ATTACHMENT 14

Memorandum

One Tech Drive, Suite 310
Andover, MA 01810-2435

T: 978.794.0336

Prepared for: City of Rochester, NH

Project Title: NPDES Permitting Support

Project No.: 150914

Technical Memorandum

Subject: Total Nitrogen Treatment Cost Updates

Date: January 30, 2020

To: Peter Nourse, PE

Michael Bezanson, PE

David Green

From: Mark Allenwood, PE

The City of Rochester, New Hampshire owns and operates a 5.0 million gallon per day (MGD) wastewater treatment facility (WWTF) which discharges treated effluent to the Cocheco River. The Cocheco River is within the Great Bay watershed and forms the Piscataqua River where the Cocheco and Salmon Falls Rivers meet.

The WWTF operates under a National Pollutant Elimination Discharge (NPDES) Permit which expired in 2002, but is administratively continued until a new NPDES permit is issued. The permit includes the following pollutant limitations:

Parameter	NPDES Permit Limit
Carbonaceous biochemical oxygen demand	6 mg/L summer, 13 mg/L winter
Total suspended solids	6 mg/L summer, 13 mg/L winter
Total ammonia as NH_3 (ave monthly)	3.61 mg/L summer, 7.65 mg/L winter
pH	6.5 to 8.0 SU
Dissolved oxygen	7.0 mg/L
E-coli	126/100 mL (geo mean), 406/100 mL (max day)

In 2012 the City retained Brown and Caldwell (BC) to evaluate the WWTF and model options to meet total nitrogen (TN) levels of 8 mg/L and 3 mg/L on both a seasonal and an annual basis. That evaluation confirmed that modifications to the WWTF within the existing tankage could not meet a TN limit of 3 mg/L seasonally or annually and could not meet a TN limit of 8 mg/L outside the growing season. The evaluation did, however, identify simultaneous nitrification/denitrification (SND) as a potential option to reduce effluent TN during the growing season.

In 2013 the City performed a full scale pilot test of the SND process to voluntarily reduce total effluent nitrogen discharged from the City's WWTF. The pilot test showed that TN could be reduced to 8 mg/L or less during the growing season, and the City has operated the WWTF in the SND mode since 2013. Due to the limitation of the SND process, wastewater temperatures during cold weather and mixing limitations within the aeration basin, effluent TN outside the growing season is in the 11-14 mg/L range.

To address the potential for TN limits of 8 and 3 mg/L as an annual average limit, BC evaluated three additional treatment options: 1) converting the secondary treatment process to a four stage Bardenpho process; 2) post aeration treatment using denitrification filters; and 3) post aeration treatment using membrane biological reactors (MBBR). Based on the evaluation of these three options, the MBBR was determined to be the most cost effective to reliably meet low level annual average TN limits..

In January of 2020, the Environmental Protection Agency (EPA) issued a DRAFT General Permit for the Great Bay watershed to address nitrogen loading to the Great Bay. This General Permit will limit Rochester's total nitrogen discharge to an annual average of 198 pounds per day of total nitrogen. This mass based permit will limit Rochester's WWTF discharge to 7.9 mg/L TN [1]at 3.0 MGD and 4.8 mg/L TN[2] at 5.0 MGD on an annual rolling average basis. To meet these permit limits, a dedicated nitrogen removal process will be required at the WWTF.

For the purposes of this memorandum, the previously evaluated TN limit of 8 mg/L is considered the same as a TN limit of 7.9 mg/L, with capital, operations and maintenance costs considered equal. Additionally,

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[1] $198\ pounds\ per\ day\ \div 8.34\ pounds\ per\ gallon\ \div 3.0\ MGD\ = 7.9\ mg/L$

[2] $198\ pounds\ per\ day\ \div 8.34\ pounds\ per\ gallon\ \div 5.0\ MGD\ = 4.8\ mg/L$

the capital cost previously estimated for a TN of 3 mg/L would be the same as the capital cost for an MBBR to meet a TN of 4.8 mg/L. The operating and maintenance costs for the lower TN limit would be slightly higher. However, for the purposes of this memorandum, additional BioWin® modeling of the process has not been completed to estimate supplemental carbon requirements at the higher TN limit. For the purposes of this memorandum, TN limits of 8 mg/L and 7.9 mg/L are considered equal, as are TN limits of 3 mg/L and 4.8 mg/L considered equal. All limits are based on an annual rolling average permit basis.

Following standard engineering practice, the design of the MBBR would be based on 80 percent of the nitrogen limit to provide a 20 percent buffer between the permit limit and actual operations. The design buffer is required to account for operational variables such as influent and recycle flows, influent TN load and water temperature. Therefore, for a TN limit of 8 mg/L, the system would be designed to meet an effluent TN level of 6.4 mg/L and for a TN limit of 3 mg/L, the system would be designed to meet an effluent TN level of 2.4 mg/L.

As noted above, the MBBR process has been identified as the most cost effective option to meet the TN limits in the General Permit. The MBBR process would be constructed adjacent to the sludge dewatering facility which is currently under construction. The MBBR process would be a three stage-two train system, with both trains running in parallel. The first stage would be anoxic with a volume of 42,000 cubic feet (cf) for both trains. The second stage would also be anoxic with a volume of 18,000 cf for both trains, and the third stage would be aerobic with a volume of 9,000 cf for both trains.

An MBBR is a hybrid fixed film process which requires an inert media for the biofilm to grow in both the first and second stage of each train. Support equipment would include three (3) mixers in the first stage of each train and one (1) mixer in the second stage of each train. The third stage would not contain media, but would be aerated at a rate of 125 standard cubic feet per minute (scfm) of process air per train, or 250 scfm total.

The MBBR tanks would be constructed of cast in place concrete. A foundation support system will be required due to clay soils in the area, and it is assumed the MBBR would be constructed on an H-Pile system driven to bedrock, similar to the sludge dewatering facility. For an annual average TN limit of 8 mg/L, the second stage would not be required. However, due to constructability issues, it is recommended that the MBBR tanks be constructed to meet an annual average TN limit of 3 mg/L. The second stage could be bypassed if operated to meet a TN limit of 8 mg/L.

The aeration blowers would be housed in a small masonry block structure located on or adjacent to the MBBR tanks. Supplemental carbon will be required to promote the denitification process, and it is assumed that the current source of acetic acid would be used for this purpose. The acetic acid would be stored in the carbon storage building, currently under construction.

A schematic layout of the MBBR system is shown in Figure 1.

The opinion of cost for an MBBR system to meet an annual average TN limit of 3 mg/L is approximately $14,200,000 and to meet an annual average TN limit of 8 mg/L is approximately $12,900,000 in 2020 dollars. Both include the cost of the carbon storage building. While the concrete structure for both TN limits would be the same, the reduced costs for a TN limit of 8 mg/L reflects the absence of media and mixers provided for the second anoxic stage.

