

# Energy Efficient Wastewater Treatment

Emily Gonthier & Jennifer Lawrence

April 30, 2018



Systems Approach  
to Green Energy



**ReNUWIt**

# Outline

- ReNUWIt
  - What is it?
  - Our Partnership through ReNUWIt
- Research
  - Municipal Wastewater Treatment 101
  - Anammox
  - Broader Impacts



# Re-Inventing the Nation's Urban Water Infrastructure

*ReNUWI is an interdisciplinary, multi-institution engineering research center.*

*Our goal is to change the ways we manage urban water.*



Stanford University



New Mexico State University



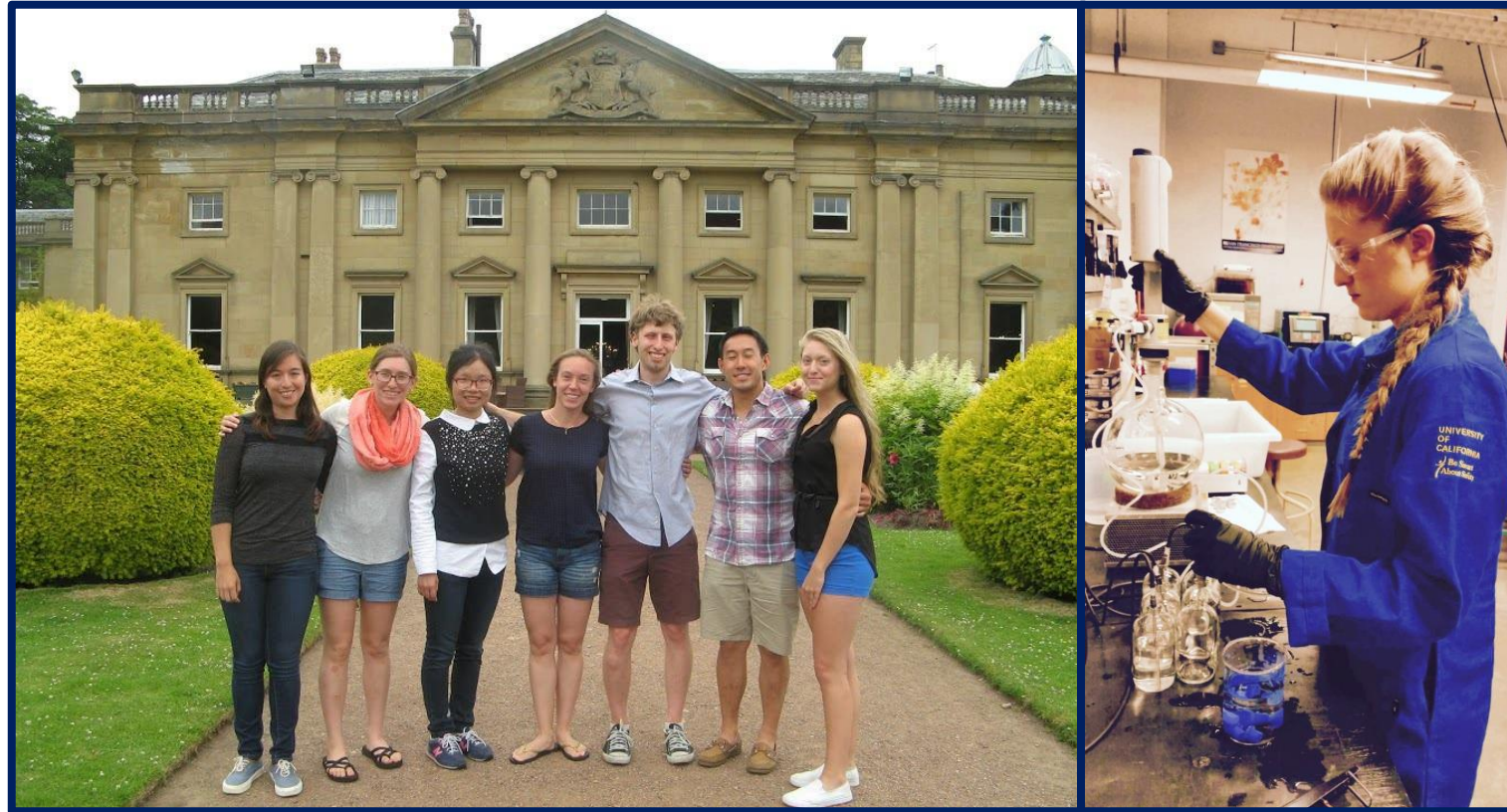
U.C. Berkeley



Colorado School of Mines



# ReNUWit – REU Program



**Summer 2015** – Emily joins the lab group as an REU, with Jennifer as her mentor

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**Fall 2016** – Emily joins the lab group as a PhD student!

# Municipal Wastewater Treatment 101



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## Raw Sewage Characteristics



