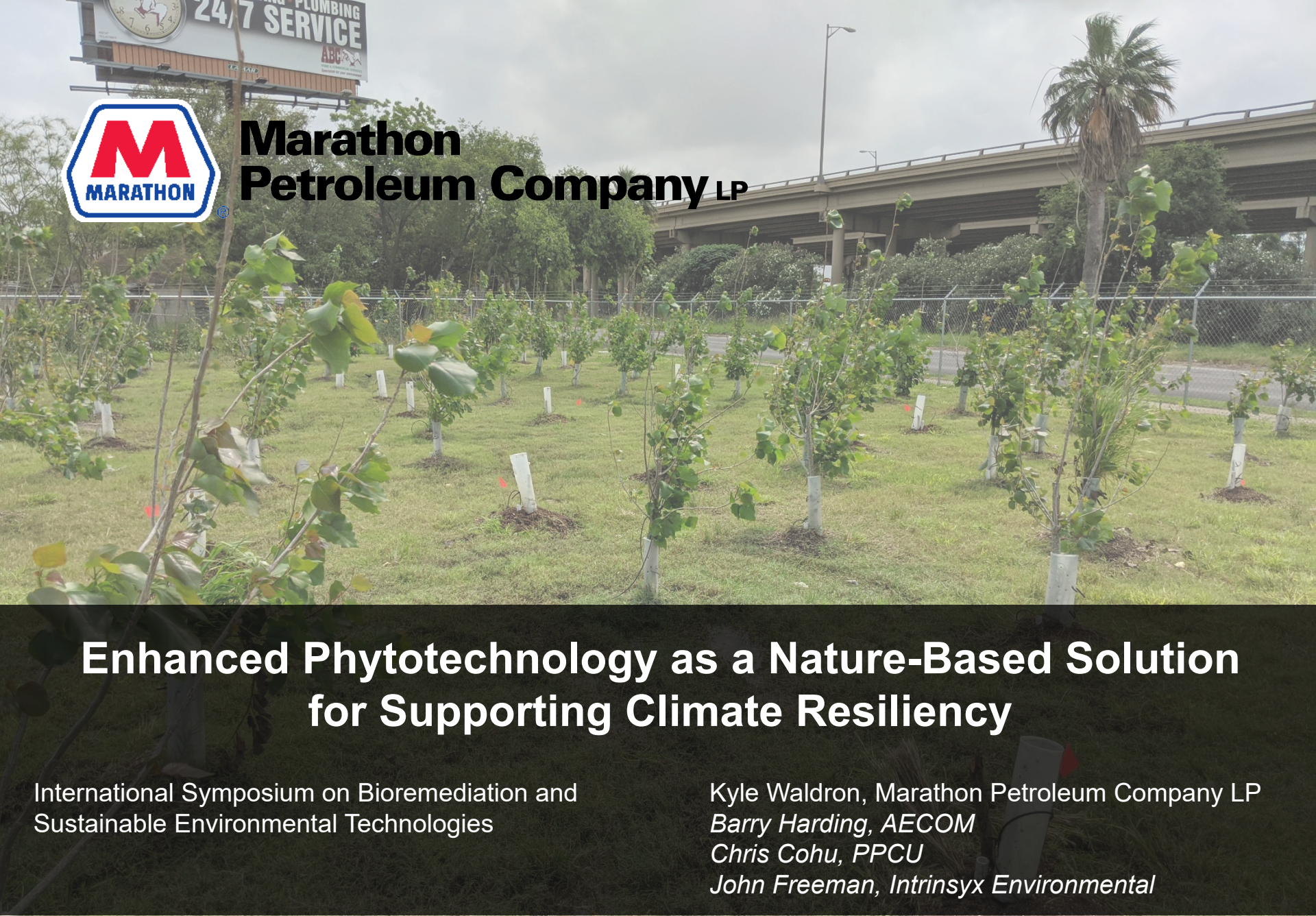


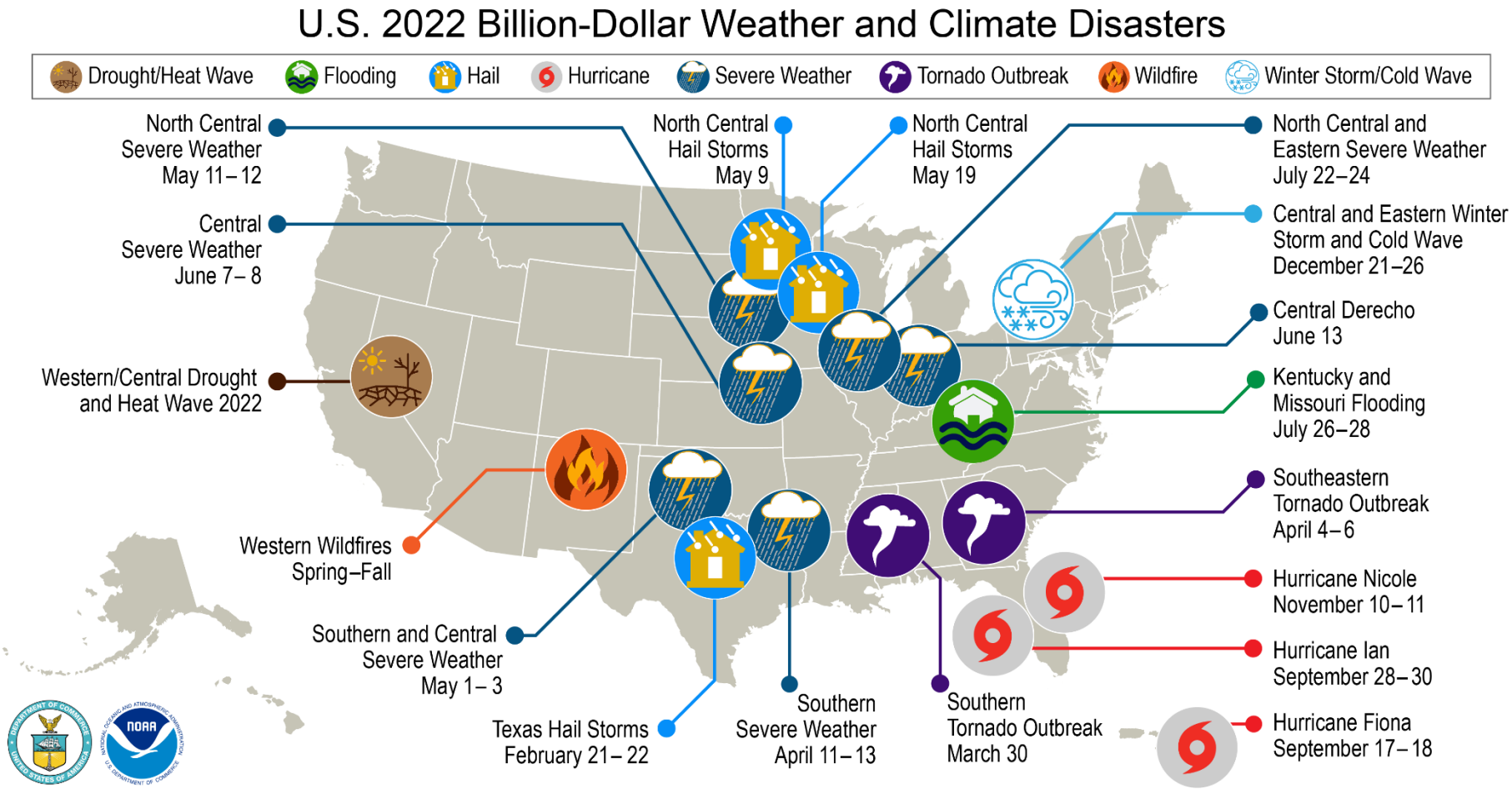
Marathon Petroleum Company LP

Enhanced Phytotechnology as a Nature-Based Solution for Supporting Climate Resiliency

International Symposium on Bioremediation and Sustainable Environmental Technologies

Kyle Waldron, Marathon Petroleum Company LP
