



Nature-based wastewater treatment

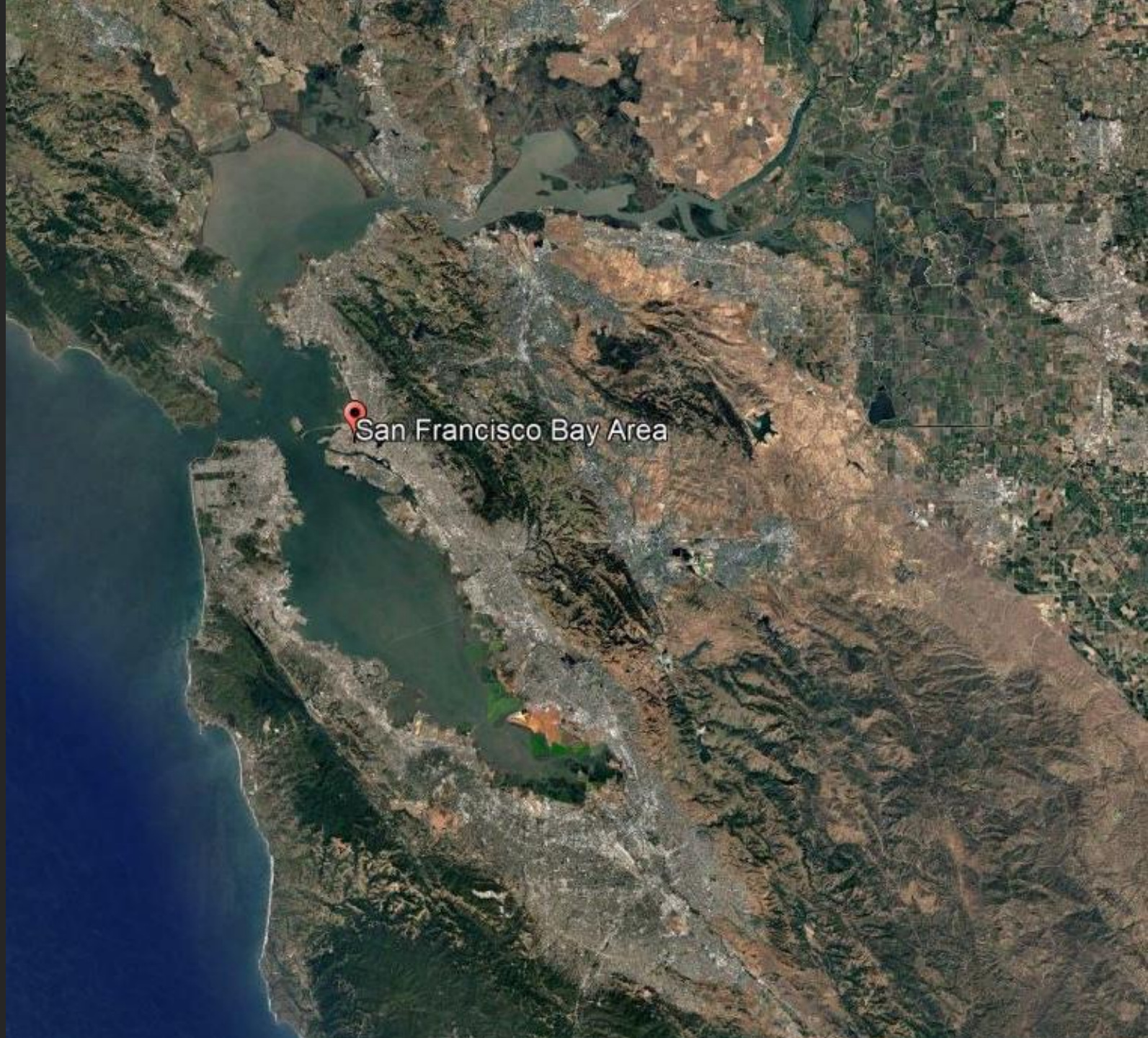
Learning from the Oro Loma Horizontal Levee

RMP ANNUAL MEETING

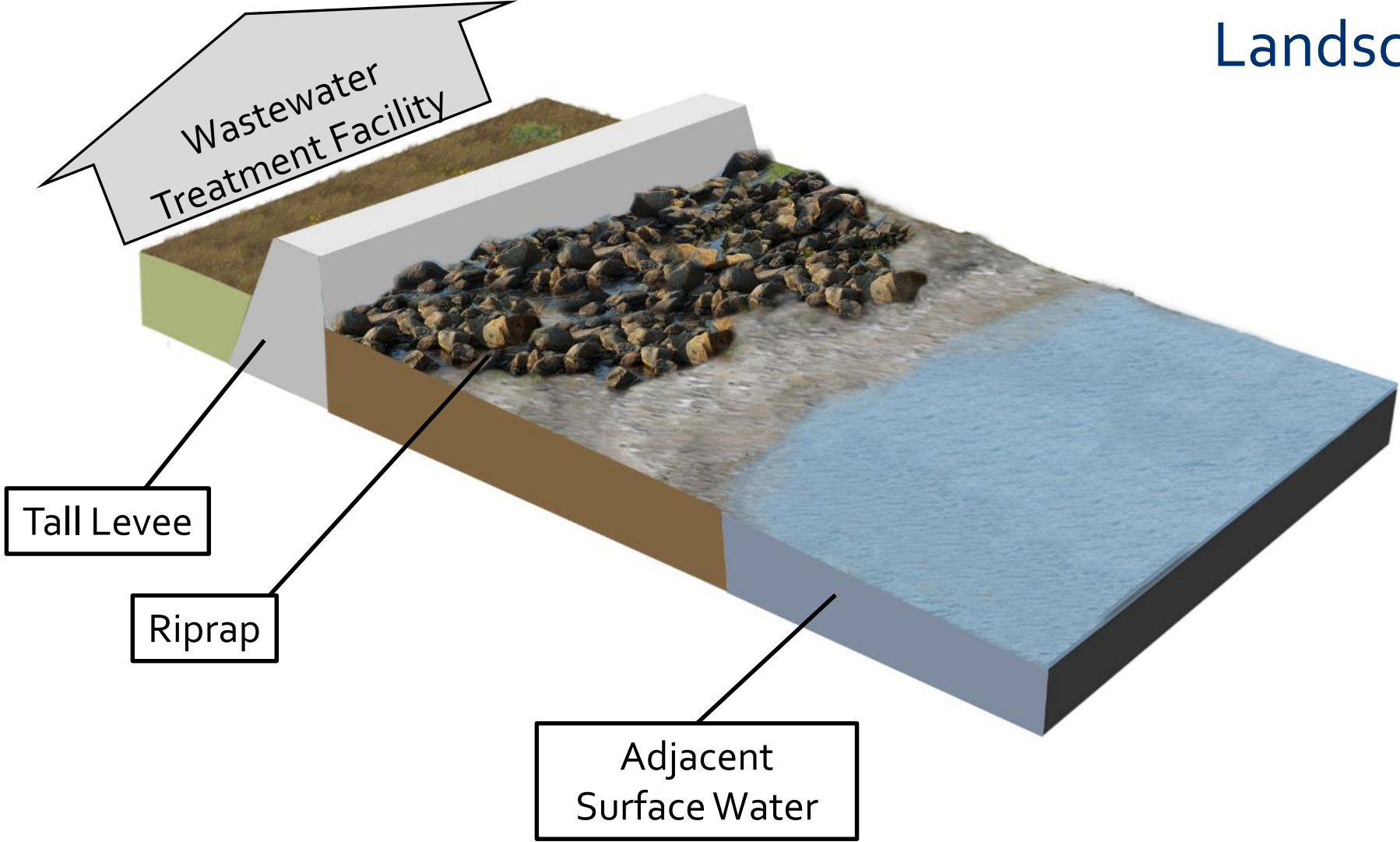
ANGELA PERANTONI, AIDAN CECCHETTI, DAVID SEDLAK

Threats to SF Bay Estuary Resilience

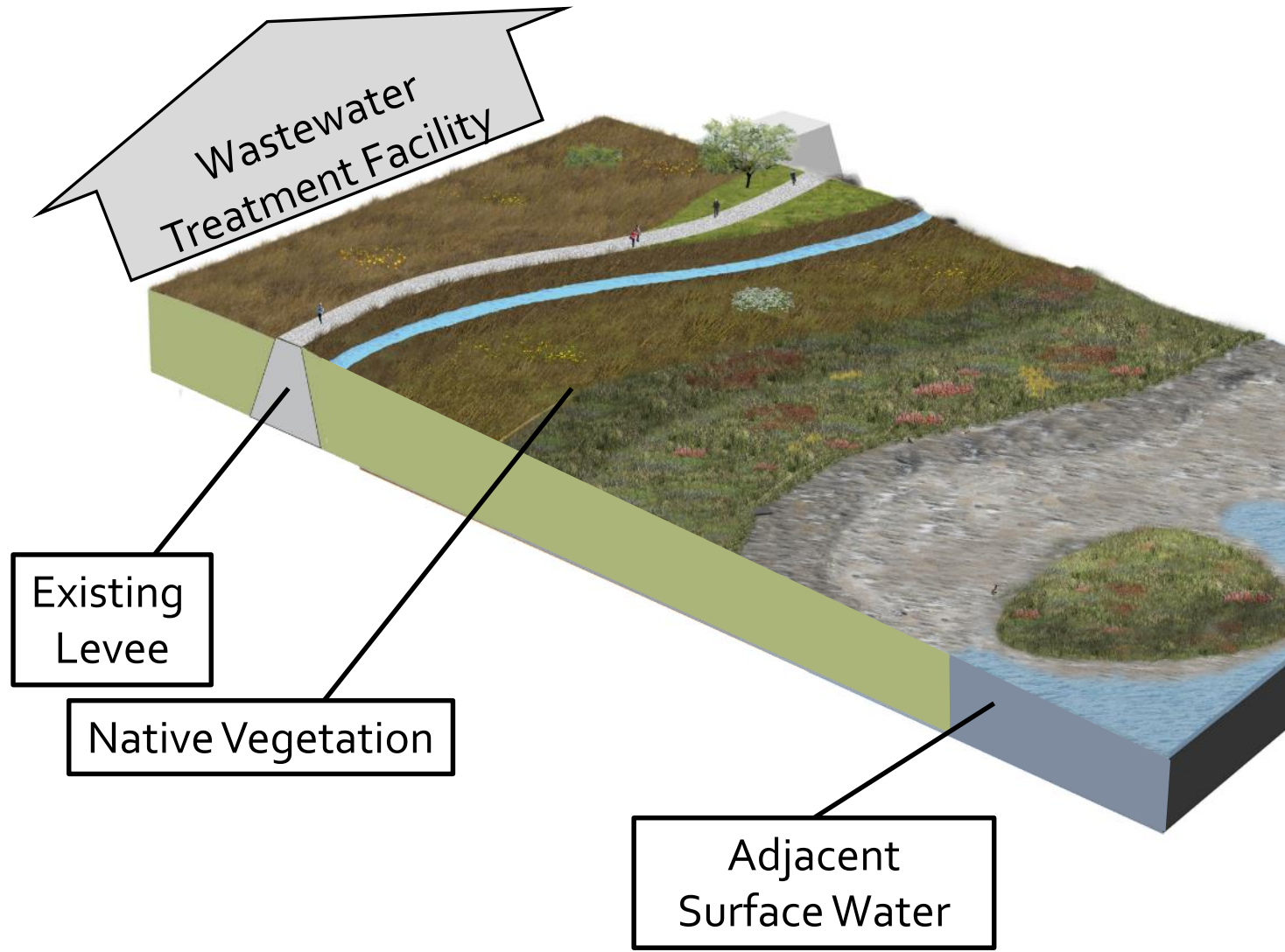
- Climate change and sea level rise
- Increased sensitivity to nutrient discharges
- Loss of wetland habitat