Pollutant	Parameter	Influent Concentration	Treatment Requirement



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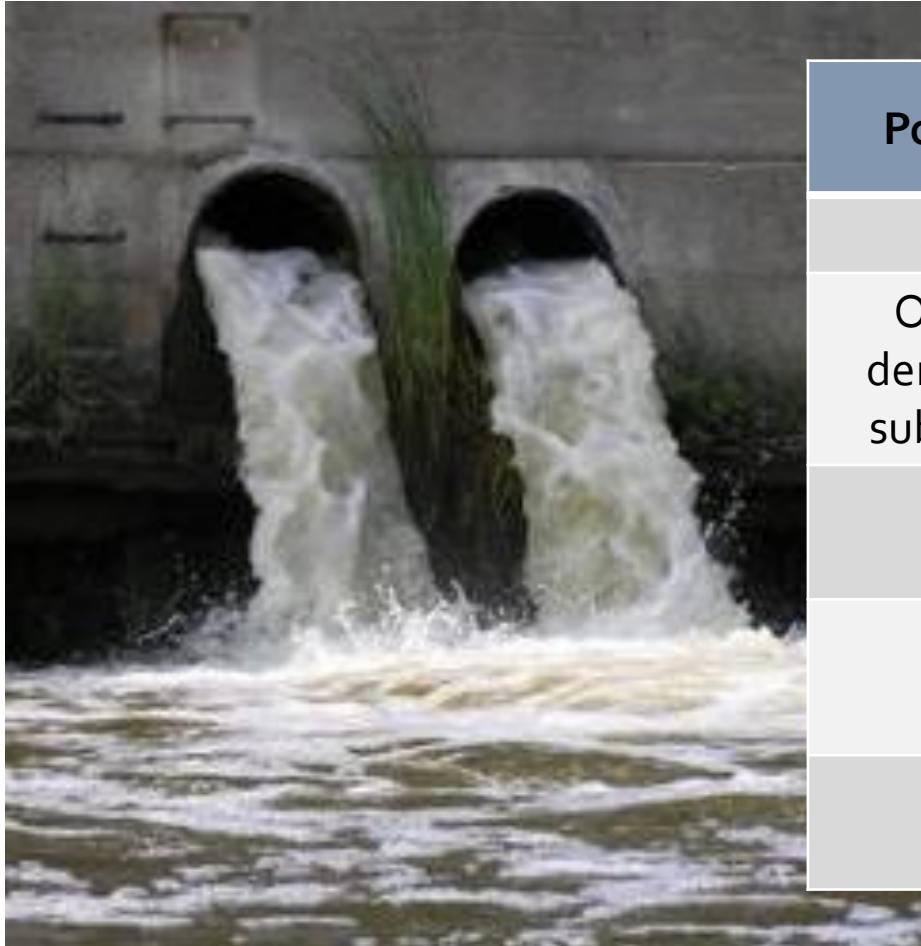
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Solids	TSS	100 – 350 mg/L	30 mg/L

