



Biogeochemical Controls on Degradation of Chlorobenzenes in a Freshwater Wetland

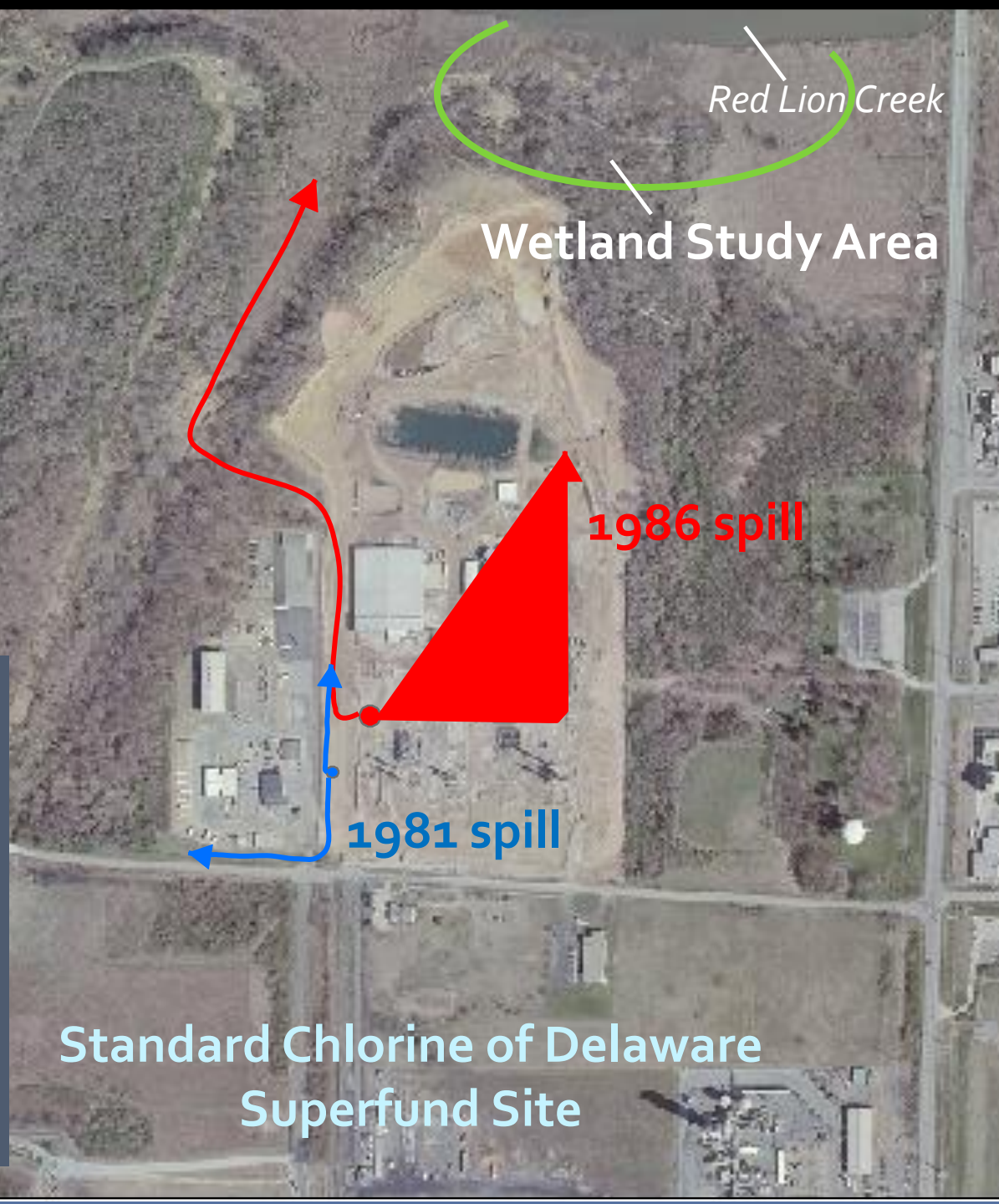


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*in Cooperation with
USEPA, Region III*

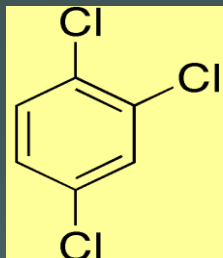


- Chemical plant built in 1965 to manufacture chlorinated benzenes
- Two major spills: 1981 (railroad tanker); 1986 (storage tanks- 579,000 gal)
- Superfund site in 1987



Objectives

- Contaminant distribution and movement in wetland
- Natural biodegradation potential in wetland
- Potential use of biostimulation or bioaugmentation, including use of WBC-2 culture



Trichlorobenzenes *
124TCB, 123TCB



Dichlorobenzenes *
12DCB, 13DCB, 14DCB



Chlorobenzene *

Aerobic
to CO₂

??



Benzene *



CO₂

*** Parent contaminant
at site**

Standard Chlorine of Delaware Wetland Sampling Sites- PDBs, Drivepoints

- Passive diffusion bags (PDBs) and dialysis samplers at 45 sites
- 2 inch drivepoints at 13 sites (plus upland wells)
- Monthly groundwater sampling at 4 sites
- Sediment cores at 2 monthly sites

Red Lion Creek



0 10 20 40 60 80
Meters

Legend

PDB Samples

Total_VOCs_ug_L

- 2.0 - 10.0
- 10.1 - 100.0
- 100.1 - 1000.0
- 1000.1 - 10000.0
- 10000.1 - 100000.0

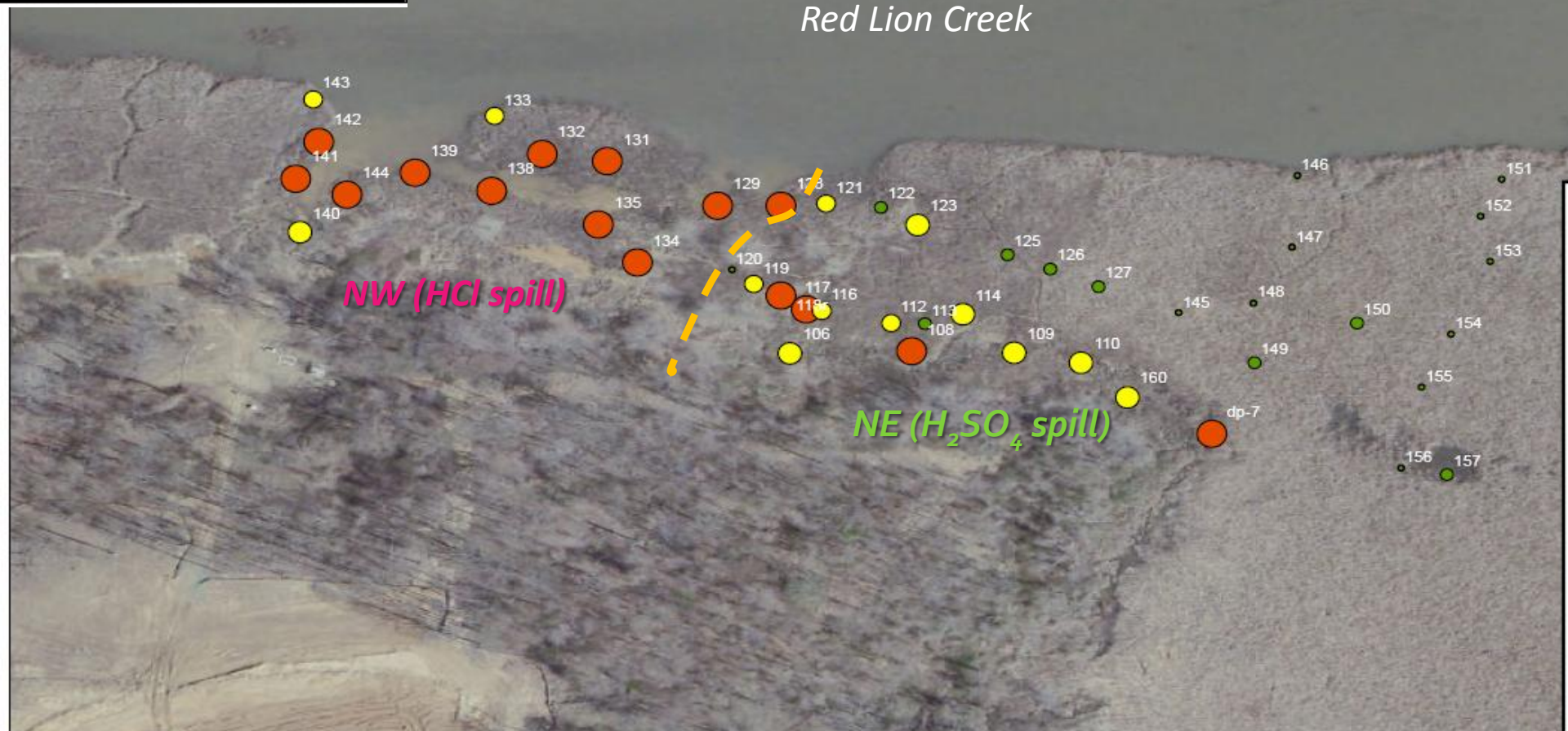


Standard Chlorine of Delaware Wetland PDB Sites- Total Chlorobenzenes and Benzene

