Blue Plains Advanced Wastewater Treatment Plant

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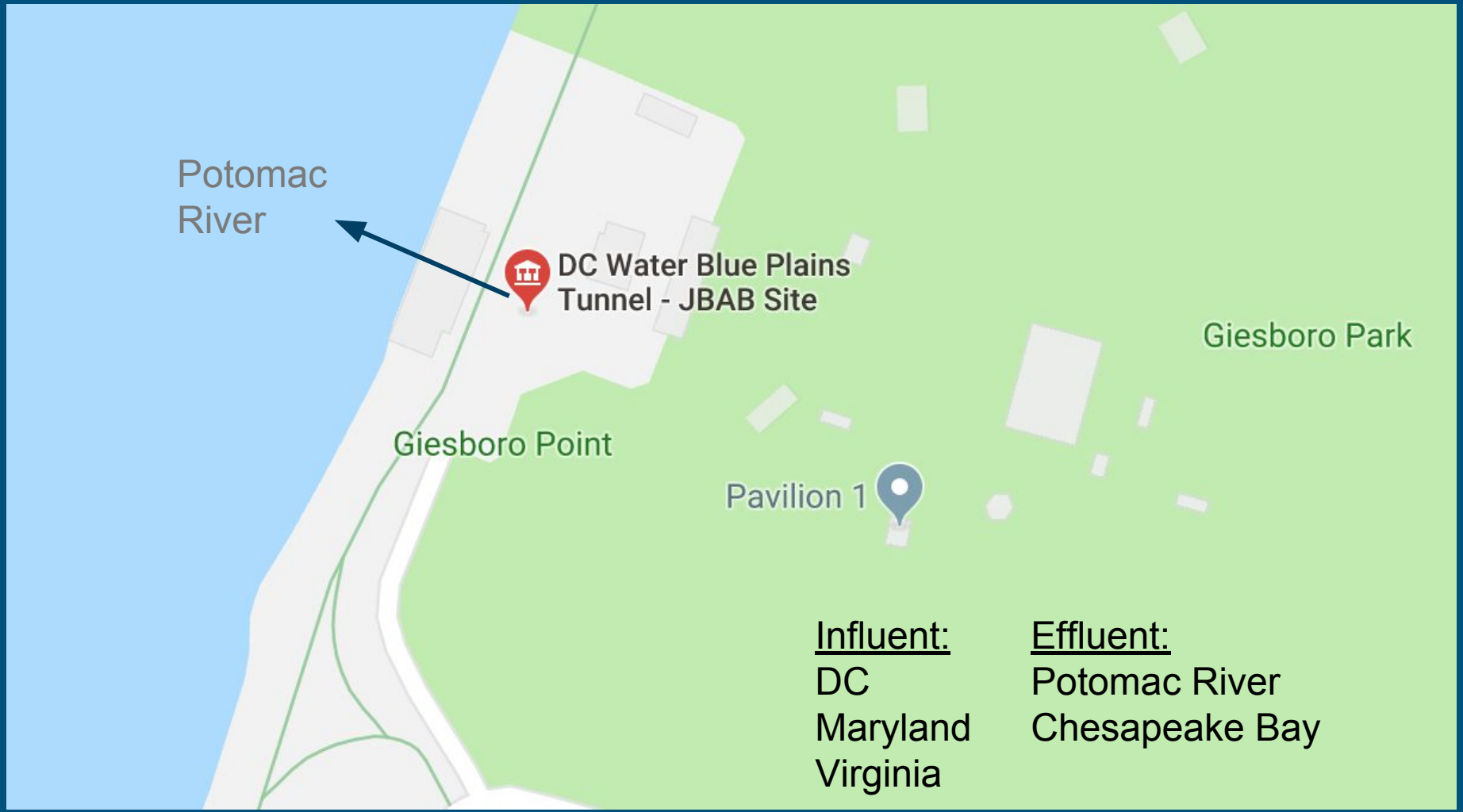
Background

- Located in Washington DC
- Opened as a primary treatment facility in 1937.
  - Facilities for a secondary treatment plant opened in 1959!
- Treats water from all of DC, and a few counties in Maryland and Virginia.
- Treats 360 MGD wastewater
  - Capable of treating 1 BGD


Potomac River
DC Water Blue Plains Tunnel - JBAB Site
Giesboro Park
Giesboro Point
Pavilion 1
Influent:
DC
Maryland
Virginia
Effluent:
Potomac River
Chesapeake Bay

FACILITIES MANAGED BY, AND SERVICE AREAS SERVED BY, DC WATER

Why is it Important?

