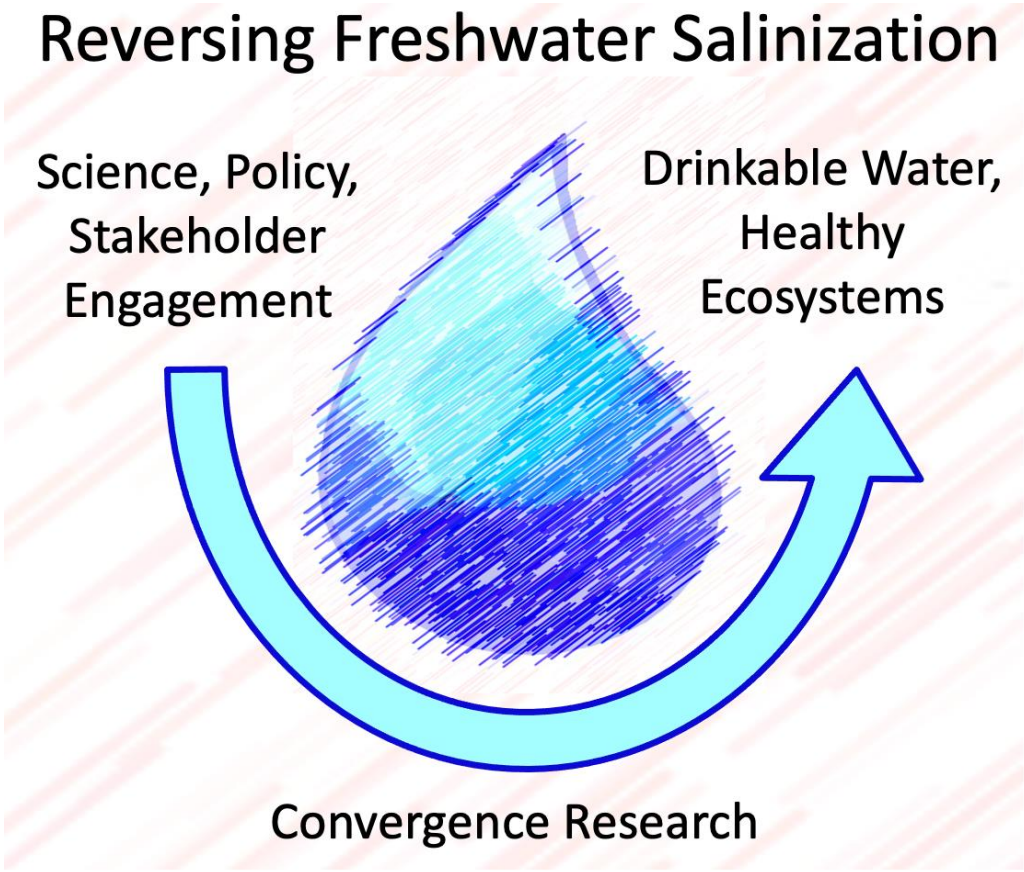
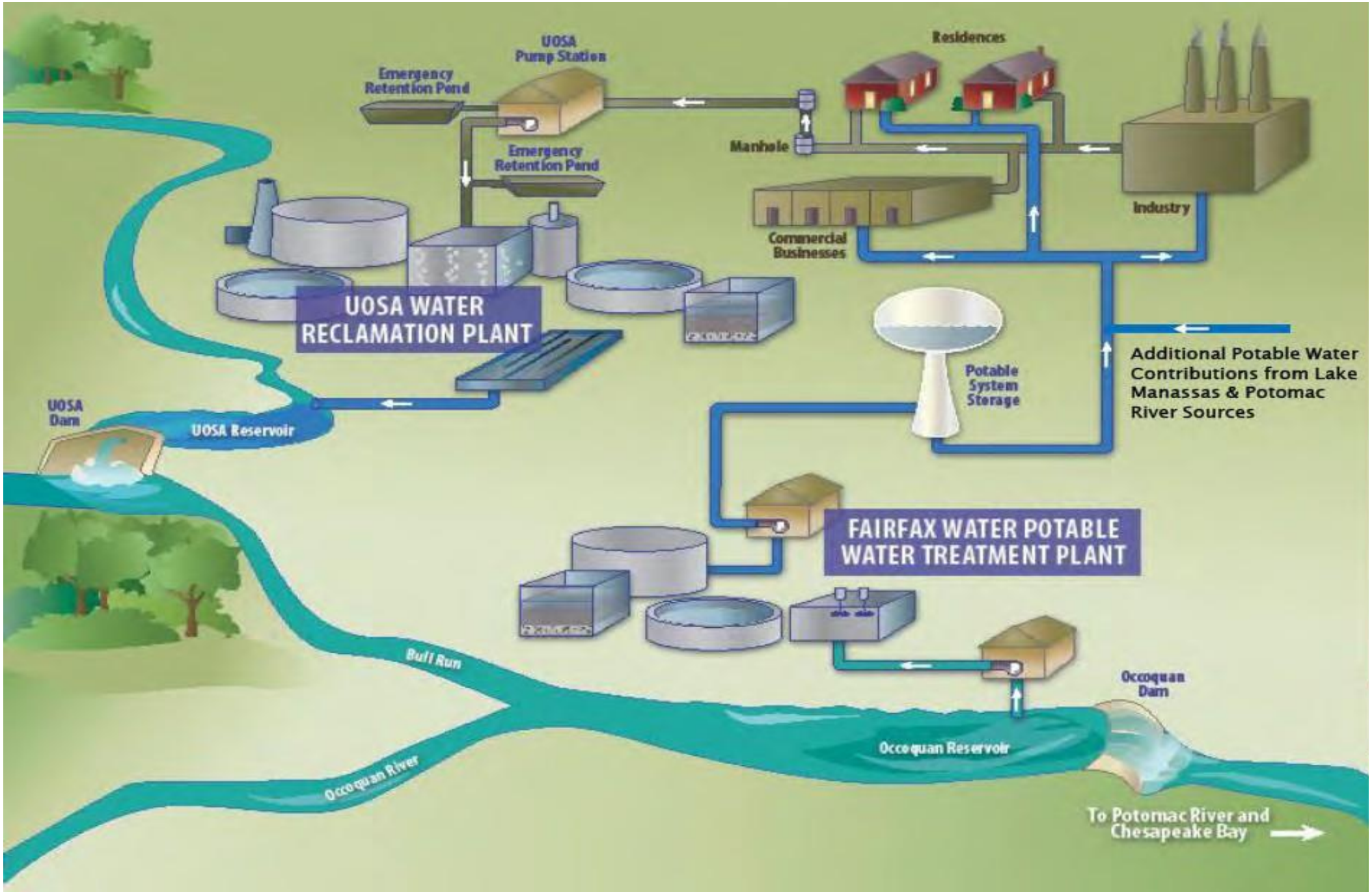


