integral INSIGHT FOR AN EVOLVING WORLD

Pump and Treet

Pushing the Limits of Sustainable Remediation Practices

Karah Conklin, P.E.

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AEHS West Coast Conference

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Sustainable and Resilient Remediation

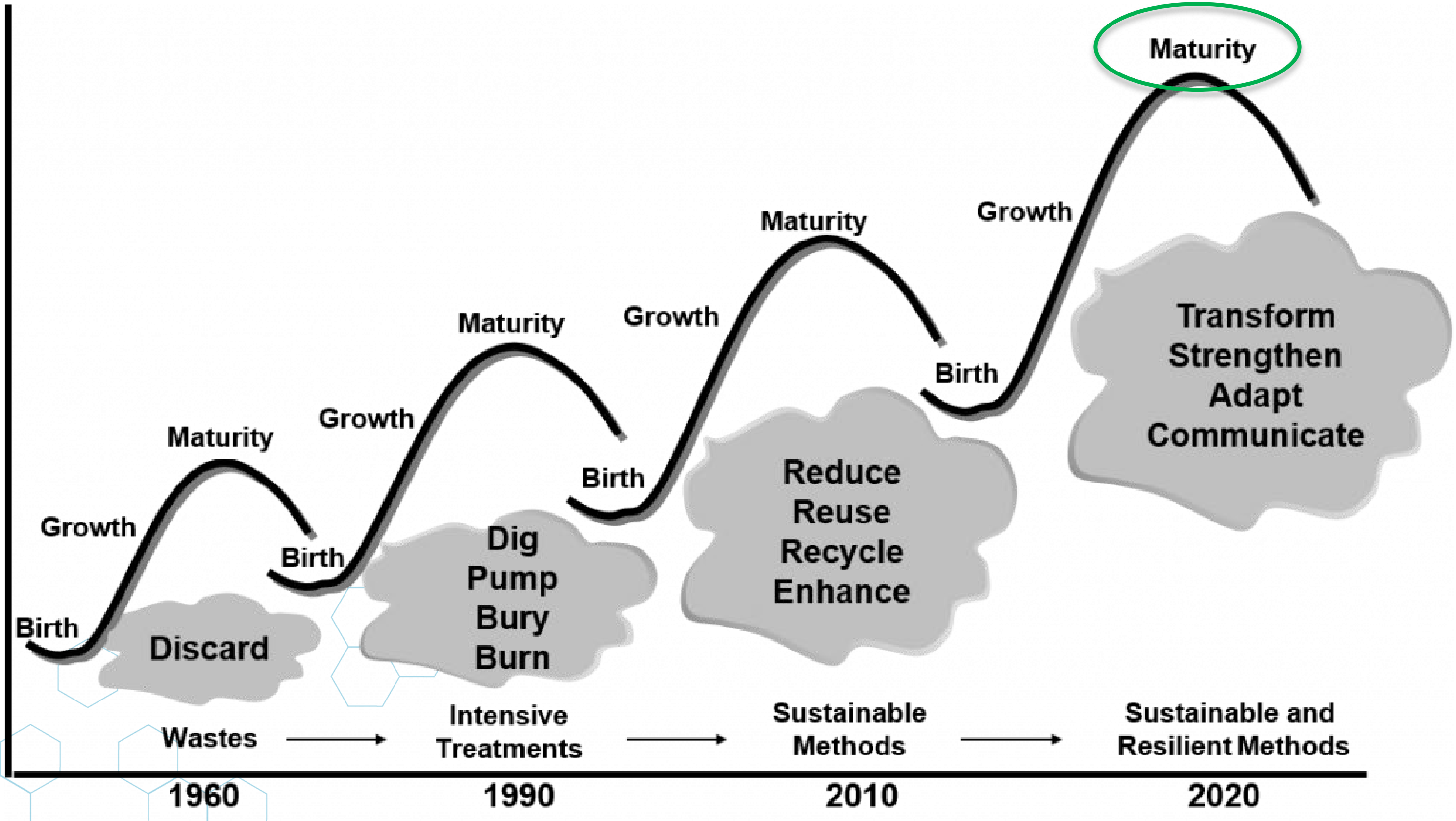
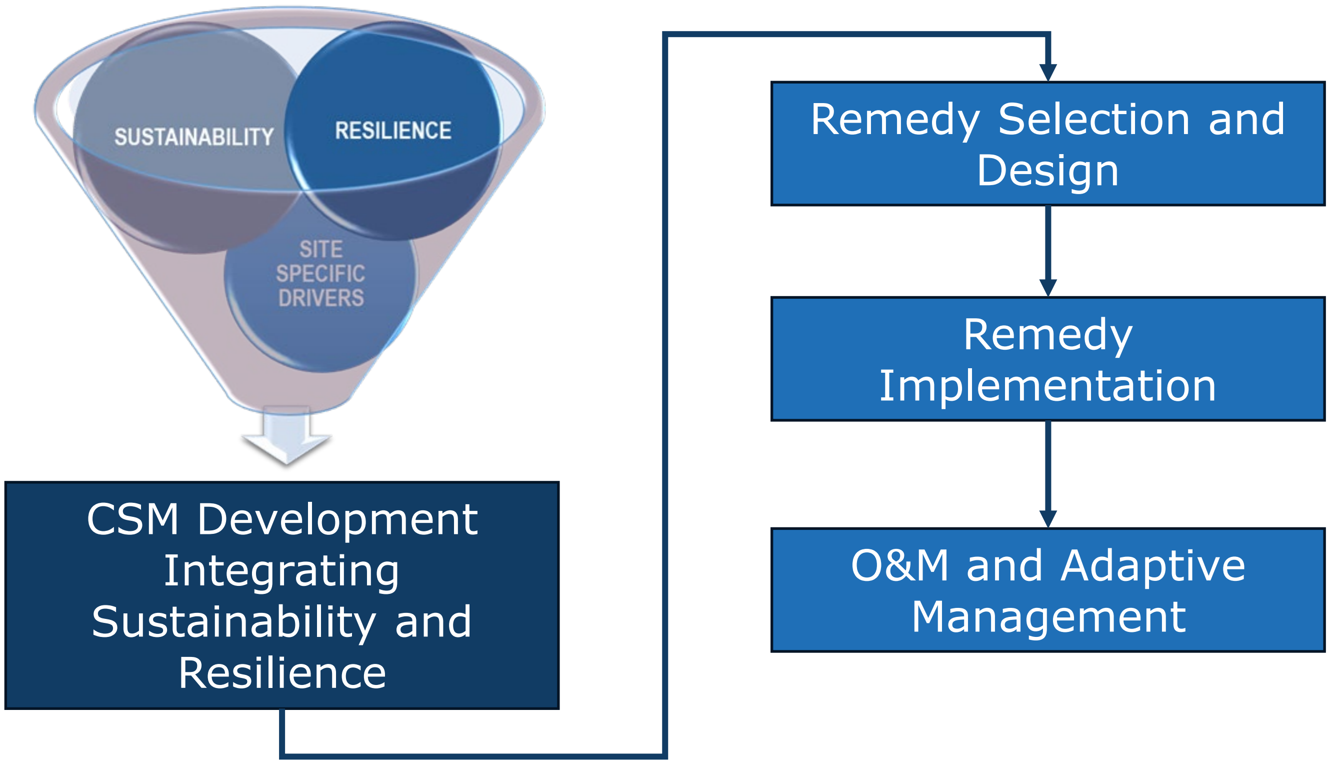