Barry Harding, AECOM
Chris Cohu, PPCU
John Freeman, Intrinsyx Environmental

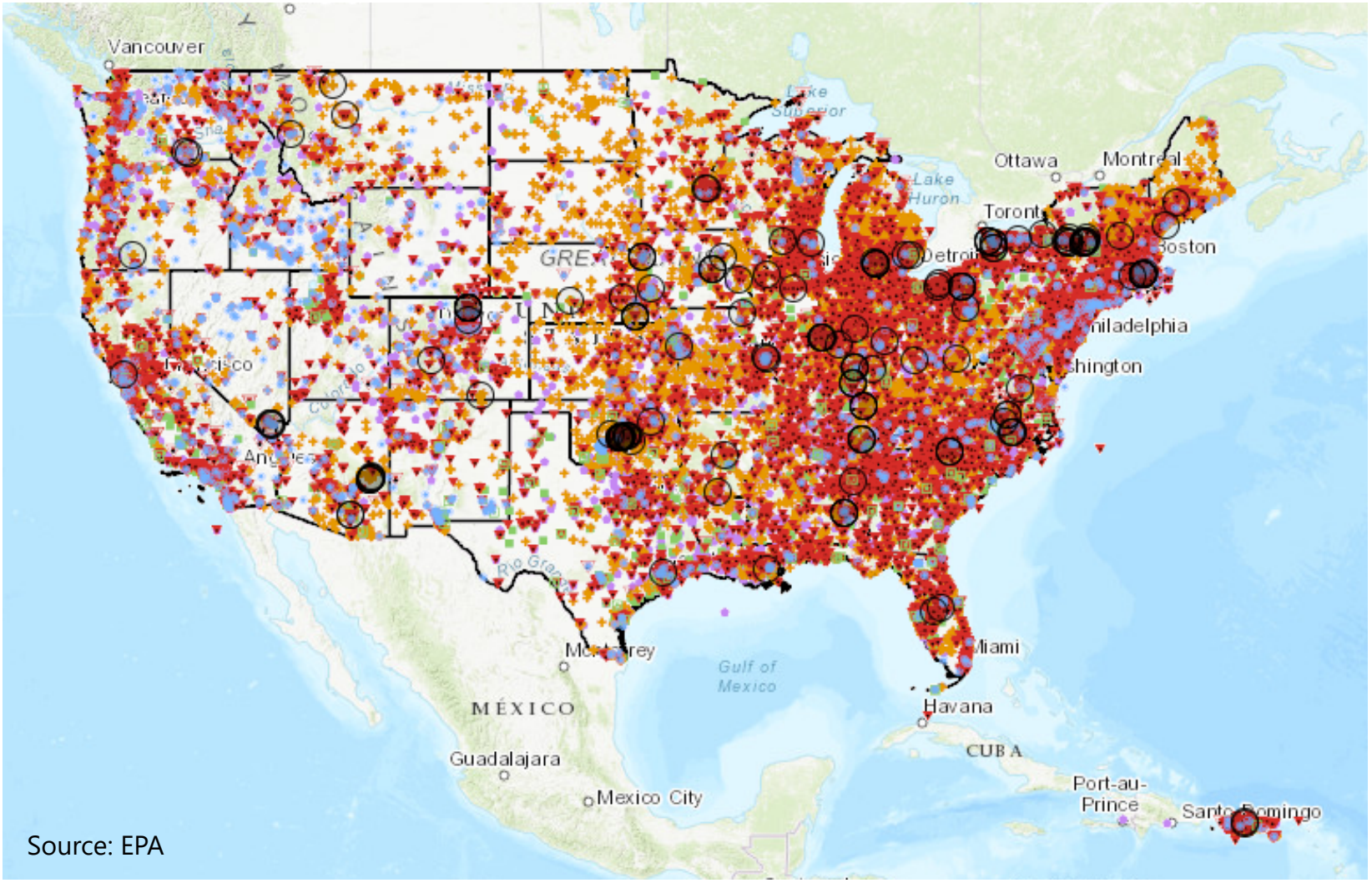
US Climate Events



*This map denotes the approximate location for each of the **18 separate billion-dollar weather and climate disasters that impacted the United States in 2022.***

