

# Hazen



## **Refractory Nitrogen Sampling Central Johnston County Regional WWTF Expansion**

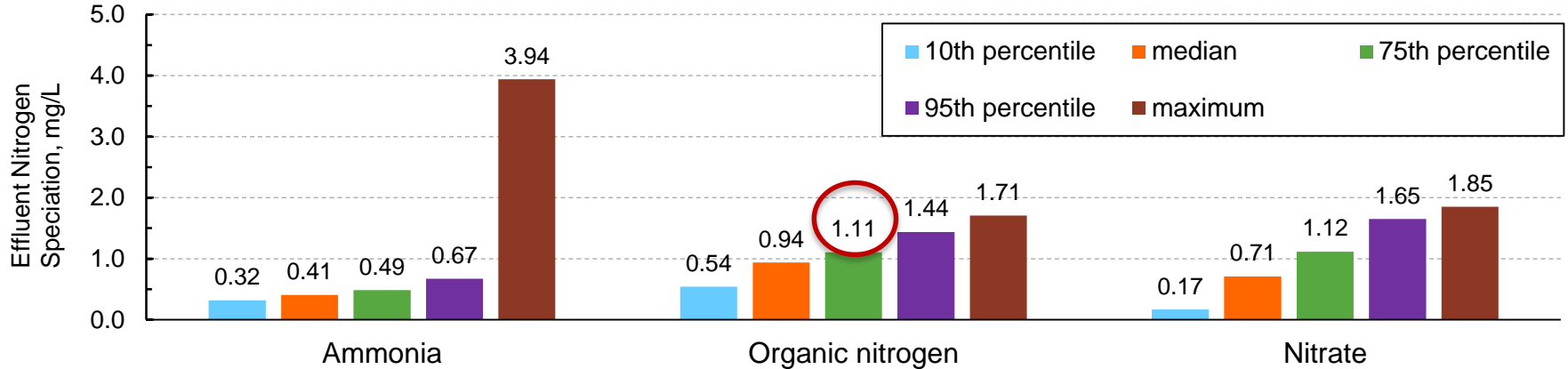
May 4, 2017

# TN & TP Permit Requirements

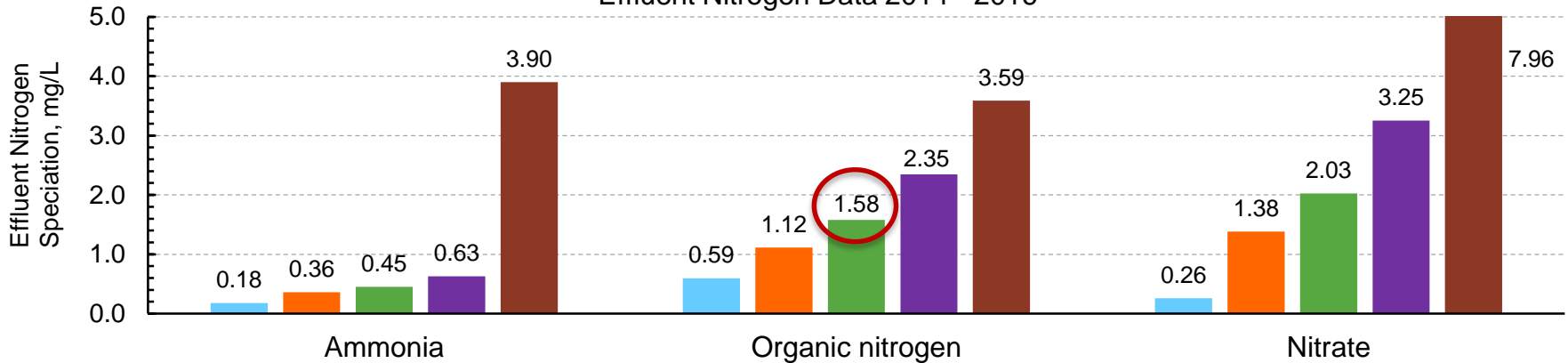
Parameter	9.5 mgd Design (Current)	13.5 mgd Design (Future)
Total nitrogen load	71,477 lb/yr	71,477 lb/yr
Total nitrogen load	195.8 lb/d	195.8 lb/d
Target concentration at design flow	2.47 mg/L	1.74 mg/L
Target concentration at average day flow	3.19 mg/L	2.25 mg/L
Total phosphorus	2.0 (quarterly avg.)	2.0 (quarterly avg.)

