3. CONTAINMENT AND GROUND MODIFICATION

Retain source DNAPL/LNAPL immobile and prevent offsite migration.

- 3.1 ▫ Impermeable boundaries: Slurry walls, sheetpiles, jet grouting, pumping
- 3.2 ▫ Stabilization/solidification: Soil mixing, cementation, in situ vitrification
- 3.3 ▫ Permeable treatment walls: Treat evolving plume as it develops

Impermeable boundaries & stabilization techniques proven @ field scale.
Permeable treatment walls under (strong) development.

3.1 Isolation and Containment

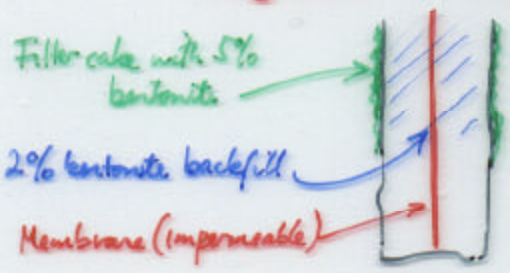
Theory

Passive systems – Impermeable boundaries, grout walls, slurry walls, jet grouting, sheet pile walls.

Active systems – Hydraulic controls – pumping

▫ Slurry walls

- Bentonite-soil
  - High plasticity ∴ resistant to fracture
  - Low conductivity. Low K with 5–7% bentonite
    4% bentonite $\Delta K \times 1000$
  - Low cost since soil used
  - Backfill typically 2% bentonite
  - Incorporation (sometimes) of sheetpiles / geomembranes / concrete cut-off.



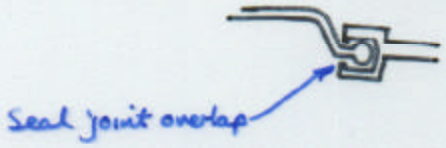
- Cement–bentonite (brittle)
- Polymers, resins, emulsions, asphalts.

Penetration and Jet Grouting

- Pressure grouting to fill voids. Hole spacings 1–3m.
- Pressure grouting to destroy initial fabric → mix soil–slurry
  - Hole spacing 0.3–2 m
  - Overlap columns.

Grout sample conductivities 10^{-5} – 10^{-8} cm/s. (Mix dependent.)

Sealable joint sheet pile walls



Drive with piledriver

Seal joint with bentonite and polymers

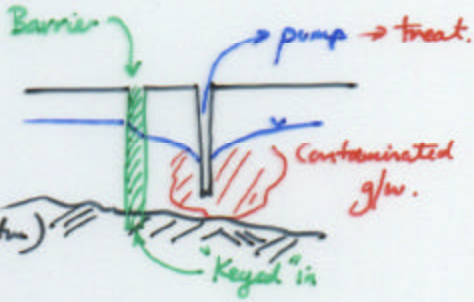
May crack aquicludes due to driving

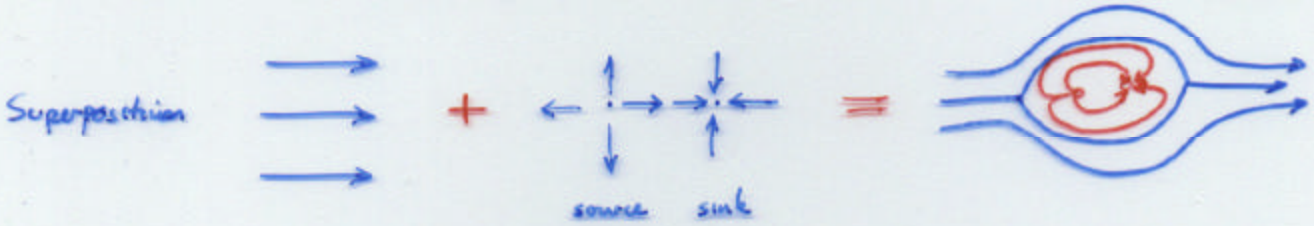
Active groundwater controls

In addition to containment

Positive flux into cell

Hydraulic barriers need to cut-off (termination)



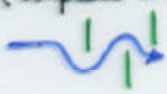


Field Implementation

1. Encompass DNAPL source area (volume) with barrier (complete containment)

or

2. Dissolved plume locally arrested with barriers.



PLAN VIEW

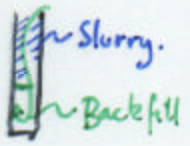
Slurry trenches – 2–3 ft deep

Max 400' deep – open for several weeks. 1000' long

Backfill – weathered shales, sand, clays, fills

2–6" slump and

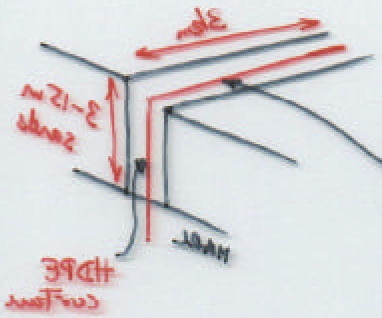
Backfill 15 pcf denser than slurry



Grouting – Particulate grout – Clay, lime, flyash, cement
Chemical grouts – Bitumen, resin, silicates (low viscosity → ↑ penetration)
Jet grouting 1-2 rpm 1-2 ft^3/min 6000 psi injection pressure.