Photo from: ITRC Adapted from Ellis and Hadley (2009).

Integrating Resilience and Sustainability into the Remedial Project Life Cycle



Adapted from ITRC 2021

Sustainable Remediation Limitations

- Site accessibility
- Timeframes
- Incomplete degradation
- Limited range of contaminants treated
- O&M requirements
- Uncertainty of natural systems

Common Sustainable Remediation Technologies

- Bioremediation
- Constructed Treatment Wetlands
- Phytotechnologies
- Permeable Reactive Barriers
- In Situ Remediation
- Soil Vapor Extraction/Sparging
- Solidification and Stabilization (S/S)
- Vegetated Soil Covers

Phytotechnologies

*The use of **plants** to remediate soil and water*

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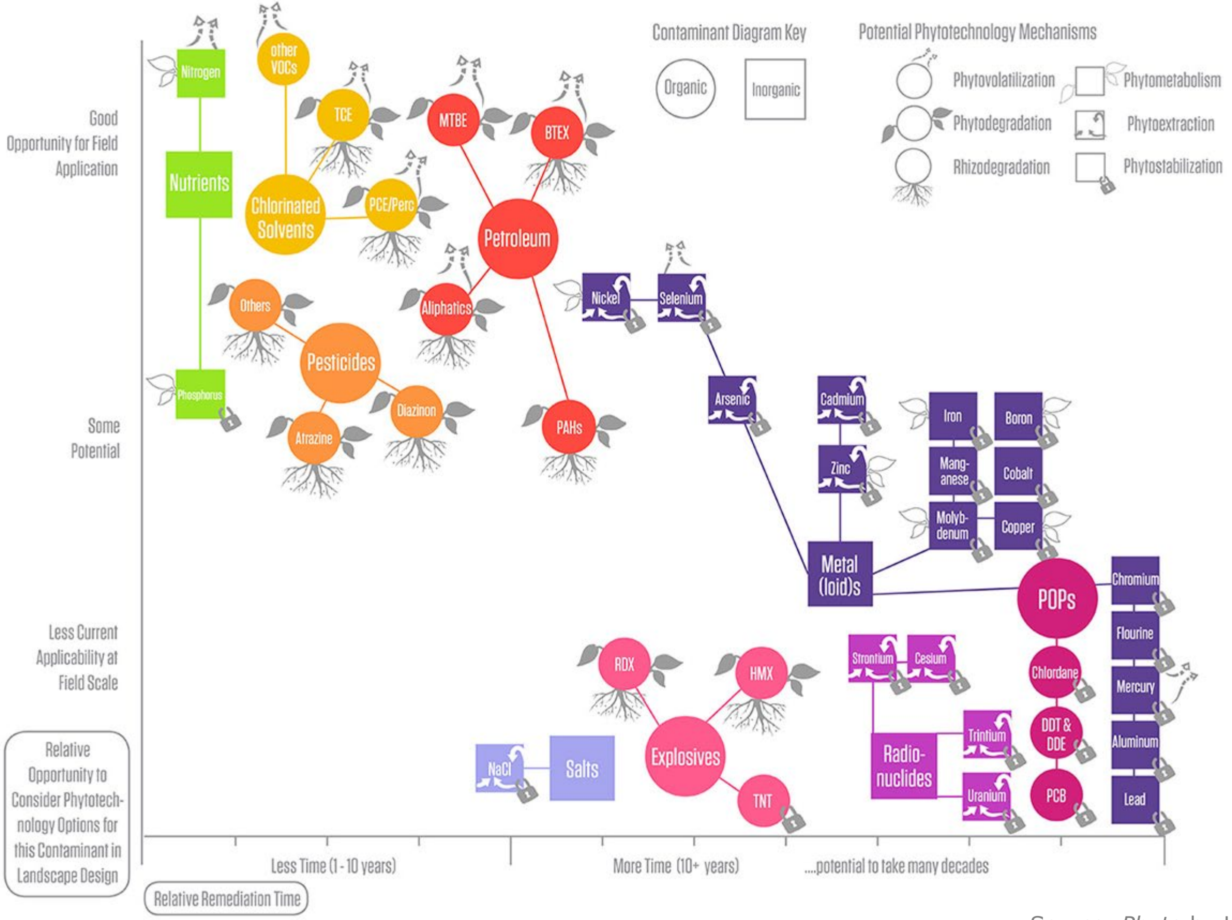
What can we treat?



Source: *Phyto* by Kate Keenen

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STRENGTHS

- Often passive
- Low O&M
- Long life
- High PR
- Aesthetically pleasing
- Cost effective

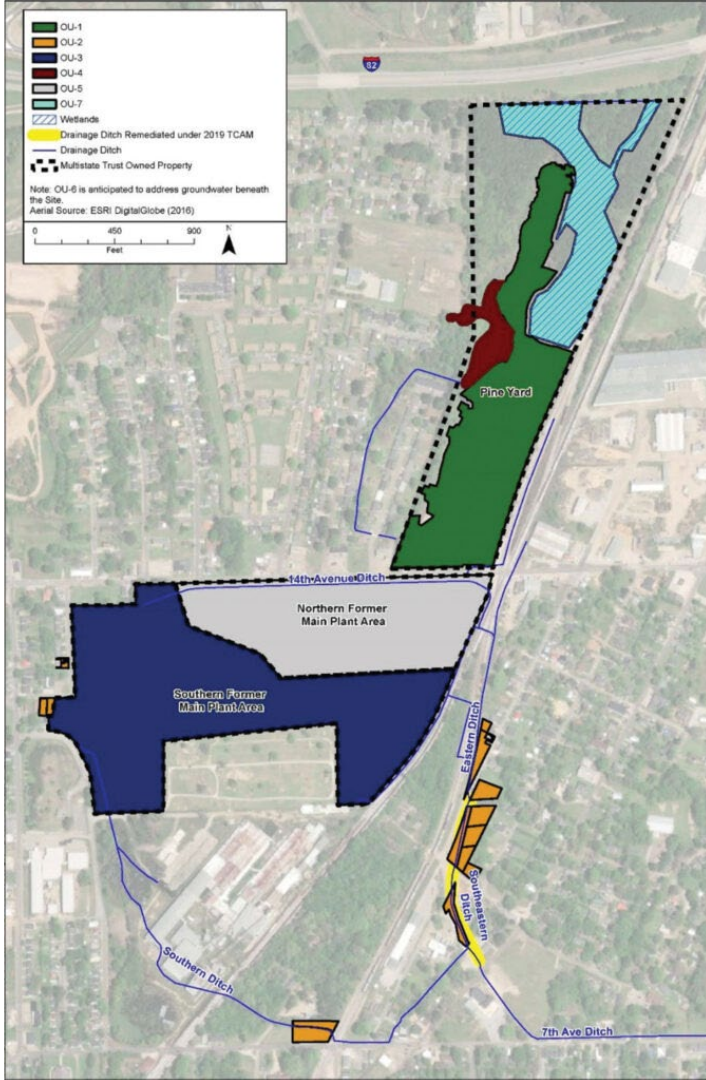
LIMITATIONS

- Ability to access contamination
- Long remediation timeframes (and thus longer O&M)
- Phytotoxicity
- Land use limitations

