SWIFT: An Innovative Approach to Managed Aquifer Recharge Using Purified Recycled Water in Virginia

WateReuse Association Northern California Chapter Meeting

Oakland, CA

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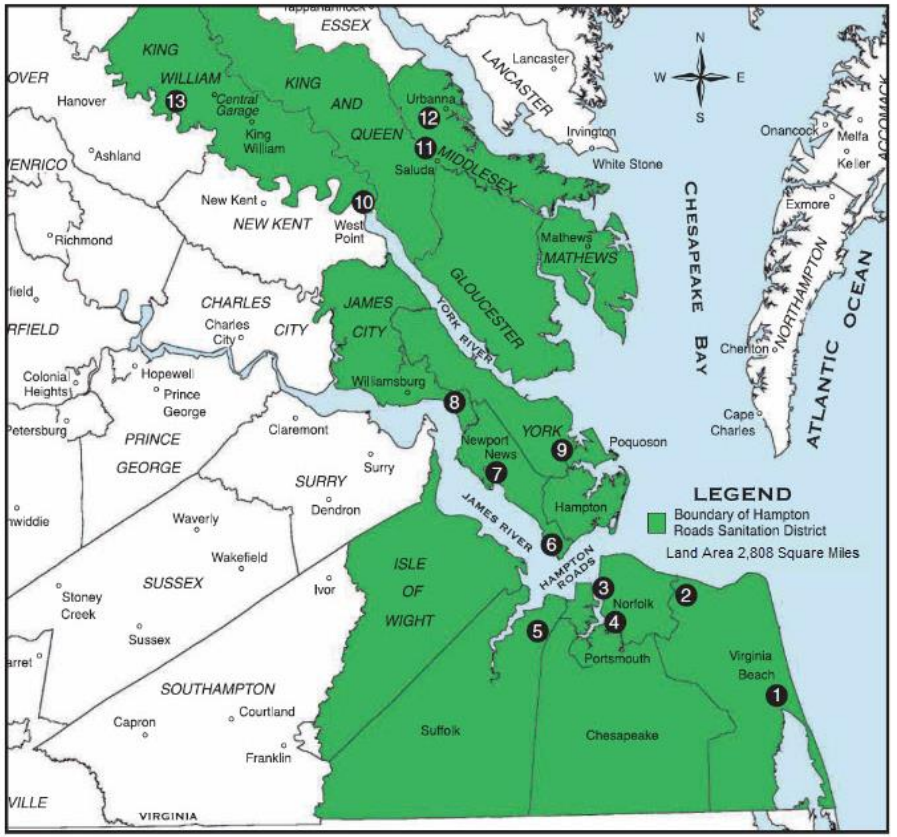
JACOBS

- Hampton Roads Sanitation District (HRSD)
- Provides wastewater treatment for 17 localities (250 mgd treatment capacity)
- Serves 1.7 million people (20% of all Virginians)

Major facilities include the following treatment plants:

1. Atlantic, Virginia Beach
2. Chesapeake-Elizabeth, Va. Beach
3. Army Base, Norfolk
4. Virginia Initiative, Norfolk
5. Nansemond, Suffolk
6. Boat Harbor, Newport News
7. James River, Newport News
8. Williamsburg, James City County
9. York River, York County
10. West Point, King William County
11. Central Middlesex, Middlesex County
12. Urbanna, Middlesex County
13. King William, King William County

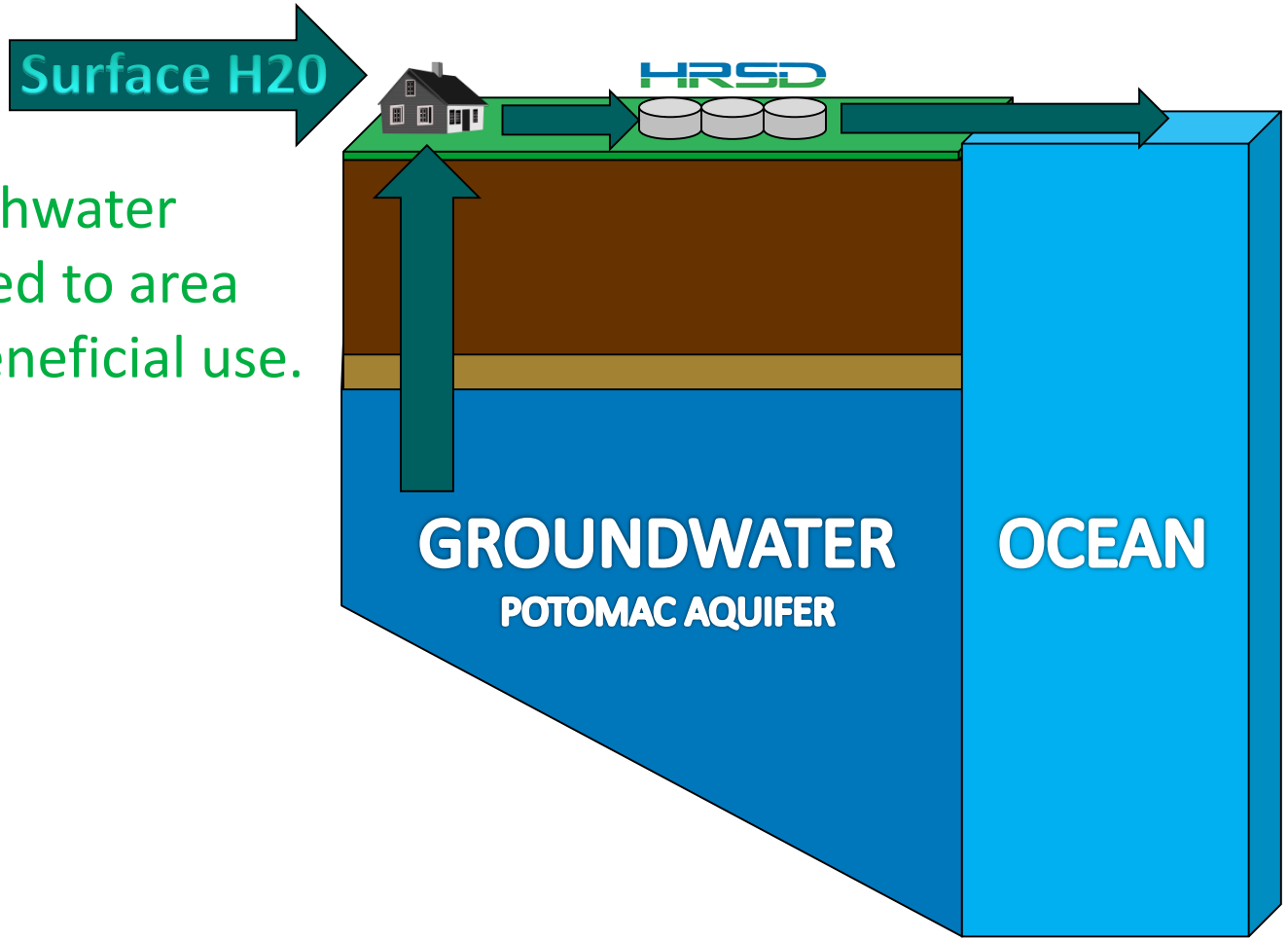
Serving the Cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, Williamsburg, and the Counties of Gloucester, Isle of Wight, James City King and Queen, King William, Mathews, Middlesex and York