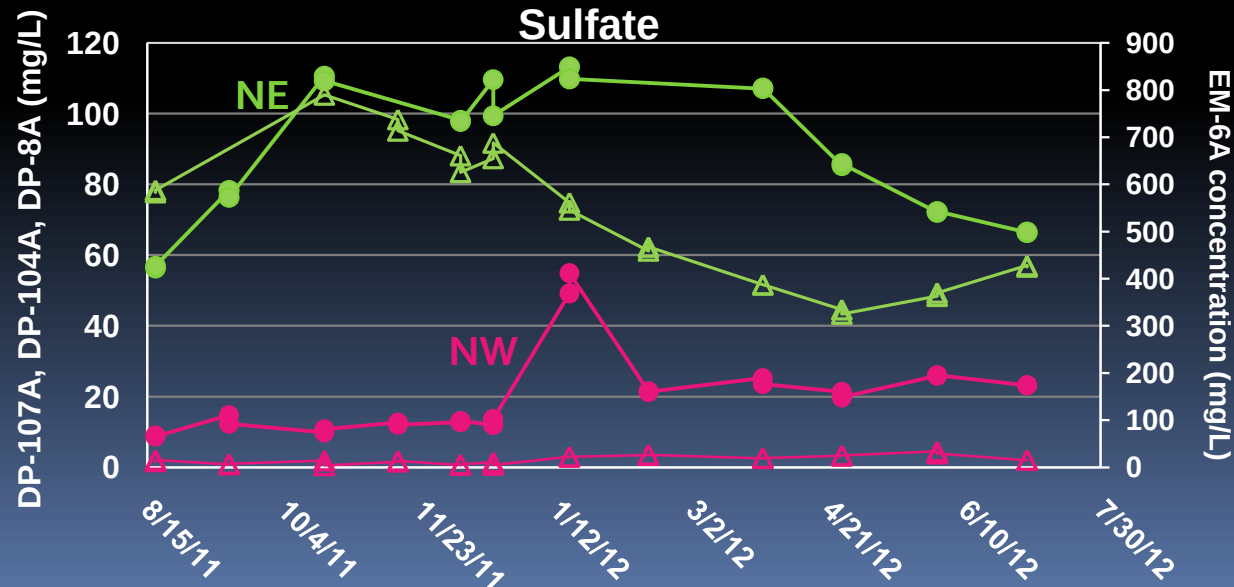
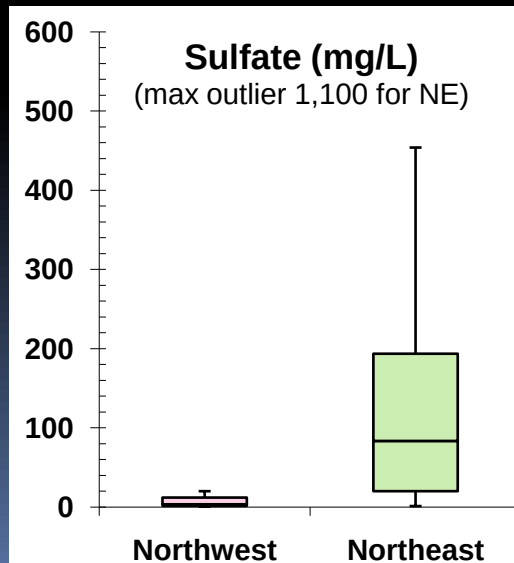
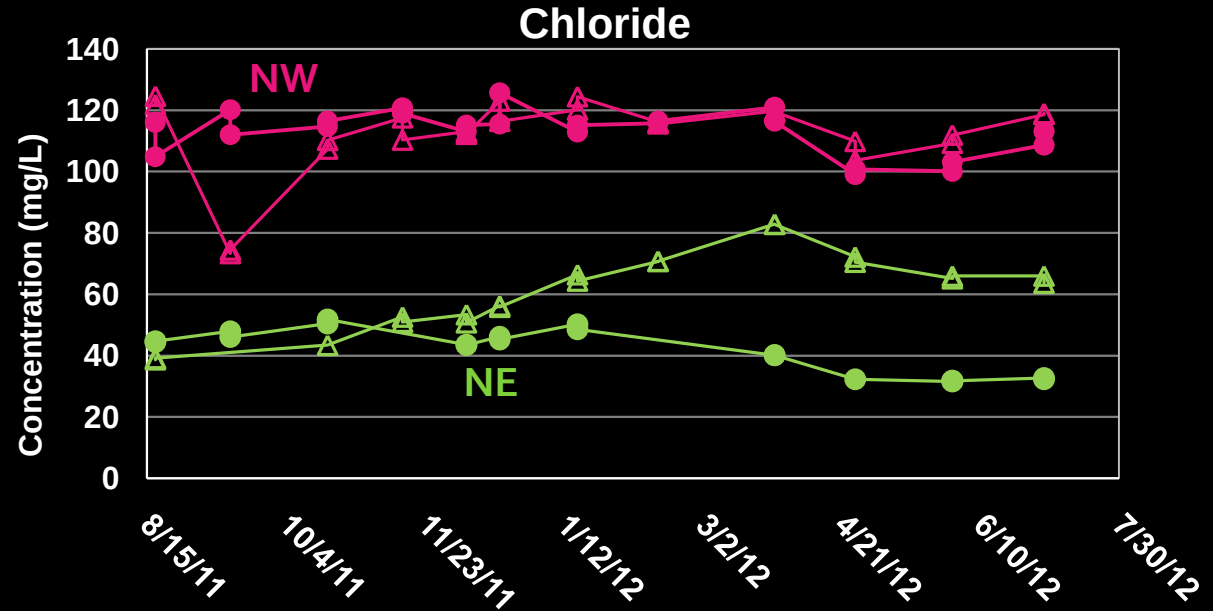
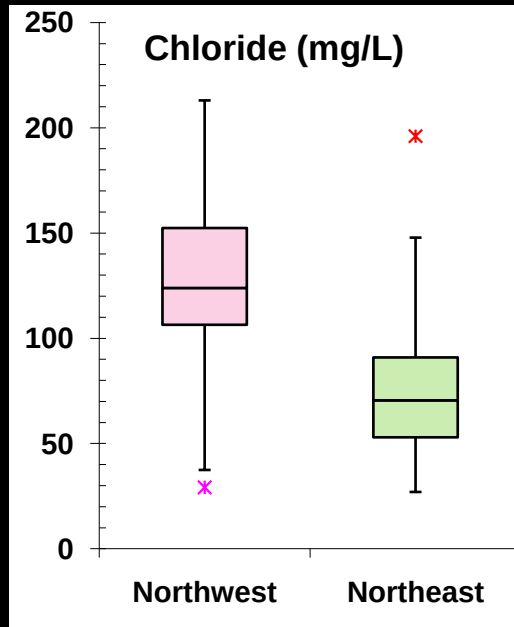
Red Lion Creek

NW (HCl spill)