# Effluent Nitrogen Speciation

Effluent Nitrogen Data 2005 - 2006



Effluent Nitrogen Data 2014 - 2016



# Nitrogen Management

- Optimized biological treatment
  - Targets ammonia and nitrate, but not organic nitrogen
- Effluent organic nitrogen
  - Non-readily biodegradable dissolved organic nitrogen (nbDON)
- nbDON management strategies:
  - Effluent diversion (reuse)
  - Nutrient credits
  - Removal (advanced treatment)
  - **Influent load management (pretreatment)**



Note: Nitrogen is not truly “refractory” if it can be biodegraded at some point, e.g., receiving stream.

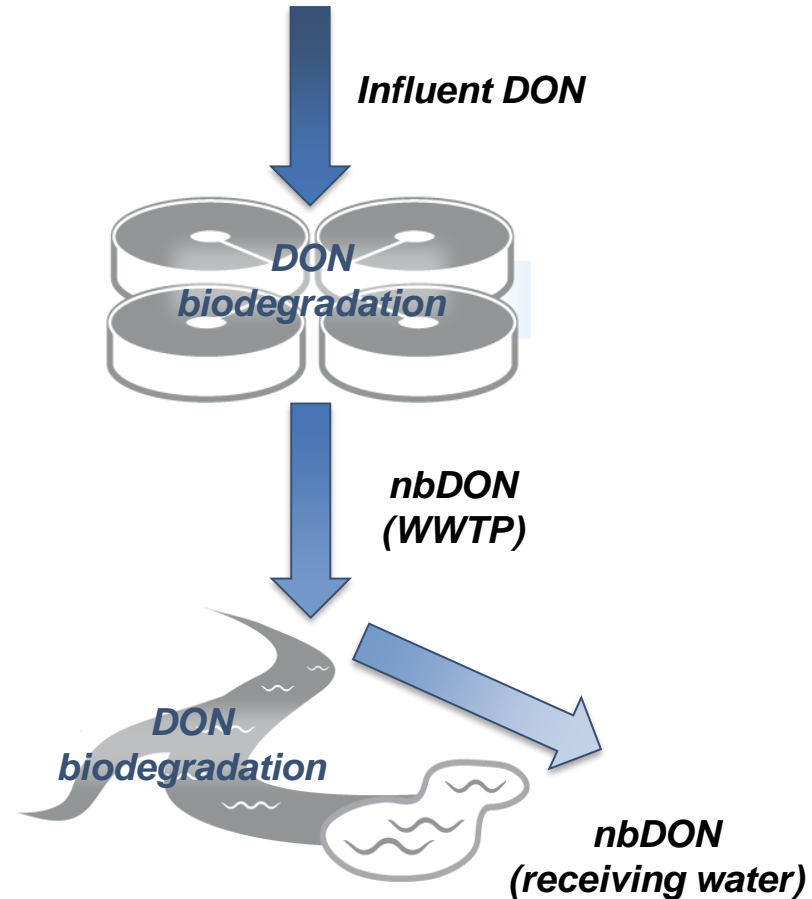
# nbDON Management via Pretreatment



- Requires quantification of total and customer-specific influent nbDON loads
- *nbDON influent load (lb/year) = Flow x nbDON influent concentration*
- Enables identification of significant nbDON contributors
- Viability assessment of nbDON pretreatment standard and/or surcharge

