier phases is used to refine later phases (also "smart approach")

Remedy Design *(Continued)*

- Why is phased approach useful?
  - Integrates data collection with site conceptual model
  - Integrates investigation and remedial activities
  - Integrates early actions with long-term actions
  - Provides flexibility to respond to new information
  - Minimizes uncertainty between phases

Remedy Design *(Continued)*

- **Design should include monitoring to:**
  - Determine effectiveness of action
  - Suggest remedy improvements
  - Refine predicted cleanup time

Remedy Design *(Continued)*

- **Design should allow for *modification* of remedy after implementation to:**
  - Improve effectiveness
  - Reduce remediation time
  - Respond to new information

Ground-Water Remediation and SACM

- Key SACM elements
- Long-term actions
- Early actions
- SACM and Policy Directive
- Remedial/removal actions

Key SACM Elements

- Superfund Accelerated Cleanup Model (SACM)
- Regional Decision Team used to:
  - Integrate investigation and assessment activities
  - Coordinate Superfund program elements
  - Coordinate early state and community involvement

Key SACM Elements
(Continued)

- Combine early and long-term actions

Time Frame	*Site Response*
Under 5 years +/-	*Early actions* to expediently reduce site risks. Integration of early actions, with site investigation.
Over 5 years +/-	*Long-term* actions for longer or more complex remediation, such as environmental restoration.

Long-Term Actions

- Types of action:
  - Restoration to cleanup levels
  - Complex source control
  - Maintaining plume and/or source containment
  - Monitoring

Early Actions

- Types of action:
  - Preventing exposure to contaminants
  - Preventing further migration
  - Controlling sources - soils, NAPLs
  - Field testing of restoration technologies

SACM and Policy Directive

- Use of early actions is a key recommendation of Policy Directive.
- Integration of early and long-term actions follows "phased approach" recommended.
- Early actions include CERCLA remedial or removal actions.

Remedial/Removal Actions

- Remedial actions
  - Sites must be on National Priorities List (NPL)
  - No statutory time or cost limitation
  - Early actions are generally interim actions
  - ARARs must be met or waived
  - Fund/state cost share required (90%/10%)

Remedial/Removal Actions
(Continued)

- Removal actions
  - Sites can be pre-NPL or NPL
  - Three types: emergency, time critical, non-time critical
  - Limited to 12 months *and* $2 million, some exemptions
  - ARARs must be met to extent practicable or waived
  - Fund/state cost share not required, but recommended

Remedial/Removal Actions
(Continued)

Remedial	*Removal*
Remedial Investigation (RI)	(Removal) Site Evaluation (SE)
Sampling and Analysis Plan (SAP)	Sampling and Analysis Plan (SAP)*
Feasibility Study (FS)	Engineering Evaluation/Cost Analysis (EE/CA)*
Record of Decision (ROD)	Action Memorandum (AM)

** Non-time critical removals only.*

Technical Impracticability Project

Peter R. Feldman
Environmental Scientist
Hazardous Site Control Division
Office of Emergency and Remedial Response
U.S. Environmental Protection Agency, Washington, DC

Peter R. Feldman is an environmental scientist in Superfund's Hazardous Site Control Division. Mr. Feldman received a B.A. in geology from Wesleyan University and an M.S. in hydrology from the University of Arizona.

Prior to joining EPA in 1991, Mr. Feldman worked in the consulting field on environmental impact and engineering studies, water-supply development projects, and hazardous waste investigations. His current responsibilities at EPA include development of policy and guidance related to ground-water remediation for the Superfund program in addition to site-specific consultations at various NPL sites.

Technical Impracticability Project

Peter R. Feldman
Office of Emergency and Remedial Response

Purpose and Overview

- Background and goals
- Technology limitations and role of TI
- Specifics of draft guidance
- Discuss issues; get feedback

Background

- Technical studies
  - 19 and 24 site studies
  - Ongoing research on pump & treat
  - DNAPL site survey

Background *(Continued)*

Use of TI waivers discussed in:

- NCP, NCP preamble
- 1988 OERR ground-water guidance
- 1989 Cannon ground-water remediation memo
- 1990 OERR/OWPE ROD language memo
- 1992 Clay ground-water remediation memo

NCP Expectation for Ground-Water Cleanup

". . . EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site."