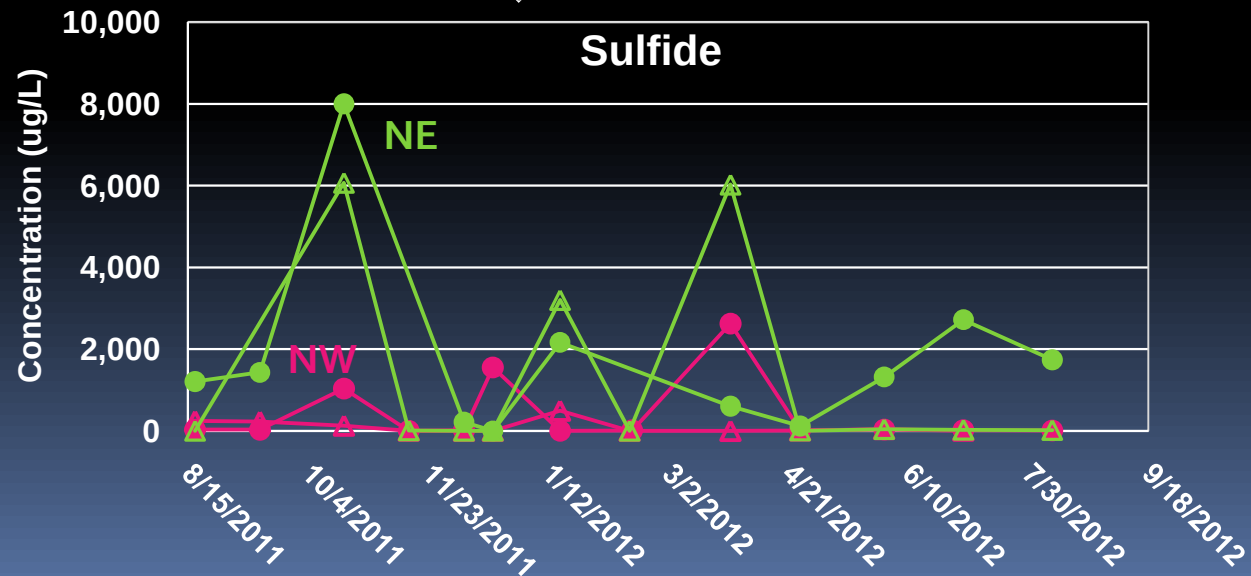
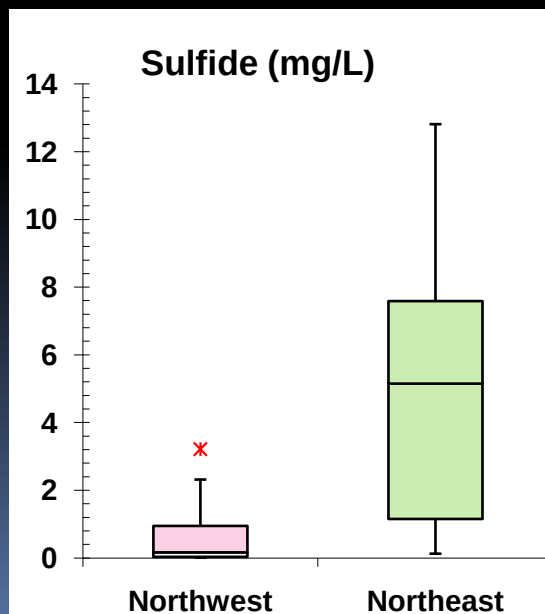
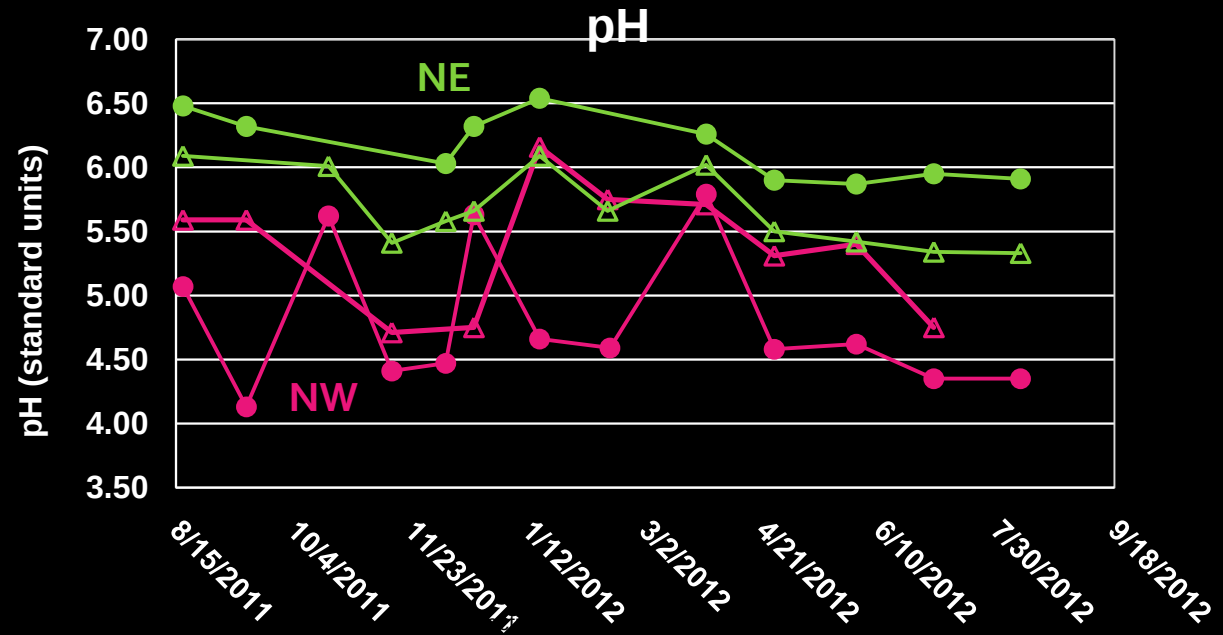
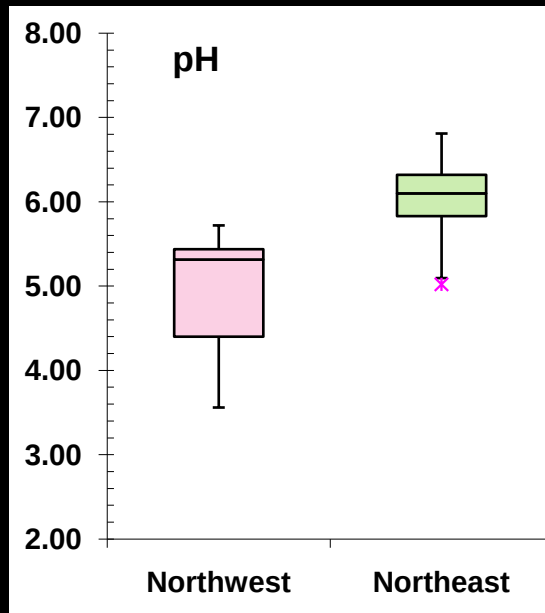
NE (H₂SO₄ spill)



