


Quantifying and assessing wet-weather resiliency of urban water resource recovery facilities

Dr. Jeseth Delgado Vela

Department of Civil & Environmental Engineering

Howard University

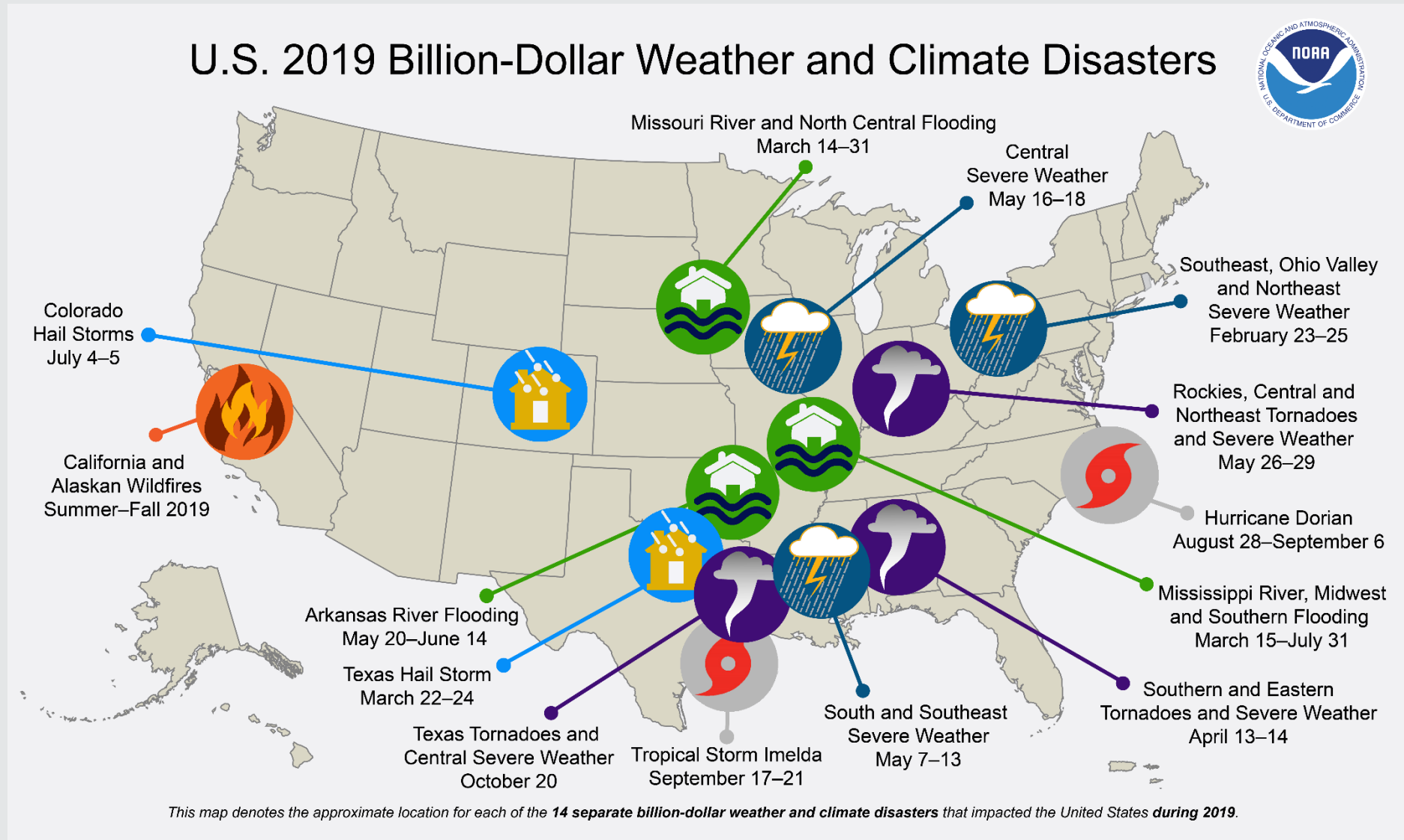
jeseth.delgadovela@howard.edu

 @jesethdv

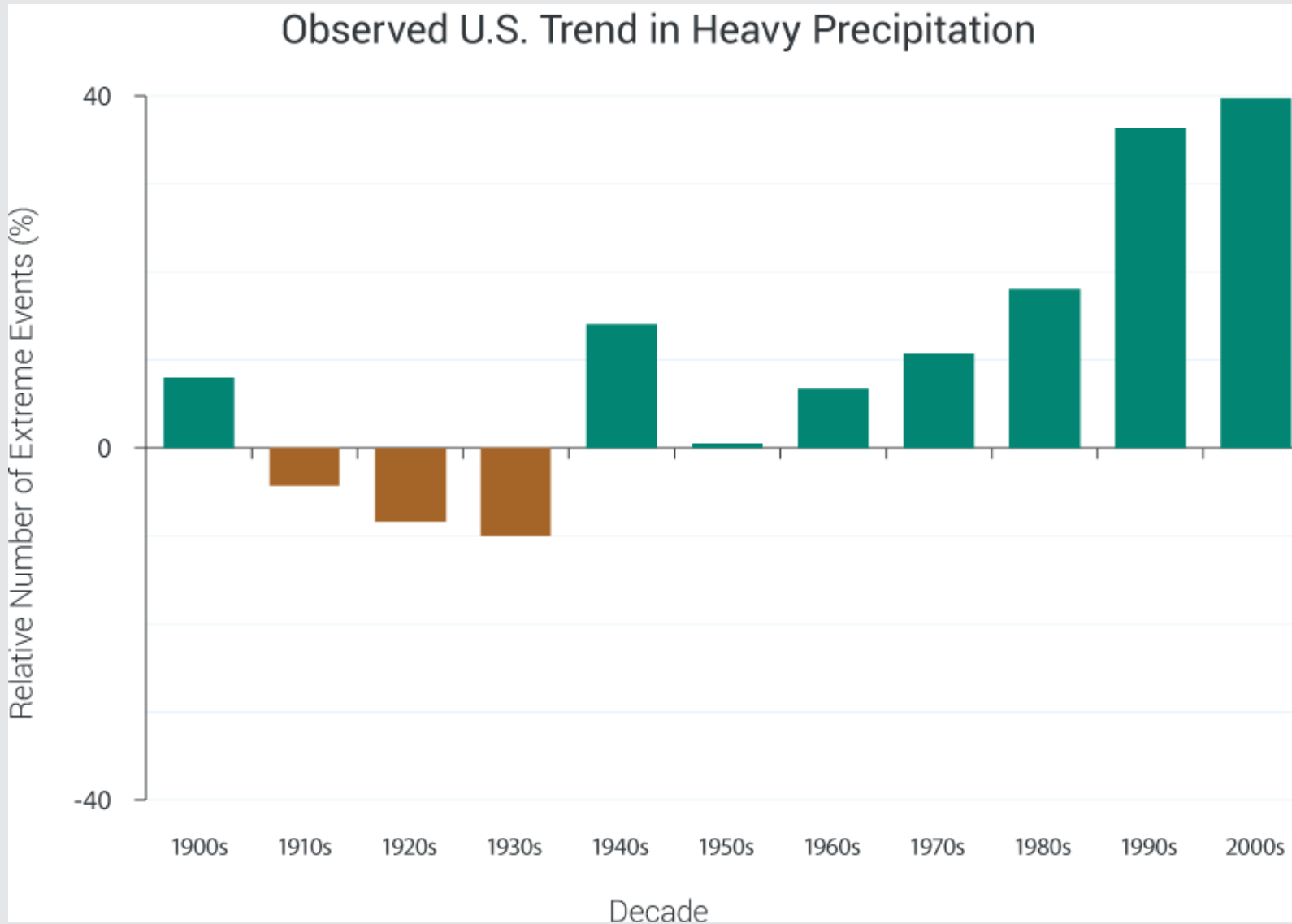


CWEA Water Resources Webinar
Howard University
June 15, 2020

Extreme weather events have a high economic cost.



