

# EFFECTIVENESS OF PHYSICAL BARRIERS AS A COMPONENT OF REMEDIAL SYSTEMS AT 4 SITES IN NEW HAMPSHIRE

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# 4 NH SITES EVALUATED

- ✘ Site 1 - Slurry Wall and Cap, LNAPL
- ✘ Site 2 - Sheet Pile Wall, No Cap, DNAPL
- ✘ Site 3 - Slurry Wall, No Cap, DNAPL
- ✘ Site 4 - Partial Sheet Pile Wall, NAPL



# SITE 1



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- ✘ Bentonite slurry wall
- ✘ 3-4 ft wide
- ✘ 4,000 ft long
- ✘ 90 - 100 ft deep
- ✘ 20-acre area
- ✘ 40 mil HDPE cap

- GW extraction from 14 wells
- Wall & cap installed 1982, P&T started 1986
- SVE from 66 wells started in 1993
- Pump & Treat, SVE ended 1996

# SITE 1

**Table 2: Alternate Concentration Limits<sup>A</sup>  
Sylvester Site, Nashua, New Hampshire**

Contaminant (16 total)	ACL (ppb)	AGQS (ppb)
Vinyl chloride	95	2
Benzene	340	5
Chloroform	1505	6
1,1,2 trichloroethane	3 <sup>B</sup>	5
Tetrachloroethylene	57	5
Trichloroethylene	1500	5
Methyl ethyl ketone	8000	170
Chlorobenzene	110	100
Methylene chloride	12250	5
Toluene	2900	1000
1,1 dichloroethane	81 <sup>B</sup>	81
Trans-1,2 dichloroethane	1800	15
1,1,1 trichloroethane	200	200
Methyl methacrylate	350	No standard
Selenium	2.6	50
Phenols	400	4000

**Table notes:**

<sup>A</sup> ACLs established in 1983 SROD, September 21, 1983 for attainment within groundwater inside the slurry wall, no cleanup levels were established for outside the slurry wall.

<sup>B</sup> The cleanup level for 1,1,2 trichloroethane and 1,1 dichloroethane were changed from 1.7 and 1.5 ppb, respectively, to 3 and 81 ppb, respectively, in a September 23, 2002 Explanation of Significant Differences.

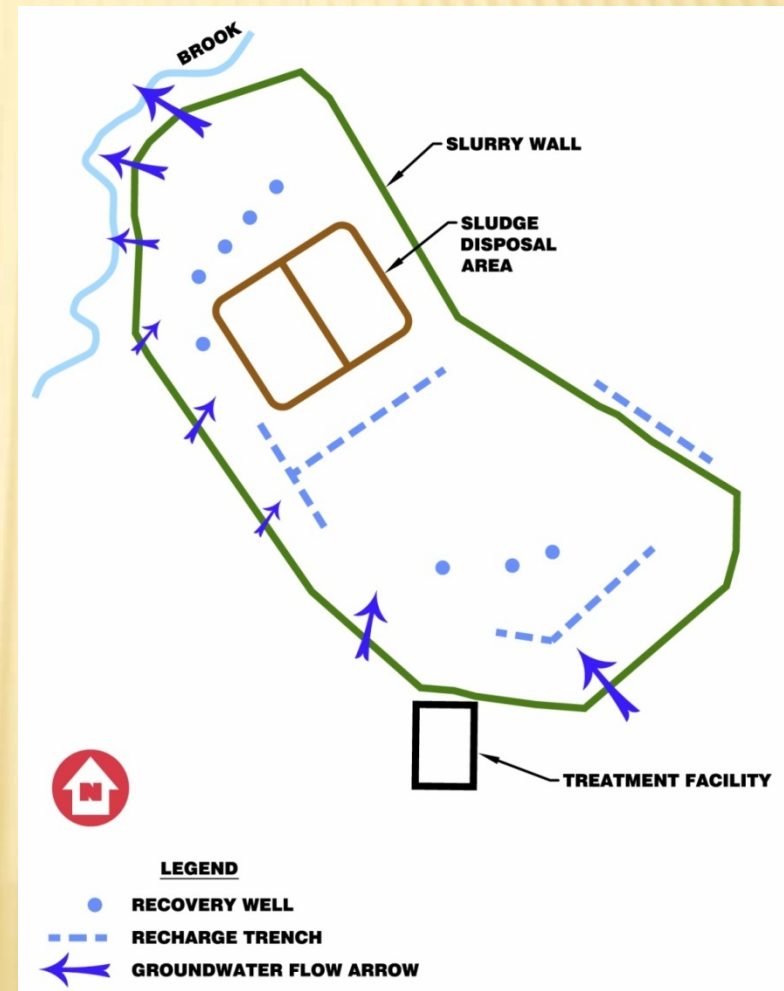
- ✘ Objective: prevent migration of contaminants from site
- ✘ Cleanup goals inside wall were ACLs
- ✘ No Cleanup levels established for outside wall
- ✘ Risk assessment justified shutdown of remediation

