CWEA / CSAWWA Water Reuse Seminar

Nov. 10, 2016

HRSD

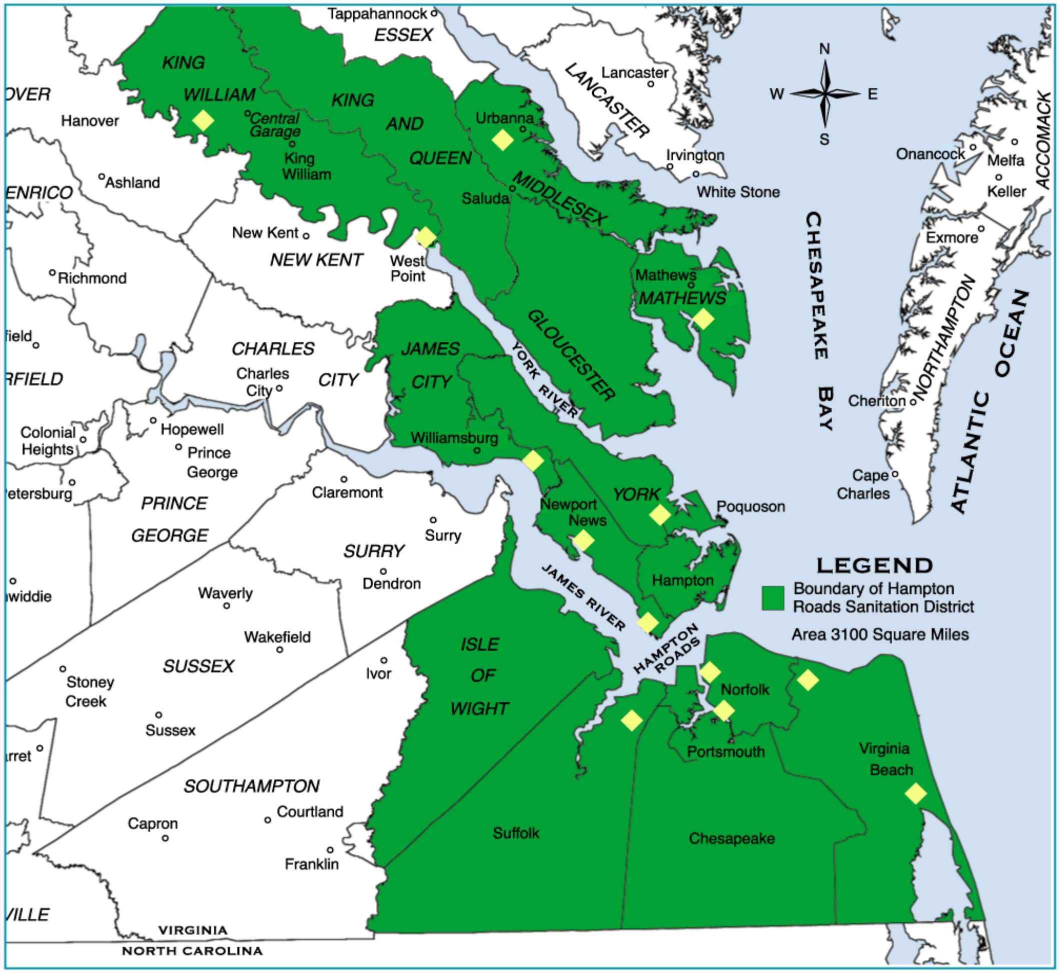
Purple Pipes to Aquifer Recharge:

A look at reuse successes, reuse failures, and the future of water recycling at HRSD

HRSD

HRSD Service Area

HRSD Service Area Map



◆ = treatment plant locations

HRSD Potential Reuse Water

Treatment Plant	Location	Design Capacity MGD
Army Base	Norfolk	18
Atlantic	Virginia Beach	54
Boat Harbor	Newport News	25
Ches-Eliz	Virginia Beach	24
James River	Newport News	20
Nansemond	Suffolk	30
VIP	Norfolk	40
Williamsburg	Williamsburg	22.5
York River	York County	15
	Total Capacity	**248.5**
	Treated -Available	**150**

Reuse Project Success:
York River Plant Reclamation

THE REALITY:

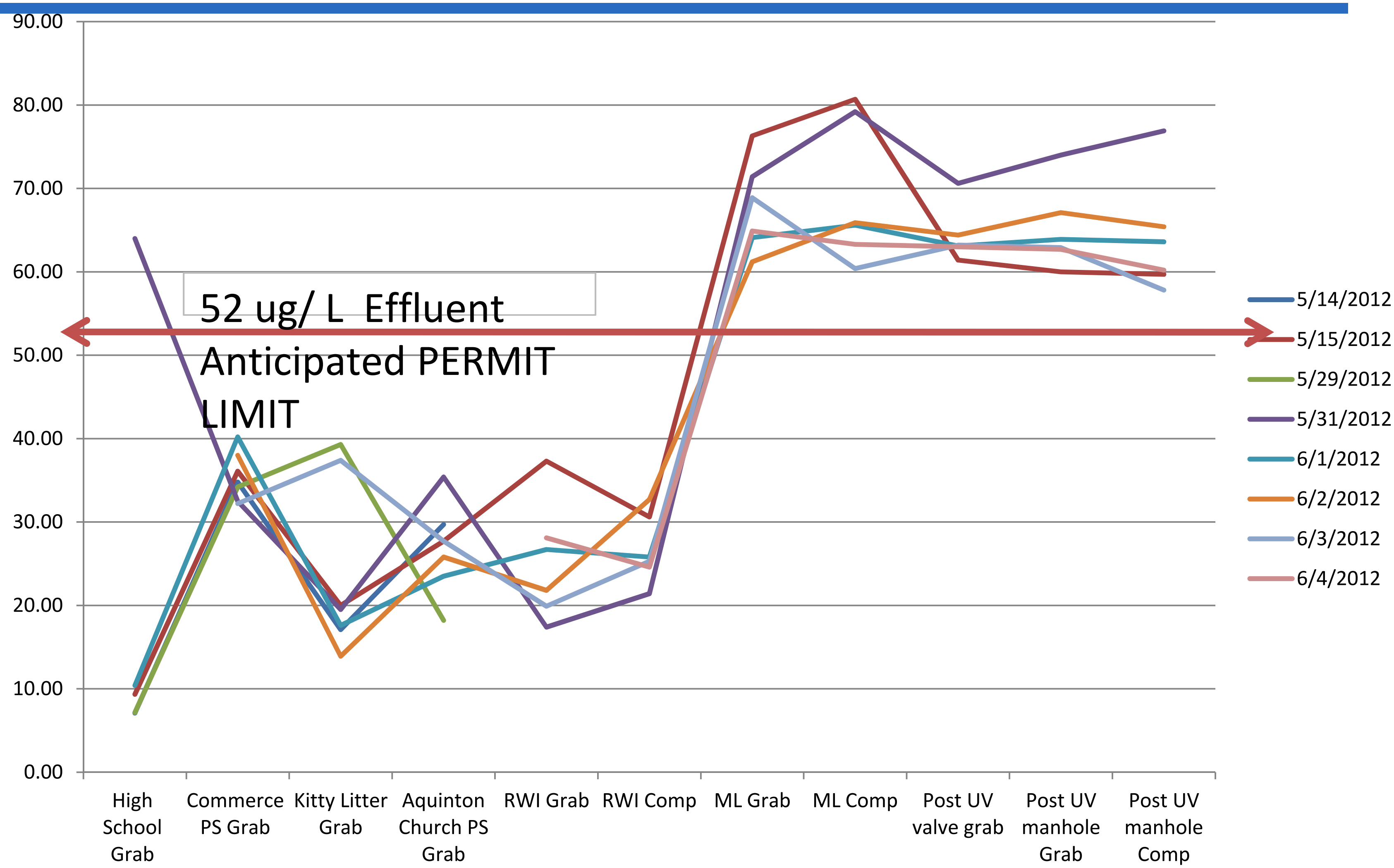
- Total project cost: ~$2.9 million
- **Proposed User Charge: $1.50 per 1,000 gallons**
- Potable Water Rate in 2002: ~$ 4 per 1,000 gallons
- R/O w/ O&M: ~$2 per 1,000 gallons

Jefferson Lab: Compare the Rate to City Water

$ 5 /1000 gallons = City of Newport News

Table 2 Scenario 1 & 2- MBR with RO Capital Cost, O&M Cost and Preliminary Rate	
Capital Cost NPV[1]	$7,878,000
Capital Cost $/1000 gallons	$5.40
O&M Cost (20 years) NPV[2]	$8,809,000
O&M Cost $/1000 gallons	$6.03
Total Cost NPV $/1000 gallons	$11.43
Preliminary Rate $/1000 gallons[3]	$16.86
Comments: [1]Capital cost net present value (NPV) includes 30 percent contingency; does not include land acquisition; administrative fees, design and legal [2] O&M annual costs estimated as $425,000 annually [3] Preliminary rate includes 5 percent interest; 2 percent bond issuance cost	

Soluble Zinc ug/L (King William Treatment Plant)



Nestle Purina Petcare needs 80,000 gallons / day.
HRSD can convey the entire flow from the local MBR plant 35,000 gallons per day.