Conventional Landscape



Horizontal Levee Landscape

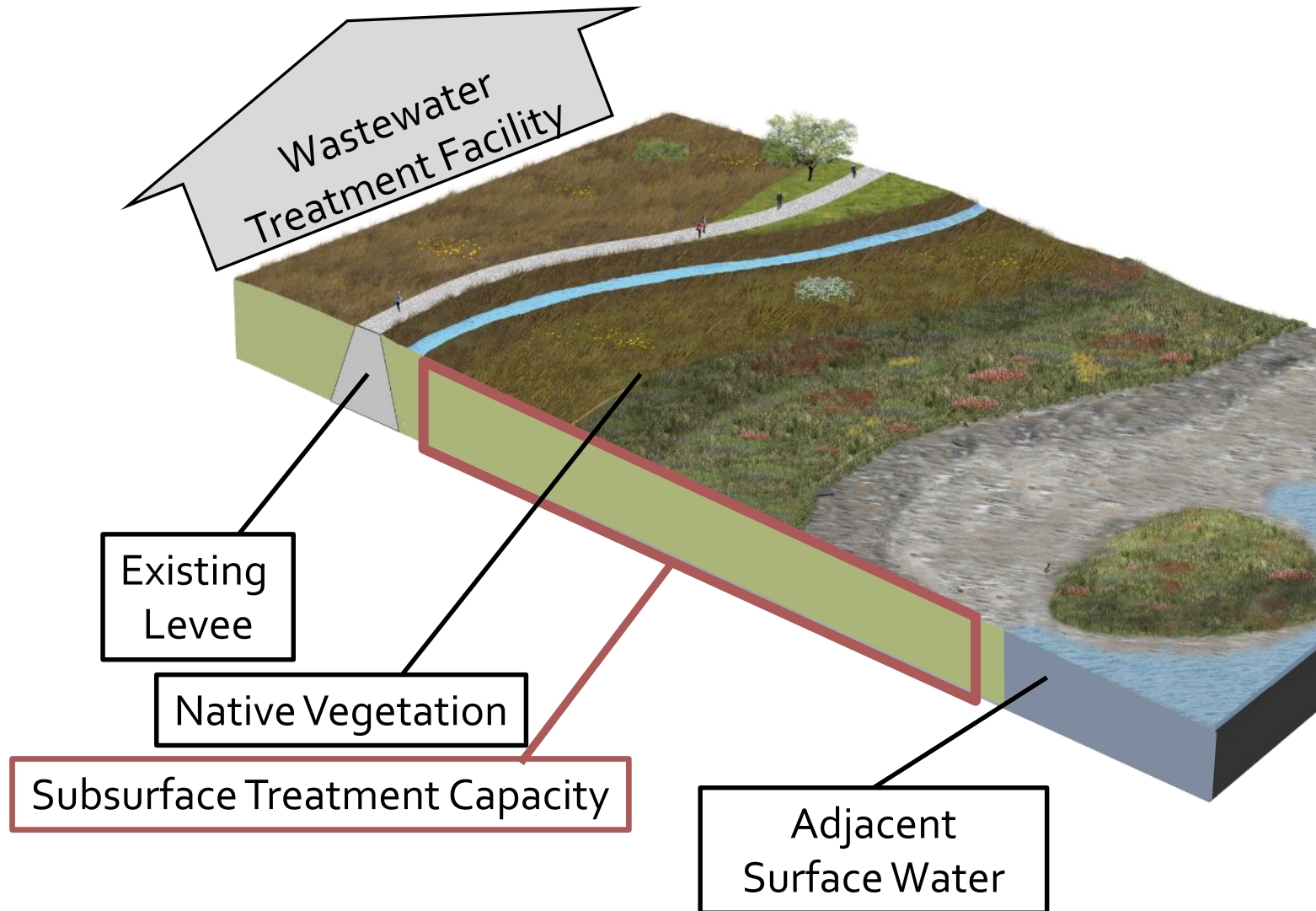


Ecosystem Services

- Provide habitat for native species
- Climate change adaptation
- Improve water quality

“May improve water quality”

Horizontal Levee Landscape

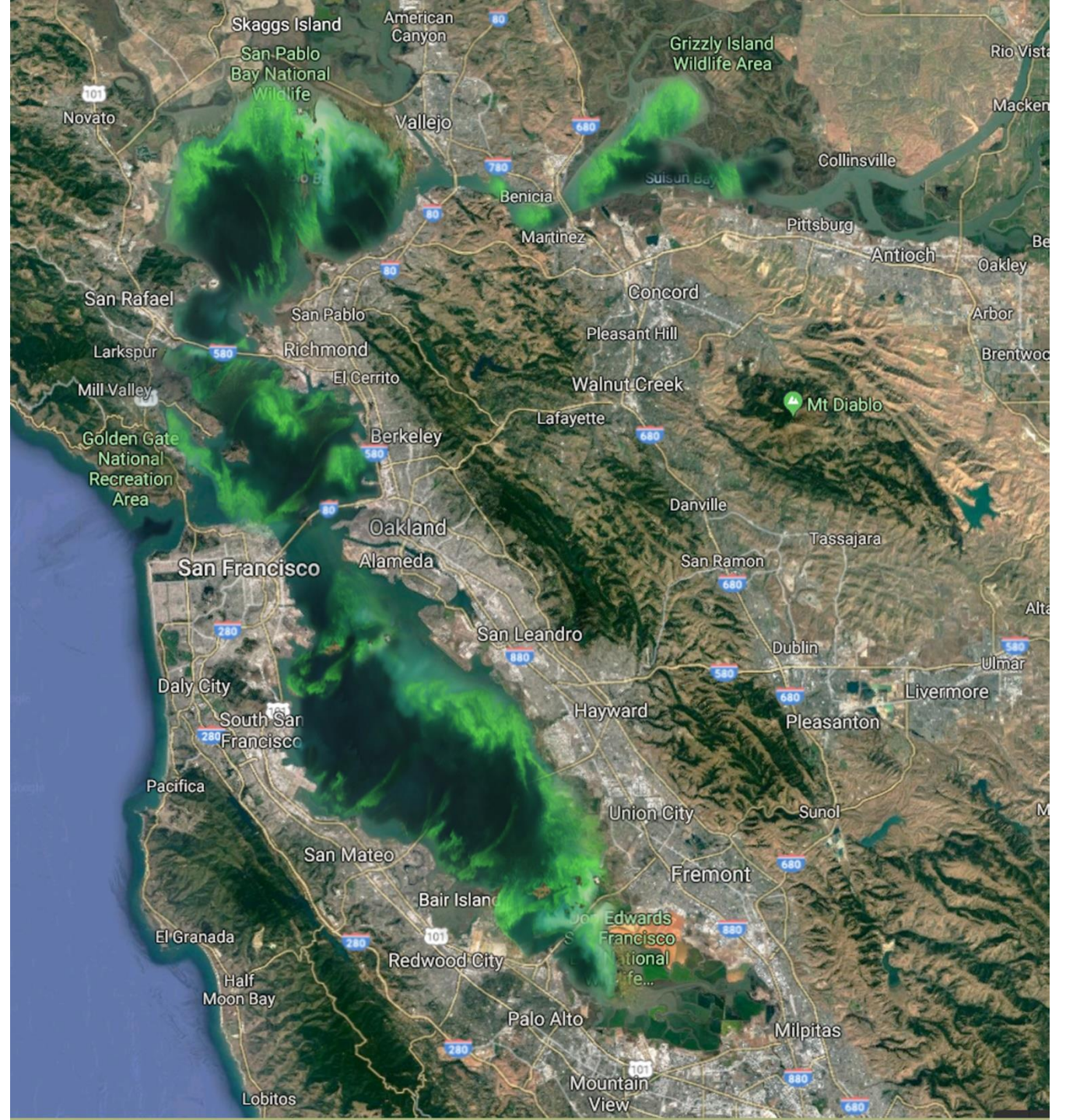


Ecosystem Services

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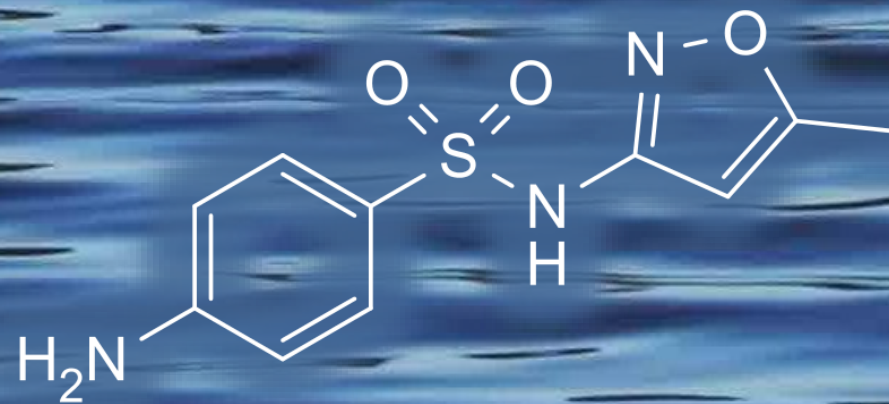
Contaminants of Interest