Sodium sources in Fairfax County drinking water and sewage collection systems

Stanley B. Grant
Department of CEE
Virginia Tech

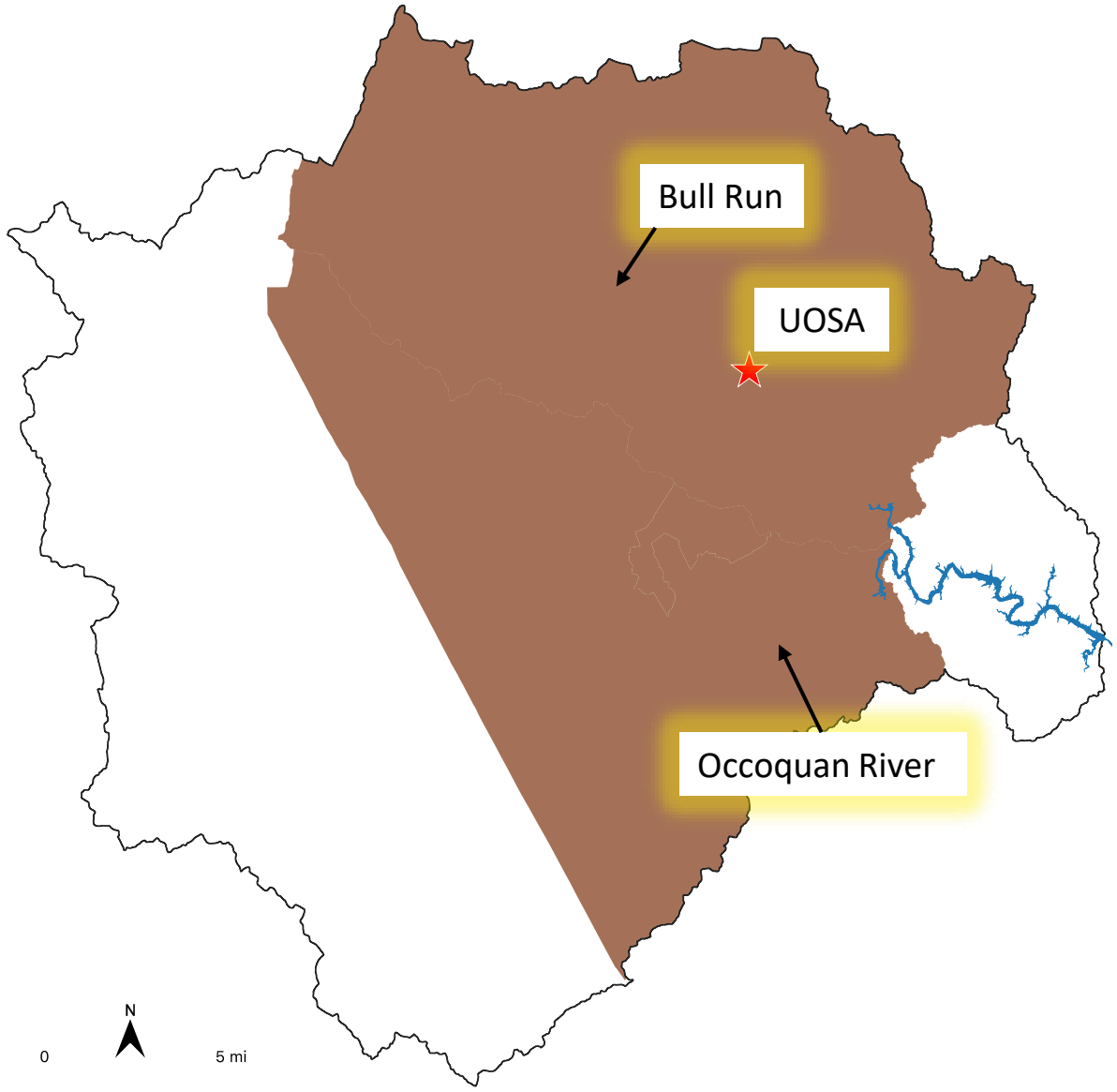
10/3/23


UOSA Pump Station
Residences
Emergency Retention Pond
Emergency Retention Pond
Manhole
Industry
Commercial Businesses
UOSA WATER RECLAMATION PLANT
Potable System Storage
Additional Potable Water Contributions from Lake Manassas & Potomac River Sources
UOSA Dam
UOSA Reservoir
FAIRFAX WATER POTABLE WATER TREATMENT PLANT
Bull Run
Occoquan Dam
Occoquan Reservoir
Occoquan River
To Potomac River and Chesapeake Bay

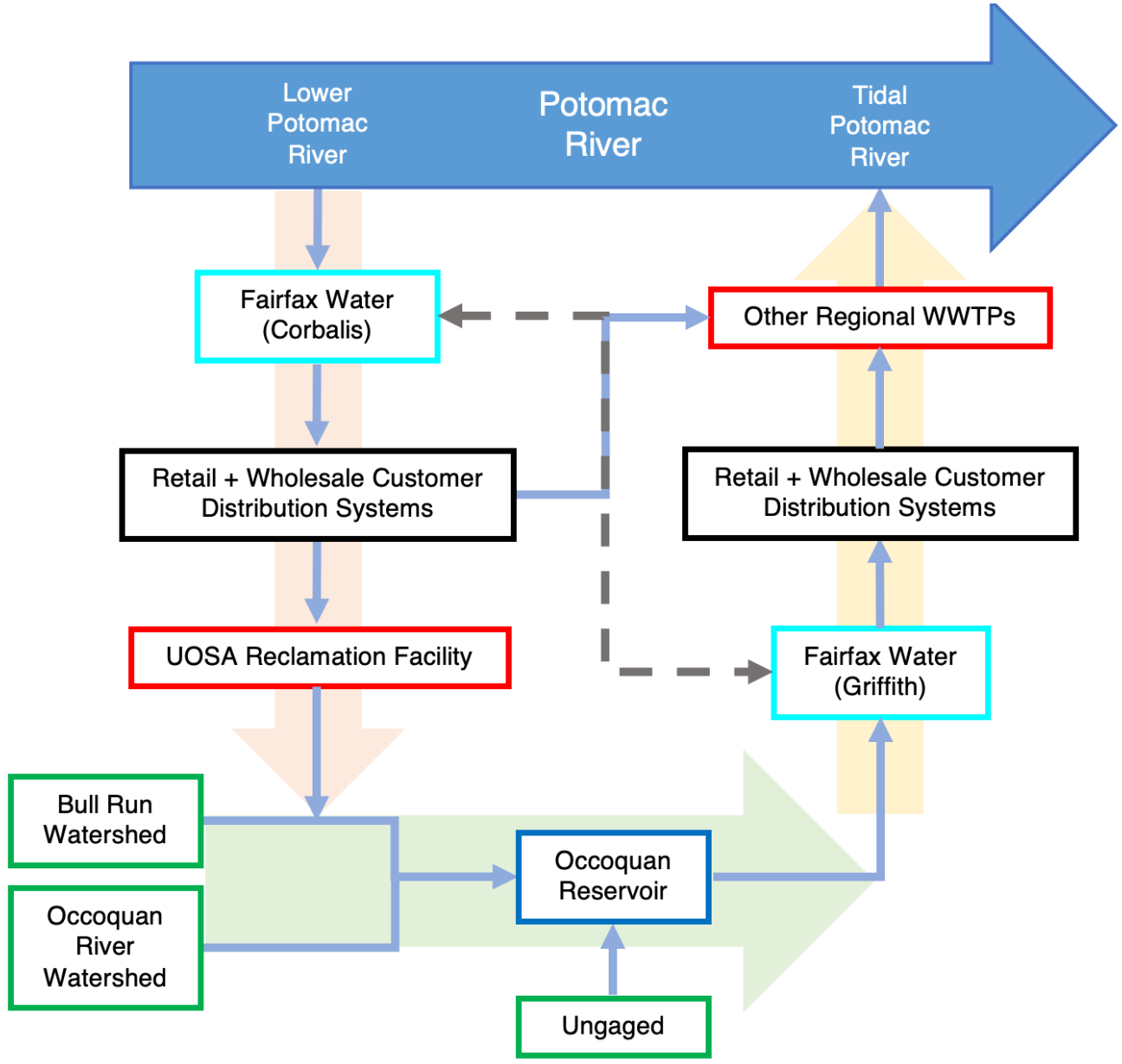
Nation's First Planned Indirect Potable Reuse (IPR) System

- Average reservoir inflow ≈ 360 million gallons per day (MGD)
  - Bull Run ≈ 114 MGD
  - Occoquan River ≈ 217 MGD
  - Upper Occoquan Service Authority (UOSA) ≈ 28 MGD