§300.430(a)(1)(iii)(F)

CERCLA ARAR Waivers

- Interim action
- Greater risk
- Technical impracticability
- Equivalent standard of performance
- Inconsistent state application
- Fund balancing

(See CERCLA 121(d)(4)(c))

Existing Guidance on TI

NCP criteria:

". . . engineering feasibility and reliability, with cost generally not a major factor unless compliance would be inordinately costly."

Definition of "Impracticable"

Impracticable: incapable of being performed or accomplished by the means employed or at command.

Impractical: not wise to put into or keep in practice or effect; not pleasing to common sense or prudence.

(from Webster's 3rd International Dictionary, 1971)

Existing Guidance *(Continued)*

On "reasonable time frame":

NCP Preamble: Very rapid (1 to 5 years) to extended (several decades)

OERR Guidance (1988): "Less than 100 years"

Existing Guidance *(Continued)*

On "engineering feasibility," 1988 Guidance considers:

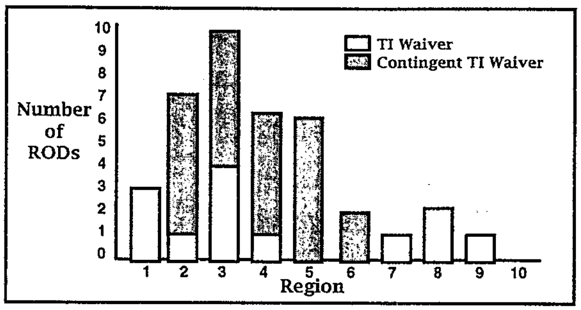
- **Widespread plumes/unidentified sources**
- **Hydrogeologic constraints (e.g., fractured rock, karst, low permeability)**
- **Contaminant characteristics (e.g., DNAPLs)**
- **Sorption/desorption kinetics**

Past Use of TI Waivers

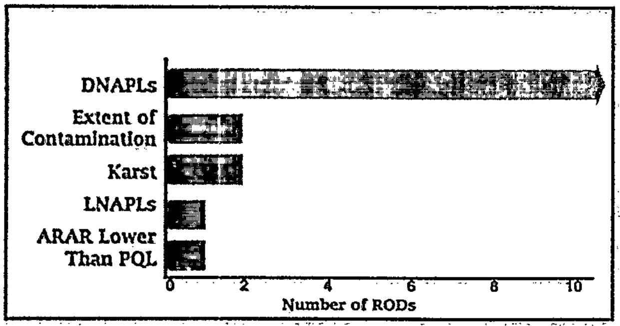
- **Waiver in ROD**
  - **Used 13 times**
- **Contingency TI waiver in ROD**
  - **Used 24 times**
- **Post-ROD waivers/contingencies**
  - **3 cases**

Use of TI Waivers

(through 1992)



Reasons for TI



Status of TI Guidance

- Draft stage only
- Regional/state review Summer '93
- Followed by EPA senior management review, final revisions

Goals of Guidance

- Consistency across regions and programs
- Address growing volume of TI decisions
- Clarify decision criteria and data requirements

Goals of Guidance *(Continued)*

- Encourage better site characterization and remedy performance monitoring
- Clarify legal and administrative issues
- Develop approach for selecting alternative remedial strategies

Ground-Water Remedy Decision Framework

Uncertainty in GW Remedy Decisions

- Remediation outcome difficult to predict
- NCP provides flexibility needed to reduce uncertainty

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Uncertainty in GW Remedy Decisions *(Continued)*

Can resolve uncertainty through:

- Thorough site characterization (NAPLs)
- Phased approach to characterization and remediation
- Early and interim actions (SACM)
- Monitor and analyze data
- Base final cleanup decisions on more complete knowledge

Uncertainty and Decision Documents

Available Options:

Little to no uncertainty ⇨	ARAR-Compliant ROD or TI Waiver in ROD
Moderate uncertainty ⇨	Contingent TI waiver in ARAR-Compliant ROD
High uncertainty ⇨	Interim Action ROD (no ARARs, or interim action waiver)