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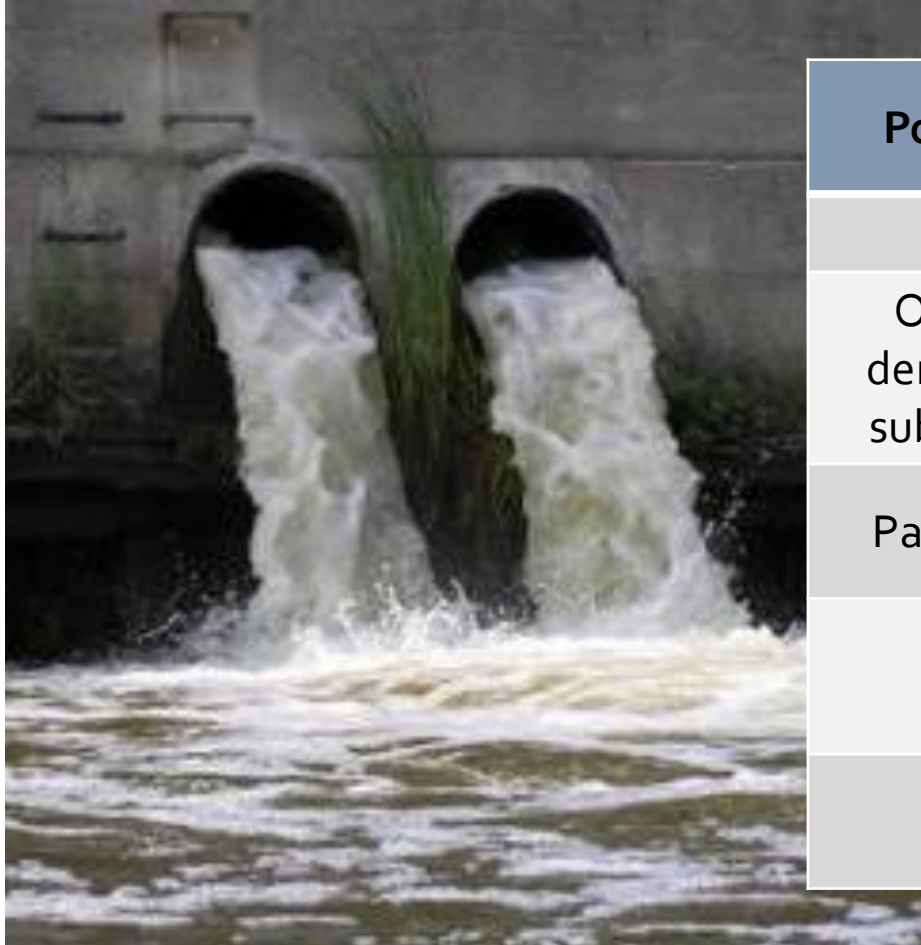
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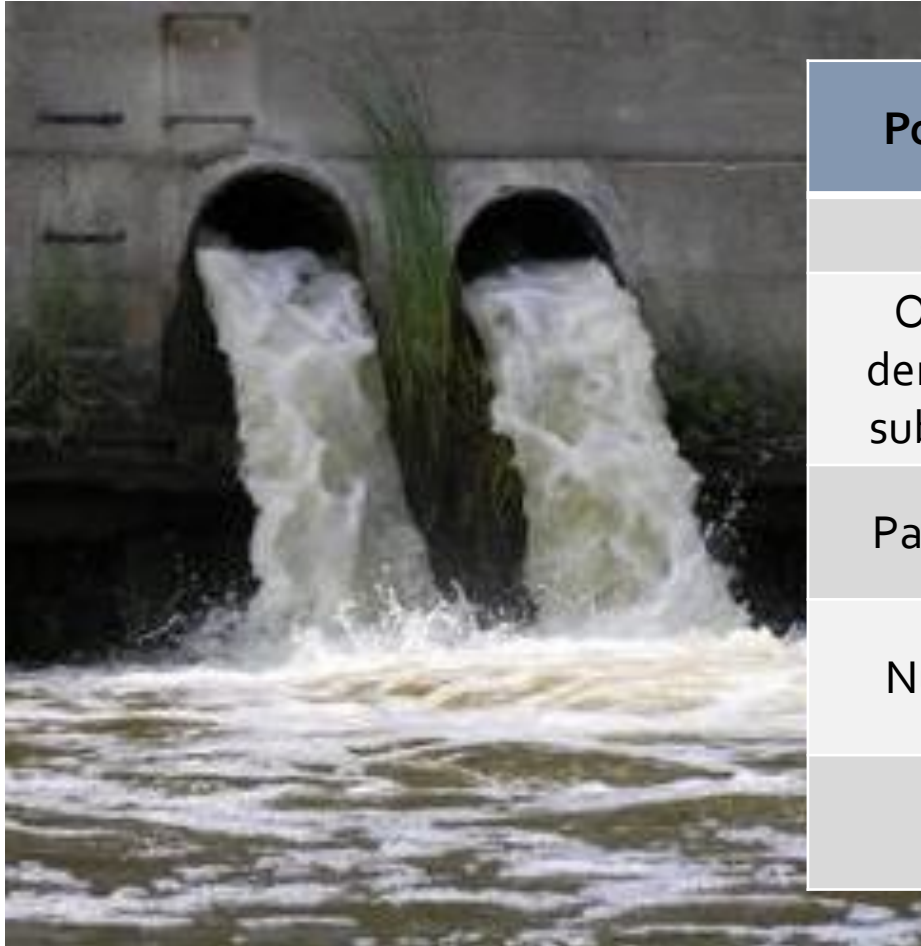
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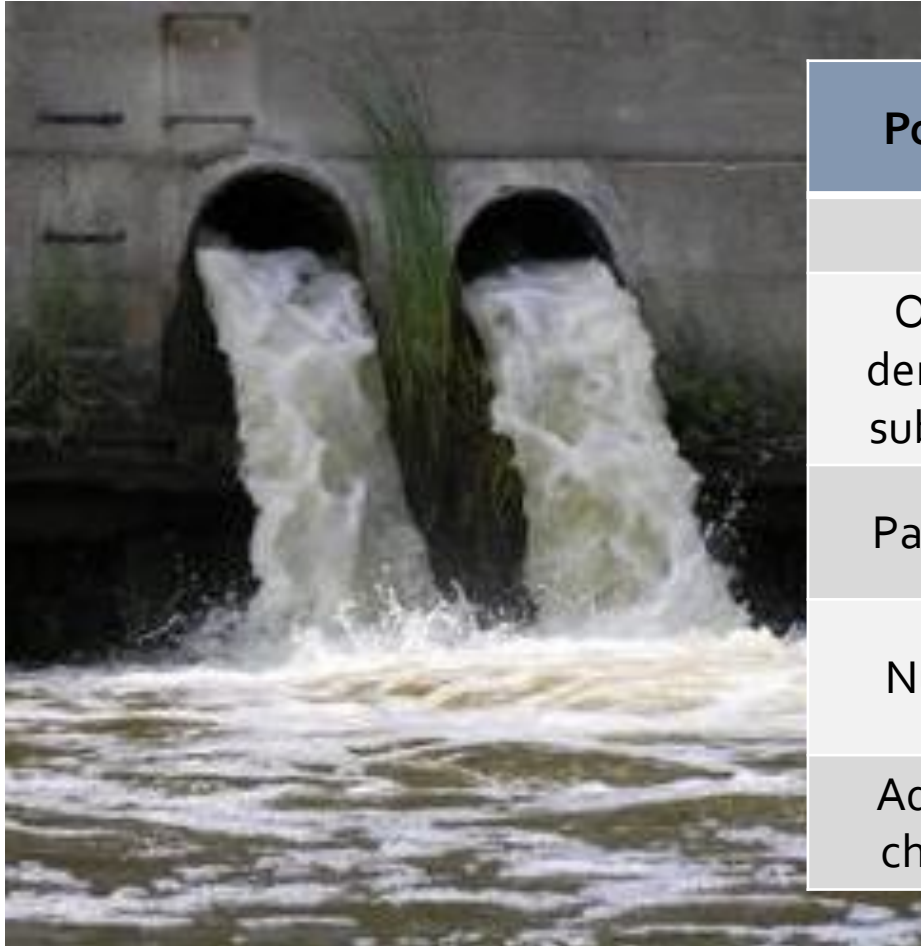