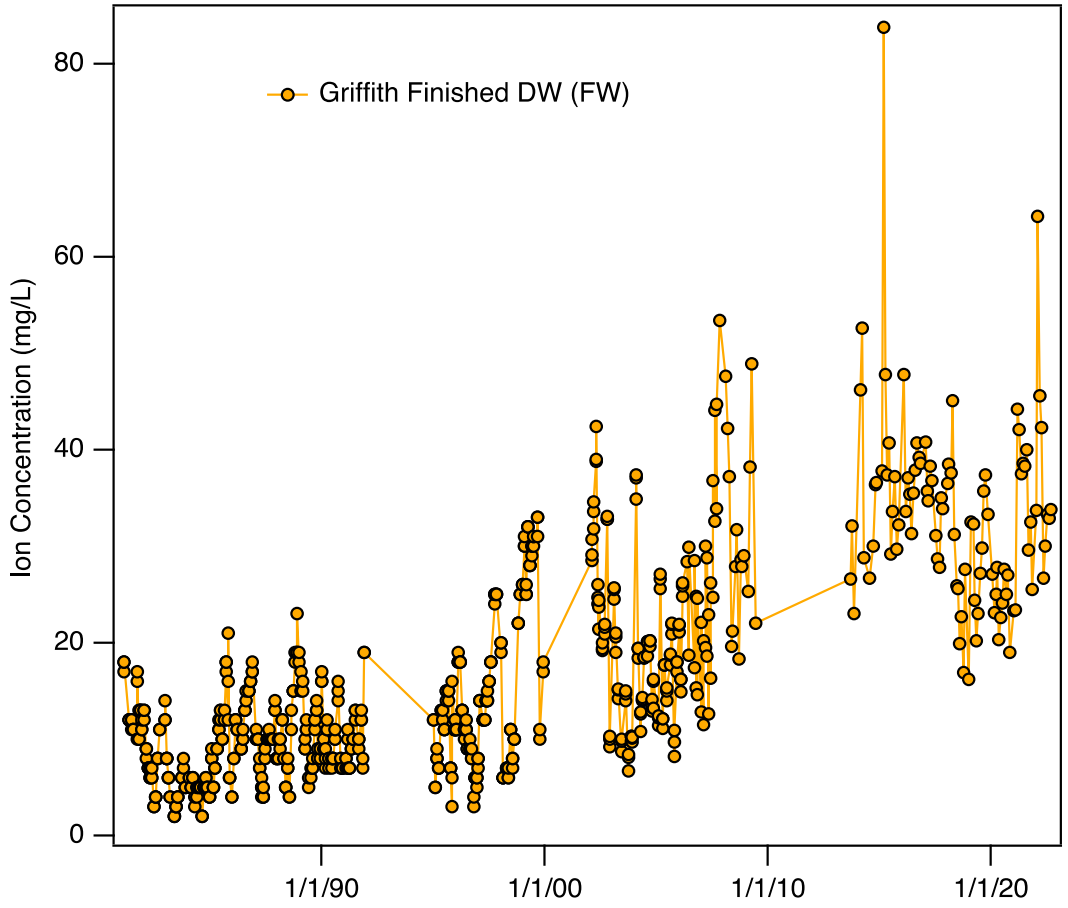
- UOSA collects wastewater from >350,000 residents and businesses and discharges treated wastewater or "reclaimed water" into Bull Run