2016

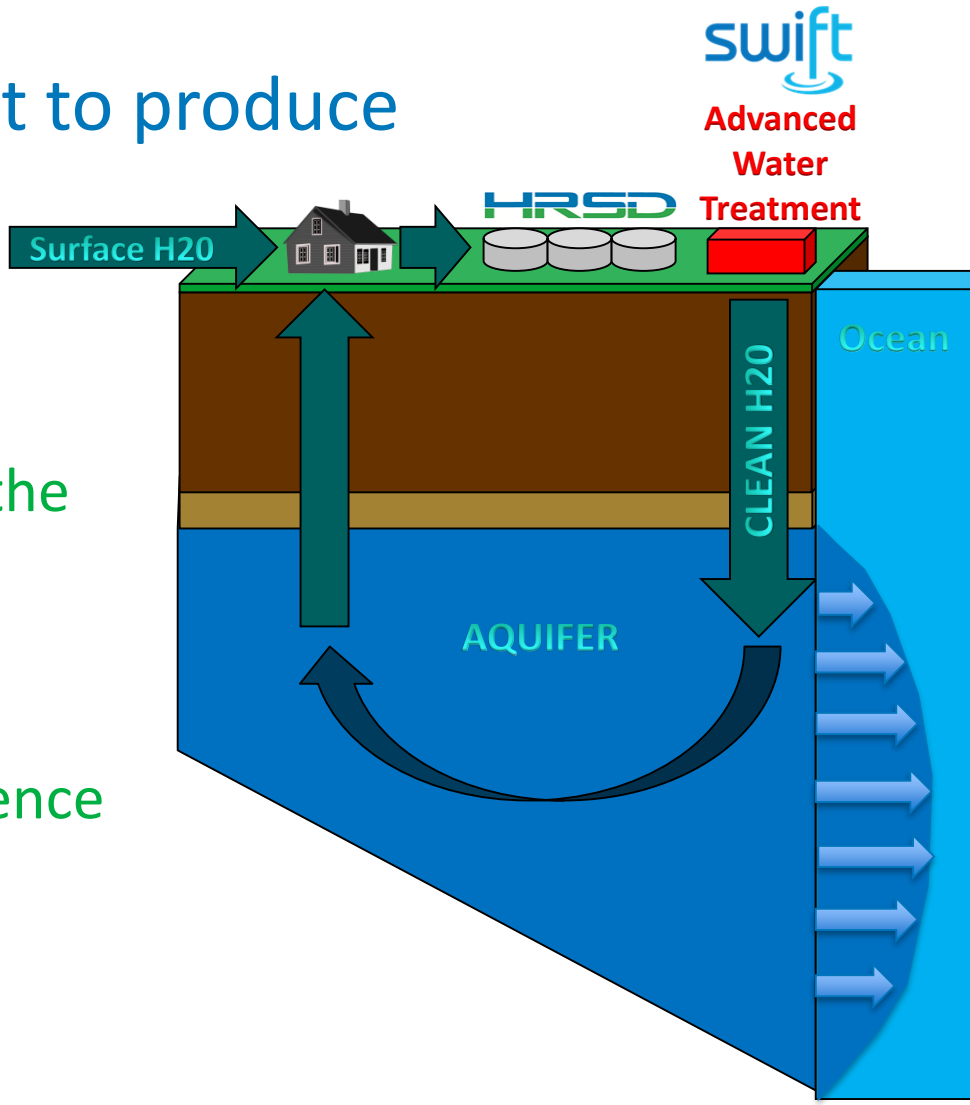
Current state of wastewater in Hampton Roads

Highly treated freshwater currently discharged to area waterways – no beneficial use.