HRSD

King William

– **PROs**

- Lower O&M - This is Traditional Reuse and is mutually beneficial to HRSD (zinc issue)
- Reduces groundwater withdrawal (critical permit issue for Nestle Purina)

-CONs

- Costs (Capital shared between HRSD/Nestle)
  – No charge for the water
- Requires reliance on single manufacturer to accept all effluent
- Some storage requirements and operational challenges
- Nestle Purina only operates 6 days/week- surface water outfall still utilized

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Cleaning wastewater every day for a better Bay.

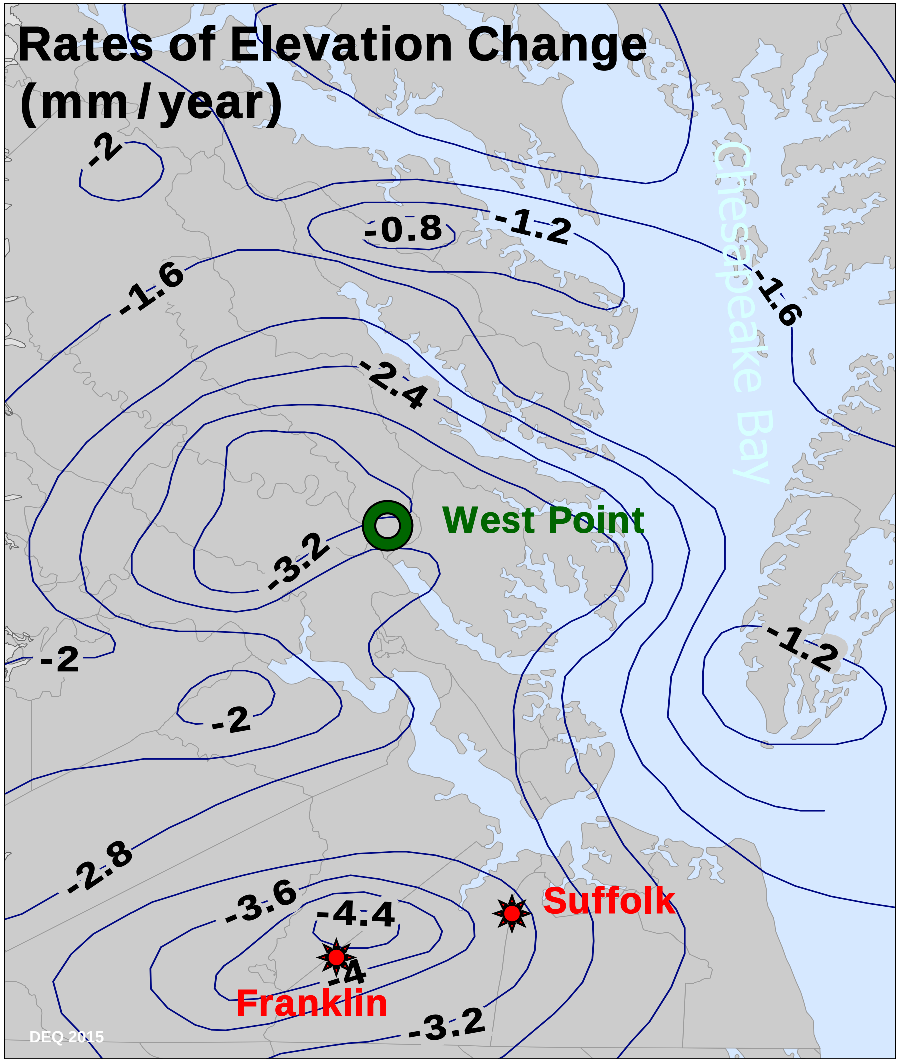
The Future of Water Recycling at HRSD

Drivers for water recycling

- Stricter wastewater regulations
- Land subsidence
- Groundwater depletion
- Saltwater contamination of the groundwater

Land subsidence – *we are sinking*

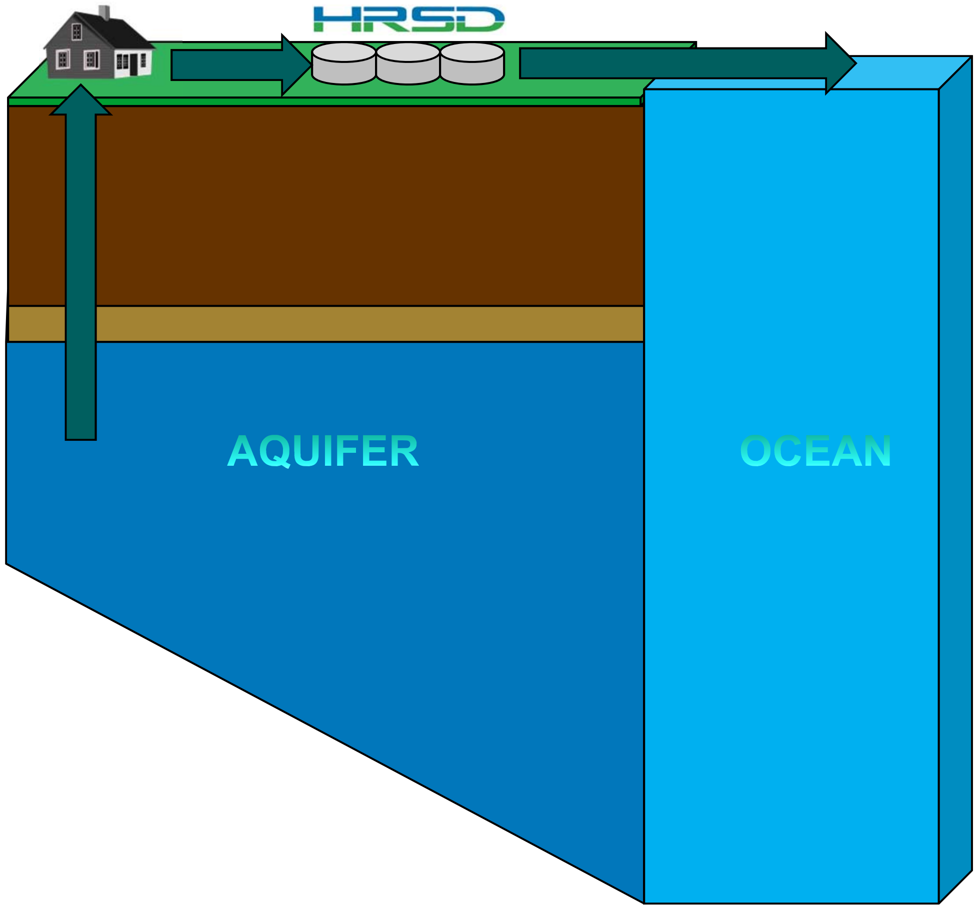
- From the USGS, Circular 1392
  - 50% of observed sea-level rise is due to land subsidence
  - Aquifer-system compaction accounts for more than half of the land subsidence
- Two potential solutions
  - Reduced withdrawal
  - Aquifer recharge