Nitrogen



Contaminants of
Interest

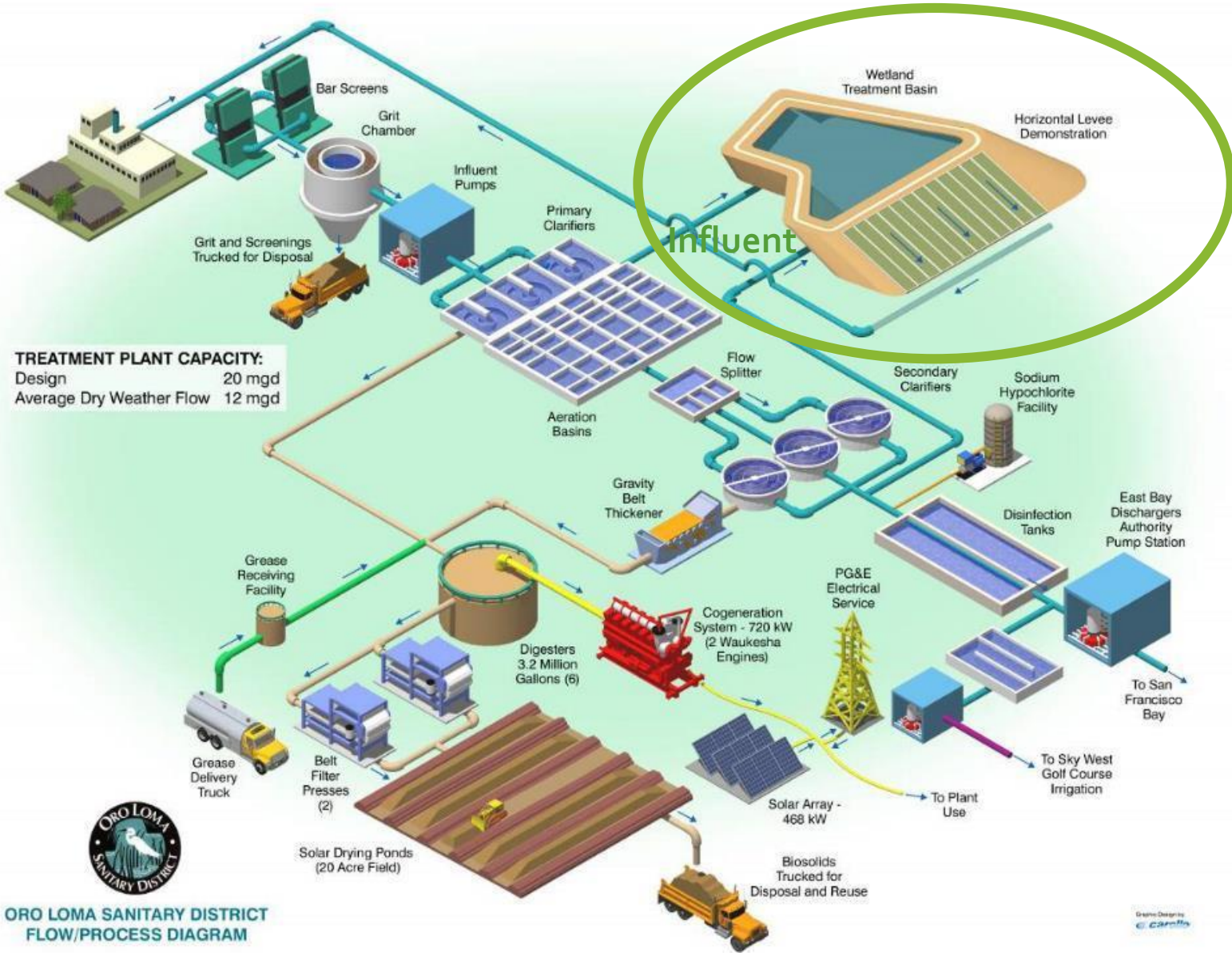
Pharmaceuticals



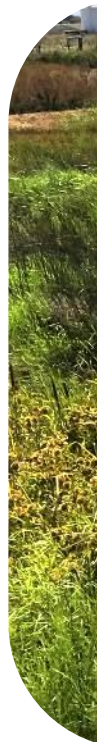
Our Approach



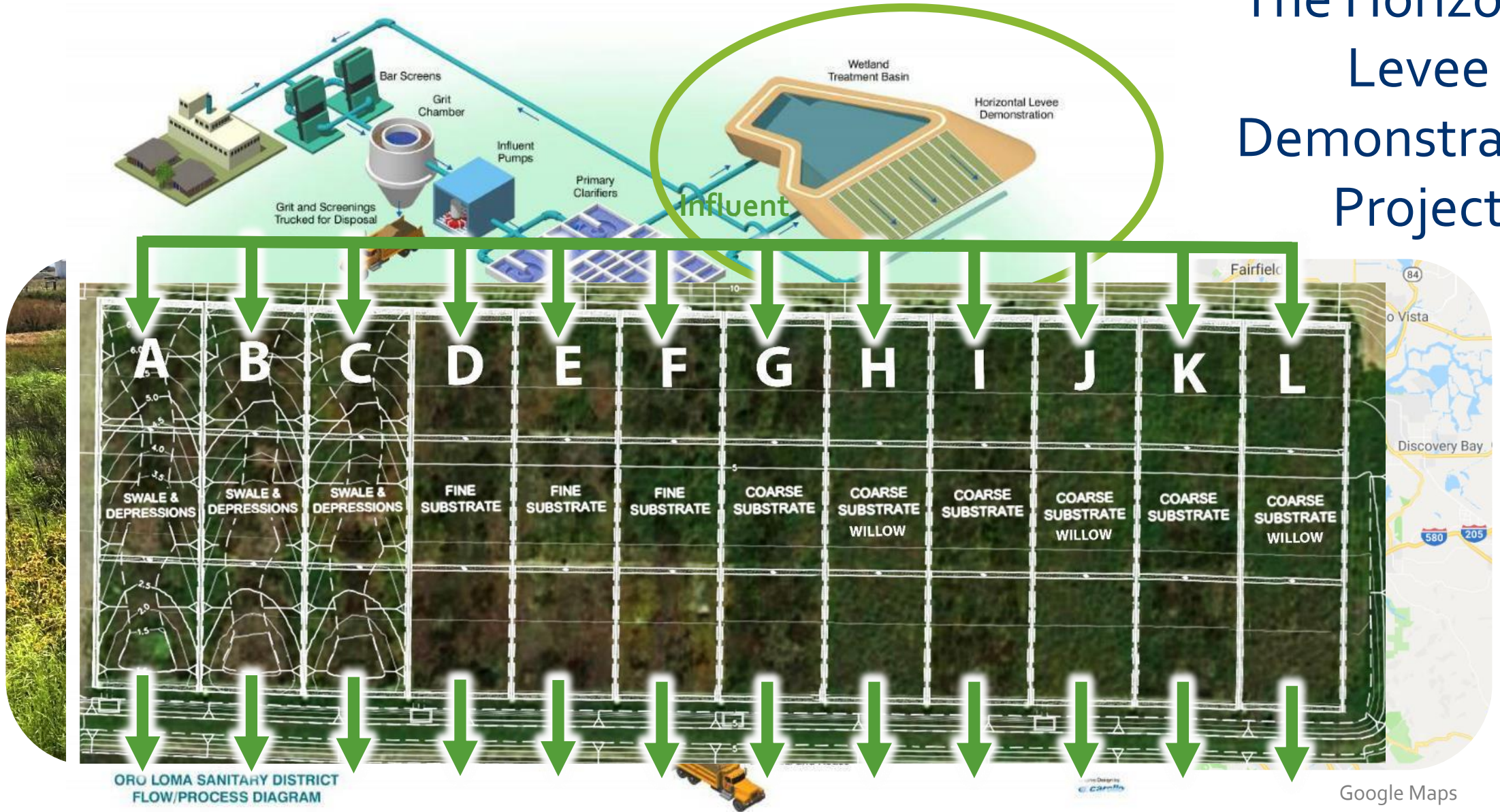
The Horizontal Levee Demonstration Project



Google Maps

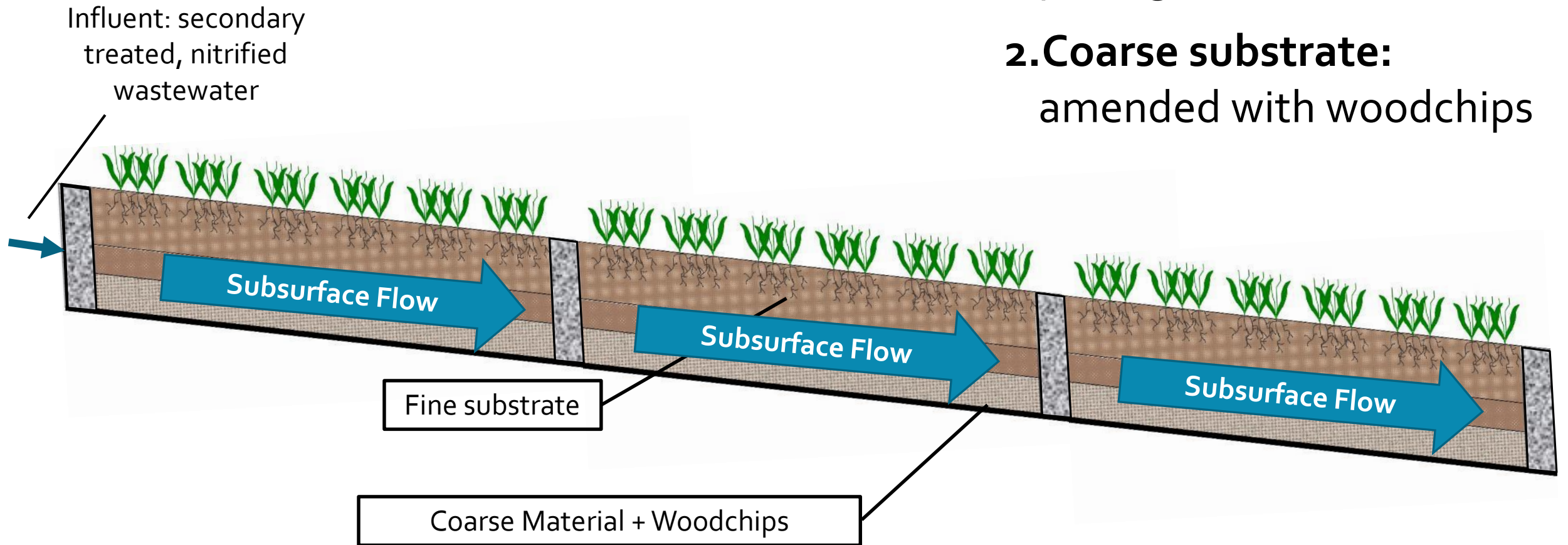


The Horizontal Levee Demonstration Project

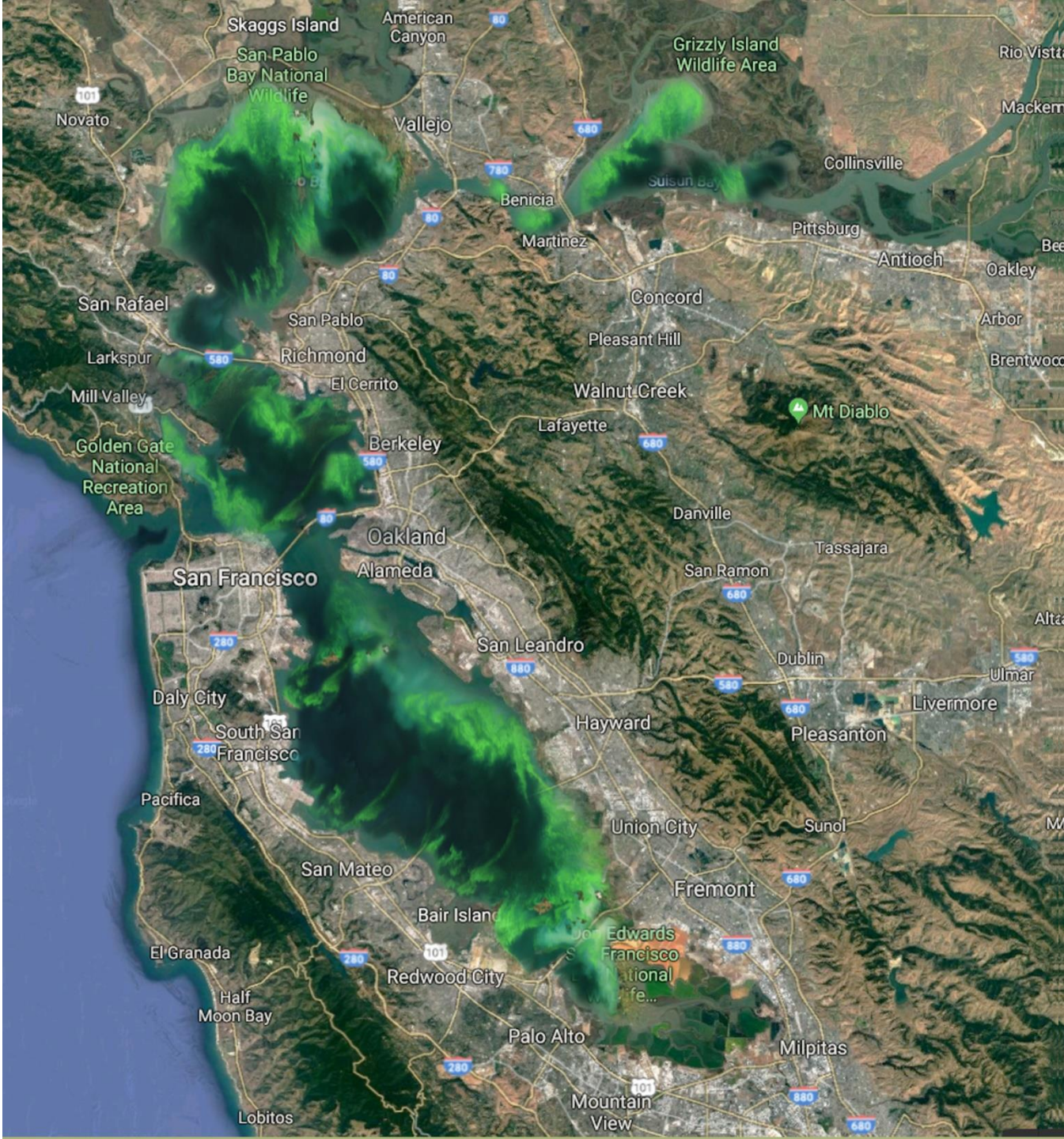


Subsurface Design

- 1. Fine Substrate:** native plant growth
- 2. Coarse substrate:** amended with woodchips



