

PWD's Nutrient Management Planning

Schuylkill Action Network 2020 Water Utility Forum | **January 2020**



PHILADELPHIA
WATER
— DEPARTMENT —

Philadelphia Water Department

Integrated, One Water Utility for 1.7M+ Customers

Drinking Water



- Source: Delaware & Schuylkill Rivers
- 3 Water Treatment Facilities
- Over 300 million gallons treated per day
- 3,000 miles of water mains
- 25+ pumping stations

Wastewater



- 3 Water Pollution Control Plants
- ~430(+) million gallons treated per day
- 3,716 miles of sewers
- 19 pumping stations
- Biosolids handling facility

Stormwater



- Roughly 60% Combined Sewer, 40% Separate Sewer
- “Green City, Clean Waters” - Large-scale green stormwater infrastructure program
- To date, the program has reduced CSO volume by approximately 2.0 billion gallons annually utilizing over 650 GSI projects and traditional infrastructure projects



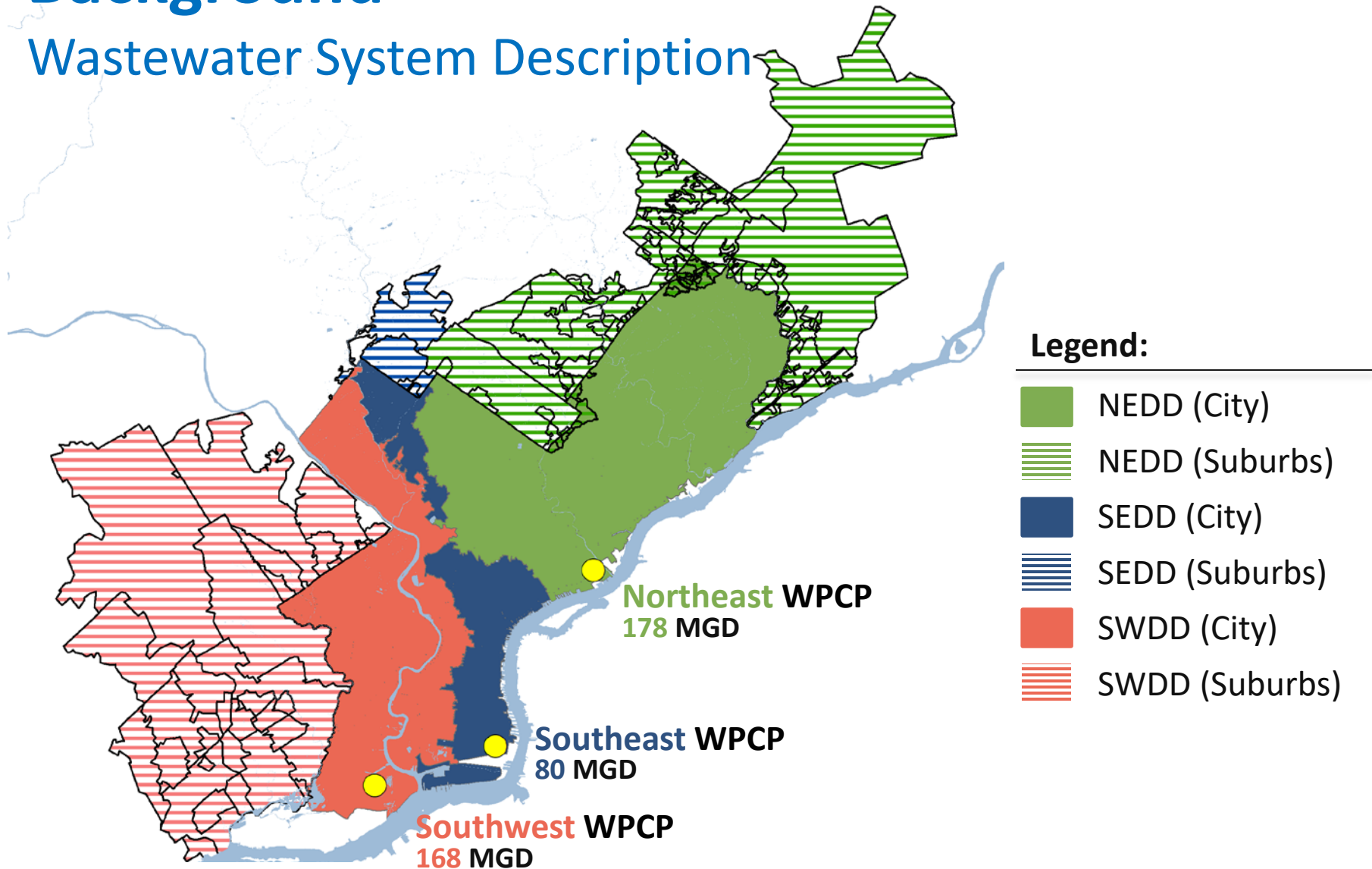


OVERVIEW

1. Background
2. Regulatory Climate
3. PWD's Nutrient Management Planning
4. Takeaways

Background

Wastewater System Description



Regulatory Climate

- ▶ Introduction
- ▶ Ammonia Toxicity
- ▶ Dissolved Oxygen
- ▶ Current Conditions

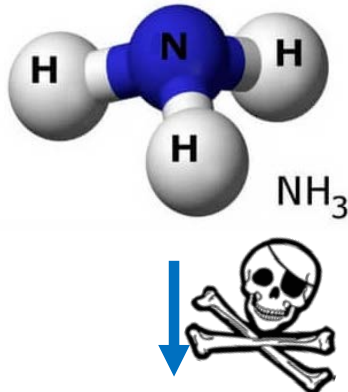
Regulatory Climate

Introduction

What we're covering

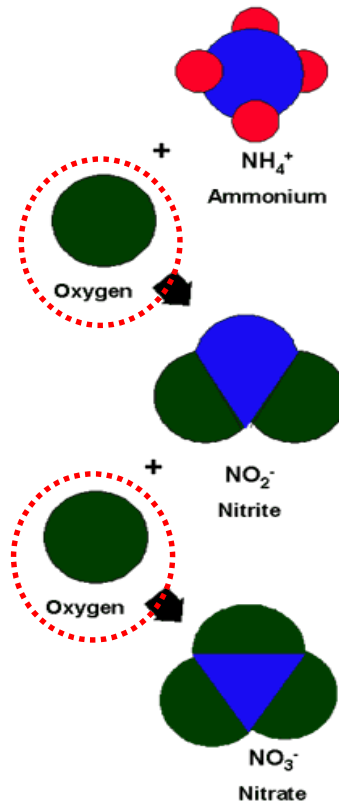
Ammonia Concern:

Un-Ionized Ammonia from Plant Discharges is toxic to aquatic species



DO Concern:

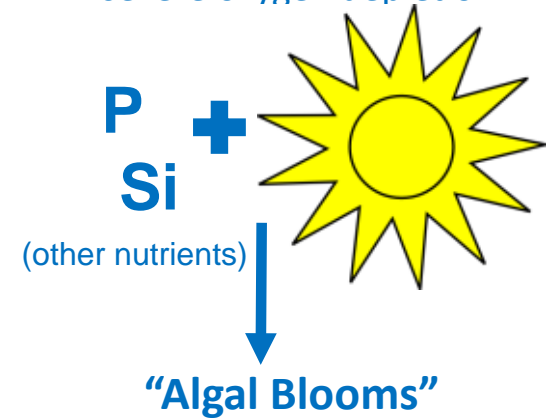
NBOD Load from Plant Discharges can deplete the River's DO



Not the issue in the Estuary

Eutrophication Concern:

Excessive richness of nutrients causing dense plant growth and severe oxygen depletion.



Regulatory Climate

Ammonia Toxicity

- **“Ammonia Toxicity” = Un-ionized Ammonia (NH₃) from Plant Discharges is toxic to aquatic species**
- **EPA updated national ammonia toxicity recommendations in 2013 based on updated science (freshwater mussels)**
 - Toxicity dependent on pH, temperature, dilution
- **DRBC expected to update ammonia toxicity standards after basin states, approximate 5-year timeframe overall**
 - May lead to WPCP ammonia effluent limits