Estimated annual operations and maintenance costs are $980,000 per year for a TN of 3 mg/L and $840,000 per year for a TN of 8 mg/L. These costs include electrical costs to operate the support equipment and assume Micro-C® would be used as a supplemental carbon source should the acetic acid currently received at no cost no longer be available.

A summary of costs is provided in Table 1 for an annual average TN of 3 mg/L and Table 2 for an annual average TN of 8 mg/L.

Figure 1 – MBBR Schematic Layout

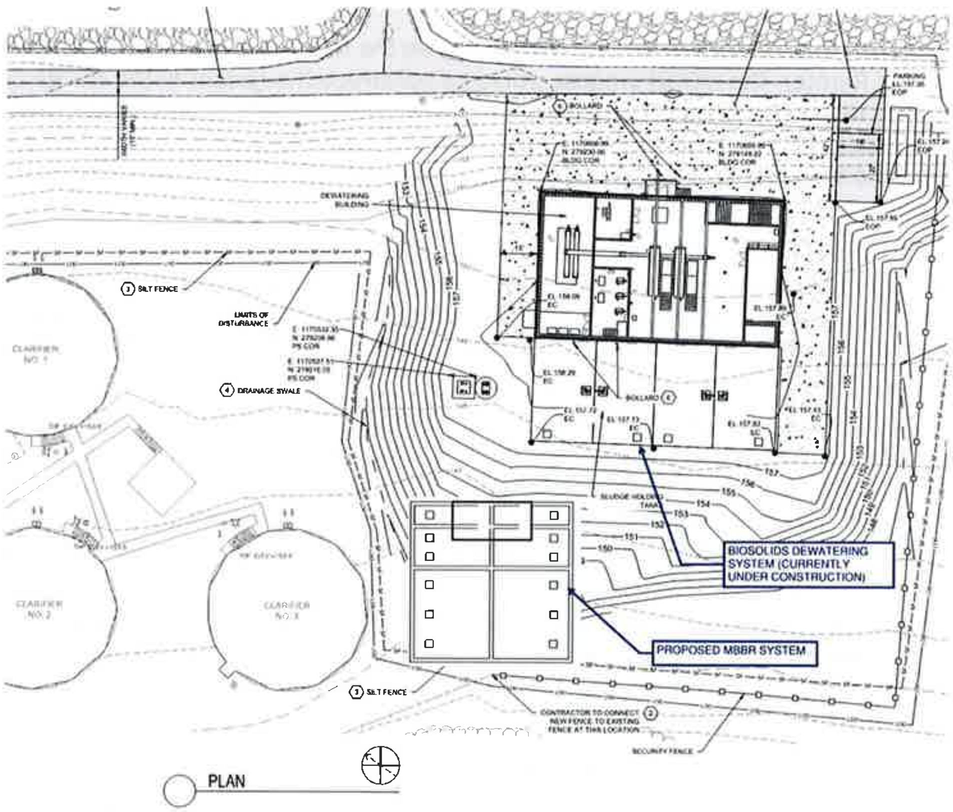

Table 1 – Summary of Costs for Annual Average TN 3 mg/L

Item	Quantity	Units	Unit Cost	Extended Cost
Excavation	4,800	CY	$ 30	$ 144,000
Backfill	535	CY	$ 40	$ 21,400
Concrete Base Slab	305	CY	$ 1,000	$ 305,000
Concrete Tank Walls	540	CY	$ 1,200	$ 648,000
Concrete Top Slab	230	CY	$ 1,800	$ 414,000
Equipment Building	840	SF	$ 400	$ 336,000
Equipment (installed)	1	LS	$ 1,950,000	$ 1,950,000
Piping	1	LS	$ 580,000	$ 580,000
Electrical	1	LS	$ 580,000	$ 580,000
Instrumentation	1	LS	$ 580,000	$ 580,000
Site Work	1	LS	$ 200,000	$ 200,000
H-Pile Supports	1	LS	$ 500,000	$ 500,000
			Subtotal	$ 6,258,400
Contingency (25%)				$ 1,564,600
Engineeering (20%)				$ 1,251,680
		Total 2012 Dollars		$ 9,074,680
CCI 2012 to 2020 Increase				23%
		Total 2020 Dollars		$ 11,140,940.51
Carbon Storage Building (bid price 2019)				$ 2,974,150
.	Grand Total, 2020 Dollars			$ 14,115,091
			Use	**$ 14,200,000**

Estimate Annual Operating Costs	**$980,000**

Notes:
The CCI 2012 to 2020 increase value is based on the Engineering New Record Construction Cost Index change from September 2012 when the cost estimate was originally developed to January 2020. These values are as follows for the Boston index:

September 2012: CCI = 12,024.06
January 2020 CCI = 14,761.88

$$(14761.88 - 12024.06) \div 12024.06 = 23\% \ increase$$

Brown AND Caldwell

Table 2 – Summary of Costs for Annual Average TN 8 mg/L

Item	Quantity	Units	Unit Cost	Extended Cost
Excavation	4,800	CY	$ 30	$ 144,000
Backfill	535	CY	$ 40	$ 21,400
Concrete Base Slab	305	CY	$ 1,000	$ 305,000
Concrete Tank Walls	540	CY	$ 1,200	$ 648,000
Concrete Top Slab	230	CY	$ 1,800	$ 414,000
Equipment Building	840	SF	$ 400	$ 336,000
Equipment (installed)	1	LS	$ 1,477,500	$ 1,477,500
Piping	1	LS	$ 501,885	$ 501,885
Electrical	1	LS	$ 501,885	$ 501,885
Instrumentation	1	LS	$ 501,885	$ 501,885
Site Work	1	LS	$ 167,295	$ 167,295
H-Pile Supports	1	LS	$ 500,000	$ 500,000
			Subtotal	$ 5,518,850
Contingency (25%)				$ 1,379,713
Engineeering (20%)				$ 1,103,770
		Total 2012 Dollars		$ 8,002,333
CCI 2012 to 2020 Increase				23%
		Total 2020 Dollars		$ 9,842,868.98
Carbon Storage Building (bid price 2019)				$ 2,974,150
.	Grand Total, 2020 Dollars			$ 12,817,019
			Use	**$ 12,900,000**

Estimate Annual Operating Costs	**$840,000**

Notes:

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$$(14761.88 - 12024.06) \div 12024.06 = 23\% \; increase$$

ATTACHMENT 15

Memorandum

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T: 978.794.0336

Prepared for: City of Rochester, NH

Project Title: NPDES Permitting Support

Project No.: 150914

Technical Memorandum

Subject: Total Phosphorus Treatment Cost Updates

Date: January 30, 2020

To: Peter Nourse, PE

Michael Bezanson, PE

David Green

From: Mark Allenwood, PE

The City of Rochester, New Hampshire owns and operates a 5.0 million gallon per day (MGD) wastewater treatment facility (WWTF) which discharges treated effluent to the Cocheco River. The Cocheco River is within the Great Bay watershed and forms the Piscataqua River where the Cocheco and Salmon Falls Rivers meet.

