LOUDOUN WATER

Data Centers – A Perspective from Data Center Alley

Doug Frasier – Pretreatment Manager

Agenda

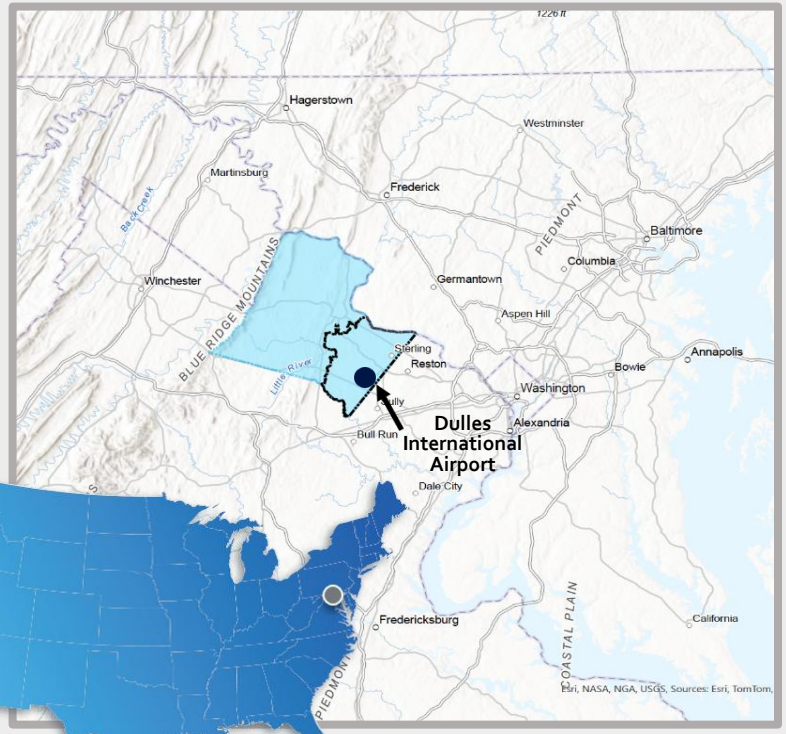
LOUDOUN WATER

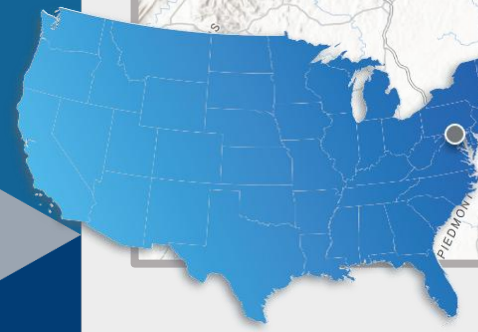
- Brief Introduction
- Lay of the Land
- Current Procedure in Loudoun County
- Next Steps
- Final Thoughts

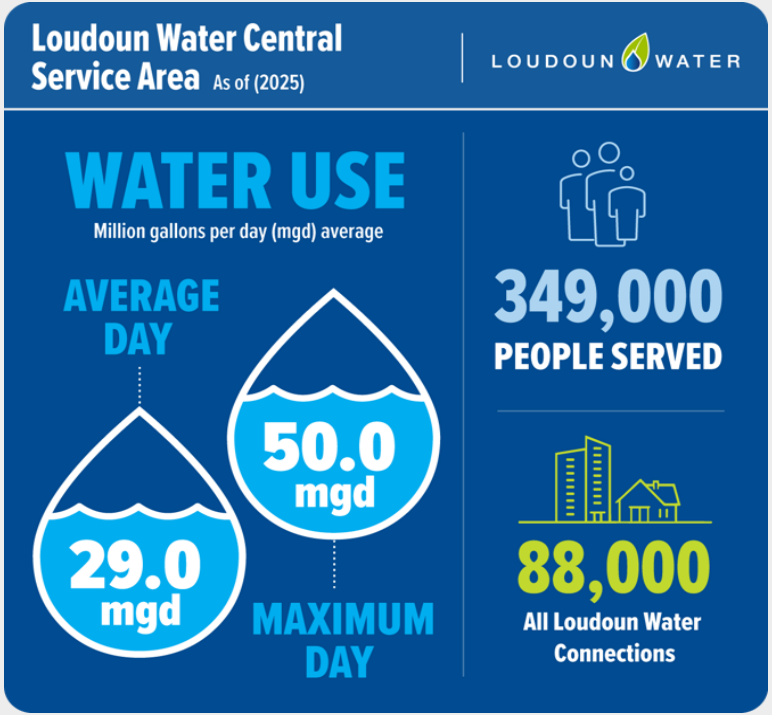
Introduction

- Pretreatment Program Manager for Loudoun Water since December 2022.
- Prior - >19 years at Virginia DEQ – Northern Regional Office
  - Water Compliance – for <3 years
  - Position in Water Permitting – VPDES/VPA/CAFO/various GPs
  - Ten years as the Regional Pretreatment and WET Coordinator

2025 Loudoun Water







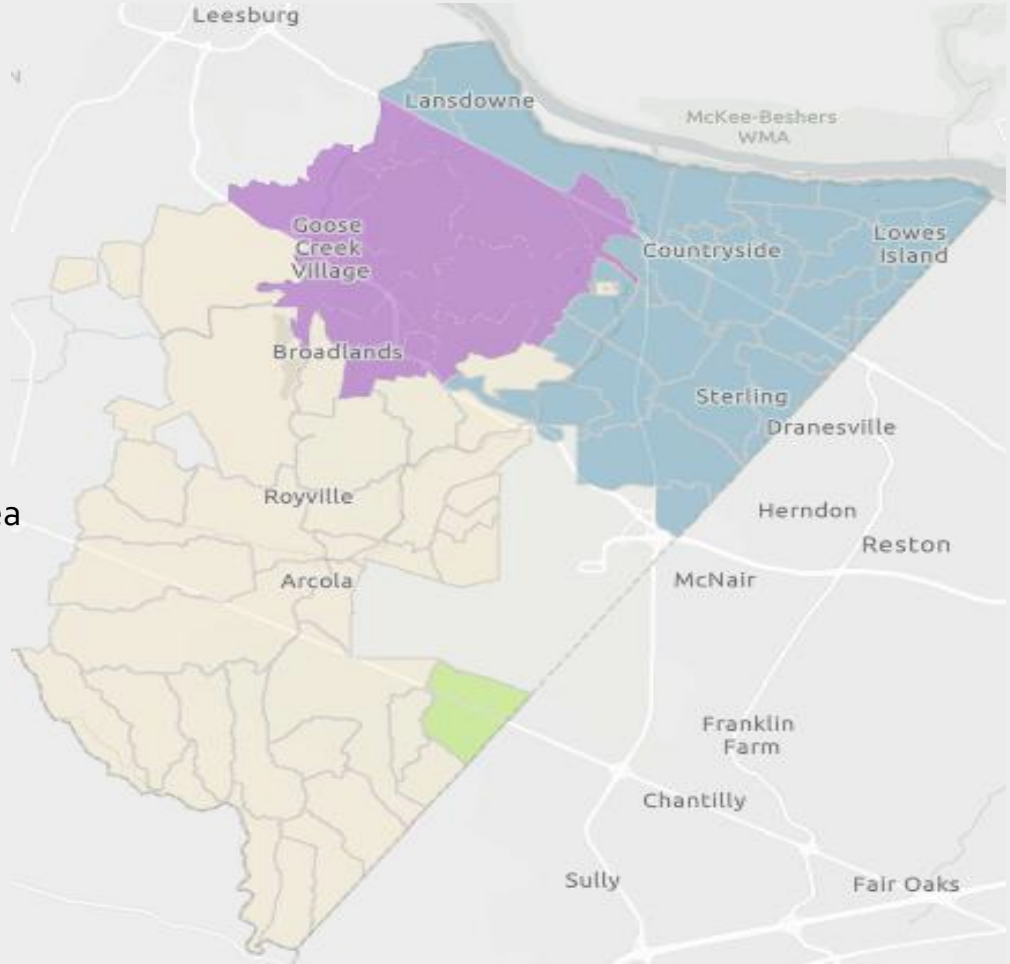
Service Area

General:

- Loudoun County = 521 sq. miles
- Service area = ~140 sq. miles
- 449,749 total population
- ~349,000 population service area

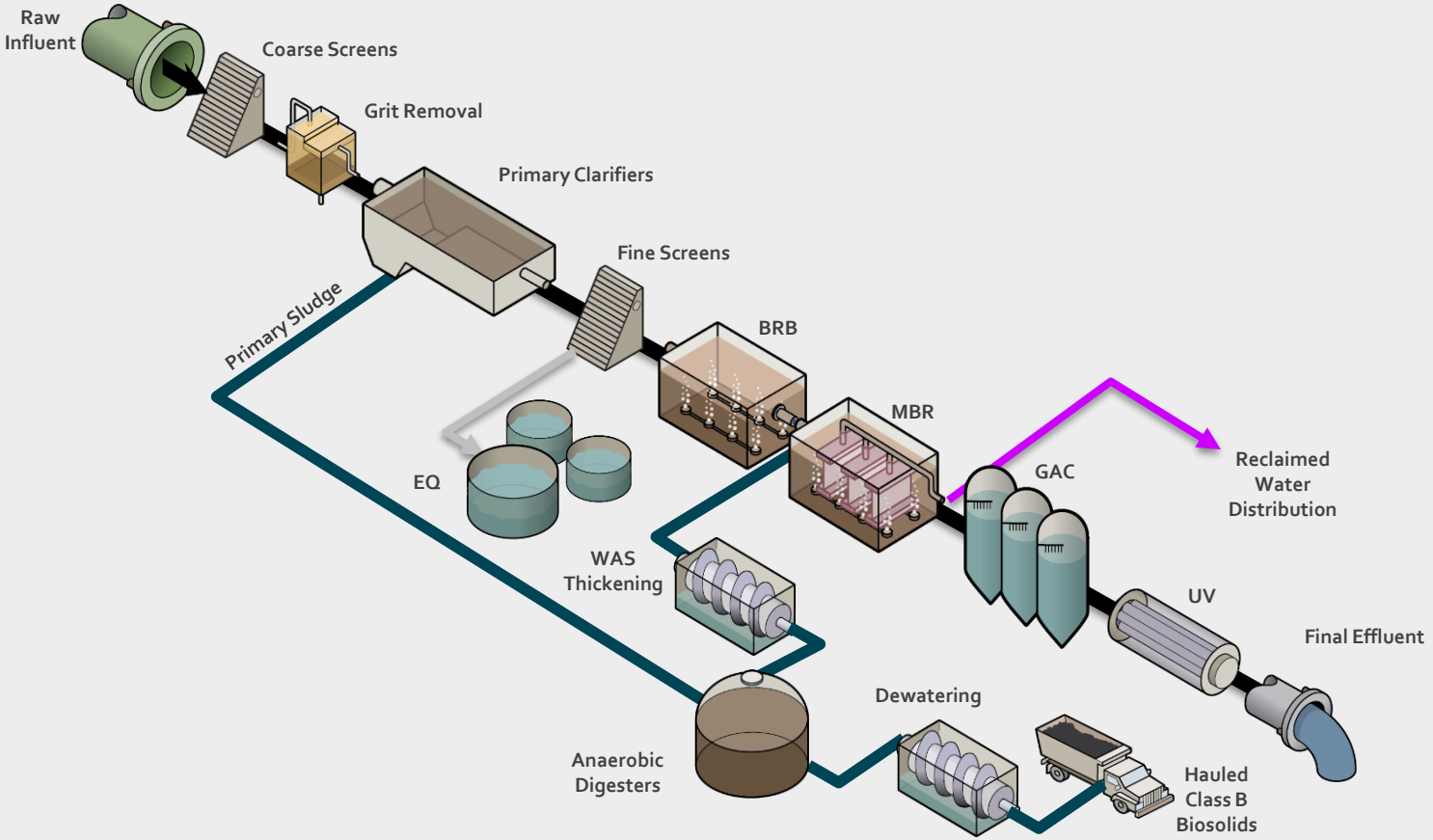
Total System (annual average)