Former Wood Treating Facility - Mississippi

Site Background

- 90-acre Former Wood-treating Facility
- Operated from 1928 to 2003
- Primary COCs in groundwater are PAHs. Primary impacts are in deeper aquifer.
- Preferred remedy at the Site is hydraulic control using phytoremediation

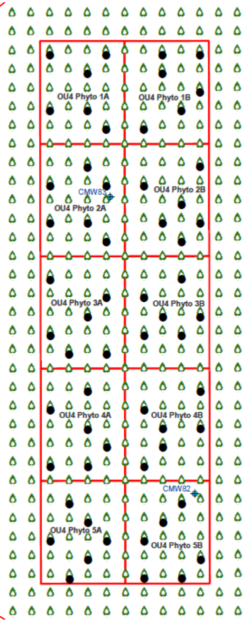


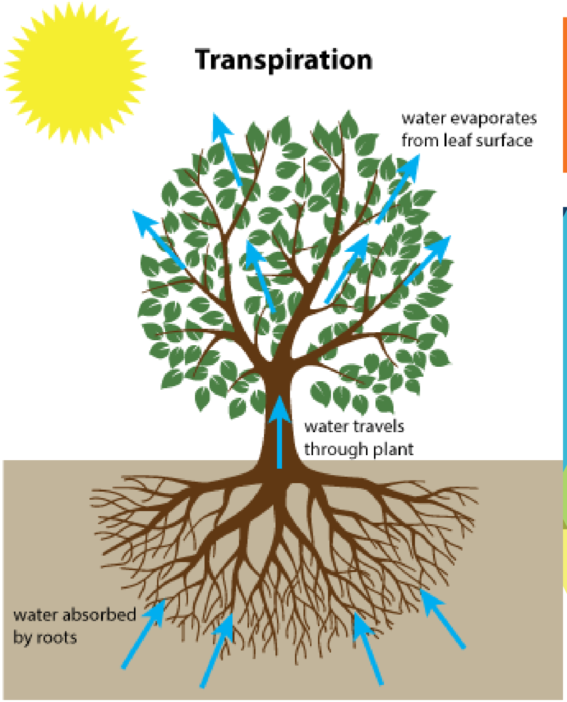
Concerns for Groundwater Remediation

- Limited Site utilities
- Low O&M budget
- Significant amount of precipitation occurs in non-growing months
- Target groundwater is at >20 feet bgs. Shallow groundwater at 5-6 feet bgs.
- Soils are mostly clay-based

Pump and Treet Pilot Study

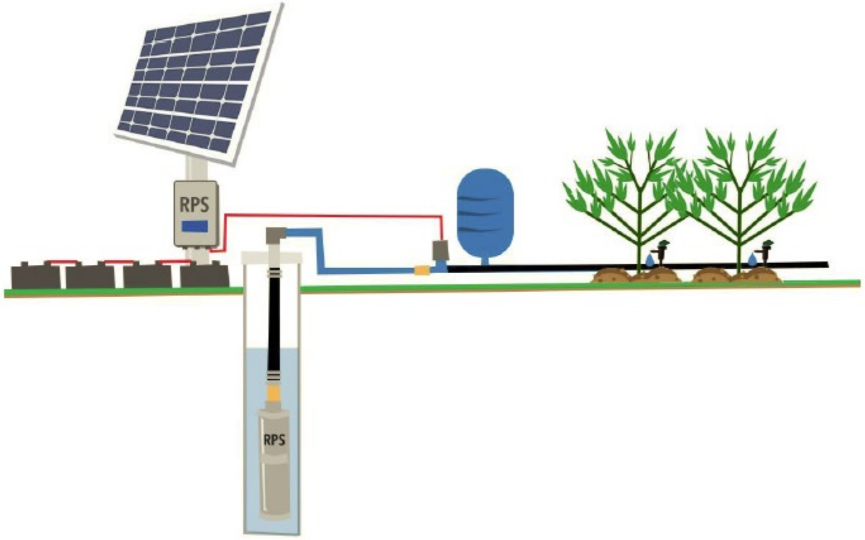
› Installed approximately 560 trees in a 125-foot by 50-foot area in 2021