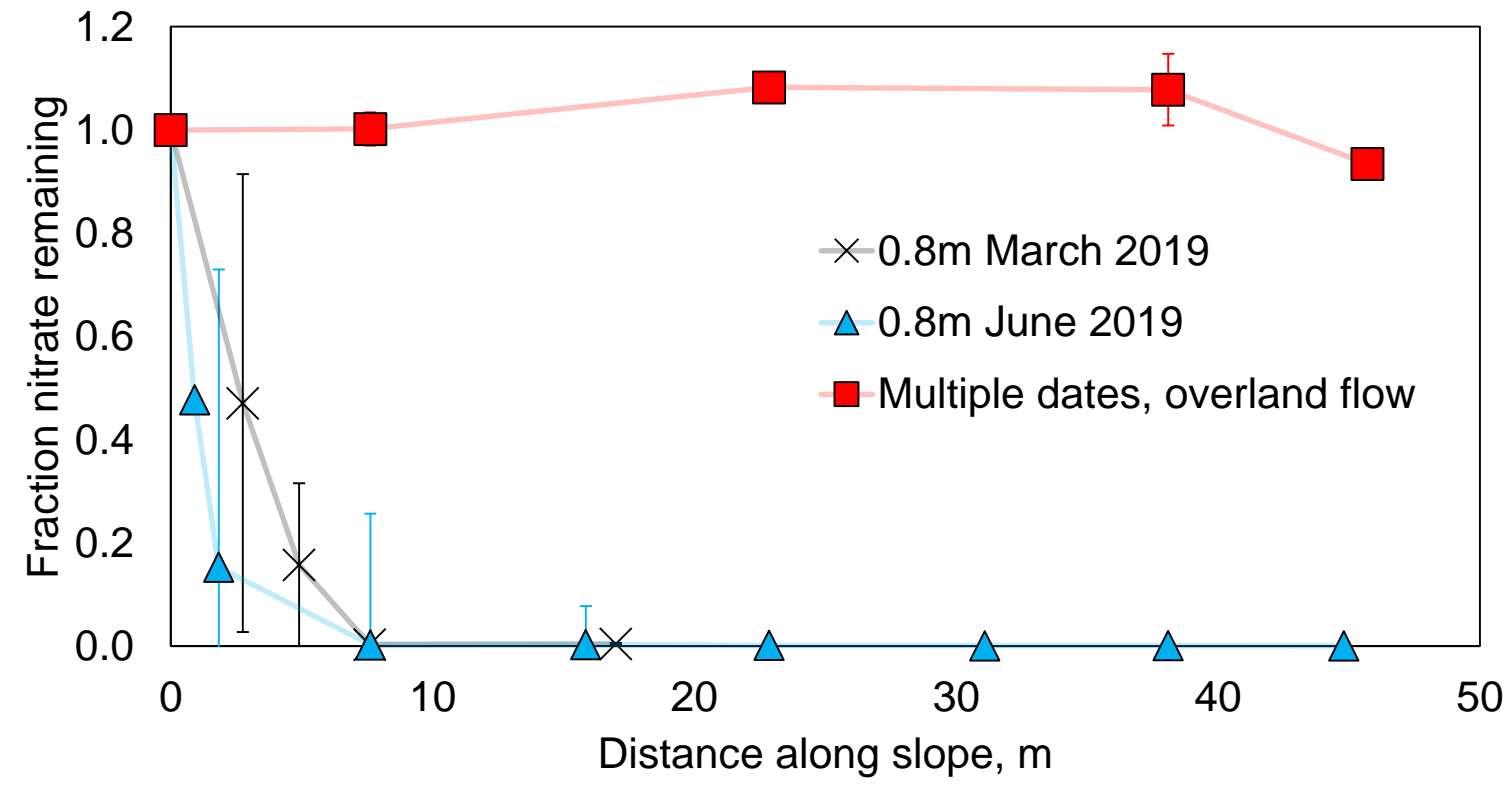
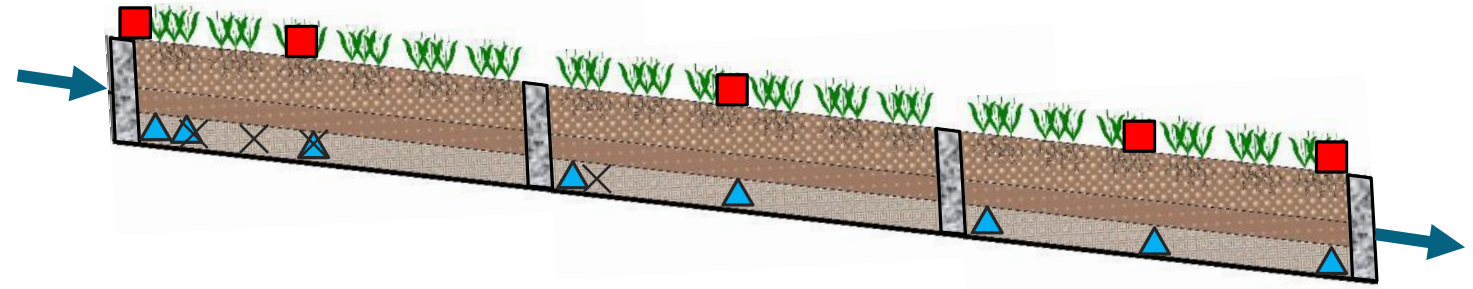
Nitrogen



Nitrate removal

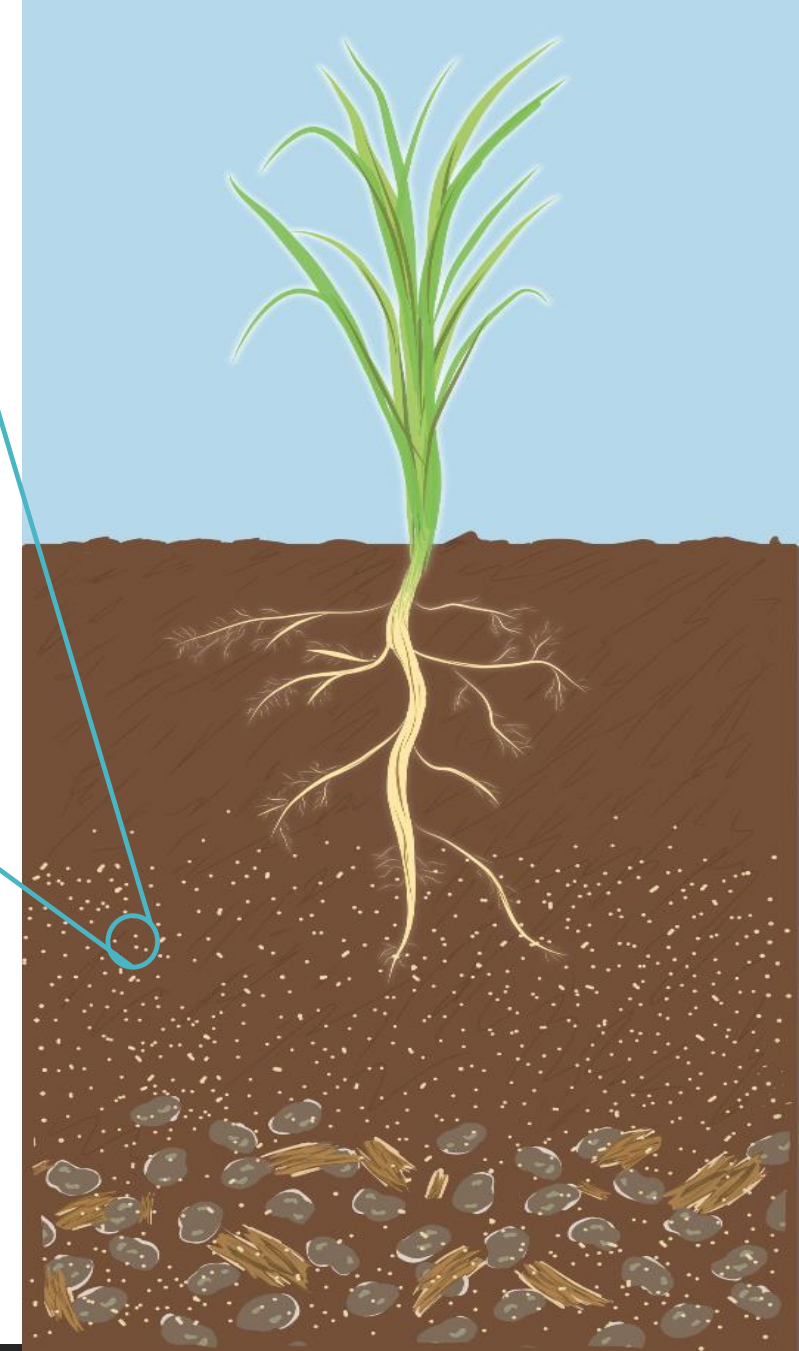
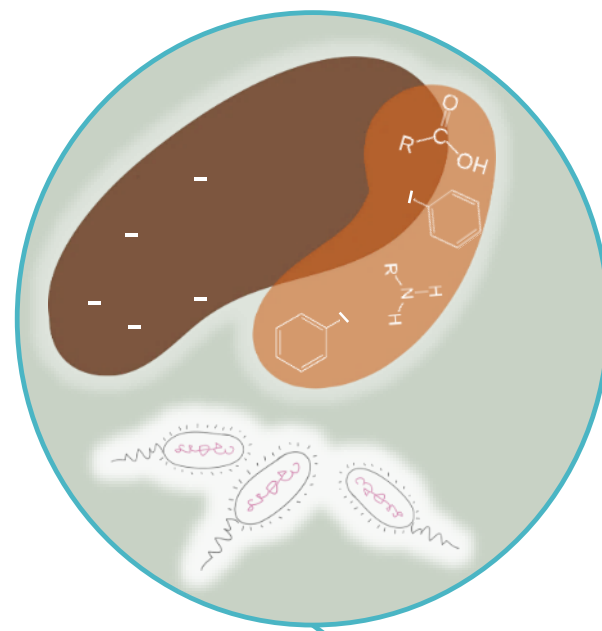
- Overland flow results in hydraulic short circuiting
- Nitrate is removed within 1/5 built capacity

Pore water and overland flow sample positions

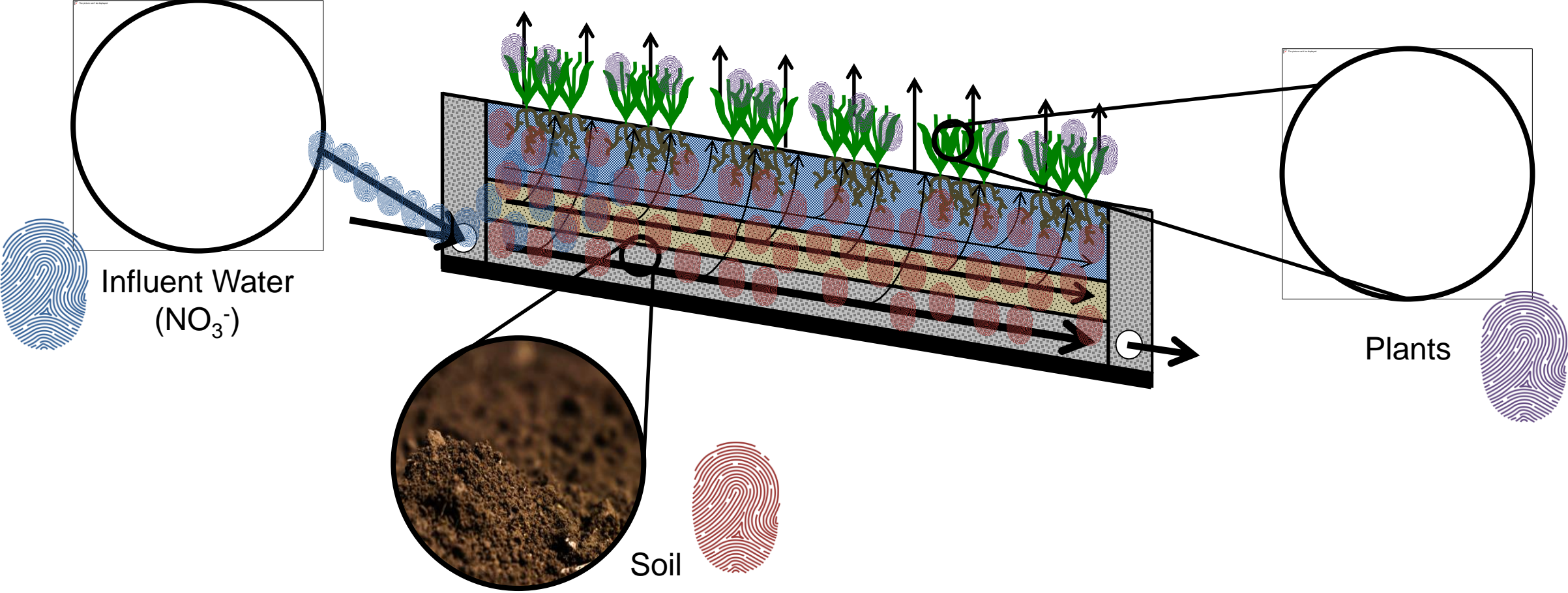


Nitrate Removal Mechanisms

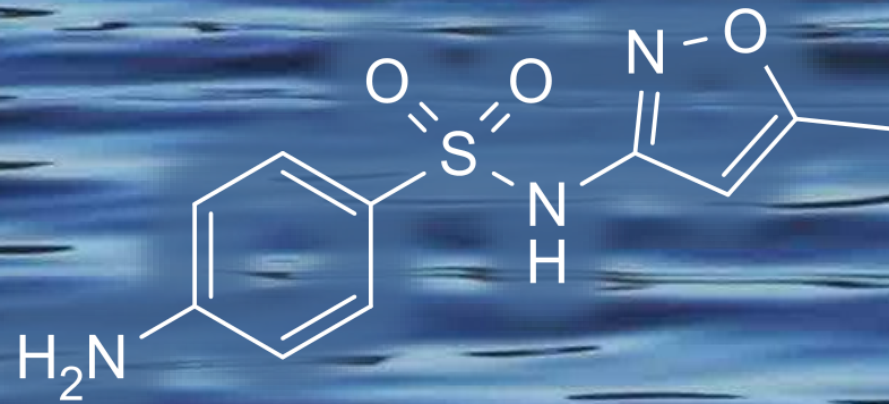
1. Microbial processes (e.g. denitrification)
2. Plant uptake