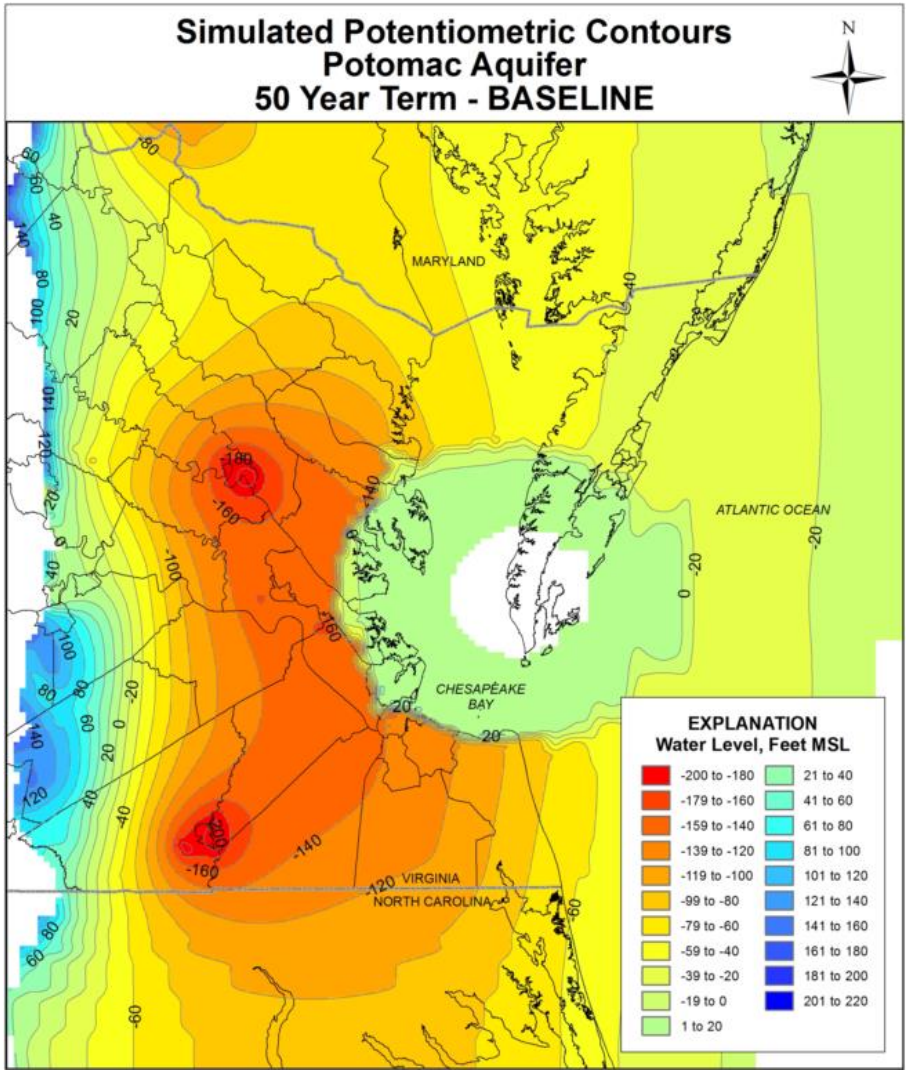


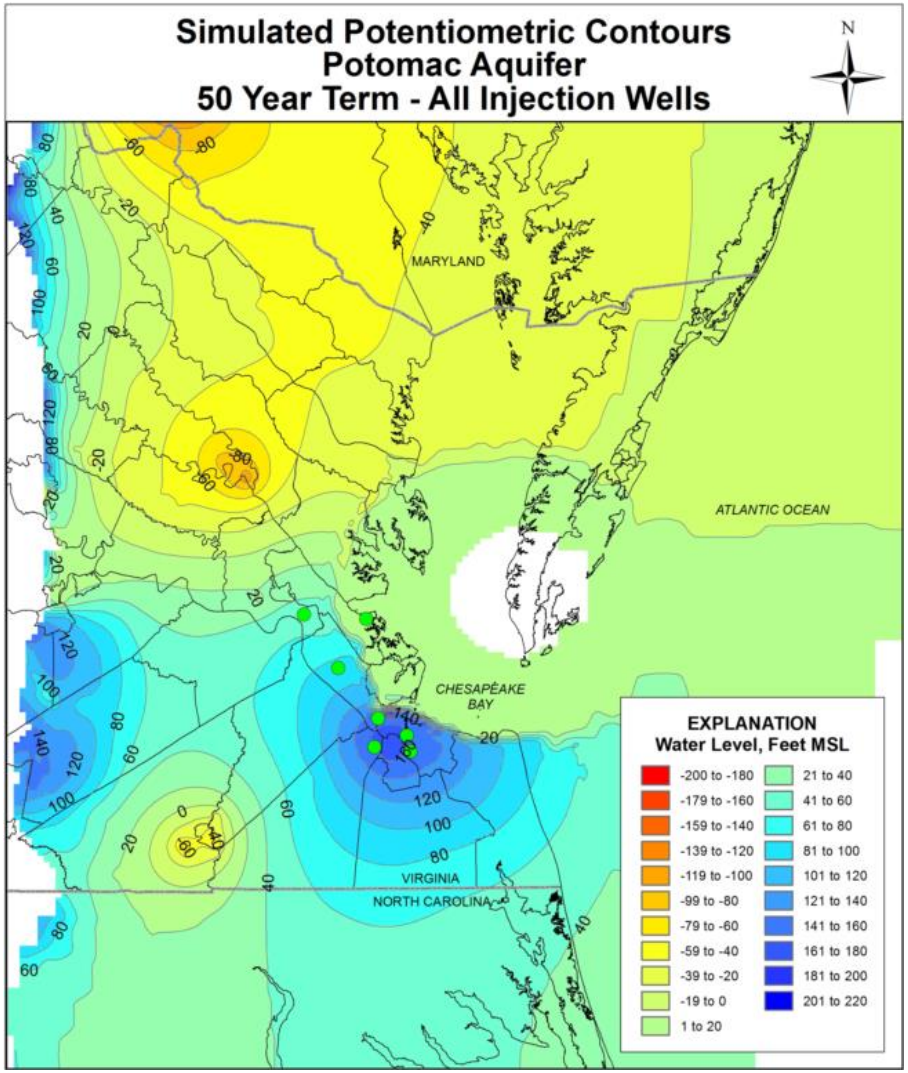
Advanced water treatment to produce **PURIFIED WATER**

- SWIFT concept - replenish the aquifer with purified water to:
  - Reduce nutrient discharges to the Bay
  - Provide a sustainable supply of groundwater
  - Reduce the rate of land subsidence
  - Protect the groundwater from seawater intrusion

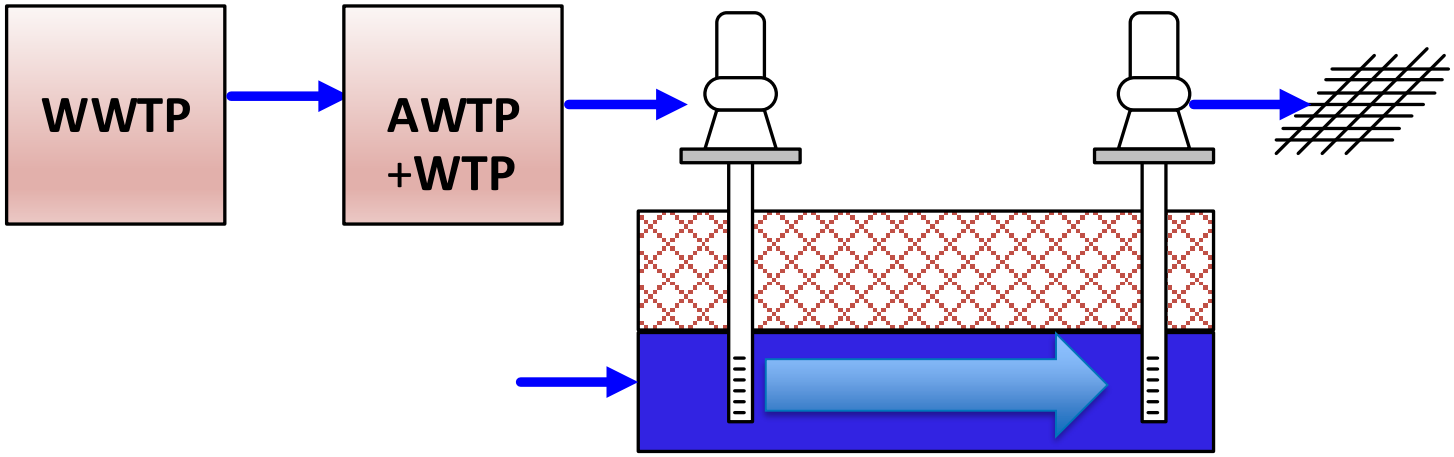


Modeled Potomac Aquifer Water Levels With And Without SWIFT





Managed Aquifer Recharge



- Soil aquifer treatment, blending with existing groundwater
- Human health criteria still apply due to drinking water designation of aquifer
- Geochemical compatibility is required!

Treatment Process Selection Approach

Identify candidate treatment processes for evaluation that can:

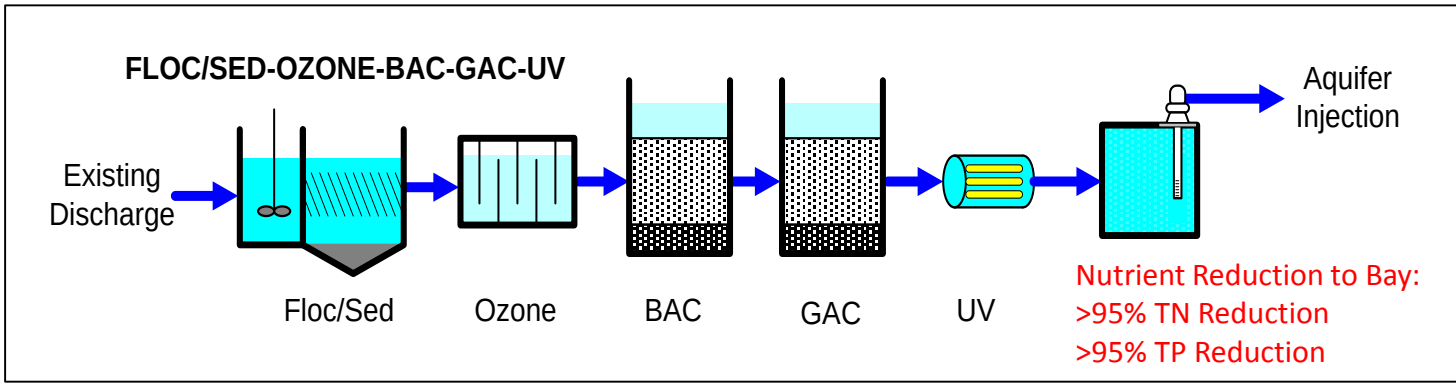
1. Comply with EPA primary MCLs
2. Provide a multi-barrier approach to removal of pathogens and organics
3. Achieve consistent TN < 10 mg/L-N

Additional considerations:

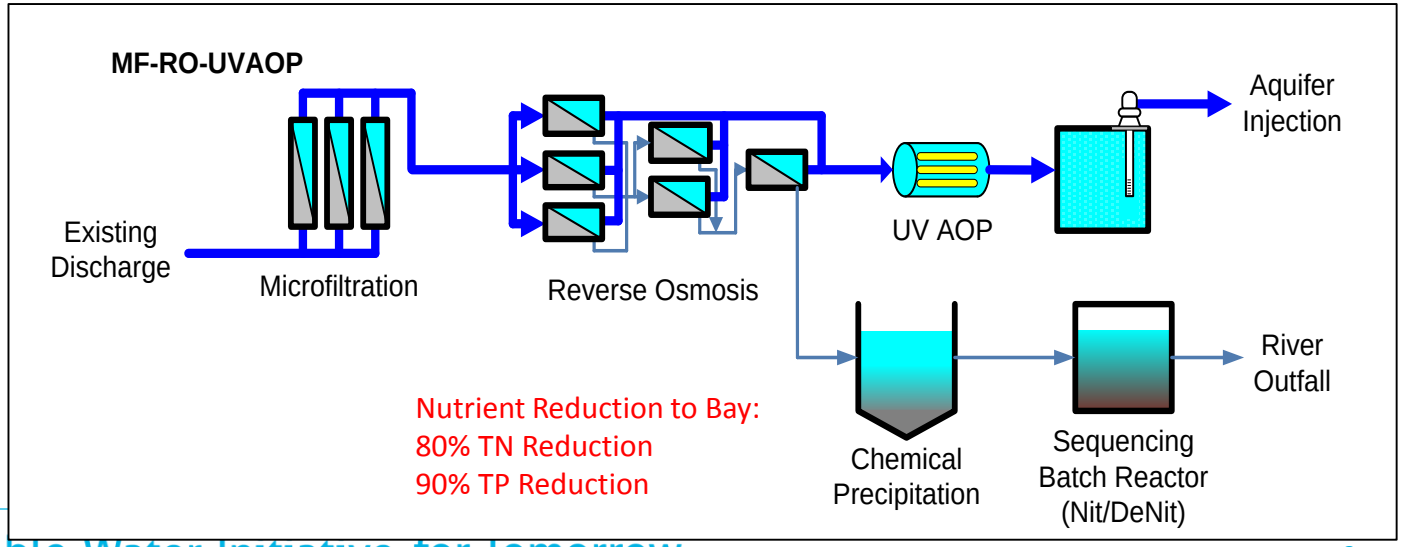
- Consider alternatives to RO-based treatment
- Consider TDS sMCL (500 mg/L) vs aquifer compatibility (>1,000 mg/L)

What advanced water treatment alternatives were considered?

Carbon Based



Membrane Based



Pathogen Reduction Comparison

Parameter	Floc/Sed-Ozone-BAC-GAC-UVD Log Reduction Credits						
	Coag/Sed (+BAC)	Ozone	BAC+GAC	UV	Cl_2	SAT	**Total**
Enteric Viruses	2	0-3	0	1-4	0-4	6	**9-19**
Cryptosporidium	4	0	0	4-6	0	6	**14-16**
Giardia	2.5	0-1.5	0	4-6	0	6	**12.5-16**

Parameter	MF-RO-UVAOP Log Reduction Credits					
	MF	RO	UVAOP	Cl_2	SAT	**Total**
Enteric Viruses	0	2	6	4	6	**18**
Cryptosporidium	4	2	6	0	6	**18**
Giardia	4	2	6	0	6	**18**

Cost Comparison

- Class IV-V cost estimate for non-specific 20 MGD AWT facility

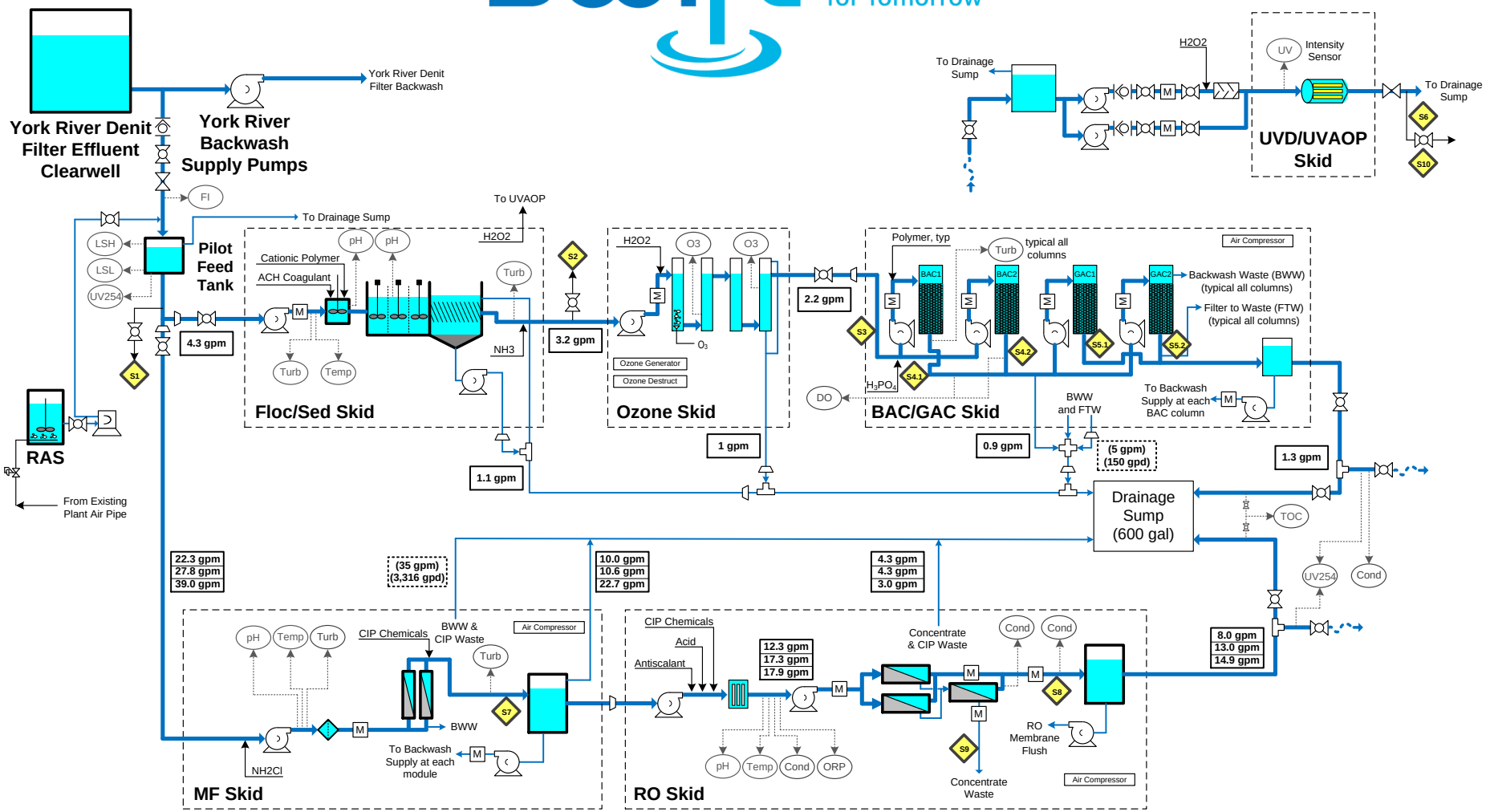
Treatment Train	Total Capital Cost	Total Annual O&M Cost	Total Net Present Value
RO-Based	$170,000,000	$7,200,000	$281,000,000
GAC-Based	$128,000,000	$3,500,000	$182,000,000