# SITE 1 REMEDIAL SYSTEM



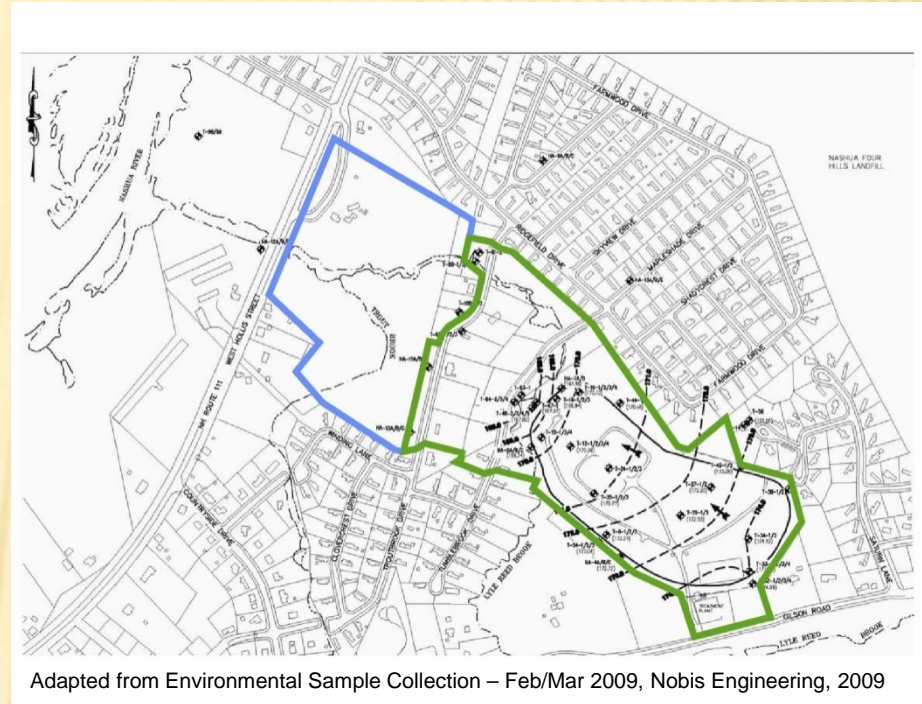
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- 30,000 to 50,000 gpd leakage through fractured bedrock
- 300 gpm extracted
- 250 gpm reinjected inside wall
- 50 gpm discharged outside wall



# SITE 1 – CURRENT STATUS

- ✘ 4<sup>th</sup> 5-Year Review conducted in 2009
- ✘ Remedy currently is protective
- ✘ In the long-term, not protective



## 5-Year Review Recommendations:

- Expand GMZ due to 1,4-Dioxane , Pb, As plume
- Perform Vapor Intrusion Study
- Evaluate effectiveness of cap & slurry wall

# SITE 2

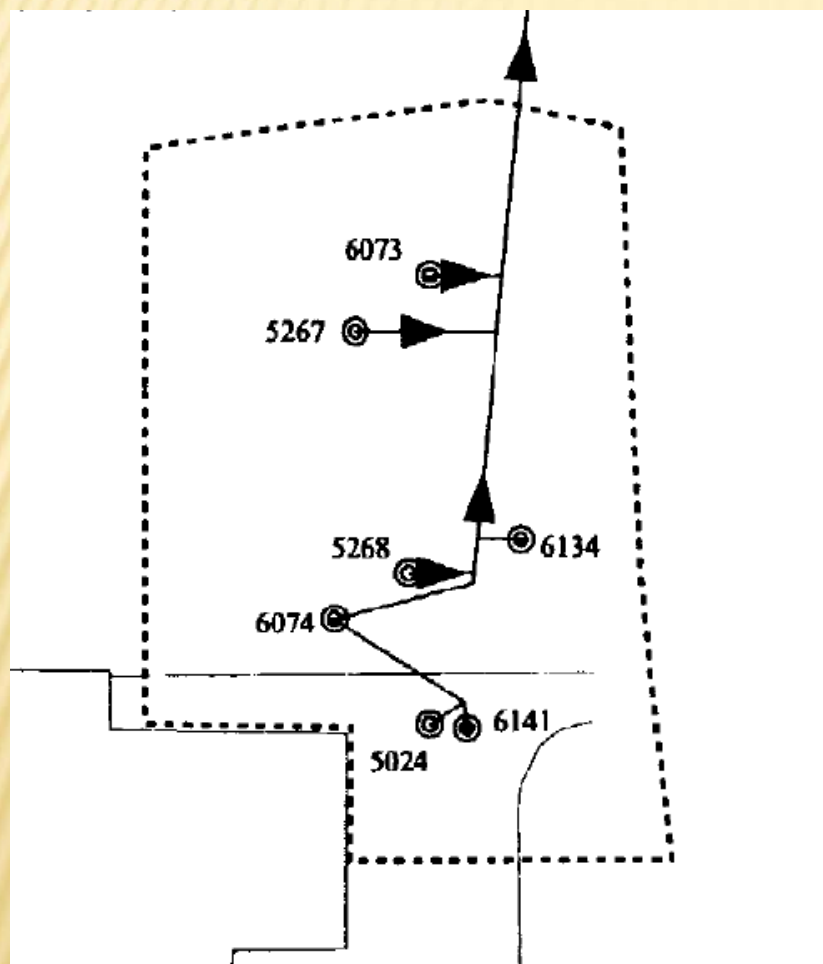


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- ✘ Former location of TCE UST with overflow pipe
- ✘ Technical Impracticability Site
- ✘ Sheet pile wall, no cap, encloses 1/3 acre