Approach for Evaluating TI

TI Waiver Application

Site________ needs a TI waiver because:

- ☐ **It will be *REALLY REALLY expensive* to clean it up, *or***
- ☐ **It will take a *REALLY long time* to clean it up**

Demonstrating TI: Factors to Consider

1. **Adequacy of site conceptual model**
2. **Hydrogeologic constraints**
3. **Contamination-related constraints**
4. **Degree and effectiveness of source control** ⇒

Demonstrating TI: Factors to Consider *(Continued)*

5. **Remedial action performance appraisal**
6. **Applicability of other technologies**
7. **Predictions of restoration timeframes**
8. **Cost estimate**

1. Site Conceptual Model

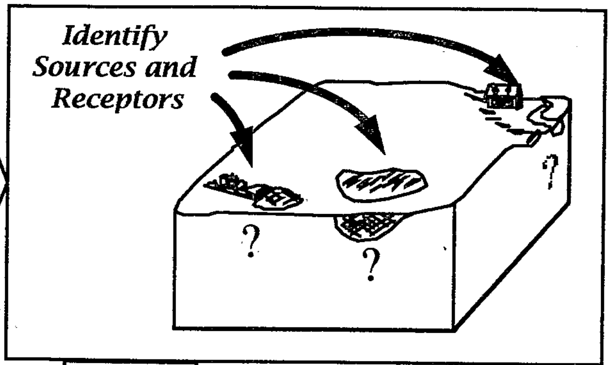
Develop using iterative approach

- Contaminant sources, properties, distribution
- Geology and hydrology
- Assumptions and hypotheses regarding transport, fate, remediation

Examples of Activities Providing Data for Model Development

Site Conceptual Model Development

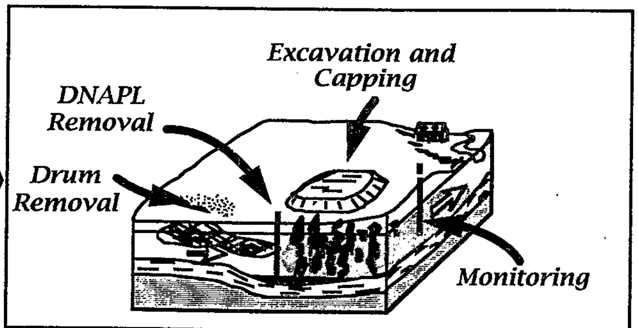
- Site background and history
- Preliminary site investigations



- Model used to scope detailed site investigation

Site Conceptual Model Development

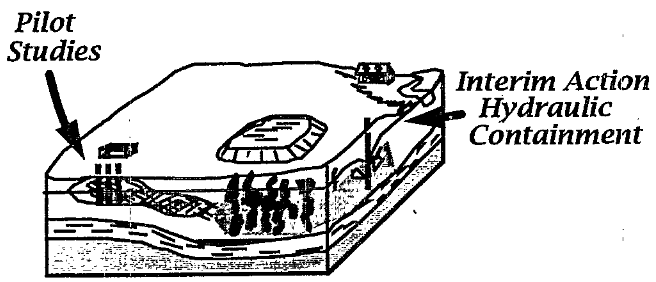
- Early action/ removal
- Site characterization (RI/FS, RFI, etc.)
- Removal of subsurface sources



- Model used to design pilot studies and subsurface actions

Site Conceptual Model Development

- Pilot studies
- Interim actions



Model used to:
- Evaluate potential for restoration (or TI)
- Develop treatment train concept/design

Site Conceptual Model Development

- Full-scale treatment
- Performance monitoring and evaluations

- Continued enhancement of conceptual model
- Enhancement or augmentation of remediation system, if required
- Further evaluation of restoration potential (or TI), if required

2. Hydrogeologic Constraints

Examples

- Heterogeneity
- Hydraulic conductivity
- Fracturing/solution features
- Depth

3. Contaminant-Related Constraints

- Phase (i.e., aqueous, nonaqueous)
- Distribution
- Physical properties (e.g., viscosity, density)
- Transport and fate (e.g., retardation, biodegradability)

4. Source Control

- Includes residual and free-phase NAPLs
- Removal, stabilization, isolation
- Monitoring to assess effectiveness

5. Remedy Performance Appraisal

- Suitability of technology or design
- Adequacy of monitoring
- Operational history; enhancements
- Trends in ground-water concentration

Trends in Ground-Water Concentration

- Aqueous plume contained/reduced?
- Rate of concentration decline?
- Dilution or natural attenuation responsible?
- Rebound during shutdown?