The WWTF operates under a National Pollutant Elimination Discharge (NPDES) Permit which expired in 2002, but is administratively continued until a new NPDES permit is issued. The permit includes the following pollutant limitations:

Parameter	NPDES Permit Limit
Carbonaceous biochemical oxygen demand	6 mg/L summer, 13 mg/L winter
Total suspended solids	6 mg/L summer, 13 mg/L winter
Total ammonia as NH_3 (ave monthly)	3.61 mg/L summer, 7.65 mg/L winter
pH	6.5 to 8.0 SU
Dissolved oxygen	7.0 mg/L
E-coli	126/100 mL (geo mean), 406/100 mL (max day)

In general, TP limits greater than 0.50 mg/L can be met with chemical addition at various locations within the treatment process to coagulate the phosphorus and have it settle out in the secondary clarifiers. For TP limits less than 0.50 mg/L, a dedicated tertiary process is typically required to meet lower limits. In 2012 the City retained Brown and Caldwell (BC) to evaluate the WWTF and evaluate options to meet total phosphorus (TP) levels of 0.10 to 0.20 mg/L, and in more recent years, the Environmental Protection Agency (EPA) has indicated that the City of Rochester will receive a 0.12 mg/L TP limit when the new NPDES permit is issued.

In 2009 Cambridge Water Technology, the then owner of the CoMag® process, requested permission to test the process on the algae laden liquid in the storage lagoons at the City's WWTF. The City agreed and, following the testing on the lgaoons, the CoMag process was tested on secondary effluent to confirm that it would meet TP limits of 0.10 mg/L or less. That testing proved positive, and based on BC's experience with the process, has recommended that CoMag be fully pilot tested to confirm the initial findings.

The CoMag process would be completely enclosed in a building that would house the reaction tanks, tertiary clarifiers, chemical storage and all associated equipment and controls. The process would include the following:

- Five (5) concrete reaction tanks operating in series, each approximately 11 feet wide by 11 feet long and 11 feet deep;
- Two (2) concrete rectangular tertiary clarifiers, each approximately 45 feet long and 15 feet wide;
- Two (2) 1.5 h.p. clarifier sludge collection systems;
- Two (2) 5 h.p. shear mills (one standby);
- Two (2) 5 h.p. magnetic drum separators (one standby);
- Three (3) 20 h.p. sludge pumps (one standby);

Following standard engineering practice, the design of the CoMag process would be based on 80 percent of the TP limit to provide a 20 percent buffer between the permit limit and actual operations. The design buffer is required to account for operational variables such as influent and recycle flows, influent TP load and chemical reactivity. For a TP limit of 0.12 mg/L, the system would be designed to meet an effluent TP level of 0.10 mg/L. Unlike the denitrification process, the CoMag process is not impacted by wastewater temperatures. Therefore, the system would either be operated year round to meet a annual average, or operated during the growing season, if the permit limit is seasonally based.

The CoMag process is a physical-chemical process that requires chemical addition to reduce the pH of the wastewater to bring dissolved phosphorus out of solution, a coagulant to destabilize the phosphorus particle charge and a flocculant to bind the phosphorus into a settleable solid. The chemical addition would take place in the five mix tanks and the settling would take place in the tertiary clarifiers.

The CoMag tanks would be constructed of cast in place concrete. A foundation support system will be required due to clay soils in the area, and it is assumed the process would be constructed on an H-Pile system driven to bedrock, similar to the sludge dewatering facility.

The support equipment would be housed in a small masonry block structure located on or adjacent to the CoMag tanks.

A schematic layout of the CoMag system is shown in Figure 1.

The opinion of cost for the CoMag system to meet a TP limit of 0.12 mg/L is approximately $15,600,000 in 2020 dollars. Estimated annual operations and maintenance costs are $260,000 per year for a TP limit of 0.12 mg/L. These costs include electrical costs to operate the support equipment and chemical costs and are based on year-round operation. A summary of costs is provided in Table 1.

Figure 1 – MBBR Schematic Layout

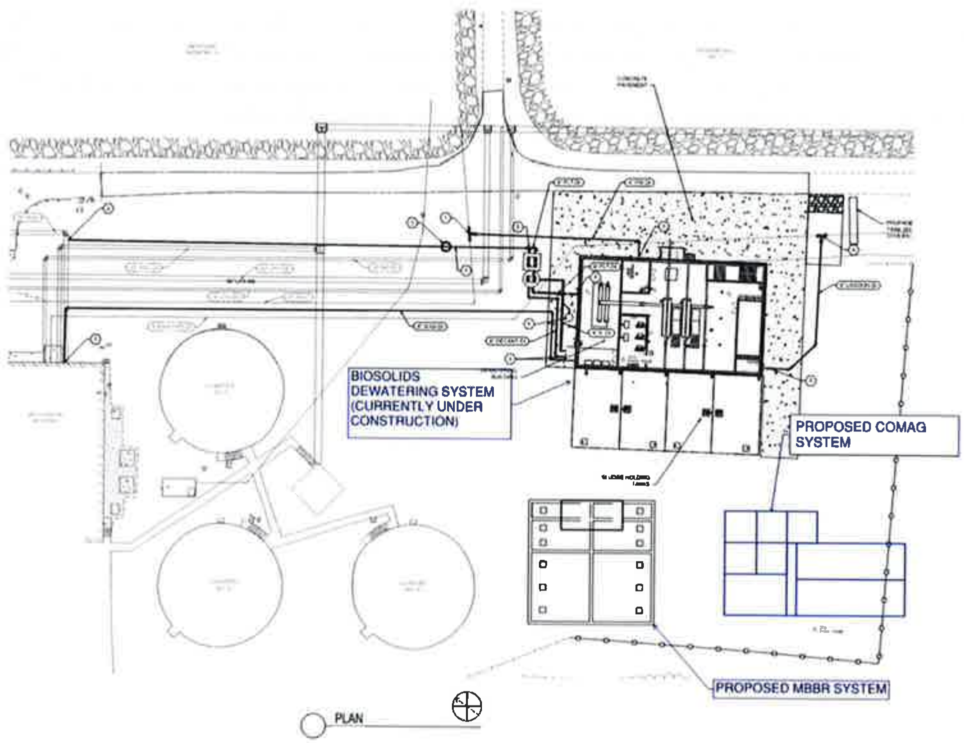


Table 1 – Summary of Costs for Annual Average TP 0.12 mg/L

Item	Quantity	Units	Unit Cost	Extended Cost
Excavation	1,950	CY	$ 30	$ 58,500
Backfill	360	CY	$ 40	$ 14,400
Concrete Base Slabs	220	CY	$ 1,000	$ 220,000
Concrete Tank Walls	190	CY	$ 1,200	$ 228,000
Concrete Top Slab	220	CY	$ 1,800	$ 396,000
Equipment Building	1000	SF	$ 250	$ 250,000
Equipment (installed)	1	LS	$ 3,200,000	$ 3,200,000
Piping	1	LS	$ 1,310,070	$ 1,310,070
Electrical	1	LS	$ 1,310,070	$ 1,310,070
Instrumentation	1	LS	$ 873,380	$ 873,380
Site Work	1	LS	$ 436,690	$ 436,690
H-Pile Supports	1	LS	$ 400,000	$ 400,000
			Subtotal	$ 8,697,110
Contingency (25%)				$ 2,174,278
Engineeering (20%)				$ 1,739,422
			Total 2012 Dollars	$ 12,610,810
CCI 2012 to 2020 Increase				23%
			Grand Total, 2020 Dollars	$ 15,511,295.69
			Use	**$ 15,600,000**