- Wall installed Nov 1996, P & T began Feb 1997

# SITE 2

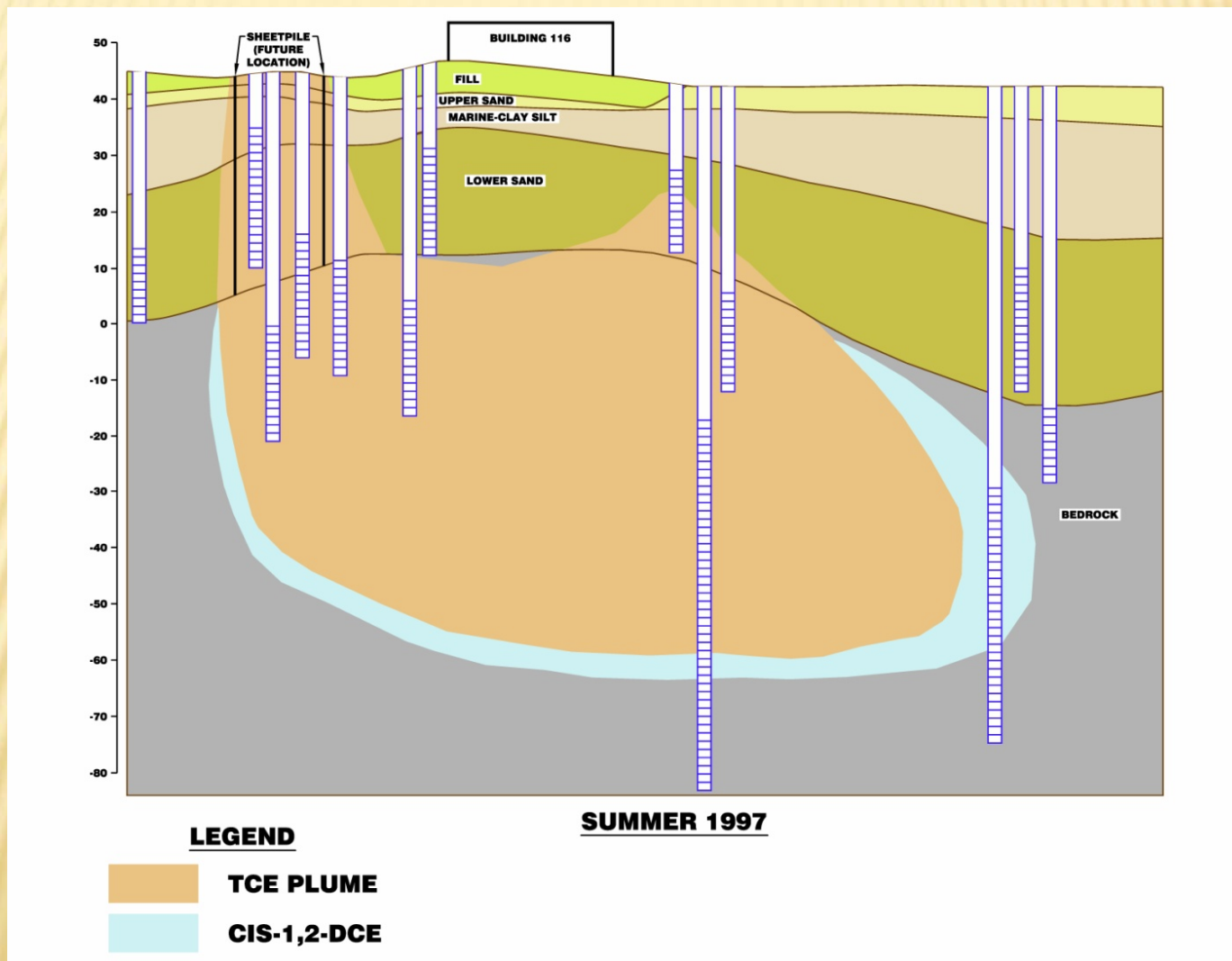


Source: Zone 3 1999 Annual Report, Pease AFB, NH , Bechtel, 1999

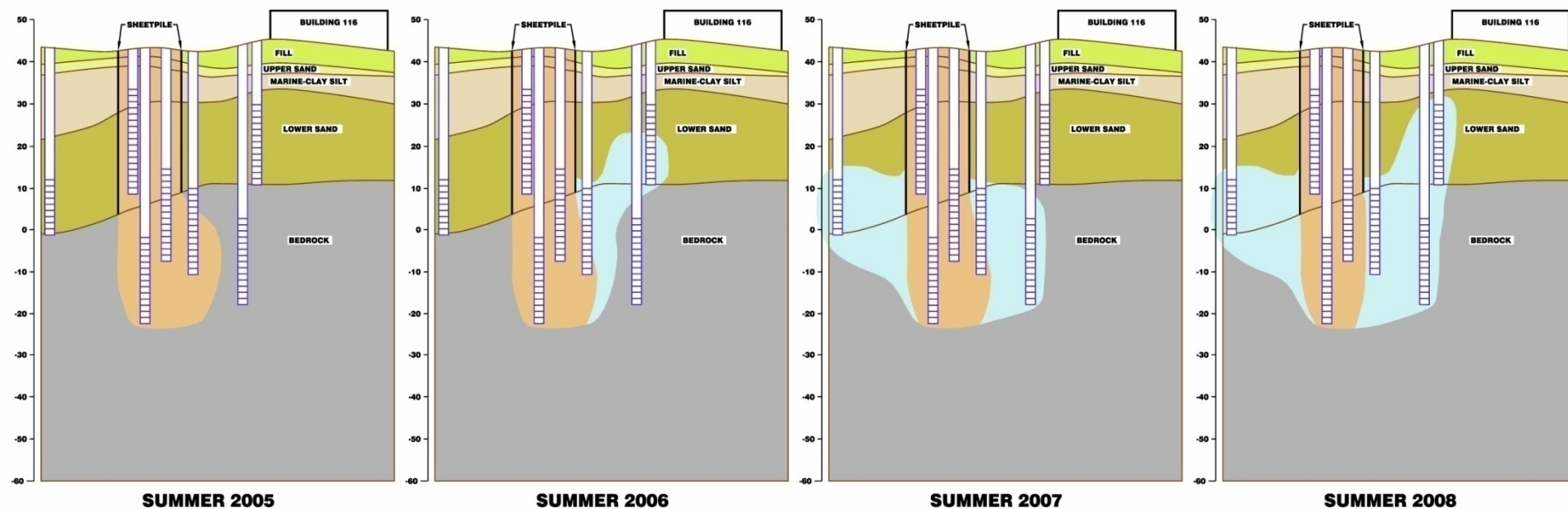
- ✘ Objective: Isolate source area where attainment of MCLs was “Technically Impractical”
- ✘ 7 extraction wells, 3 overburden, 4 bedrock
- ✘ Total pumping rate in 2001 was 6.9 gpm
- ✘ Extraction rate declined to 0.9 gpm by 2008