Groundwater depletion

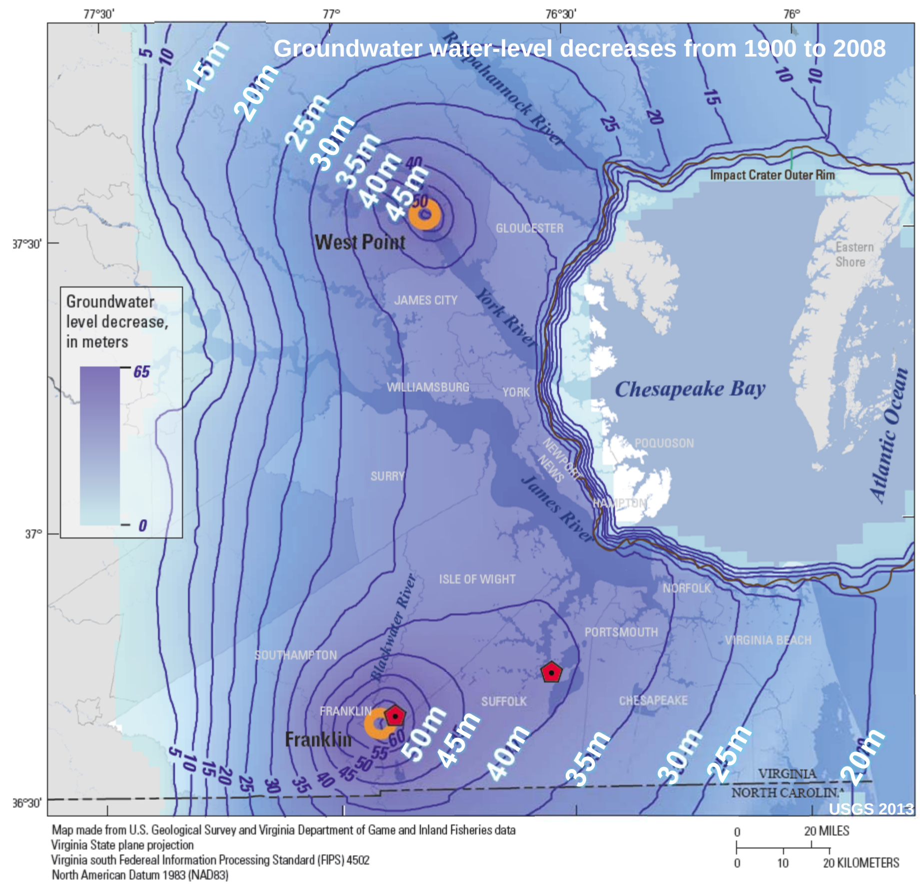
Currently mining the aquifer

- Natural aquifer recharge is not keeping up with withdrawals
- Water is cleaned and discharged to local waterways, ultimately to the ocean with no downstream use – "one and done"



Groundwater depletion

- Top DEQ priority
- 177 permits = 147.3 MGD
  - Currently withdrawing approximately 115 mgd
- 200,000 unpermitted “domestic” wells
  - Estimated to be withdrawing approx. 40 mgd
- Economic development implications and stranded capital



EXPLANATION

20 — Line of equal groundwater water level decline (predevelopment to 2008)—Shows change in elevation. Contour interval is 5 meters

Groundwater withdrawal center

U.S. Geological Survey extensometer station

Saltwater contamination of groundwater

- Lateral Intrusion of seawater

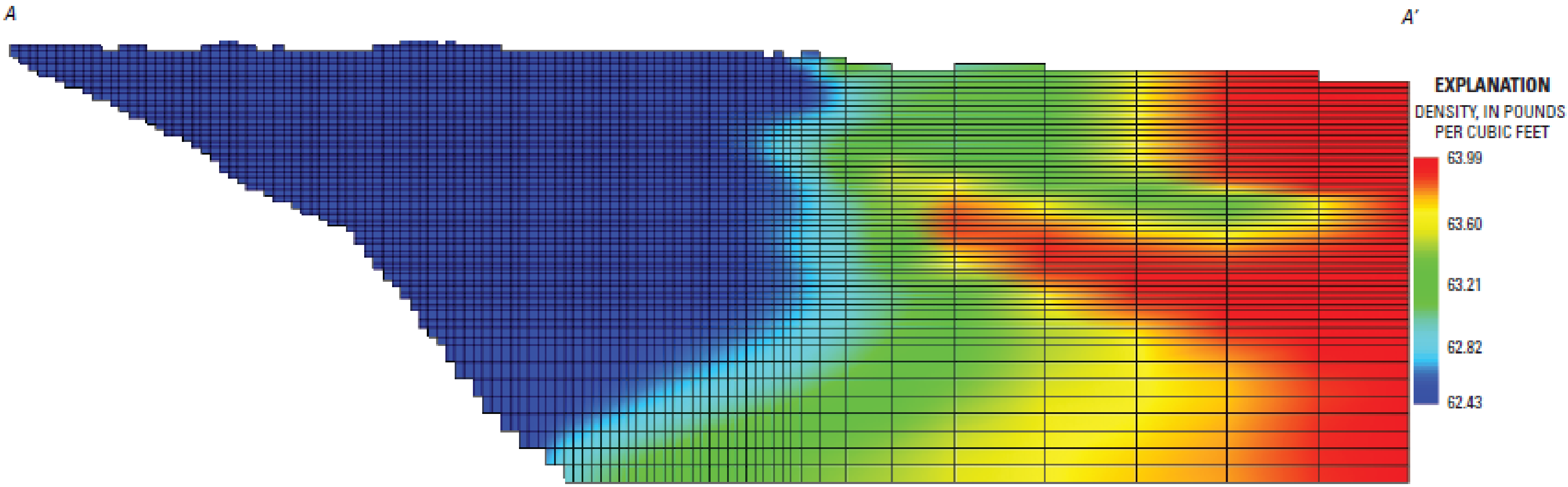


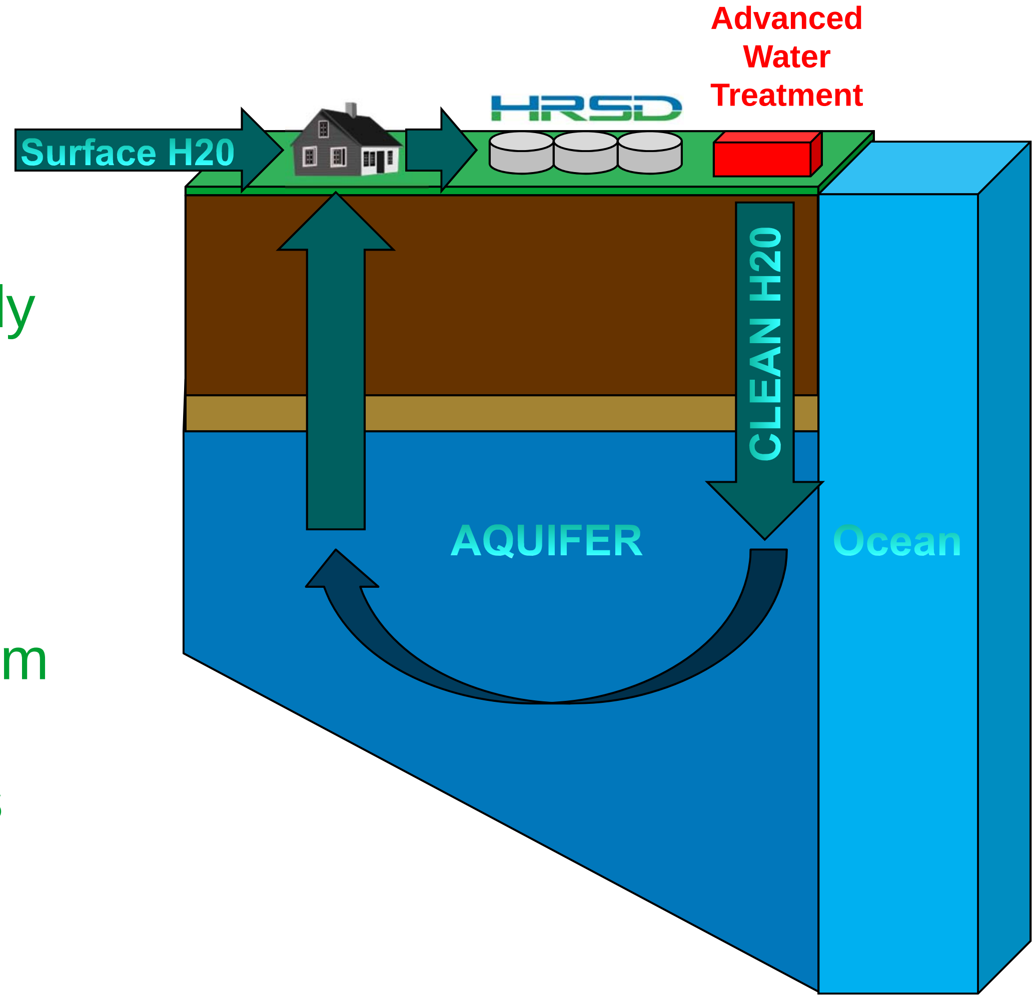
Figure A3. Simulated water density near the saltwater transition zone of the Virginia Coastal Plain. (Location of cross section shown in figure A2.)