- 23 MGD total
- 10 MGD to BRWRF
- 13 MGD to DC Water



Broad Run Water Reclamation Facility

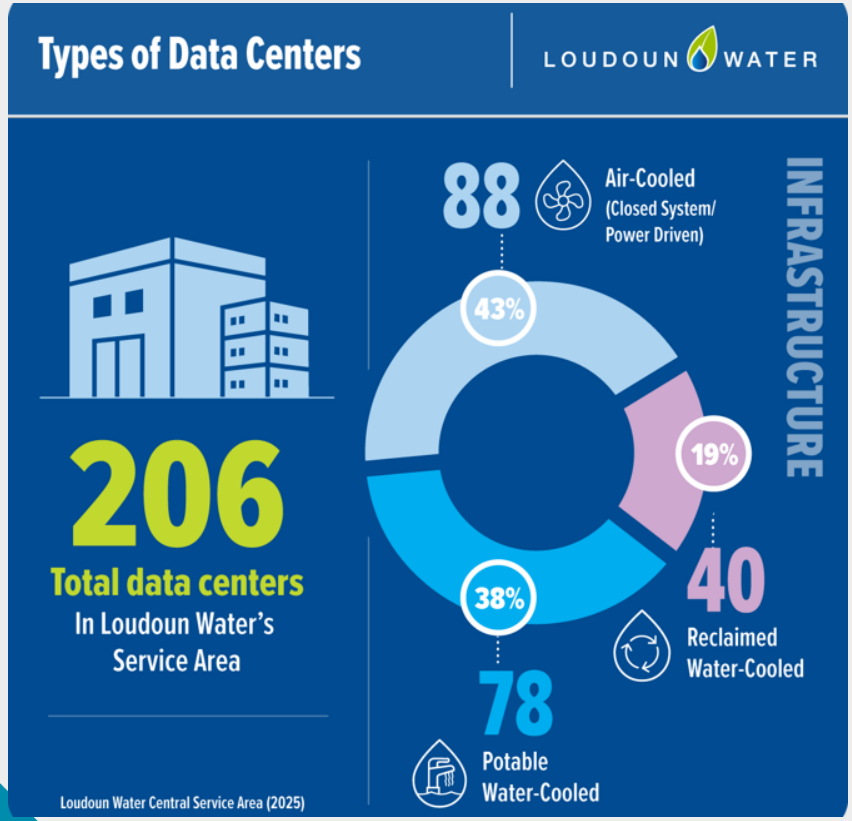
LOUDOUN WATER

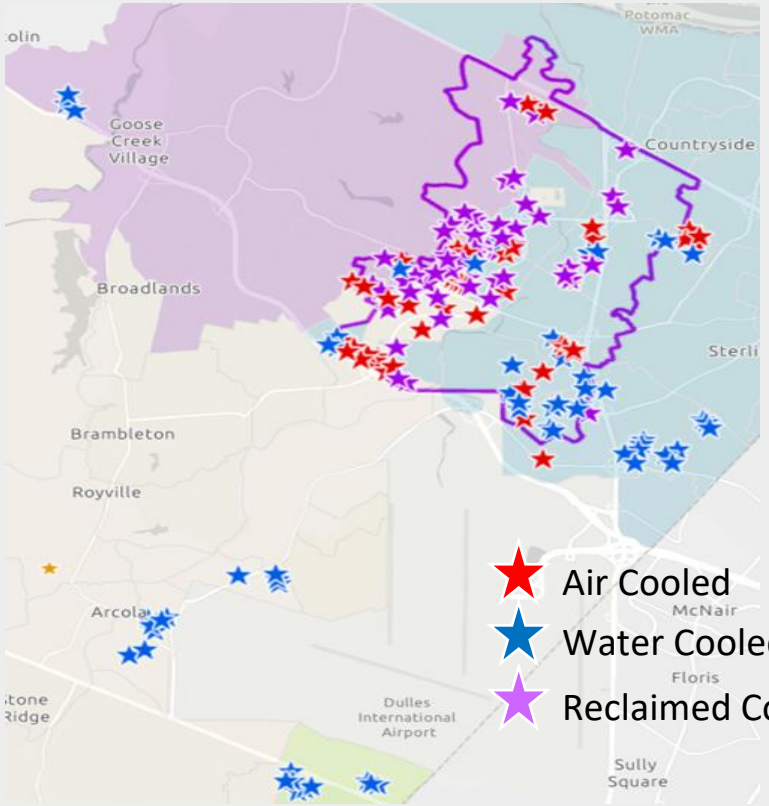


BRWRF Effluent Permit

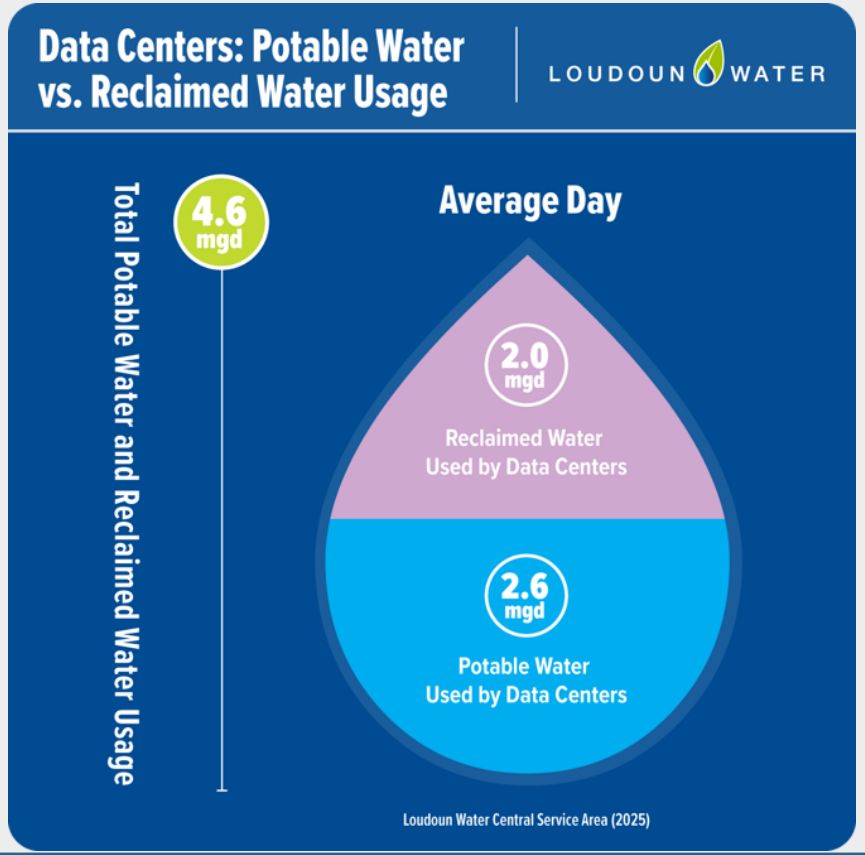
Parameter	Discharge Limitations						Monitoring Requirements	
	Monthly Average[1]		Weekly Average[1]		Minimum	Maximum[1]	Frequency	Sample Type
Flow[2] (MGD)	NL		NA		NA	NL	Continuous	TIRE
pH	NA		NA		6.0 S.U.	9.0 S.U.	1/D	Grab
COD	10 mg/L	620 kg/day	20 mg/L	1250 kg/day	NA	NA	1/D	24H-C
Total Suspended Solids, TSS	1.0 mg/L	62 kg/day	2.0 mg/L	120 kg/day	NA	NA	1/D	24H-C
Total Kjeldahl Nitrogen, TKN	1.0 mg/L	140 lb/day	2.0 mg/L	280 lb/day	NA	N/A	1/D	24H-C
Dissolved Oxygen	NA		NA		6.0 mg/L	NA	1/D	Grab
Turbidity	0.5 NTU		NA		NA	NA	3/D 8H	Grab
E. coli (Geometric Mean)	<2 n/100 mL		NA		NA	NA	1/D	Grab
$NO_2 + NO_3$ as Nitrogen	NL (mg/L)		NA		NA	NA	1/W	24H-C
Total Nitrogen[4]	NL (mg/L)		NA		NA	NA	1/W	Calculated
Total Nitrogen – Year to Date[5]	NL (mg/L)		NA		NA	NA	1/M	Calculated
Total Nitrogen – Calendar Year [5]	3.0 mg/L		NA		NA	NA	1/YR	Calculated
Total Phosphorus	0.10 mg/L	14 lb/day	0.20 mg/L	28 lb/day	NA	NA	1/D	24H-C
Total Phosphorus – Year to Date[5]	NL (mg/L)		NA		NA	NA	1/M	Calculated
Total Phosphorus – Calendar Year [5]	0.10 mg/L		NA		NA	NA	1/YR	Calculated
Chronic Toxicity – *C. dubia* (TU_c)[3]	NA		NA		NA	NL	1/YR	24H-C
Chronic Toxicity – *P. promelas* (TU_c)[3]	NA		NA		NA	NL	1/YR	24H-C

Existing


Types of Data Centers
LOUDOUN WATER
206
Total data centers
In Loudoun Water's Service Area
88
Air-Cooled
(Closed System/ Power Driven)
43%
19%
38%
40
Reclaimed Water-Cooled
78
Potable Water-Cooled
INFRASTRUCTURE
Loudoun Water Central Service Area (2025)


Goose Creek Village
Broadlands
Brambleton
Royville
Countryside
Sterli
Arcola
McNair
Floris
Dulles International Airport
Sully Square
Potomac WMA
Air Cooled
Water Cooled
Reclaimed Cooled

Data Center Demands



*Average Annual Usage

LOUDOUN WATER

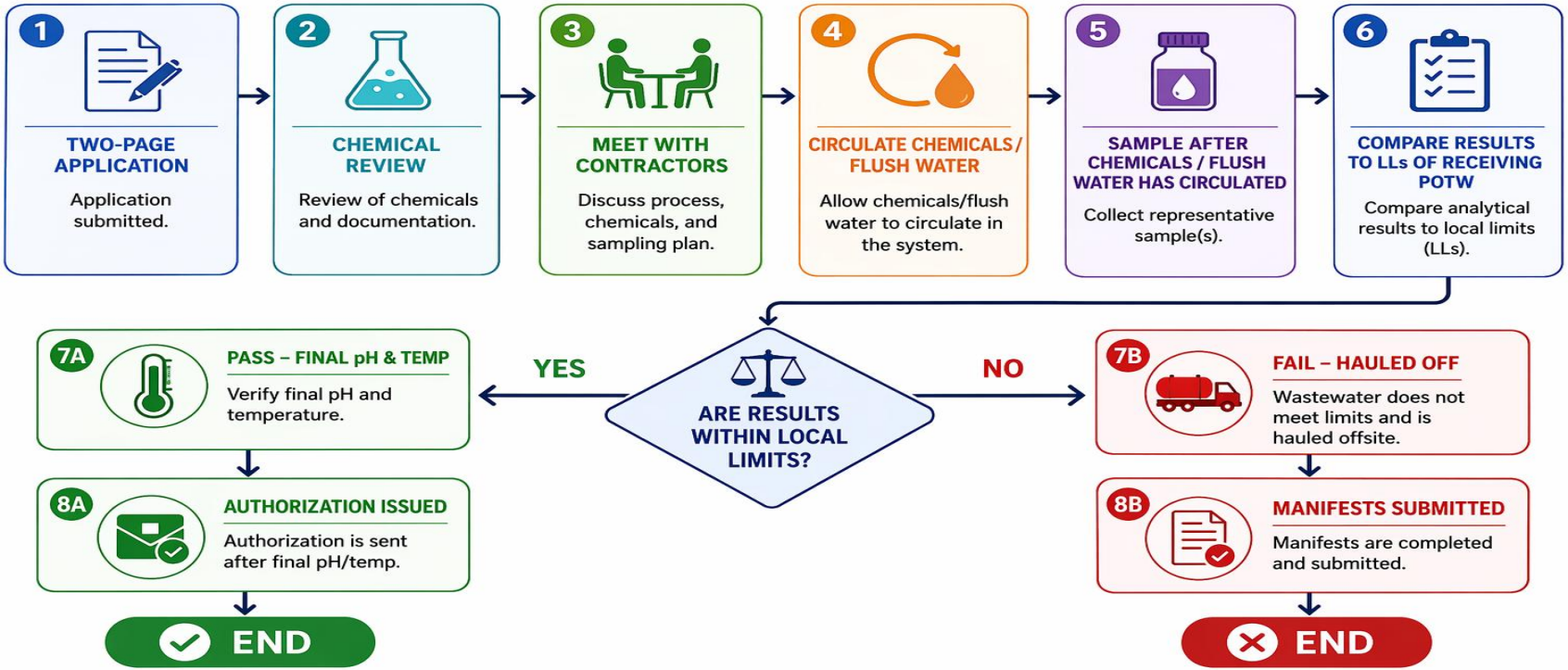
Data Center Construction

Current Procedure at Loudoun Water

- Established oversight of the commissioning and passivation of the cooling systems
- Provides an avenue to regulate the type of chemicals used
- Managed control of something that is out of our control
- Discharge events processed:
  - CY2024 – 42
  - CY2025 – 57
  - CY2026 – **157** [as of 09.30.2026] – big push on AI