# SITE 2 CROSS-SECTION PRE-WALL



# SITE 2 - CROSS-SECTIONS



## LEGEND



## Current status:

- Decreased capacity from extraction wells
- Bedrock plume of cis-1,2-DCE is expanding

Adapted from Zone 3 2008 Annual Report, Former Pease AFB, URS, 2009

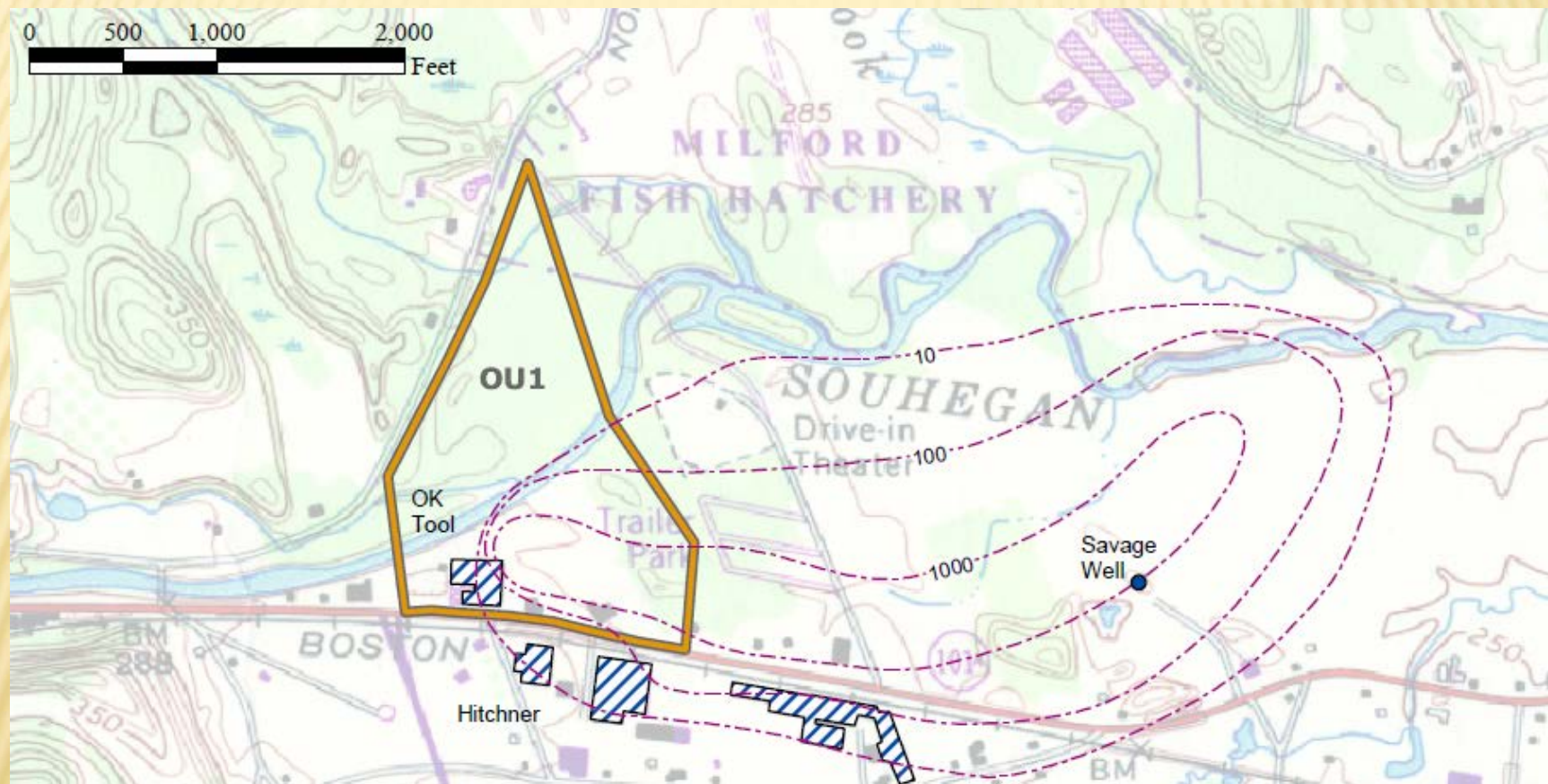
# SITE 3



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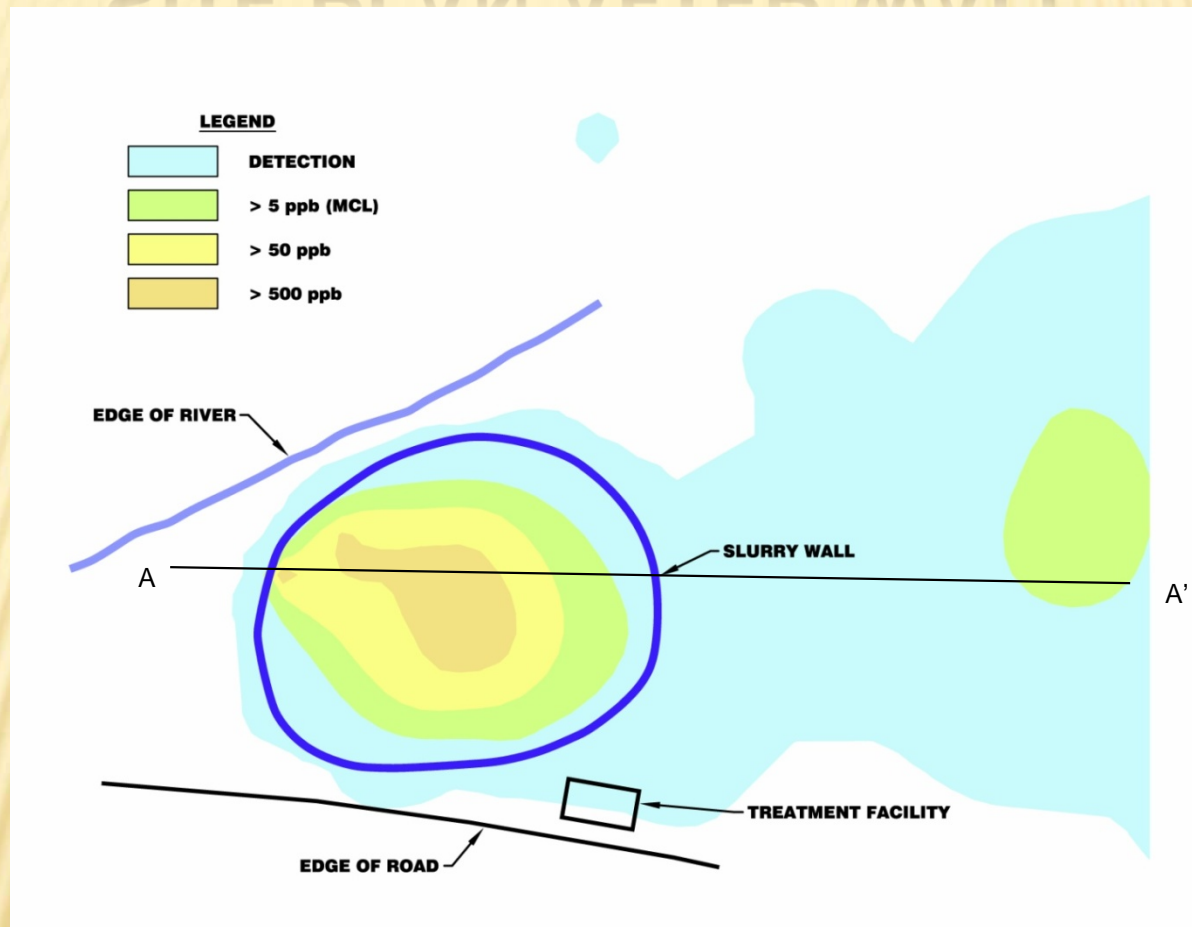
- ✘ Objective: Containment more cost effective than P&T alone for DNAPL
  - ✘ Soil-bentonite slurry wall
  - ✘ Encloses 5-acres
  - ✘ 3-ft min wall thickness, 50 to 115 ft deep
  - ✘ No surface cap
- 
- Wall construction – 1998, P&T started – 1999
  - Two interior wells, pumping at 14 to 60 gpm
  - Discharge to exterior recharge gallery