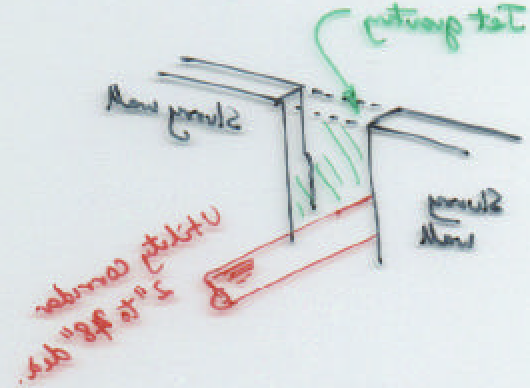
Level of Demonstration

Liguria, Italy — 3 km by 3-15 m deep wall
Containment of contaminants
Tongue and groove curtain



Testing → $k = 10^{-6}$ to 10^{-7} cm/s.

Jet grouting for complex heterogeneous areas.



Applicability – Limitation

- Generally to isolate and recover NAPLs
  Pump and flush within boundary – eg. Surfactant
- Durability of clay with acidic and organic compounds
  Reasonable resistance to organics
  Cement brittle but less susceptible to organics/acid
- Grouting – Fracture sealing – but complete seal?
  Verification difficult.

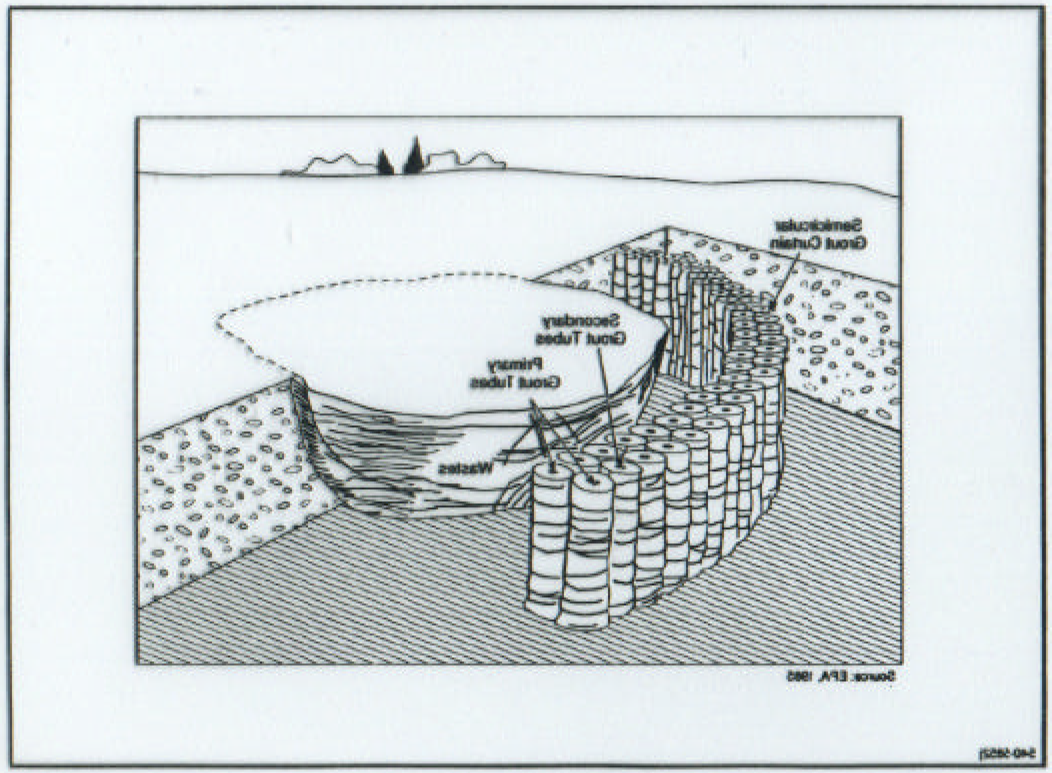
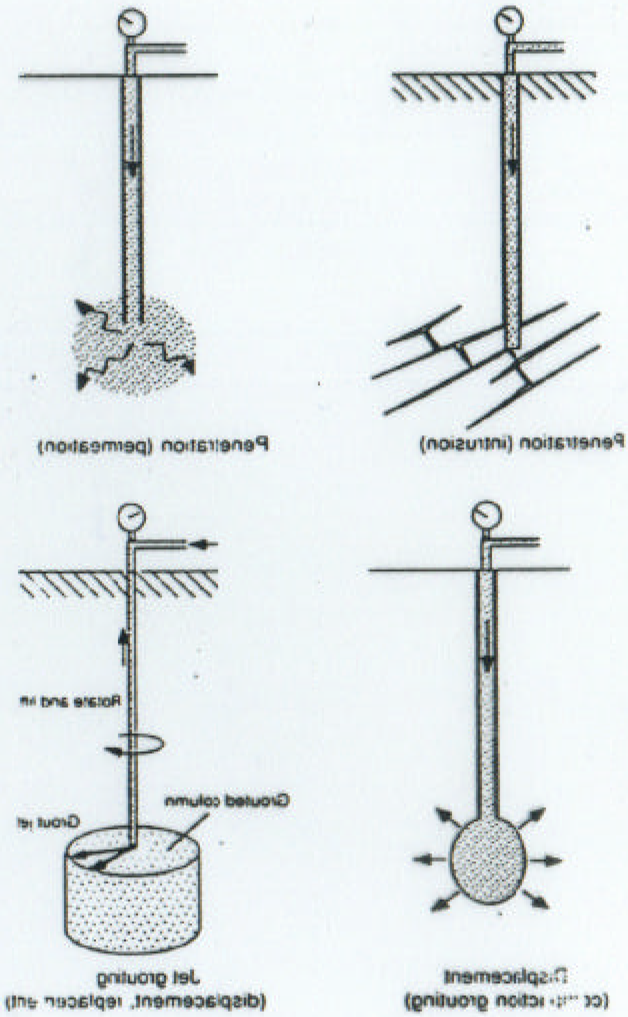