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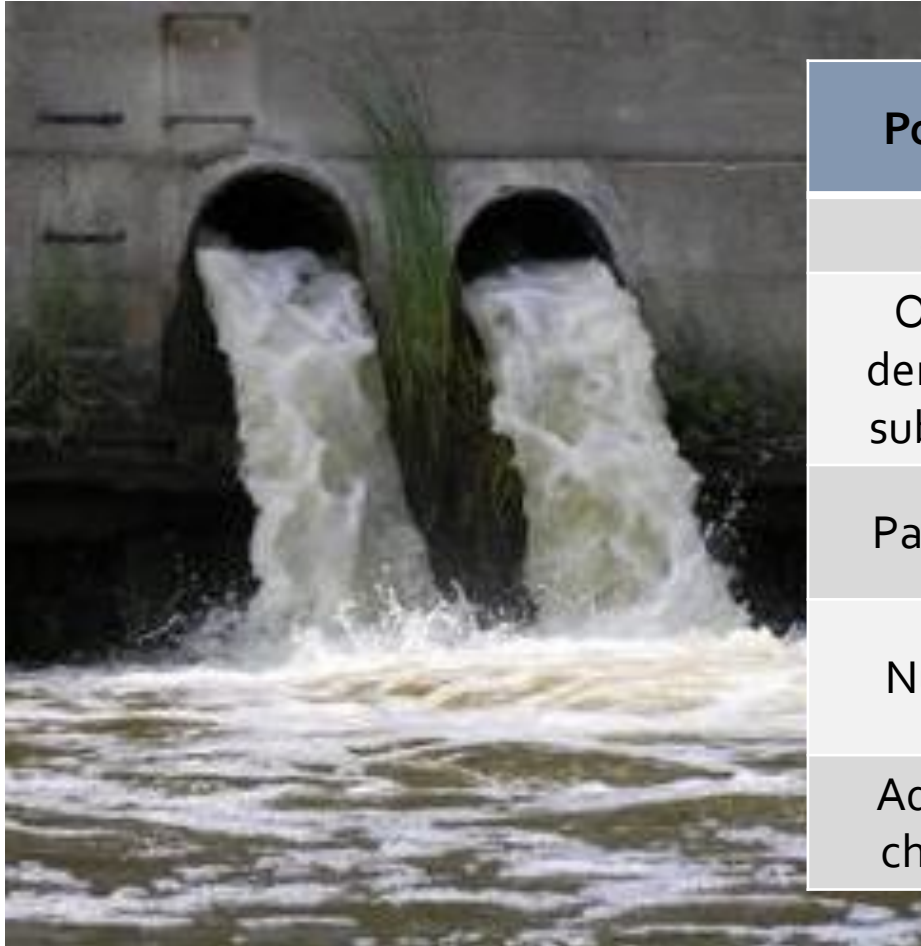
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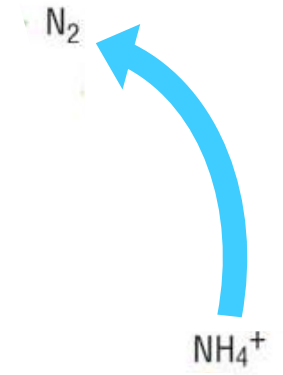
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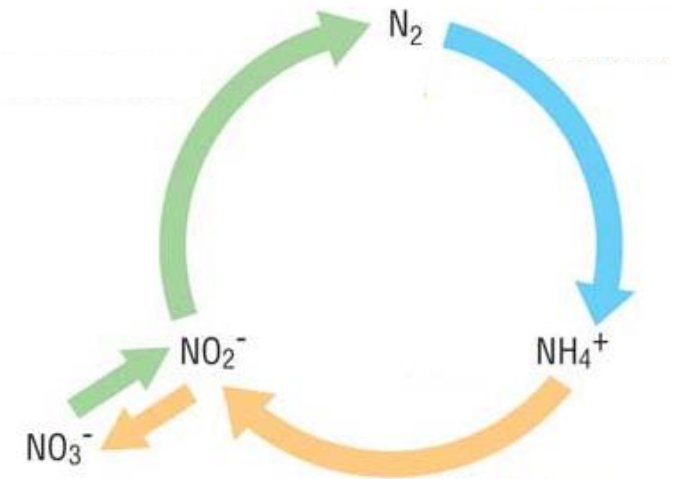