6. Applicability of Other Technologies

- Use of innovative technologies encouraged by statute
- Burden on PRP to demonstrate none applicable

7. Restoration Timeframes

- Not explicit TI decision criterion
- Predicted through modeling - inherent uncertainty
- Deemphasize threshold value for "reasonable" timeframe
- Useful for alternatives comparison or to indicate possible constraints

8. Cost

- Subordinate to protectiveness
- Legitimate consideration in "engineering feasibility"
- ARARs may not be subject to cost/benefit analysis

TI Evaluation Tools

- Literature
- Treatability studies and pilot systems
- Modeling
- Remedy performance appraisals ⇒

TI Evaluation Tools *(Continued)*

Other factors to consider

- Accurate evaluation might require installation of system
- Restoration potential might vary across site
- Use of treatment trains might be necessary

TI Review Process

- Decisions made by Regional Administrator
- HQ consultation at Division Director level
- Regional or ORD technical support role critical

Possible Outcomes of Review Process

- Decision package inadequate
- Install/enhance system to reach ARARs
- Install/enhance system to reach non-ARAR standard
- Maintain existing system to reach non-ARAR standard
- Use source control, institutional controls, natural attenuation

Alternative Remedial Strategies

NCP expectations

- Prevent further migration
- Prevent exposure
- Evaluate further risk reduction

Alternative Remedy Selection

- Nine criteria analysis of alternatives

Also consider:

- Current and future use
- Likelihood of exposure
- Availability of alternate supplies

Alternative Remedial Strategies

Suggested Approach

More preferable

1. Less stringent ARAR
2. Waive portion of site only
3. Site-specific cleanup levels
4. Remediate to extent practicable; focus on source control, containment, and exposure control

Less preferable

CERCLA ACLs

Alternate Concentration Limits can be used where:

- Contaminated ground-water discharges to surface water
- No statistically significant concentration increase
- Can prevent exposure to contaminated ground water

NCP Policy on ACLs

- ACLs not an entitlement, but a limitation on use of higher limits
- Remediation to ARARs must also be impracticable (nine criteria analysis)
- Where ACLs used, TI waivers not necessary

Summary

- Reduce uncertainty through phased approach
- Emphasize source control
- Detailed site characterization and performance monitoring needed

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Summary *(Continued)*

- TI Waivers used only where justified on engineering basis
- Distinguish between poorly designed systems and real problems
- Alternative remedial strategy must be established ⇒

Summary *(Continued)*

- Assess protectiveness and reliability
- Take further action if warranted

Enforcement Concerns

Matthew J. Charsky
Geologist
CERCLA Enforcement Division
Office of Waste Programs Enforcement
U.S. Environmental Protection Agency, Washington, DC

Matthew J. Charsky is a geologist in the Office of Waste Programs Enforcement. Mr. Charsky was responsible for the Oversight Guidance on PRP RI/FS which was issued in 1991 and for conducting the regional training to promote this guidance. He currently is completing a risk assessment evaluation to determine who will conduct future Superfund risk assessments. Mr. Charsky also has participated as the enforcement representative on numerous work groups and reviewed many guidance documents associated with ground-water and treatment technologies, particularly on technical impracticability, multi-source ground water, and available and potential treatment technologies for ground water.

Prior to joining EPA, Mr. Charsky worked at the Federal Energy Regulatory Commission where he developed and reviewed Environmental Impact Statements (EISs) and Environmental Assessments (EAs) under the National Environmental Policy Act (NEPA) for natural-gas pipeline construction projects nationwide.