Extensive Pilot Testing Conducted to Select the Appropriate Treatment

HRSD

swift Sustainable Water Initiative for Tomorrow

ch2m



RO-Based Pilot System

Carbon (GAC) Based Pilot System

Coag/Floc/Sed

BAC/GAC

Ozone

UVD

Pilot Water Quality Results

Primary MCLs

YR Pilot Plant Performance and Drinking Water Primary MCLs

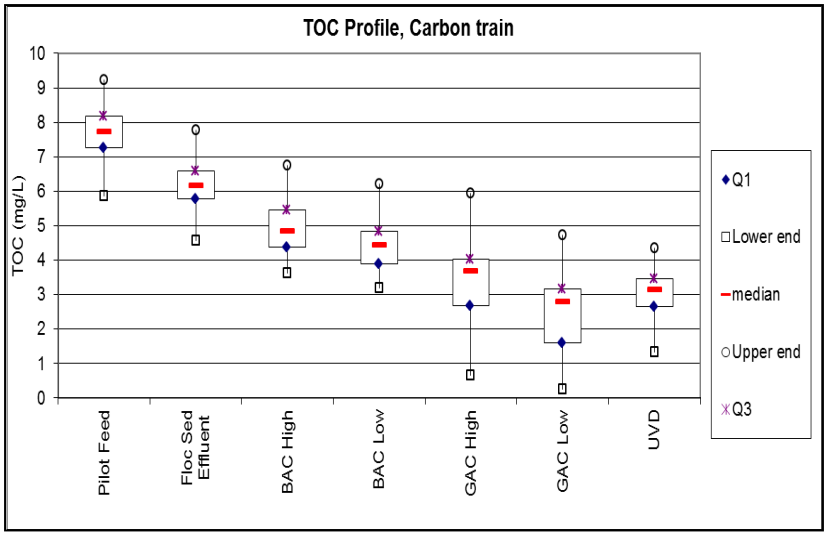
		Carbon Train				Membrane Train			
Parameter	**Primary MCL mg/L**	**Max**	**Min**	**Average**	**Sample Location**	**Max**	**Min**	**Average**	**Sample Location**
Barium	**2**	0.008	0.008	0.008	S6	<0.005	<0.005	<0.005	S10
Chlordane	**0.002**	<0.00002	<0.00002	<0.00002	S6	<0.00002	<0.00002	<0.00002	S10
Endrin	**0.002**	<0.00001	<0.00001	<0.00001	S6	<0.00001	<0.00001	<0.00001	S10
Heptachlor	**0.0004**	<0.00001	<0.00001	<0.00001	S6	<0.00001	<0.00001	<0.00001	S10
Heptachlor Epoxide	**0.0002**	<0.00001	<0.00001	<0.00001	S6	<0.00001	<0.00001	<0.00001	S10
Lindane	**0.05**	<0.00001	<0.00001	<0.00001	S6	<0.00001	<0.00001	<0.00001	S10
Methoxychlor	**0.04**	<0.00001	<0.00001	<0.00001	S6	<0.00001	<0.00001	<0.00001	S10
Toxaphene	**0.003**	<0.00005	<0.00005	<0.00005	S6	<0.00005	<0.00005	<0.00005	S10
PCBs- AR1016	**0.0005**	<0.0001	<0.0001	<0.0001	S6	<0.0001	<0.0001	<0.0001	S10
PCBs- AR1221	**0.0005**	<0.0001	<0.0001	<0.0001	S6	<0.0001	<0.0001	<0.0001	S10
PCBs- AR1232	**0.0005**	<0.0001	<0.0001	<0.0001	S6	<0.0001	<0.0001	<0.0001	S10
PC	**0.000**		-0.0001			<0.0001			S1

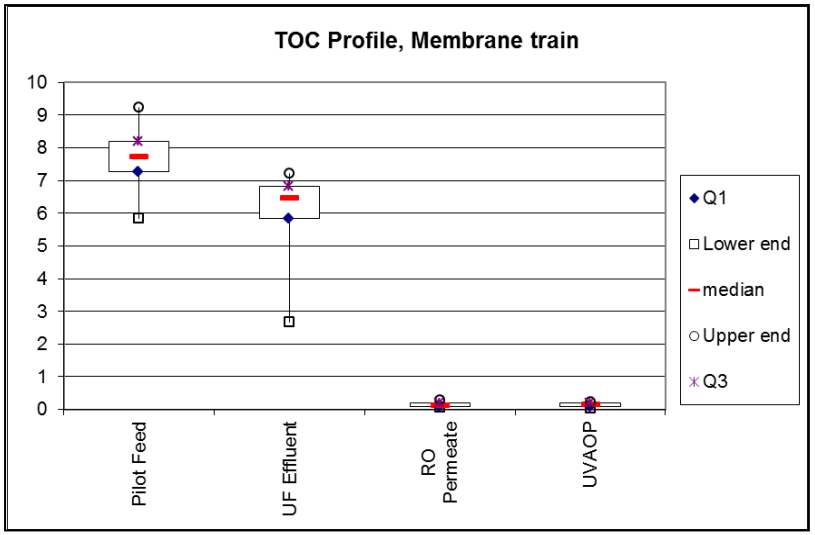
- Vast majority of primary MCL contaminants not detected
- Of those detected, none were even close to MCL limits

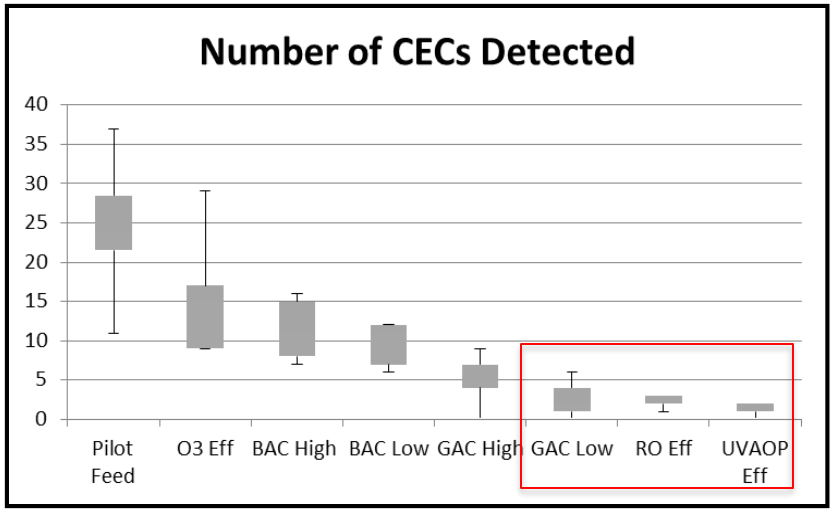
Pilot Performance: Secondary MCLs

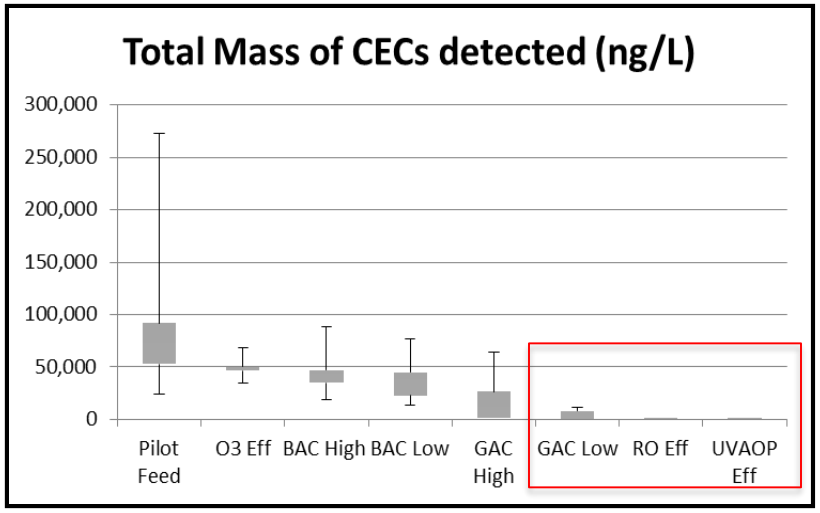
			Pilot Effluent Values			
Parameter	**Unit**	**Value**	**GAC: 50%**	**GAC: 99%**	**RO: 50%**	**RO: 99%**
Aluminum	mg/L	0.05	<0.04	<0.04	<0.04	<0.04
Chloride	mg/L	250	171	221	<4	<4
Color	color units	12	2	5	1	2
Copper	mg/L	1	<0.5	<0.5	<0.5	<0.5
Corrosivity		Non-corrosive	N/A	N/A	N/A	N/A
Fluoride	mg/L	2	0.6	0.7	<0.1	<0.1
Foaming agents	mg/L	0.5	N/A	N/A	N/A	N/A
Iron	mg/L	0.3	<0.02	0.05	<0.02	<0.02
Manganese	mg/L	0.05	<0.01	0.01	<0.01	<0.01
Odor	TON	3	N/A	N/A	N/A	N/A
pH	pH unit	6.5 - 8.5	7.5 - 7.7	7.5 - 7.7	7.5 - 7.7	7.5 - 7.7
Silver	mg/L	0.1	<0.005	<0.005	<0.005	<0.005
Sulfate	mg/L	250	95	107	<1.0	1.6
TDS	mg/L	500	541	635	12	29
Zinc	mg/L	5	<0.03	<0.03	<0.03	<0.03