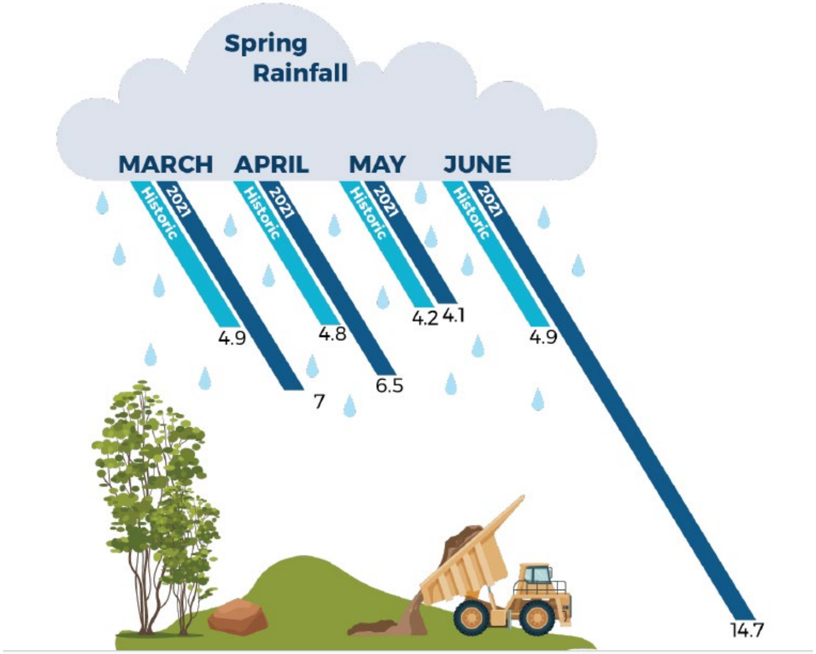
Pump and Treet Pilot Study

- Installed approximately 560 trees in a 125-foot by 50-foot area in 2021
- Utilized a solar driven pumping system to extract groundwater and gravity irrigated trees during the growing season.



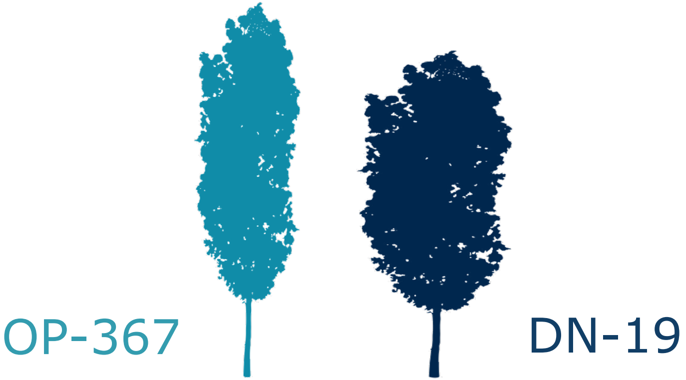
Results and Observations

- Trees were average of 9 feet tall at the end of Year 1and 17 feet at the end of Year 2



Results and Observations

- Trees were average of 9 feet tall at the end of Year 1and 17 feet at the end of Year 2
- Shallow groundwater levels decreased by 1.5 after 1 full growing season
- DN-19 hybrid poplar trees held onto their leaves longer than the OP-367 hybrid poplars



Results and Observations

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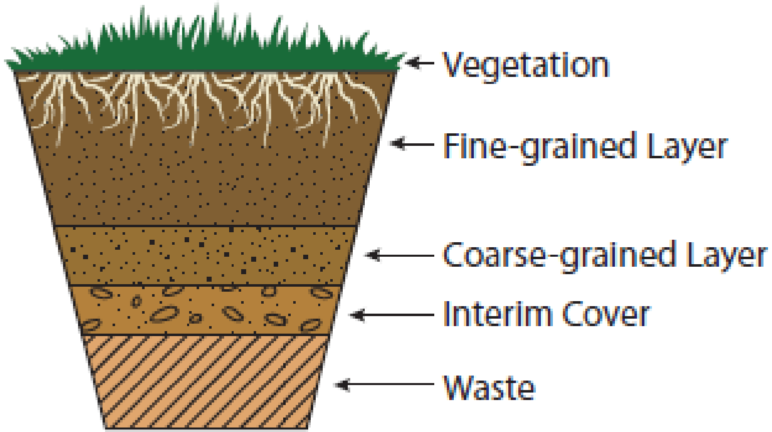
- Shallow groundwater levels decreased by 1.5 after 1 full growing season
- DN-19 hybrid poplar trees held onto their leaves longer than the OP-367 hybrid poplars
- No accumulation of PAHs in soil and no increase in PAHs in shallow groundwater
- O&M for solar pumping system was ~2-3 hours per week

