Onsite Systems, Soils, and Climate Change

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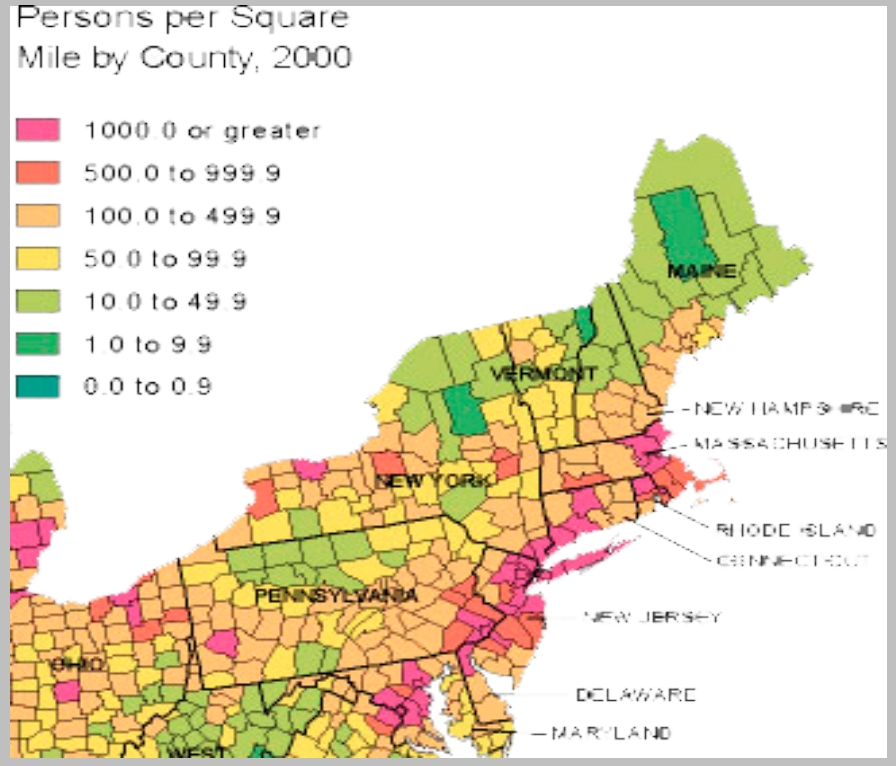
Overview

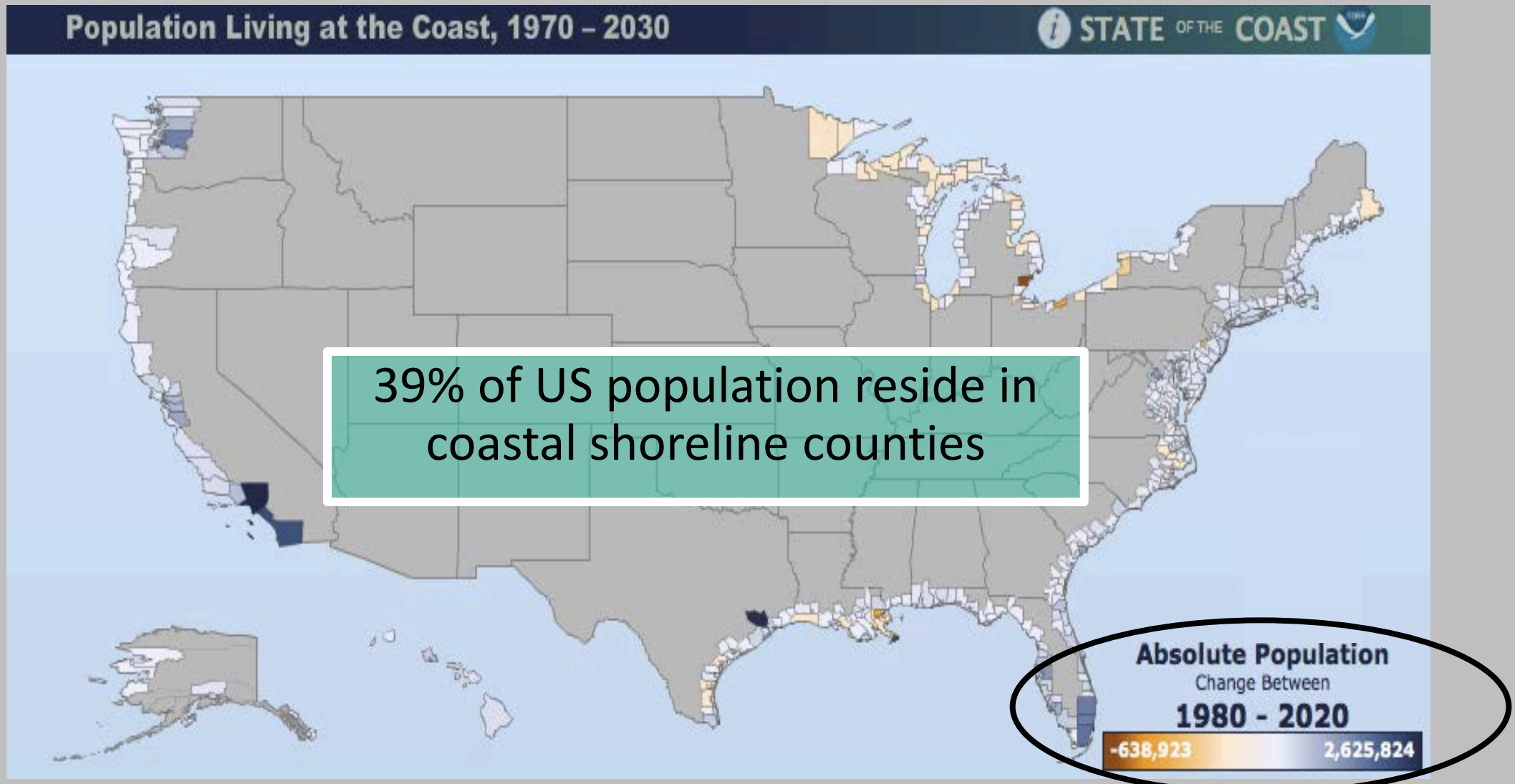
- OWTS technologies
- Wastewater renovation
- Climate change
- Initial results
- Next step

New England

- Pop. NE US = 55 million
- 30% of population rely on OWTS
- **16.5 million** could be affected by climate change effects on OWTS just in NE US



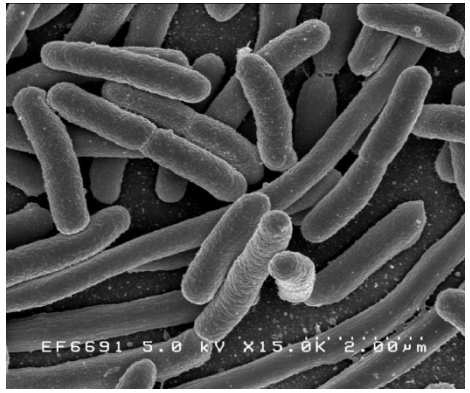
Coastal Population



The Problems

Microorganisms:

- Bacteria
- Viruses
- Protozoan
- Worms

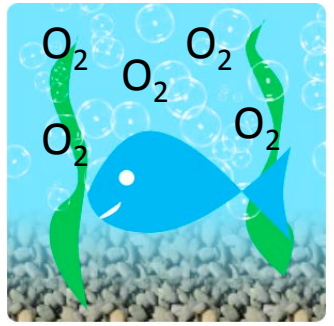


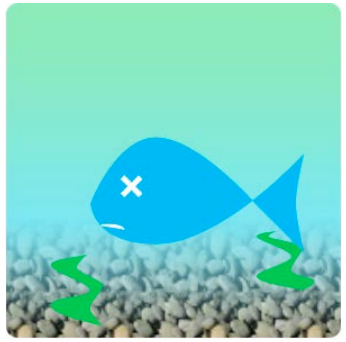
Nutrients-N&P:

- Eutrophication
  - Fresh – P
  - Coastal – N
- Anoxia

BOD:

- Low O_2/Anoxia





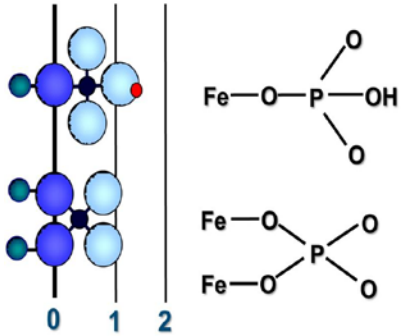
Soil Drainfield Treatment

Microorganisms:

- Predation
- Adsorption/ filtration

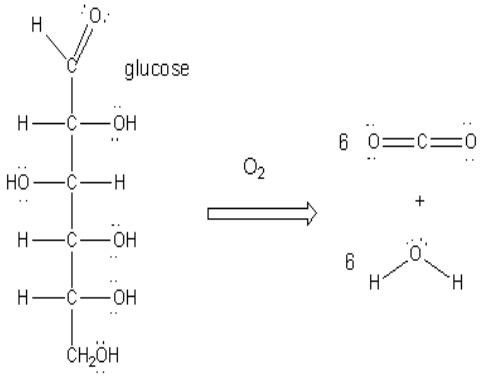
Nutrients:

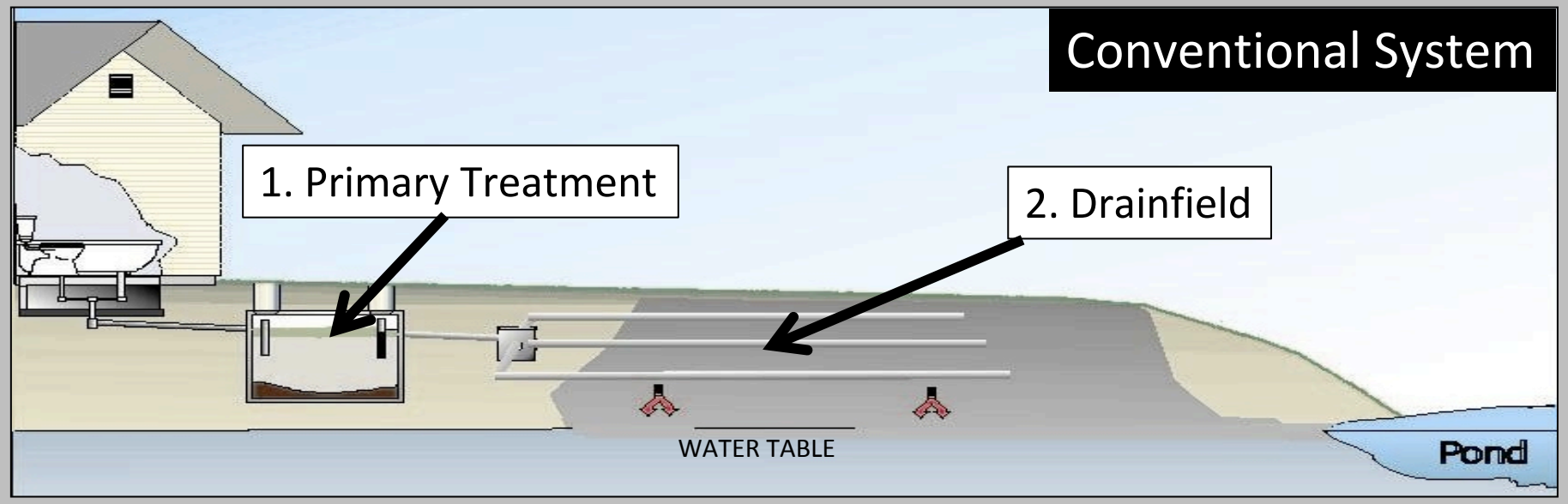
- Phosphorus
  - Fe/Al hydroxides
  - Adsorption/ precipitation
- Nitrogen
  - Nitrification
  - Denitrification

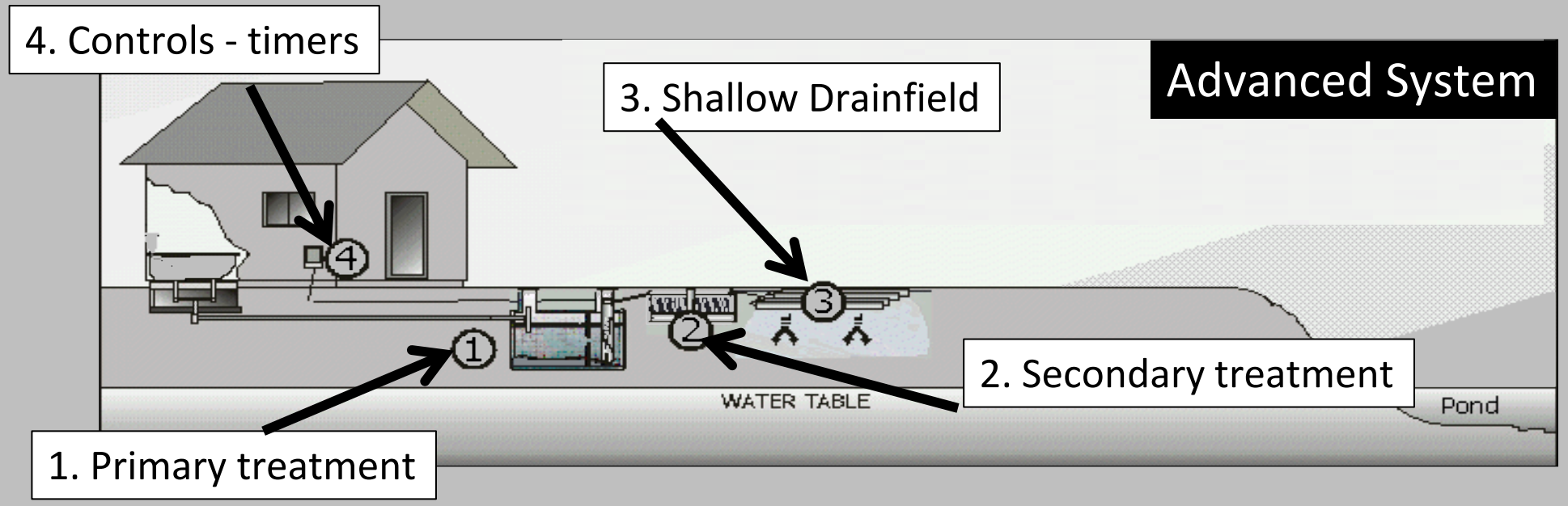


BOD:

- Microbial degradation

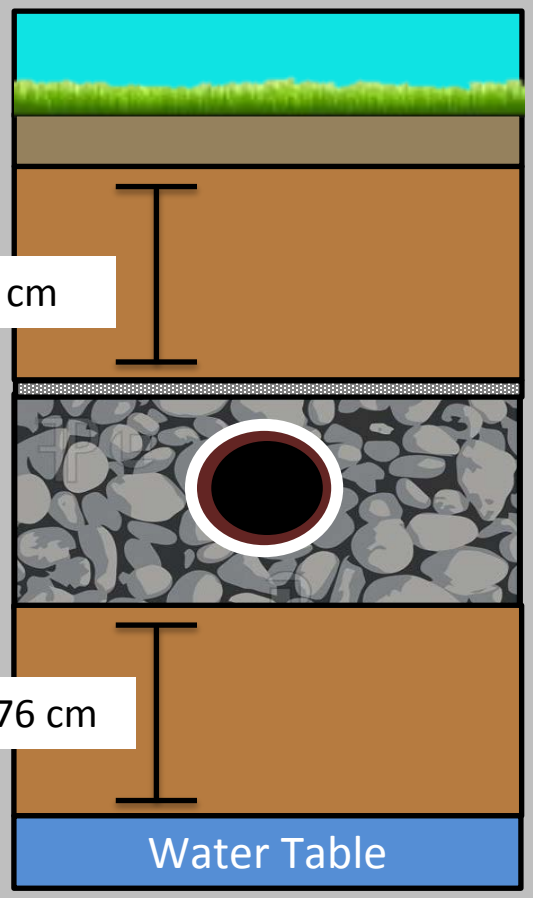



Conventional System
1. Primary Treatment
2. Drainfield
WATER TABLE
Pond

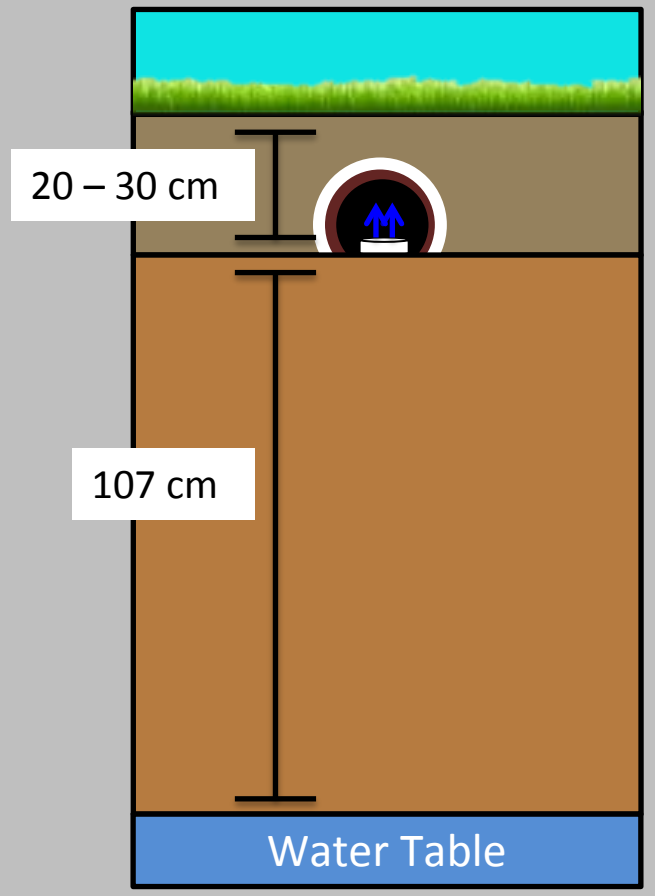

4. Controls - timers
Advanced System
3. Shallow Drainfield
2. Secondary treatment
1. Primary treatment
WATER TABLE
Pond

Conventional

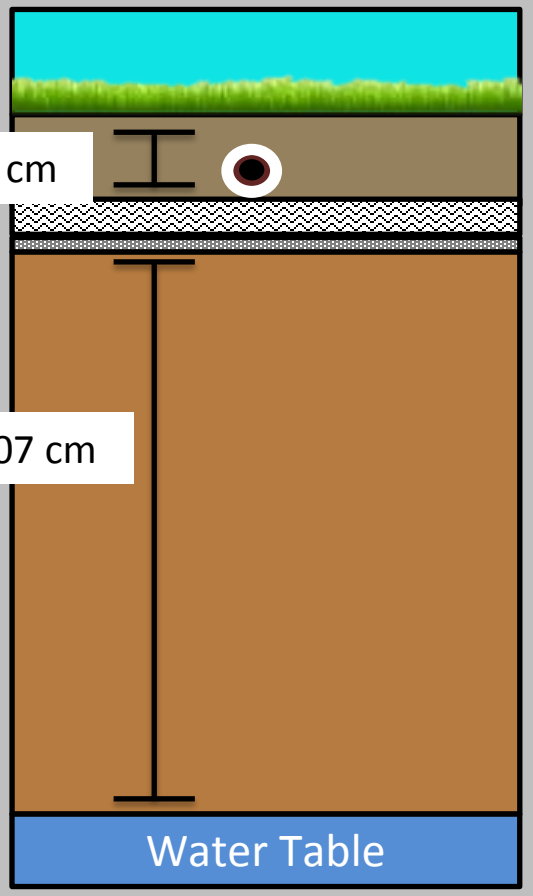
Advanced



Pipe and Stone
(P&S)