Nitrogen Isotopic Methods



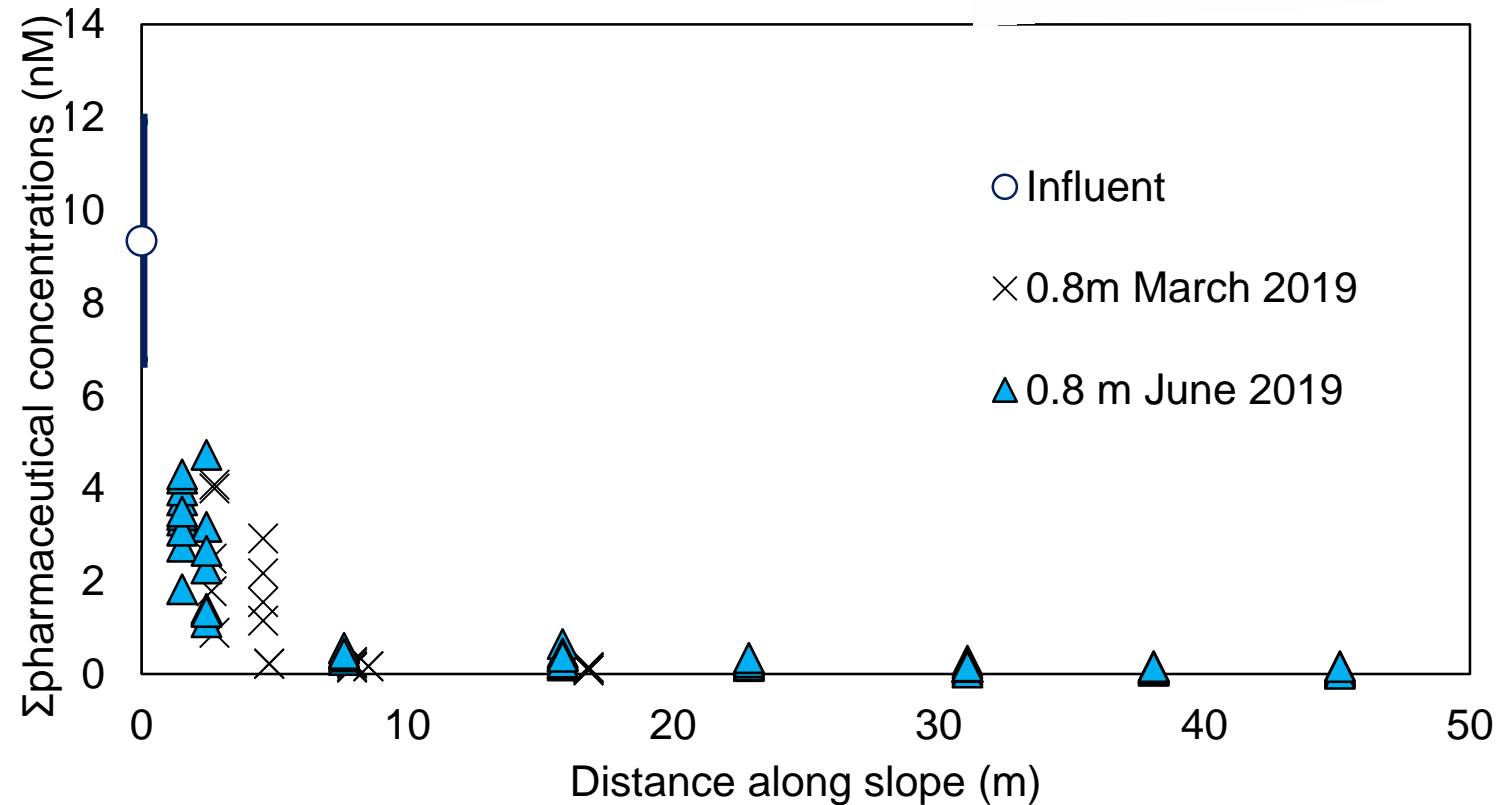
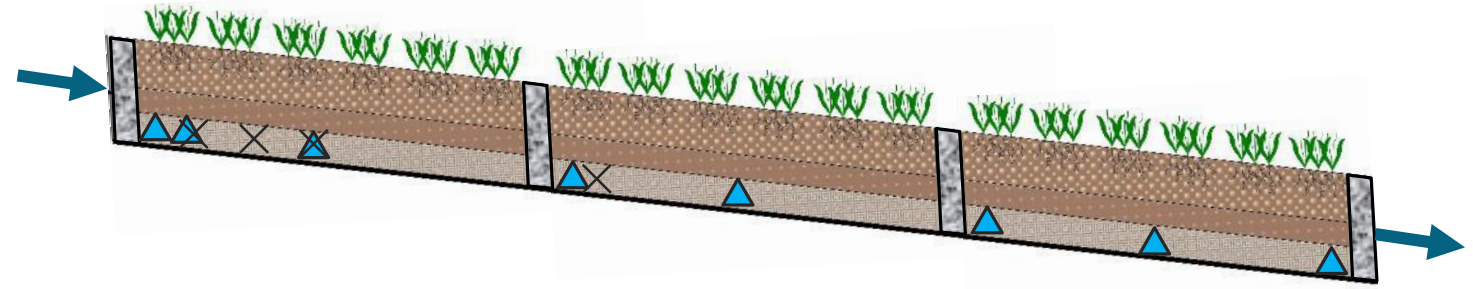
Pharmaceuticals



Pharmaceutical Removal

Recalcitrant antivirals,
beta-blockers, antibiotics

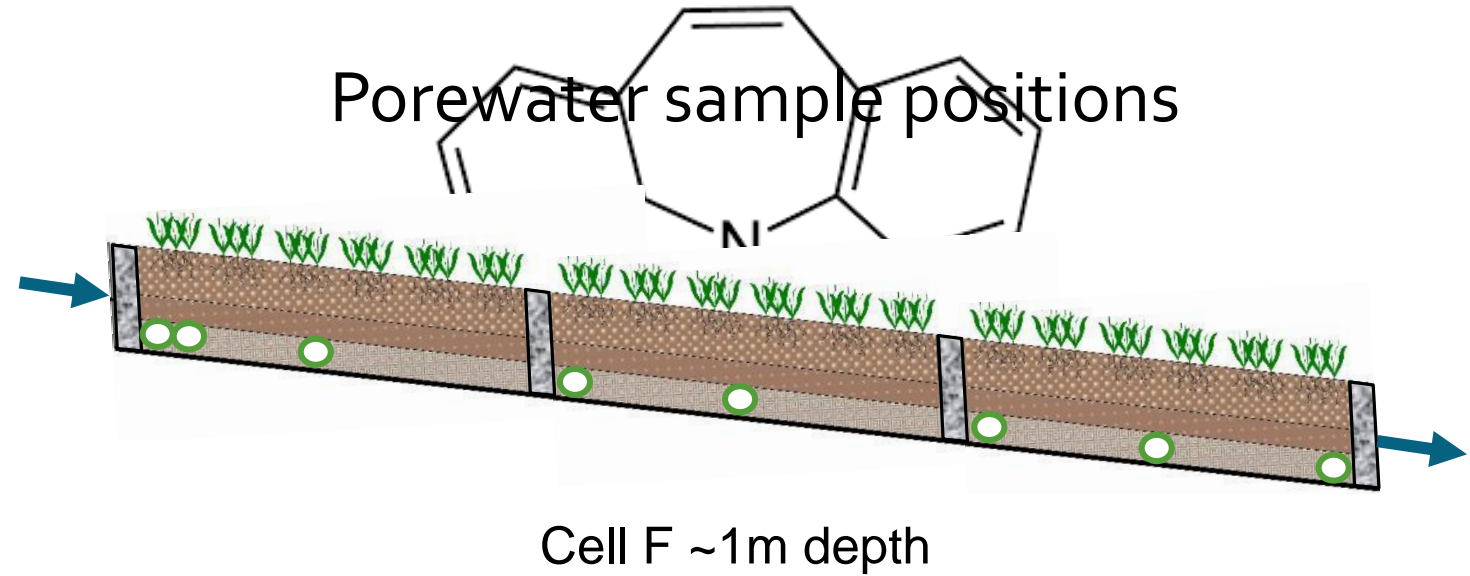
Porewater sample positions



Carbamazepine


- Anti epileptic drug
- Recalcitrant in biologically-based treatment systems
- Marker for wastewater impacted waterbodies

Porewater sample positions




1.2

Concentration (nM)

 ELSEVIER

Water Research 38 (2004) 947–954

 WATER RESEARCH

www.elsevier.com/locate/watres

Carbamazepine as a possible anthropogenic marker in the aquatic environment: investigations on the behaviour of Carbamazepine in wastewater treatment and during groundwater infiltration

M. Clara*, B. Strenn, N. Kreuzinger

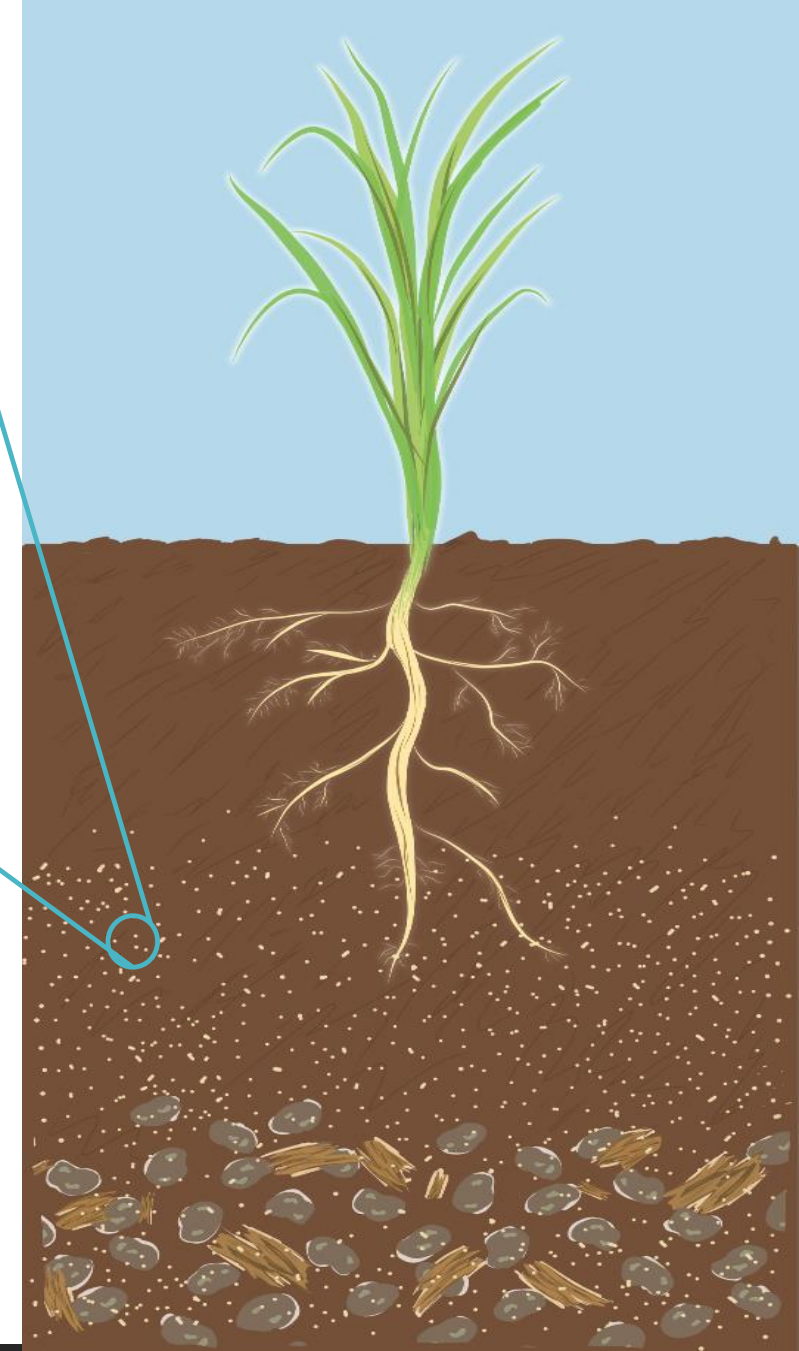
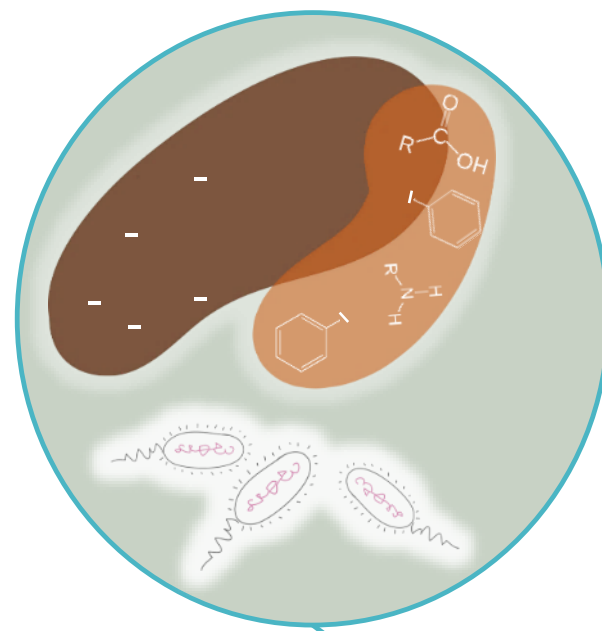
Institute for Water Quality and Waste Management, Vienna University of Technology, A-1040 Vienna, Karlsplatz 13/226, Austria