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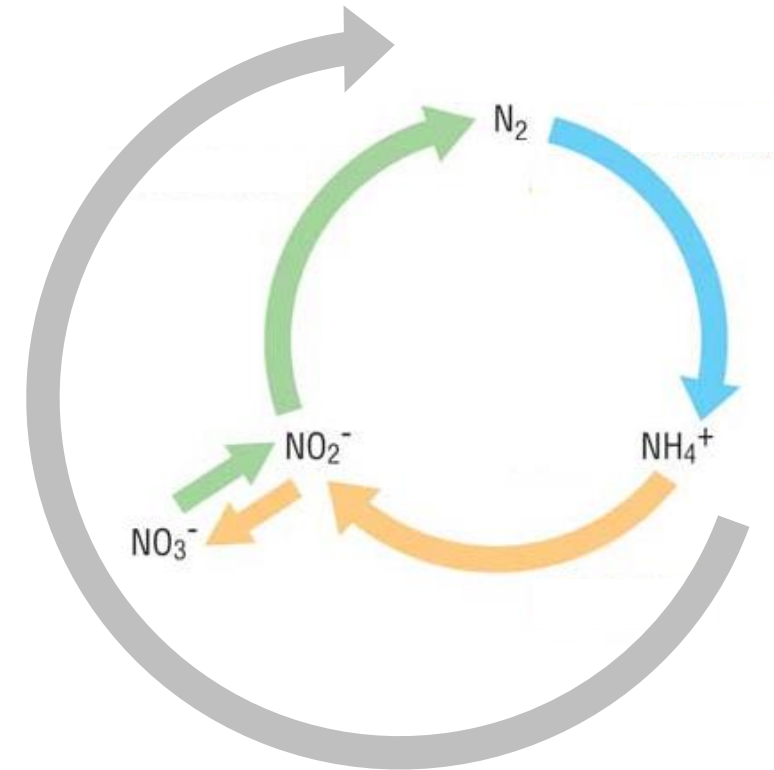