Regulatory Climate

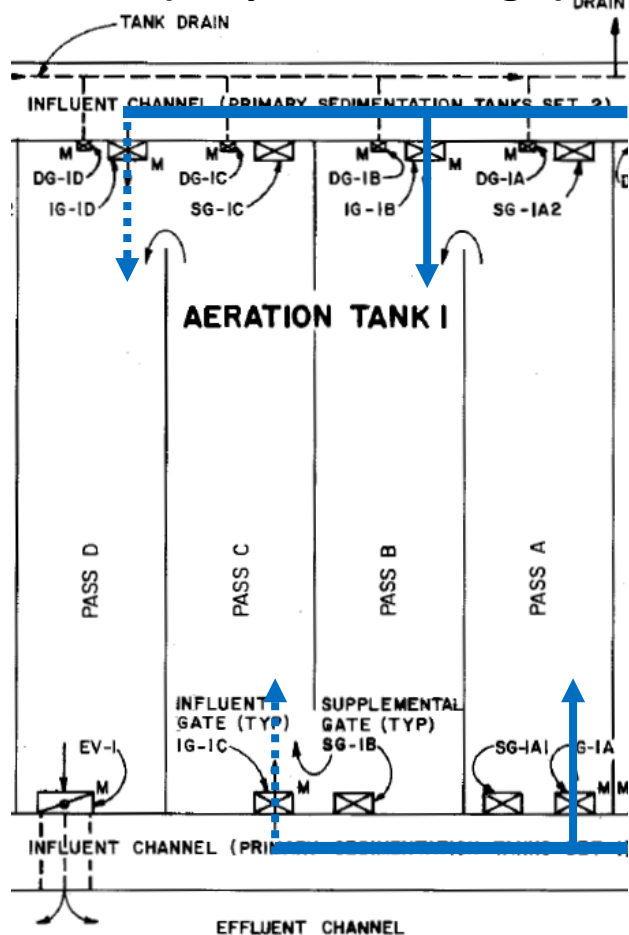
Dissolved Oxygen | Oxygen Demand

- **Classification of Oxygen Demand**
 - **BOD** – Biological Oxygen Demand
 - **CBOD** – Carbonaceous Biological Oxygen Demand
 - **NBOD** – Nitrogenous Biological Oxygen Demand
- **1968 Waste Load Allocations for CBOD₂₀, none for NBOD**
- **1970s PWD WPCPs designed for treating CBOD, not NBOD**
- **NBOD is a primary source of DO depletion in Delaware Estuary**
 - Estimated BOD₅ load = 66,000 lbs/day
 - Estimated ammonia load = 68,000 lbs/day
 - Estimated total NBOD load = 250,000 lbs/day

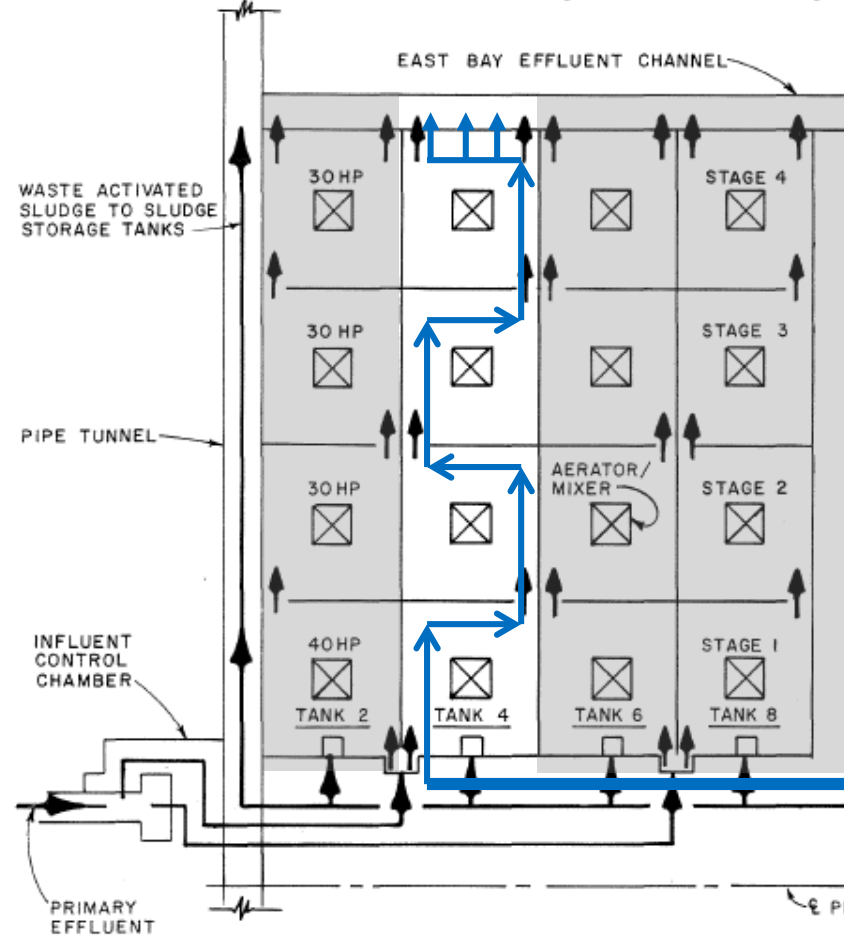
Regulatory Climate

Dissolved Oxygen | PWD Plant Designs

NE WPCP (Step Feed Design)

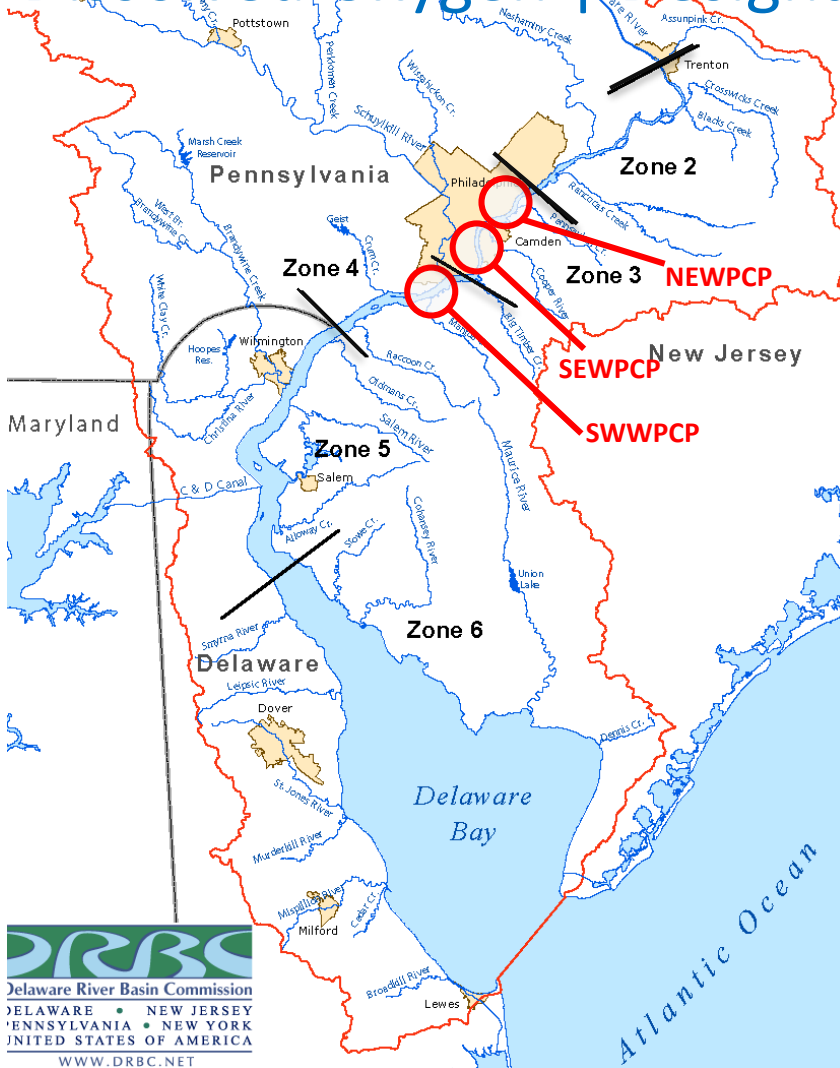


SE and SW WPCPs (Plug Flow Design)



Regulatory Climate

Dissolved Oxygen | Designated Use



DRBC's Regulatory Mechanism:

Designated Use

- **Recreation (Human Activities)**
 - Contact: Primary, Secondary
- **Aquatic Life**
 - Fish Propagation, Maintenance
 - Zones 3, 4, + upper portion of 5 only have a "maintenance" use

Water Quality Criteria

- **Recreation (Human Activities)**
 - Bacteria
- **Aquatic Life**
 - Dissolved Oxygen
 - "Propagation" Use requires a higher DO criteria



Regulatory Climate

Ammonia Toxicity and Dissolved Oxygen

DRBC Nutrient Criteria Plan

Part 1: Highest Attainable Use

- Who: DRBC
- Why: Update designated use to be in alignment with fish observations
- WQ Outcome: More Stringent instream DO criteria
- Potential PWD Outcome: New ammonia effluent limit

Part 2: Effects-Based Nutrient Criteria

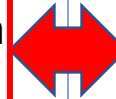
- Who: DRBC
- Why: EPA/state effort address nutrients
- WQ Outcome: Stringent N/P instream criteria
- Potential PWD Outcome: New TN and TP effluent limits

Ammonia Toxicity Criteria

- Who: DRBC
- Why: EPA and basin states are updating to more stringent criteria
- WQ Outcome: Instream ammonia toxicity criteria
- Potential PWD Outcome: New ammonia effluent limit