FIGURE 3-3 GROUT CURTAIN



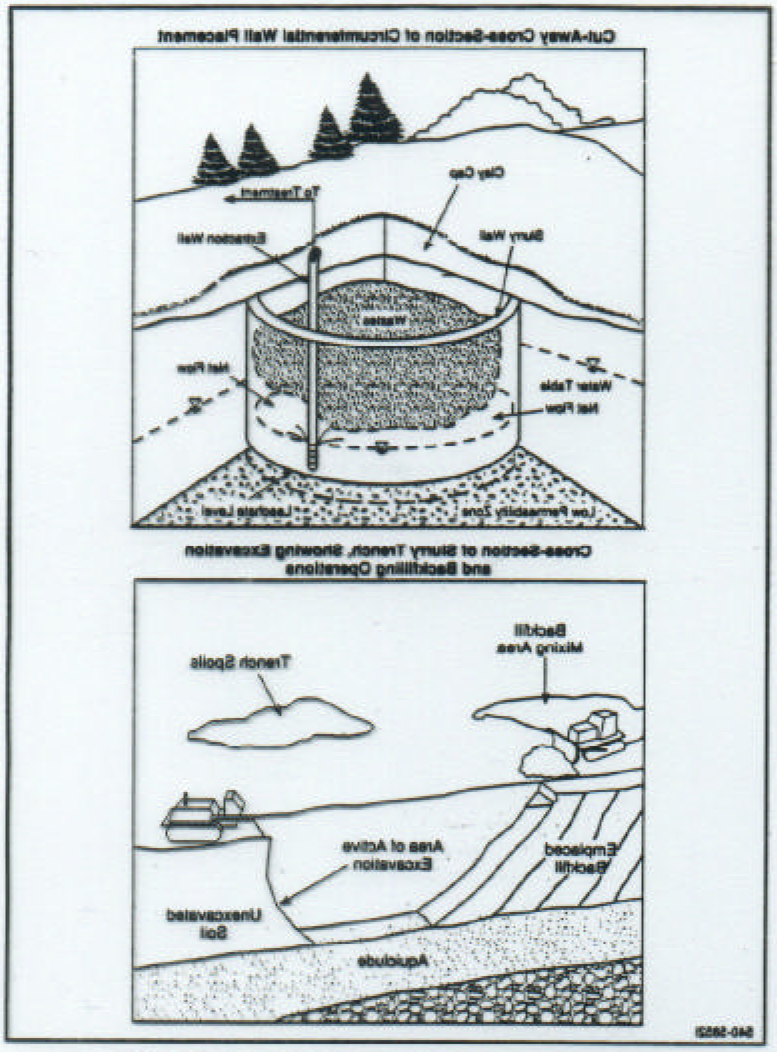


FIGURE 3-2 TYPICAL SLURRY WALL CROSS SECTIONS

Cost/Availability

Slurry walls and jet grouting offered by specialized contractors.
Usually cheaper than other containment systems
Slurry walls $7 - 13/ft^2$
Grouting $60 - 100/yd^3$