Chloride, Sulfate- Spatial and Temporal

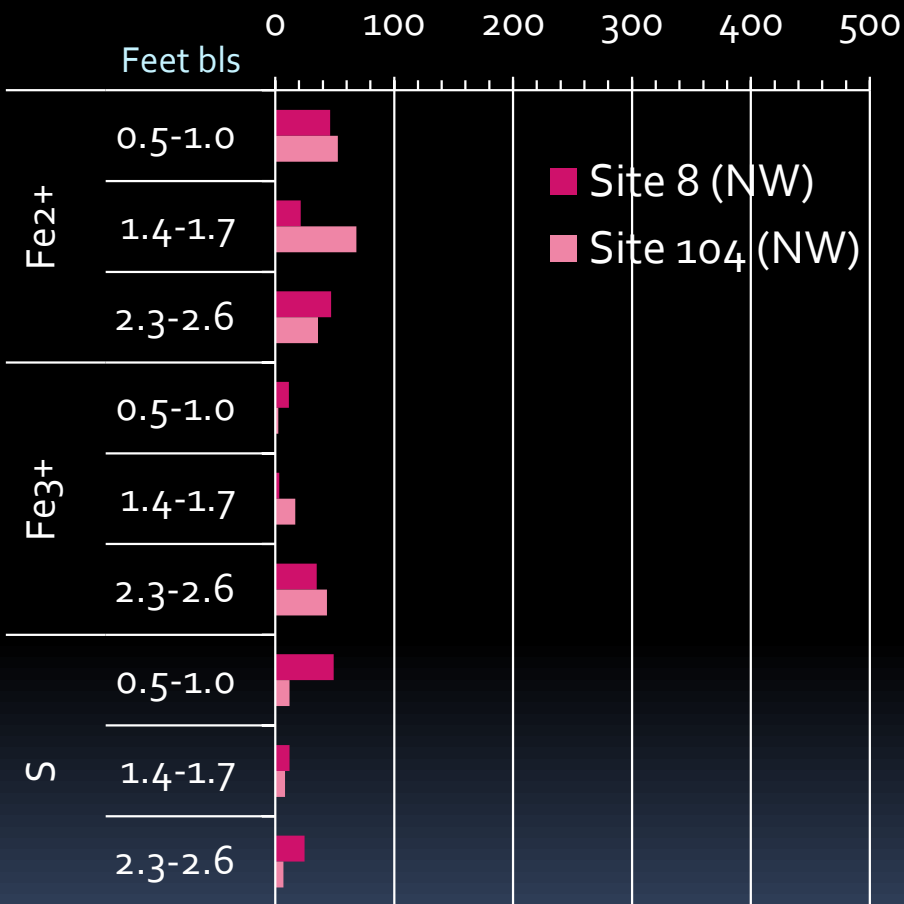


pH, Sulfide - Spatial and Temporal

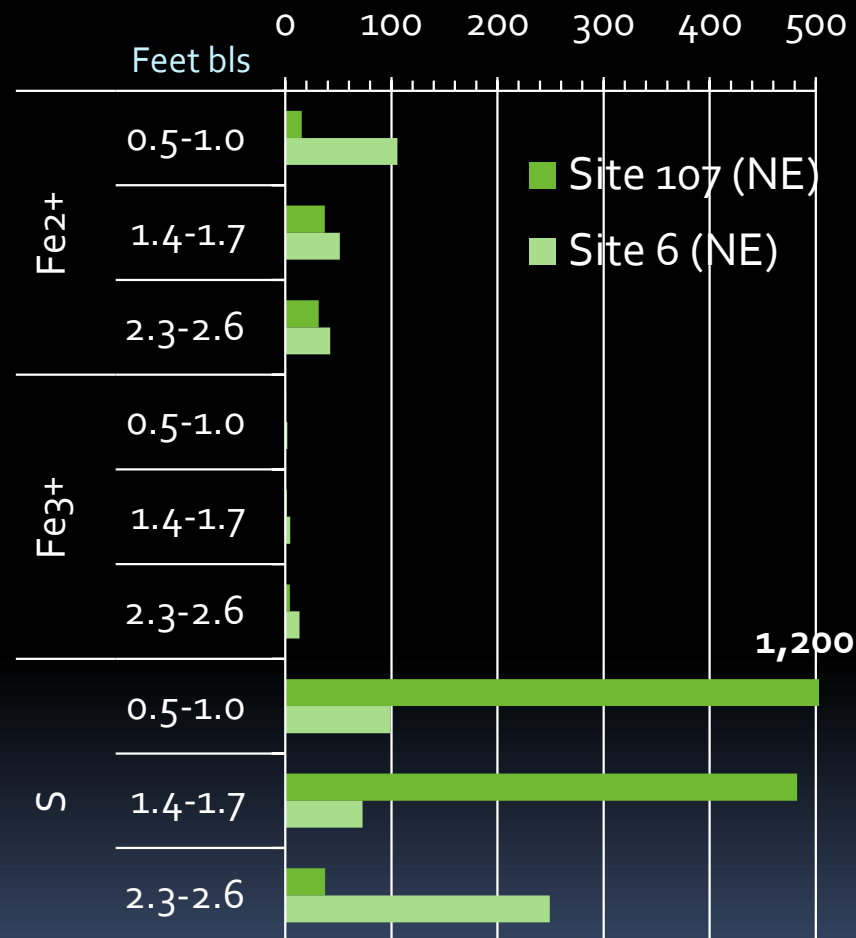


Iron, Sulfide- Sediment Cores

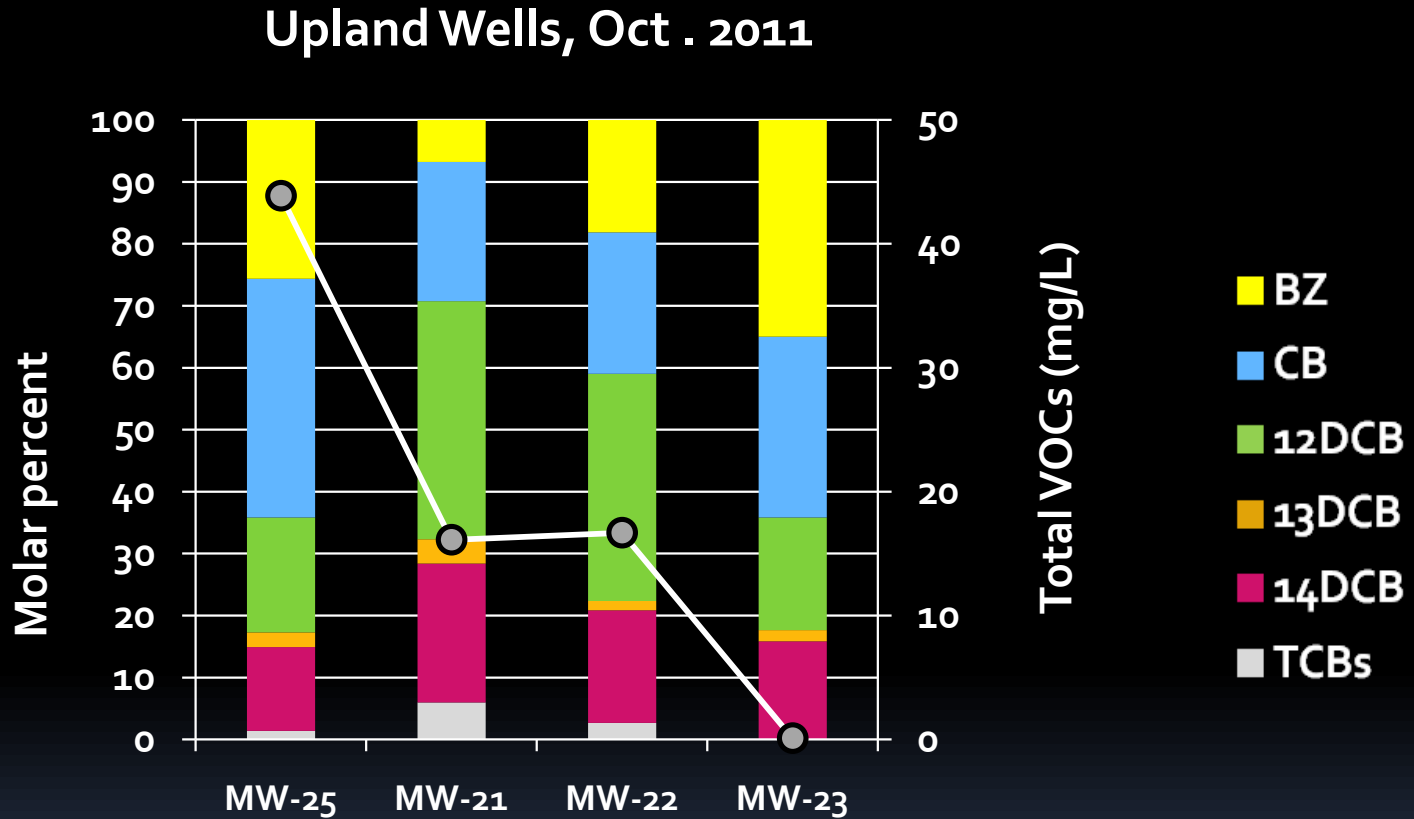
Concentration, $\mu\text{mol/g}$



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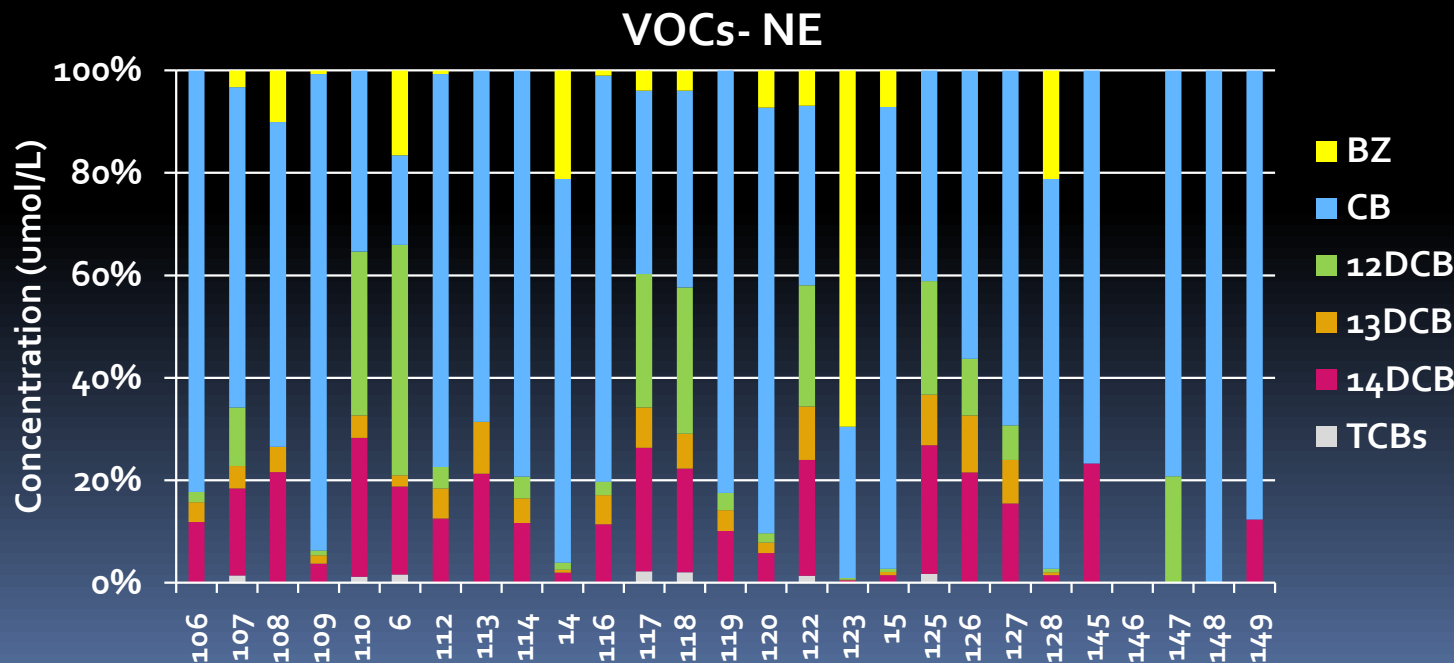