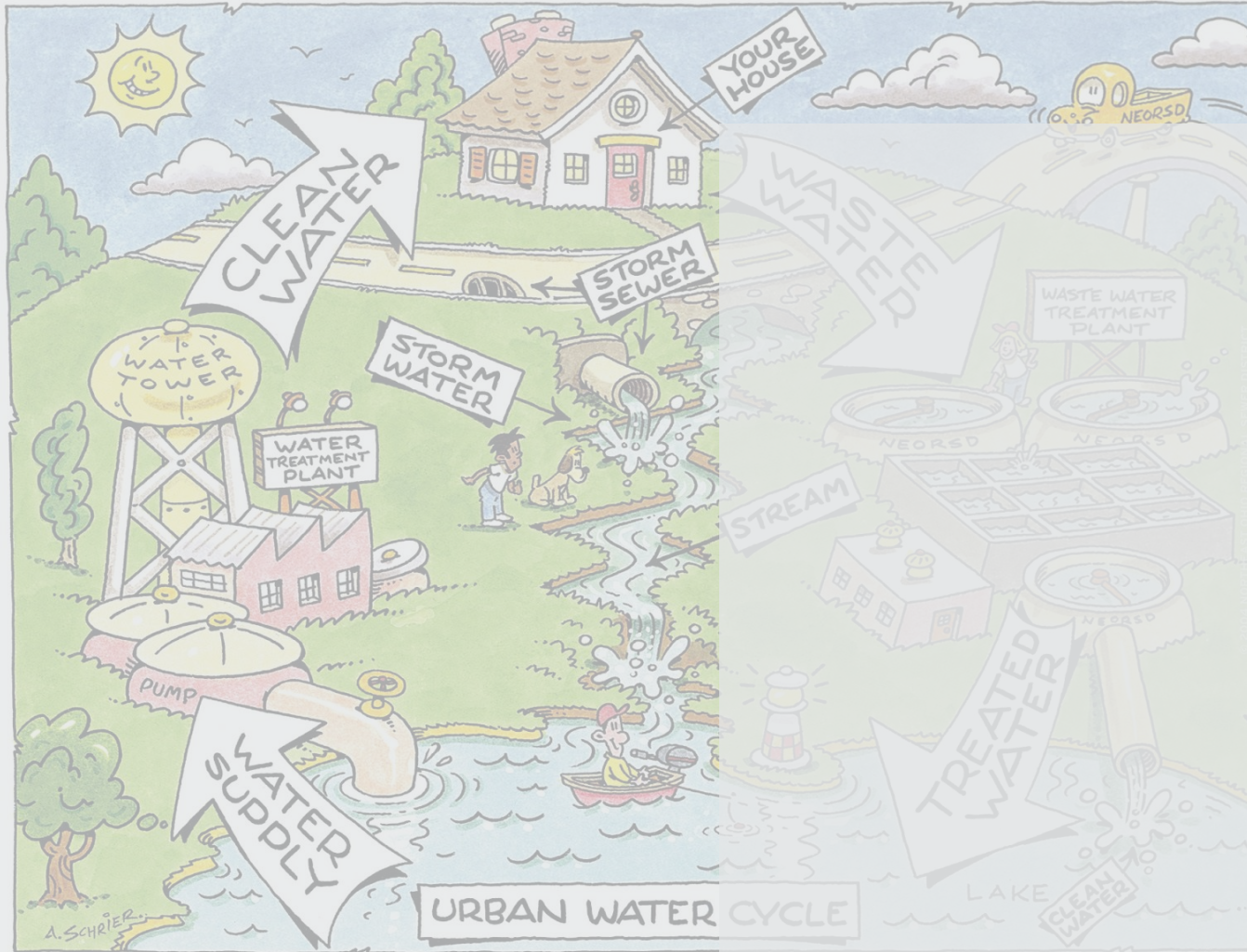
Heavy downpours are increasing.



2-day once-in-a-five-year rain event, normalized to 1901-1960

(Figure source NOAA, adapted from Kunkel et al. 2013).

Across the urban water system, there are different considerations with respect to resiliency.



PRESENTED BY THE NORTHEAST OHIO REGIONAL SEWER DISTRICT

WWW.NEORSO.ORG

Drinking Water

- Multiple barriers of control for disinfection.
- Investment from Department of Homeland Security
- Detailed risk assessment and mitigation

Stormwater

- Resilience to wet weather is well characterized.
- Large scale investments



Wastewater

- Resilience affected by sewer network system and combined vs separate sewers.
- Do sustainability and resiliency goals conflict or strengthen one another?

There are a variety ways of defining resiliency.

Definition 1:

Maximum Performance Reduction

How much is performance affected?

Definition 2:

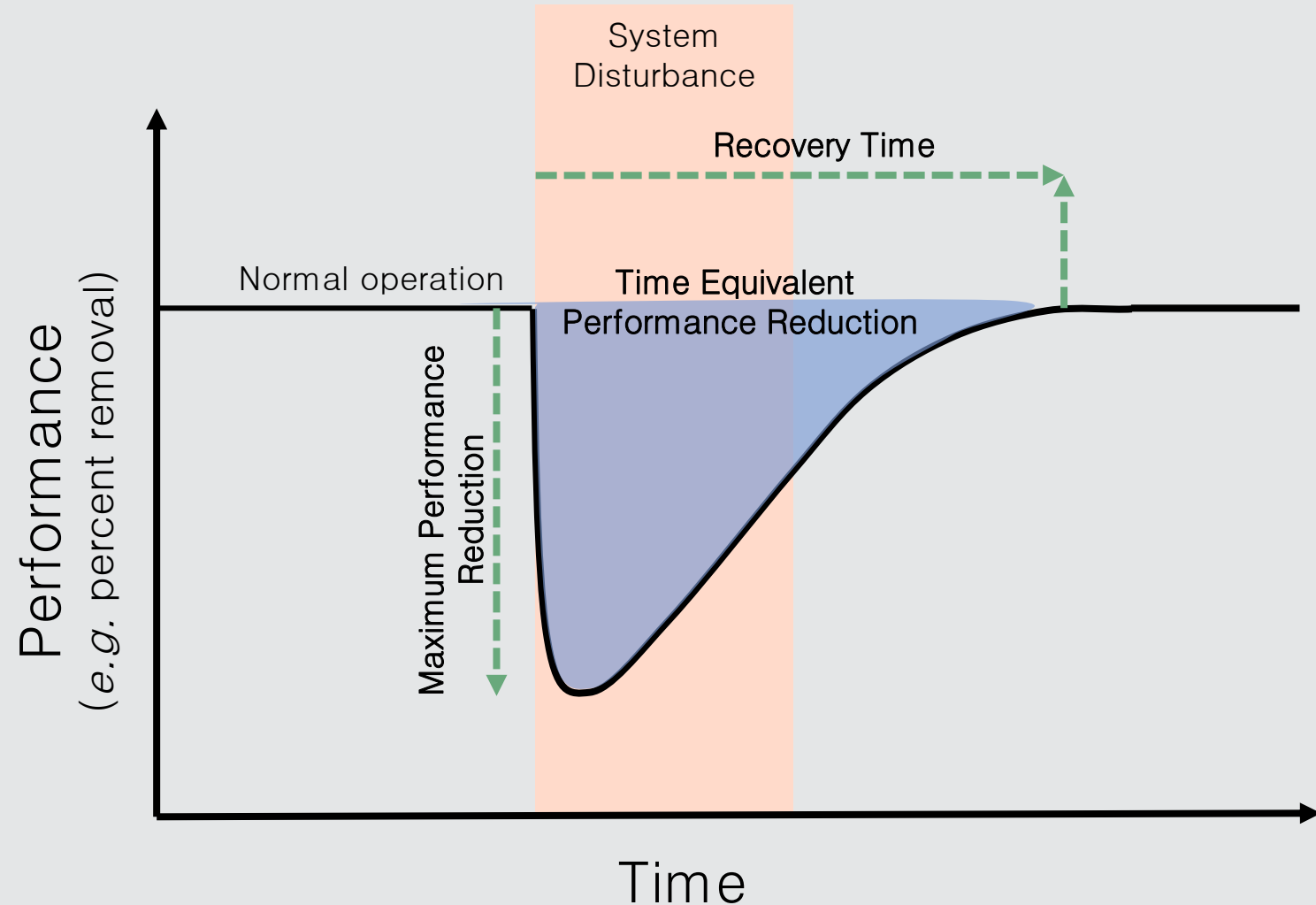
Recovery Time

How long does it take for performance to recover?

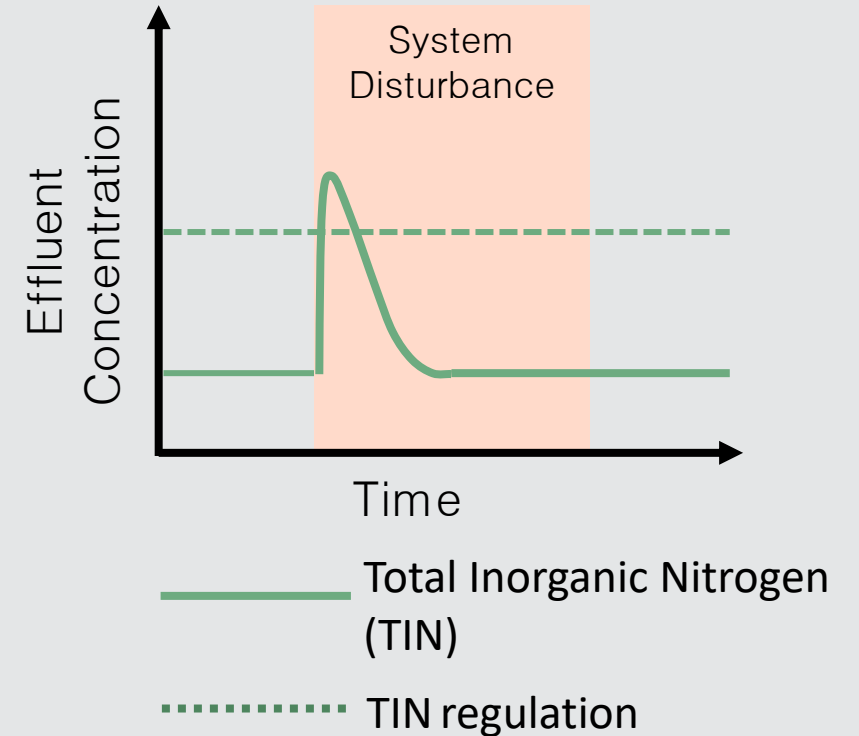
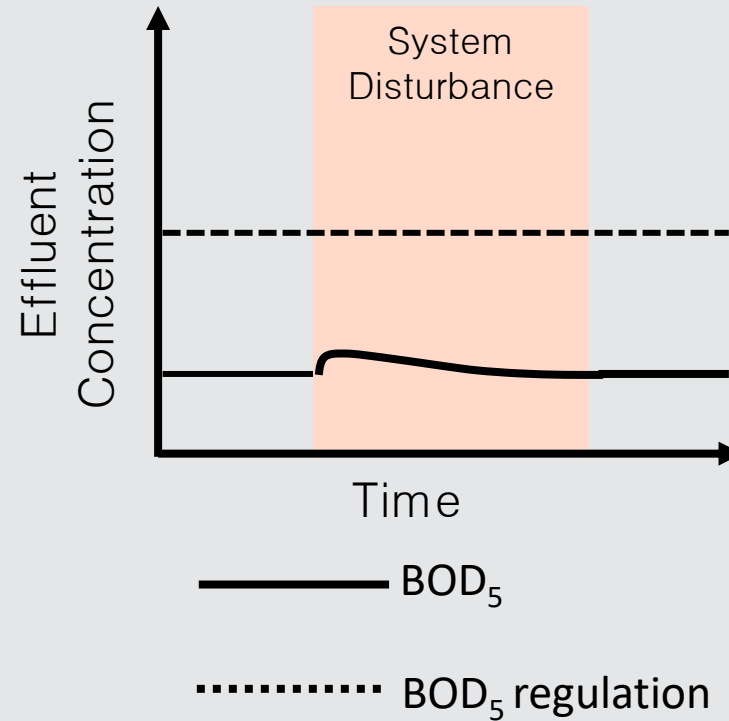
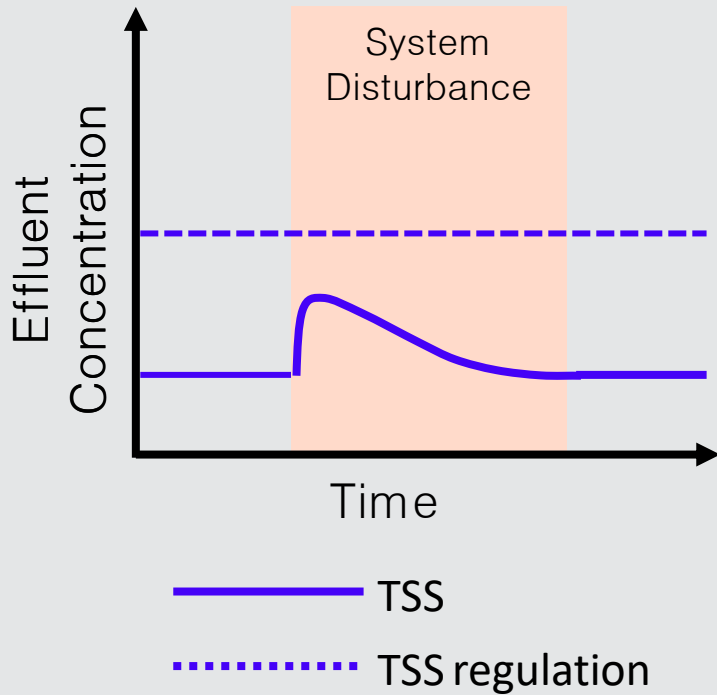
Definition 3:

Time Equivalent Performance Reduction

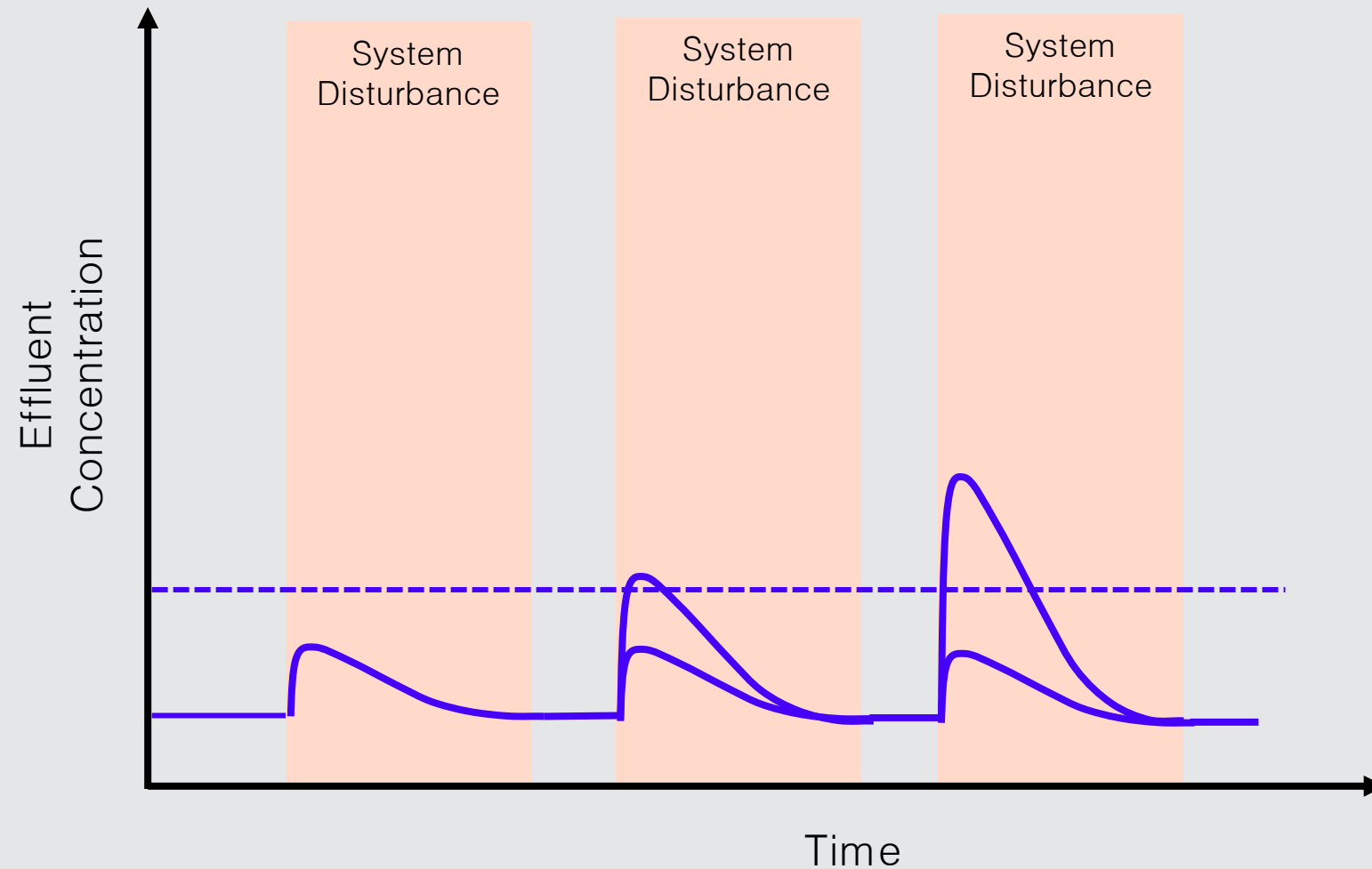
Performance reduction and recovery time.



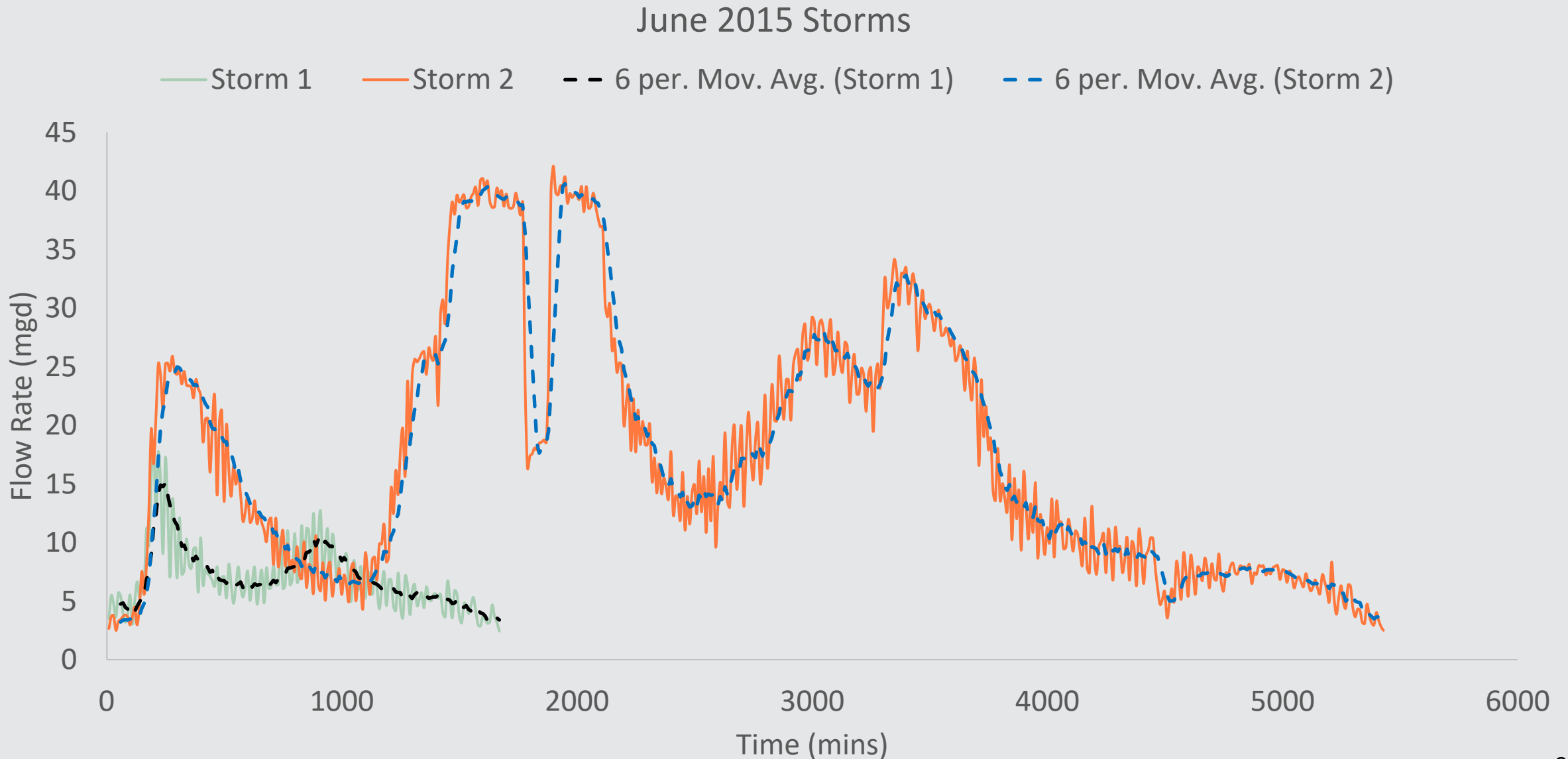
Resiliency may vary across the different treatment parameters.



What is the impact of sequential system disturbances?



Sequential system disturbances are common.



We are quantifying resiliency in full-scale treatment plants.