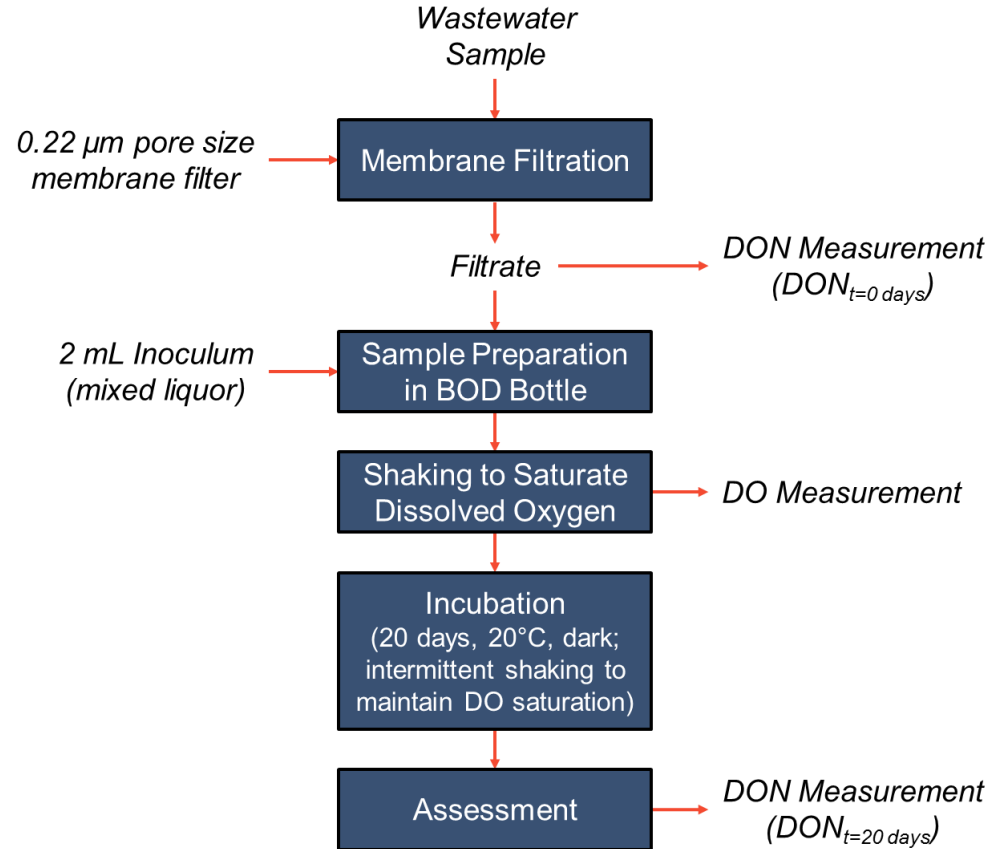
# nbDON Quantification

- Analytical Technique
  - North Dakota State University
- Technology-based bioassay
  - Estimates DON biodegradation at WWTP
- Water quality-based bioassay
  - Estimates DON biodegradation in receiving water



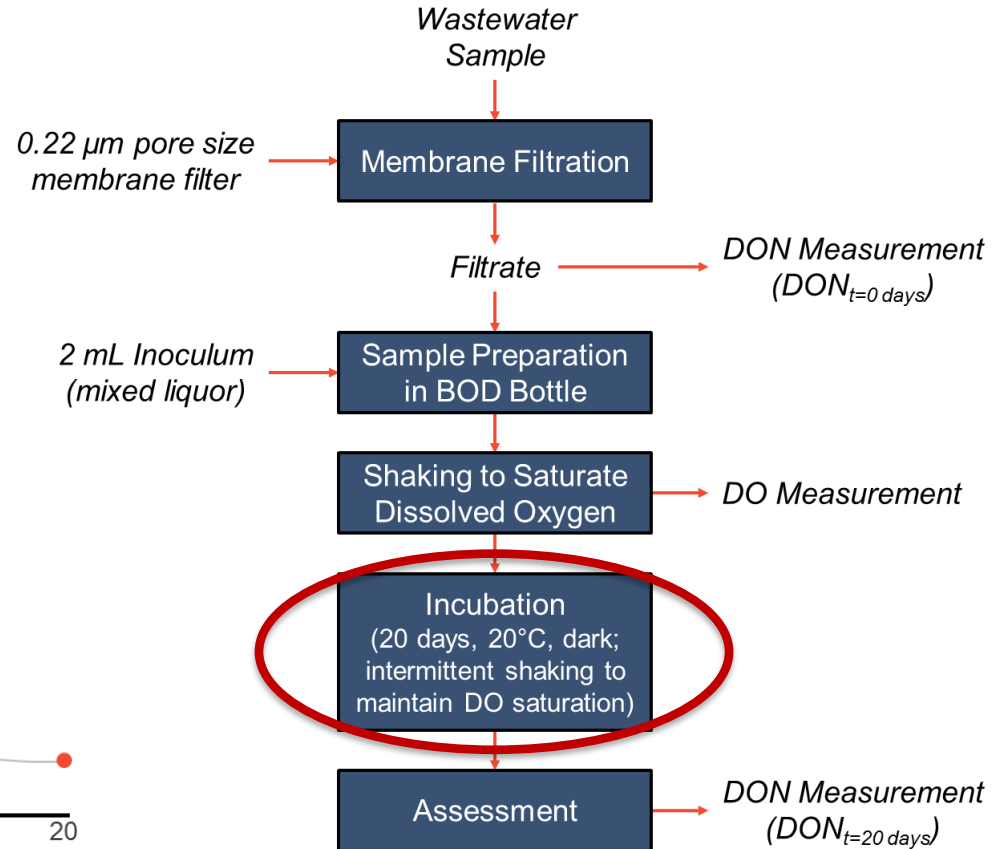
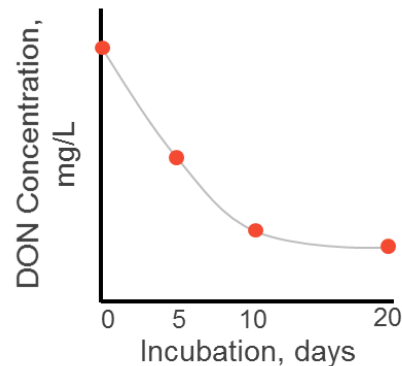
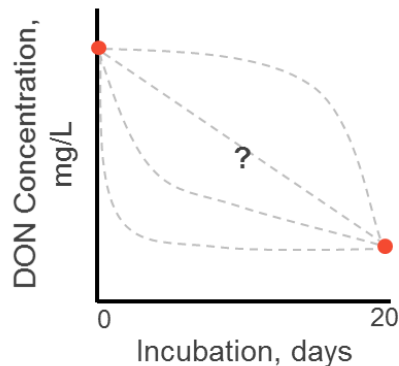
# nbDON Quantification: Bioassay Method