Study purpose

- Can HRSD address any or all of these critical issues with a sustainable approach to water recycling?

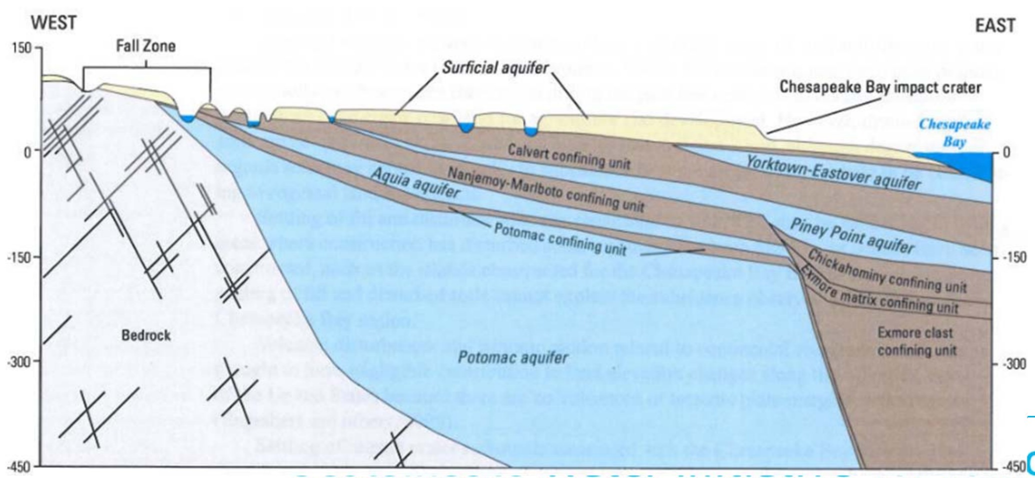
Sustainable water recycling

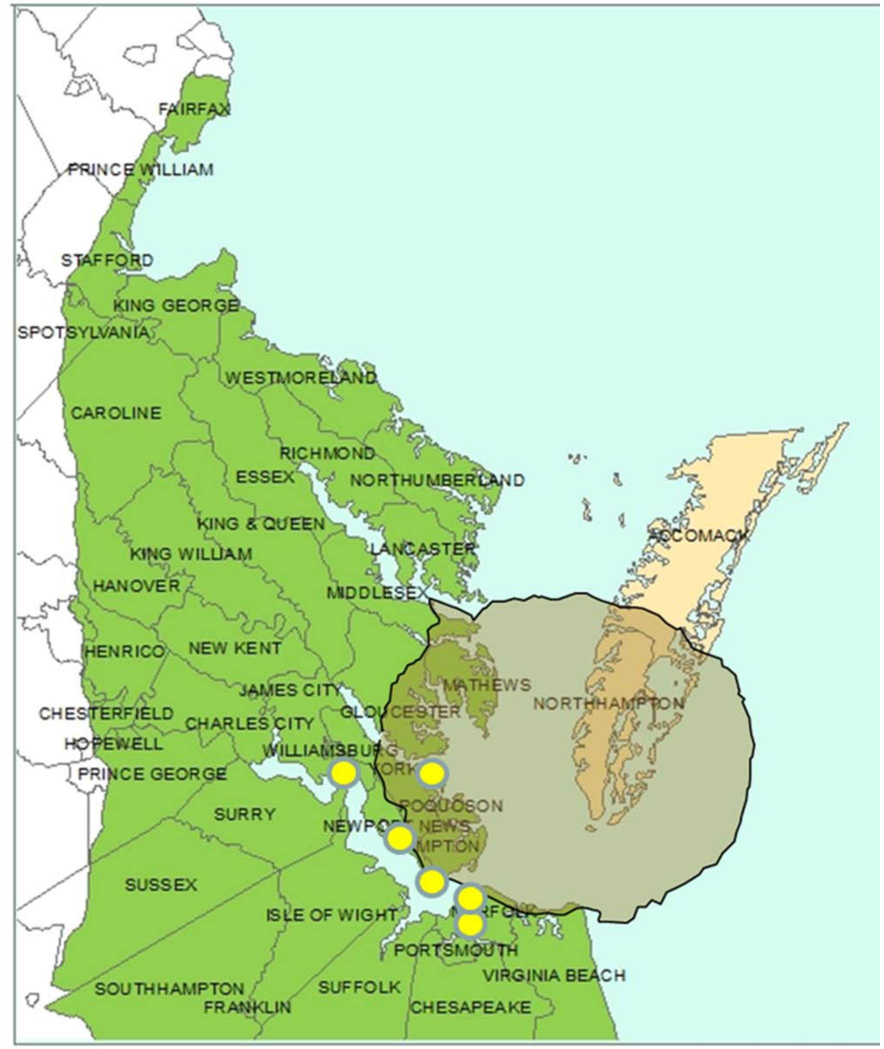
- HRSD's concept - Inject clean water into the aquifer to:
  - Provide a sustainable supply of groundwater throughout Eastern Virginia
  - Reduce the rate of land subsidence
  - Protect the groundwater from saltwater contamination
  - Reduce nutrient discharges to the Bay



Hydrogeologic setting

- VA Coastal Plain aquifer system
- Vast majority of the withdrawal from Potomac Aquifer
- Chesapeake Bay Impact Crater