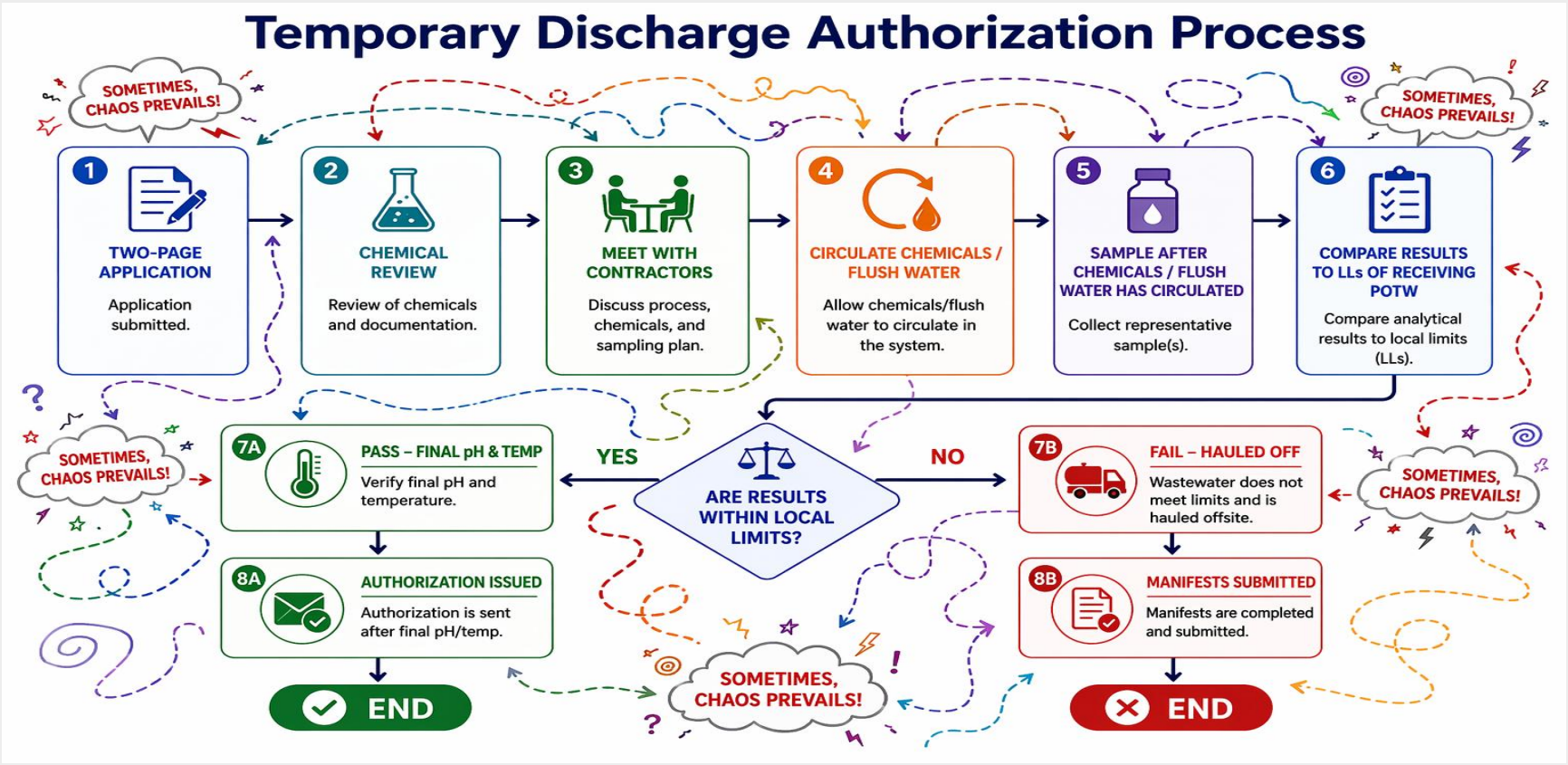
LOUDOUN WATER

Temporary Discharge Authorization Process



LOUDOUN WATER

Temporary Discharge Authorization Process



Example Metals Characteristics

LOUDOUN WATER

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
Piping Volume (gal)	40,000	15,000	14,000	90,000	3,537	200,478	1,844	7,000	1,850	198,537	7,200
Arsenic (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium (mg/L)	ND	ND	ND	0.504	0.408	ND	ND	ND	ND	ND	ND
Copper (mg/L)	0.165	0.795	0.180	ND	3.040	ND	ND	ND	ND	0.282	0.183
Lead (mg/L)	ND	ND	ND	ND	0.101	ND	ND	ND	ND	ND	ND
Molybdenum (mg/L)	ND	ND	ND	ND	ND	ND	0.489	ND	ND	ND	ND
Nickel (mg/L)	ND	0.012	ND	0.043	0.047	ND	ND	ND	ND	0.032	ND
Selenium (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (mg/L)	0.144	0.038	0.041	0.630	16.600	0.025	0.534	0.015	0.196	0.185	0.109
Mercury (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium (mg/L)	216	66.40	22.40	506	20.80	19.80	180.00	66.50	45.90	22.20	32.00
Bromide (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide (mg/L)	0.034	0.232	ND	0.060	ND	ND	0.032	ND	0.072	ND	ND

Example POC Characteristics

LOUDOUN WATER

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
Piping Volume (gal)	**40,000**	**15,000**	**14,000**	**90,000**	**3,537**	**200,478**	**1,844**	**7,000**	**1,850**	**198,537**	**7,200**
Chemical	Nitrogen	Nitrogen	None	Nitrogen	None	None	Nitrogen	Phosphorus	Nitrogen	None	None
NH3 (mg/L)	1.06	7.90	0.04	0.71	9.44	0.65	0.23	0.11	ND	0.73	0.03
NOx (mg/L)	3.89	0.53	1.25	0.7	1.01	0.46	1.05	0.43	157.80	0.46	0.57
Ortho-p (mg/L)	0.12	ND	0.47	0.08	ND	0.45	0.03	0.96	0.12	0.40	0.41
UVT (%T/cm)	0	2	94	2	24	93	1	82	7	87	95
COD (mg/L)	267	**711**	7	**1,992**	224	ND	**794**	48	**2,030**	11	ND
TKN (mg/L)	6.37	0.77	ND	6.78	8.17	0.68	3.07	ND	18.63	0.98	ND
TN (mg/L)	10.26	1.30	1.25	7.55	9.18	1.14	4.11	0.43	**176.43**	1.44	0.57
TP (mg/L)	0.27	0.66	0.49	2.49	0.36	0.54	0.30	1.21	0.45	0.45	0.45
Toly (mg/L)	**13.20**	**116.00**	ND	0.07	ND	ND	8.50	ND	**14.00**	ND	ND
QAC's (mg/L)	0.60	0.80	0.10	1.20	1.00	0.00	ND	1.90	1.30	0.10	0.10

BRWRF Noted Experiences

2013	• Biosolids Molybdenum Event
2019	• Effluent Phosphorus Event
2021	• Unintended Molybdenum Discharge
2022	• Effluent Nitrification Inhibition Event
2023	• Elevated Copper Issues