Estimate Annual Operating Costs	**$260,000**

Notes:
The CCI 2012 to 2020 increase value is based on the Engineering New Record Construction Cost Index change from September 2012 when the cost estimate was originally developed to January 2020. These values are as follows for the Boston index:

September 2012: CCI = 12,024.06
January 2020 CCI = 14,761.88

$$(14761.88 - 12024.06) \div 12024.06 = 23\% \ increase$$

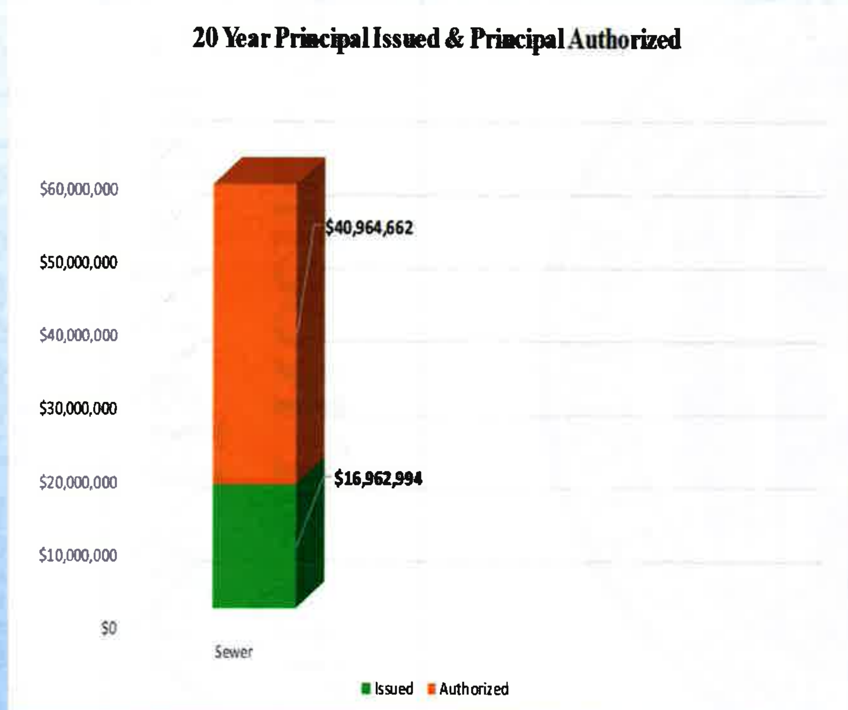
ATTACHMENT 16

City of Rochester
New Hampshire

EPA Sewer Financial Impacts
Debt Service & User Rates

M. Sullivan Deputy Director Finance 2-20-20

SEWER FUND: CURRENT DEBT POSITION



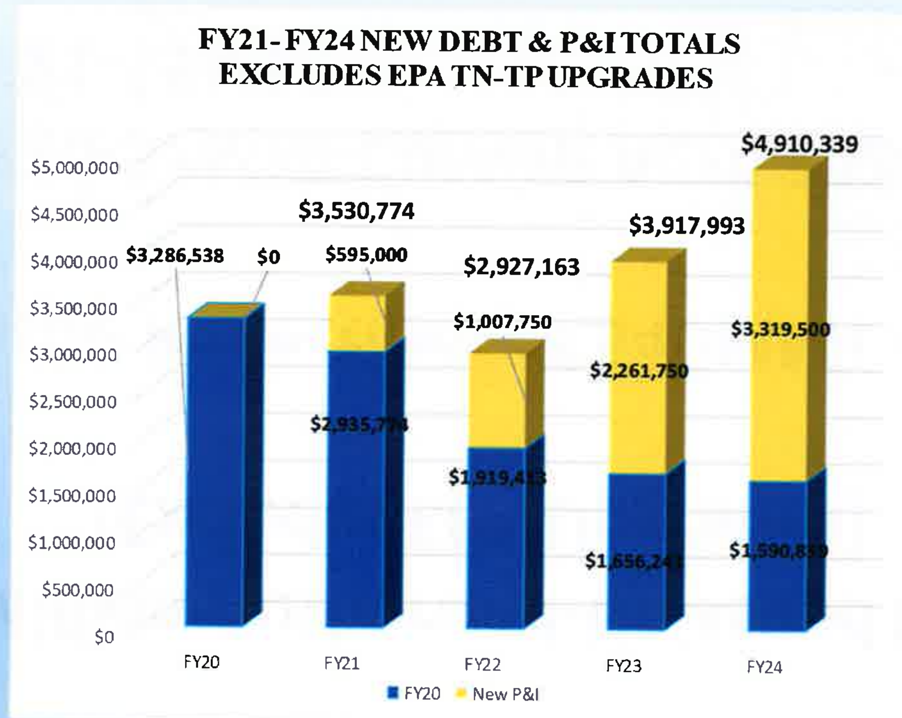
SEWER FUND: BOND ISSUE CYCLES

$ 40 Million-Authorized-Unissued Bonds
(Excludes EPA Upgrades)

Debt Issue Projections of $40MM:

FY20-$7MM-Current April 2020 bond issue
FY21-$5MM
FY22-$15MM
FY24-$13MM

SEWER FUND: FORECASTED DEBT POSITION



SEWER FUND: NEW BOND ISSUES IMPACT

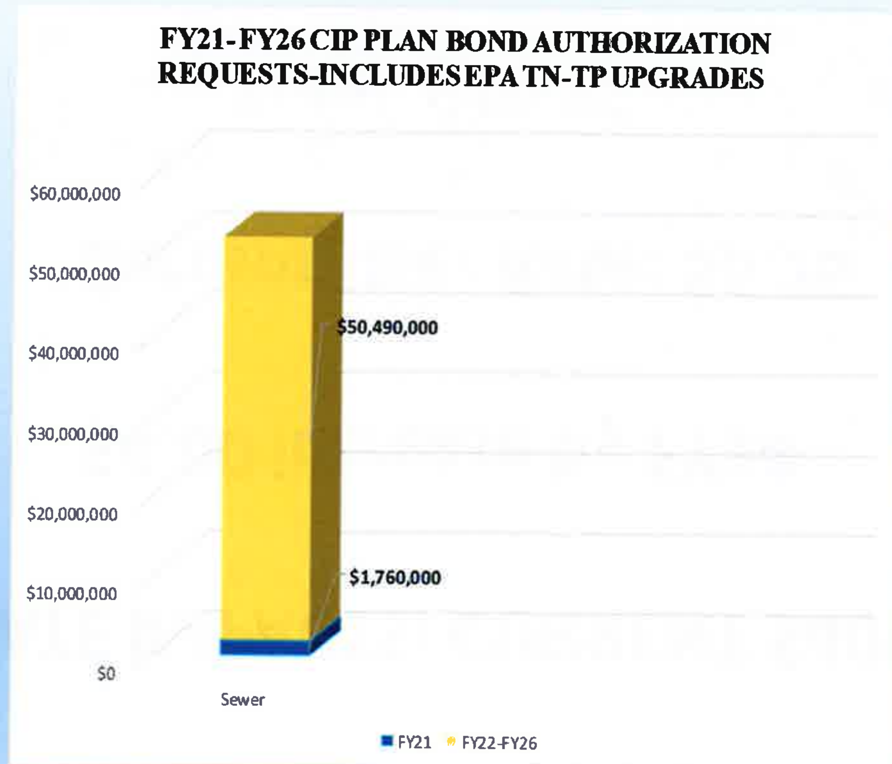
USER RATE IMPACTS: CURRENT $40MM FY20-FY24

$4.00 increase by FY24

Current User Rate: $6.75

Total: $10.75

SEWER FUND: FUTURE CIP BOND REQUESTS



SEWER PLANT: EPA TN-TP UPGRADE IMPACTS

$ 30 Million Facility Upgrade-Nitrogen & Phosphorus

$ 2.4 Million Annual Debt Service Payments
$ 1.2 Million Annual Operating Expenses
Total Annual Expenses: $ 3.5 Million

User Rate Impact: $5.00 per unit

SEWER PLANT: EPA TN-TP UPGRADE IMPACTS

Other Anticipated Impacts

- Significant water conservation efforts, reduced revenues
- Increases in customer delinquencies
- Increases in requests for sewer deduct meters
- Increases in system tampering
- Additional Meter Technician staffing resources

Additional User Rate Impact: $2.00-$3.00 per unit

SEWER PLANT: EPA TN-TP UPGRADE IMPACTS

Loss of Large Volume User

- Large volume user is equivalent of 2,000 residential accounts.

- **Additional User Rate Impact: $2.00-$3.00 per unit**

EPA Direct & Potential Indirect User Rate Increase
$11.00

SEWER PLANT: EPA TN-TP UPGRADE IMPACTS

- **Current Sewer User Rate: $6.75**
- Other User Rate Increases-Current Authorized FY20-FY24: **$4.00**
- Direct **TN & TP** EPA Related User Rate Increase: **$5.00**
- Anticipated Indirect EPA User Rate Increases: **$3.00**
- EPA impact- Loss of High Volume User: **$3.00**

Grand Total Sewer User Rate: $21.75

SEWER PLANT: CURRENT & EPA UPGRADE IMPACTS

Average Residential Annual Sewer Bills

- Current Average Residential: **$472- 70 units Annually**
- Current Authorized & Unissued Projects: **$280**
- Direct EPA Increases TN & TP: **$350**
- Other Indirect EPA Increases: **$420**
- **Estimated Average Annual Residential Bill: $1,522**

SEWER PLANT UPGRADE IMPACTS

Community Demographics*

Category	Service Area Tracts-Rochester	Strafford & Rockingham Counties
Median Household Income	$46,800	$79,250
Median Home Value (2018)	$185,600	$293,000
Households with Population 65+	30%	27%
% with Social Security Income	40%	30%
Population Under Poverty Level	***20%***	7%
% of Households with Public Assistance	11%	2%
% of Households with Food Stamps /SNAP	25%	6%
% of Households with Disability	39%	23%

*Source: Applied Economic Research June 2019 Analysis

SEWER PLANT: EPA UPGRADE IMPACTS

Community Demographics*

- Large User Rate increases displace funds that support mortgages
- Potential for average loss of value of $16,000 per residential unit
- Combined $80 million loss in residential values in the service tract
- User Rate represents 2.7% of median household income-high impact

*Source: Applied Economic Research June 2019 Analysis

ATTACHMENT 17

Geosyntec consultants

vhb

Memorandum

Date:	April 15, 2020
To:	Peter C. Nourse, Director of City Services, Michael Bezanson, P.E., City Engineer, Department of Public Works, City of Rochester, New Hampshire
From:	Daniel Bourdeau, P.E., CPESC, CPSWQ, and Renee L. Bourdeau, P.E., Geosyntec Consultants Bill Arcieri, VHB
CC:	Sherry Young, Rath, Young and Pignatelli, John Coon, JD, PhD
Subject:	Preliminary Response to Environmental Protection Agency Region 1 Draft Great Bay Total Nitrogen General Permit (NPDES Permit No. NHG58A000)

The Environmental Protection Agency (EPA) released a Draft National Pollutant Discharge Elimination System (NPDES) Great Bay Total Nitrogen General Permit (GBTN GP) on January 7, 2020 for twelve municipalities with wastewater treatment facilities that discharge to the Great Bay watershed in New Hampshire. The current draft of the GBTN GP would require the City of Rochester (Rochester or City) to significantly reduce the total nitrogen load from the wastewater treatment facility (WWTF). The GBTN GP also includes an optional non-point source nitrogen reduction pathway described in Appendix II of the draft permit. The optional pathway identified in the GBTN GP is intended for municipalities to meet load reduction targets before making significant additional investment in WWTF upgrades. However, that is not the case for the City of Rochester. The permit as drafted will require significant investment in Rochester's WWTF for total nitrogen treatment.

Under this optional pathway, a multi-year/stepped approach is proposed to reduce Rochester's estimated non-point source load by approximately 45% over a 23-year period from the effective permit date. This memorandum summarizes preliminary order of magnitude investments that would be required of Rochester to meet the optional 45% non-point source load reduction.