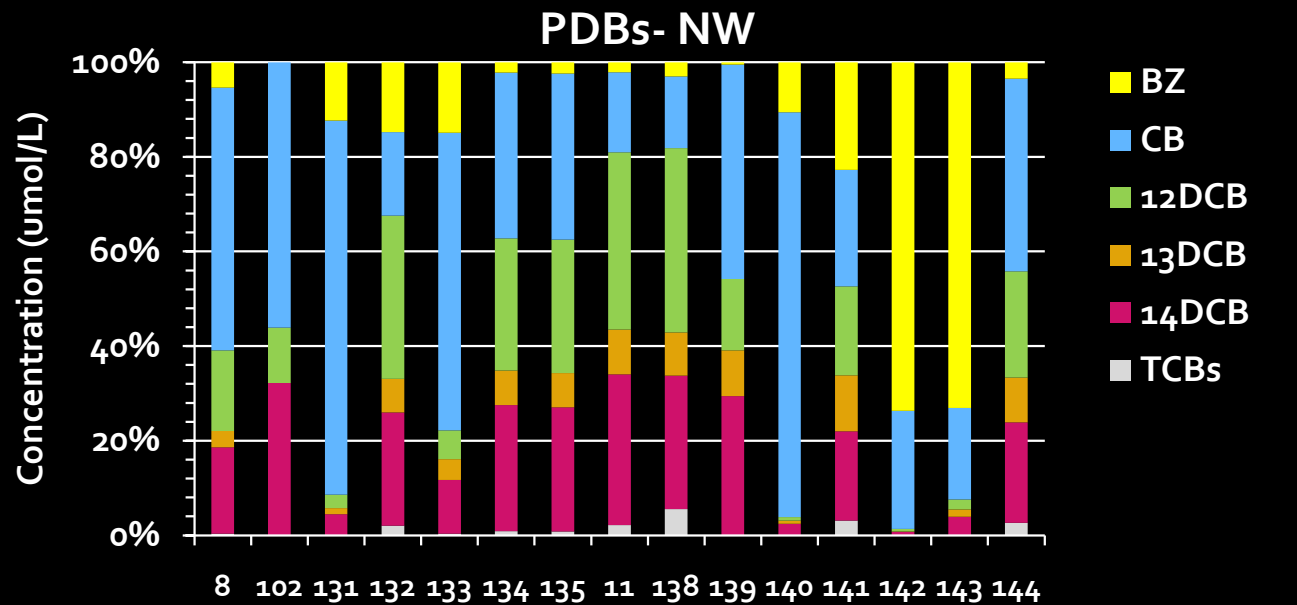
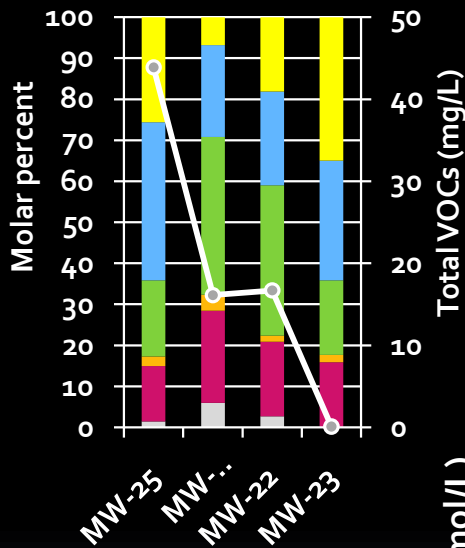


VOC Composition- Molar Percent, Upland Wells



VOCs- PDBs, October 2011

Upland Wells, Oct . 2011



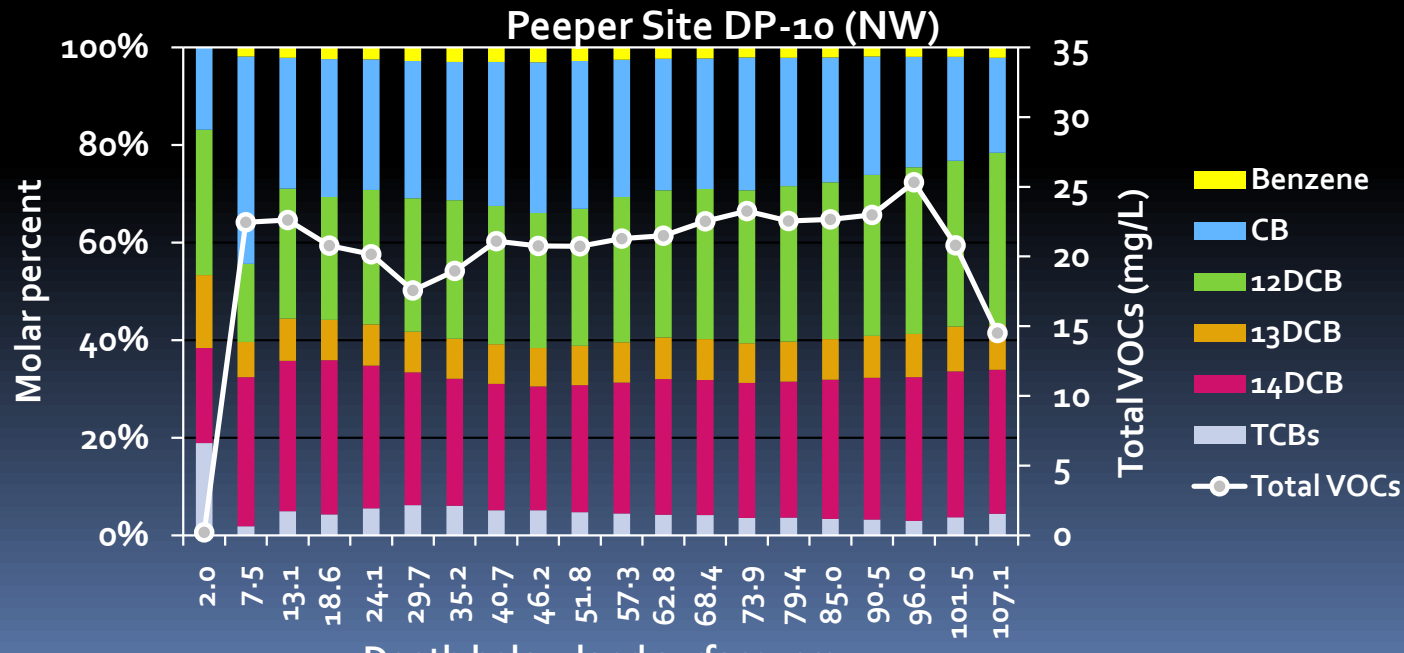
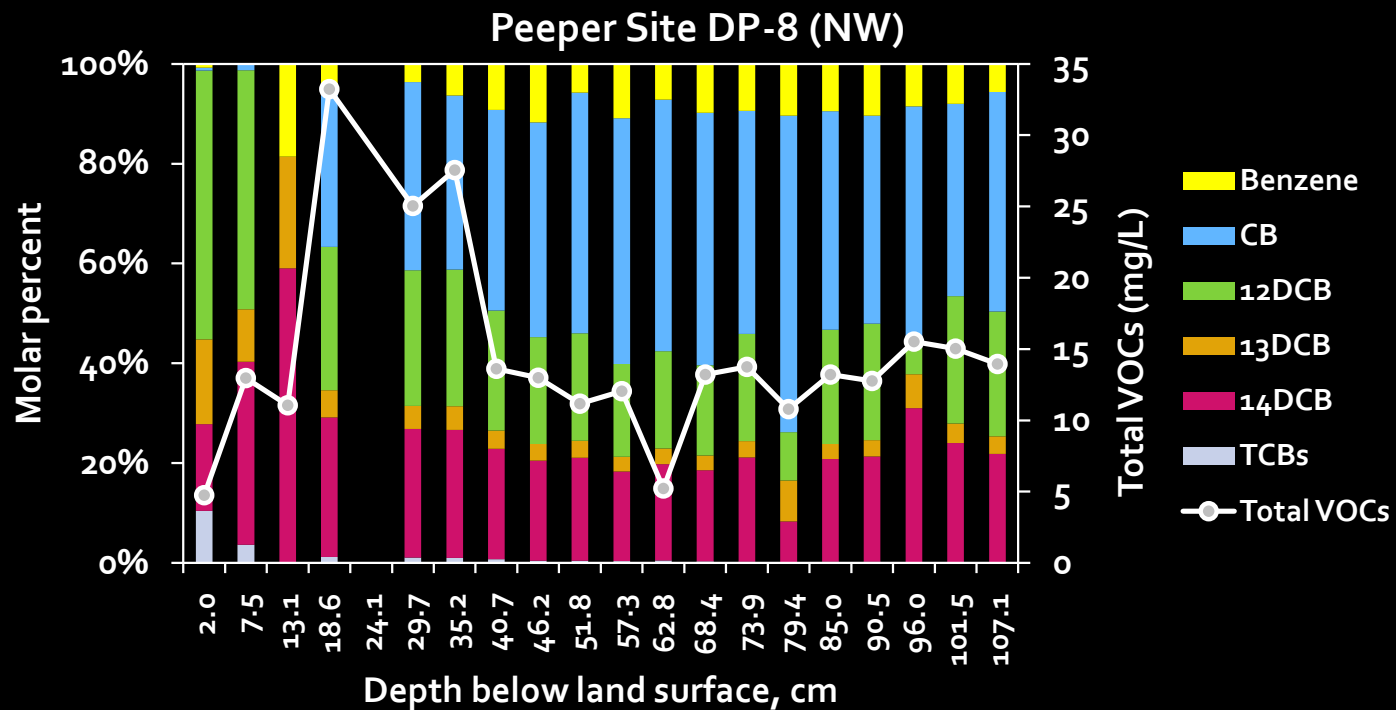
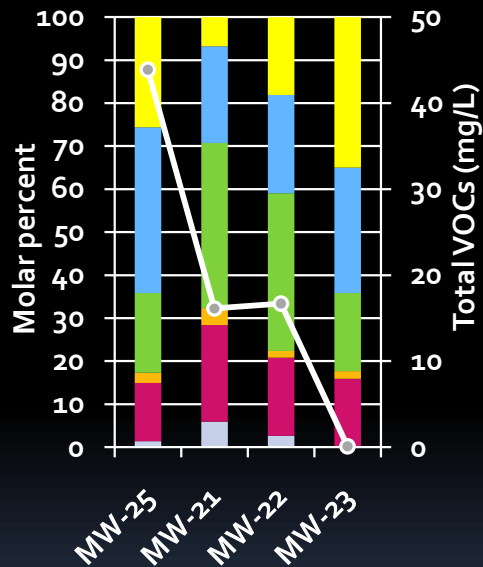
Standard Chlorine of Delaware Wetland Sampling Sites-Peepers