Enforcement Concerns

Matthew J. Charsky
Office of Waste Programs Enforcement

Contacts

Matt Charsky, OWPE
CERCLA Enforcement Division
(703) 603-8931

Trish Gowland, OWPE
CERCLA Enforcement Division
(703) 603-8975

Kurt Lamber, OWPE
CERCLA Enforcement Division
(703) 603-8986

Overview

1. Program Consistency
2. Categories of Uncertainty
3. Available Options
4. What's Important
5. Current Technologies

Communication

Program Consistency

1. Superfund Delegation on TI Waivers for DNAPLs
2. Fund vs. Enforcement-Lead
3. Superfund vs. RCRA
4. OSWER vs. OE

Superfund Delegation

- Proposed remedies for sites warranting consultation concerning TI waivers for DNAPLs in ground water and soil is delegated at the Division Director's level in Headquarters

(Twenty-fourth Remedy Delegation Report – FY 1993, February 18, 1993)

Fund vs. Enforcement-Lead

- More enforcement-lead known or suspected DNAPL sites than fund-lead
- More enforcement-lead RODs with contingency language for TI than fund-lead
- Perception that ARAR waiver for TI gives a "greater advantage" to PRPs

Superfund vs. RCRA

1. Proposed Subpart S
2. Current Projects
3. Contacts

RCRA Framework

The *proposed* RCRA Corrective Action Rule "Subpart S"

Corrective Action for Solid Waste Management Units (SWMUs) at hazardous waste management facilities; (proposed Subpart S Rule 40 CFR 264.540, (a) and (b)) [FR July 27, 1990, Volume 55, Number 145]

RCRA Framework *(Continued)*

- Currently used as guidance
- Provides only the published discussion of TI in the RCRA program

Current Status of RCRA Program

RED & OSW	Working on TI (technical and process issues) via OERR work group and RCRA subgroup
OSW	Drafting a policy strategy for TI use
	Planned completion: FY93

Contacts

Rose Lew, OWPE
RCRA Enforcement Division
(202) 260-6720

Guy Tomassoni, OSW
Permits & State Programs Division
(703) 308-8622

Dave Bartenfelder, OSW
Permits & State Programs Division
(703) 308-8629

Consent Decree Language Addressing TI Waivers

Provide guidance regarding the use of *TI language* in Remedial Design/Remedial Action (RD/RA) consent decrees and statements of work (SOWs) involving remediation of ground water.

Focused Purpose

Address situations where *well-designed ground-water extraction systems* might not be able to *reduce the levels* of one or more contaminants to the *required performance standards* in a timeframe that EPA deems reasonable given the particular circumstances of the site.

Current Draft – Dated August 1992

Current Status

- Sample language, not model language
- No official inference
- Regional/HQ staff input in order to achieve all inclusive language
- Work group presently disbanded

Current Draft – Dated August 1992 *(Continued)*

- Outstanding issues:
  - Technical requirements
  - Judicial review

Contact:

Mary Andrews
Attorney – Advisor
Office of Enforcement
(202) 260-3109

Relating Timeframe of Identified/Suspected DNAPL to Categories of Uncertainty

1. During Negotiations
2. During Site Characterization
3. At Decision Document Stage
4. Performance Data

Available Options for DNAPLs at Superfund Sites

1. Waive ARAR Due to TI in ROD
   - State standard
   - Chemical-specific standard
   - Entire/portion of aquifer

Available Options *(Continued)*

2. Contingency Language for TI in ROD
   - Aim for remediation
   - Back off to another level of protection
   - No waiver of ARARs
   - Delay waiver to later stage (i.e., RD/RA)

Available Options *(Continued)*

3. Interim Actions
   - Issue removal order to contain as interim remedy
   - Gather additional data outside area of containment

What's Important?

- Build defensible data package
- Contact available resources
- Verify remedy performance data
- Justify which MCLs are unachievable and the basis for other standards

Current Technologies

- Current technologies *might* be able to contain DNAPL sources
- Current technologies *might* be able to remediate DNAPL in the aqueous phase
- Need to promote development of innovative technologies to do a better job than current technologies

Summary

- The Enforcement Program's DNAPL policy is evolving.
- The Enforcement Program favors a cautious and conservative approach when DNAPLs are known or suspected.

Summary *(Continued)*

- The Enforcement Program aims to set achievable DNAPL goals and, when appropriate, justify the need for an ARAR waiver due to TI.

Conservative Approach

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