- Collects and treats wastewater for more than 672,000 residents and 17.8 million annual visitors
- It’s the most advanced wastewater treatment plant in the world
  - Nitrification, denitrification, filtration and disinfection make it an **advanced** facility
  - In 2015, they also implemented anaerobic digestion of organic matter
- Biosolids produced meet Class A standards and can be used in urban and rural settings

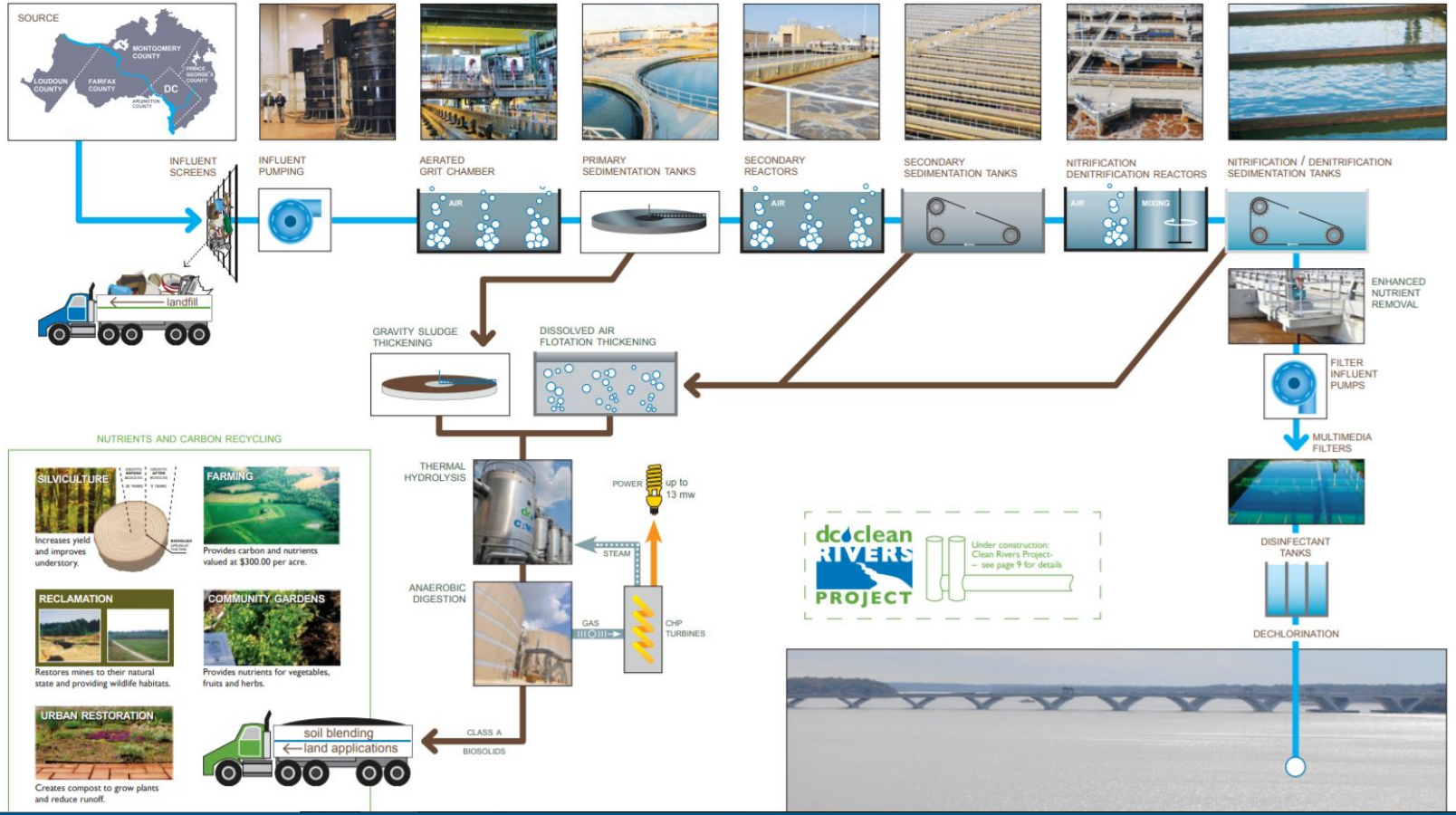
Regulations & Limits

- Combined sewers have both sanitary, sewage and stormwater flow
  - Lead to combined system overflows (CSOs) and there are 53 CSO outfalls listed in the NPDES Permit

Effluent	Avg. Monthly Limitations (lb/day)
TSS	21,600
Carbonaceous Biological Oxygen Demand	15,430
Phosphorus	555
Ammonia Nitrogen	Vary depending on Weather Conditions, but range from 12,960 to 40,000
DO	Not less than 4.0 mg/L at any time

Facility Outline

1. Screening and Grit Removal - Removal of large particles
2. Primary Clarifiers - Solid particles settle out and fall to the bottom
3. Secondary Reactors & Sedimentation - microbes treat organic matter and they are then settled out
4. Nitrification - First step of Nitrogen removal; features innovative anammox bacteria.
5. Denitrification - Nitrate is converted into Nitrogen gas in an anoxic environment.
6. Multimedia Filtration & Disinfection - Filters remove solids and chlorine is added to kill pathogens.
7. Solids Thickening & Dewatering - Water is removed from sludge.
8. Biosolids End Use - Leftover solids can be re-used for agriculture.