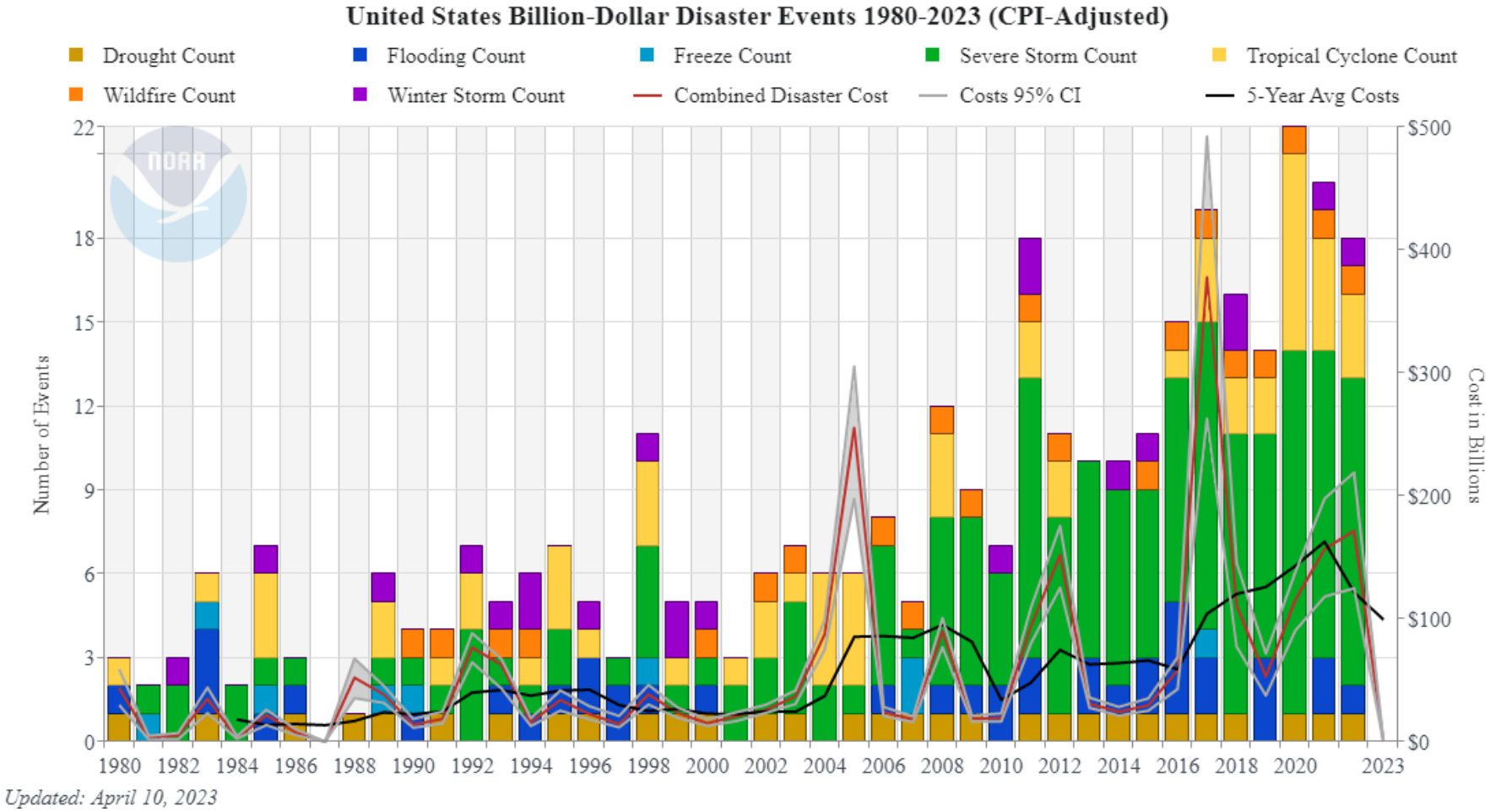
Source: NOAA

Hazardous Waste Cleanup Sites



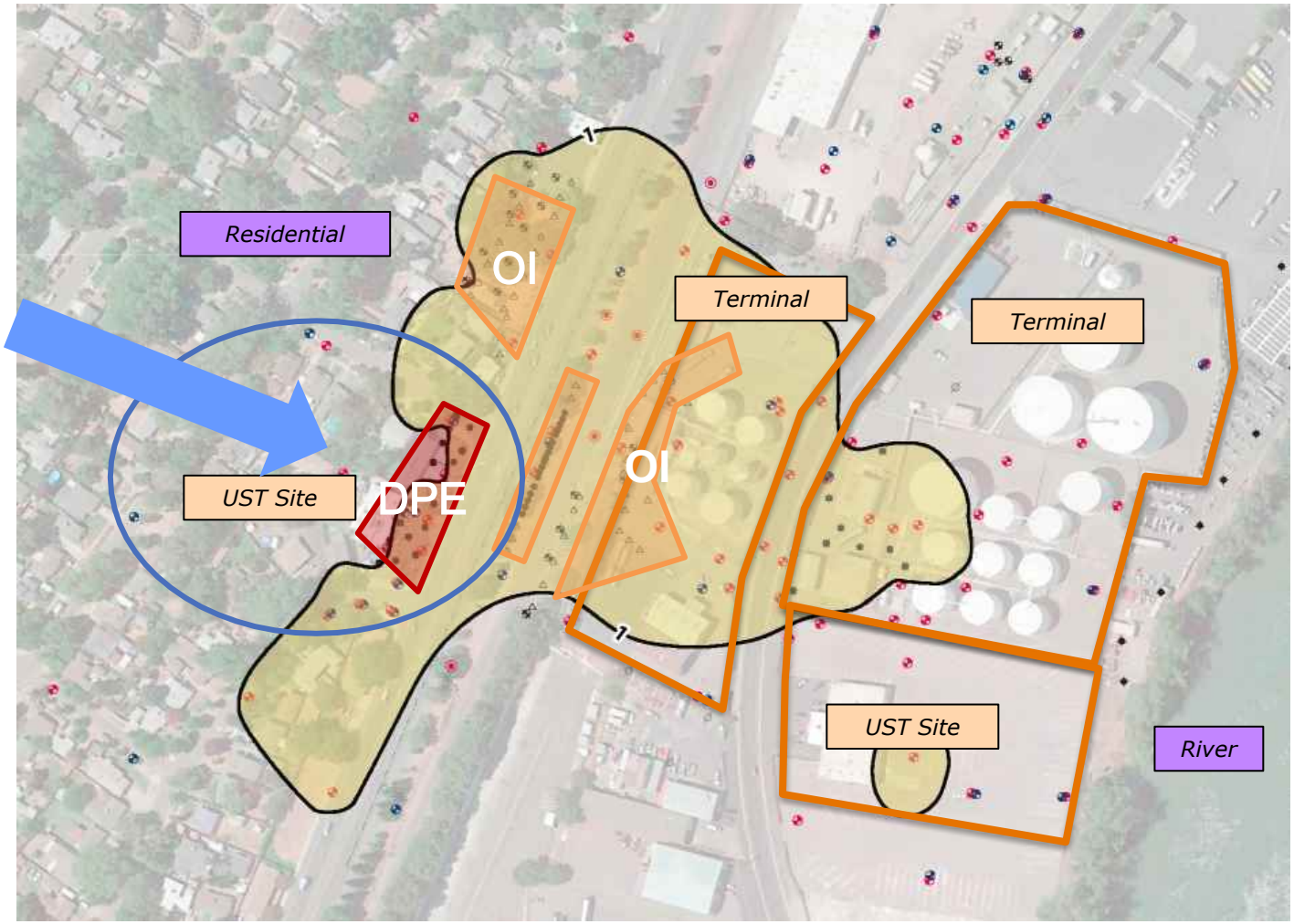
Source: EPA

Cost of Climate Events

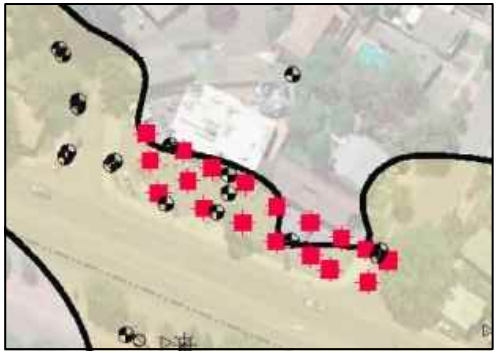


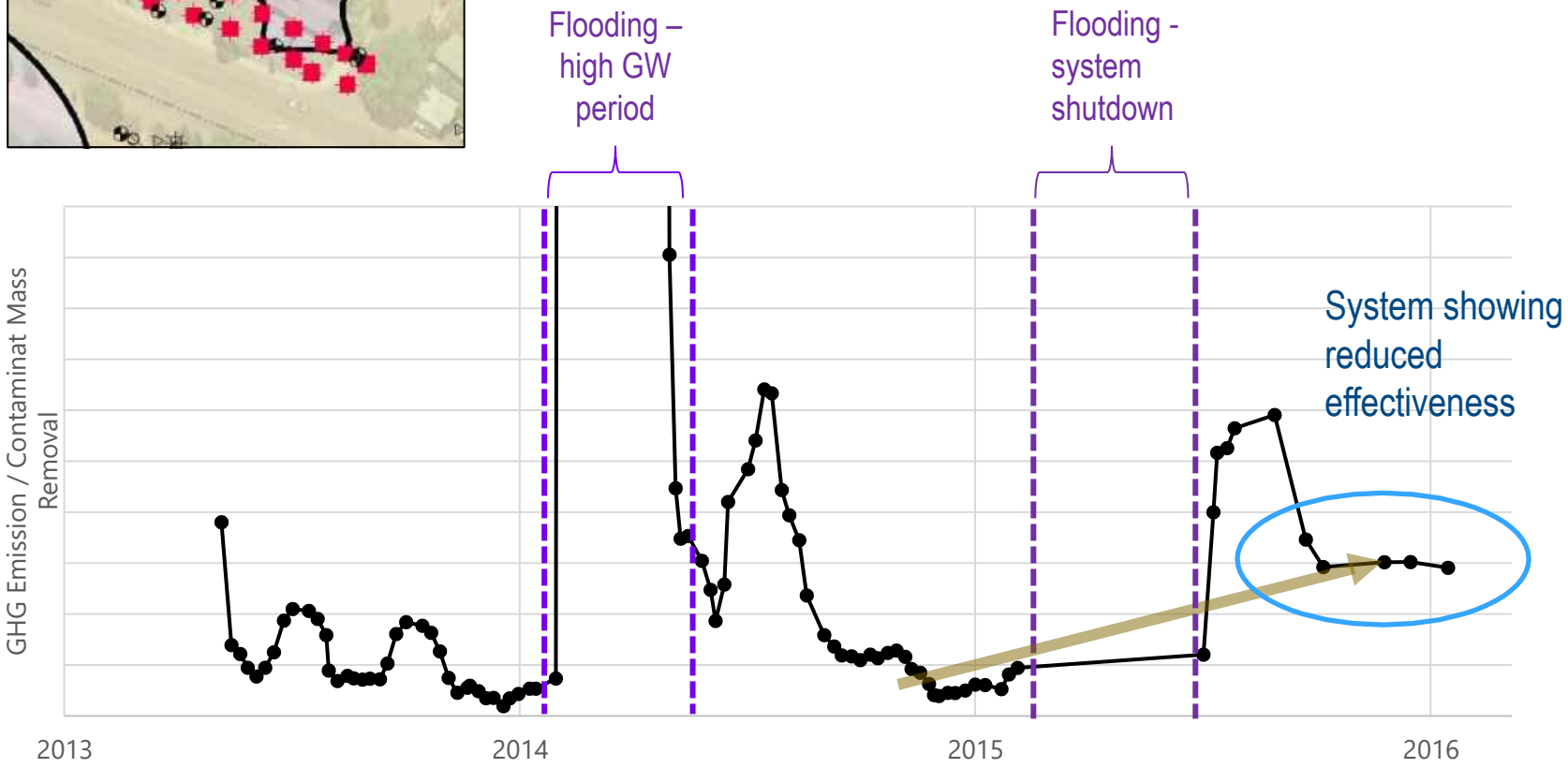
Source: NOAA

Petroleum Terminal – Energy Intensive Remediation Systems