- Inoculum depends on bioassay type
  - Technology-based: WWTP MLSS (bacteria)
  - Water quality-based: Representative of receiving water (bacteria/algae)
- Triplicate testing recommended



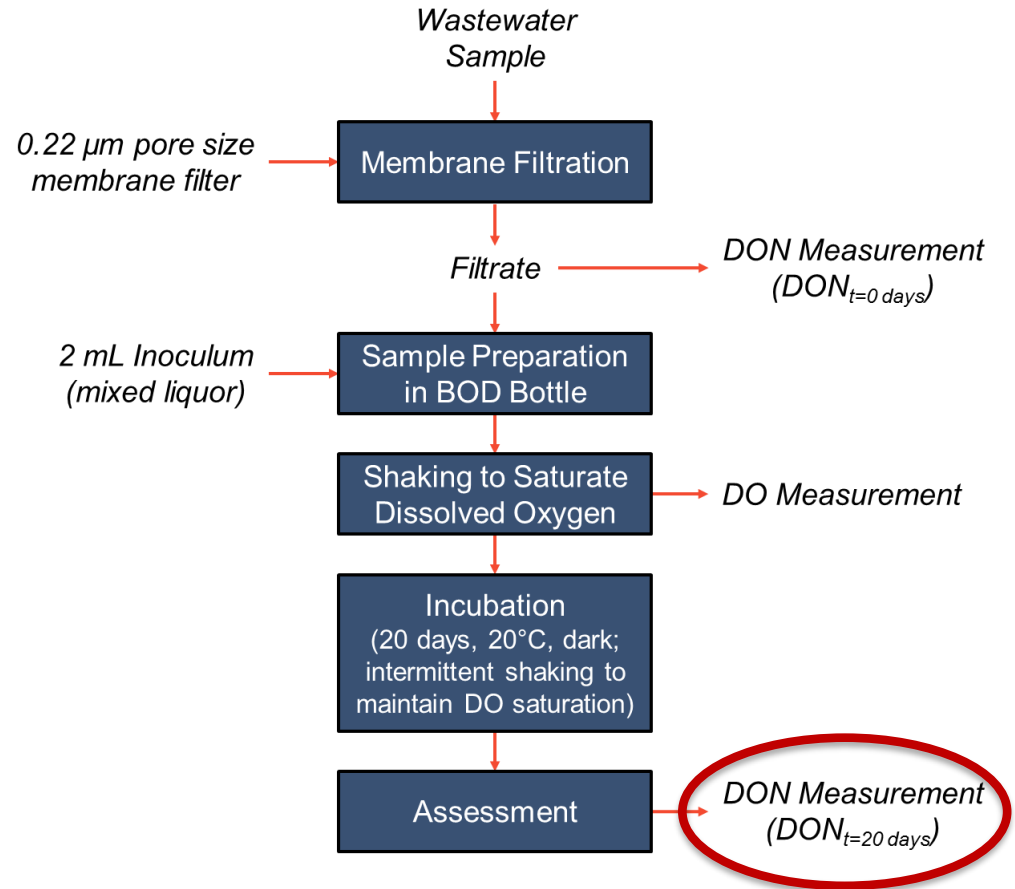
# nbDON Quantification: Kinetic Enhancement