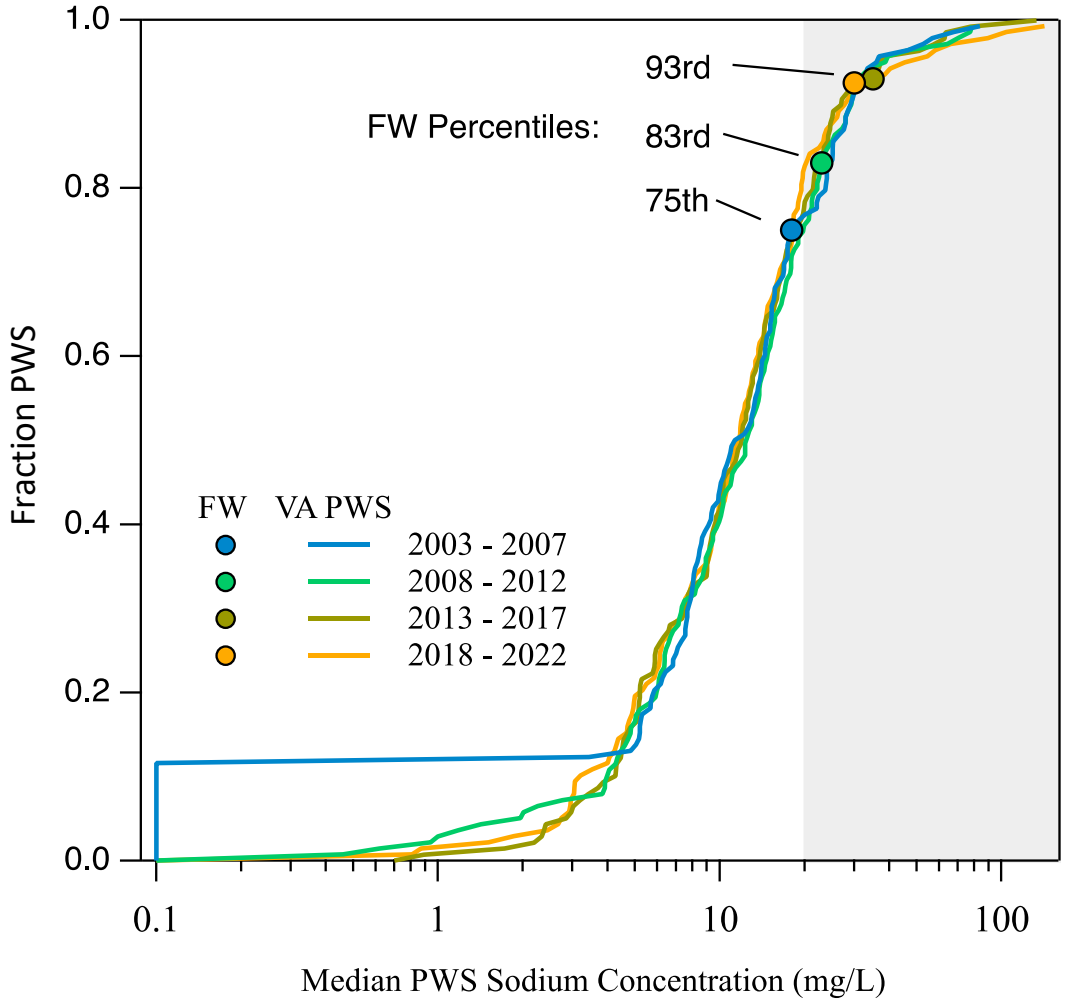


A more realistic version of the Occoquan "One Water" System



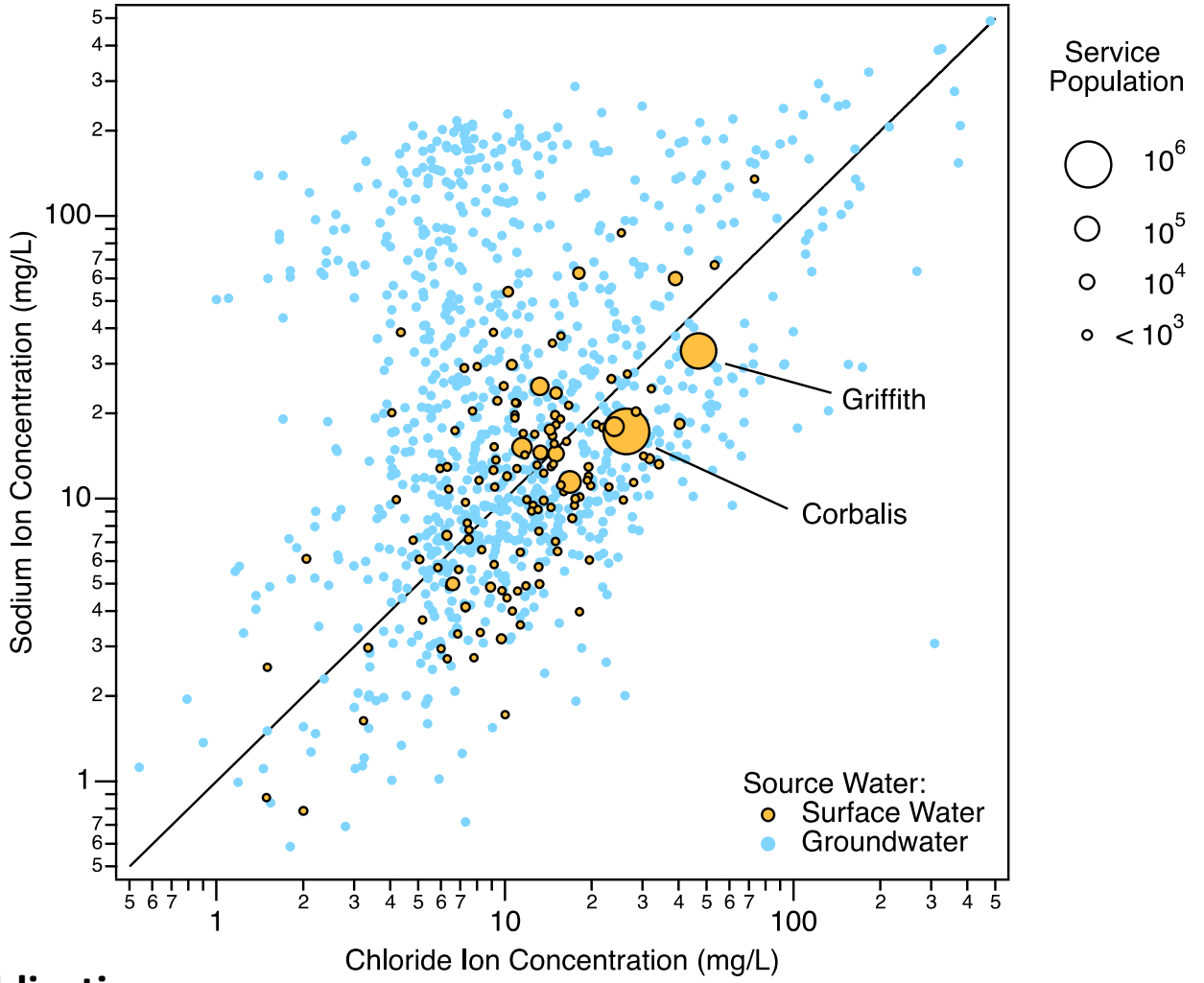
[Na^+] in Griffith Finished Drinking Water is rising over time, and currently 93 percentile state-wide