# Nitrogen Removal Technologies 101

Conventional Nitrogen Removal

- Nitrification
- Denitrification



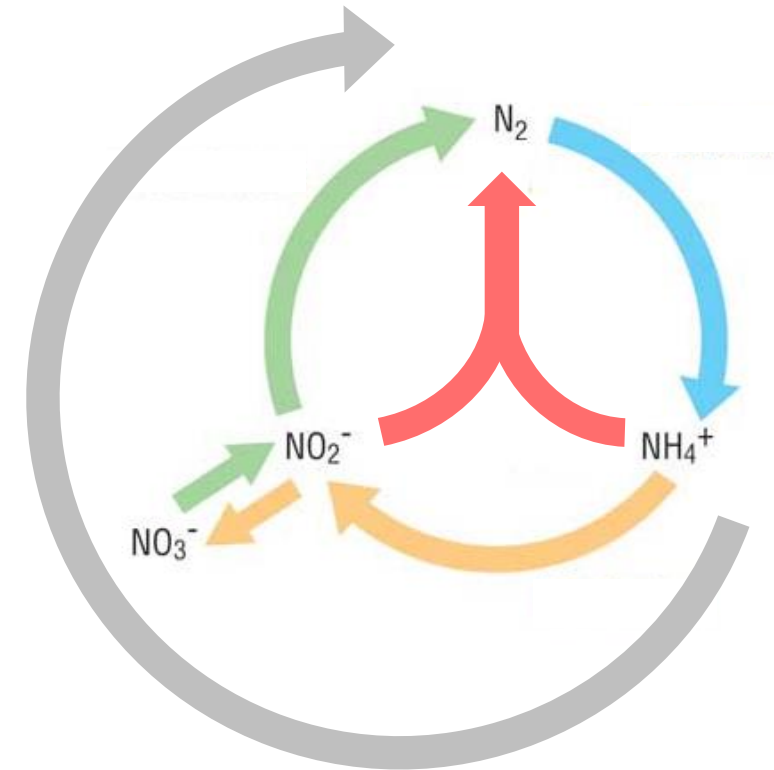
# Nitrogen Removal Technologies 101

## Conventional Nitrogen Removal

- Nitrification
- Denitrification

## Anammox / Deammonification

- Partial nitritation
- Anaerobic ammonium oxidation (anammox)



# The Anammox Process

## Strengths

- ▶ Decreased aeration demands
  - 60% reduction in energy consumption
- ▶ Decreased organic carbon demands
  - 90% reduction in waste biomass
  - Reduction in CO<sub>2</sub> emissions
- ▶ Reduction in N<sub>2</sub>O emissions

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## Weaknesses

- ▶ Slow growth rate
  - Long start-up periods
- ▶ Sensitivity to reactor conditions
  - Instability
  - Periodic Failures
- ▶ Bacteria not yet isolated

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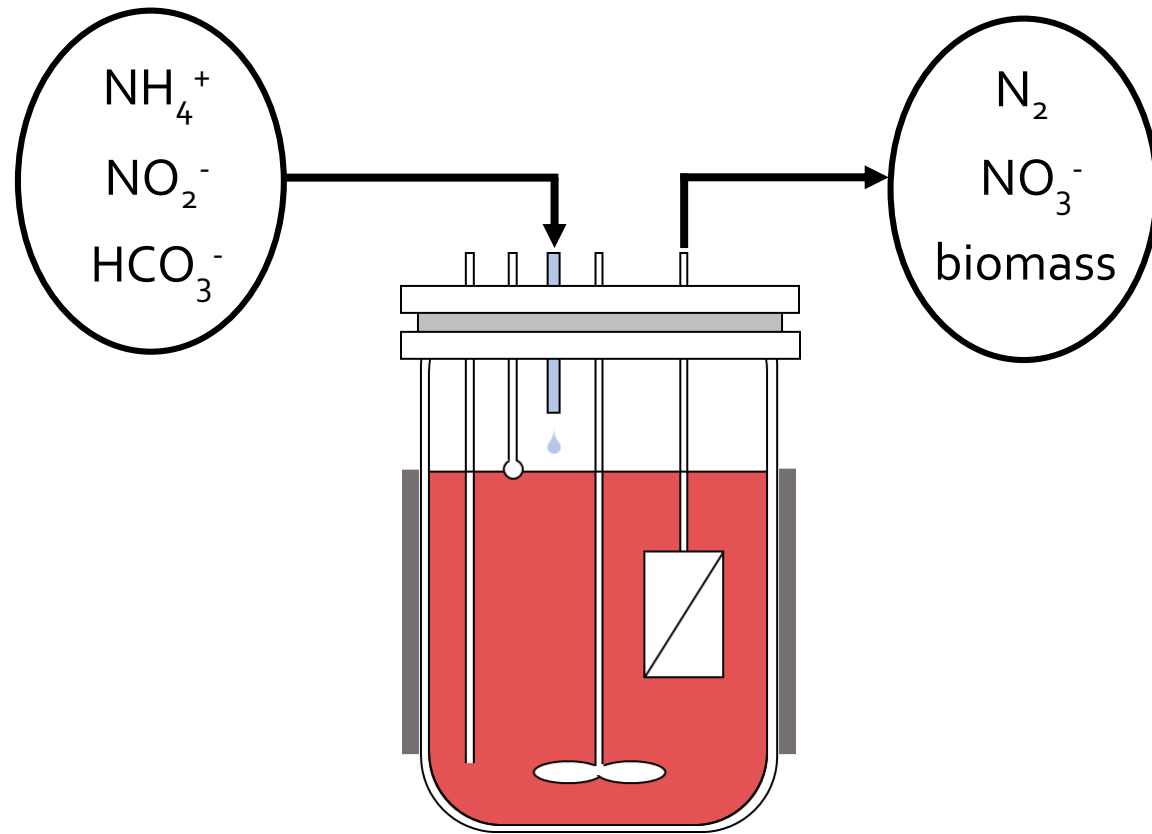
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**Research Goal:** Utilize insights from microbiology to understand and improve the functionality of the anammox process