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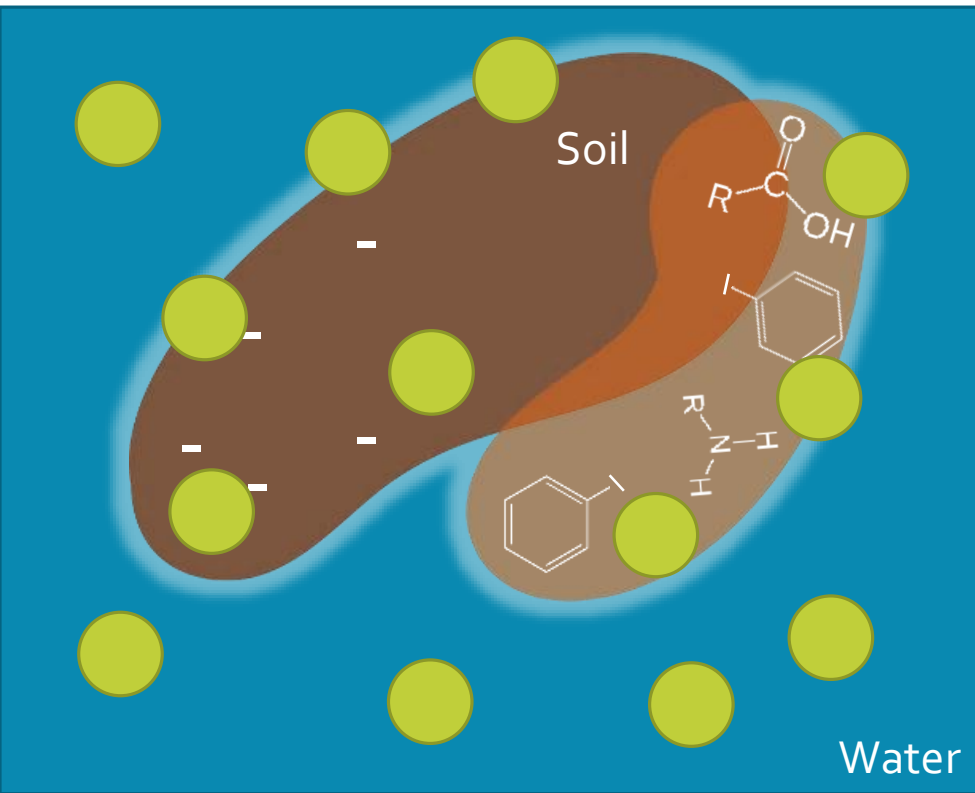
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Pharmaceutical Removal Mechanisms

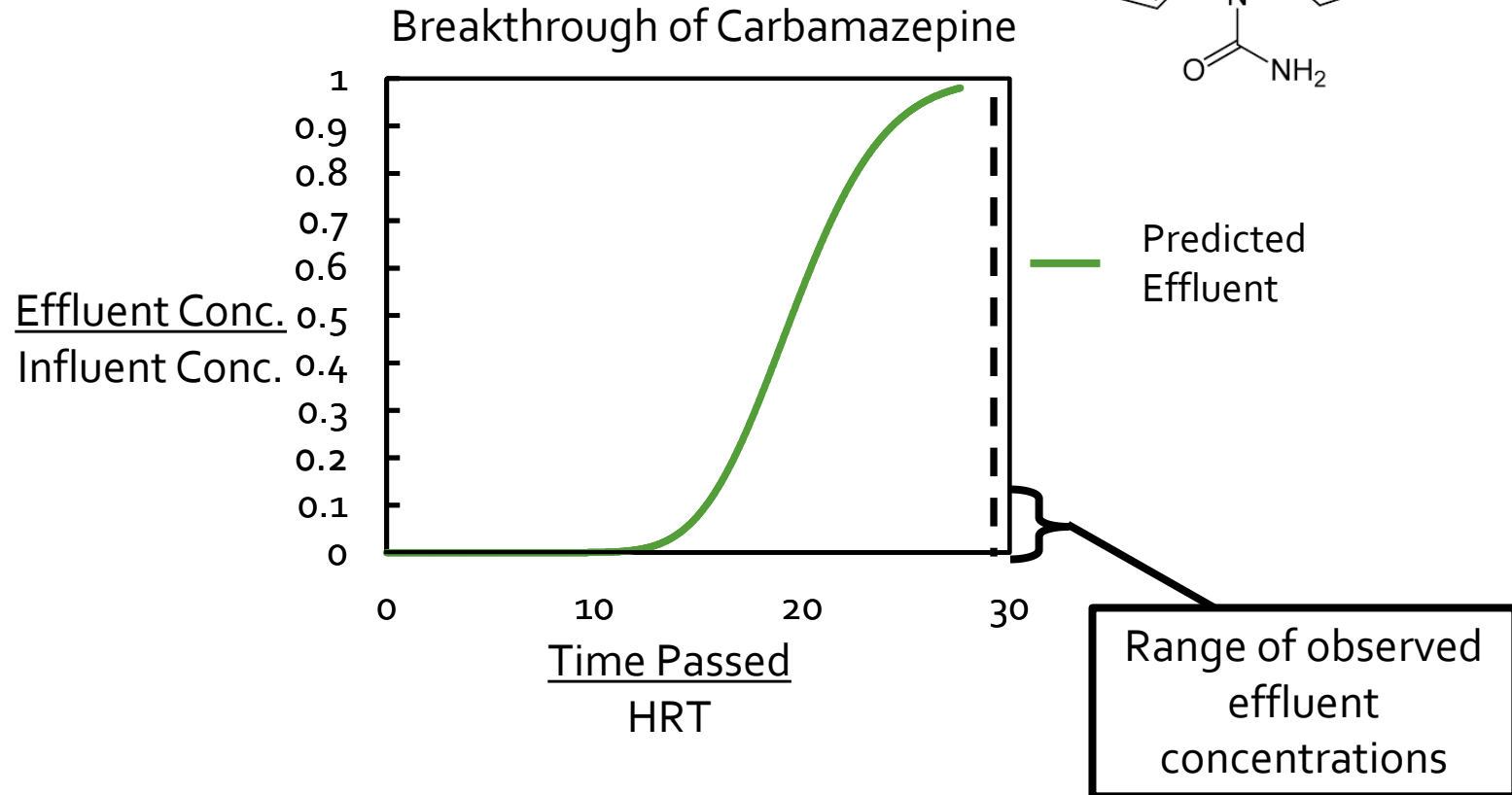
1. Sorption
2. (Bio)transformation
3. Plant uptake



Sorption

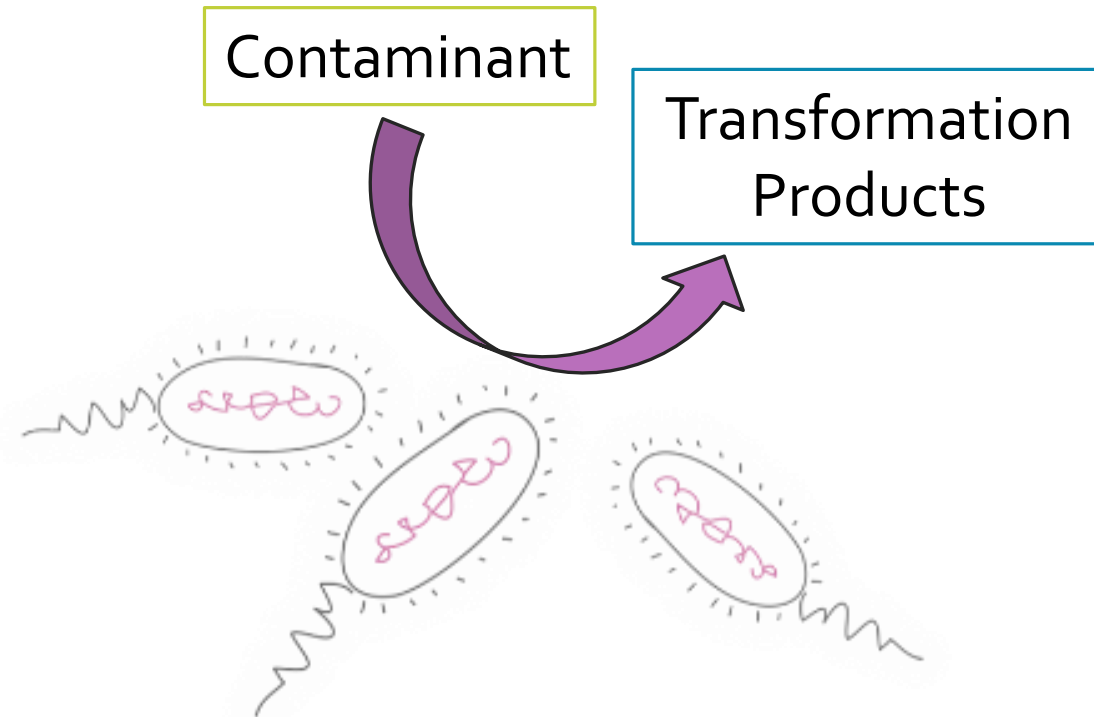
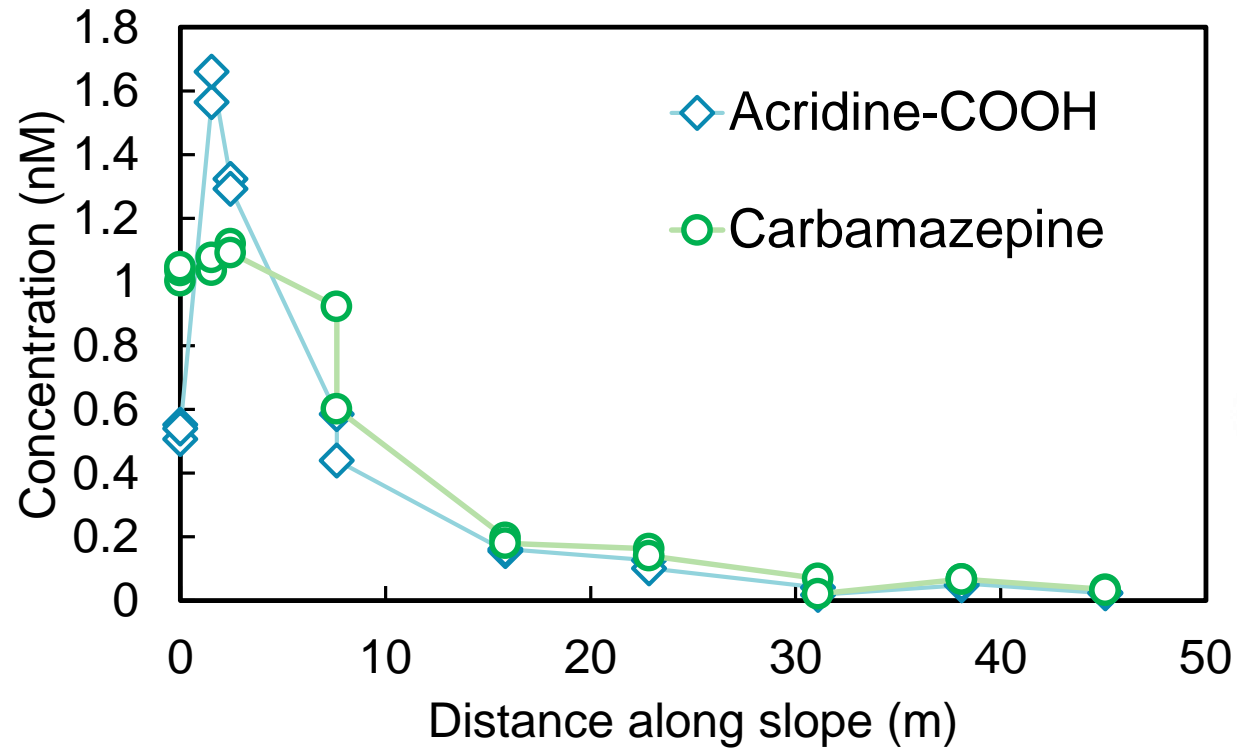