# SITE 3 – BEFORE WALL



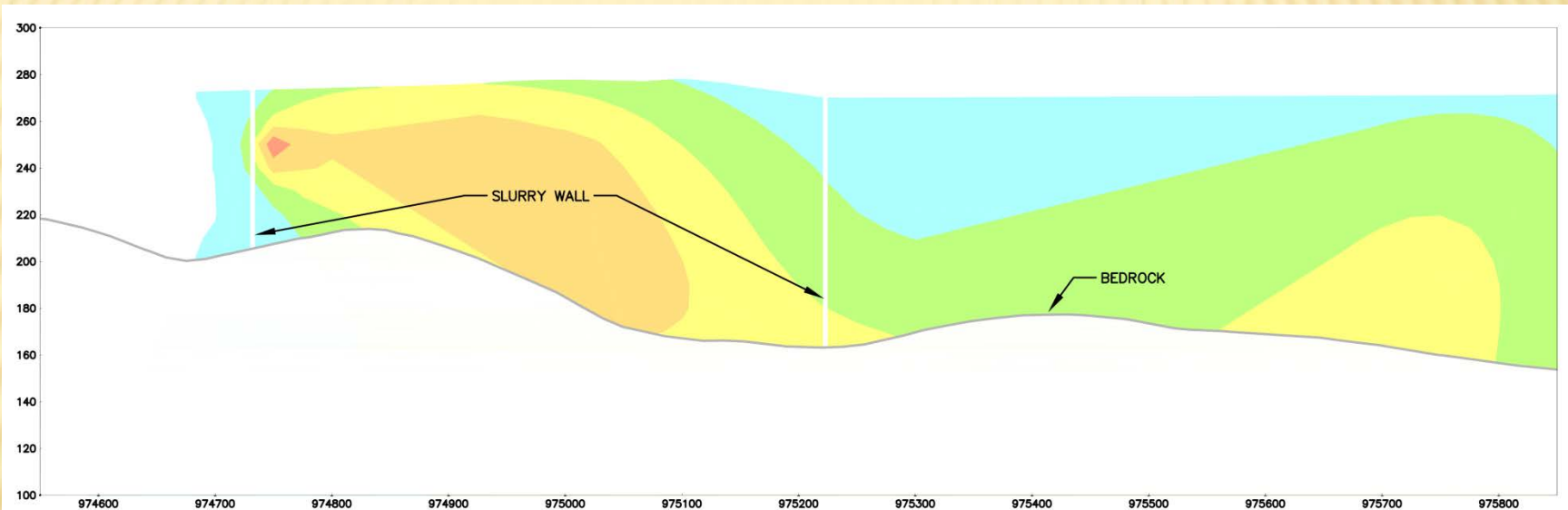
6,000 ft long VOC plume before wall construction

# SITE 3 – SITE PLAN AFTER WALL



Plume outside wall reduced to below MCLs in shallow overburden in OU1 after 10 years.

# SITE 3 – CROSS-SECTION AFTER WALL

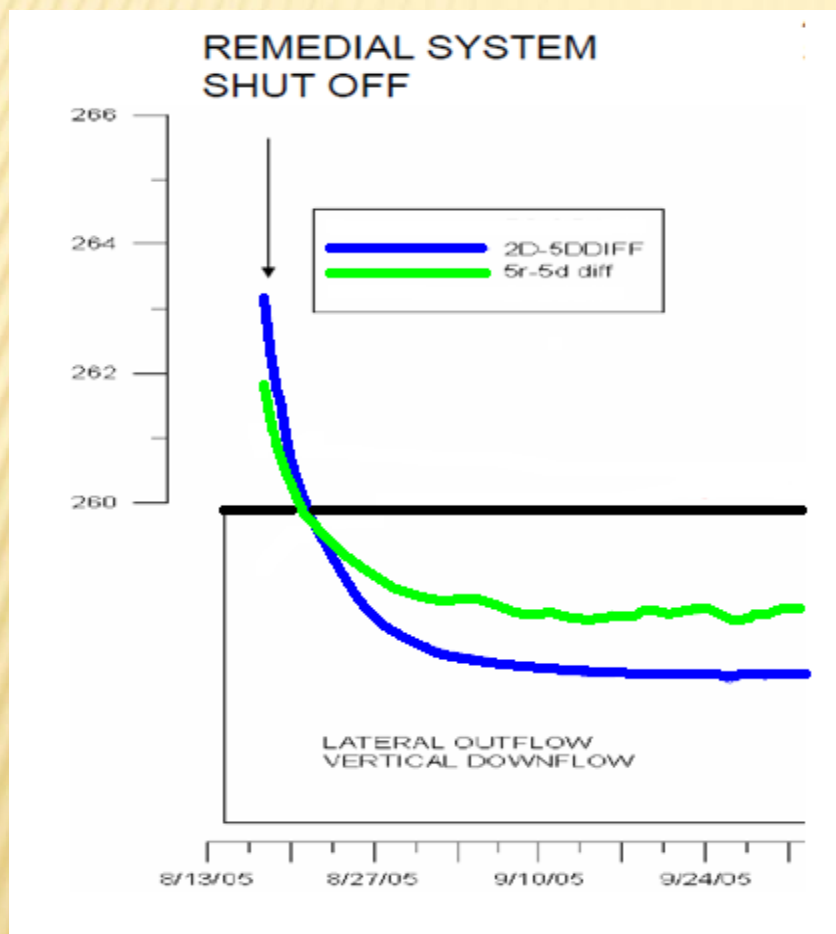


**LEGEND**



Plume slightly exceeds MCLs in deep overburden outside wall in OU1 after 10 years.

# SITE 3 - GRADIENTS



- ✘ Immediately after shutdown of extraction wells, groundwater gradients reverse
- ✘ With sufficient pumping rate, gradients are upward and inward
- ✘ Without pumping, gradients are downward and outward