Out of over 300 discharges/sampled events only 5 to note

2013 Biosolids Molybdenum Event

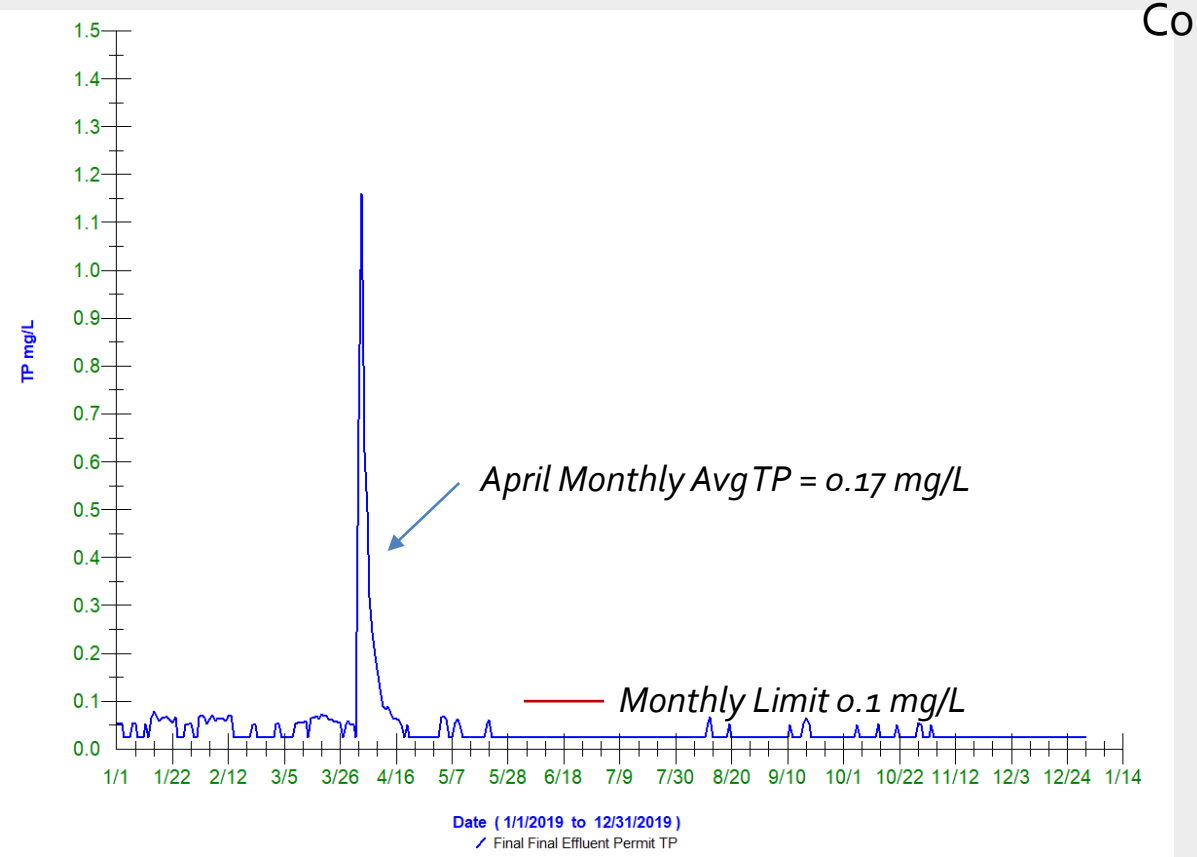
BROAD RUN WRF MOLYBDENUM RESULTS 2010 to 2013

COUNT	Start of Period	End of Period	Date Sampled	Results	Reporting Limits	Units	Ceiling Conc Max	Results Above Ceiling Conc	Comments
1	09/01/10	10/31/10	09/22/10	22	7.10	mg/kg	75		
2	11/01/10	12/31/10	11/24/10	25	4.90	mg/kg	75		
3	01/01/11	02/28/11	01/05/11	19	5.00	mg/kg	75		
4	01/01/11	02/28/11	02/28/11	16	5.80	mg/kg	75		extra sample
4	03/01/11	04/30/11	03/14/11	ND	54.00	mg/kg	75		
5	05/31/11	06/30/11	05/02/11	ND	13.00	mg/kg	75		
6	07/01/11	08/31/11	07/06/11	ND	85.00	mg/kg	75		
7	09/01/11	10/31/11	09/07/11	ND	44.00	mg/kg	75		
8	11/01/11	12/31/11	11/02/11	ND	12.00	mg/kg	75		
9	01/01/12	02/29/12	01/04/12	ND	13.00	mg/kg	75		
10	03/01/12	04/30/12	03/01/12	ND	13.00	mg/kg	75		
11	05/01/12	06/30/12	05/01/12	ND	11.00	mg/kg	75		
12	07/01/12	08/31/12	07/05/12	<25	25.00	mg/kg	75		
13	09/01/12	10/31/12	09/05/12	<25	25.00	mg/kg	75		
14	11/01/12	12/31/12	11/08/12	<25	25.00	mg/kg	75		
15	01/01/13	02/28/13	01/02/13	ND	25.00	mg/kg	75		
16	01/01/13	02/28/13	02/13/13	ND	0.20	mg/kg	75		extra sample
17	03/31/13	04/30/13	03/07/13	ND	21.00	mg/kg	75		
17	05/31/13	06/30/13	05/01/13	ND	11.00	mg/kg	75		
18	07/31/13	08/31/13	07/10/13	8.9	2.40	mg/kg	75		
19	09/30/13	10/31/13	09/04/13	11.5	2.20	mg/kg	75		
20	11/30/13	12/31/13	11/03/13	102	2.40	mg/kg	75	yes	
			AVG	29.2	AVG w/o 20 >>		17.1		
			MIN	8.9	MIN w/o 20>>>		8.9		
			MAX	102.0	MAX w/o 20>>>		25.0		

Suspected as data center activity. No data in place for full determination.

300 DMT Biosolids landfilled
(approximately 3 months)

2019 Phosphorus Event



Confirmed Data Center Event

*Sewershed sampling showed **TP of 66 mg/L***

Review of passivation chemicals indicated "oxides of phosphorus"

When discharge ceased influent TP concentrations dropped by half

2021 Unintended Molybdenum Discharge

LOUDOUN WATER

Air Cooled Data Center – Expanding Chilled Water Loop

Review of chemicals to be used completed and approved
Discharge allowed and samples collected for analysis
Below results received:

Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)
0.013	ND	0.006	0.079	0.070	99.3	ND	ND	0.014

New piping system had been connected to a small portion of existing closed loop system that released molybdenum into discharge unintentionally

2022 Nitrification Inhibition Event

Discharge request was submitted, chemicals reviewed and approved, sample collected and results received prior to discharge.