Effects-Based

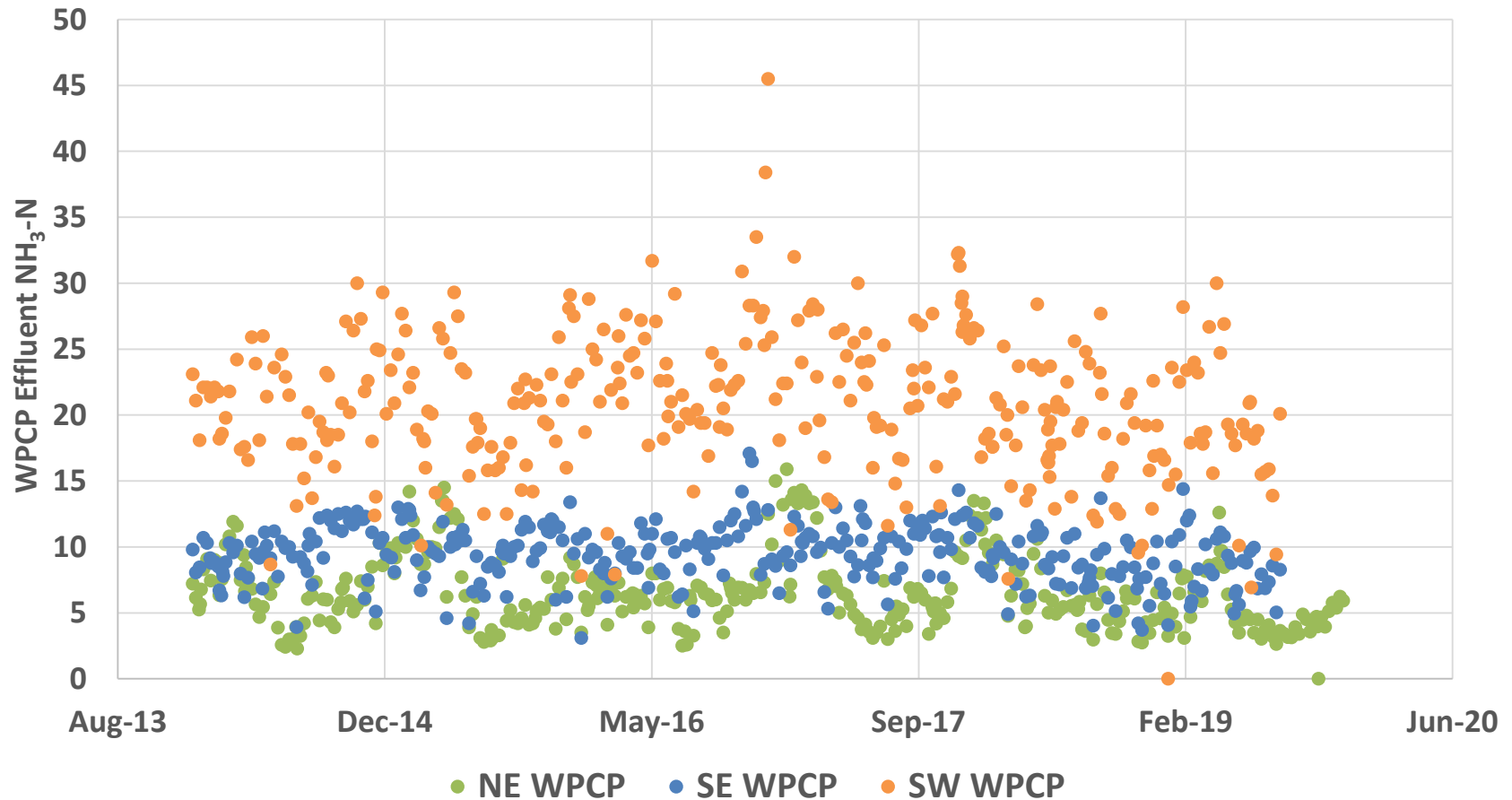
- Nutrients are not causing depressed DO (the DO sag)
- DRBC should identify nutrient effects to establish criteria
- Presently the DO sag is the highest priority estuary improvement objective



Regulatory Climate

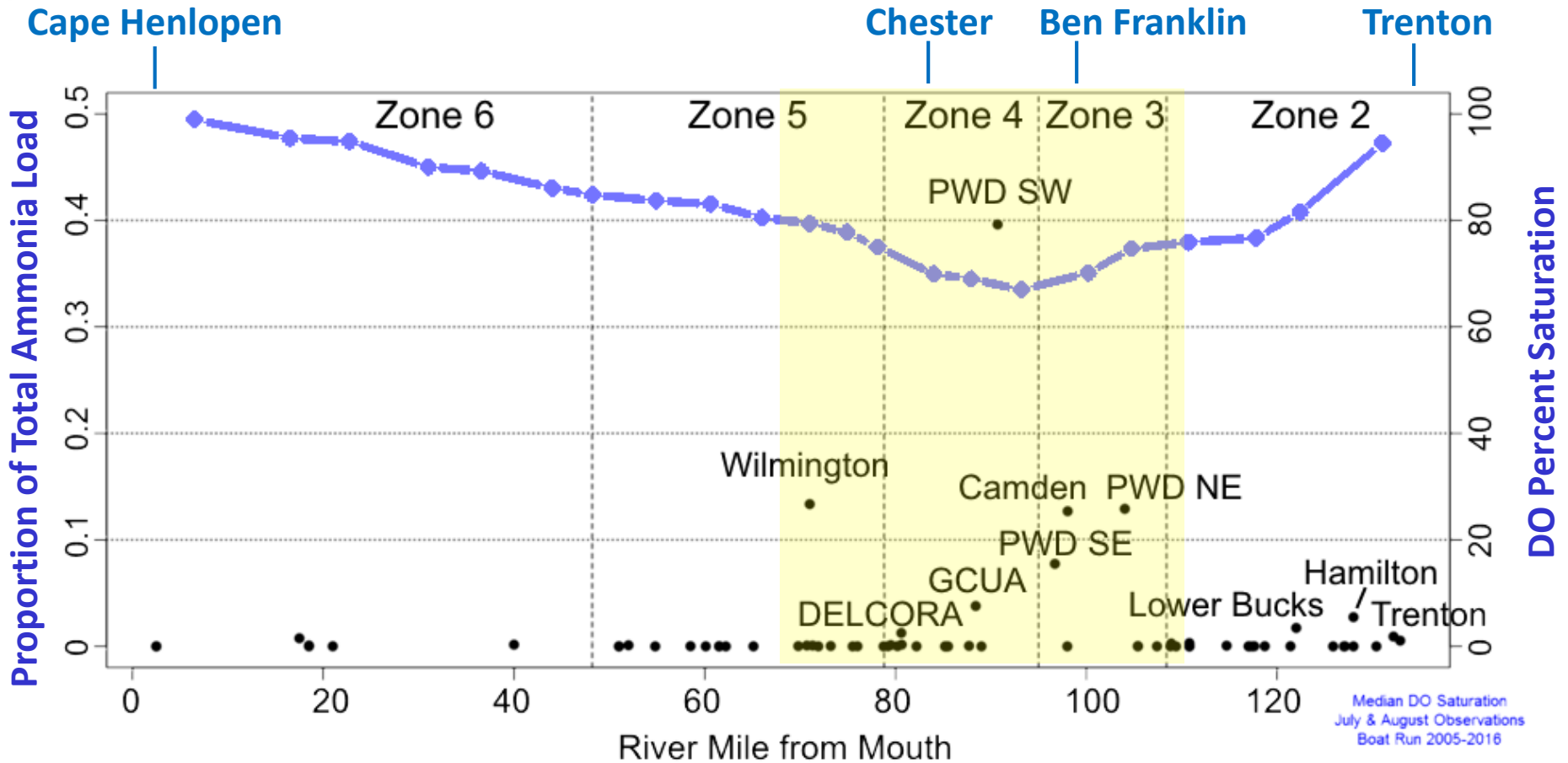
Current Conditions | PWD Effluent Ammonia