I. SUMMARY OF TOTAL NITROGEN BASELINE LOAD ESTIMATES

For simplicity and purposes of this preliminary assessment, we used the baseline non-point source load estimate generated by the Great Bay Nitrogen Non-Point Source Study (GBNNPSS) prepared by New Hampshire Department of Environmental Services (NHDES) in 2014[1]. However, NHDES includes a disclaimer in the GBNNPSS report that states that the model results should only be used for planning purposes and it was not intended to be used for regulatory purposes. Despite this

[1] Great Bay Nutrient Non-Point Source Study (https://www.des.nh.gov/organization/divisions/water/wmb/coastal/documents/gbnnpss-report.pdf)

disclaimer, US EPA relied upon the NHDES model for calculating non-point source loads from the Lower Piscataqua River area in the GBTN GP Fact Sheet. The City of Rochester may choose to use alternative non-point source accounting methods in the future, potentially including a refined version of the NHDES model, since the model was not developed for regulatory purposes. GBNNPSS developed non-point source load estimates for various nitrogen sources including atmospheric deposition on both impervious and pervious surfaces; chemical fertilizer application on lawns, managed turf and agriculture; agriculture livestock and pet waste; and human waste (septic systems). The load estimates for each of these sources were based on various default model assumptions (*i.e.*, not site-specific), estimated septic system use and other local factors contributing to loads, land use in the Great Bay Estuary (GBE) watershed, as well as assumed travel pathways along which attenuation was specified by default model parameters. A core assumption of the model is that all nitrogen loads that enter the watershed in a given year are delivered to the GBE in that same year (*i.e.*, no accounting of lag times associated with nitrogen transport).

In the GBTN GP Fact Sheet, EPA recommends that baseline non-point source load estimates be normalized to account for an average rainfall year. Therefore, the estimated delivered non-point source load identified in the GBNNPSS for Rochester is decreased from 109,003 lbs N/year (299 lbs N/day) to 93,668 lbs. N/year (257 lbs N/day)[2]. To achieve the 45% reduction target, Rochester would need to reduce the estimated delivered non-point source load by approximately 42,151 lbs N/year (115 lbs N/day) at the end of the 23-year permit period to achieve a future estimated non-point source load of 51,517 lbs N/year[3].

Figure 1 presents the estimated delivered non-point source load by source with human waste (septic systems) contributing to 36% of the total load, followed by atmospheric deposition (31%), fertilizer (21%) and animal/pet waste (12%).

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[2] GBNNPSS estimated Rochester's non-point source load is 109,003 lbs N/year, based on 2009 rainfall (a wet year). The value was multiplied by 0.86 which is the ratio of the 2009 annual rainfall (52.6 in/yr) and the average annual rainfall from 1989-2017 (45.2 in/yr). Rainfall adjusted load = (45.2/52.6)*109,003 lbs N/year = 93,668 lbs N/year.
[3] Future estimated non-point source load = 93,668 lbs N/year – 42,151 lbs N/year = 51,517 lbs N/year.

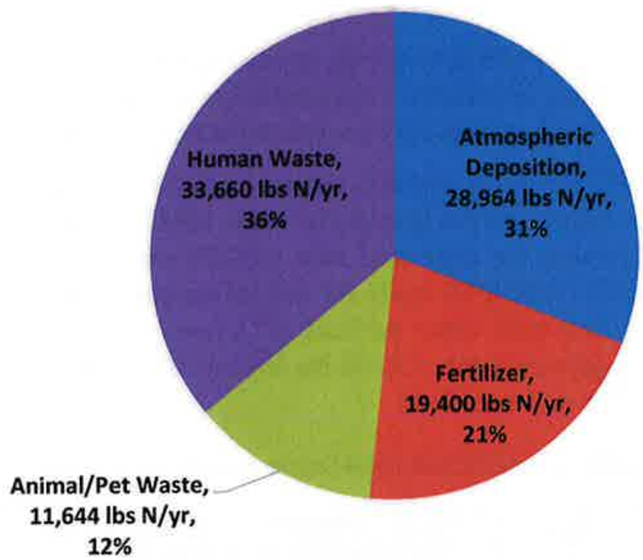

Figure 1. Rainfall Adjusted Estimated Delivered Non-Point Source Load (GBNNPSS, normalized for rainfall)

Table 1 presents the City of Rochester's rainfall adjusted estimated non-point source load by source and applied land uses. Both the initial and delivered loads are presented in this table. The initial load is the nitrogen load contributed from the various watershed surfaces/sources. The delivered load is the amount of a pollutant (e.g., nitrogen) that is delivered from a watershed to the estuary under the core model assumption that all loads that enter the watershed will reach the estuary in that same year. The delivered load accounts for pollutant attenuation and loss during transport to the estuary and tributaries to Great Bay. The initial load is used in this memorandum to estimate the load of nitrogen removed from the watershed through the implementation of nitrogen reduction strategies. The estimated initial load removed is then multiplied by an attenuation and loss factor (delivery factor) to determine the delivered load of nitrogen removed by source control measures. The 45% optional non-point source reduction is based on the delivered load[4] that is assumed to reach the estuary and tributaries to Great Bay, and therefore,

[4] The GBNNPSS uses delivery factors to estimate nitrogen lost in the surface water and groundwater pathway during transport from the land surface to the estuary. The study estimated mean percent loss of nitrogen in freshwater streams of 13% (87% reaches the estuary) and indicates that this factor does not change with travel time to the estuary. The delivery factor of 87% is consistent across the Great Bay Watershed, regardless of geographic distance from a receiving water body or the estuary. EPA/NHDES has estimated that the delivery factor to the estuary from the WWTF point source is approximately 75.6%, which is discharged directly into the freshwater portion of the Cochecho River. It shall be noted that the inconsistency in these values has not been justified by EPA or NHDES.

the delivered load removed through implementation of each of the nitrogen reduction strategies is presented in this memorandum.

Of the estimated total delivered non-point source load, approximately 15% (13,923 lbs N/year) is attributed to atmospheric deposition on naturally vegetated areas or water surfaces within the City of Rochester's municipal boundary, typically considered to be an unmanageable load.

The theoretical load was estimated for a forested natural land use condition with no human influences within the City to understand the magnitude of the GBTN GP target reduction. This load was calculated by multiplying the total land area (28,268 acres) within the City by the pollutant export rate used in the GBNNPSS study for natural vegetation (0.57 lbs N/ac/yr) and adding this to the load associated with water surfaces (813 acres x 3.49 lbs N/ac/year). This theoretical load for the City is approximately 19,100 lbs N/year which represents approximately 20% of the total non-point source delivered load.

Table 1. Rainfall Adjusted Estimated Non-Point Source Load by Source and Land Use

Source	Land Use	Rainfall Adjusted Initial Load (lbs N/yr)	Rainfall Adjusted Delivered Load (lbs N/yr)	Percent of Total Delivered Load
Atmospheric	Natural/Water Surface	80,826	13,923	15%
	Agriculture	8,226	1,280	1%
	Lawn	7,375	1,128	1%
	Managed Turf	611	65	0%
	DIA[a]	11,325	5,237	6%
	DCIA[b]	8,427	7,331	8%
Chemical Fertilizer	Agriculture	13,843	2,950	3%
	Lawn	74,287	15,338	16%
	Managed Turf	5,095	1,113	1%
Animal/Pet Waste	Agriculture[c]	13,202	2,703	3%
	Lawn	4,198	893	1%
	DIA+DCIA	12,242	7,620	8%
	Septic System Disposal	1,555	428	0%
Human Waste	within 200m	9,222	5,533	6%
	outside 200m	109,275	28,126	30%
TOTAL		**359,709**	**93,668**	**100%**

Notes: a. DIA = Disconnected impervious area

b. DCIA = Directly connected impervious area

c. Animal/pet waste associated with agriculture is associated with horses and cattle. Animal/pet waste from lawns, DIA + DCIA and septic system disposal is associated with cats and dogs.