DPE Remediation – Emissions per Contaminant Mass Removal

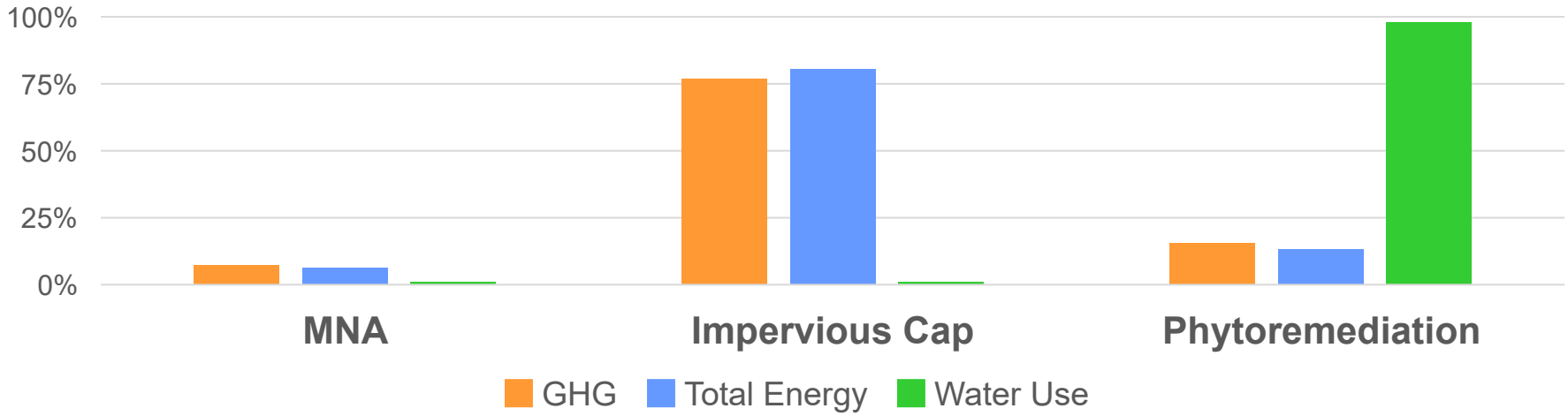




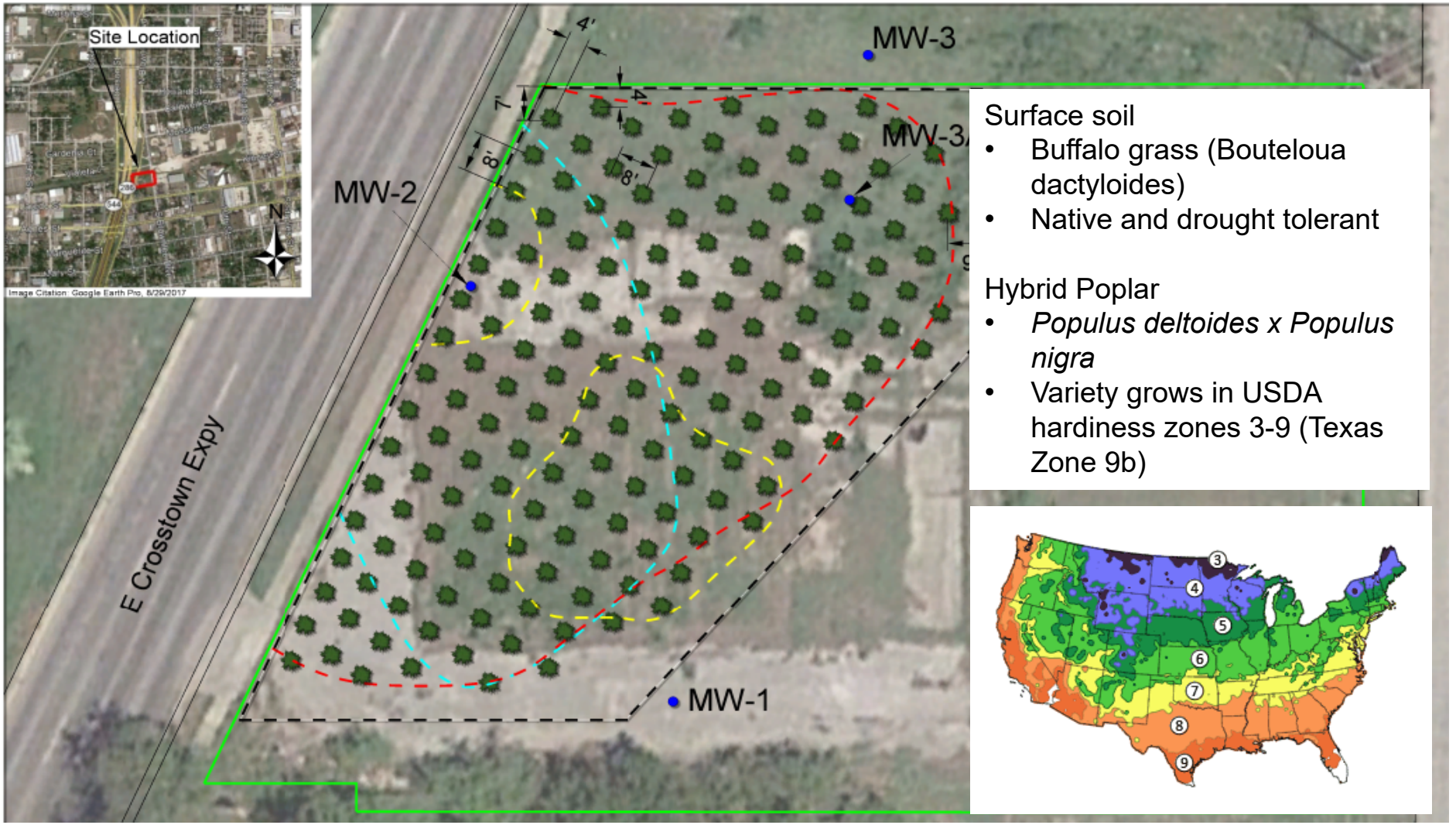
Former Bulk Fuel Storage Terminal Located along the Gulf Coast

Alternatives Evaluation

MNA	Impermeable Cap	Phytoremediation
No disturbance	Short term effectiveness, but requires maintenance in perpetuity	Long term effectiveness
Natural attenuation occurring	Prevents direct contact exposure to contaminated soil	Lower environmental impact for most metrics (vs cap)
Challenges with regulatory acceptance	Cap inhibits attenuation rates	Treats soil and groundwater
		Resilient to weather events