SOURCE
MONTGOMERY COUNTY
LOUDOUN COUNTY
FAIRFAX COUNTY
DC
PRINCE GEORGE'S COUNTY
ARLINGTON COUNTY
INFLUENT SCREENS
INFLUENT PUMPING
AERATED GRIT CHAMBER
PRIMARY SEDIMENTATION TANKS
SECONDARY REACTORS
SECONDARY SEDIMENTATION TANKS
NITRIFICATION DENITRIFICATION REACTORS
NITRIFICATION / DENITRIFICATION SEDIMENTATION TANKS
AIR
MIXING
landfill
ENHANCED NUTRIENT REMOVAL
FILTER INFLUENT PUMPS
MULTIMEDIA FILTERS
DISINFECTANT TANKS
DECHLORINATION
GRAVITY SLUDGE THICKENING
DISSOLVED AIR FLOTATION THICKENING
THERMAL HYDROLYSIS
POWER up to 13 mw
STEAM
ANAEROBIC DIGESTION
GAS
CHP TURBINES
CLASS A BIOSOLIDS
soil blending
land applications
NUTRIENTS AND CARBON RECYCLING
SILVICULTURE
Increases yield and improves understory.
FARMING
Provides carbon and nutrients valued at $300.00 per acre.
RECLAMATION
Restores mines to their natural state and providing wildlife habitats.
COMMUNITY GARDENS
Provides nutrients for vegetables, fruits and herbs.
URBAN RESTORATION
Creates compost to grow plants and reduce runoff.
dc clean RIVERS PROJECT
Under construction: Clean Rivers Project- – see page 9 for details

Step 1: Preliminary Treatment

- Wastewater taken through 1,800 miles of sewers and is pumped up from below ground
- Screens remove objects and large particles
- Grit chamber removes rocks & non-degradables - aeration by diffusers agitates the water and allows grit to settle, and grit is removed through vacuum pumps
- 4 truckloads of debris are moved to a landfill weekly

Step 2: Primary Clarifiers

- Water enters a circular clarifier
  - Sludge will settle at the bottom
  - Suspended solids such as fats, oils, and grease (FOG) will float to the top
  - Removes 35%CBOD and 50% TSS
  - Ferric Chloride & Anionic Polymers are added
- Rakes at the bottom will remove sludge
- Skimmers at the top of the tank will remove FOG, which are sent to landfills

Step 3: Secondary Treatment

- Activated Sludge Tank
  - Uses microbes (bacteria) to treat and remove organic material from wastewater
  - Air is pumped into the tanks through bubble diffusers
  - Bacteria feed on organic matter and carbon in the wastewater
- Air causes bubbling and microbes turn water a reddish-brown
- The water is then brought to a sedimentation basin to settle out any solids, and a portion of the microbes are reintroduced to secondary reactors
- Phosphorus is captured in biosolids and recycled back into the land

Step 4: Nitrification & Denitrification

- Why nitrogen **must** be removed
  - Water is discharged to the Potomac, which is a tributary to the Chesapeake Bay
  - Protects the watershed from potential algae blooms
  - Blue Plains currently removes over 40% of the total nitrogen from the effluent
- Nitrification
  - First step of advanced treatment
  - Wastewater and bacteria are placed in an aerated reactor
  - Bacteria oxidizes the NH_4 into NO_3
- Denitrification
  - Occurs in a non aerated reactor
  - Anaerobic heterotrophic bacteria
  - Methanol is added as carbon food source for the microbes.
  - Nitrates are converted into nitrogen gas which is safely released into the atmosphere.