A. Land Area

Figure 2 presents the land area in Rochester by land use type as presented in the GBNNPSS (NHDES, 2014). Approximately 66% of the land area in Rochester is natural vegetation, 17% is impervious area (DCIA + DIA), 7% agricultural, 6% lawns, 3% water surfaces and 1% managed turf. **Figure 3** presents the land ownership within Rochester. Approximately 85% of the total land area in Rochester is privately owned, 9% City owned[5], 3% State owned and 3% water.

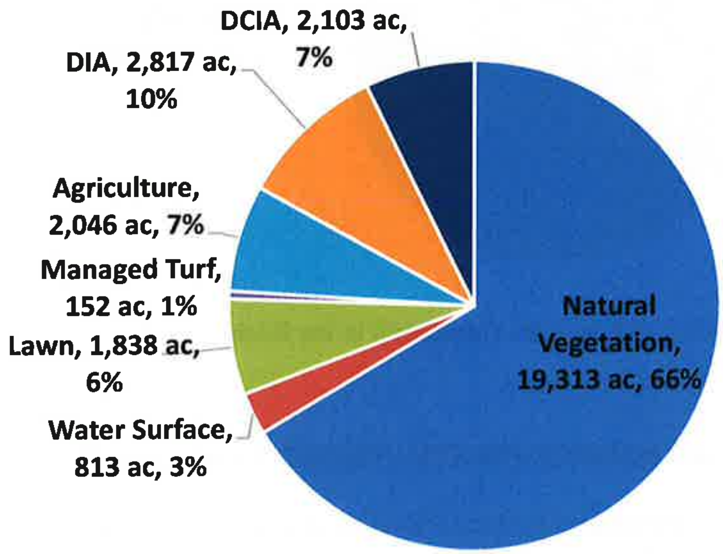

Figure 2. Area by Land Use from GBNNPSS[6]

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[5] The City-owned area reported herein does not include drainage easement area located on private property.
[6] Areas extracted from the GBNNPSS (NHDES, 2014).

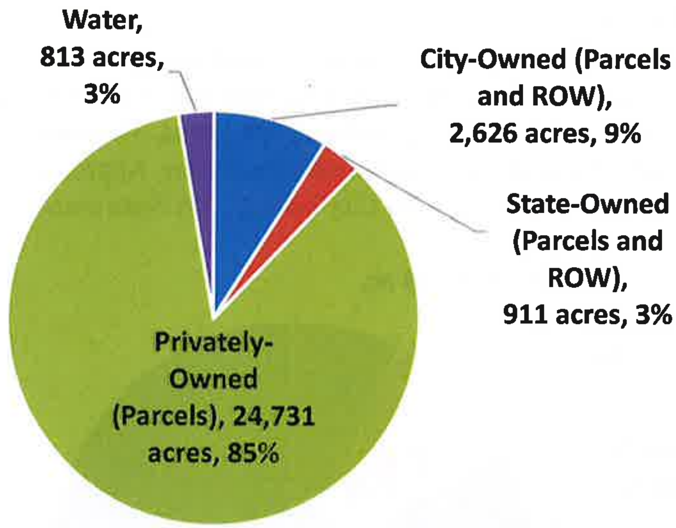

Figure 3. Land Area by Ownership in the Rochester[7]

II. SUMMARY OF LOAD REDUCTION STRATEGIES EVALUATED

Non-point source load reduction strategies evaluated to achieve a 45% reduction (42,151 lbs N/yr) in non-point source loads included structural and non-structural best management practices (BMPs); sewer extensions; and advanced septic system retrofits. An extensive literature review was conducted as part of this evaluation to review the current nationwide state of the practice of nutrient reduction management strategies. We also took into full consideration the status of the NHDES and University of New Hampshire Pollutant Tracking and Accounting Program (PTAP) (that currently can only "track" implementation, but not "account" for removal efforts) and we applied the EPA 2017 New Hampshire Small Municipal Separate Storm Sewer System (MS4) General Permit non-structural and structural removal efficiencies. Below is a summary of the estimated potential load reductions associated with various structural and non-structural control measures. The load reduction is reduced from the initial load, prior to the load being delivered to the estuary or tributaries to Great Bay. One-time capital cost to implement the program or practices and annual operation and maintenance (O&M) costs were estimated. A life-cycle cost was calculated for each program or practice and assumes a 20-year loan term, 2.5% annual interest rate, and 1% annual O&M inflation.

A. Catch Basin Cleaning Program

Using load reduction estimates provided in the EPA 2017 New Hampshire Small MS4 General Permit, approximately 1,220 lbs N/year[8] of delivered load reduction could be achieved through a

[7] Areas provided by the City of Rochester using assessors and 2015 New Hampshire GRANIT data.
[8] Initial atmospheric and pet waste load from impervious area (31,993 lbs N/yr) * 6% estimated load reduction = initial load removed (1,920 lbs N/yr). The delivered load removed = initial load removed (1,920 lbs N/yr) * weighted average delivery factor (0.63) = 1,211 lbs N/year, rounded up to 1,220 lbs N/year.

catch basin cleaning program (based on a minimum of two cleanings per basin per year from the impervious area from City (290 lbs N/year), State (120 lbs N/year) and privately owned (810 lbs N/year) impervious cover). This represents a 6% reduction of the initial atmospheric and pet waste load from the impervious area. This program would result in a 1.3% reduction (or 1,220 lbs N/year) in the total baseline delivered load. The annual operational cost for catch basin cleaning is estimated to be $160,000. The City recently purchased a new vacuum truck for catch basin cleaning, which has a typical service life of 10-years. Therefore, it is estimated that over a 20-year period the City would need to replace their catch basin cleaning equipment resulting in an additional one-time cost of approximately $500,000[9].

B. Street Sweeping and Leaf Collection Program

Using load reduction estimates provided in the EPA 2017 NH MS4 Permit, approximately 250 lbs N/year[10] of delivered load reduction could be achieved through enhanced street-sweeping (2 times per year) with a regenerative sweeper and an additional 690 lbs N/year[11] from an annual organic waste and leaf litter collection (1 time per year). The street sweeping program assumes that all impervious area from City, State and privately owned would be swept with a regenerative sweeper at least two times per year. This represents a 2% reduction of the initial atmospheric load from DCIA, DIA, lawns and managed turf (250 lbs N/year). This program would result in a 1.0 % reduction in the total baseline delivered load.