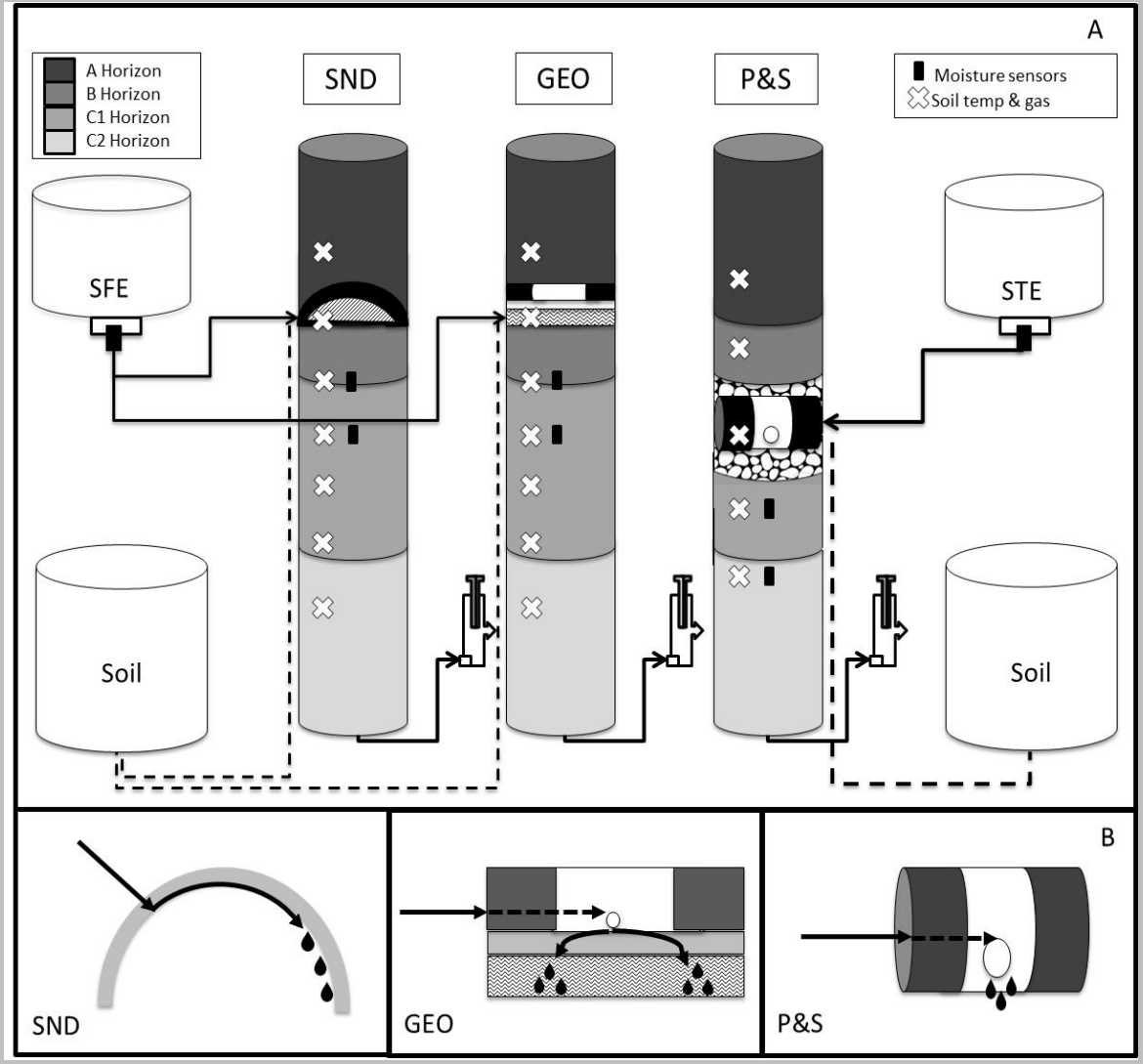
Pressurized Shallow
Narrow Drainfield
(PSND)

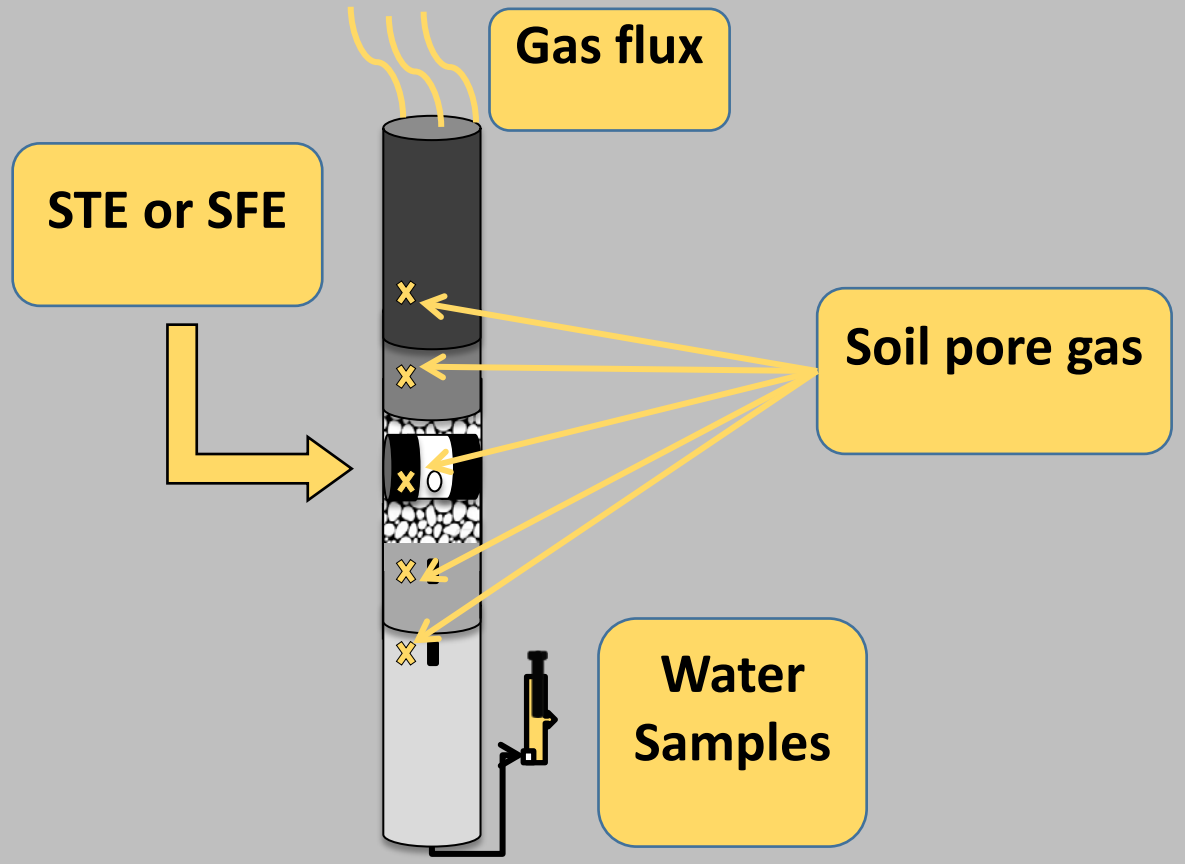


Geomat
(GEO)

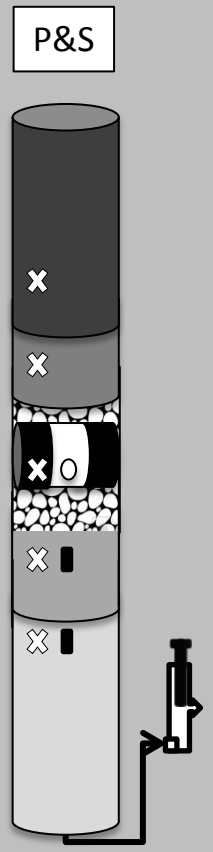
Intact Soil Mesocosms

Intact Soil Mesocosms



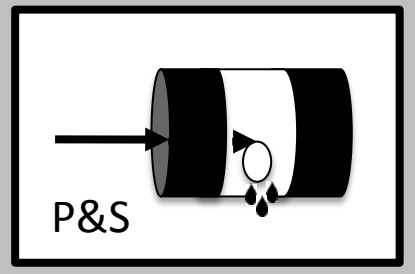


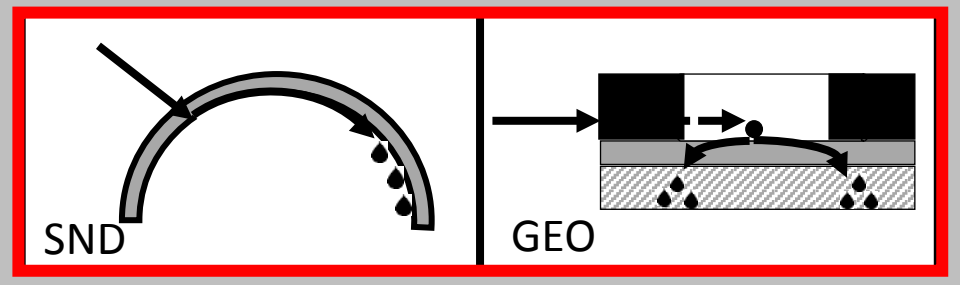
Technology Differences

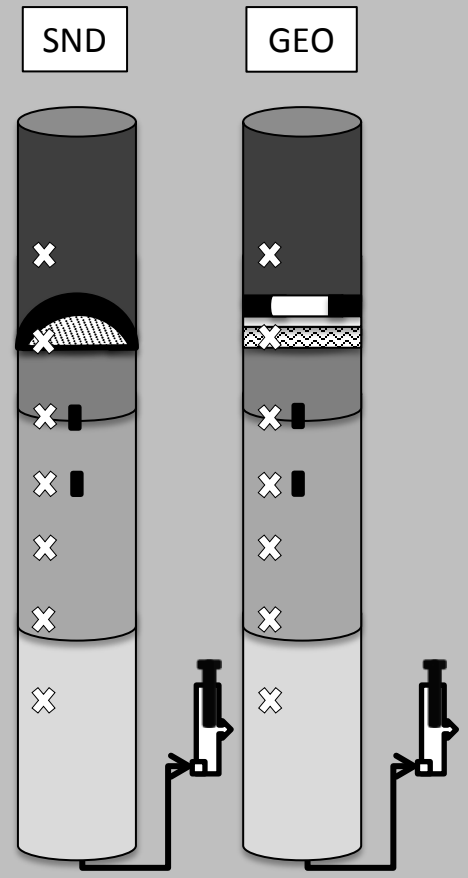


- Septic tank effluent
- Deeper placement of infiltrative area
- “Social” dosing
- Relies heavily on soil