Vegetated Landfill Covers



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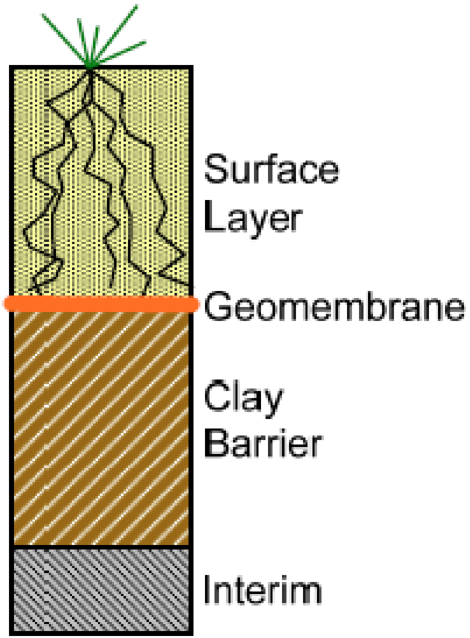
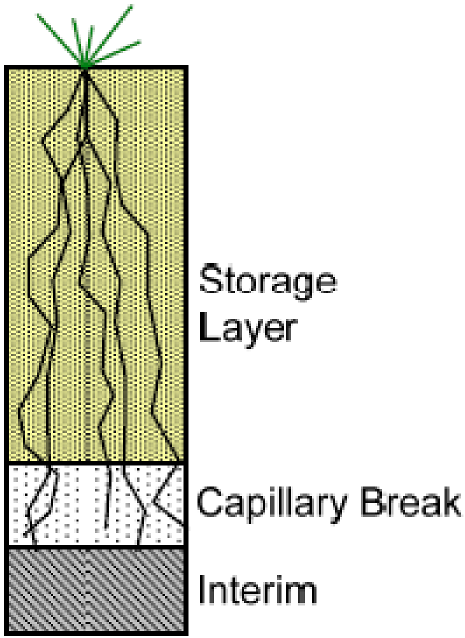
Cover Differences



Conventional Cover



Water Balance Cover

Source: *Craig Benson, UofWI*

STRENGTHS

- Cost-effective
- Lower maintenance
- Enhanced erosion resistance
- Improved aesthetics and land use options
- Potential for water infiltration reduction

LIMITATIONS

- Generally more applicable in arid or semi-arid climates
- Root penetration into waste (exposure)
- Nutrient and soil quality concerns
- Reliability under extreme weather events
- Limited methane management options

Former Dye-Manufacturing Facility – New York

Former Dye-Manufacturing Facility – New York

- 9 acre landfill utilized for industrial waste from facility
- Operated from 1978 until 2001
- Waste included solvents, dye waste, zinc oxide, chromium hydroxide, debris/lab waste

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Former Dye-Manufacturing Facility – New York

Groundwater extraction and treatment

- Metals – aeration, GAC, and metals adsorption
- VOCs – air stripping, vapor and liquid phase GAS
- DO injection system

Issues/Concerns

- Significant O&M required
- Did not address direct exposure
- Did not address continued groundwater contamination

Former Dye-Manufacturing Facility – New York

Initial Remediation Approach

- Groundwater extraction and treatment:
  - Metals – aeration, GAC, and metals adsorption
  - VOCs – air stripping, vapor and liquid phase GAS
  - DO injection system

Final Remedial Approach

- Vegetated evapotranspiration landfill cover
- Perimeter groundwater collection system, augmented with phytoremediation
- Drainage swales to redirect precipitation

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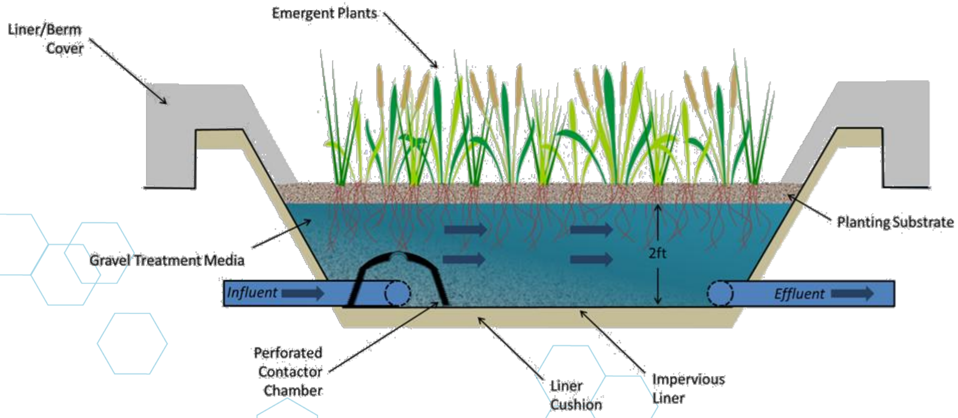
Soil Cover/Cap in New York

Constructed Treatment Wetlands



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What can we treat?