Phytoremediation System



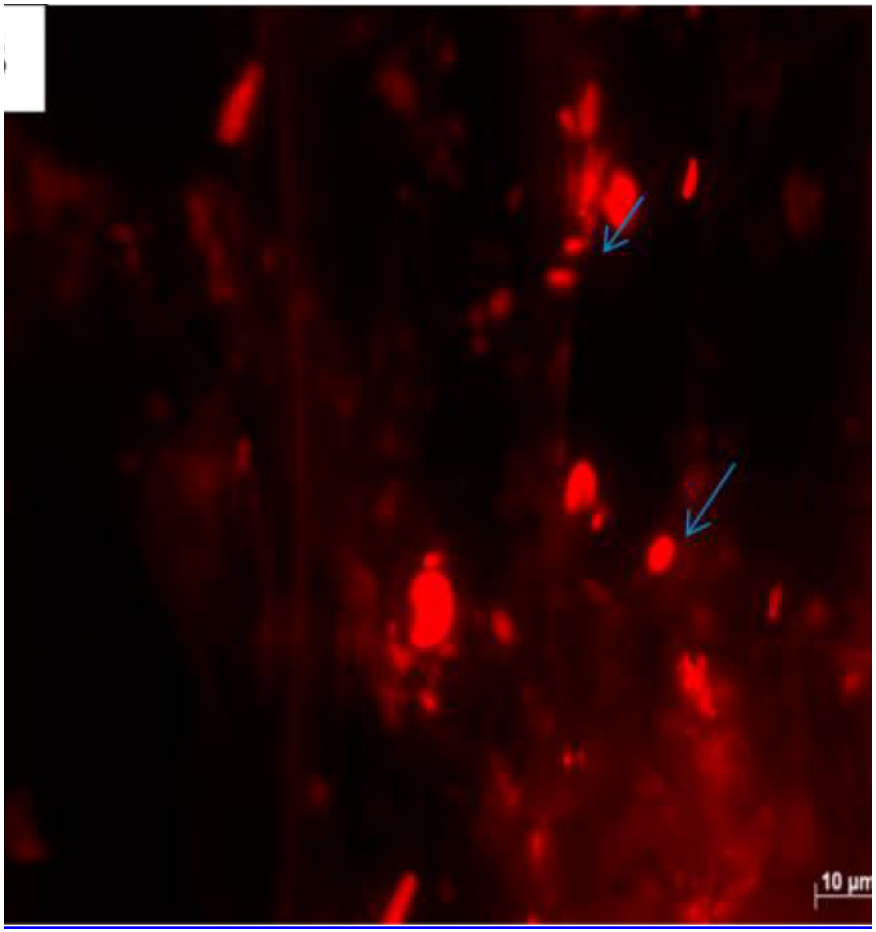
Surface soil

- Buffalo grass (Bouteloua dactyloides)
- Native and drought tolerant

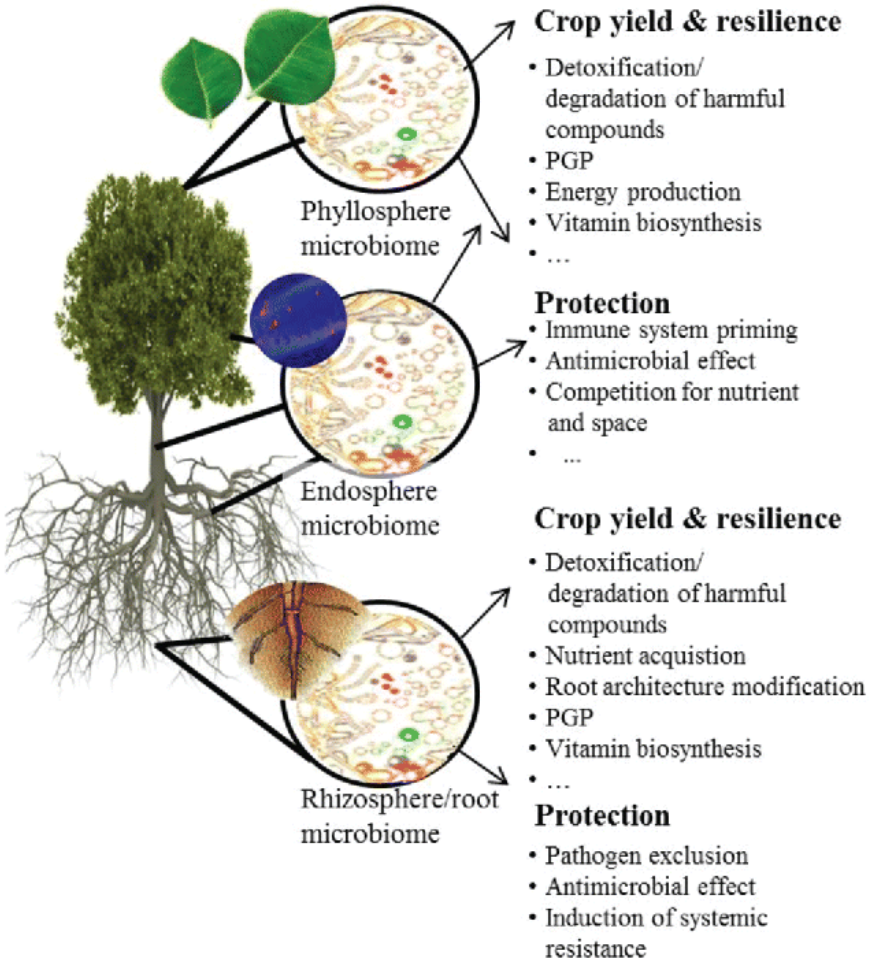
Hybrid Poplar

- *Populus deltoides x Populus nigra*
- Variety grows in USDA hardiness zones 3-9 (Texas Zone 9b)

Endophyte Assisted Phytoremediation



Khan, Zareen et al. “Degradation, phytoprotection and phytoremediation of phenanthrene by endophyte Pseudomonas putida, PD1.” *Environmental science & technology* vol. 48,20 (2014): 12221-8. doi:10.1021/es503880t