Preliminary Results: Not for Publication

Virginia PWS with higher median [Na^+] serve much smaller communities



Larissa Trejo

Preliminary Results: Not for Publication

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January 30, 2020

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Department of Civil and Environmental Engineering, Virginia Tech
Occoquan Watershed Monitoring Laboratory
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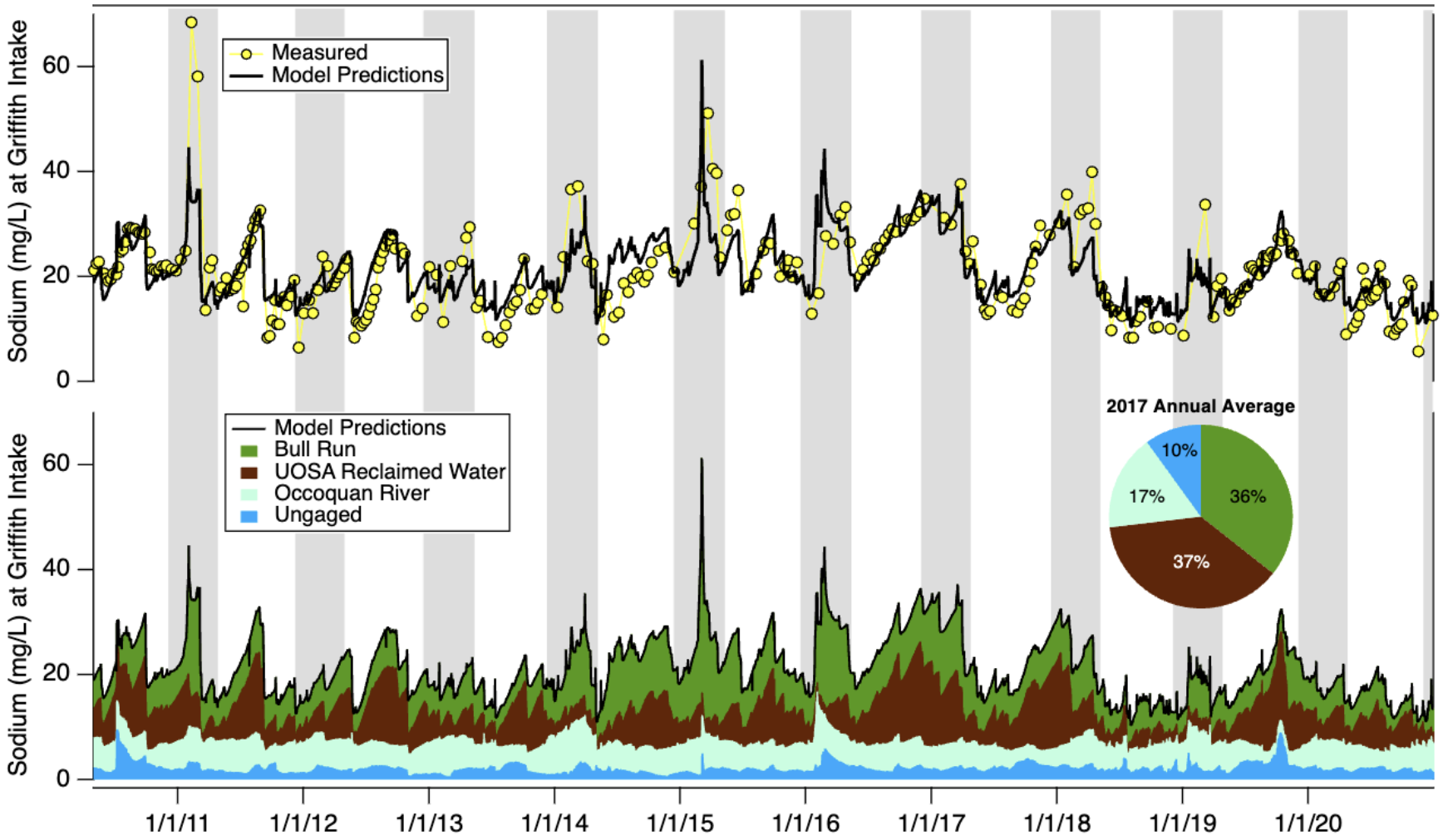
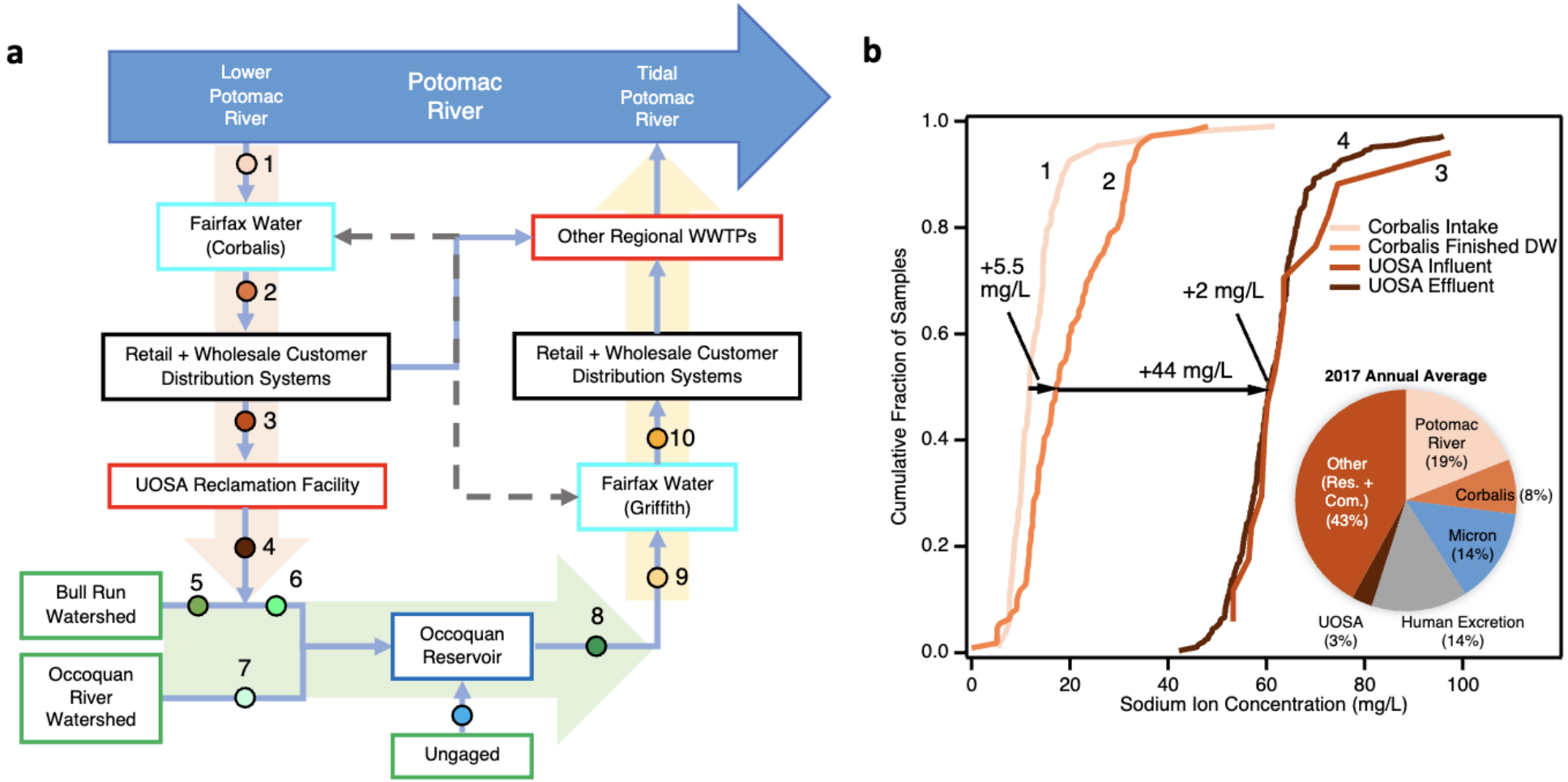
Over the past twenty years, the continued increase of sodium concentrations in both our source waters, especially in the Occoquan Reservoir, is a source of concern for us. Fairfax Water is collaborating with regional partners in efforts to reduce both point and nonpoint salt discharges with the goal of reversing the observed upward long-term trend of sodium concentrations. As you may be aware, sodium and other inorganic constituents like bromide and chloride are not removed by the water or wastewater treatment technologies currently employed in our region. Therefore, curtailing it at the source is the most viable option, given that the treatment capability to remove sodium can be very expensive, putting it conservatively at over $1 billion. With this objective in mind, Fairfax Water helped support the faculty-stakeholder workshop put together by Virginia Tech on January 14, 2020 to identify research needs and foster collaborations to better address the issue of salinization.