PWD's WPCPs: Monitored Effluent $\text{NH}_3\text{-N}$



Regulatory Climate

Current Conditions | Dissolved Oxygen and Ammonia

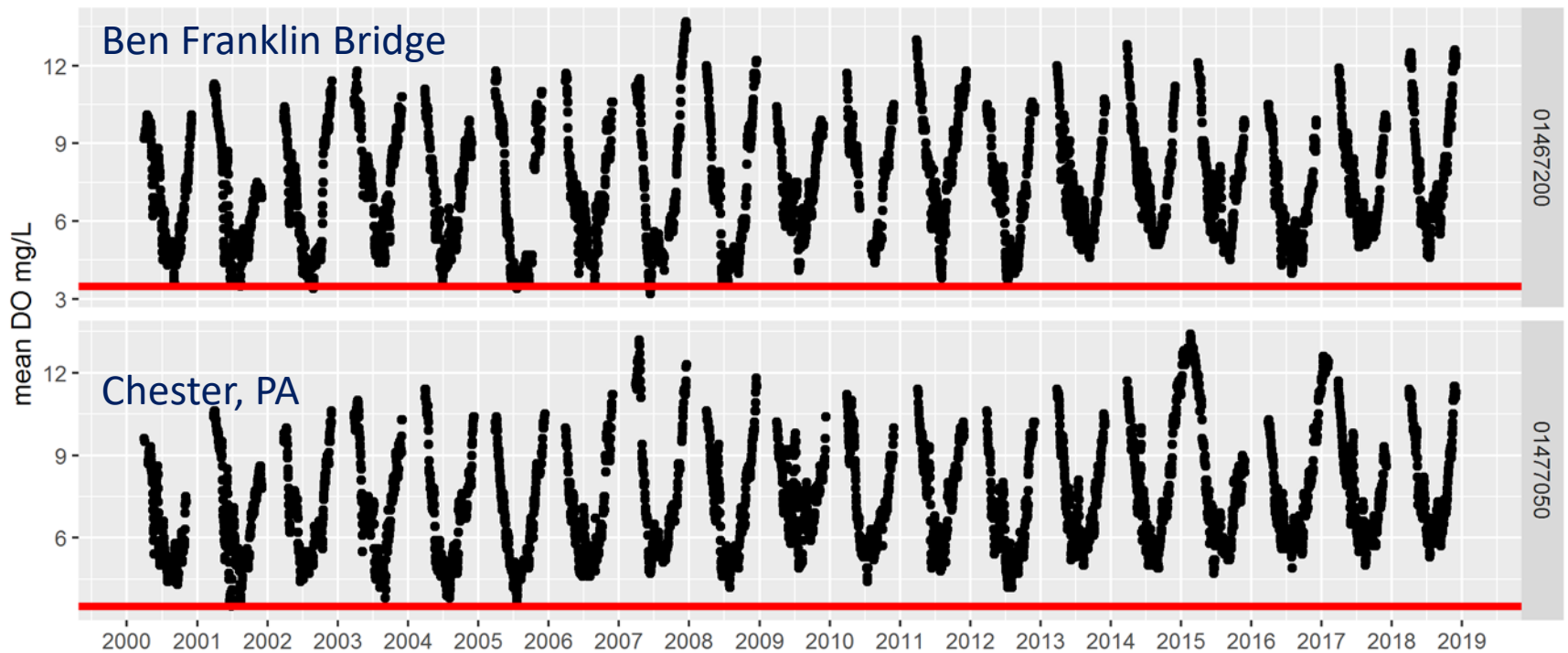


Regulatory Climate

Current Conditions | Dissolved Oxygen

DRBC's current in-stream standard is a **Daily Average of 3.5 mg/L DO**

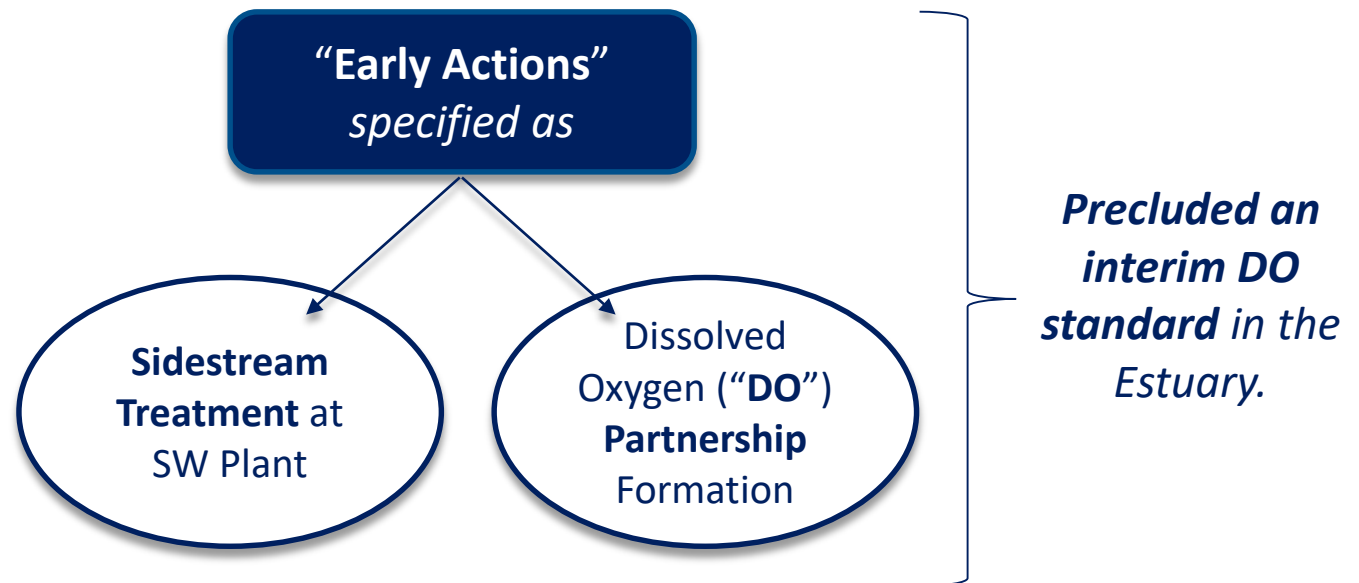
- The concentration is typically met in Zones 3 & 4;
- Large summer DO variability from year to year, mostly due to temperature



Regulatory Climate

Current Conditions | Interim Commitments

2016 - PWD committed to “Early Action” on ammonia reduction (DRBC)



2017 - DRBC included PWD's commitment in their Resolution

- The Resolution authorizes the initiation of a process to review Estuary designated use and protective water quality criteria



PWD's Nutrient Management Planning

PWD's Nutrient Management Planning

Structure

- Integrated PWD effort, involves multiple teams across utility;

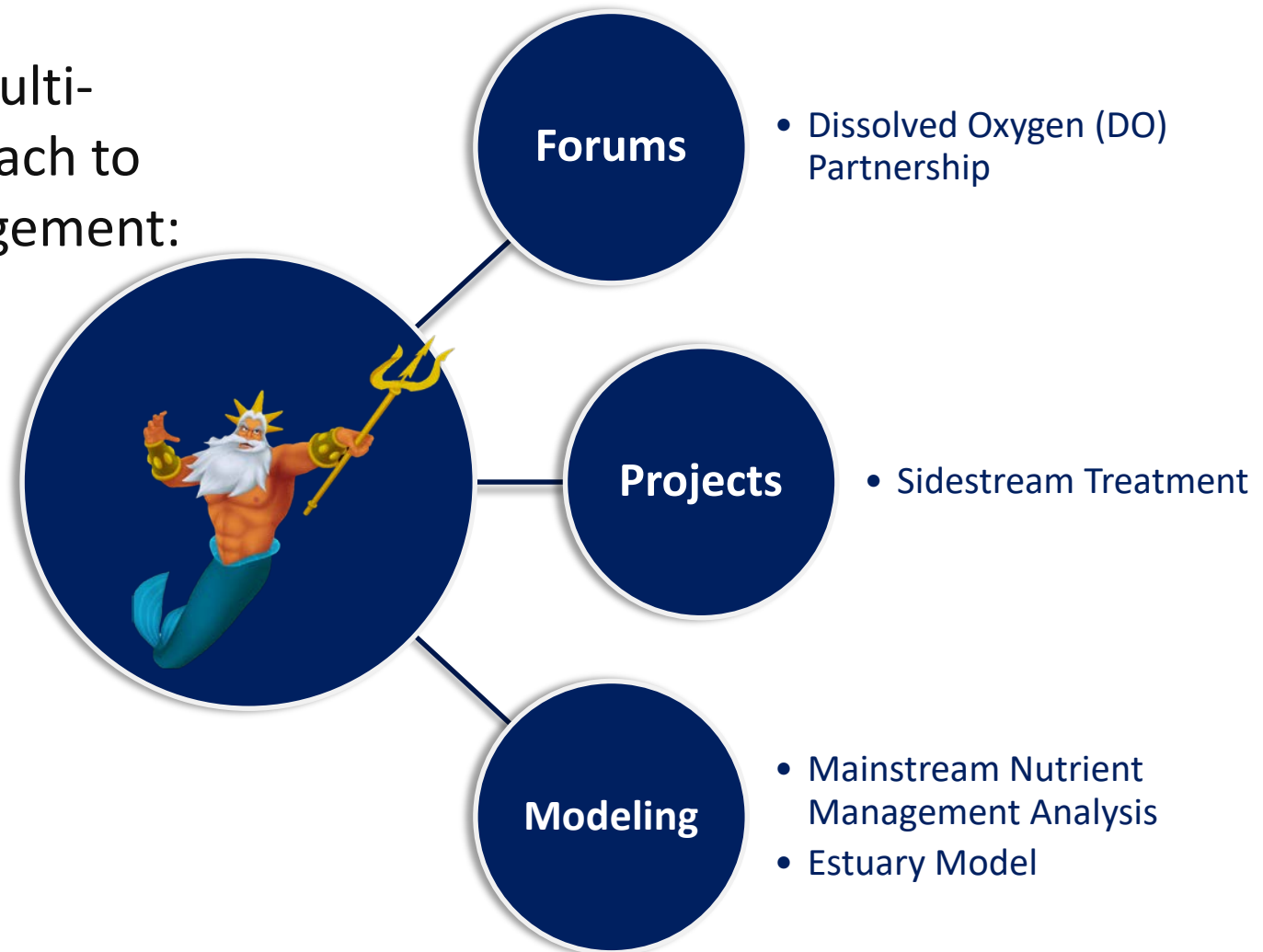


- Planning strategy developed in 2016;
- Routine meetings covering a variety of topics.