Engineered treatment system designed to achieve water quality improvements by maximizing processes that occur in natural wetlands

- Mine Drainage
- Sanitary Wastewater
- Landfill Leachate
- Agricultural Runoff
- Airport Runoff
- Urban and Industrial Stormwater
- Industrial Wastewater
- Groundwater Remediation

- Metals
- Nutrients
- Solids
- PCBs
- BTEX
- PAHs
- Chlorinated Solvents
- Glycol
- BOD
- pH
- TSS

STRENGTHS

- Cost-effective
- Lower maintenance
- Low energy requirements
- Improved aesthetics
- Adaptable for varying flows

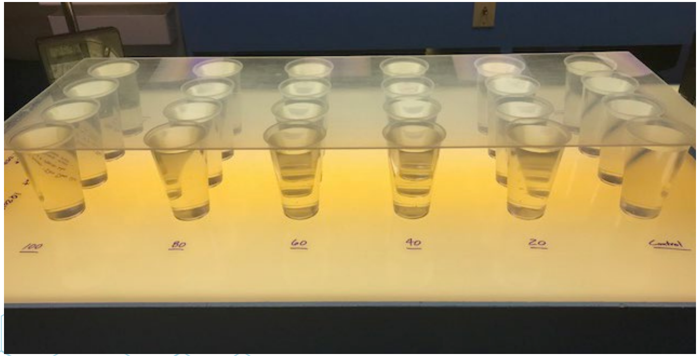
LIMITATIONS

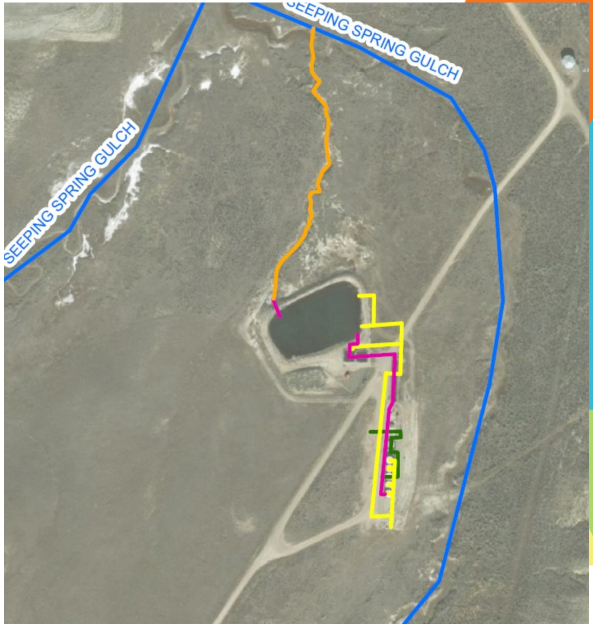
- Large areas required
- Treatment limitations
- Climate sensitivity
- Exposure concerns
- Reliability under extreme weather events

Active Oil and Gas Development Facility - Colorado

Site Background

- 1MGD produced water pond from oil well production
- Bench scale evaluation
- Toxicity, alkalinity, PAHs, and temperature issues for discharge





Pilot System

- Utilized an aerated, compost and gypsum-based wetland to treat PAHs and general toxicity
- Aeration provided by solar panel system
- Hydraulics run by gravity

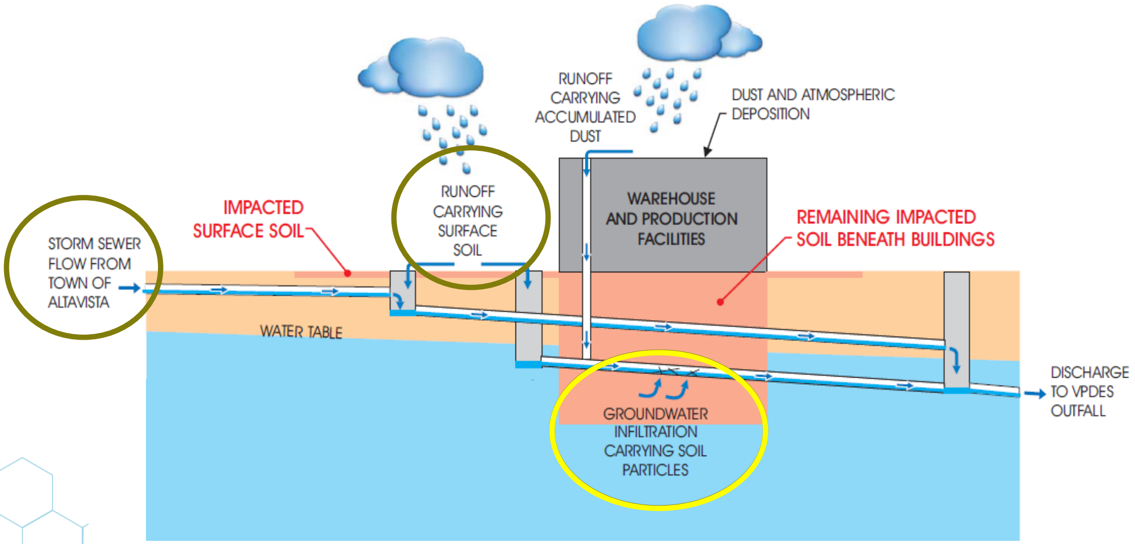
Pilot System

- System met ALL NPDES discharge criteria, including temperature
- Full-scale system being designed
- Projected to save client over $1M annually vs GAC treatment AND got client out of compliance NOV/C&D