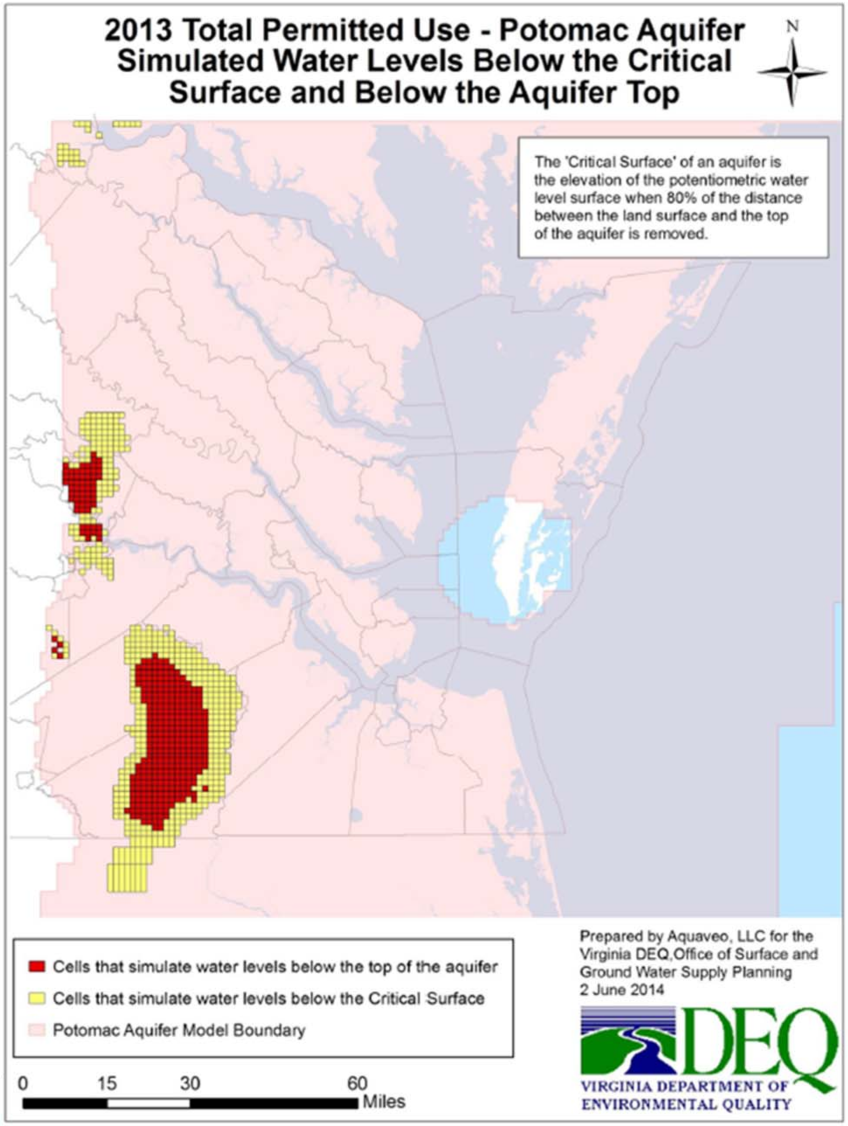




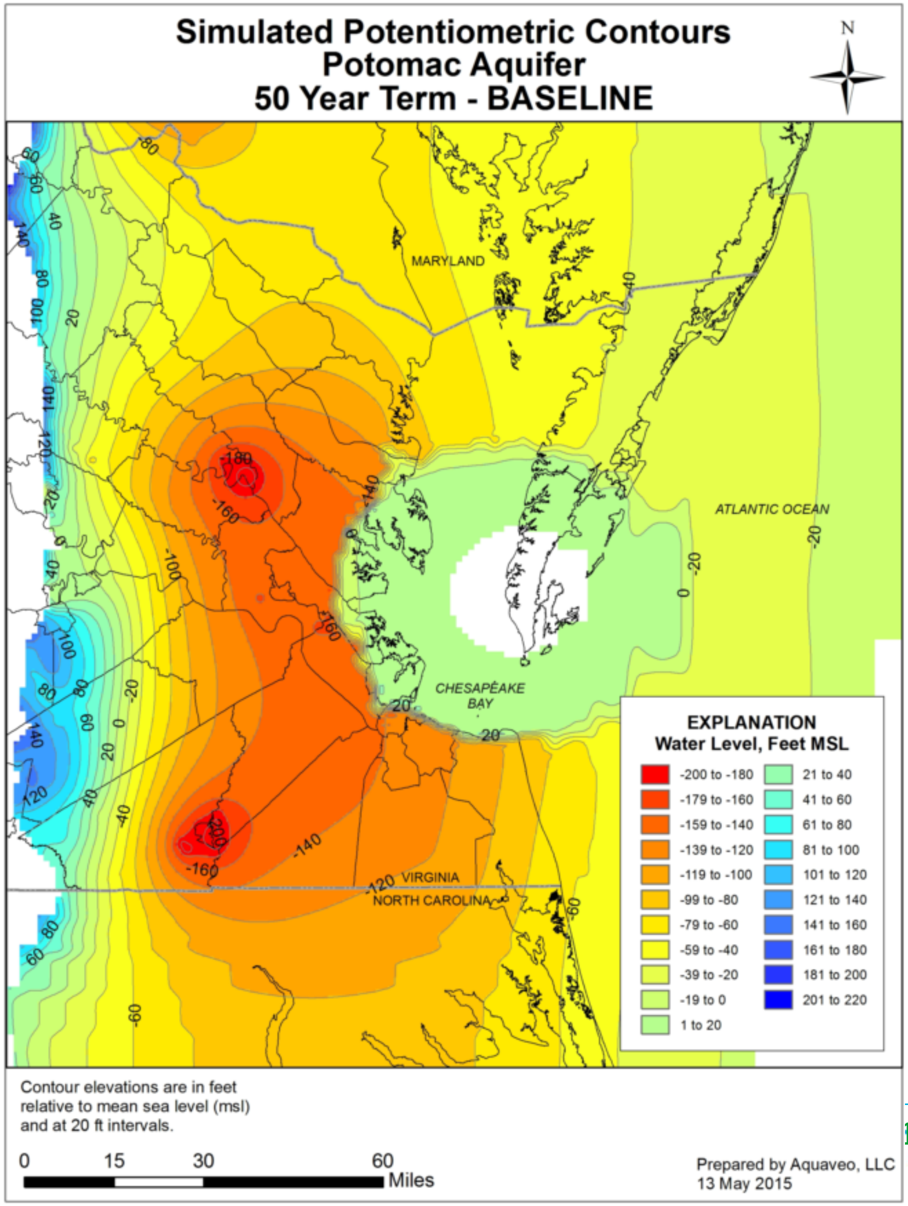
Effective: January 1, 2014
Prepared By: Virginia Department of Environmental Quality
Groundwater Withdrawal Permitting Program

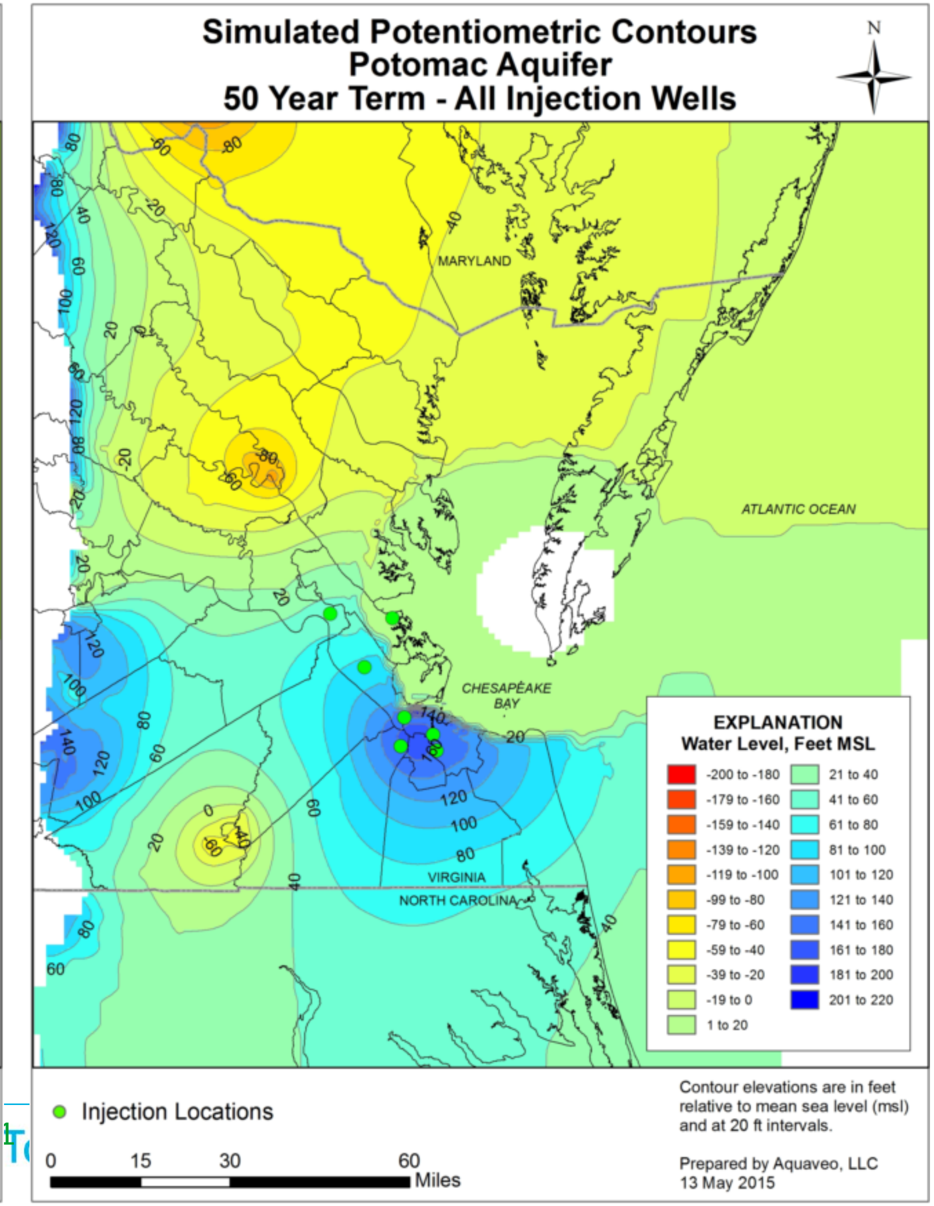
Hydraulic issues

- Over-allocated withdrawal
  - Water levels falling several feet/yr
- Model simulations predict the total permitted withdrawals are unsustainable



Potomac Aquifer water levels before and after injection





Groundwater modeling results summary

- Injecting clean water eliminates Critical Cells
- Injection benefits the entire Eastern Virginia Groundwater Management Area
- Dispersed location of plants is beneficial for injection – required pressures are reasonable
- Confirmed “wireless” water distribution concept – entire aquifer benefits
- York River injection well site will need to be outside of the crater limits