Red Lion Creek



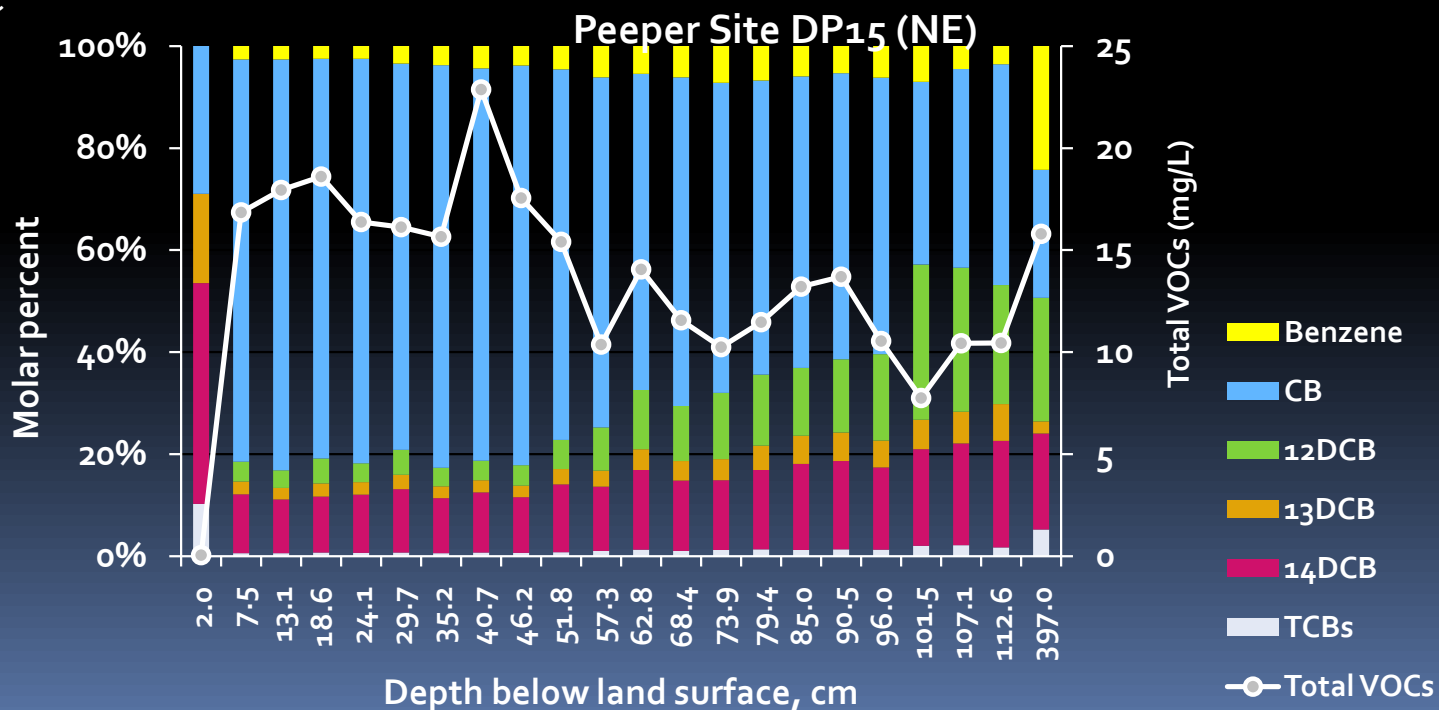
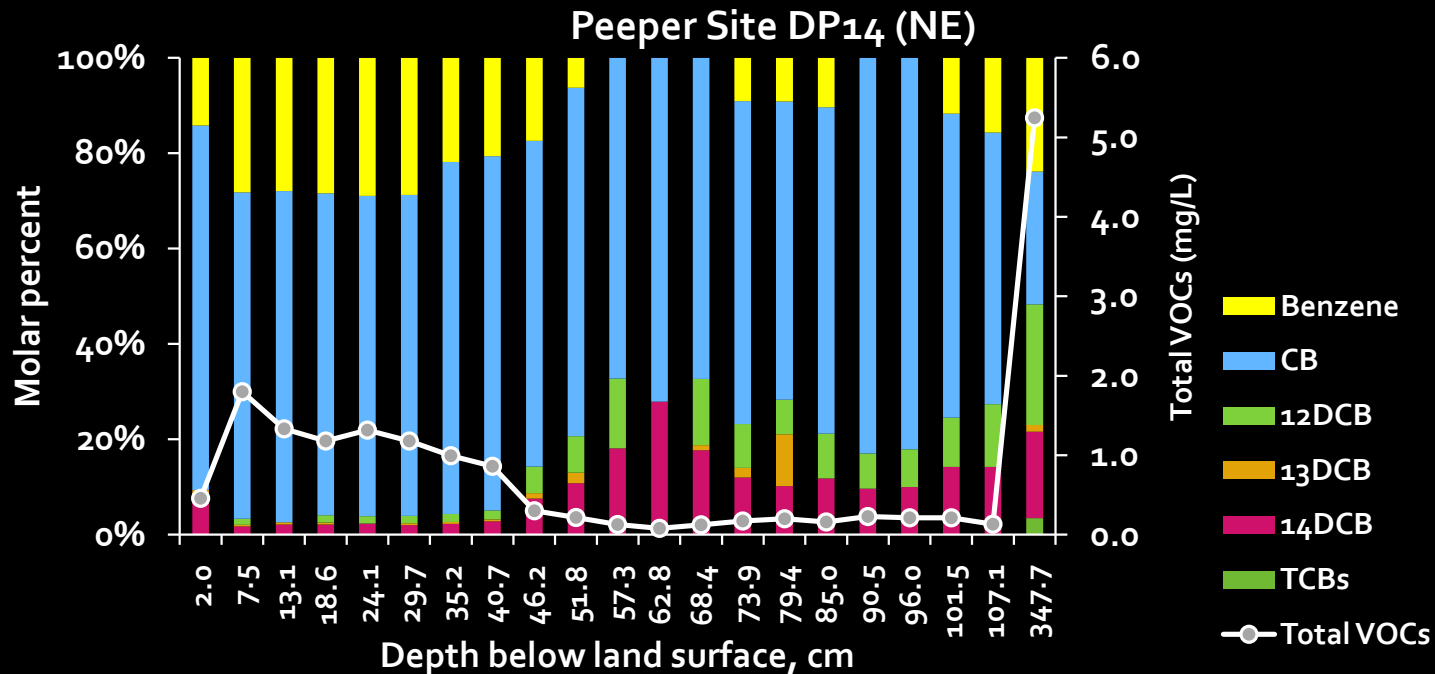
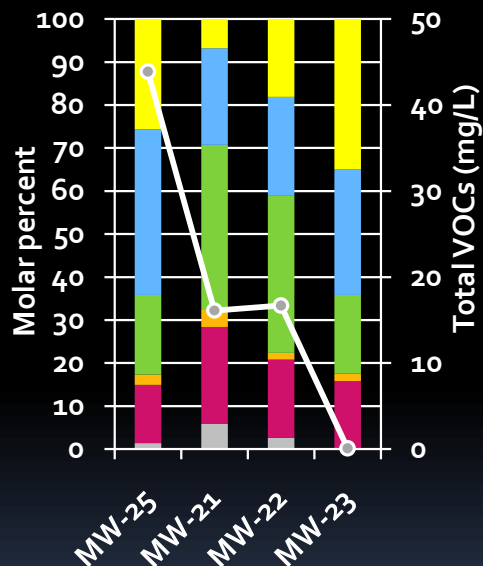
VOCs - Northwest Peepers, Oct.-Dec. 2011