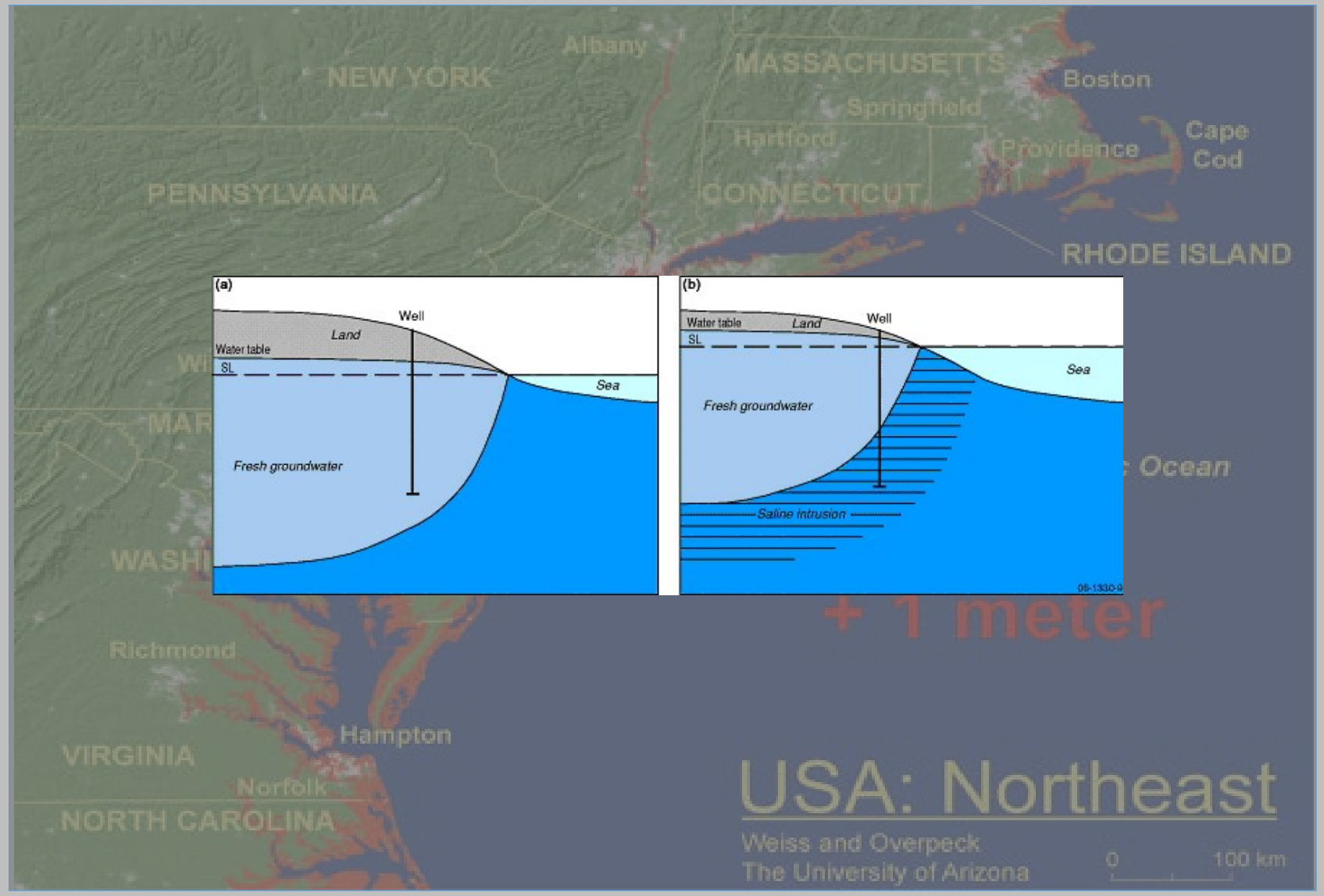
- Pre-treated sand filter effluent
- Shallow placement of infiltrative area
- Timed dosing controls
- Less reliance on soil