# SITE 3 - CURRENT STATUS

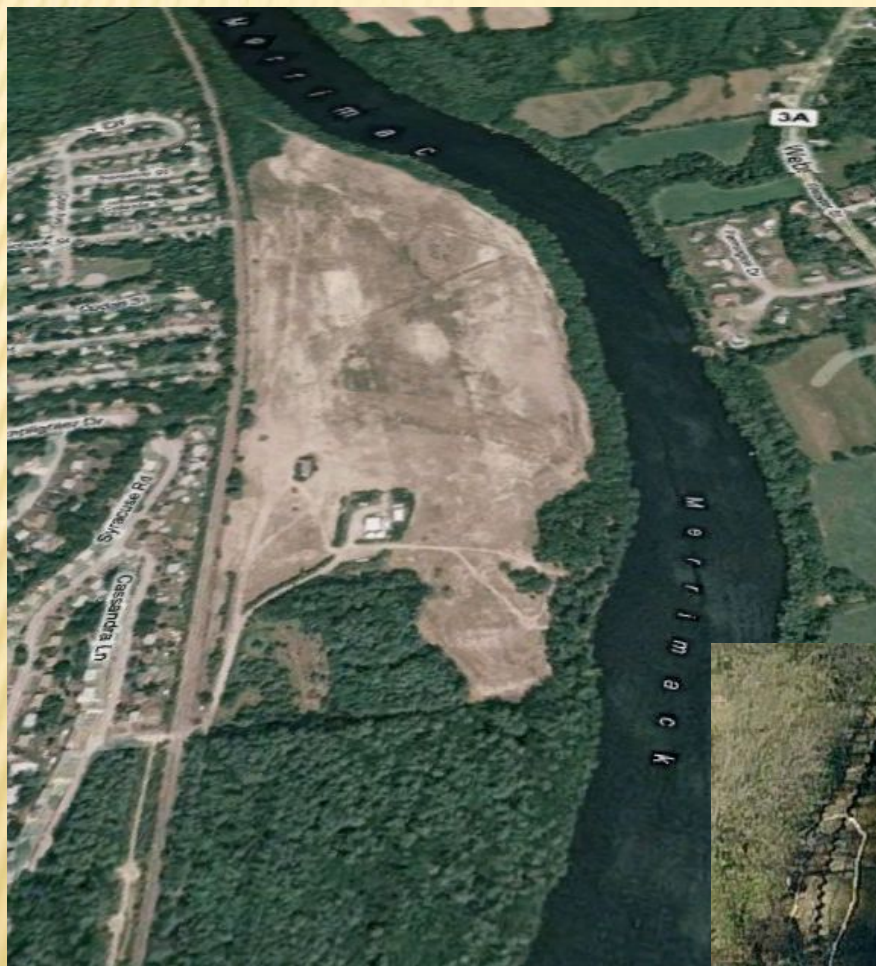


- ✘ 4 deep bedrock wells installed
- ✘ PCE as high as 8 ppm observed in deep bedrock beneath wall
- ✘ Further investigations in bedrock are planned
- ✘ Ongoing ISCO program in overburden inside wall

● Locations of new bedrock wells



# SITE 4

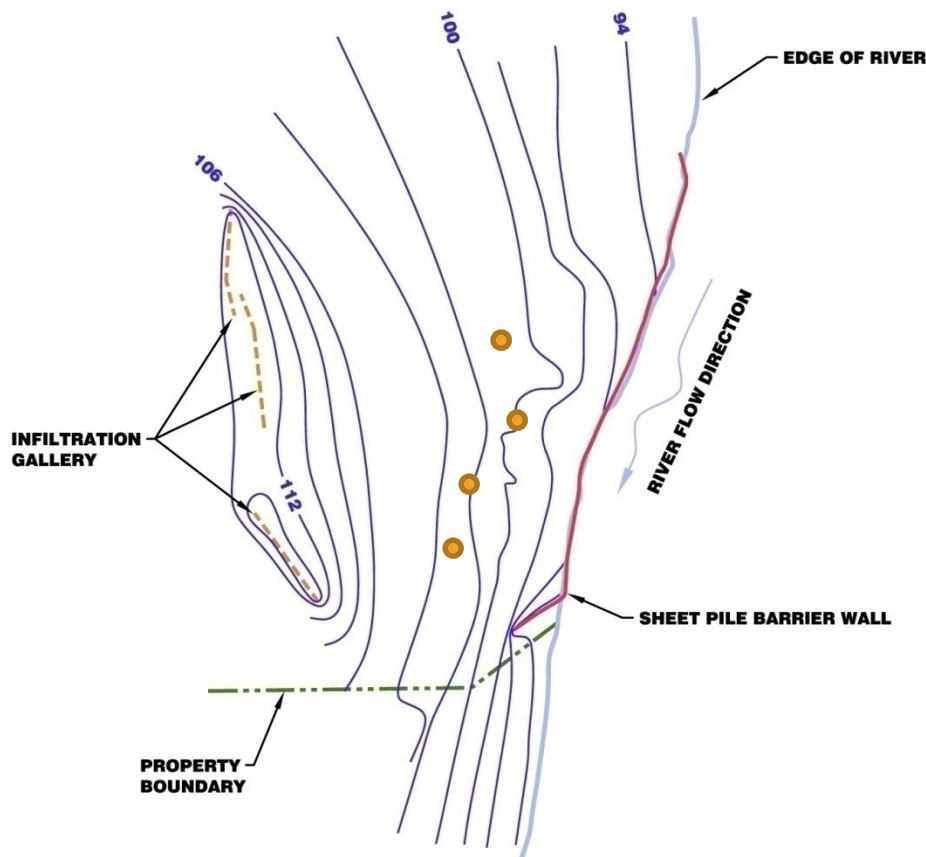


- ✘ Creosote/fuel oil (NAPL)
- ✘ GW & NAPL extraction & treatment 1986 to 1997
- ✘ Sheet pile barrier system & product recovery wells constructed along 750 ft of river shoreline in 1997