Summary of Organics Testing Results









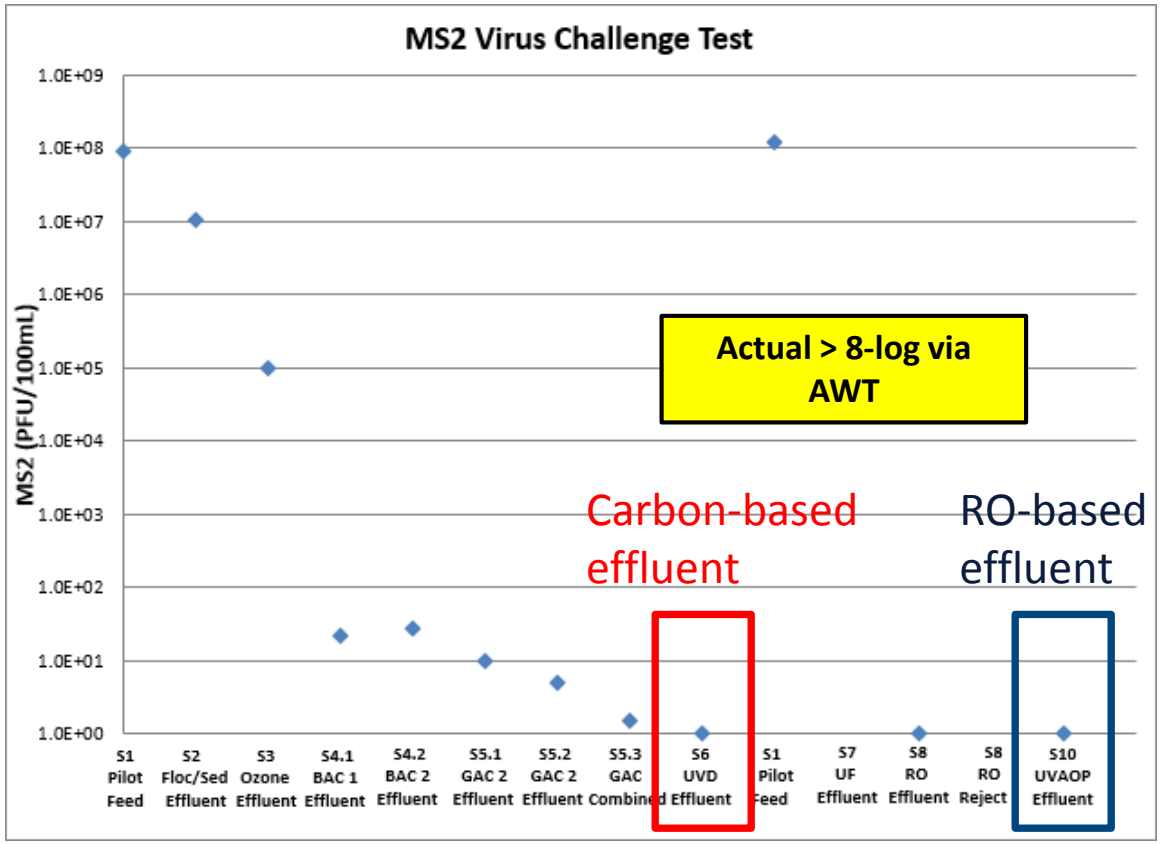
Contaminants of Emerging Concern (CECs)

- Treatment case study for sampling done on 8/31/16
- Multi-barrier approach is shown by decrease in concentration through the treatment process
- All values shown in ng/L

Contaminant	Pilot Feed	Ozone Eff	BAC1 Eff	BAC2 Eff	GAC1 Eff	GAC2 Eff		RO Eff	UVAOP Eff
Iohexal	7500	4000	1500	1400	15	<10		31	<10
Sucralose	43000	28000	17000	12000	<100	<100		140	130
TCPP	980	720	260	110	<100	<100		<100	<100
Primidone	130	46	28	21	<5	<5		<5	<5

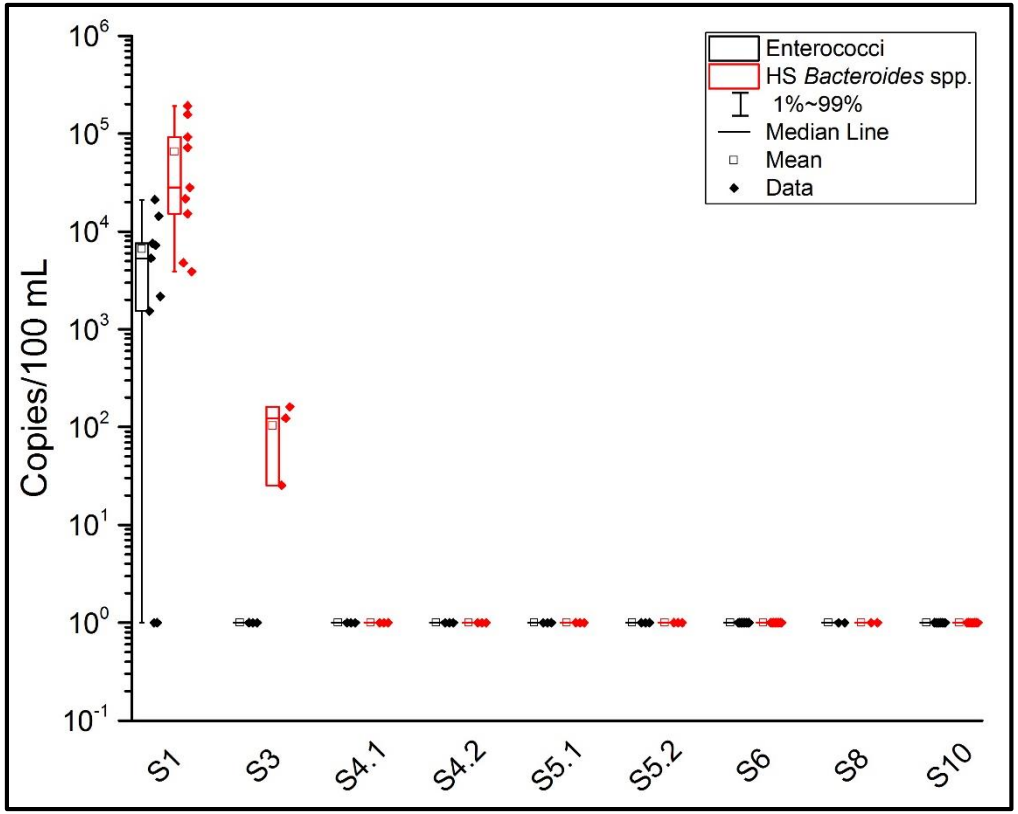
Pathogen results (viruses)