Geochemistry

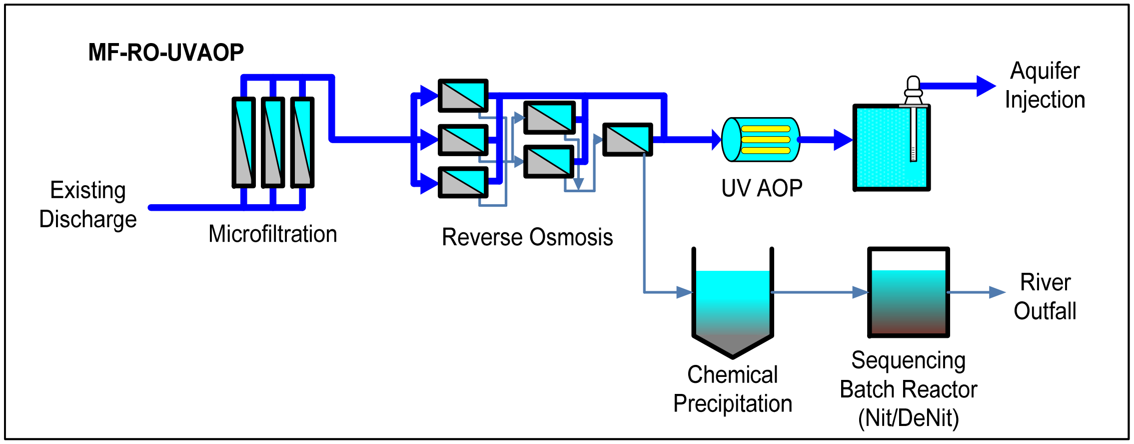
- Injectate must be compatible with the native groundwater and the aquifer material.
  - Operational issues
  - Regulatory issues
- Physical plugging
  - Disrupting clay particles
  - Precipitating minerals
  - Can clog the screen, filterpack and aquifer immediately around the well
- Dissolution/mobilization of metals

Geochemical compatibility

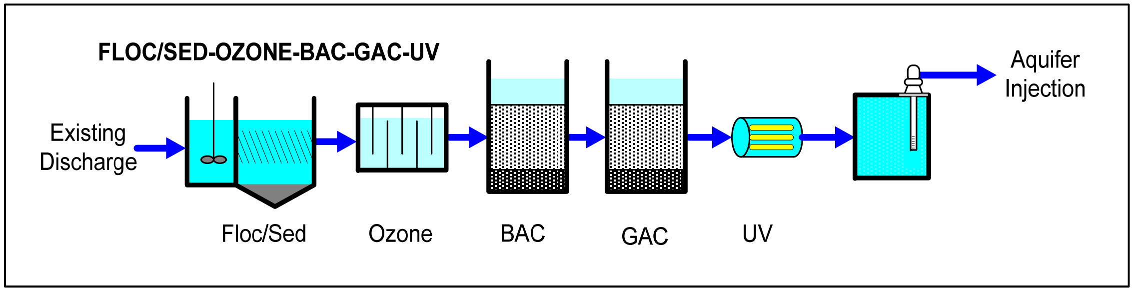
- Treatment processes produce water with varying aquifer and groundwater compatibility
- **GAC/BAC**– generally more compatible
- **RO** – requires adding salt and alkalinity to be compatible

Advanced water treatment alternatives

Reverse Osmosis (RO)

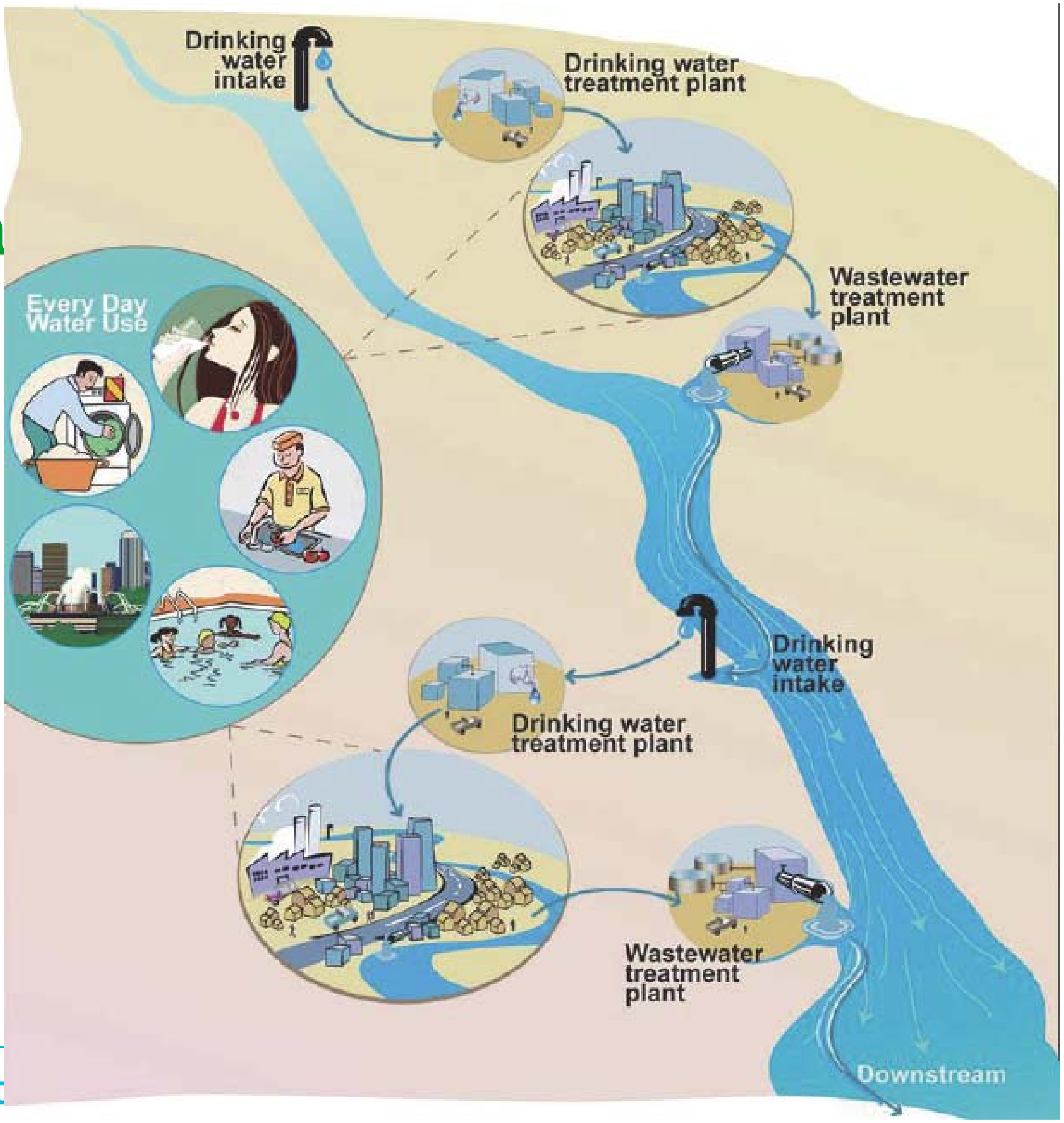


Biologically-Active Granular Activated Carbon (BAC)/ Granular Activated Carbon (GAC)



De Facto water recycling

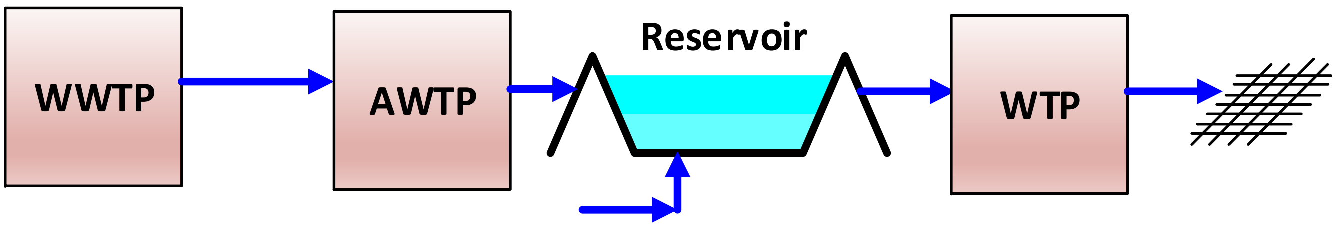
- **Common throughout the world and in Virginia**
  - –**James River**
  - –**Shenandoah**
  - –**Potomac**
  - –**Roanoke River Basin (Lake Gaston)**