# Laboratory-Scale Anammox Bioreactor

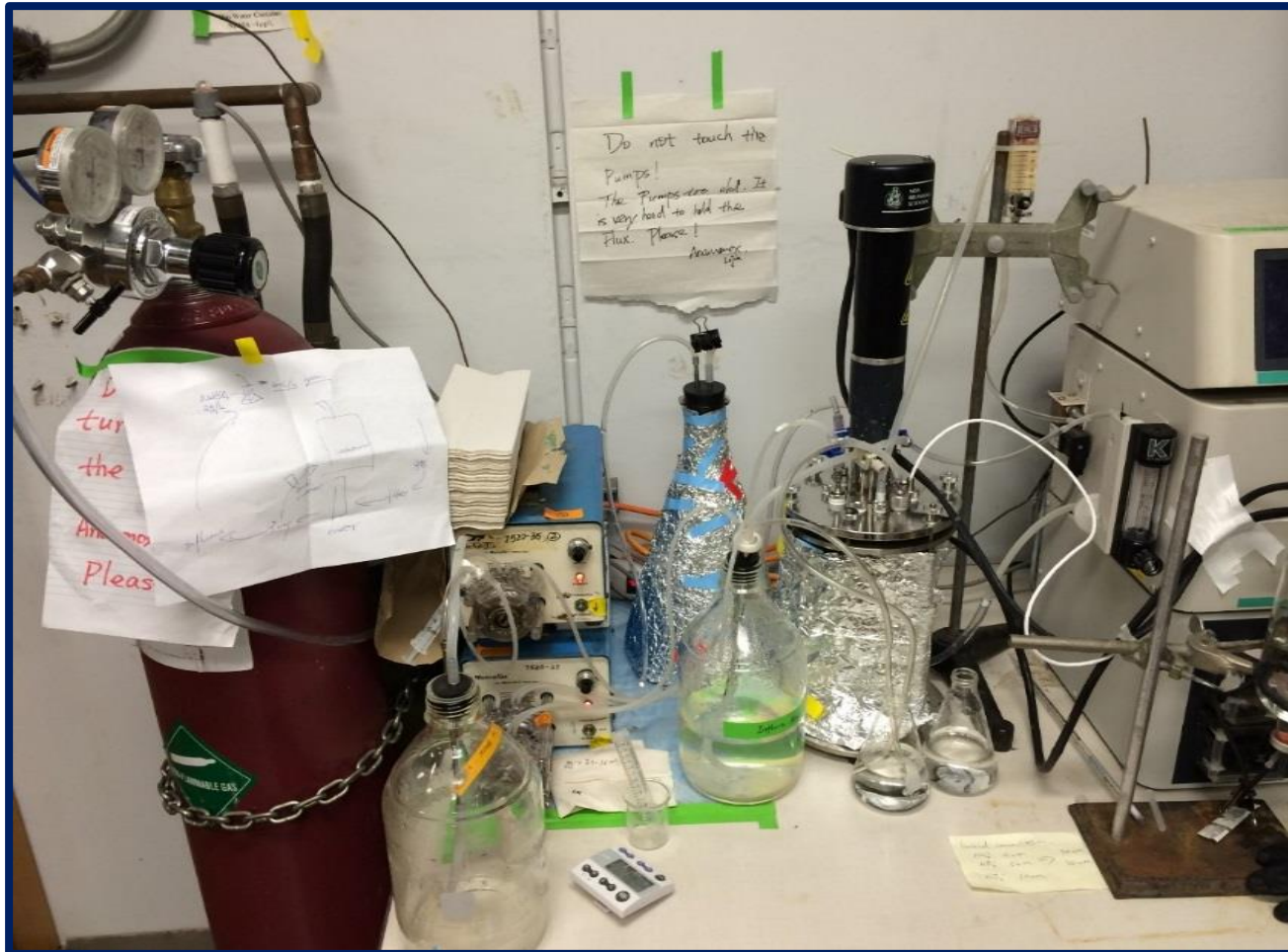


1L Membrane Bioreactor

## Operating Conditions

- Influent:
  - Synthetic wastewater
  - $\text{ArCO}_2$
- Reactor:
  - Volume: 1L
  - Temperature:  $37^\circ\text{C}$
  - HRT: 12-48 hours
  - SRT: 50 days