- **RO-based train (calc'd):**
  - 8-log via AWT
  - 6-log via SAT
  - Total =14-log
- **Carbon-based train (calc'd):**
  - 6 to 10-log via AWT
  - 6-log via SAT
  - Total > 12-log



Summary of Pathogen Results (bacteria)

Date	S6 (UVD)		S10 (UVAOP)	
	Total Coliform	E. Coli	Total Coliform	E. Coli
	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL
7/20/2016	31	<1	No sample	No sample
7/27/2016	No sample	No sample	<1	<1
8/3/2016	5	5	<1	<1
8/10/2016	No sample	No sample	<1	<1
8/17/2016	1	<1	<1	<1
8/19/2016	<1	No sample	<1	<1
8/22/2016	<1	No sample	<1	<1
8/24/2016	<1	<1	<1	<1
8/26/2016	<1	<1	<1	<1
8/29/2016	<1	<1	<1	<1
8/31/2016	<1	<1	No sample	No sample
9/2/2016	1	<1	1	<1
9/9/2016	<1	<1	<1	<1
9/12/2016	770	4	15	<1
9/14/2016	<1	<1	<1	<1
9/16/2016	<1	<1	<1	<1
9/19/2016	<1	<1	<1	<1
9/21/2016	<1	<1	<1	<1
9/23/2016	<1	<1	<1	<1
9/26/2016	<1	<1	No sample	No sample
9/28/2016	<1	<1	<1	<1
9/30/2016	<1	<1	<1	<1
10/3/2016	<1	<1	<1	<1
10/5/2016	<1	<1	<1	<1
10/7/2016	<1	<1	<1	<1
10/12/2016	<1	<1	<1	<1
10/14/2016	<1	<1	<1	<1
10/17/2016	<1	<1	<1	<1
10/19/2016	<1	<1	<1	<1
10/21/2016	<1	<1	<1	<1

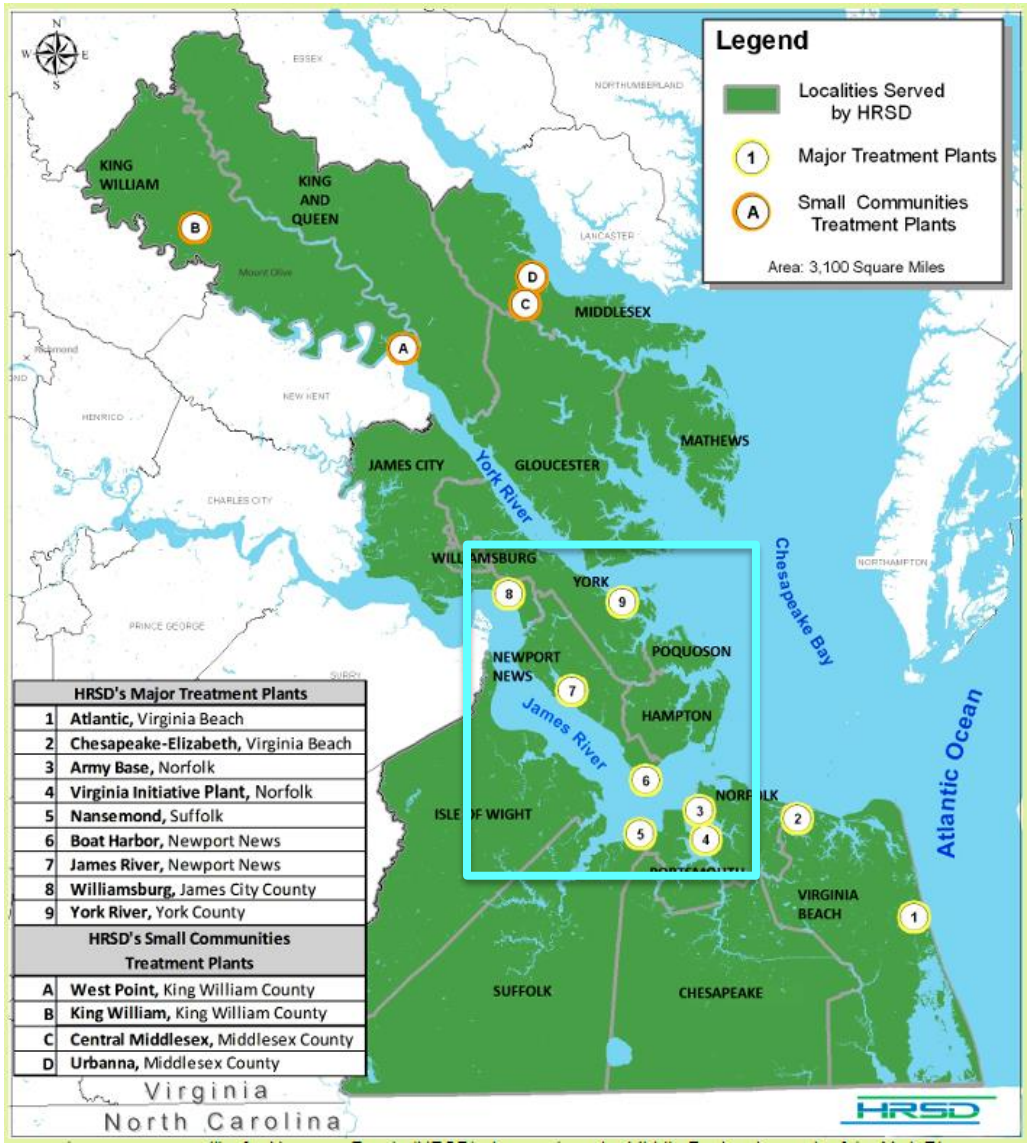


Summary of Pilot Testing Results: Carbon vs. Membranes

- Both carbon-based and membrane-based trains meet all primary drinking water quality standards
- Carbon-based approach is equally protective of public health compared to membrane-based approach
- Carbon-based approach better geochemical compatibility with less chemical conditioning required
- Carbon-based approach selected for implementation

Where is SWIFT going?

- On-going Pilot Testing (2016 – 2018)
- 1 MGD Research Center (April 2018)