PWD's Nutrient Management Planning

Focus Areas

PWD takes a multi-pronged approach to nutrient management:



PWD's Nutrient Management Planning:

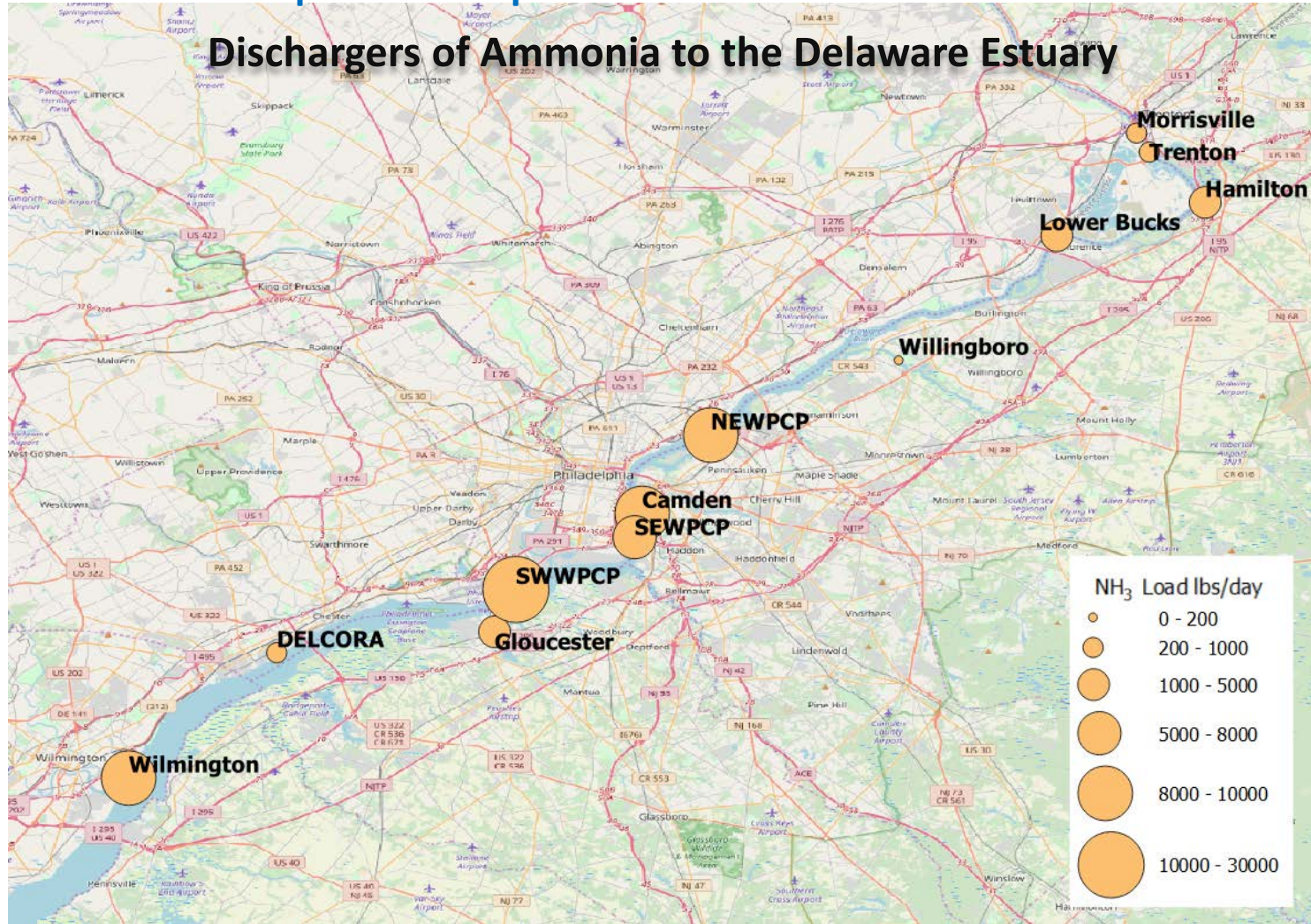
Dissolved Oxygen (DO) Partnership

Sidestream Treatment

Mainstream Nutrient Management Analysis

Estuary Model

PWD's Nutrient Management Planning DO Partnership Concept



PWD's Nutrient Management Planning

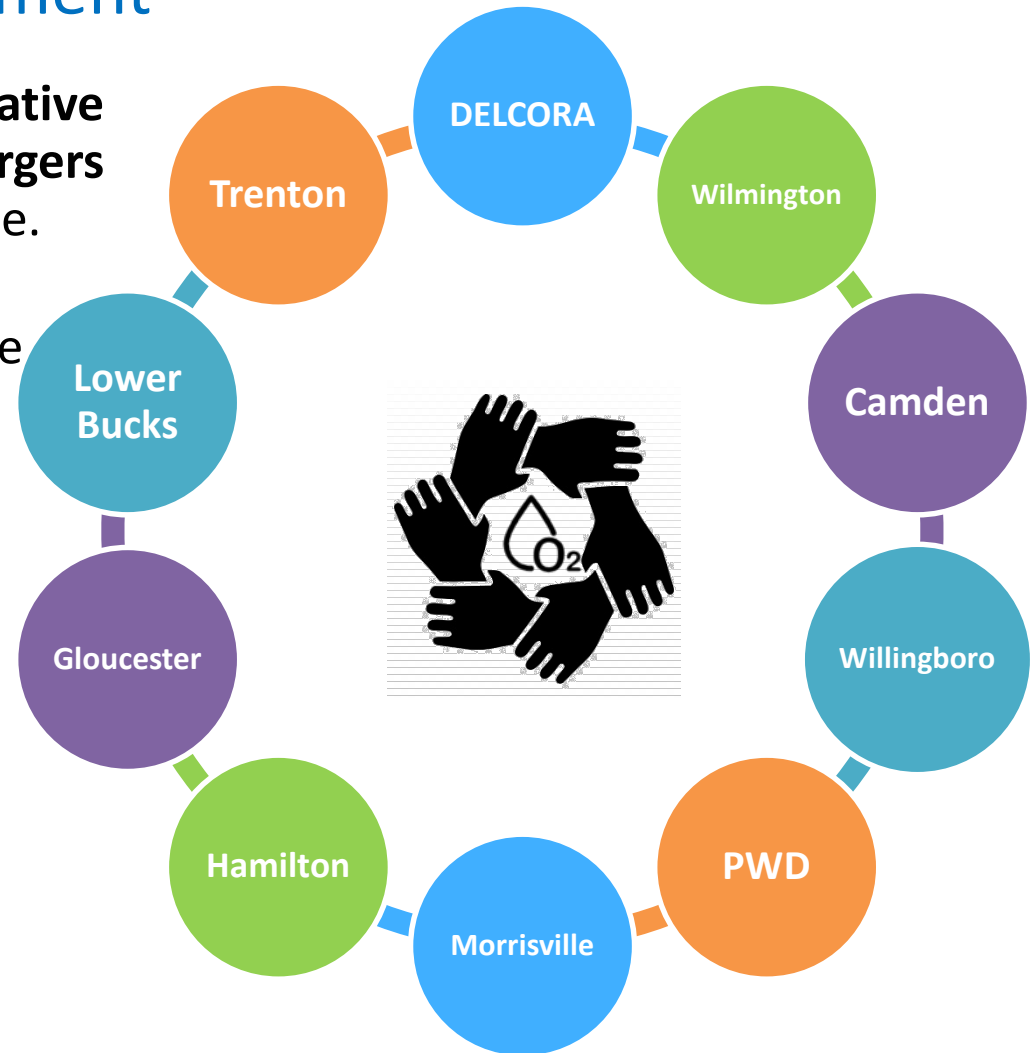
DO Partnership Establishment

The DO Partnership is a **collaborative framework for municipal dischargers** to have a unified voice and message.

Mission: "To collaborate to improve dissolved oxygen in the Delaware Estuary."

P&R has a contract with the DO Partnership Facilitator to:

- Remain objective
- **Convene** quarterly **meetings**
- **Discuss** common interests and goals
- **Present** on low-cost, science-based WWTP-related alternatives



PWD's Nutrient Management Planning:

Dissolved Oxygen (DO) Partnership

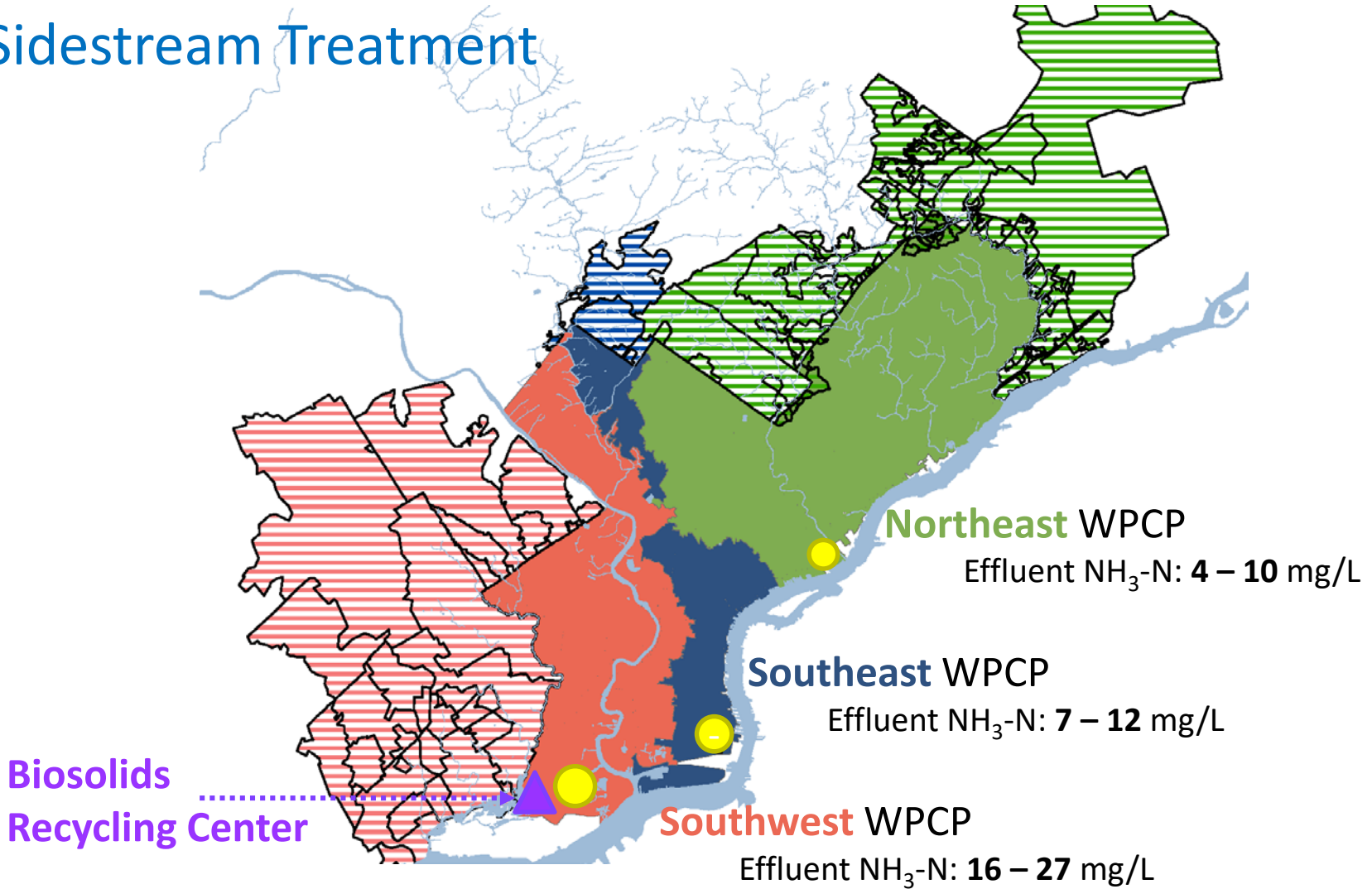
Sidestream Treatment

Mainstream Nutrient Management Analysis

Estuary Model

PWD's Nutrient Management Planning

Sidestream Treatment



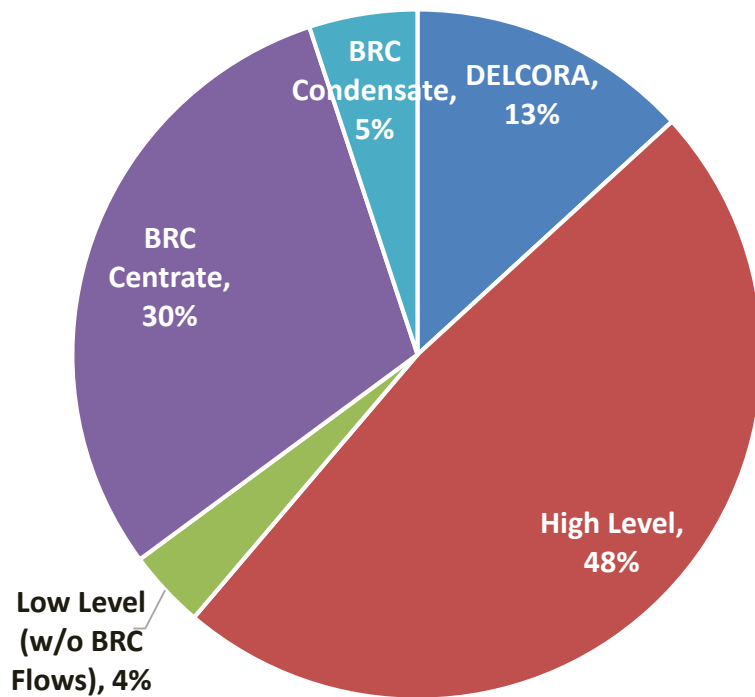
Note: effluent level ranges are from 2014-March '19 data.

PWD's Nutrient Management Planning

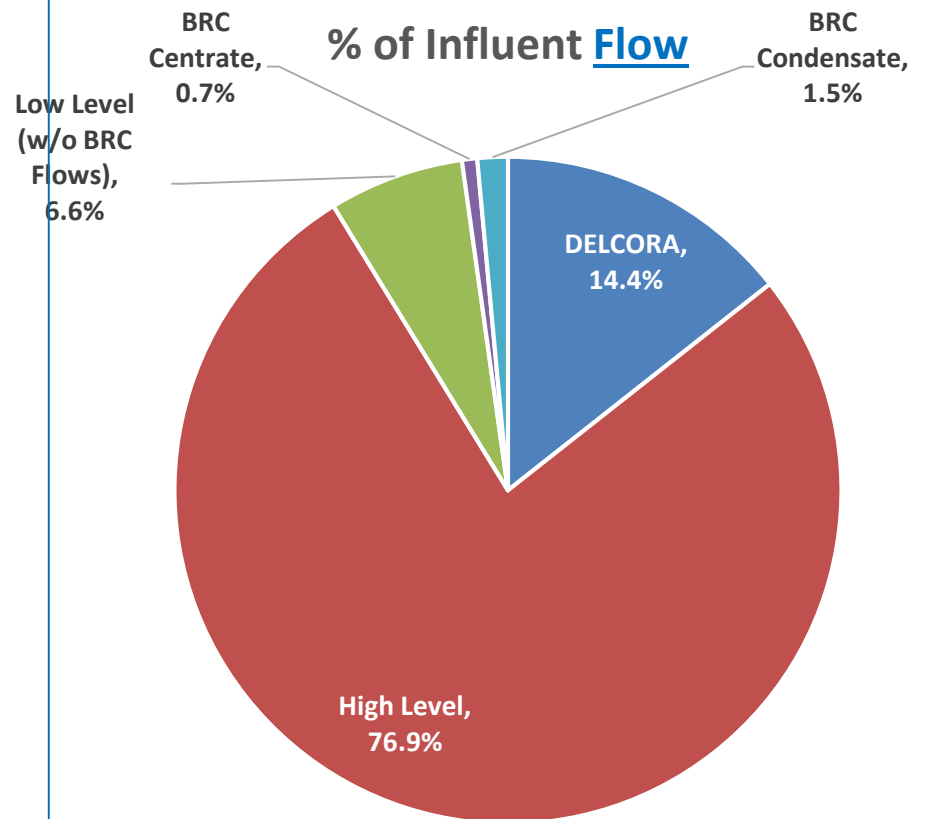
Sidestream Treatment at SWWPCP

% of Influent $\text{NH}_3\text{-N}$ Loading

**Data from 2017 and 2018 Sampling Events*



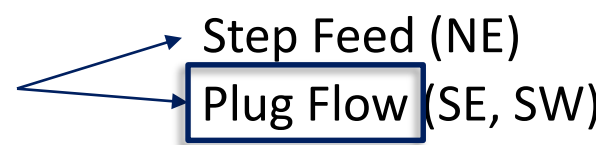
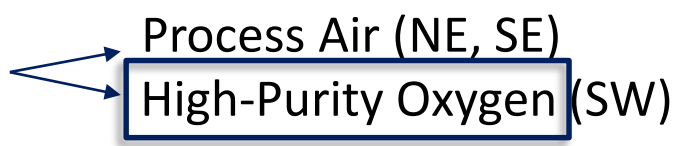
% of Influent Flow



■ DELCORA
 ■ High Level
 ■ Low Level (w/o BRC Flows)
 ■ BRC Centrate
 ■ BRC Condensate

PWD's Nutrient Management Planning

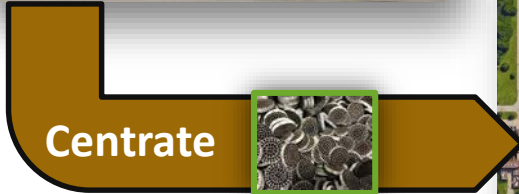
Sidestream Treatment | Early Action

- **“Early Action” as defined by DRBC:**
 - **“Opportunities [...] to reduce oxygen-depleting discharges to this stretch of river in the **short term**”** (DRBC Press Release, 2017)
- **PWD's WPCPs**
 - Design: Effects on retention time 
 - Step Feed (NE)
 - Plug Flow (SE, SW)
 - Aeration: Effects on biological activity 
 - Process Air (NE, SE)
 - High-Purity Oxygen (SW)
 - SWWPCP is the plant of concern for effluent NH₃-N
 - No quick, low-cost operational “tweak” to reduce effluent NH₃-N
- **Sidestream treatment of nutrient-rich BRC flows is a means for PWD to implement “Early Action”.**