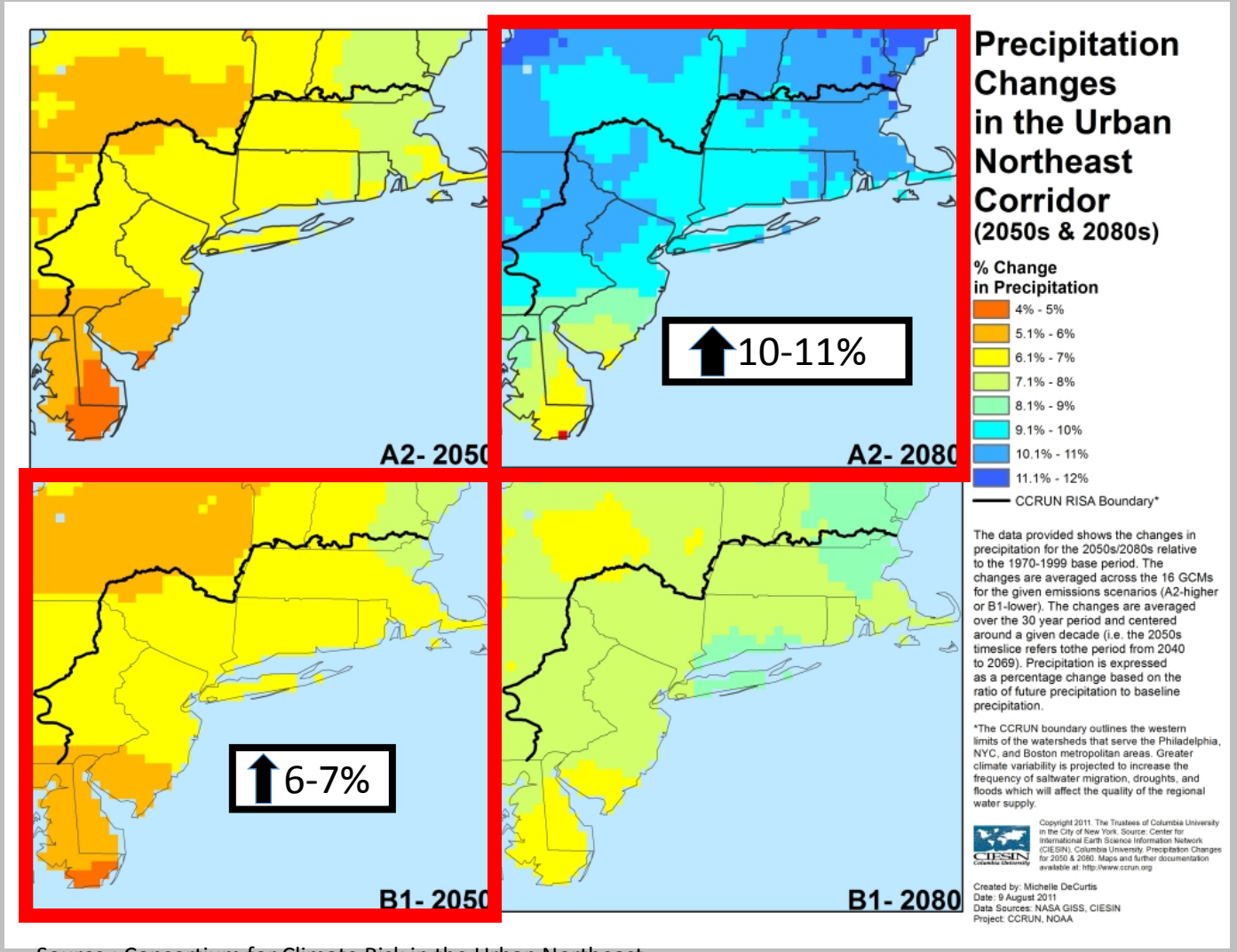




Climate Change – Sea Level Rise

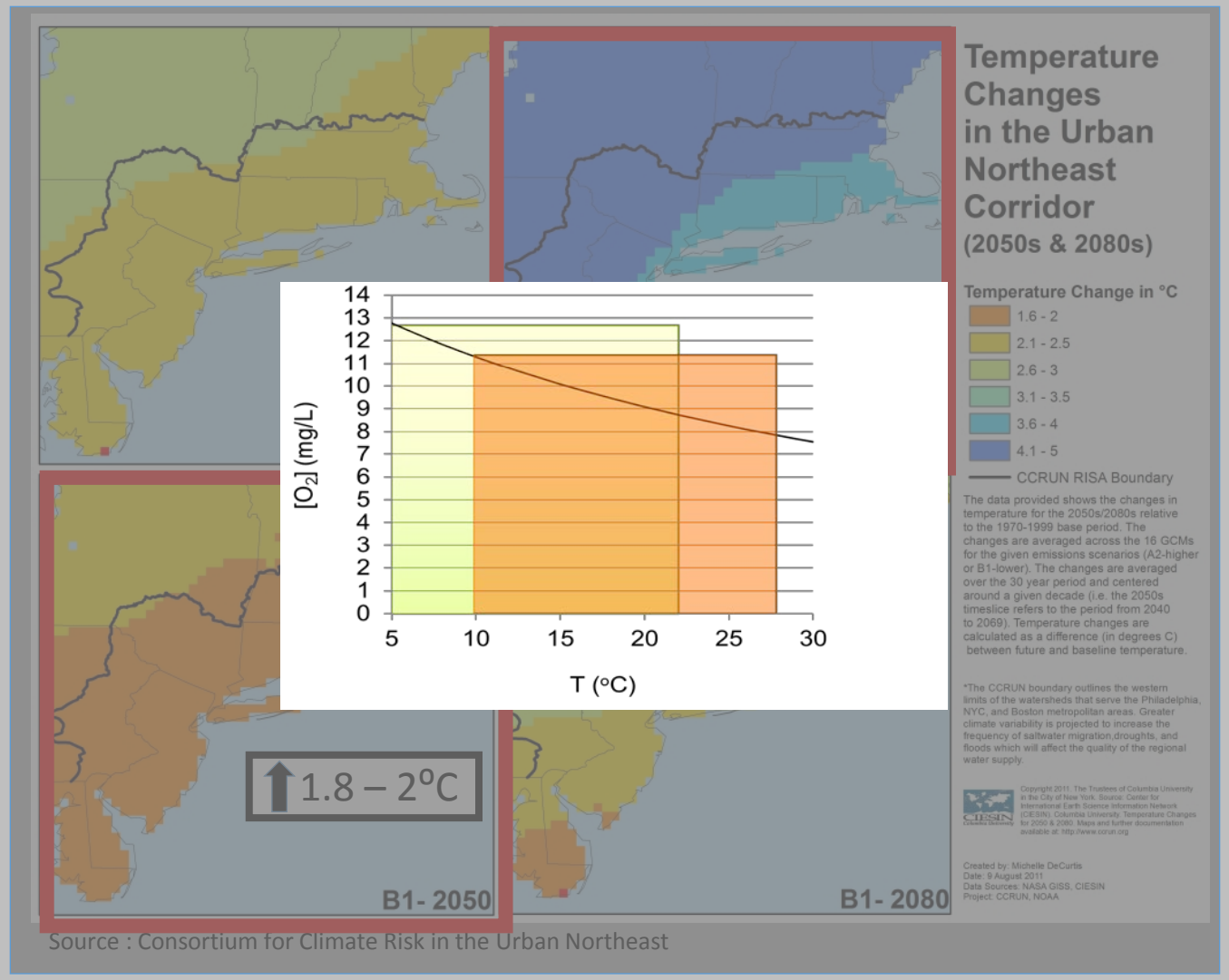


Increased Precipitation



Source : Consortium for Climate Risk in the Urban Northeast

Climate Change - Temperature

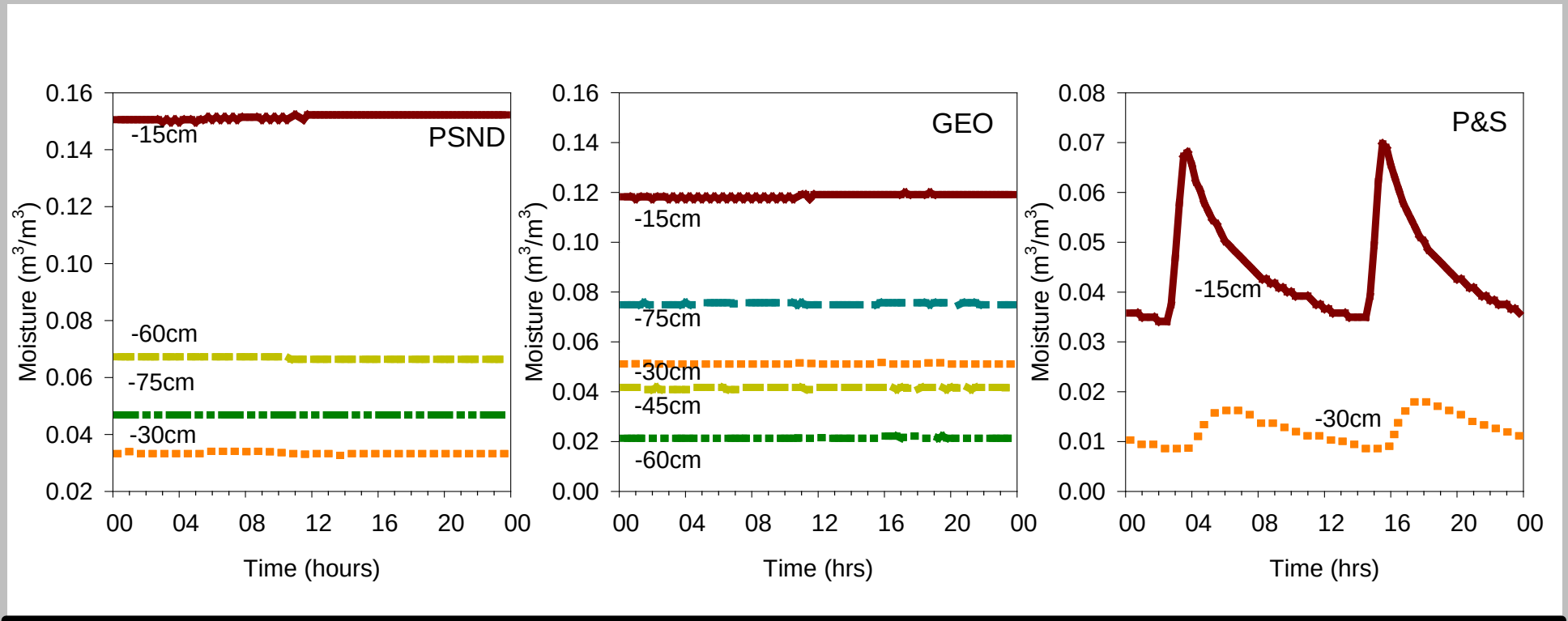


Source : Consortium for Climate Risk in the Urban Northeast

Climate change – Expected Results

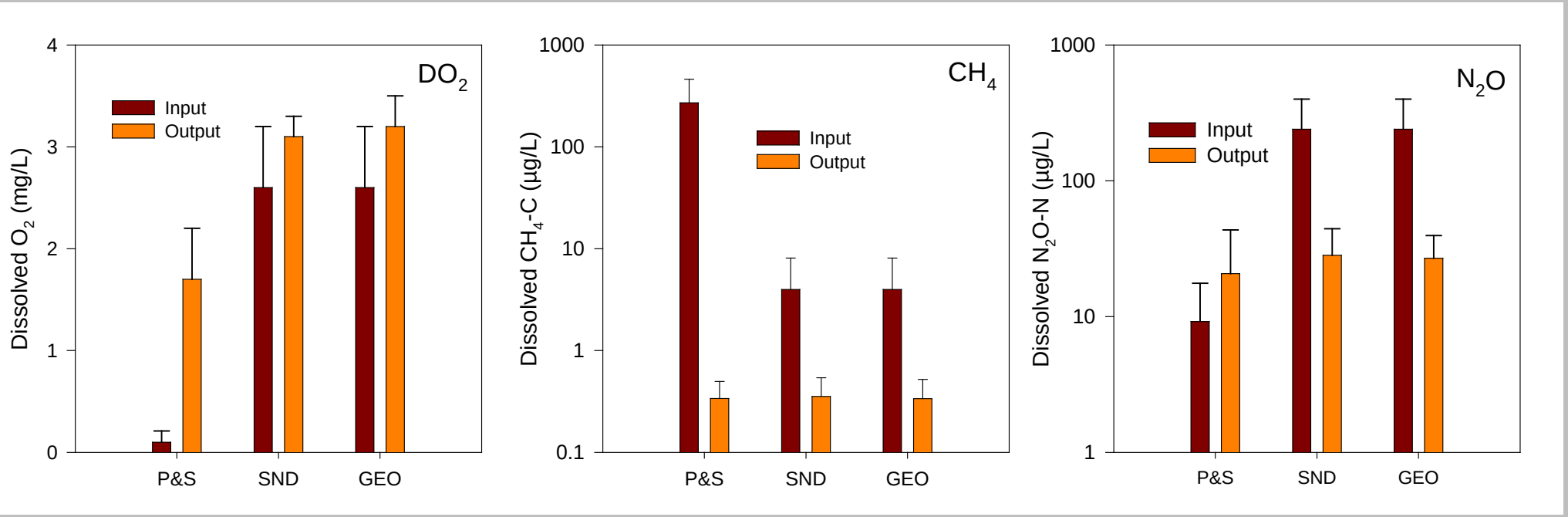
Property/Process		
Volume	↑	↓
Strength	↓	↑
Oxygen	↓	↓
Respiration	↑	↑
Nitrification	↓ (?)	↓ (?)
Denitrification	↑ (?)	↑ (?)
Xenobiotic degradation	↓	↓
S oxidation	↓	↓
P retention	↓	↓
Pathogen removal	↓	↑