Upland Wells, Oct. 2011

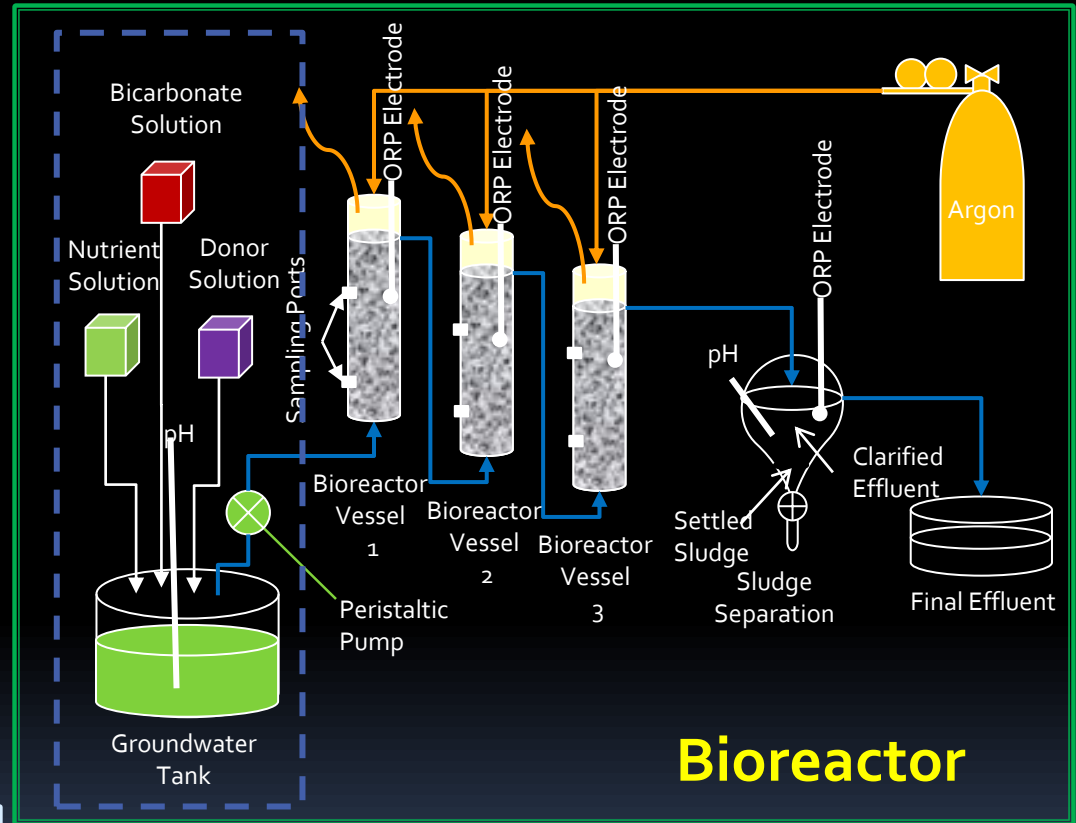
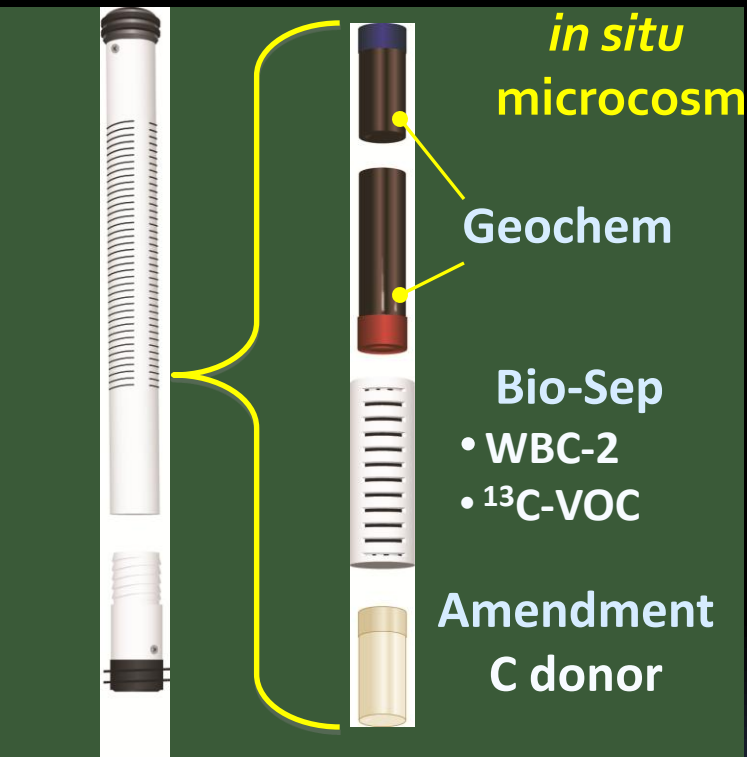


VOCs - Northeast Peepers, Oct.-Dec. 2011

Upland Wells, Oct . 2011



Methods- Field and Laboratory Experiments



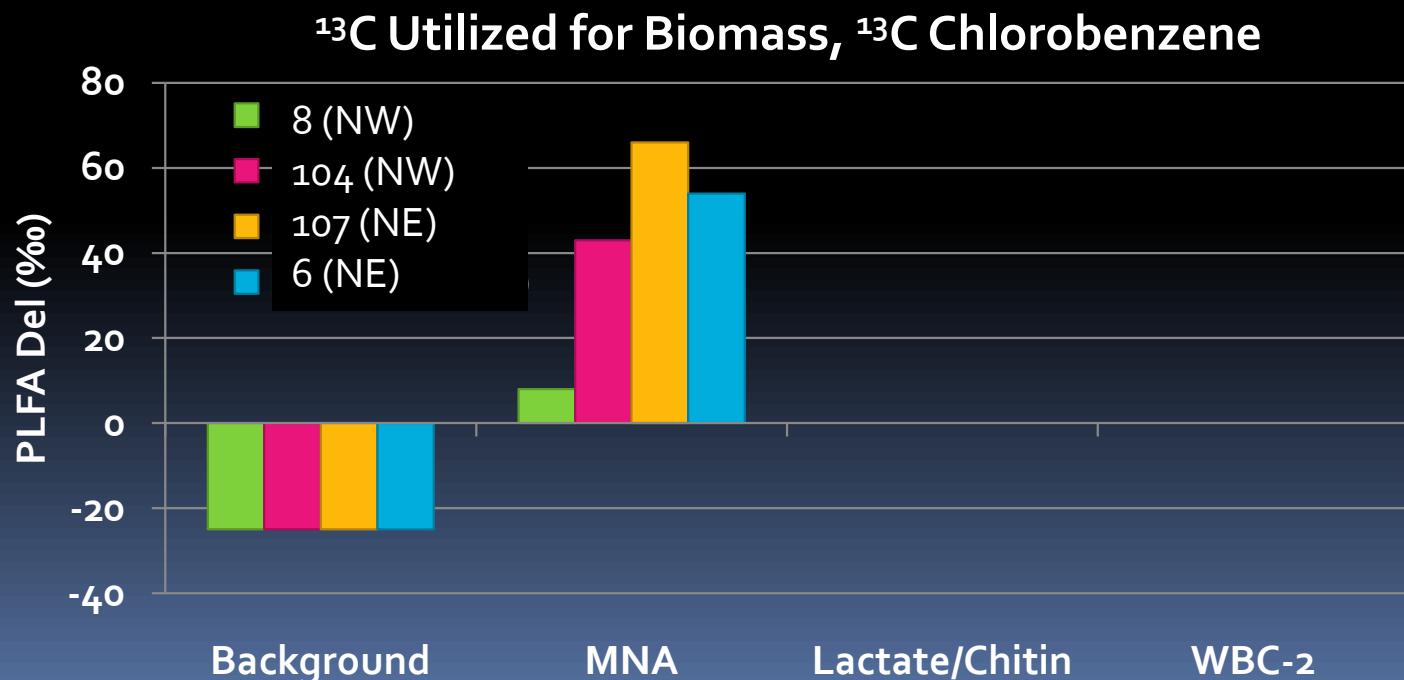
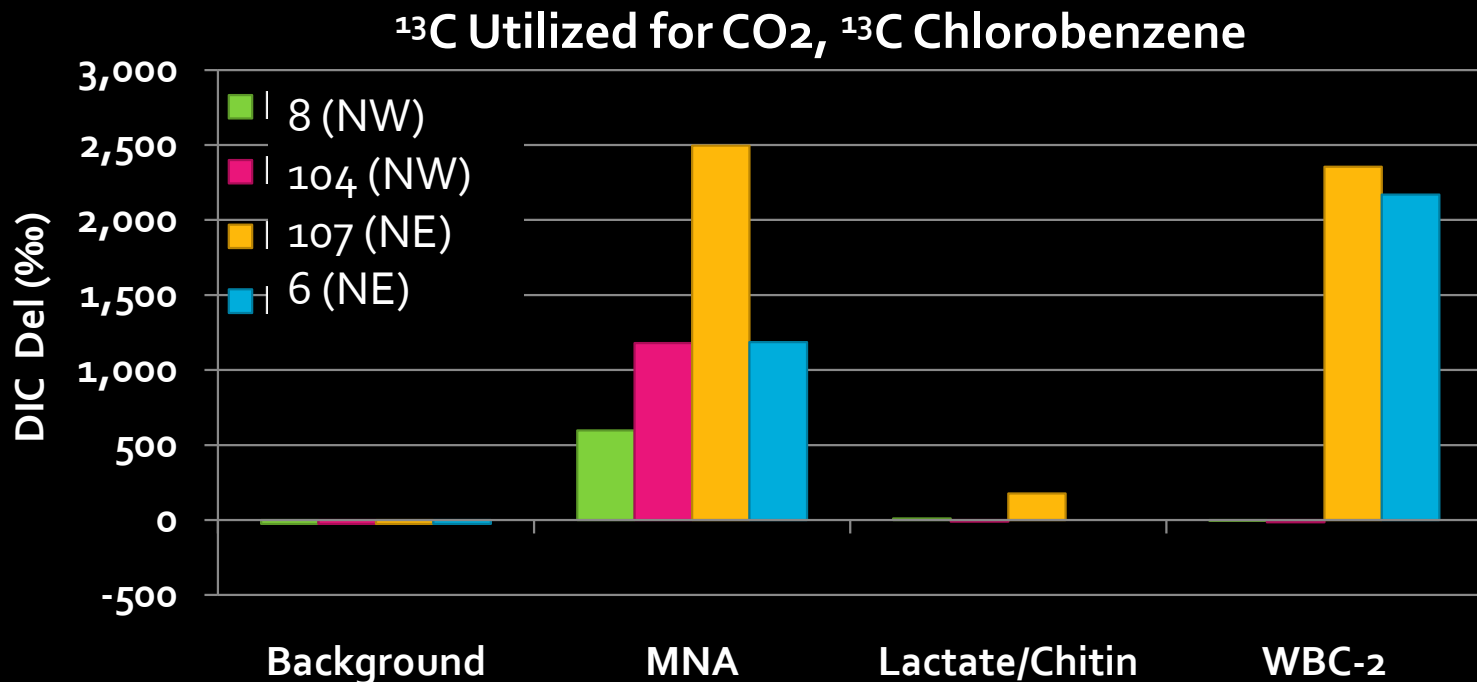
Bio-Sep® beads provide a large surface area for microbial attachment