Model-predicted sources of [Na^+] in the Occoquan Reservoir (Griffith intake)



Residential and commercial connections are the biggest source of sodium in the reclaimed water

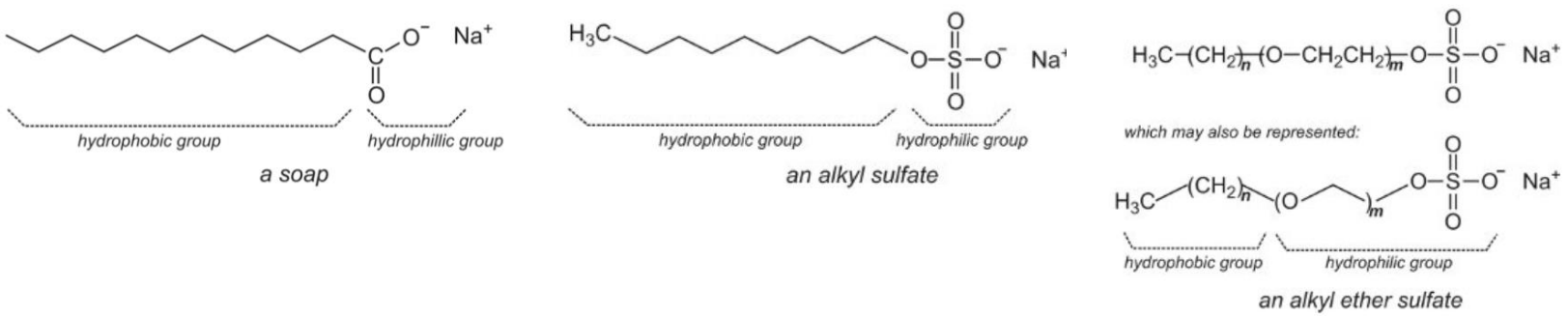


Bulk of sodium from residential households is likely coming from laundry operations