Soil Moisture Content



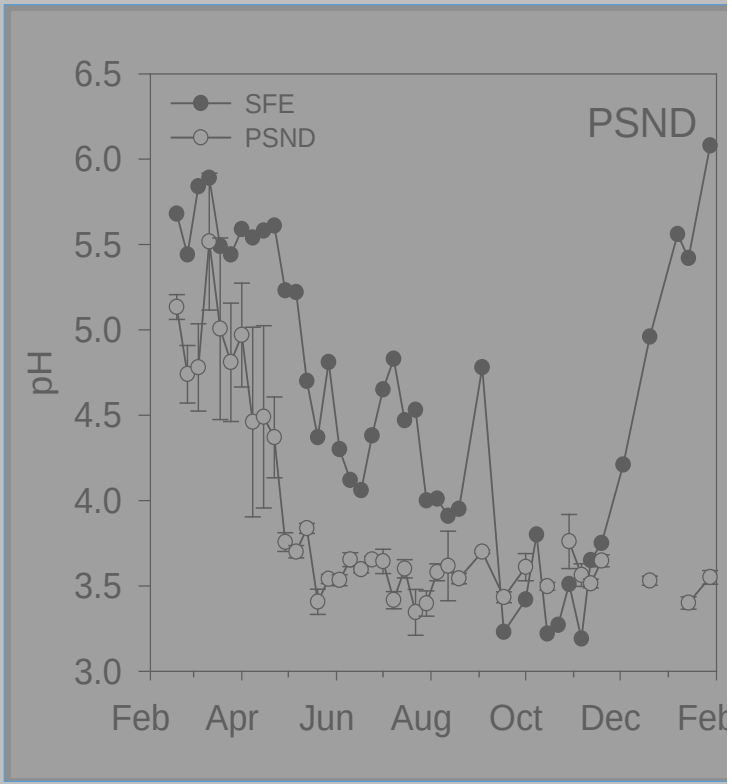
- P&S: Variable moisture, levels overall lower
- SND/GEO: Constant moisture, levels overall higher

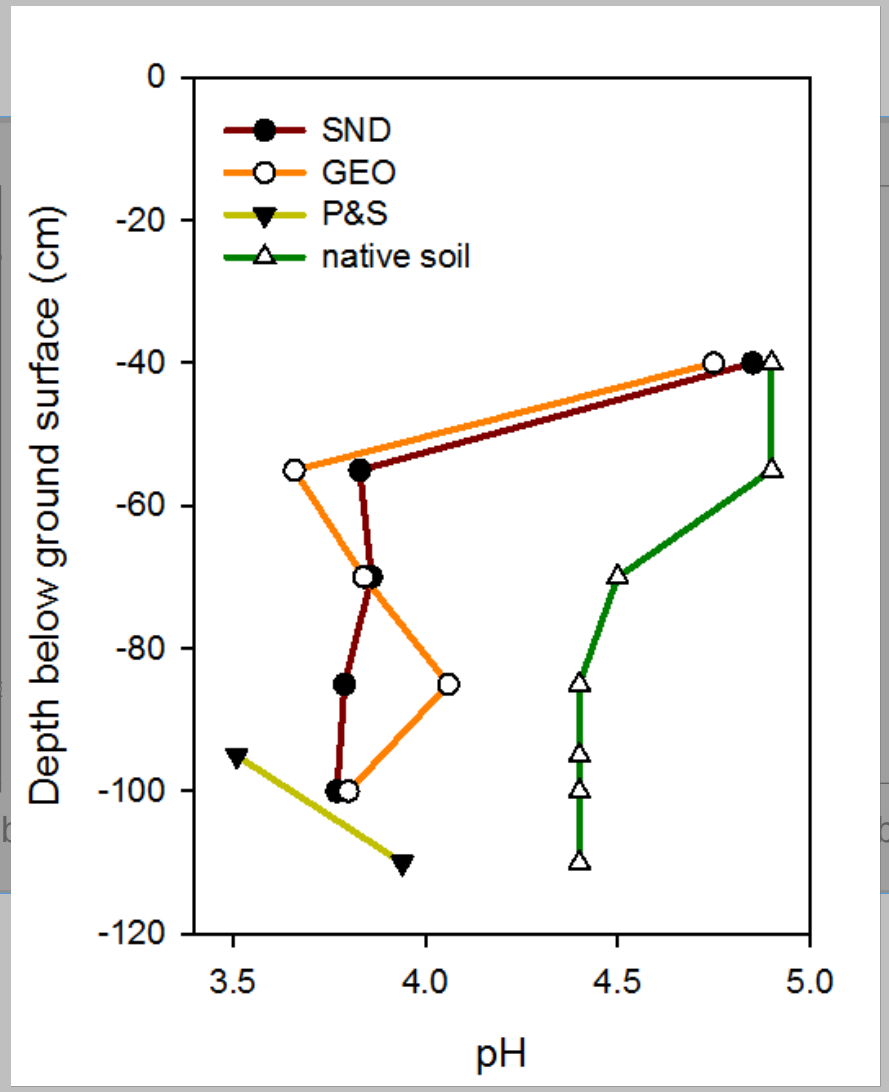
Soil Moisture Content

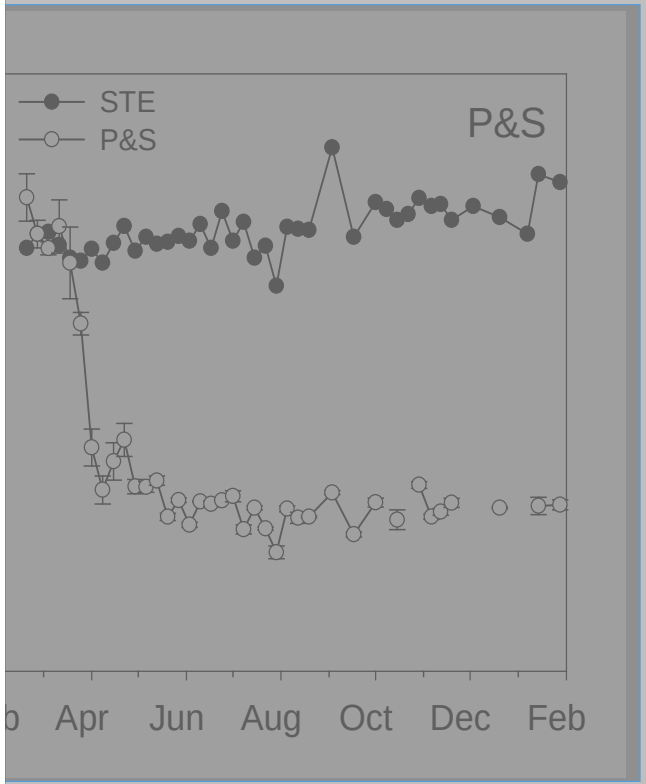


- SND/GEO DO_2 significantly higher than P&S (diffusion > microbial consumption)
- Higher diss. CH_4 in P&S inputs (BOD_5)
- Higher diss. N_2O in SND/GEO inputs (nitrification)