Polyethylene support matrix seeded with native microorganisms or WBC2

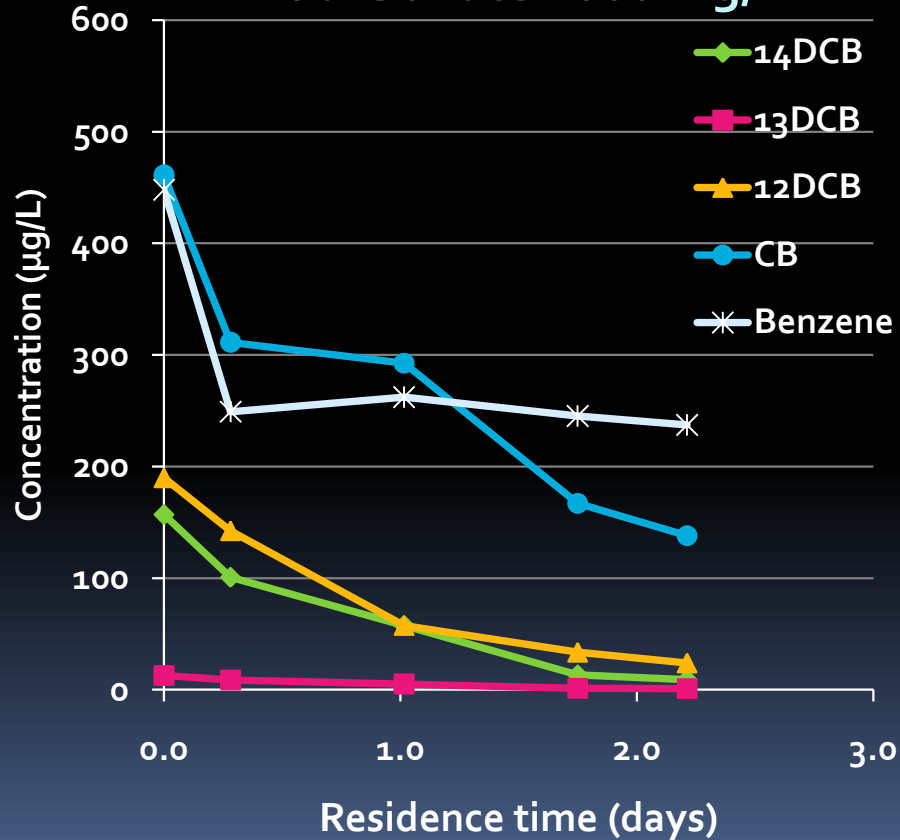
■ Oct. -
 Dec. 2010
 ^{13}C ISMs:
 Chloro-
 benzene

66% removal
 of ^{13}C -chloro-
 benzene in
 MNA and WBC-2
 treatments

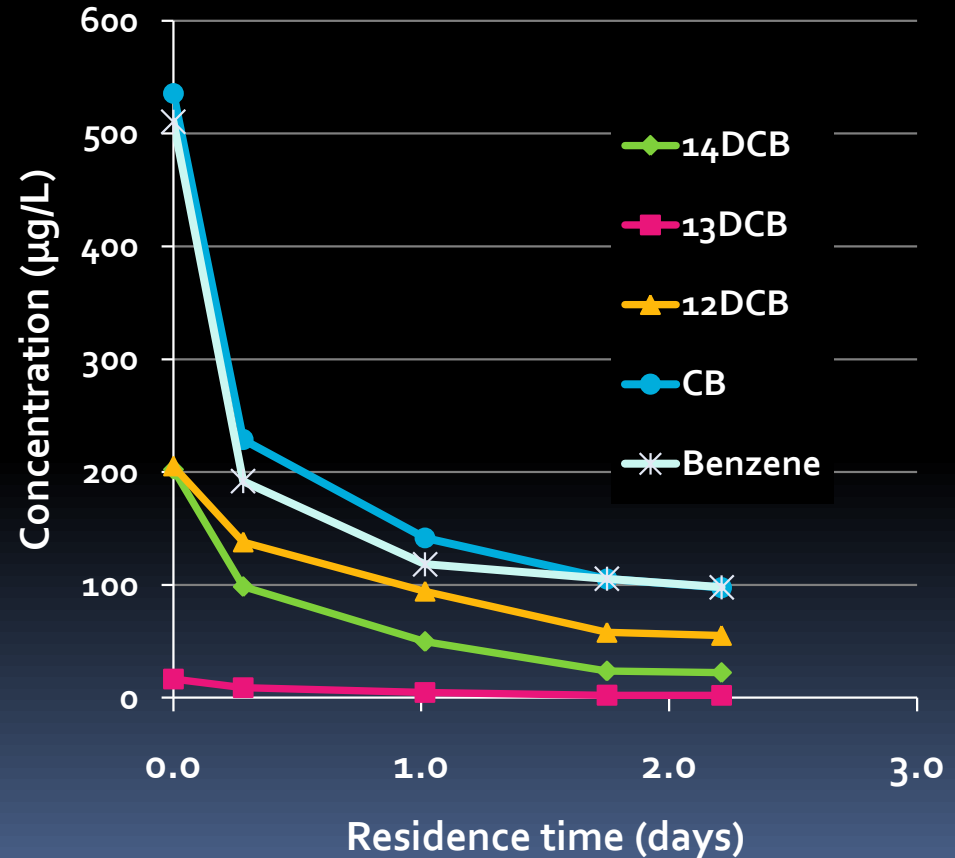


Anaerobic Bioreactors

C Reactor, May 2012- Native
Initial Sulfate= 600 mg/L



D Reactor, May 2012- WBC2 Seeded
Initial Sulfate= 600 mg/L





*loss of
VOCs*

*process
(redox, met-
abolites)*

*Microbial
activity*

**Natural
Attenuation/
Bioremediation**