Operational water recycling projects

Project	Location	Type of Potable Reuse	Year	Capacity	Current Advanced Treatment Process
Montebello Forebay, CA	Coastal	GW recharge via spreading basins	1962	44 mgd	GMF + Cl_2 + SAT (spreading basins)
Windhoek, Namibia	Inland	Direct potable reuse	1968	5.5 mgd	O_3 + Coag + DAF + GMF + O_3/H_2O_2 + BAC + GAC + UF + Cl_2 (process as of 2002)
UOSA, VA	Inland	Surface water augmentation	1978	54 mgd	Lime + GMF + GAC + Cl_2
Hueco Bolson, El Paso, TX	Inland	GW recharge via direct injection and spreading basins	1985	10 mgd	Lime + GMF + Ozone + GAC + Cl_2
Clayton County, GA	Inland	Surface water augmentation	1985	18 mgd	Cl_2 + UV disinfection + SAT (wetlands)
West Basin, El Segundo, CA	Coastal	GW recharge via direct injection	1993	12.5 mgd	MF + RO + UVAOP
Scottsdale, AZ	Inland	GW recharge via direct injection	1999	20 mgd	MF + RO + Cl_2
Gwinnett County, GA	Inland	Surface water augmentation	2000	60 mgd	Coag/floc/sed + UF + Ozone + GAC + Ozone
NEWater, Singapore	Coastal	Surface water augmentation	2000	146 mgd (5 plants)	MF + RO + UV disinfection
Los Alamitos, CA	Coastal	GW recharge via direct injection	2006	3.0 mgd	MF + RO + UV disinfection
Chino GW Recharge, CA	Inland	GW recharge via spreading basins	2007	18 mgd	GMF + Cl_2 + SAT (spreading basins)
GWRS, Orange County, CA	Coastal	GW recharge via direct injection and spreading basins	2008	70 mgd	MF + RO + UVAOP + SAT (spreading basins for a portion of the flow)
Queensland, Australia	Coastal	Surface water augmentation	2009	66 mgd via three plants	MF + RO + UVAOP
Arapahoe County, CO	Inland	GW recharge via spreading	2009	9 mgd	SAT (via RBF) + RO + UVAOP
Loudoun County, VA	Inland	Surface water augmentation	2009	11 mgd	MBR + GAC + UV
Big Spring (Wichita Falls), TX	Inland	Direct potable reuse through raw water blending	2013	1.8 mgd	MF + RO + UVAOP

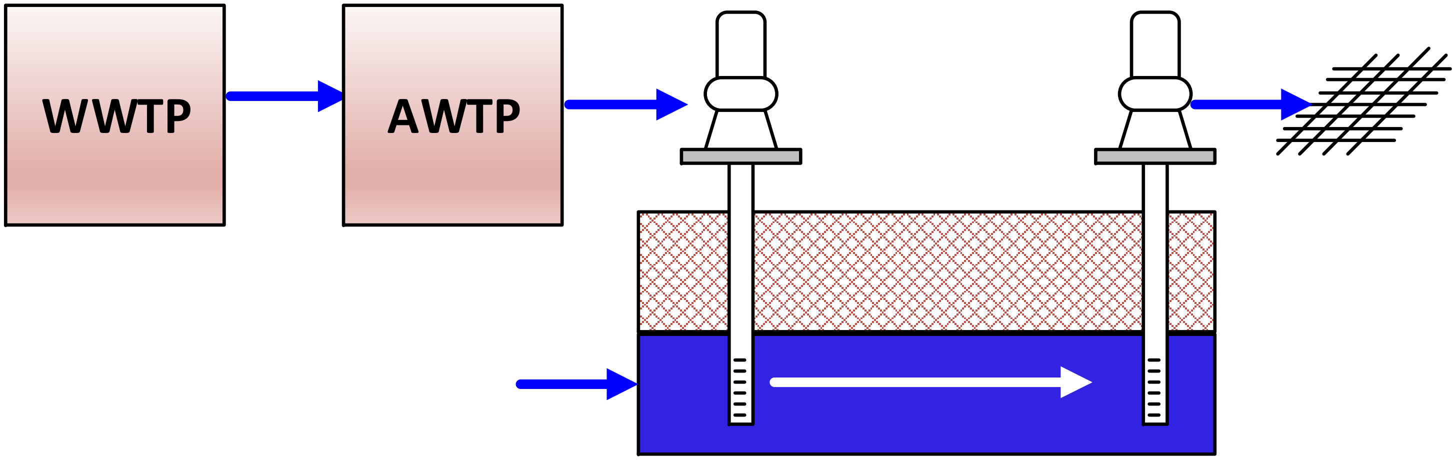
Water recycling - Surface water augmentation



- Examples:
  - x Upper Occoquan Service Authority
    Leader in Water Reclamation and Reuse
    - (Northern Virginia)
  - Gwinnett County (Georgia)
  - Singapore NEWater

Water recycling - Groundwater recharge via direct injection

This is a form of Indirect Potable Reuse



- Examples:
  - Groundwater Replenishment System (Orange County, CA)
  - West Basin (El Segundo, CA)
  - Los Alamitos (Long Beach, CA)
  - Scottsdale Water Campus (AZ)
  - Hueco Bolson (El Paso, TX)

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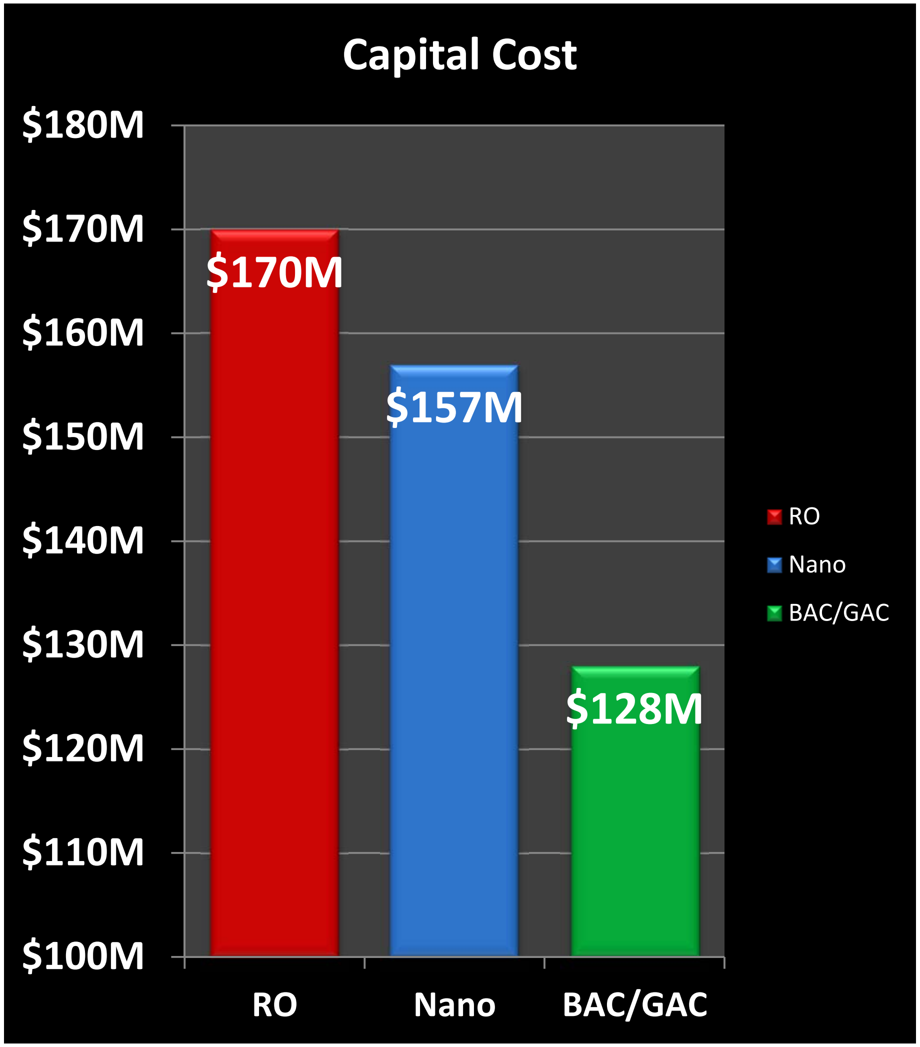
Recycled water quality - Functional targets