- Base method:
  - Two sampling times
  - Pre- and post-incubation
- Kinetic enhancement:
  - Sampling times throughout incubation to further define **biodegradation kinetics**



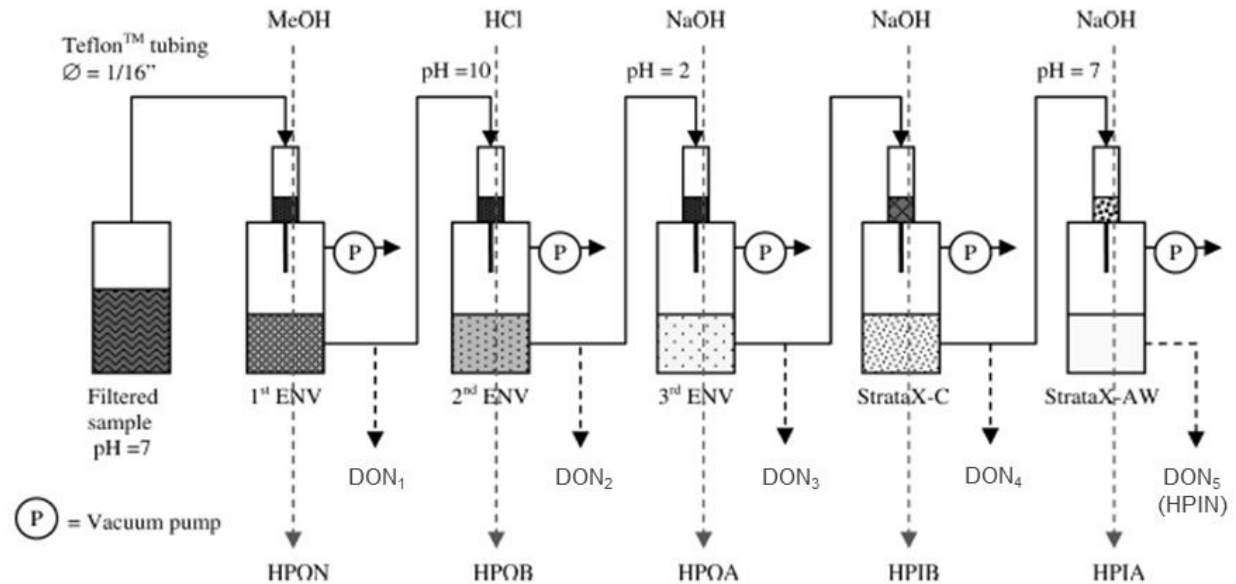
# nbDON Quantification: Fractionation Enhancement

- Base method:
  - One aggregate nbDON measurement
- Fractionation enhancement:
  - One aggregate nbDON measurement and contributing fractions
  - Further defines nbDON quality
  - **Important for treatability**



# nbDON Quantification: Fractionation Enhancement

- Fractionation based on polarity and acid/base/neutral properties
  - Two fractions: Hydrophobic vs. hydrophilic
  - Six fractions: Hydrophobic vs. hydrophilic; acid vs. neutral vs. base