 Contaminant



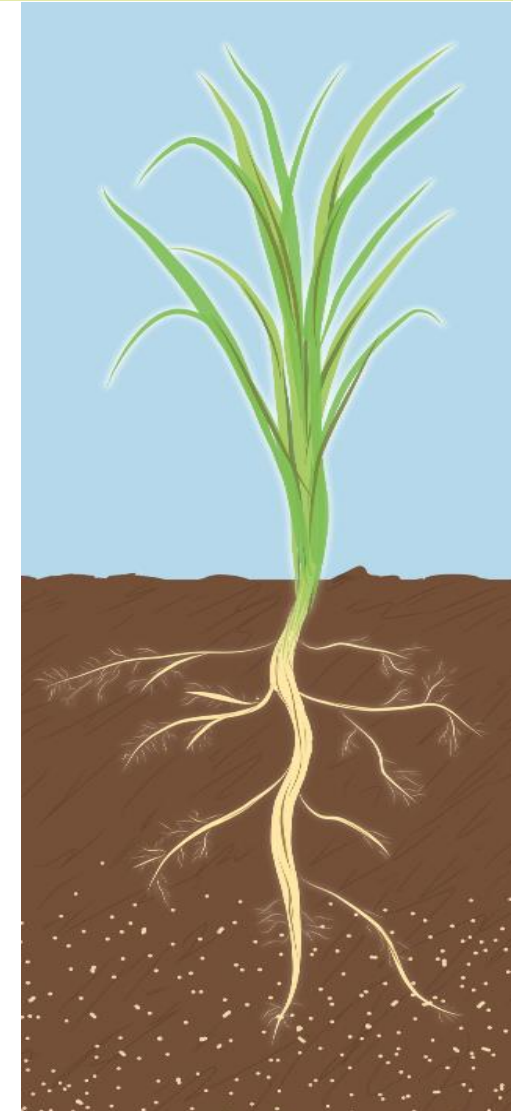
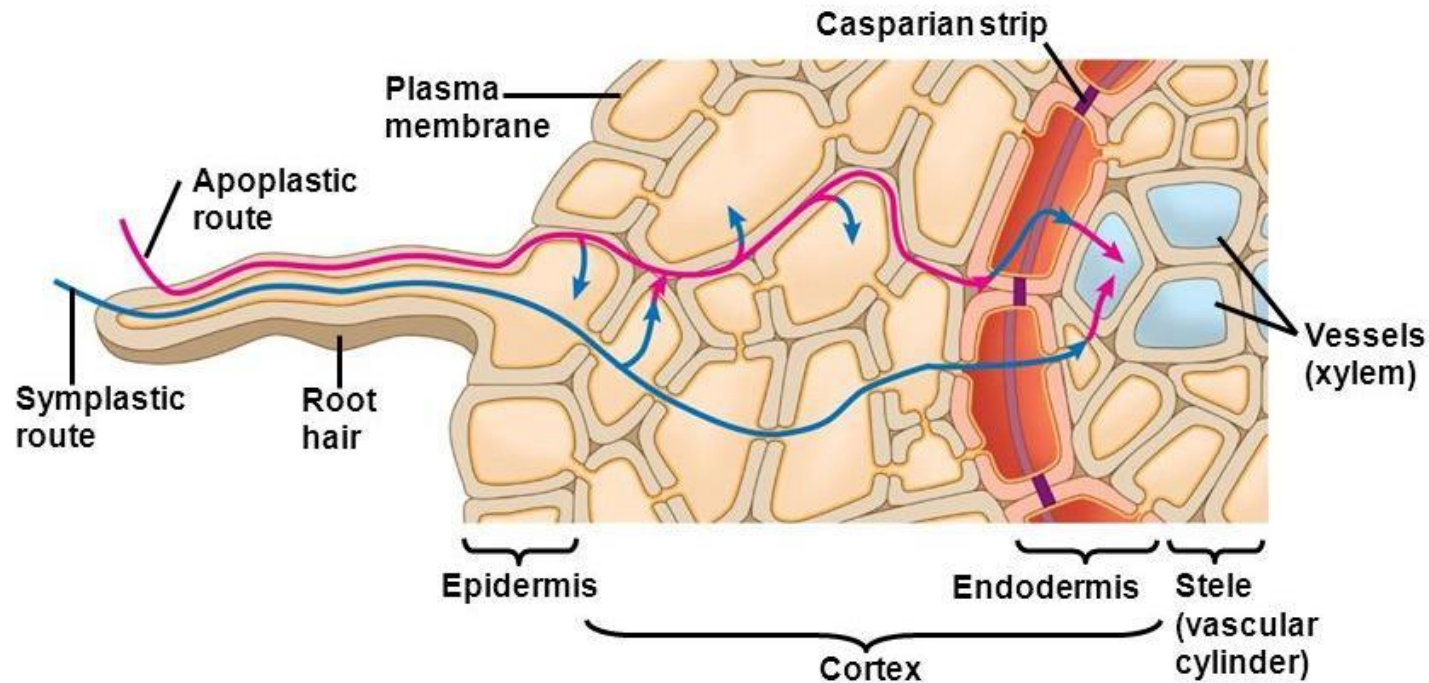
Biotransformation

Cell F ~1m depth



Plant Uptake

- Compounds with **maximum propensity** for uptake are uncharged and of intermediate hydrophobicity
- Uptake can account for ~5% of the loss of carbamazepine
- Low concern exposure to animals, but more research is being done



Plant Uptake

Research Questions

How much does plant uptake vary spatially?

Are pharmaceuticals transformed in the plant or after plant death?

How do concentrations vary as a function of evapotranspiration?

Methods



Plant Uptake

Research Questions

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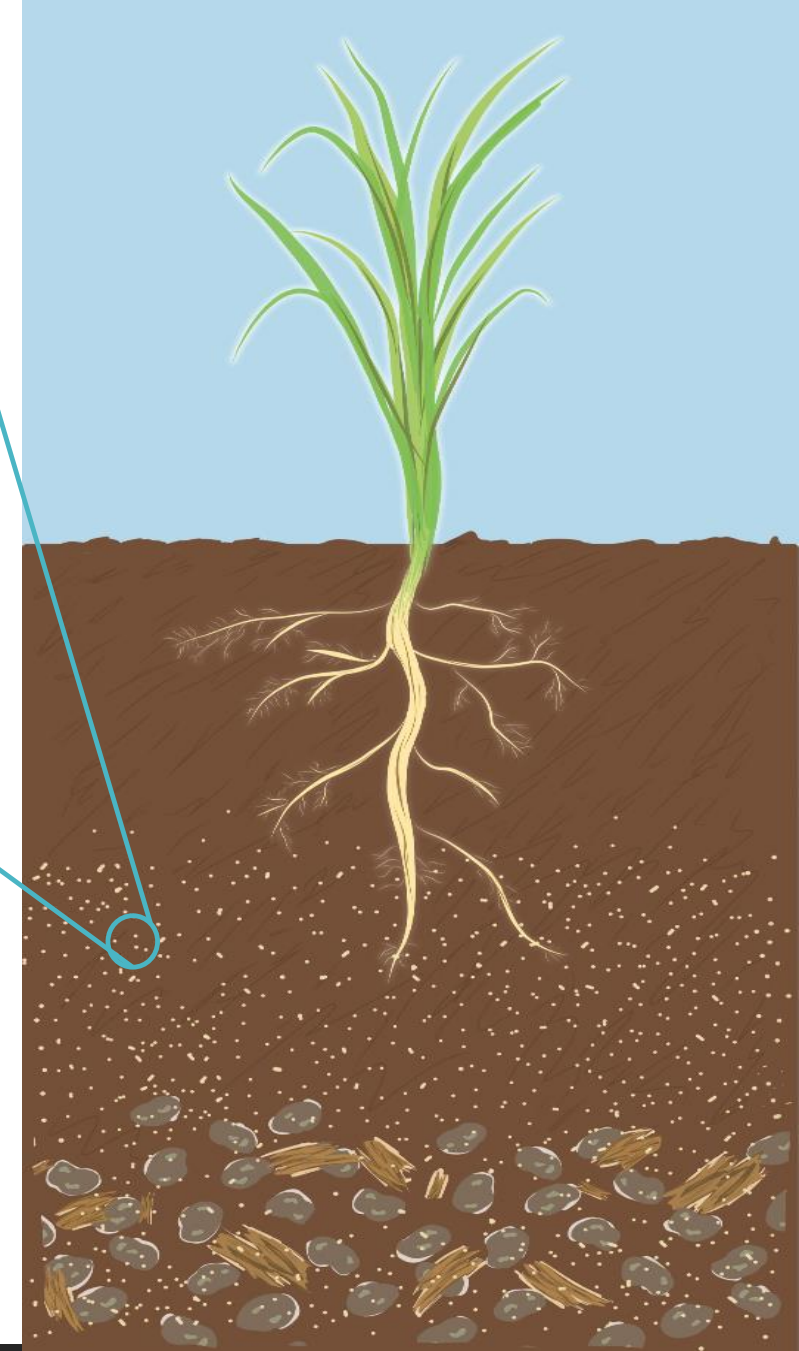
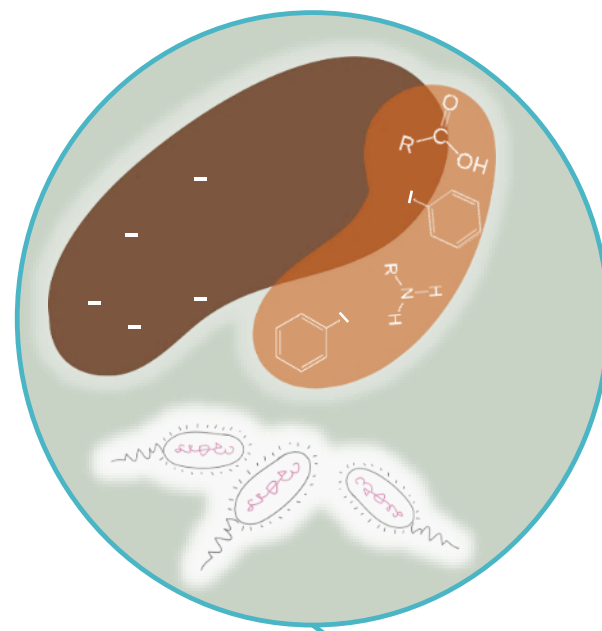
How do concentrations vary as a function of evapotranspiration?