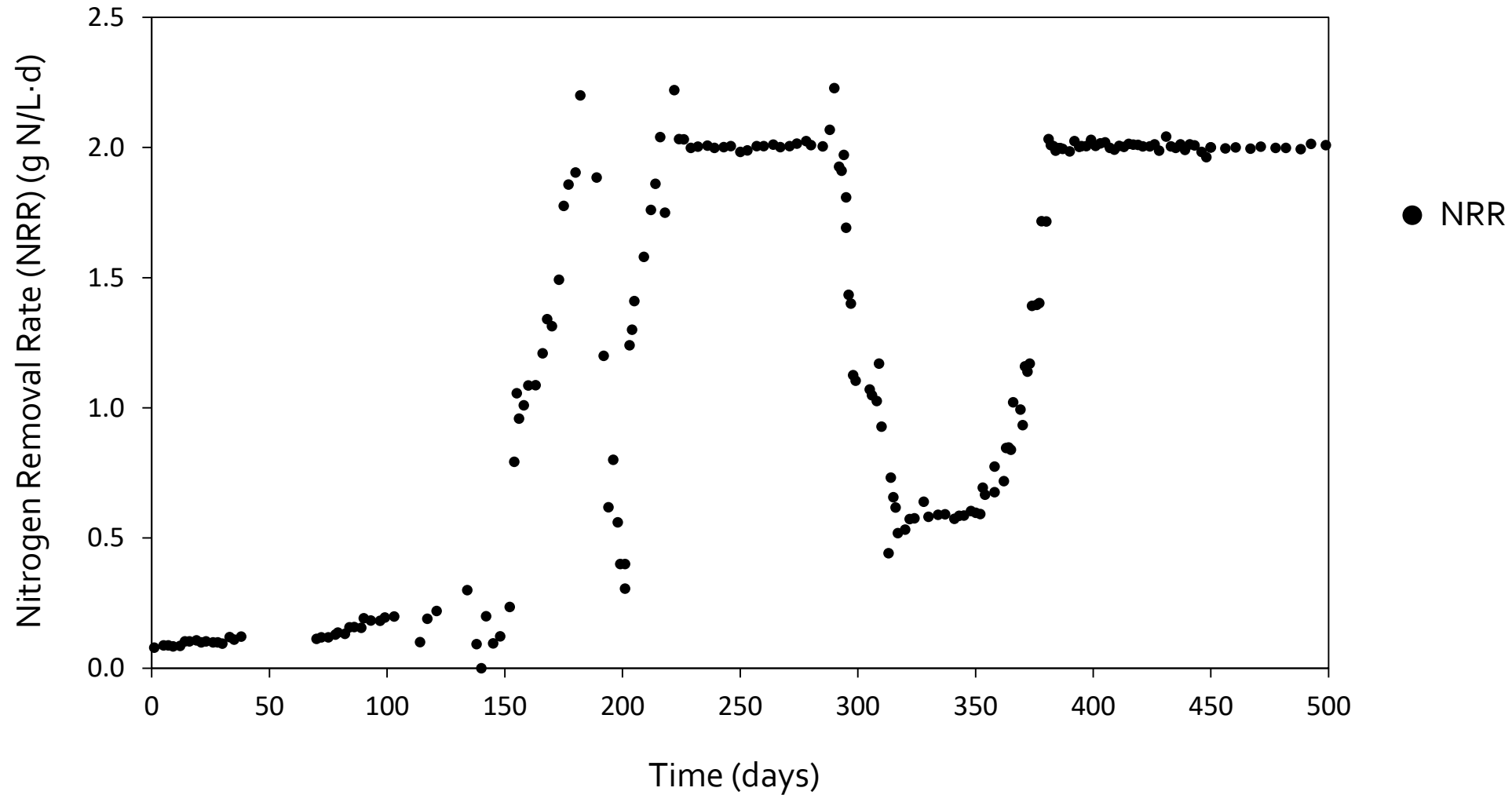
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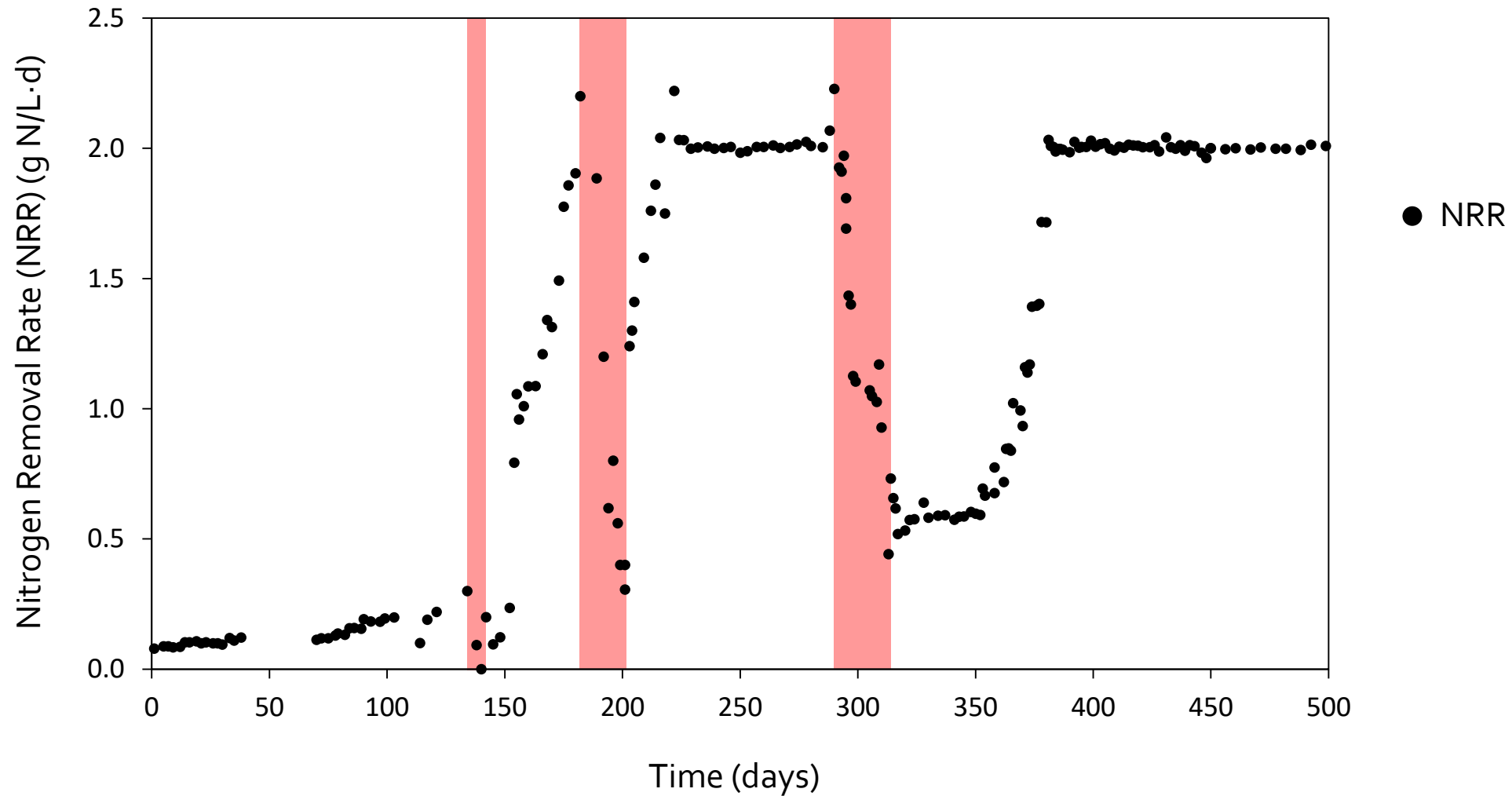
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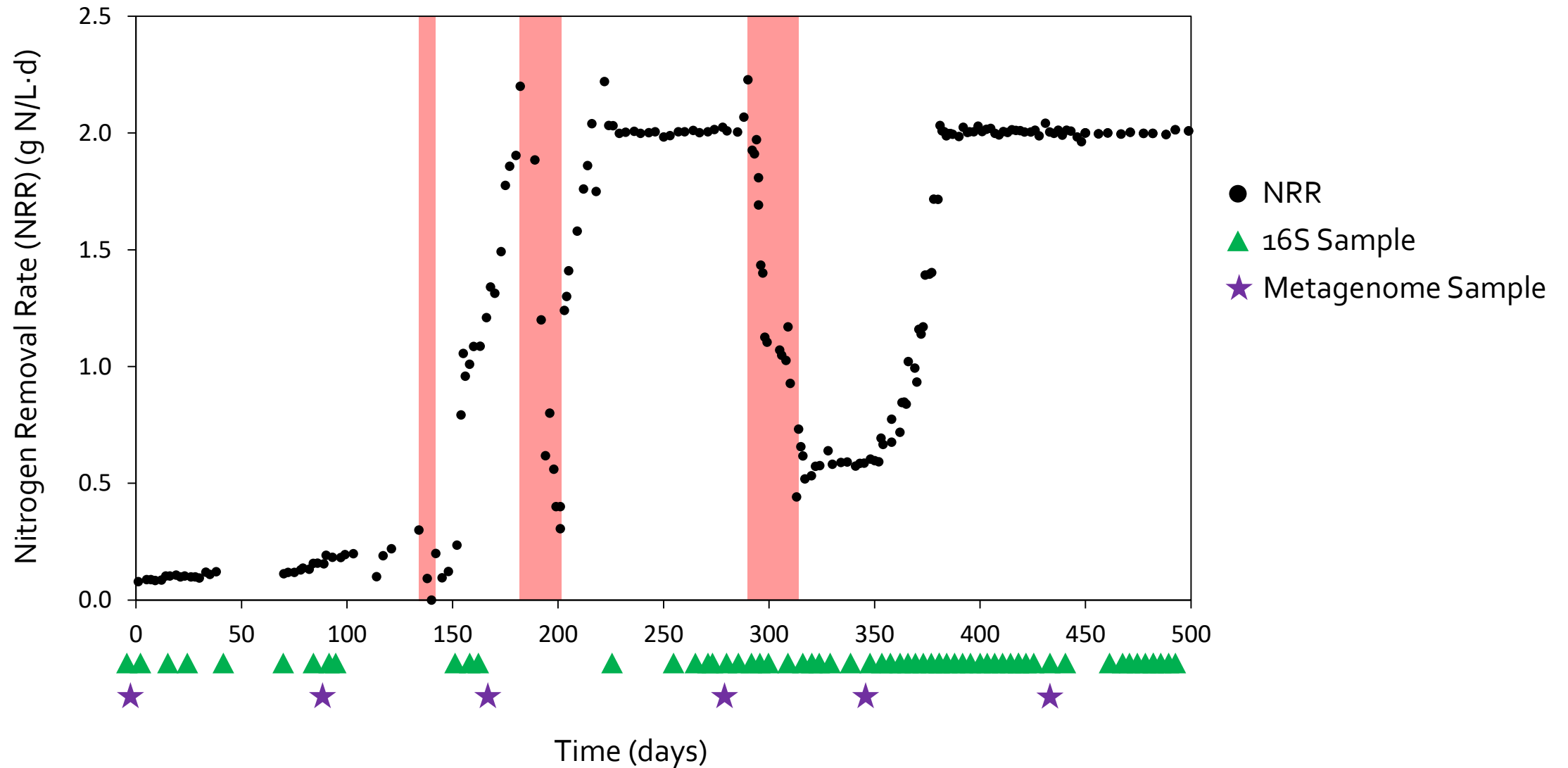




# Bioreactor Performance



# Bioreactor Performance



# Next Steps

- Verify hypotheses with batch experiments.
- Identify strategies to deal with carbon fluctuations at the wastewater treatment plant.



Questions?