Quantifying resiliency plants in DC, Maryland, and Virginia

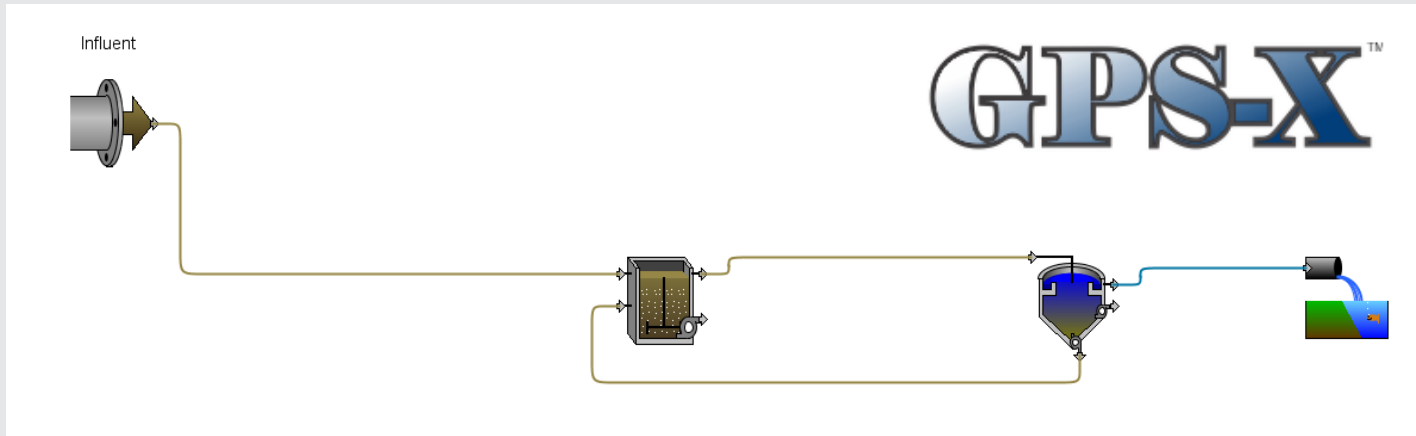
- Multiple process and sewer configurations
- Multiple rain events per plant

Collaborators in Houston, TX are doing similar work

- No primary clarifiers
- No TIN limits

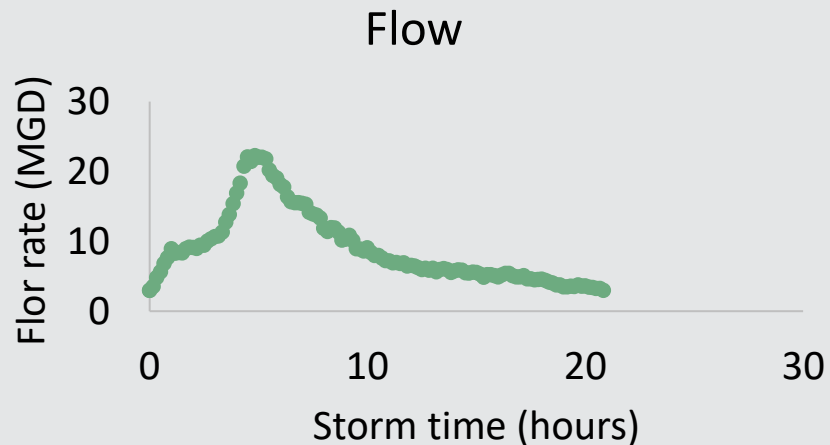


Plant scale modeling helps us assess resiliency to a variety of extreme events.



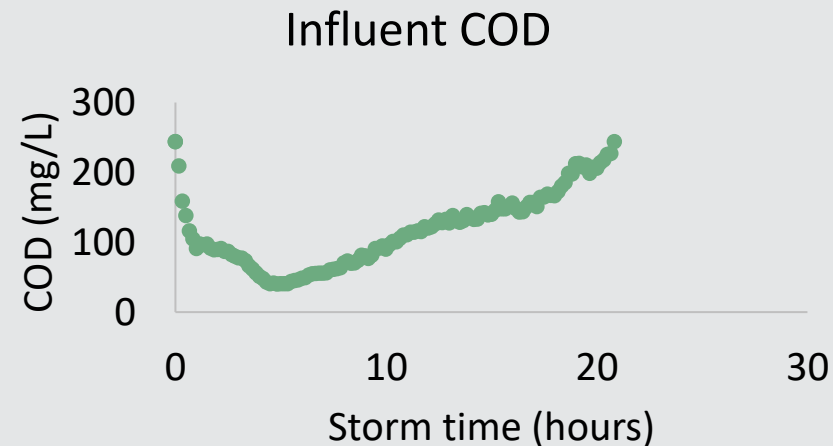
3 MGD plant
Conventional Activated Sludge
No primary clarifier (Houston scenario)
10 mg cBOD/L
3 mg ammonia-N/L
15 mg TSS/L

Historical storm event from April 2019

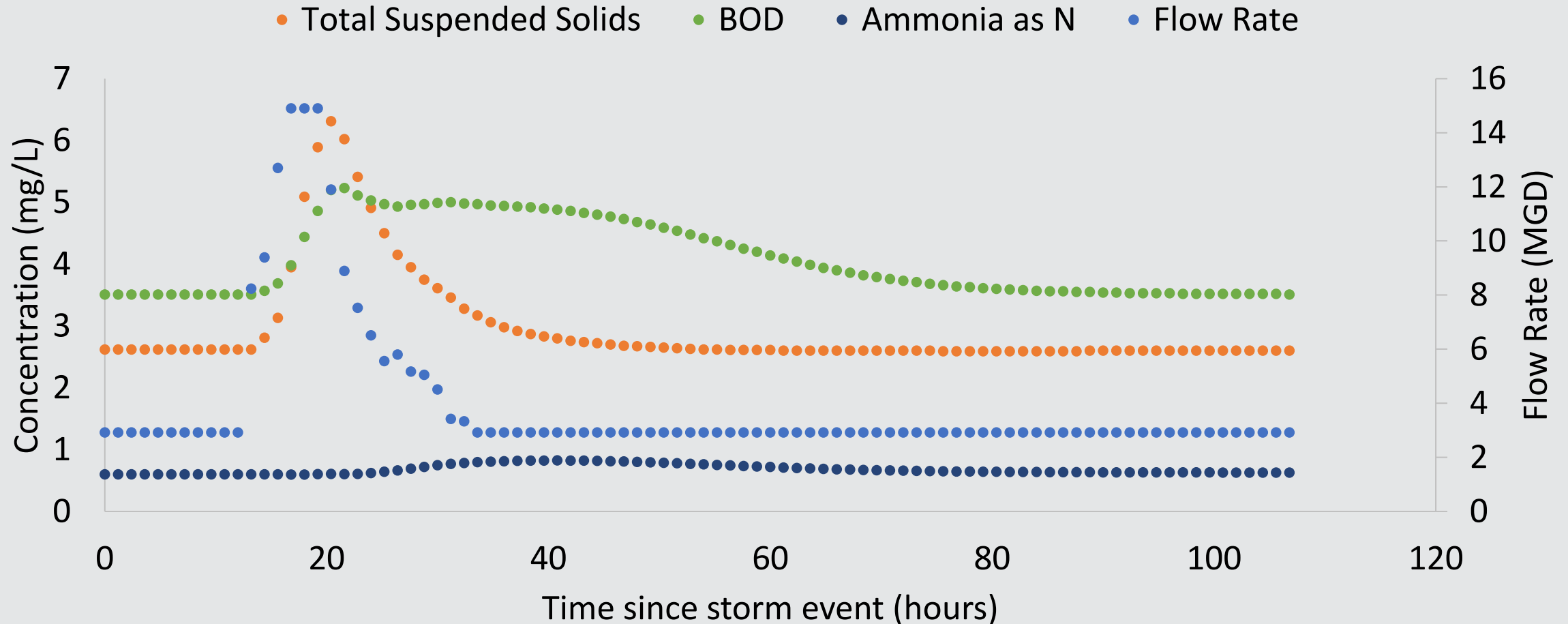


Simulated pollutographs:

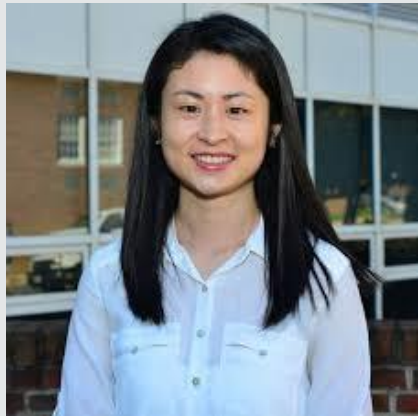
$$\text{Pollutant Concentration} = a * \text{Flow}^b$$



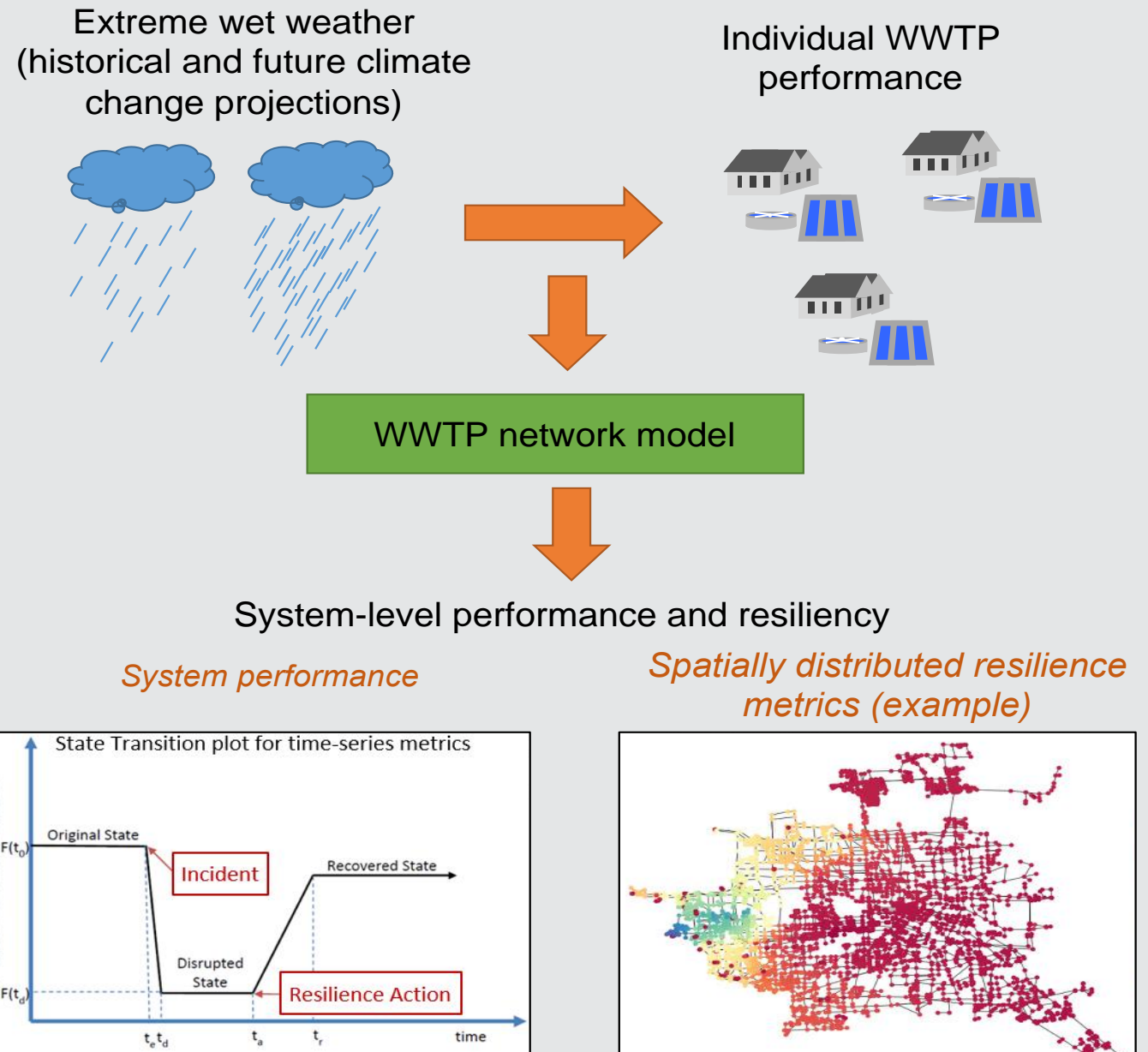
Preliminary modeling results show different treatment parameters have different resiliency netrucs.



Future work includes evaluating resiliency varies across a network of WRRFs in Houston, TX



Lu Liu



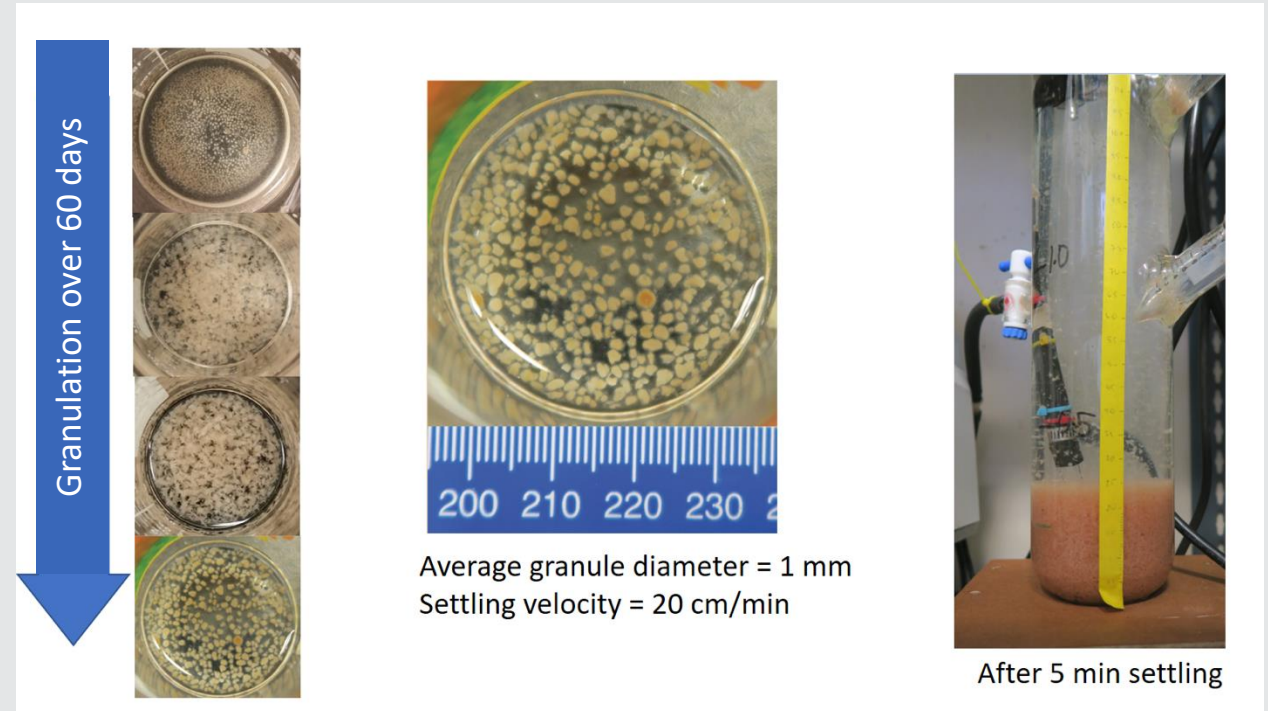
Increasingly, many plants are thinking about process intensification to manage sustainability goals.