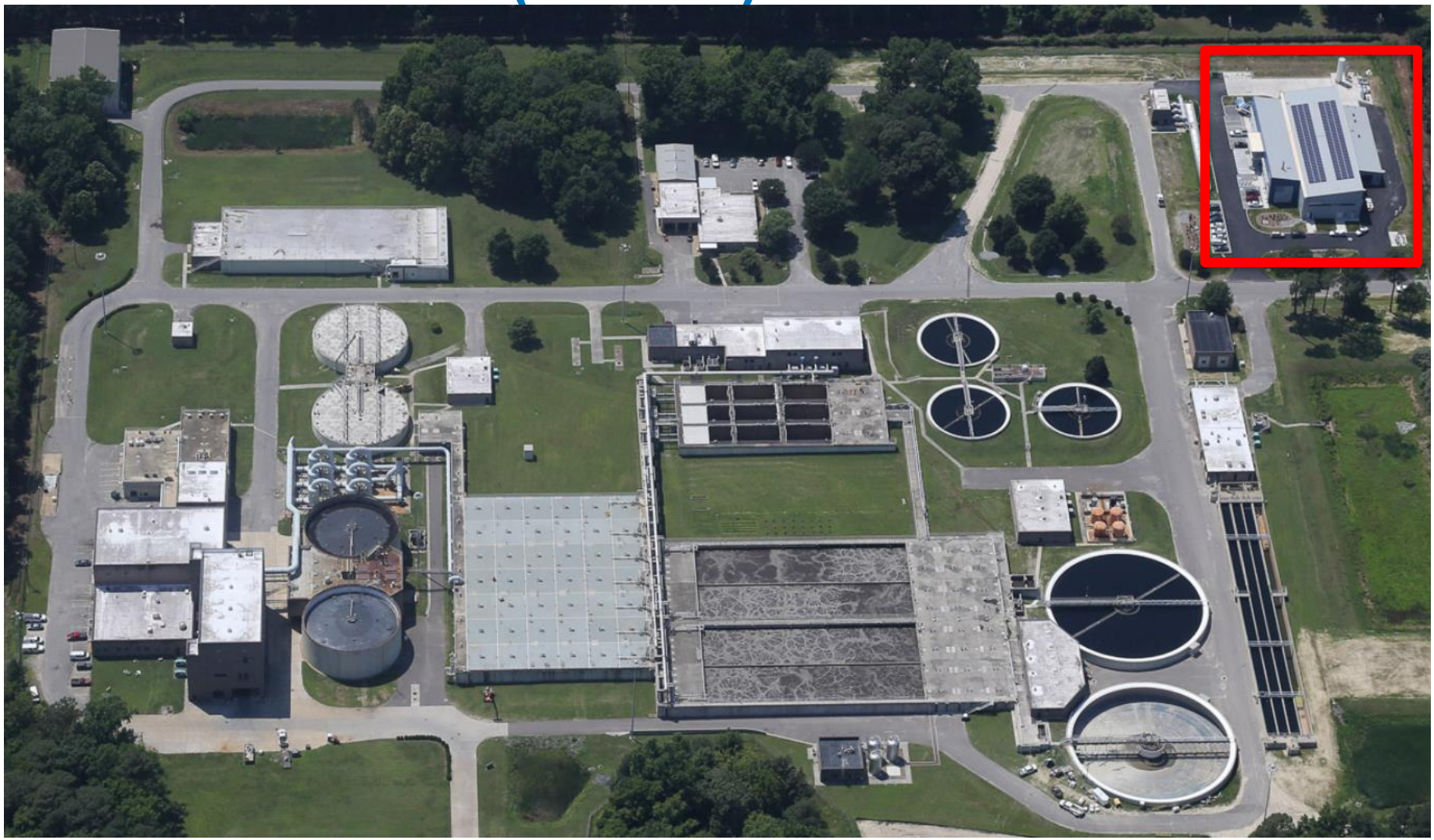
HRSD's Major Treatment Plants	
1	**Atlantic,** Virginia Beach
2	**Chesapeake-Elizabeth,** Virginia Beach
3	**Army Base,** Norfolk
4	**Virginia Initiative Plant,** Norfolk
5	**Nansemond,** Suffolk
6	**Boat Harbor,** Newport News
7	**James River,** Newport News
8	**Williamsburg,** James City County
9	**York River,** York County
HRSD's Small Communities Treatment Plants	
A	**West Point,** King William County
B	**King William,** King William County
C	**Central Middlesex,** Middlesex County
D	**Urbanna,** Middlesex County

SWIFT Research Center

(1.0 MGD AWT + recharge well + monitoring wells + public outreach and education center + research facilities)

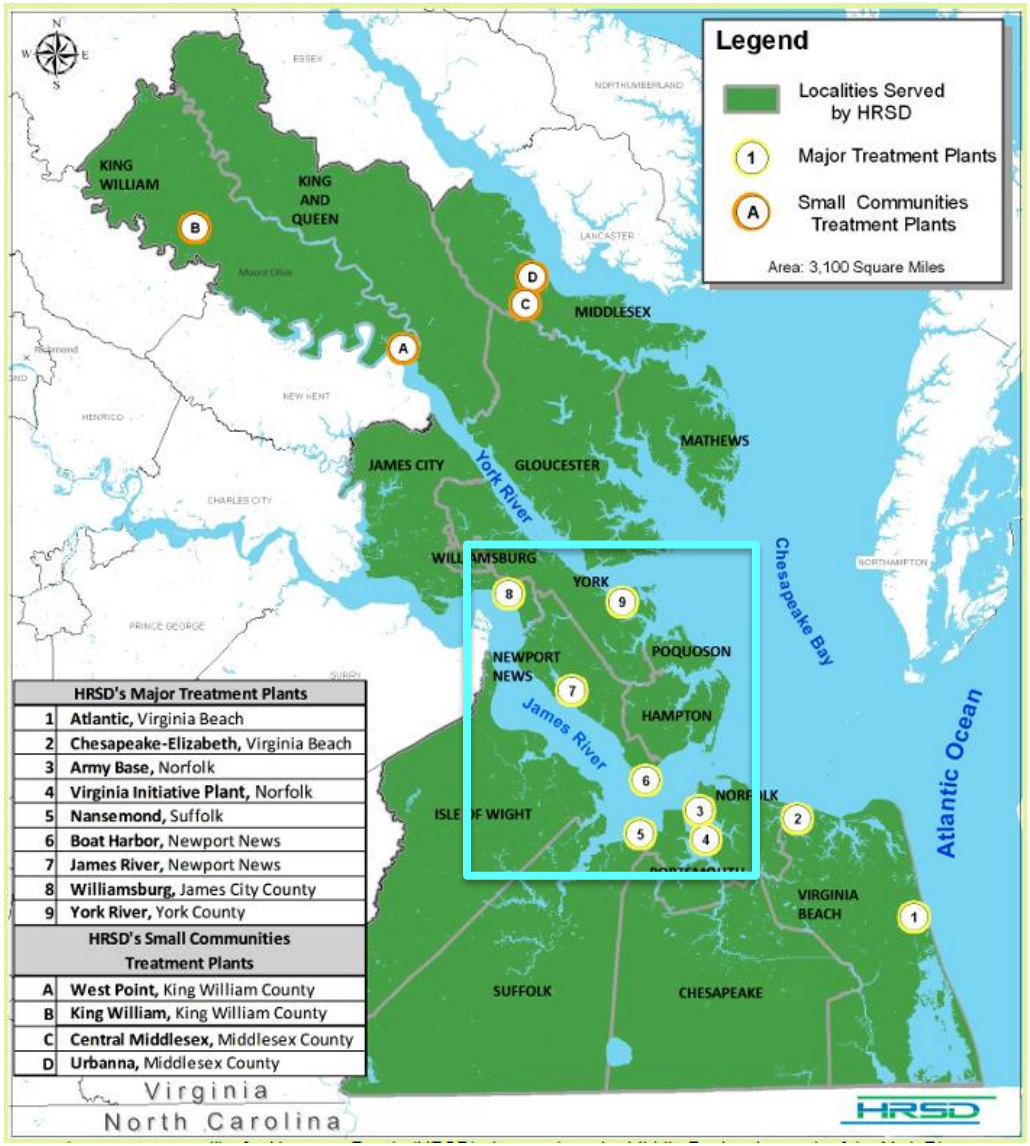
**Design/Construction by Crowder/Hazen*

1 mgd SWIFT Research Center at HRSD Nansemond Treatment Plant (30 MGD)



Where is SWIFT going?

- On-going Pilot Testing (2016 – 2018)
- 1 MGD Research Center (April 2018)
- Advanced treatment to be provided for 7 major WWTPs (>100 MGD)
- Full implementation planned by 2030



Thank you

Questions?

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