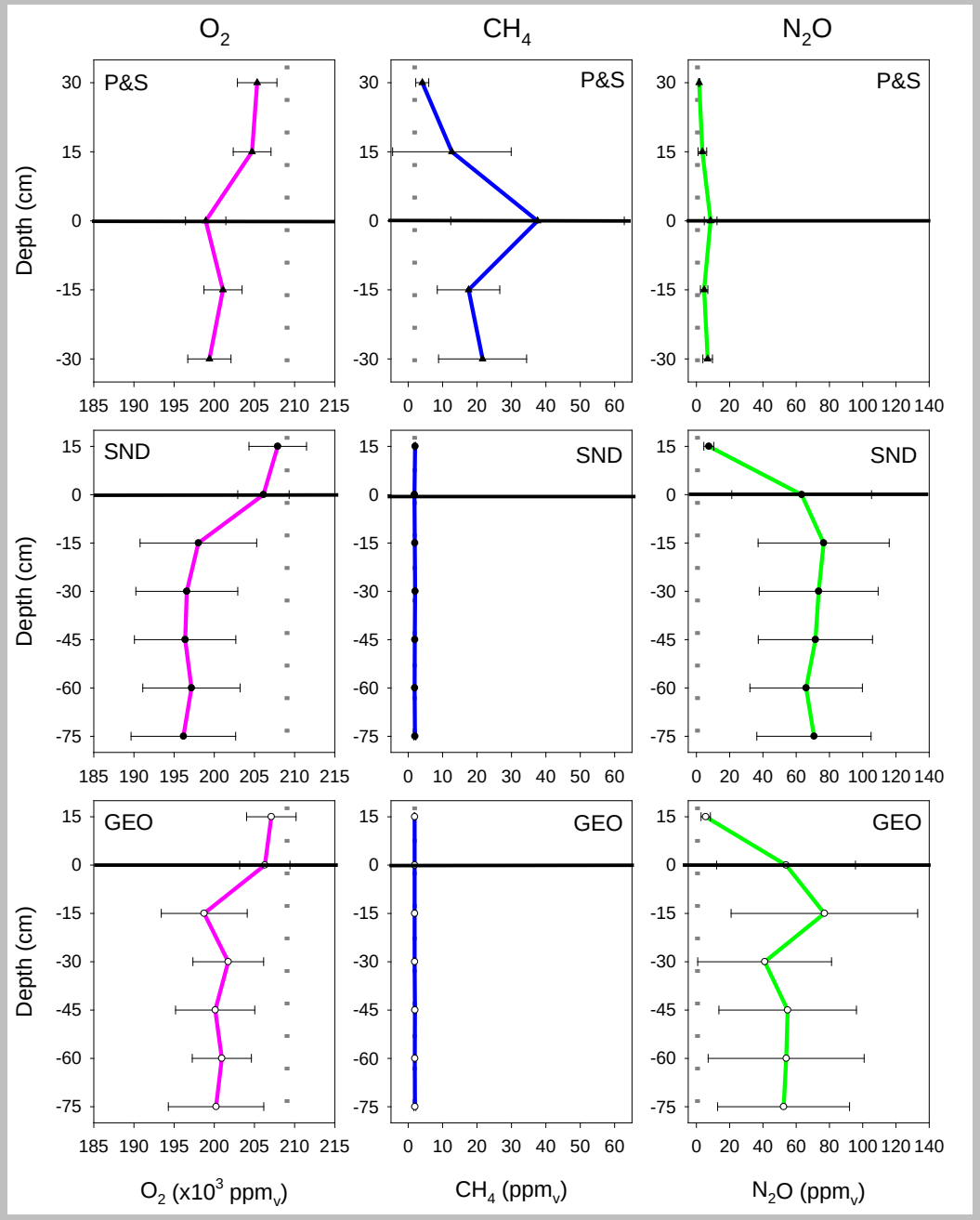
Soil and Water pH







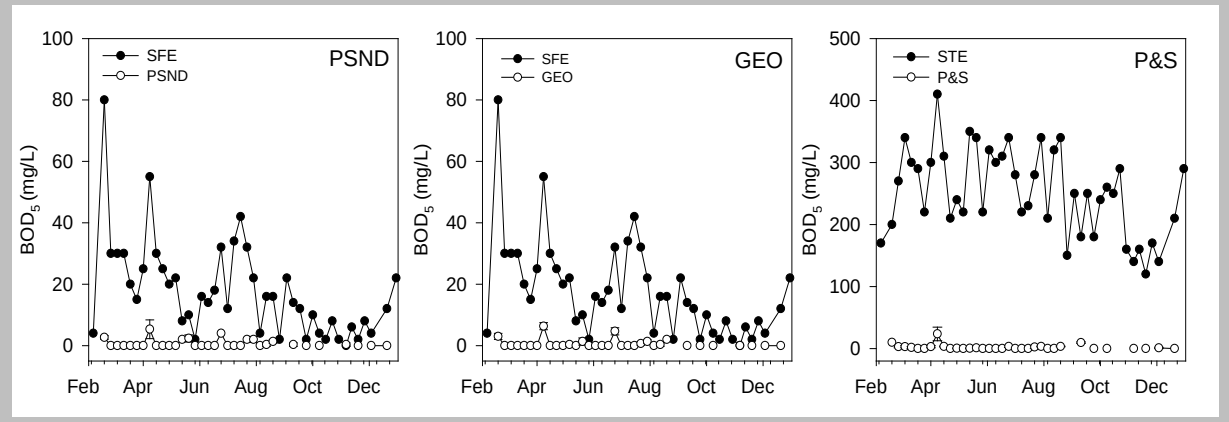
Gas Phase O_2, CH_4, N_2O

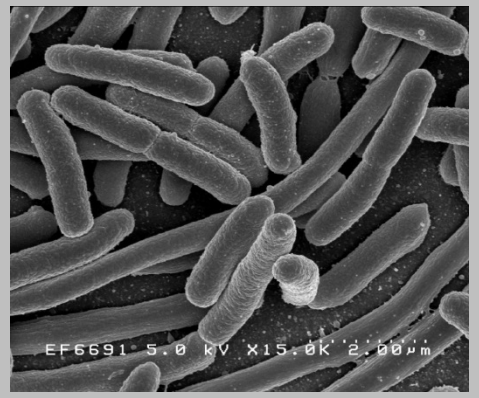


- O_2 significantly higher in SND/GEO
- CH_4 in SND/GEO at atm levels
- 20X higher N_2O production in SND/GEO (*in-situ* prod.)

BOD_5, Fecal Coliform and Total P Removed

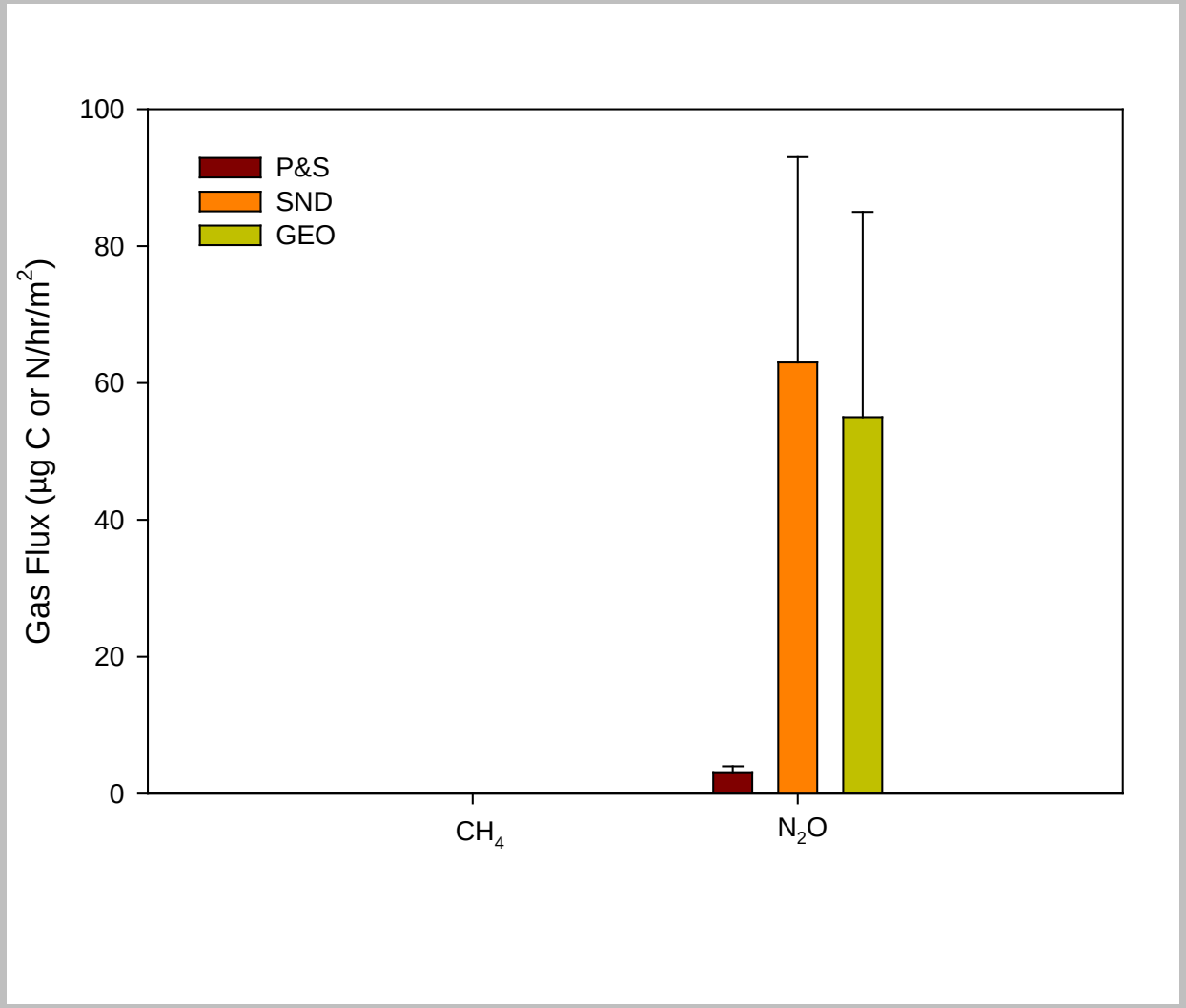
- Within the drainfield, complete removal of BOD_5, fecal coliform bacteria, and total P.
- BOD_5
  - Microbial consumption by C-limited soil community
- Fecal coliform Bacteria/*E. coli*
  - Filtration, absorption, low pH, release of toxic Al compounds
- Total P
  - Low pH, retention by Al/Fe oxides