Reduce:

- Physical footprint
- Energy demands
- Chemical Use
- Carbon footprint

Examples include

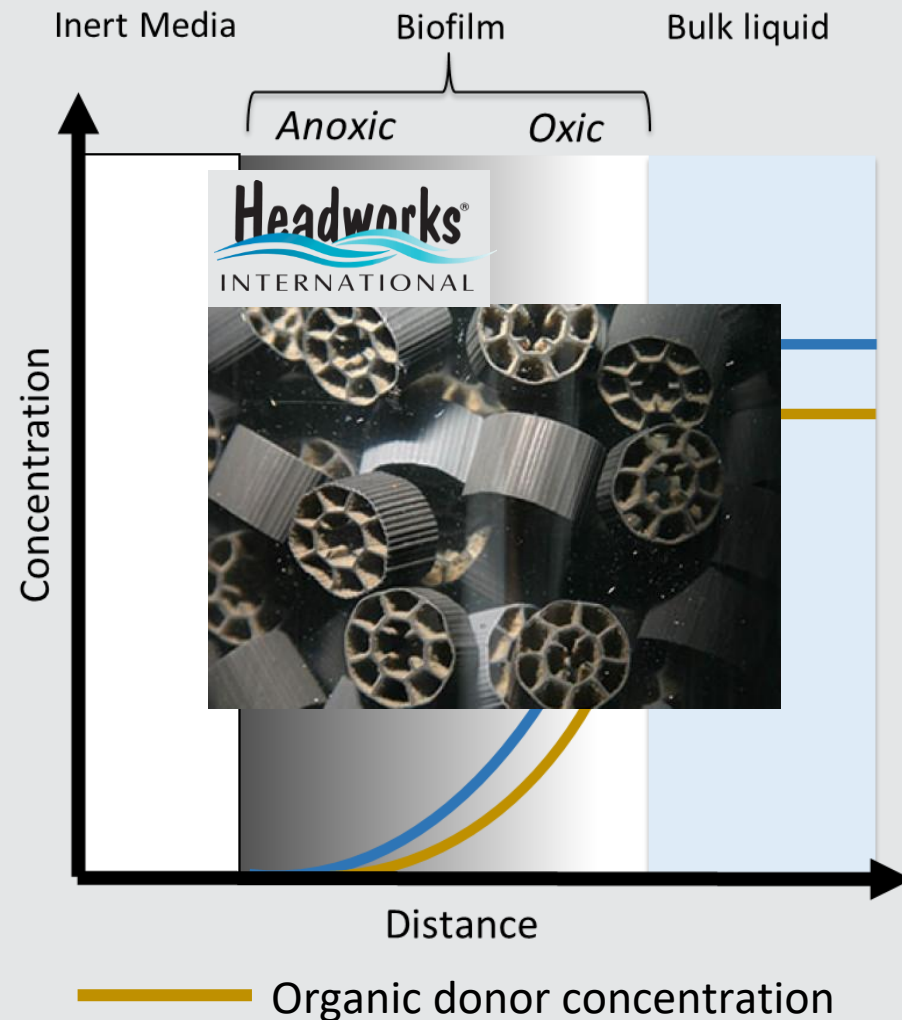
- Granular sludge process
- Chemically enhanced primary treatment
- Membrane Bioreactors
- **Biofilm processes**



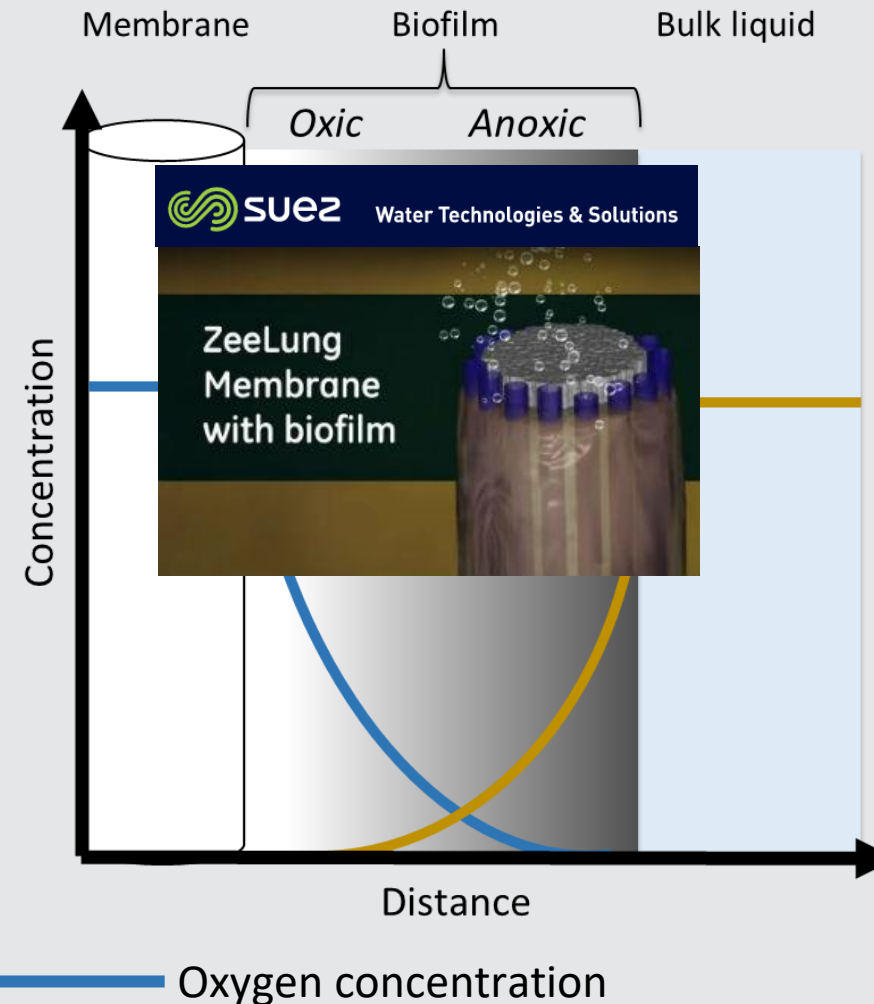
Bekele, Z. A., **Delgado Vela, J.**, Bott, C. B., & Love, N. G. (2020). Sensor-mediated granular sludge reactor for nitrogen removal and reduced aeration demand using a dilute wastewater. *Water Environment Research*.

Different biofilms have different geometries.