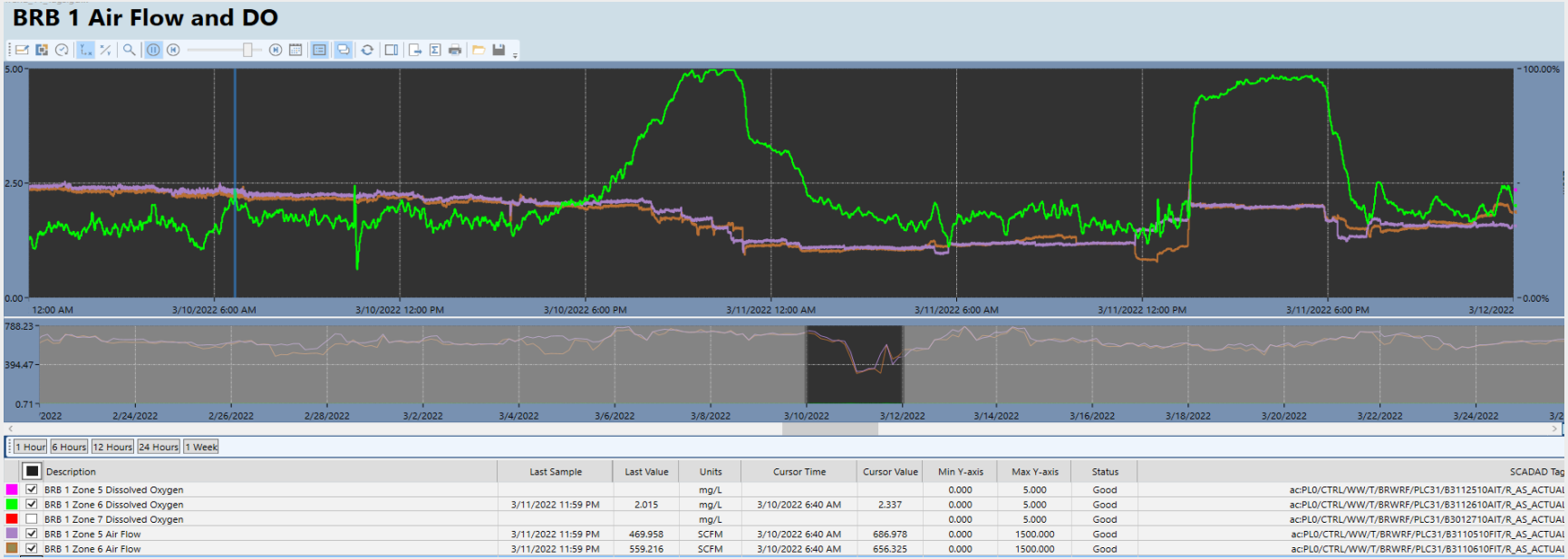
140,000 gallon piping system

Estimated 500,000 gallons flushed

Copper (mg/L)	Zinc (mg/L)	NH_3 (mg/L)	NOx (mg/L)	COD (mg/L)	TKN (mg/L)	TP (mg/L)
0.06	0.089	9.84	2.90	2,751	44.56	1.39

Discharge began on 3/10 around 12 pm

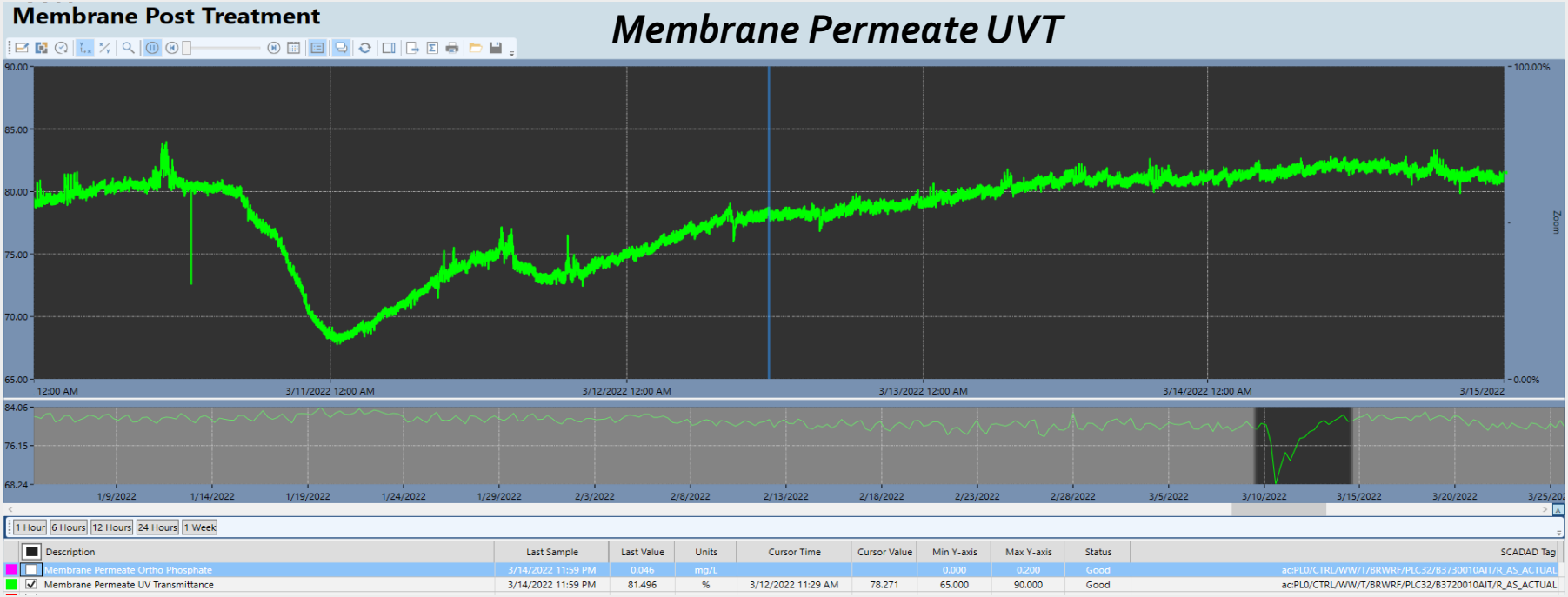
BRWRF Impacts around 5pm



Description	Last Sample	Last Value	Units	Cursor Time	Cursor Value	Min Y-axis	Max Y-axis	Status	SCADAD Tag
BRB 1 Zone 5 Dissolved Oxygen			mg/L			0.000	5.000	Good	ac:PL0/CTRL/WW/T/BRWRF/PLC31/B3112510AIT/R_AS_ACTUAL
BRB 1 Zone 6 Dissolved Oxygen	3/11/2022 11:59 PM	2.015	mg/L	3/10/2022 6:40 AM	2.337	0.000	5.000	Good	ac:PL0/CTRL/WW/T/BRWRF/PLC31/B3112610AIT/R_AS_ACTUAL
BRB 1 Zone 7 Dissolved Oxygen			mg/L			0.000	5.000	Good	ac:PL0/CTRL/WW/T/BRWRF/PLC31/B3012710AIT/R_AS_ACTUAL
BRB 1 Zone 5 Air Flow	3/11/2022 11:59 PM	469.958	SCFM	3/10/2022 6:40 AM	686.978	0.000	1500.000	Good	ac:PL0/CTRL/WW/T/BRWRF/PLC31/B3110510FIT/R_AS_ACTUAL
BRB 1 Zone 6 Air Flow	3/11/2022 11:59 PM	559.216	SCFM	3/10/2022 6:40 AM	656.325	0.000	1500.000	Good	ac:PL0/CTRL/WW/T/BRWRF/PLC31/B3110610FIT/R_AS_ACTUAL