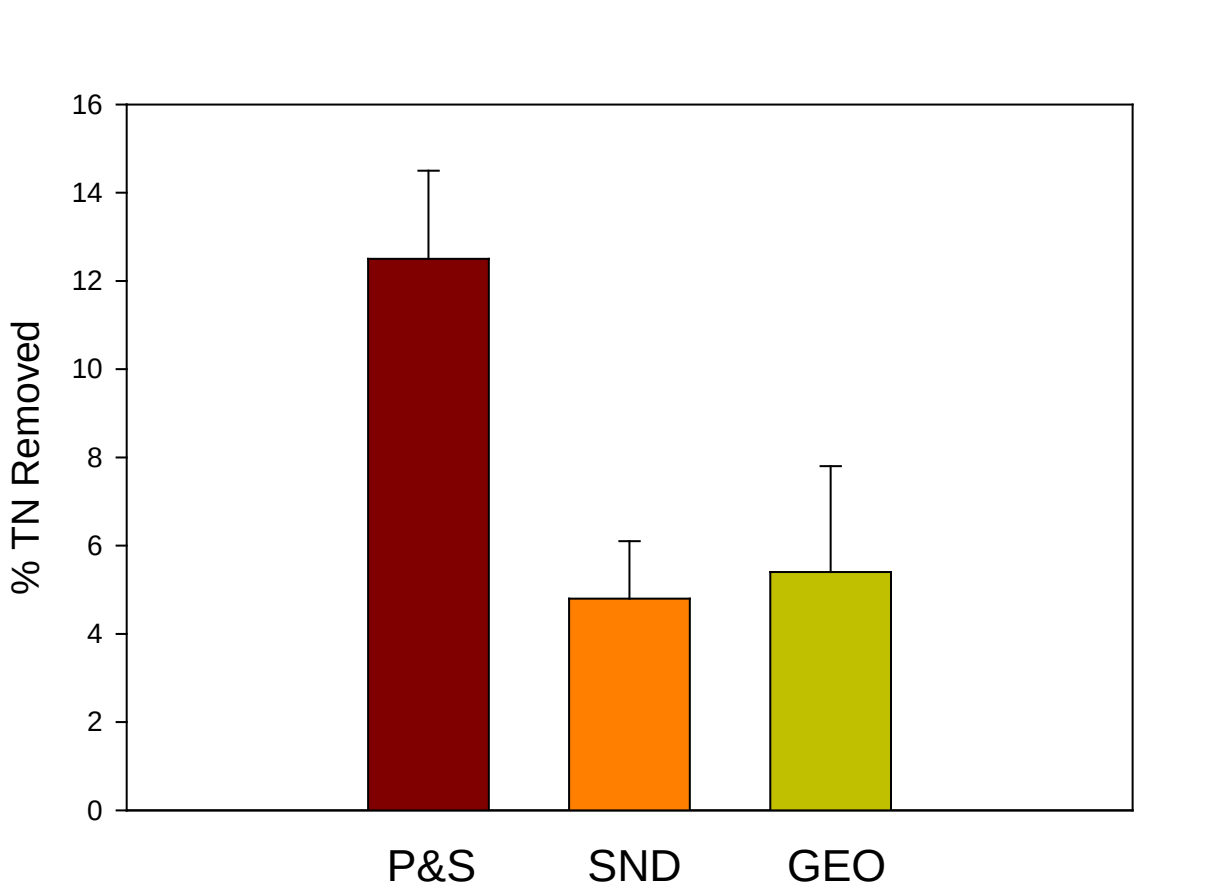
15
P
30.97

Gas Flux



- No CH_4 Flux, (oxidized to CO_2)
- Significantly higher N_2O flux in SND/GEO (*in-situ* prod.)
- N_2O not a major N loss pathway

Total N Removal

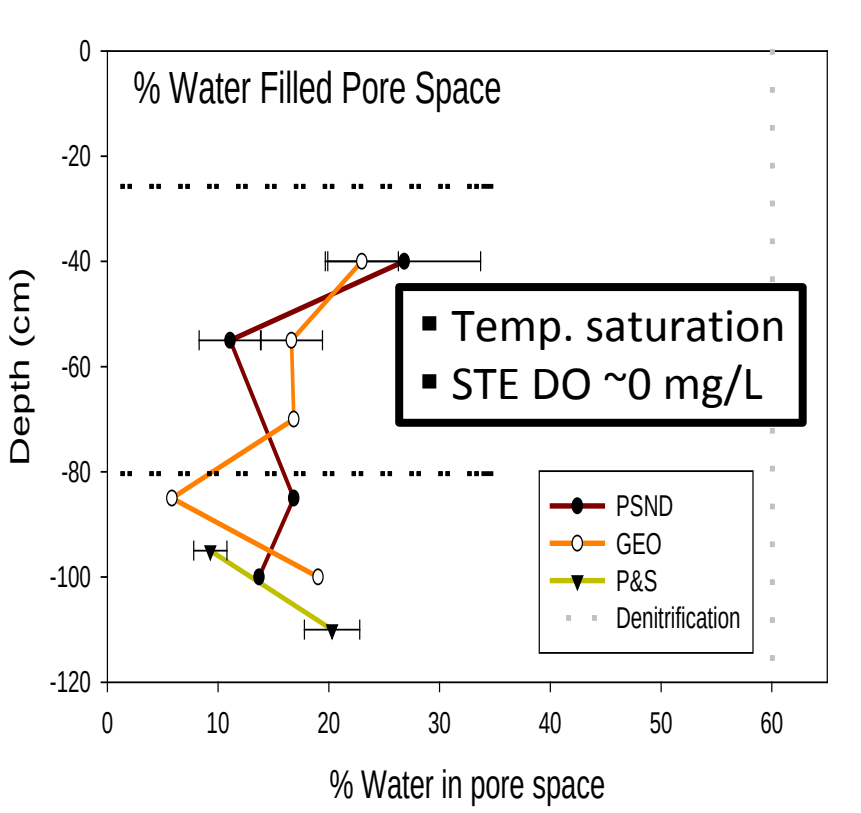


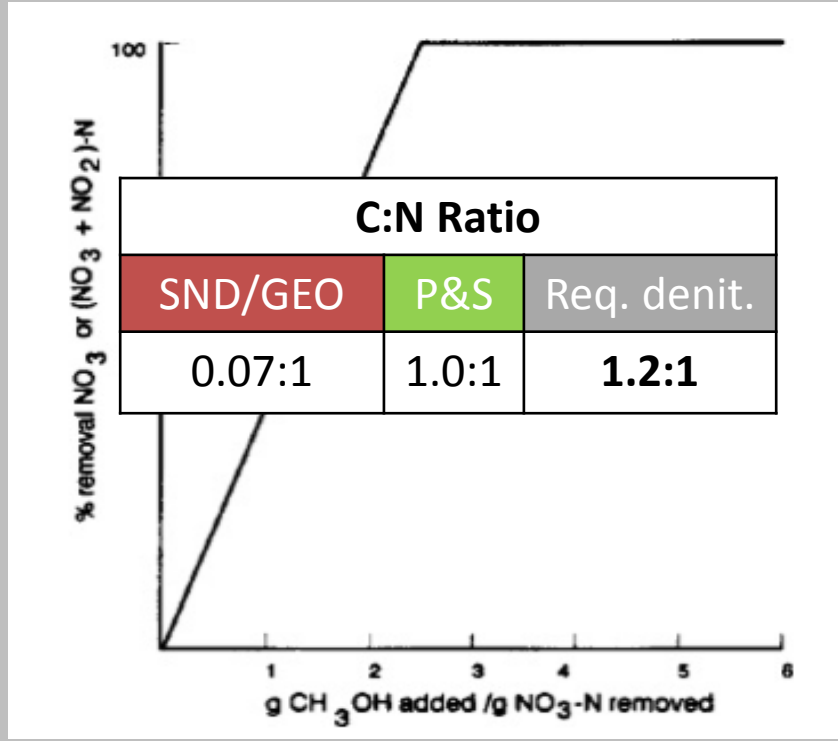
Total Nitrogen Removal

- P&S: 12%
- SND: 4.8%
- GEO: 5.4%

- Microbial biomass and N_2 production

Total N Removal Mechanisms





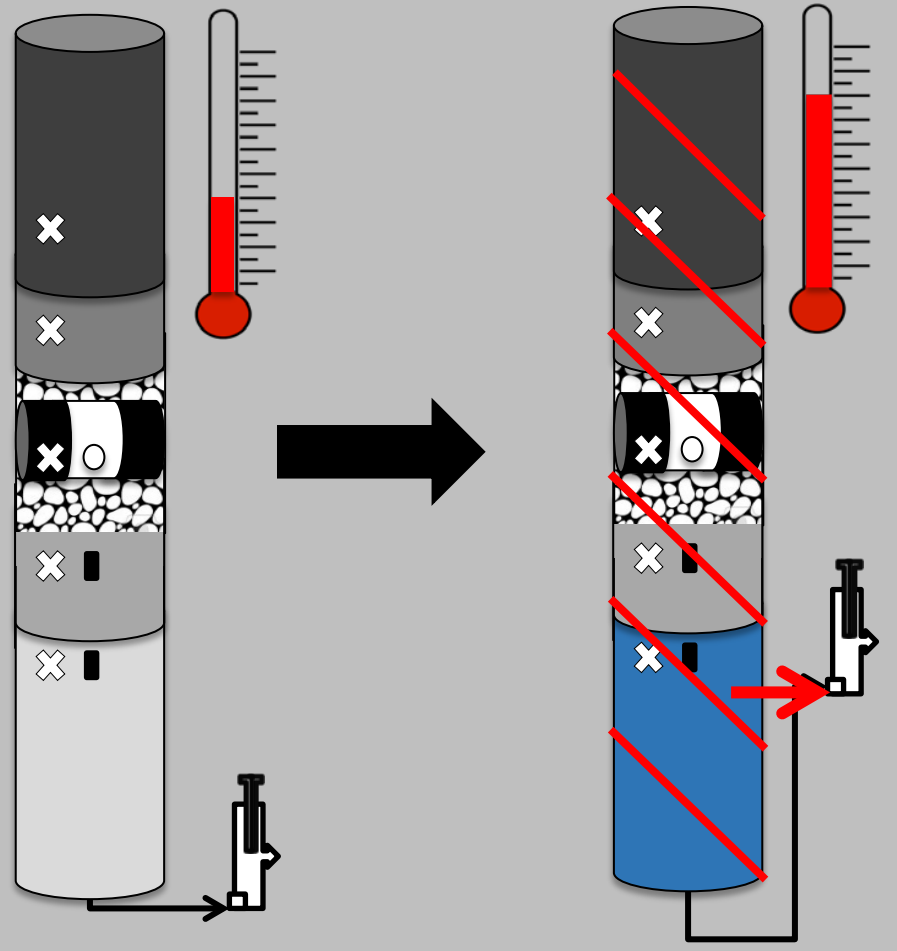
C:N Ratio		
SND/GEO	P&S	Req. denit.
0.07:1	1.0:1	**1.2:1**

$$6\,NO_3 + 5\,CH_3OH \rightarrow 3\,N_2 + 5\,CO_2 + 7\,H_2O + 6\,(OH)^-$$

- SND/GEO: C limited, more O_2, denitrification unlikely
- P&S: more C, periodically anaerobic

Next Step - Climate change

Current:
WT
Temp 20°C



Climate Change:
WT up 30cm
Temp 24°C

Questions?

Funding:
- URI Sea Grant
- RI Agricultural Experiment Station

riaes
RI Agricultural Experiment Station

Research Team:
- Jose Amador – NRS
- Tom Boving – GEO
- George Loomis – NRS & NEOWTC
- Dave Kalen – NRS & NEOWTC
- Ivan Morales – Ph.D. student
- Ethan Sneesby – B.S. student

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