Co-diffusional Biofilms



Counter-diffusional Biofilms



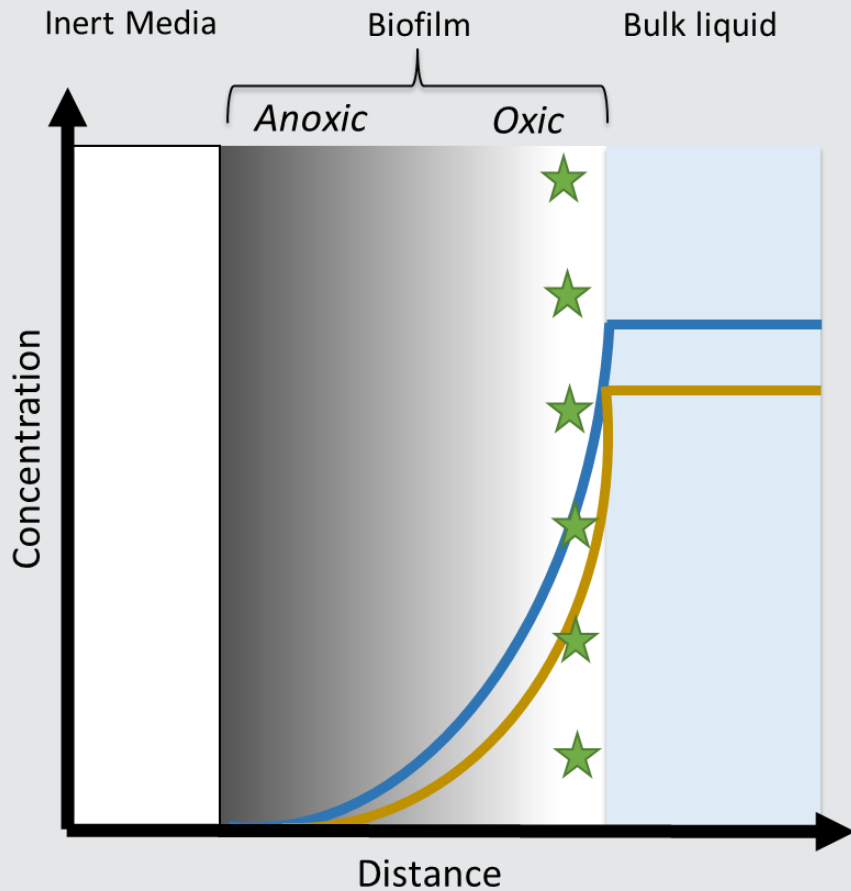
Will biofilm geometry impact process resiliency?

— Oxygen concentration

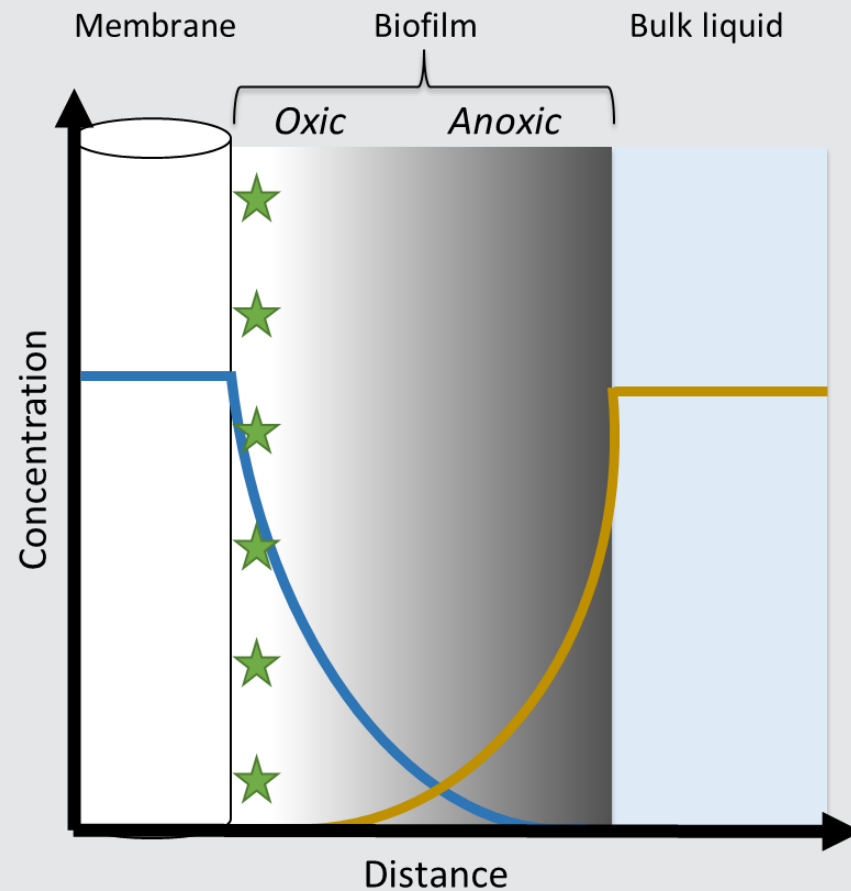
— Organic donor concentration

★ Location of nitrifying bacteria

MBBR: co-diffusional biofilm



MABR: counter-diffusional biofilm



GPS-X™

Future work includes pilot scale studies of distinct biofilm geometries.



Lauren Stadler



Priyanka Ali



Both biofilm configurations will be tested at the pilot scale across different types of extreme wet weather events in Houston, TX.

The COVID-19 pandemic has exposed other WRRF system resiliencies (and vulnerabilities).

Areas of resiliency

- Water and wastewater not shutoff
- Data collection efforts can be paired down
- Utility workers are essential
- Processes have multiple lines of defense against pathogens

Areas of vulnerability

- WRRFs depend on rate payers
- Utility workers also get sick
- Need agility to characterize new pathogens

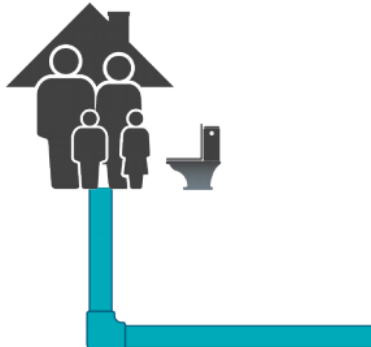
There are many teams working worldwide on SARS-CoV-2 monitoring in wastewater



<https://www.covid19wbec.org/collaborators>

Ongoing work at HU related to COVID-19 pandemic.

Number of people
Number infected asymptoma
Number infected symptomatic




Fecal shedding rate per person

- Over time and course of infection
- Based on symptoms, age, and other factors

MATTER

Is It Safe to Come Out of Lockdown? Check the Sewer

Wastewater could provide early, painless and localized data about the rise or fall of coronavirus levels.

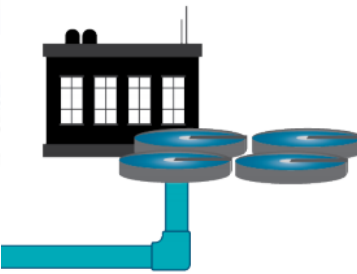


Researchers from Brazil's National Institute of Science and Technology collected sewage samples to test for coronavirus in Belo Horizonte last month. Douglas Magno/Agence France-Presse — Getty Images

By Carl Zimmer

May 1, 2020

The New York Times



Water Research Foundation. ALL RIGHTS RESERVED. 46

Viral RNA can be

- Currently HU
- characterize

water

the region to

Acknowledgements

Funding sources (Bold=this project)

- National Science Foundation
 - Grant: **1931937**, 2029025
- DC Water
- Environmental Protection Agency



Collaborators/Team

- Lauren Stadler- Rice University
- Liu Lu- Rice University
- Priyanka Ali- Rice University

- Andrew Shaw- Black and Veatch



BLACK & VEATCH