Textile Manufacturing Facility - Virginia

Site Background

- PCB in soil beneath plant due to historical PCB spill
- Infiltration into the storm sewer system led to PCB exceedances in stormwater discharge



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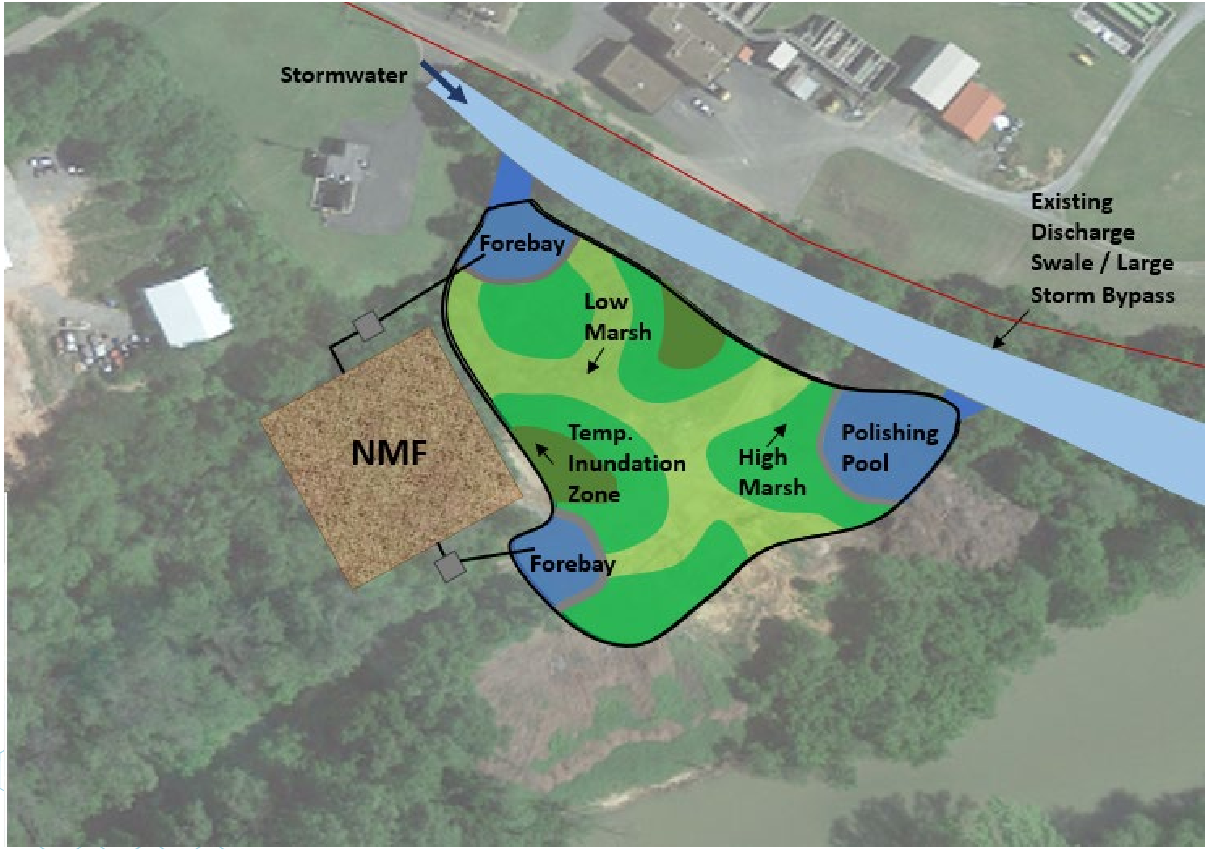
PCB Minimization Strategy

- Stormwater diversion away from impacted areas
- Storm sewer rehabilitation and lining
- End of Pipe Treatment
    - Minimal space available
    - Large rain events
    - Hard to maintain

Natural Media Filtration and Constructed Wetland



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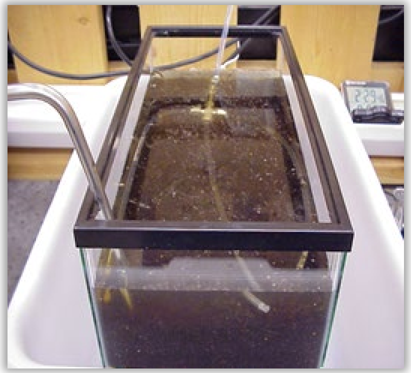
Compost NMF for PCB removal

- Filtration
- Adsorption
- Reductive Dechlorination

Bench Scale



Field Pilot

Summary

- As sustainable remediation technologies have matured, practitioners now have greater opportunities to push the boundaries of these methods.
- These approaches can be adapted to diverse challenges and offer valuable insights for future advancements in the field.

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