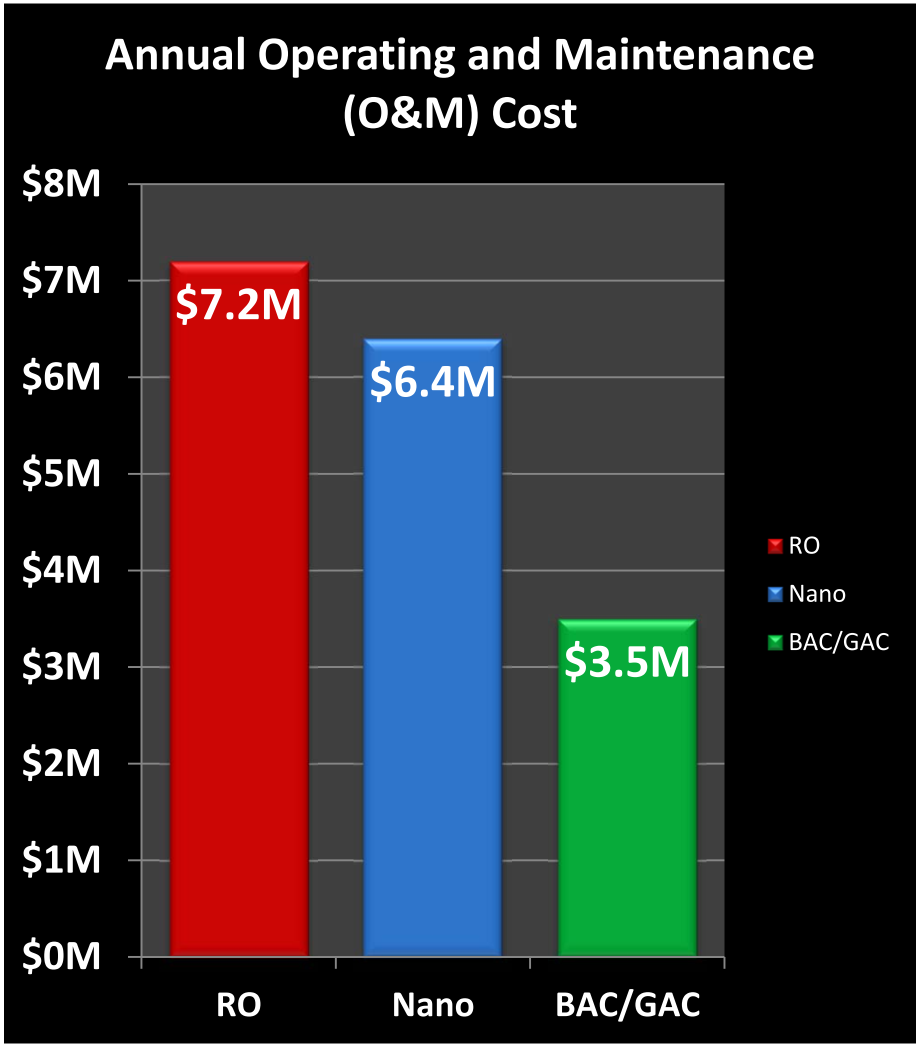
Two major water quality aspects to consider:

- Receiver (or Aquifer) “centric” issues
  - Anti-degradation criterion – determined by others (DEQ, stakeholders, EPA)
  - Aquifer compatibility – water chemistry interactions (pH, alkalinity, etc.)

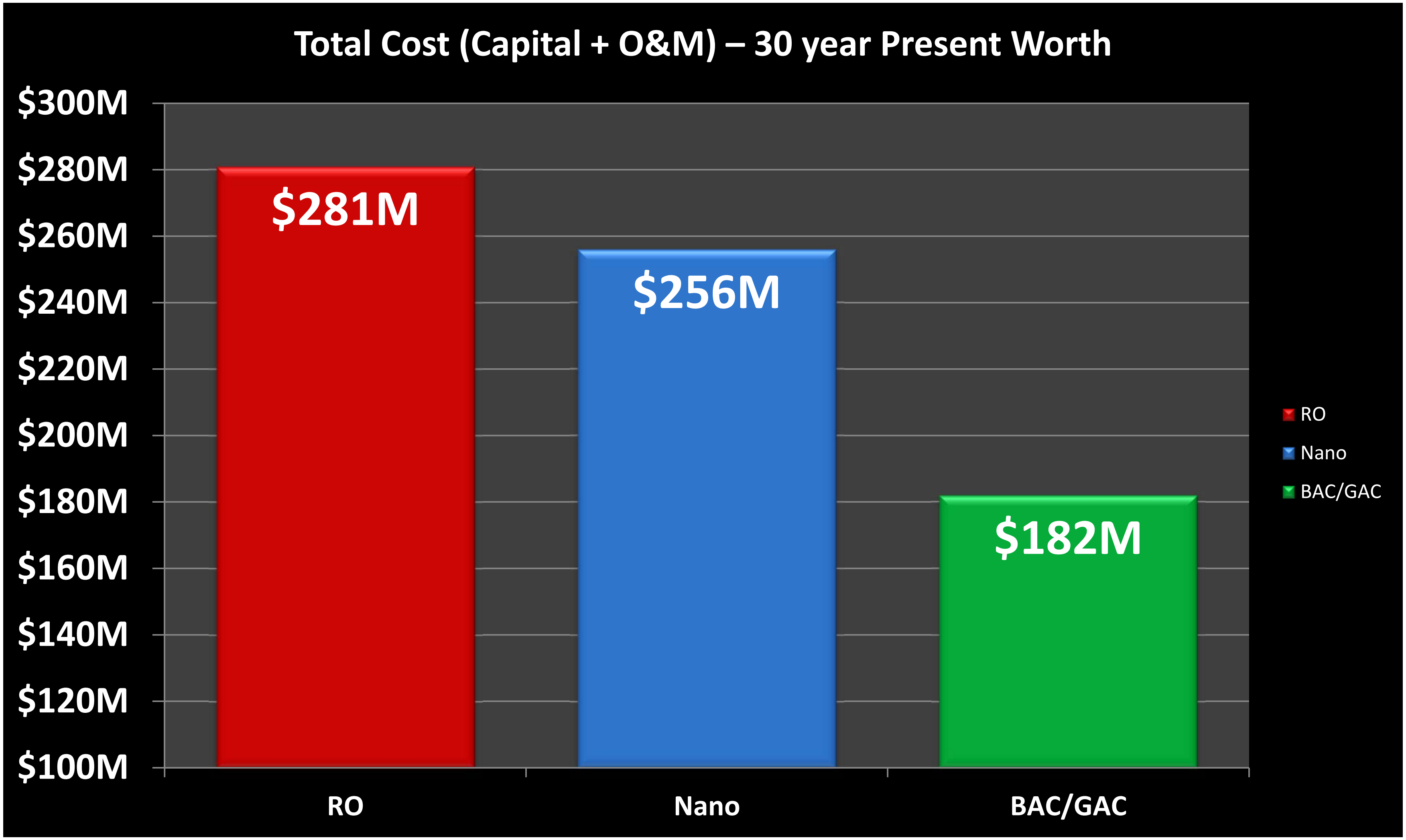
- User (human-health) “centric” issues
  - Injectate water quality based on regulatory definitions:
    - Drinking water standards (MCLs)
    - Water Reuse standards (no VA injection standard yet)

Cost for 20 MGD





30-year Present Worth – 20 MGD



Cost Summary

- Total project in the $1 billion range (120 mgd)
  - For 7 plants (not CE or Atlantic)
  - York needs additional study to locate injection site
- Annual operating costs $21 - $43 M
- Sets stage for integrated planning discussion
- Operating costs (low end) could be recovered with very reasonable permitted withdrawal fee
  - Provides incentive for permits without significant reserves for potential future needs – right sized
  - Encourages conservation

Conclusion – Summary of Benefits

- Regulatory stability for treatment processes
- Potential reduction in the rate of land subsidence
- Sustainable source for groundwater replenishment
- Protection of groundwater from saltwater contamination
- Eliminates need to pipe recycled water to specific users – "wireless" solution
- Significantly reduced discharge into the Chesapeake Bay (only during wet weather)
  - Increases available oyster grounds
  - Creates source of nutrient allocation to support other needs

Next steps

- Model and quantify
  - Impact on saltwater intrusion
  - Impact on land subsidence
  - Safe yield
  - Spatial analysis and travel time to existing withdrawals
- Additional water treatment technology analysis and evaluation – pilot-scale
- Scope demonstration-scale project (1 MGD) – advanced treatment & aquifer injection
- Further evaluation of geochemistry
- Develop more detailed costs for each plant
- Engage stakeholders

Timeline

- Room scale pilot projects – evaluation early 2017
- 2017
  - Endorsement from DEQ/VDH to move forward
- 2018
  - 1 MGD Demonstration pilot (2 year study)
- 2020
  - EPA/DEQ/VDH formally approves
- 2020 to 2030
  - Construction through phased implementation
- 2030 Fully operational
  - 120 MGD of clean water injected into the aquifer

Questions?

*Future generations will inherit clean waterways and **be able to keep them clean**.*

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