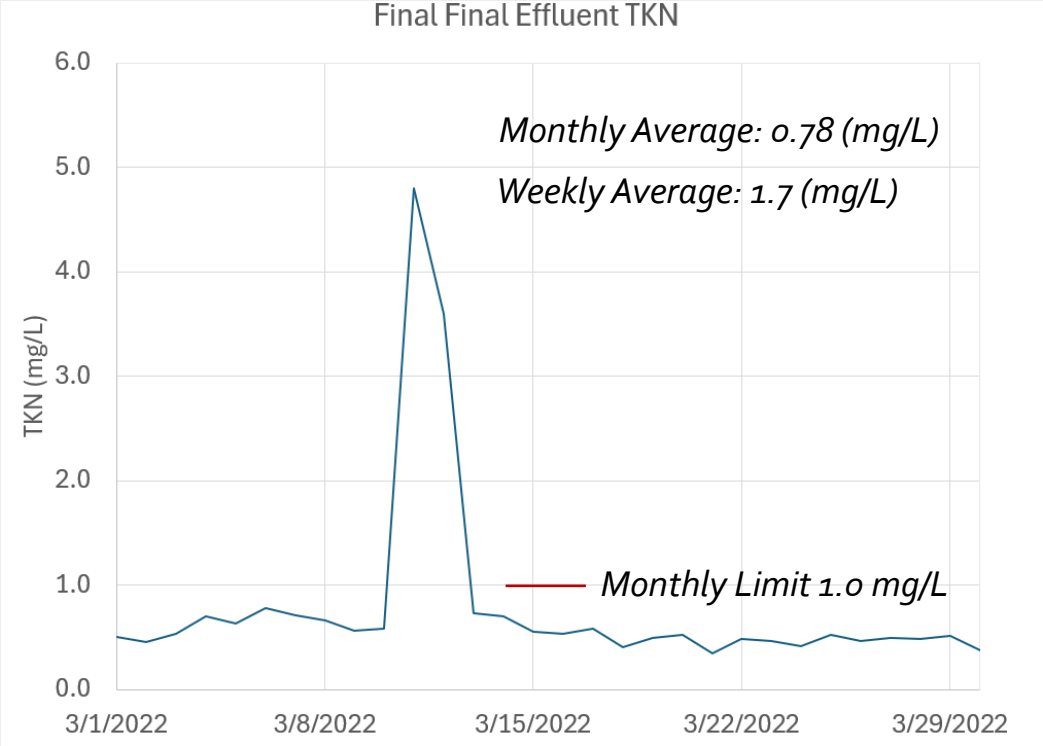
Loss of Air Demand

BRWRF Impacts around 5pm



Drop in UVT

BRWRF Final Effluent



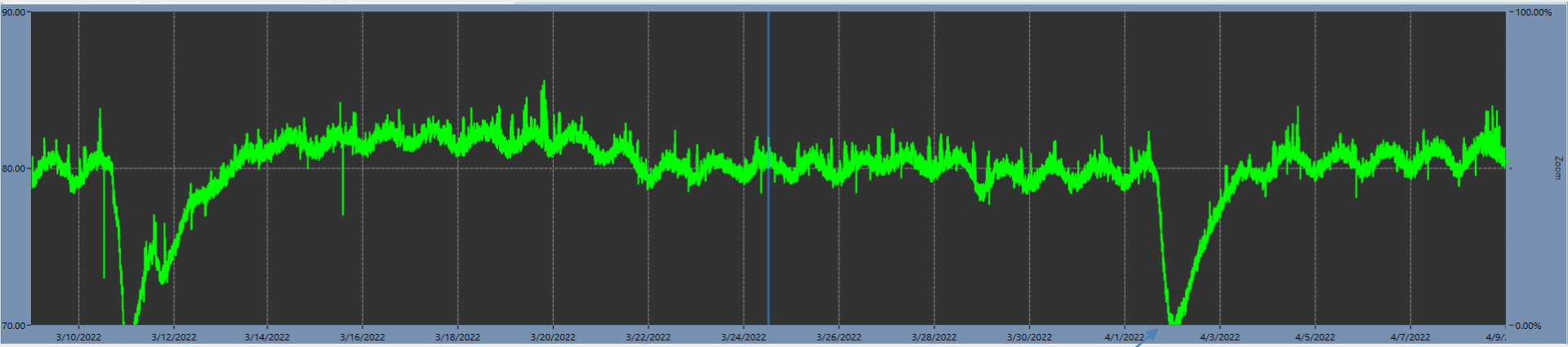
At this point we are still not sure actual cause

We were not definite if this was caused by a Data Center discharge since we had previous success with this facility

In a collection system with so much construction activity, it can be difficult to pinpoint cause

Second Inhibition Event

Membrane Permeate UVT



We officially knew it was the data center now because second event also coincided with their discharge

Chemical Flush Evaluation

Hydrostatic Test Stage:	
Volume:	~ 80,000 gallons
Product Used:	
Amount Used:	330 gallons
Chemical In: date/time	Chemical was added while filling and
Chemical Cleaning Stage	
Product Used:	
Amount Used:	(6) 55 gal, (2) 55 gal (3) 5 gal
Date/Time In:	3-28-2022 @ 4:30 am
Date/Time Out:	4-1-2022 ; 9:30 PM
Online Chemical Treatment	
Inhibitor: - Initial Charge	See Notes
Biocide: - Initial Charge	See Notes
Azole: - Initial Charge	See Notes
Date/Time In:	N/A
Note:	Until daily operation, system is currently in lay-up.
Layup Inhibitor - Initial Charge	; 330 Gallons
Layup Biocide - Initial Charge	; 55 Gallons

Formula 1 composition

Chemical Component	Percentage in Product (<)
Sodium Hydroxide	3
Sodium Tolytriazole	28

Formula 2 composition

Chemical Component	Percentage in Product (<)
Sodium Silicate	10
Sodium Hydroxide	6
Sodium tolytriazole	4

Formula 3 composition

Chemical Component	Percentage in Product (<)
Proprietary Ammonium Derivative	5
Sodium Hydroxide	5
Phosphinocarboxlic Acid	3
Tolytriazole Sodium Salt	2

Triazole Likely Nitrification Inhibitor

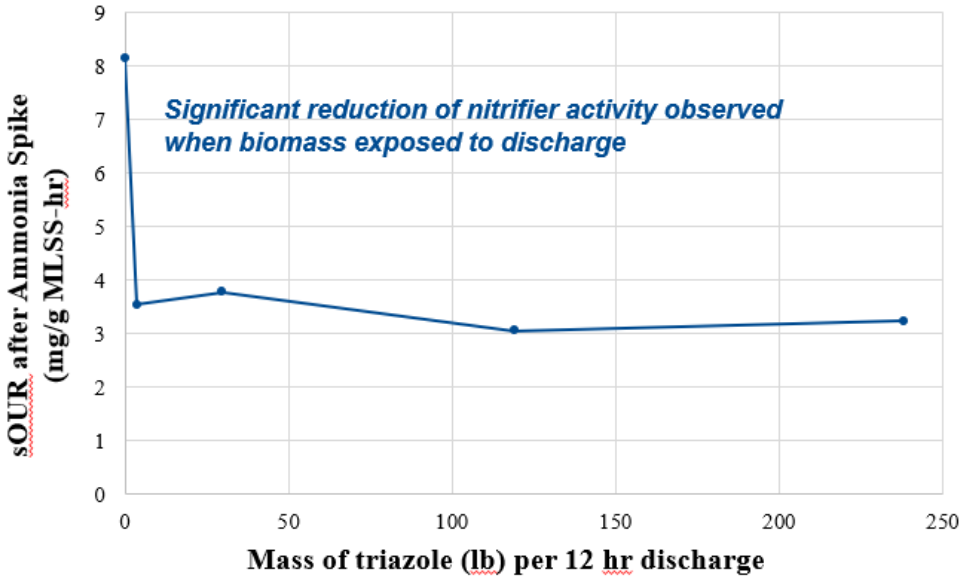
	Volume	Sodium tolytriazole content
	gal	%
Product 3	440	2.0
Product 2	330	4.0
Product 1	15	28.0
All products	785	3.3
Total discharge volume generated	**75,000**	**0.035**

~ 238 lb discharged

Assuming BRWRF influent flow of 8.26 mgd over 12 hr

6.9 mg/L in raw influent

Impact of Discharge on Nitrifier Activity



- ~ 50 to 60% inhibition of nitrifier activity observed even at lower flow combinations
- Recall that testing provides conservative estimate of impact of discharge
  - In batch test - discharge diluted with MLSS and ammonia additions in batch test
  - In full-scale – discharge diluted with raw influent prior to treatment at BRWRF
    - Disinfectant potency will be higher in batch tests vs. full-scale

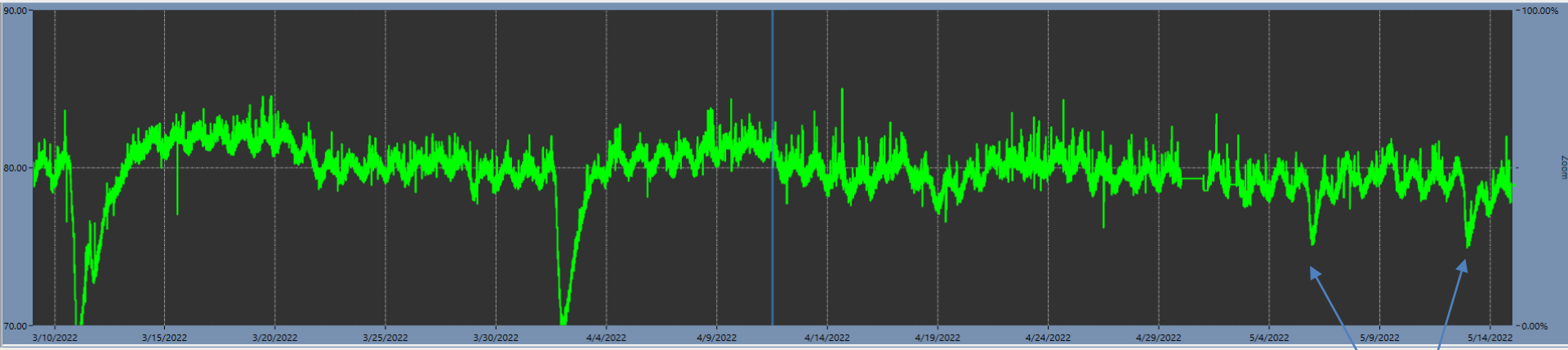
Solution Reached with Data Center

- Data Center Agreed to remove Formula 1 (primary source of triazole)
- Data Center Agreed to reduce flow rates (400,000 gpd to 150,000 gpd)