Methods

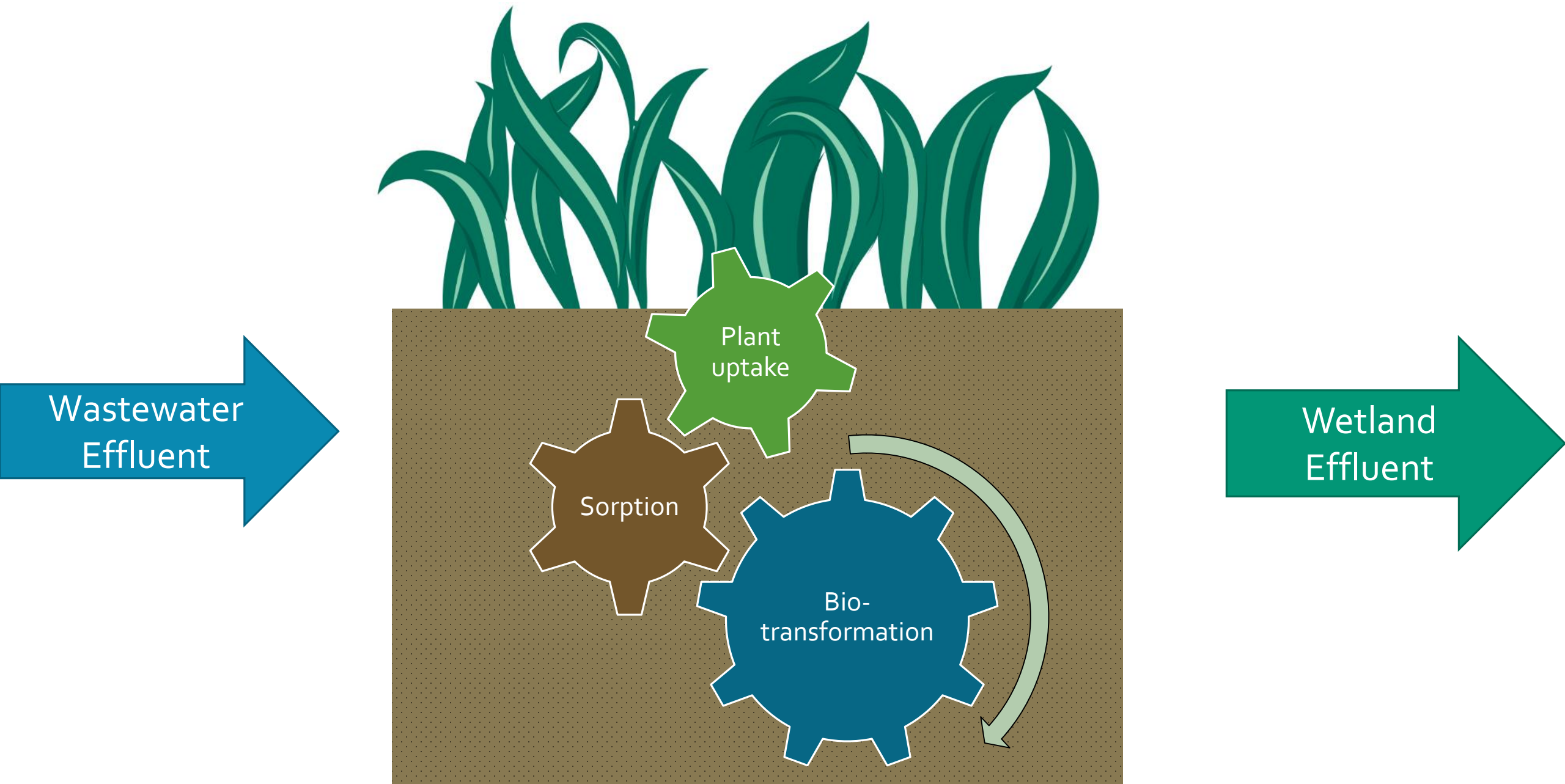


Removal Mechanisms

1. Sorption
2. (Bio)transformation
3. Plant uptake







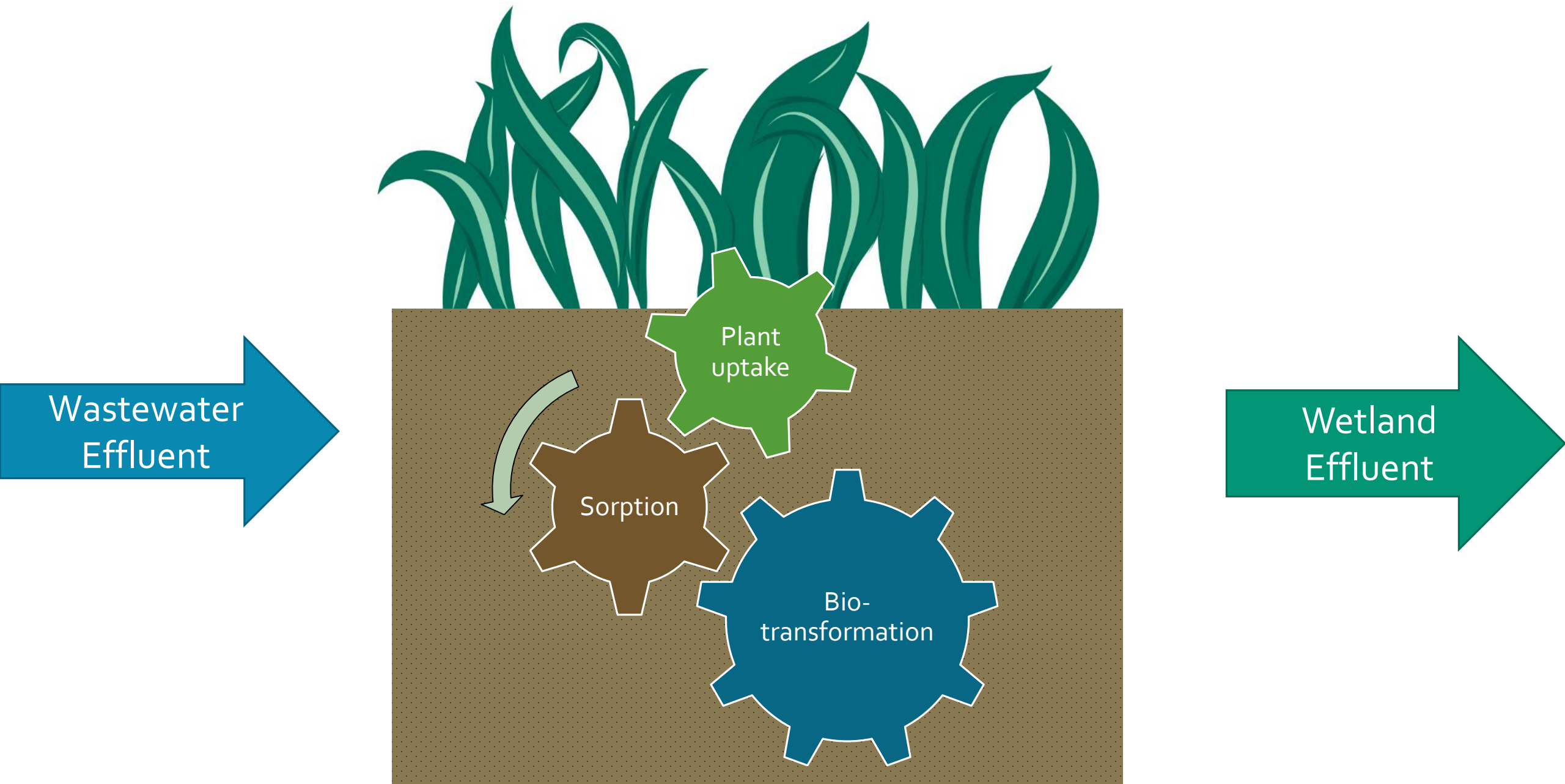
Wastewater
Effluent

Plant
uptake

Sorption

Bio-
transformation

Wetland
Effluent



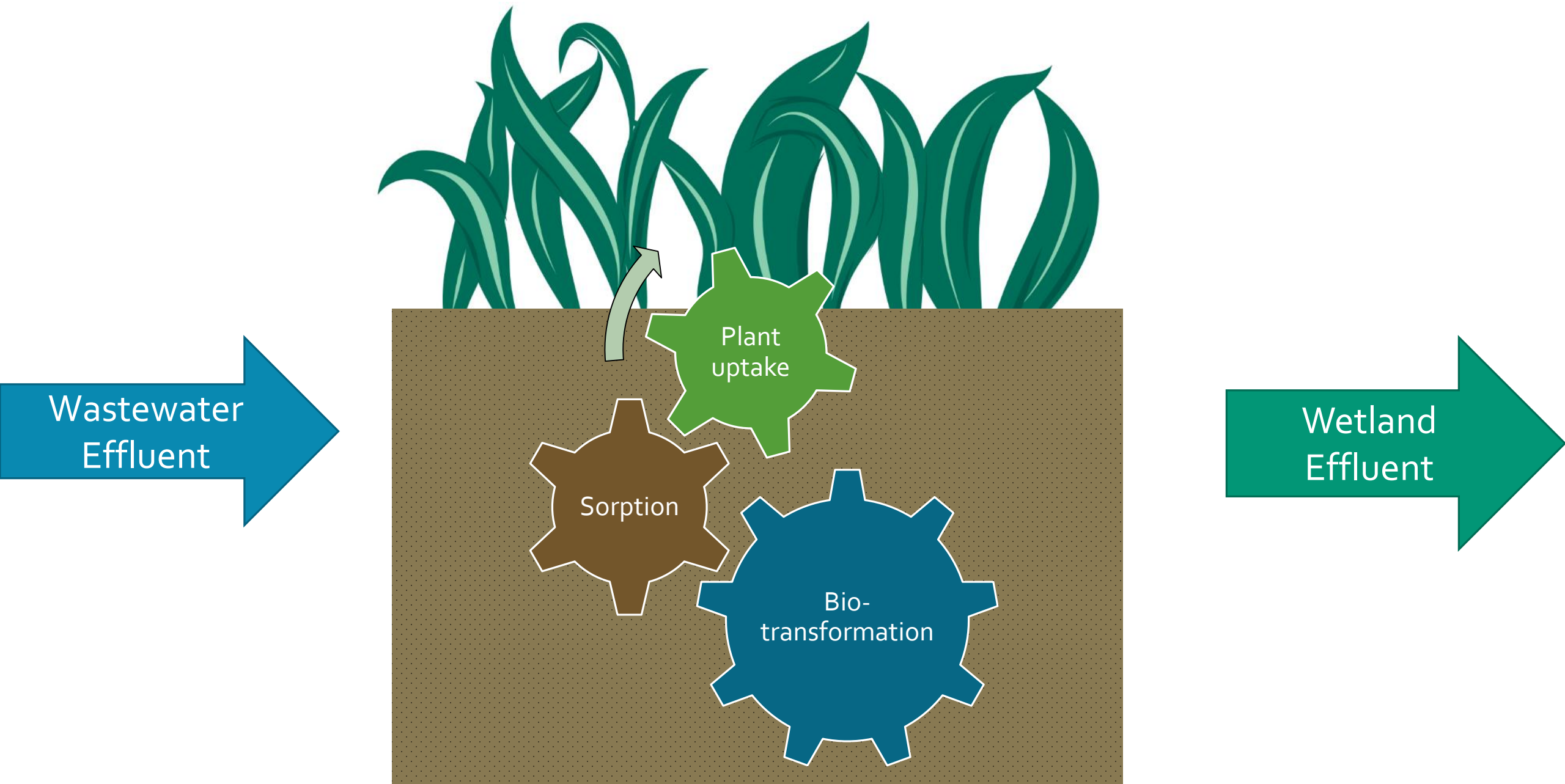
Wastewater
Effluent

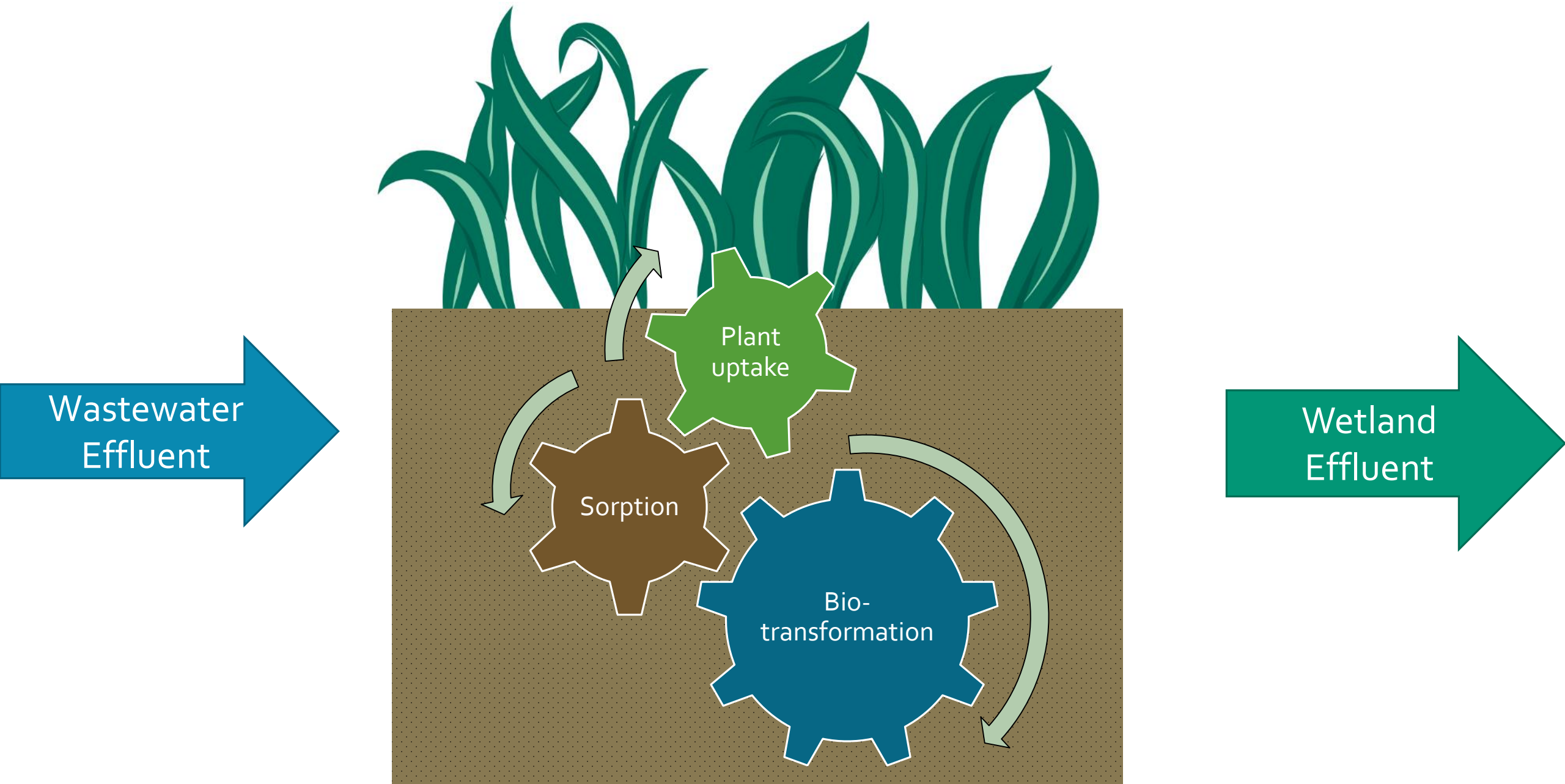
Plant
uptake

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Wastewater
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ReNUWIt
Re-inventing the Nation's
URBAN WATER
INFRASTRUCTURE



Thank you!



My Advisor, David Sedlak, and the Sedlak research group!