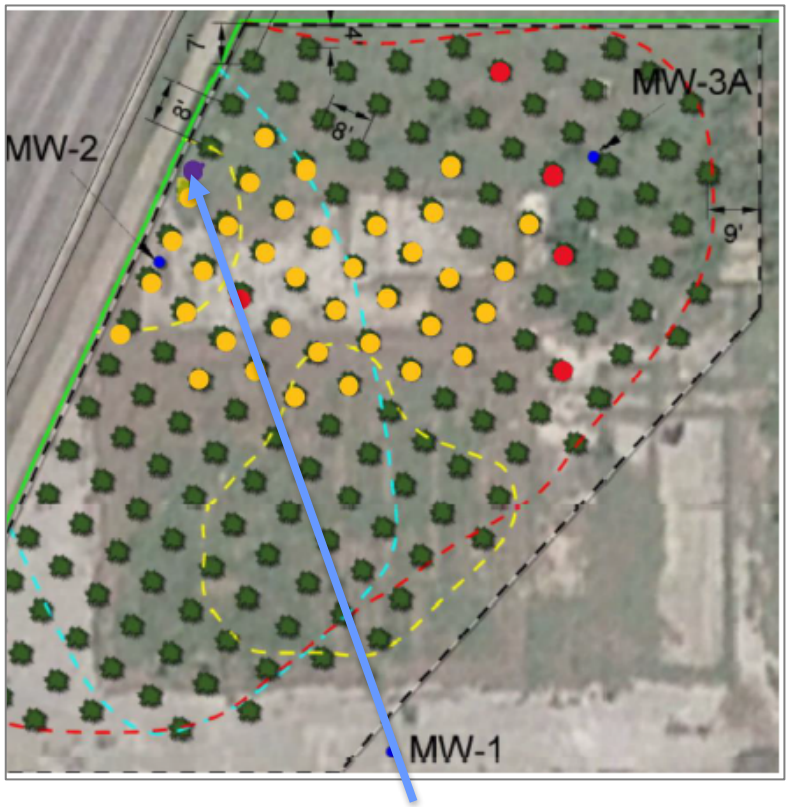


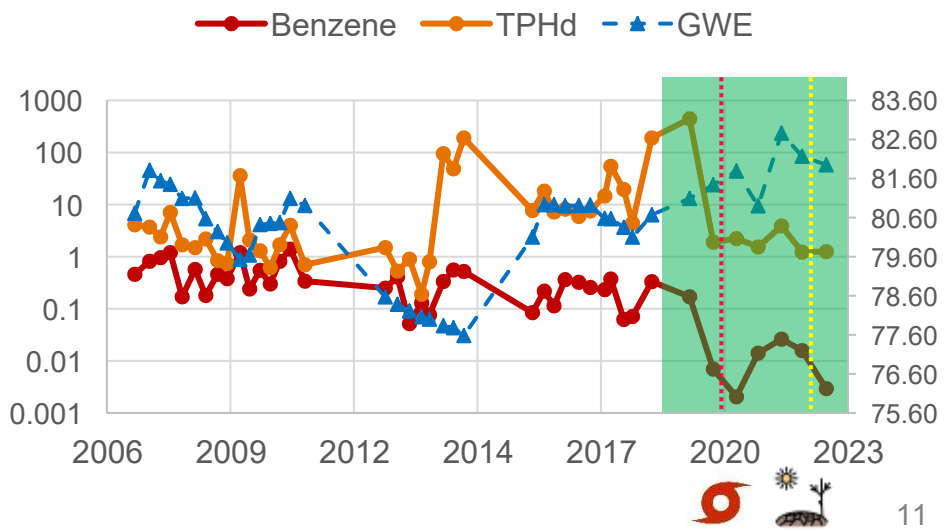
Thijs, Sofie et al. “Phytoremediation: State-of-the-art and a key role for the plant microbiome in future trends and research prospects”, *International Journal of Phytoremediation*, 19:1, 23-38, (2017) DOI: 10.1080/15226514.2016.1216076


2019


2020


2021


MW-2
MW-3A
MW-1
7'
8'
8'
9'

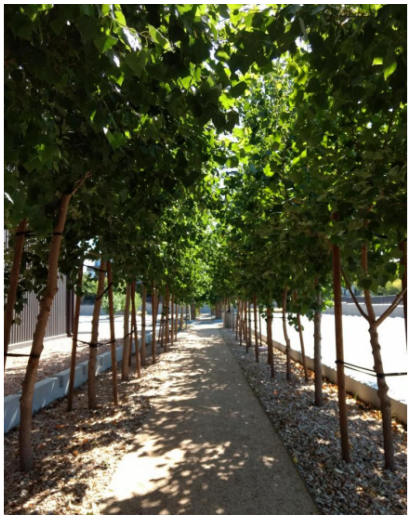

Benzene
TPHd
GWE
1000
100
10
1
0.1
0.01
0.001
83.60
82.60
81.60
80.60
79.60
78.60
77.60
76.60
75.60
2006
2009
2012
2014
2017
2020
2023

Incorporating Solutions into Future Site Use

Full scale sites

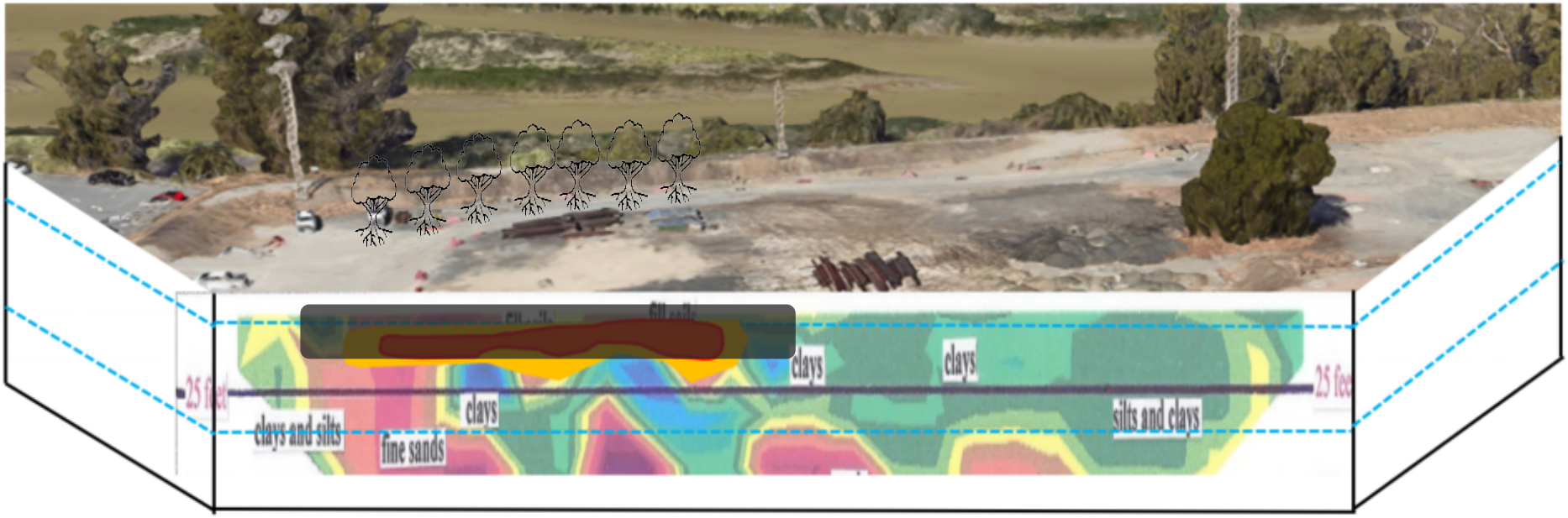
Source: Trihydro

Integration into reuse



Source: Intrinsyx; PPCU

Application of Multiple Bioremediation Technologies



Final Thoughts

Future Opportunities

- Metrics –
  - remedial footprint / unit of contaminant mass removal
- Bioremediation research
  - Microbiome optimization
  - Improving biodiversity
  - Adaptability based on changing conditions
- Considerations:
  - Green gentrification
  - Remedy appropriate to climate concern

Resources

- ITRC – Sustainable Resilient Remediation Guidance
  - State resource map
- SURF (Sustainable Remediation Forum) –
  - Case Studies
  - White papers
  - EJ initiative