Chemical Component	Percentage in Product (<)
Sodium Hydroxide	3
Sodium Tolytriazole	28

Found An Acceptable Approach to Discharge

Membrane Permeate UVT



Reduced Discharge

2023 Elevated Copper Issue

LOUDOUN WATER

Power issues created long durations between construction and data center startup

Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Zinc (mg/L)	Mercury (mg/L)
ND	ND	ND	2.560	ND	ND	0.030	ND	ND	0.420	ND

NH3 (mg/L)	NOx (mg/L)	Ortho-p (mg/L)	COD (mg/L)	TKN (mg/L)	TN (mg/L)	TP (mg/L)
0.02	0.03	ND	77	2.00	2.03	0.08

There is no such thing as a clean water flush

Summary of Issues Experienced with Data Center Discharge

LOUDOUN WATER

Slug Loading Due to Passivation Chemicals	Phosphorus and Molybdenum
Accidental Release of Closed Loop Glycol	Molybdenum
Nitrification Inhibition from Biocides	Tolyltriazole and Quaternary Ammonium Compounds
Elevated Metal Concentrations from Long Term Water Storage	Copper

LOUDOUN WATER

Post Construction

LOUDOUN WATER

Data Center Wastestream Characteristics

Early Data Center Blowdown Sampling

LOUDOUN WATER

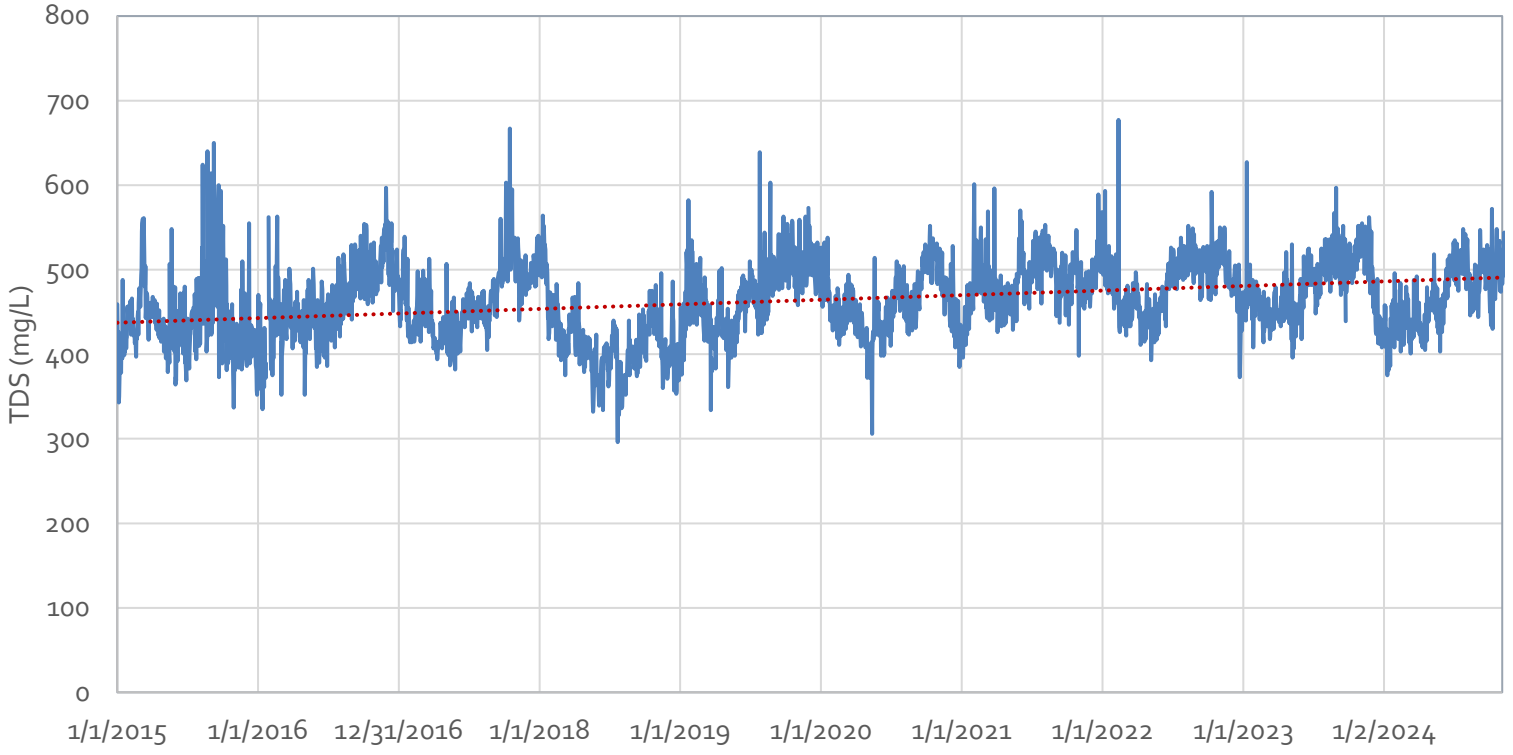
Table 7-12: Projected Data Center Wastewater Characteristics

Criteria	sCOD	COD	TSS	TKN	NH_3-N	TP	TDS
Average Conc. (mg/L)	2.1	47	0.6	1.3	0	2.9	1,260

Table 5-1: TDS Characterization Results

Sample	Date	Ca, mg/L	Mg, mg/L	K, mg/L	Na, mg/l	HCO3, mg/L	Cl, mg/l	SO4, mg/L	TDS, mg/L[1]
Data Center 1	9/16	122.0	44.0	67.4	281.0	263	406	364	1547
Data Center 2	9/16	204.0	74.0	102.0	493.0	5	697	1020	2595

BRWRF Influent TDS



September 2025 Blowdown Sampling

COD (mg/L)	BOD (mg/L)	TSS (mg/L)	TKN (mg/L)	TP (mg/L)	ALK (mg/L)
32.1	2.2	4.8	3.6	1.2	144

Tolyltriazole (mg/L)	QAC (mg/L)	UVT %
0.3	0.1	65.3

Metals

Chromium (mg/L)	Copper (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Zinc (mg/L)
0.065	0.218	0.535	0.056	0.673

Next Steps…

Permits?

- Currently no indications of issues at the plant
- Sampling data doesn't indicate POCs
- More importantly, what would we regulate?
- Number alone
- Unnecessary regulatory burden*

Concerns

- Maintenance/cleaning activities
- Rehab/replacement of cooling system
- Chemical usage changes
- BMPs not in place/implemented
- Staff lacks knowledge

Advising Leadership to Consider Sector Control

- It is a practice that has been implemented elsewhere
- It recognizes the discharge but with conditions
- Uniform BMPs and reporting requirements
- Quiet guardrails, seamless operations

Sector Control / Discharge Authorization Document

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- Ensure spill-response signage is posted with plant contact information for sanitary system incidents
- Notification of maintenance activities or unintended discharges
- Reminder to Data Centers that we can conduct onsite visits to review chemical storage practices and confirm BMPs are followed
- Keep lines of communication active and open

Final thoughts…

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Data centers will continue to evolve — and so will the challenges they bring

Close communication, early engagement, and clear expectations remain essential

We must be ready to adjust and adapt as conditions change

Commissioning activities **can** be effectively managed with the right framework

Developing an appropriate mechanism to control and manage day-to-day operations is key to long-term success

QUESTIONS?

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Thank you!

- Email – ddfrasier@loudounwater.org

Links of interest –

- Mapped: U.S. States With the Most Data Centers in 2025
- How Loudoun County became the data center capital of the world – NBC4 Washington