Table 1. Molar ratios in water discharged from the CSIRO model house

	Washing Machine	Dish Washer	Shower	Kitchen sink	Vanity Unit	Toilet+ Vanity	Total
Cl (g/wk)	6.296	7.580	2.269	5.021	0.5258	15.902	37.595
Cl (mol/wk)	0.178	0.214	0.064	0.142	0.0148	0.449	1.060
Na (g/wk)	55.609	7.456	2.466	3.213	0.766	15.362	84.872
Na (mol/wk)	2.418	0.324	0.107	0.140	0.033	0.668	3.69
Molar Na/Cl	**13.58**	**1.51**	**1.67**	**1.00**	**2.23**	**1.5**	**3.48**

Soaps ***Detergents***



a soap *an alkyl sulfate* *an alkyl ether sulfate*

Social marketing aimed at product switching: NSF Smart and Connected Communities RFP

Smart and Connected Communities (S&CC)

PROGRAM SOLICITATION
NSF 22-529

REPLACES DOCUMENT(S):
NSF 21-535

National Science Foundation

Directorate for Computer and Information Science and Engineering
Division of Computer and Network Systems
Division of Information and Intelligent Systems

Directorate for Education and Human Resources

Directorate for Engineering
Division of Civil, Mechanical and Manufacturing Innovation

Directorate for Social, Behavioral and Economic Sciences
Division of Behavioral and Cognitive Sciences
Division of Social and Economic Sciences

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

Proposals Accepted Anytime

Until April 1, 2024

Key takeaways:

- The Griffith Water Treatment Plant provides drinking water for up to 1 million people in Fairfax County and surrounding communities
- Sodium ion concentrations in the finished drinking water from the Griffith Water Treatment Plant:
  - Routinely exceed EPA guidance for an extremely low-sodium diet (20 mg/L) and the lower sodium taste threshold (30 mg/L)
  - Are 92nd percentile relative to all other public water systems in the State of Virginia that rely on surface water

Key takeaways:

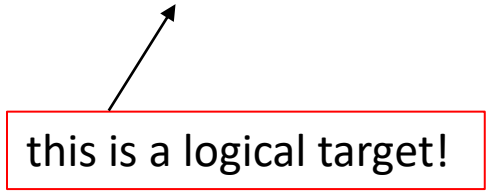
- On an annual average (2017) basis, sodium ion concentrations in the reservoir at Griffith's water intake are from:
  - **37%**--UOSA's reclaimed water (varies seasonally, lower in winter and higher in late summer—opposite seasonal pattern for all watershed sources)
  - **36%**--dry and wet weather stream discharge from Bull Run
  - **17%**--dry and wet weather stream discharge from Occoquan River
  - **10%**--dry and wet weather stream discharge from ungagged portions of the watershed (e.g., Hooes Run which drains Woodbridge in PWC).
- On an annual average (2017) basis, sodium ion concentrations in Griffith's finished drinking water are from:
  - **74%**--Occoquan Reservoir (from watershed and reclaimed water sources)
  - **26%**--Griffith (primarily as NaOH to comply with CCT requirements, and combat dropping pH and high alkalinity in the reservoir at the end of the summer*)

*this seasonal pattern is likely driven by high summer nitrate concentrations in the reclaimed water

Key takeaways:

On an annual (2017) average basis, sodium ion concentrations in UOSA's Reclaimed Water are from:

- **3%**--Sodium added by UOSA during wastewater treatment
- **8%**--Sodium added by Corbalis during water treatment
- **14%**--Sodium discharged to sewer network by Micron Technologies
- **14%**--Sodium discharged to sewer network from human excretion
- **19%**--Sodium from the Potomac River (raw water for Corbalis)
- **43%**--Sodium added by residential, commercial, institutional, industrial and other wastewater generators



Key takeaways:

Sodium added by residential, commercial, institutional, industrial, and other users:

- It is likely that a substantial fraction of the residential sodium inputs are from laundry detergents
- Our analysis of popular laundry detergent brands indicates that there is (orders-of-magnitude) differences in sodium ion content (e.g., in general powder detergent >> liquid detergent)
- Thus, there is a real opportunity to address this problem through social marketing efforts, focused on encouraging residents (and laundry mats, for example) to switch from high to low sodium products
- Depending on the details of the technology and operation of their cooling systems, data centers may also be significant contributors—**but we don't know!**

Identified Opportunities—OWML could work with Fairfax County staff to:

- Conduct sewer source tracking, assessing the magnitude of sodium ion inputs from:
  - Data Centers
  - Residential communities
  - Laundromats (as an end-member where laundry detergent effluent is nearly all the sewage produced)
  - Other areas/inputs found to be significant—we'll follow the salt trail wherever it leads!
- Test pilot scale solutions, including novel monitoring and social marketing interventions, for consideration as part of Fairfax County's ongoing wastewater program*

*These efforts could potentially be co-funded through external funding sources, for example the extremely competitive *National Science Foundation's Smart and Connected Communities* program