Anammox

- Blue Plains is currently investing in constructing an anammox reactor called DEMON
  - Combines the process of nitrification & denitrification
  - Lowest greenhouse gas emissions
  - Uses 60% less energy than current treatment
  - Does not require the methanol supplement
  - Could save the plant $8 million a year in methanol and energy
- Anammox - “Anaerobic Ammonium Oxidation”

Anammox

- An **anammox-based** process:
  - Anammox bacteria: (Candidatus Brocadia anammoxidans)
  - Converts ammonium (NH_4) and nitrogen dioxide (NO_2) into nitrogen gas (N_2) and water (H_2O)
    - $NH_4^- + NO_2^- = N_2 + 2(H_2O)$
- Does not require organic carbon
- Very expensive and not a lot of knowledge is currently available - discovered two decades ago

Step 5: Multimedia Filtration & Disinfection

- Filtered through sand and anthracite
- Disinfected with sodium hypochlorite-based chlorination at the filter influent
- Residual chlorine is removed before discharge with sodium bisulfate
- Final plant effluent looks the **same** as drinking water and is cleaner than the Potomac River

Step 6: Solids Thickening & Dewatering

Primary Solids

- Sent to screening and grit removal, then to gravity thickeners for thickening
- Combined with secondary solids after thickening

Secondary Solids

- Sent to dissolved air flotation tanks
- Supersaturated air is used to float the solids to the surface
- Solids are then skimmed off and combined with the gravity thickened solids
- Sent through **thermal hydrolysis** which a) eliminates pathogens and b) prepares the “food” in the digesters
- Produce Class A biosolids

Thermal Hydrolysis

- First utility in North America to use thermal hydrolysis for wastewater treatment
- Pressure-cooks the solids left over after wastewater treatment to produce combined heat and power
- Generates a net 10 MW of electricity.
- DC Water is the largest single source consumer of electricity in the District, and the digesters cut consumption up to a third.

Step 7: What happens to all the waste?

- The Class A biosolids are reused in agriculture, providing farmers with fertilizer to help their crops grown and save them money. Treating the water and solids from wastewater keeps excess nitrogen and phosphorous out of our waterways, protecting our water and the plant and animal life within it.
- In 2014, the plant began collecting all biosolids and will use methane that is produced as an alternative method to power the plant.

Thinking about the Environment:

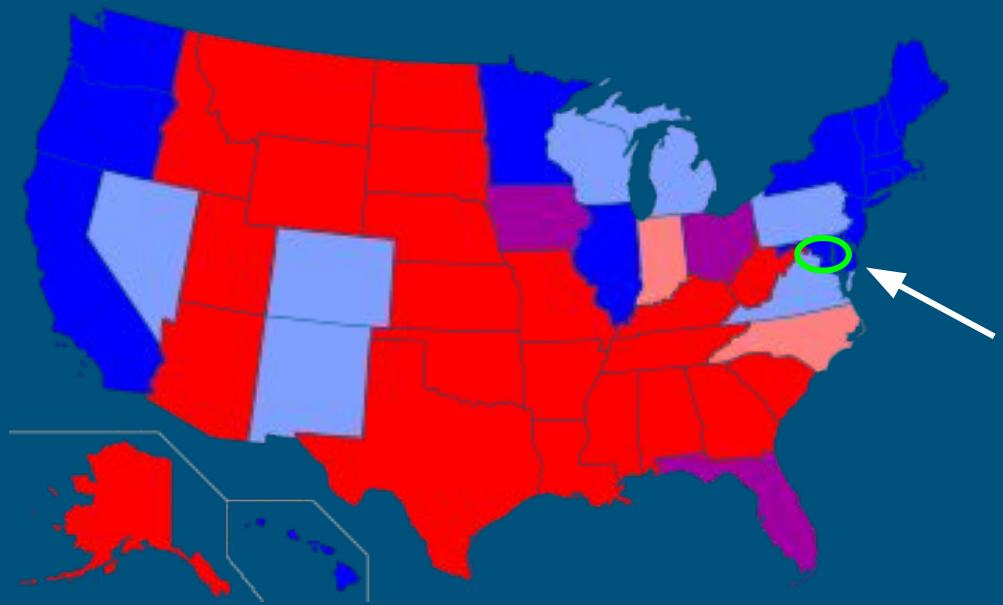
Clean Rivers Project: ongoing program to reduce combined sewer overflows (CSO's) into the District's waterways.

- Designed to *capture and clean wastewater during rainfalls* before it ever reaches our rivers.
- *Reduce overflows* from the combined sewer system, *improve flooding conditions*.
- Installing *green infrastructure* in areas around the City: help reduce flooding and *treat stormwater runoff*.

Solution:

- Will create massive underground tunnels to store the combined sewage during rain events, releasing it to Blue Plains after the storms subside.

Politics:



- DC is a democratic area.
- Primarily concerned with liberal ideals i.e. environmental effects
- Mayor = Muriel Bowser
- May impact how the plant is run
- Push for nitrate removal

Company Mantra:

“Protect the environment and meet or surpass all regulatory standards.”

Thank You
Any Questions?

References

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https://www.dcwater.com/clean-rivers-project

https://www.dcwater.com/wastewater-treatment (image slide 4)

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