*Certain fractions lend themselves to certain treatment technologies*

# nbDON Quantification: Summary

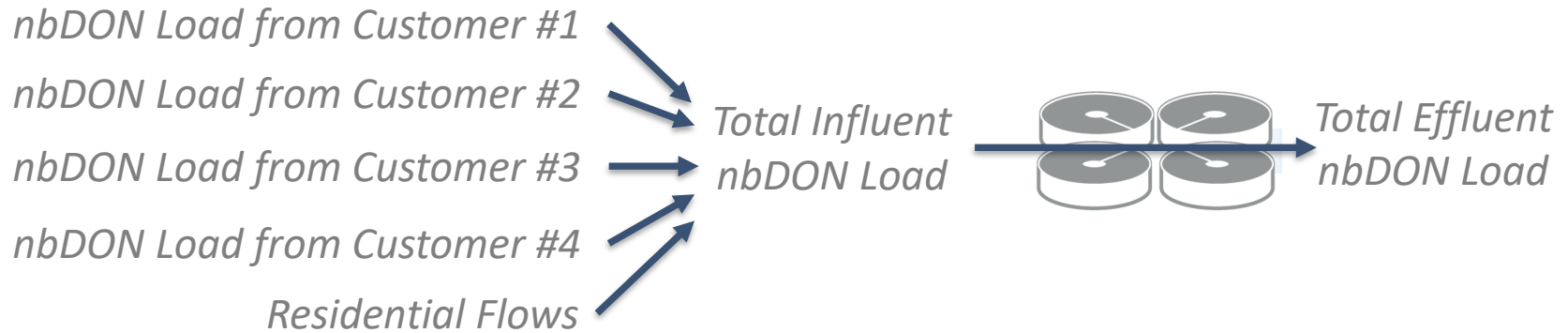
Method	Objective	Pros	Cons
Technology-based bioassay	<ul style="list-style-type: none"> <li>To measure the fraction of DON susceptible to biodegradation during wastewater treatment</li> </ul>	<ul style="list-style-type: none"> <li>Stand-alone method</li> <li>Can be setup to assess a specific wastewater treatment process</li> </ul>	<ul style="list-style-type: none"> <li>Not a commercially available test</li> <li>Multi-day (20 days) incubation period</li> </ul>
Water quality-based bioassay	<ul style="list-style-type: none"> <li>To measure the fraction of DON susceptible to biodegradation in the environment</li> </ul>	<ul style="list-style-type: none"> <li>Stand-alone method</li> <li>Can be setup to assess a specific receiving water</li> </ul>	<ul style="list-style-type: none"> <li>Not a commercially available test</li> <li>Multi-day (20 days) incubation period</li> </ul>
Kinetic enhancement	<ul style="list-style-type: none"> <li>To further define DON biodegradation kinetics during bioassay incubation</li> </ul>	<ul style="list-style-type: none"> <li>Provides insights into DON removal during wastewater treatment and anticipated impacts of process modifications</li> </ul>	<ul style="list-style-type: none"> <li>Must be used in tandem with DON bioassay</li> </ul>
Fractionation enhancement	<ul style="list-style-type: none"> <li>To further define the quality of nbDON</li> </ul>	<ul style="list-style-type: none"> <li>Provides insights into nbDON treatability and informs treatment technology selection</li> </ul>	<ul style="list-style-type: none"> <li>Must be used in tandem with DON bioassay</li> </ul>

# nbDON Quantification: Costs

nbDON Method	Cost per Sample	Analytes per Sampling Event	Notes
Bioassay Method (analysis conducted pre- and post-incubation)	\$600	Dissolved oxygen, dissolved total Kjeldahl nitrogen, dissolved ammonia nitrogen, dissolved nitrogen oxides	Cost includes bioassay preparation and incubation monitoring to ensure continued dissolved oxygen availability
Kinetic Enhancement (pre- and post-incubation plus two intermediate samples)	\$1,200	Same as bioassay method	Additional sampling events may be included for a cost of \$100 per additional sampling event per replicate
Fractionation Enhancement (two nbDON fractions: hydrophobic and hydrophilic)	\$750	Same as bioassay method	----
Fractionation Enhancement (six nbDON fractions: HPON, HPOB, HPOA, HPIN, HPIB, HPIA)	\$1,500	Same as bioassay method	-----

# Recommendations for Johnston County

- Goals:
  - Conduct a headworks analysis of influent nbDON loads
  - Determine the anticipated effectiveness of nbDON management via the County's Pretreatment Program
  - Develop in-house nbDON analytical capabilities



# Johnston County Sampling Plan

Sampling Location	Sampling Events	Bioassays by NSDU		Bioassays by Johnston County		Number of Surrogate Analysis Samples (Total BOD, soluble BOD, total COD, soluble COD, DOC and SUVA254)
		Replicates per Event	Total	Replicates per Event	Total	
Combined WWTF influent wastewater	3	3	9	1	3	18
WWTF effluent	3	3	9	1	3	18
SIU #1	3	3	9	1	3	18
SIU #2	3	3	9	1	3	18
SIU #3	3	3	9	1	3	18
SIU #4	3	3	9	1	3	18
Residential raw wastewater	3	3	9	1	3	18
Total samples		21		21		42

# Sampling Protocol

- 1 L of sample required at each location
- All samples must be filtered through a 0.3 um glass membrane to avoid contamination
  - Other types of filters can leach dissolved carbon and nitrogen
  - Filtering through a 1 um glass fiber filter first is fine
- Amber bottles with narrow necks must be used
- 0.5 L of MLSS shipped with each sample set
- Samples shipped overnight in coolers with ice packs

Questions?