PWD's Nutrient Management Planning

Sidestream Treatment at SWWPCP

Synagro



Centrate



Deammonification

Est. **~85% Reduction** of Ammonia into SW

Southwest WPCP

**cropped for presentation purposes*



Plant Effluent

Est. **~25% Reduction** of Ammonia out of SW

Delaware Estuary

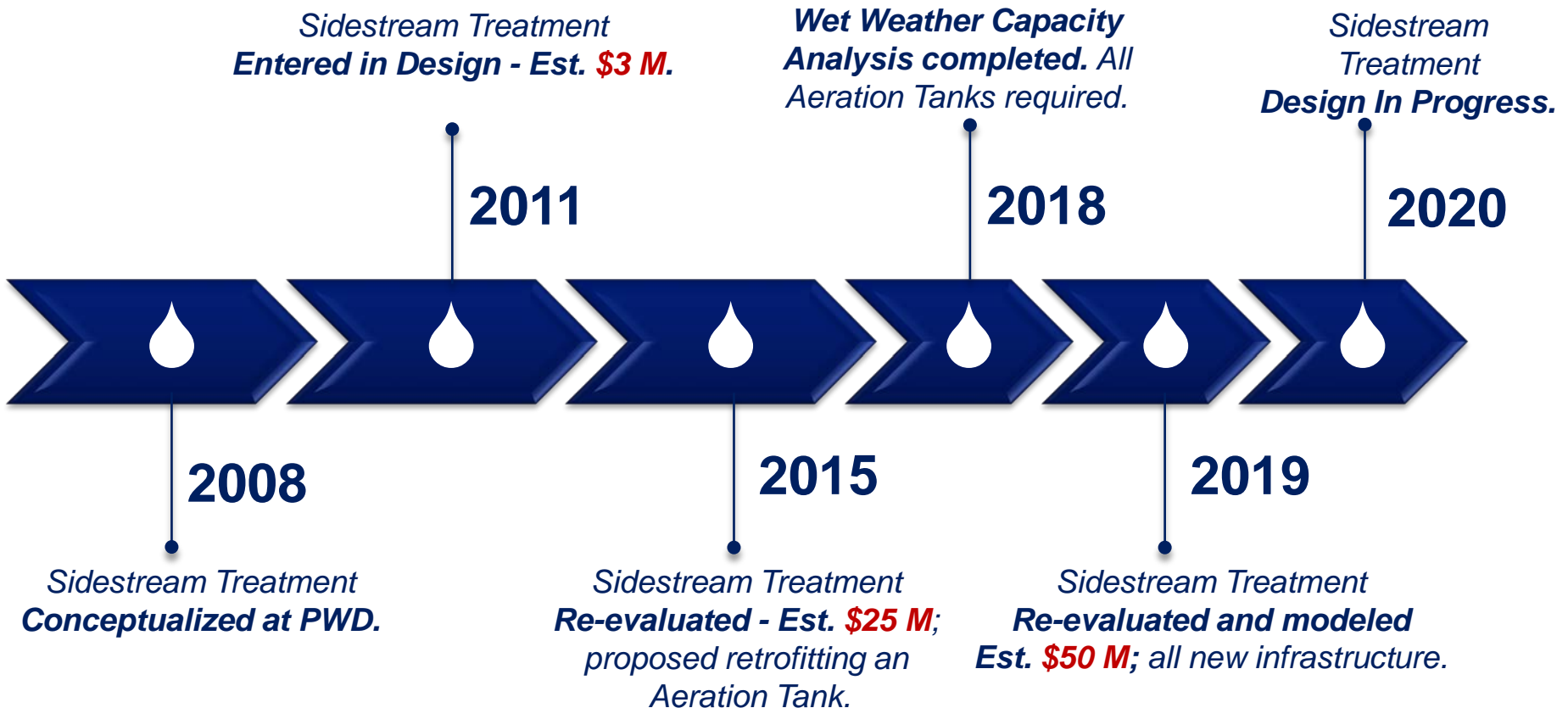


Est. **~10% Reduction** in Total Municipal NBOD Load into Estuary

PWD's Nutrient Management Planning

Sidestream Treatment at SWWPCP

Timeline of sidestream treatment project:



PWD's Nutrient Management Planning:

Dissolved Oxygen (DO) Partnership

Sidestream Treatment

Mainstream Nutrient Management Analyses

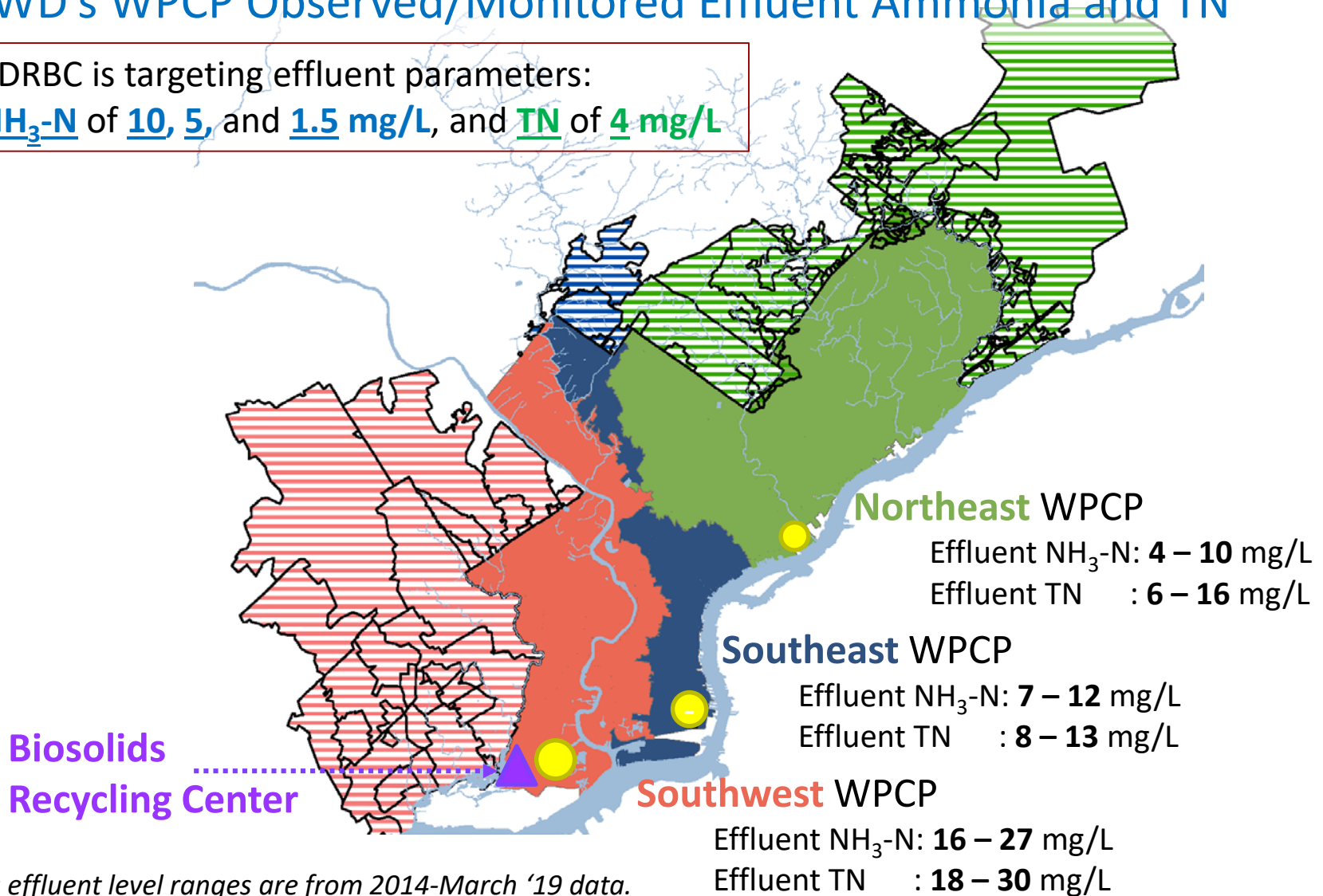
Estuary Model

WPCP Mainstream Analyses

PWD's WPCP Observed/Monitored Effluent Ammonia and TN

*DRBC is targeting effluent parameters:

NH₃-N of 10, 5, and 1.5 mg/L, and TN of 4 mg/L



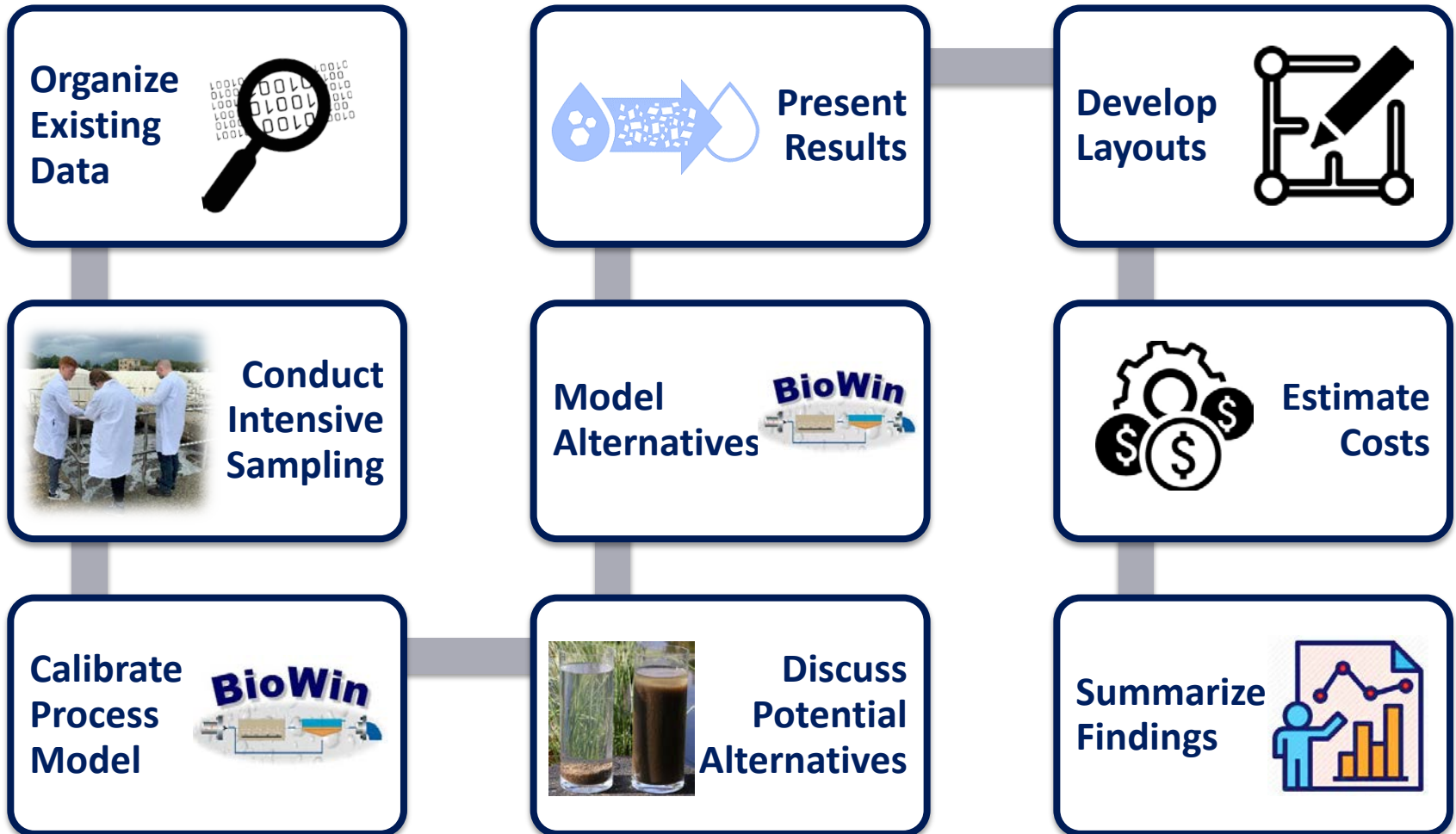
WPCP Mainstream Analyses

Approach to Evaluating Alternatives

- The evaluations for each WPCP will use a **model-based approach** to assess the potential of **NH₃-N** and **TN reduction** through **both minor and major** infrastructure/process upgrades
- PWD is using:
 - **External** (consulting) **resources** to complete the technology screening and modeling evaluations
 - **Internal resources** to discuss the technologies considered and develop the deliverable to DRBC

WPCP Mainstream Analyses

Approach to Evaluating Alternatives



WPCP Analyses

Nutrient Planning Commitment - Timeline

Analysis	2018												2019												2020						
	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul				
SW Mainstream																															
SE Mainstream																															
NE Mainstream																															
DRBC/ Kleinfelder																															



Planned timeframes for workshops

PWD's Nutrient Management Planning:

Dissolved Oxygen (DO) Partnership

Sidestream Treatment

Mainstream Nutrient Management Analysis

Estuary Model

Estuary Model

Integrated, proprietary tool that supports PWD's drinking water, stormwater and wastewater planning.

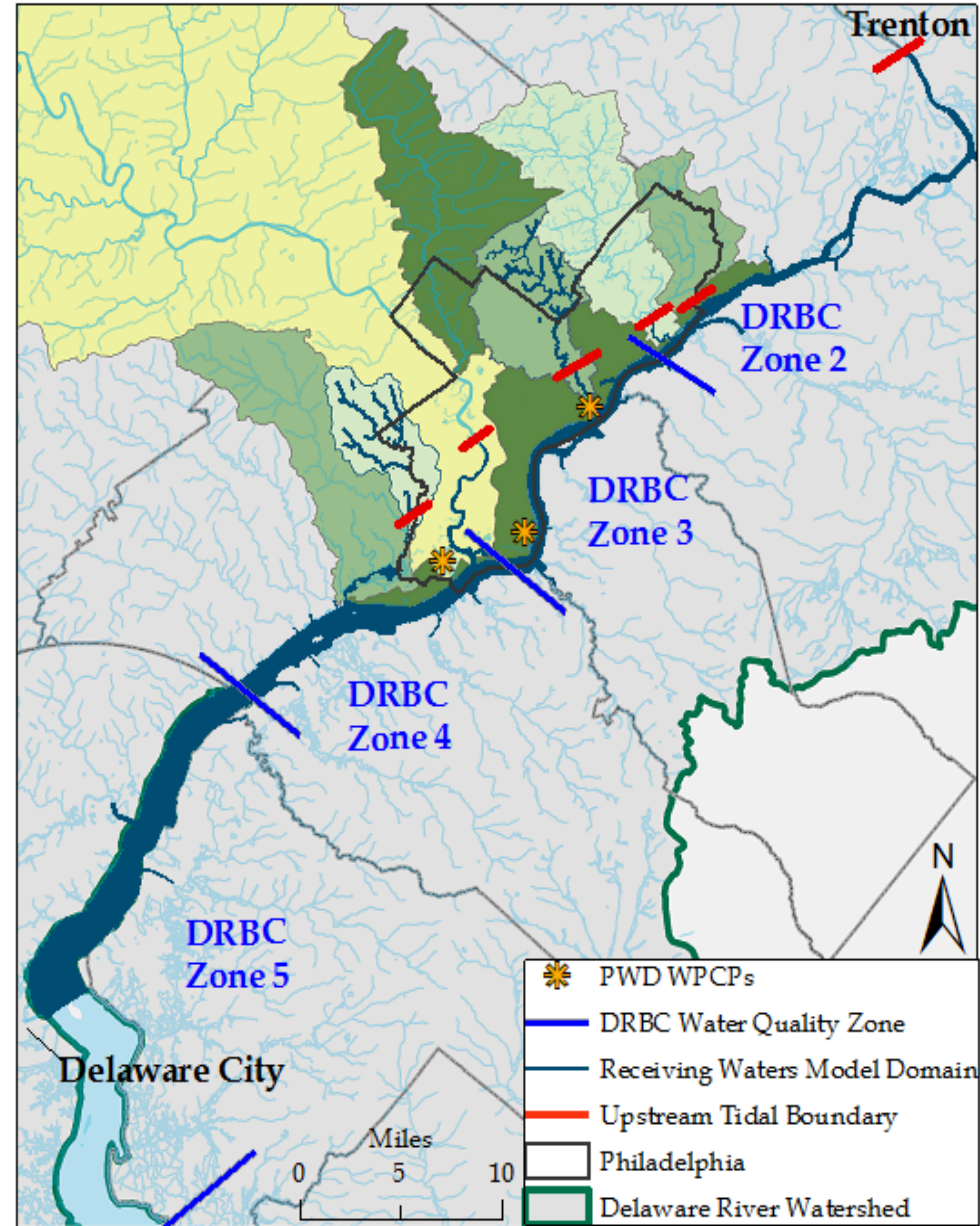
Model can simulate:

- Tidal Schuylkill, Delaware and tributaries
- Hydrodynamics, DO, bacteria, nutrients, salinity

Model can be used to:

- Study impact of PWD plant nutrient management alternatives on Estuary;
- Plan for PWD compliance with any new DO (and bacteria) criteria; and
- Check, inform or refine DRBC results, wasteload allocations, and water quality criteria changes.

Philadelphia Receiving Waters Model Domain



Takeaways

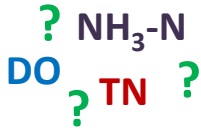
The image shows an industrial facility, likely a wastewater treatment plant, under a dark, overcast sky. In the foreground, there are several large, rectangular concrete basins filled with water, separated by metal railings. In the background, a long, white, elevated pipe structure runs across the scene, supported by several pillars. The overall atmosphere is dim and industrial.

Takeaways

Nutrient Management Planning | Wastewater Perspective



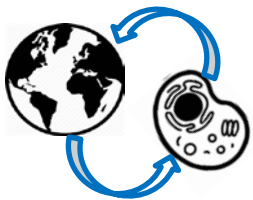
- Regular **communication** between utilities and regulating agencies is critical;



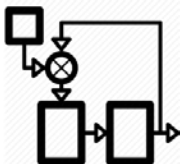
- Utilities should advocate for **prioritization of criteria**;



- PWD's **commitment** to Early Actions **precluded an interim** Estuary DO **standard**;



- Nutrient Management Planning for a wastewater utility involves high-level **discussions**, ground-level **evaluations**, and a **schedule** to adhere to;



- To understand the most **cost-effective investment**, PWD is using a **model-based framework** to evaluate plant improvements and benefit(s) to the Delaware Estuary.

A photograph of a water treatment facility at dusk or dawn, featuring large concrete basins, metal railings, and industrial pipes under a cloudy sky. The image is overlaid with a semi-transparent blue filter.

Thank you!

▶ Questions?

▶ Contact Information:

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