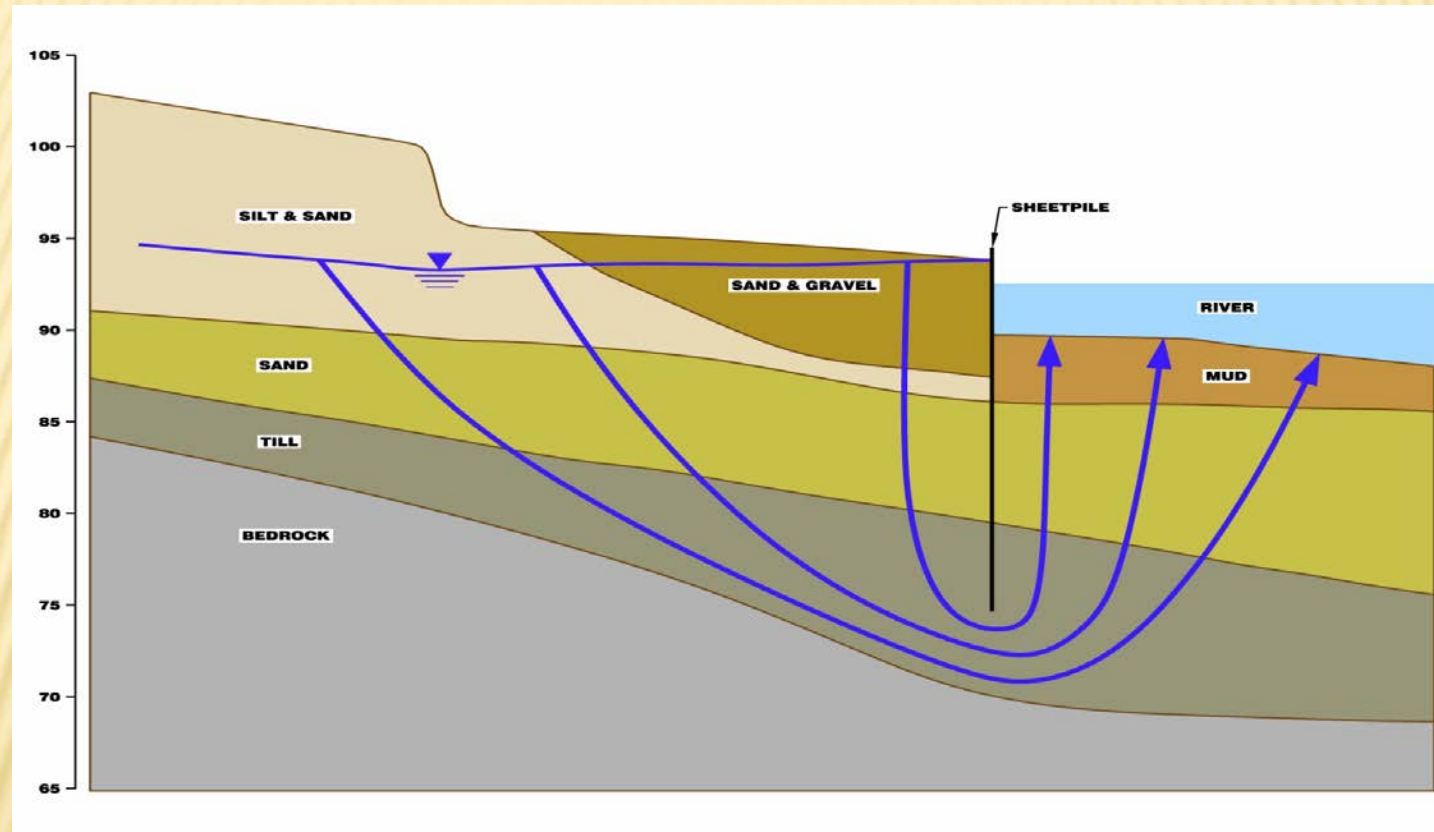
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# SITE 4 - SITE PLAN



- ✘ 4 recovery wells
- ✘ 3 infiltration galleries, 500 ft long combined
- ✘ Original capacity was 30 gpm
- ✘ Current capacity is 20 gpm
- ✘ Pumping rates limited by infiltration gallery capacity

# SITE 4 - CROSS-SECTION



Adapted from Response to NHDES Comments, Key Environmental, Inc., 2008

- Floating NAPL observed in river
- NAPL has been observed in till
- NAPL migrating through till beneath wall?

# SITE 4 – CURRENT STATUS



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- ✘ Pumping rates limited by infiltration gallery capacity, resulting in periodic overtopping of wall
- ✘ Floating NAPL in river
- ✘ NAPL migrating through till beneath wall
- ✘ Infiltration galleries need expansion

# OBSERVATIONS

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- ✘ Barrier walls did not completely contain contaminants and did not completely stop contaminant migration.
- ✘ In most cases, contaminants were well contained in overburden, but flow beneath wall was typical.
- ✘ Containment was more effective, if hydraulic control was achieved.
  - + Capping to limit infiltration
  - + Effective groundwater extraction/reinjection

# LESSONS LEARNED

- ✘ Understanding site hydrogeology is extremely important
  - It will change after wall is constructed.
- ✘ Important considerations:
  - + Type of contaminant (LNAPL vs DNAPL)
  - + Continuity of confining layers underlying site
- ✘ Maintaining preferred hydraulic gradients is critical to preventing leakage.
- ✘ Keep wells and recharge galleries well maintained.