The leaf litter collection program assumes that all leaf litter and organic debris would be collected in the fall from all impervious area (DIA and DCIA) and managed turf and lawns surfaces within the City. This program would result in a 1.0 % reduction (or 690 lbs N/year) in the total baseline delivered load. The annual operation and maintenance cost to implement these programs is estimated to be $80,000. It is also estimated that over a 20-year period a new regenerative sweeper truck would need to be purchased with an additional one-time capital cost of approximately $375,000[12].

C. Agricultural Nutrient Reduction Program

Nitrogen is one of the most important crop inputs; yet, it is also one of the most complex. It is susceptible to environmental losses, and its effectiveness is impacted by soil types and weather. Feasible and widely used agricultural BMPs include the use of slow release fertilizer, the use of cover crops and development of waste management plans for management of manure.

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[9] Replacement cost for catch basin equipment and annual operation and maintenance are based on values received from the City of Rochester, based on their capital expenditures and investments.

[10] Initial atmospheric load from impervious cover (19,750 lbs N/yr) * 2% estimated load reduction = initial load removed (395 lbs N/yr). The delivered load removed = initial load removed (395 lbs N/yr) * weighted average delivery factor (0.64) = 251 lbs N/year, rounded to 250 lbs N/yr.

[11] Initial atmospheric load from impervious cover, lawn and managed turf (27,737 lbs N/yr) * 5% estimated load reduction = initial load removed (1,387 lbs N/yr). The delivered load removed = initial load removed (1,387 lbs N/yr) * weighted average delivery factor (0.495) = 687 lbs N/year, rounded to 690 lbs N/yr.

[12] Replacement cost for a regenerative sweeper is based on 2019 municipal bids to purchase a regenerative sweeper. Annual operation and maintenance costs are based on values received from the City of Rochester, based on their capital expenditures.

UNH Cooperative Extension recommends that at least 15% of the fertilizer used on crops be comprised of slow release fertilizer. The slow release formula allows for the gradual release and uptake of nitrogen and phosphorous which in turn reduces wash off of excess nutrient.

Cover crops are another valuable agricultural BMP available for protecting water quality, especially groundwater quality. Cover crops reduce soil erosion by protecting the soil surface from raindrop impact, increasing water infiltration, trapping and securing crop residues, improving soil aggregate stability and providing a network of roots which protect soil from flowing water.

The Chesapeake Bay Program (CBP) established nitrogen removal efficiency credits of up to 40% for farmers that adopt agricultural fertilizer BMPs primarily through enhanced and comprehensive nutrient management plans. The enhanced nutrient management plans involve several agronomic practices and land/crop treatment measures. Further, the 2010 Maryland Total Maximum Daily Load (TMDL) Plan listed nitrogen removal credits for the following agriculture BMPs:

- Nutrient Management Plan Compliance: 3 pounds per acre reduction
- Precision Agriculture: 2 pounds per acre reduction
- Cover Crops: 5.8 pounds per acre reduction
- Conservation Tillage: 4.6 pounds per acre reduction
- Streamside Buffer: 17.1 pounds per acre reduction

The proposed measures outlined in the CBP to reduce nitrogen loads in existing agricultural operations consist of:

- Enhancing Nutrient Management Plans (application timing, rate and agronomic utilization)
- Increased Use of Land Treatment Measures (cover crops, conservation tillage, vegetated stream buffers)
- Possible Use of Structural Nutrient Management (structural BMPs for treatment removal, additional storage, anaerobic digesters and/or offsite transport systems)

A potential program for Rochester could focus on the development and implementation of enhanced nutrient management plans including increased use of land treatment measures and possible structural nutrient management measures for agricultural activities in collaboration with United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) and UNH Cooperative Extension. Implementation of a program such as this could achieve, at a minimum, a potential reduction of 15% from the initial agricultural load. This is consistent with assumptions made in the Oyster River Watershed Integrated Plan[13], developed for Durham, NH.

The cost per farm to develop a nutrient management plan is estimated to be approximately $5,000. The total cost for implementation of a nutrient reduction management plan for an average farm in

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[13] Vanasse Hangen Brustlin, Inc. (VHB). 2014. *Oyster River Integrated Watershed Plan for Nitrogen Load Reductions.* July 2014.

the Northeast was estimated at $9,300 per year, based on data provided by the USDA NRCS[14]. This is equivalent to $12,000 per year in 2019 dollars (an assumed additional 30% was added to account for inflation to 2019 dollars). Further it is estimated that approximately $7,500 would be required per year for city staff to manage the program, for a total annual cost of $19,500.

The implementation of nutrient management planning on agricultural lands in Rochester could result in a 1.1% reduction (or 1,040 lbs N/year[15]) in the total baseline delivered load. This program would require Rochester to work with NRCS to develop, implement and enforce this program. The annual operation and maintenance cost to implement this program is estimated to be $19,500, with a one-time capital cost of approximately $5,000 for the City to implement a comprehensive plan.

D. Nitrogen Fertilizer Ban

EPA has suggested that a city-wide ban on lawn fertilizer use could be used as a non-point source reduction strategy. The adoption of a total ban on lawn fertilizer would be challenging for a single municipality such as Rochester to implement and enforce, as the ability to purchase fertilizer would still exist in the region. A statewide ban would be most effective in supporting the load reductions proposed in the GBTN GP. It is estimated that a fertilizer ban would likely result in a reduction of approximately 90% of the total initial load from lawns and managed turf associated with chemical fertilizer application. This program would result in a 15.8% reduction (or 14,800 lbs. N/year[16]) in the total baseline delivered load. It is estimated, based on best engineering/planning judgement, that development and implementation of the program at a City-wide scale would be a one-time capital cost of approximately $100,000 with an annual operation and maintenance cost to enforce the ban of $10,000[17].

E. Pet Waste Collection Program

The GBNNPSS estimated non-point source load attributed to pet waste (domestic animals including dogs and cats). To reduce this load, Rochester would need to implement a pet waste collection program which would require installation of pet waste elimination stations with bags for pet owners and a trash receptacle to dispose of waste in used bags. The City would need to implement these stations in high pet traffic areas. Further, Rochester would need to provide educational materials to pet owners alerting pet owners of the program. It is estimated, based on best engineering judgement, that the development and implementation of this program would require a one-time capital cost of approximately $25,000 with an annual operation and

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[14] NRCS. 2003. *Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plan.* Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA).

[15] Initial atmospheric, fertilizer and animal waste load from agriculture (35,271 lbs N/yr) * 15% estimated load reduction = initial load removed (5,291 lbs N/yr). The delivered load removed = initial load removed (5,291 lbs N/yr) * weighted average delivery factor (0.197) = 1,042 lbs N/year, rounded to 1,040 lbs N/yr.

[16] Initial fertilizer load from lawn and managed turf (79,400 lbs N/yr) * 90% estimated load reduction = initial load removed (71,460 lbs N/yr). The delivered load removed = initial load removed (71,460 lbs N/yr) * weighted average delivery factor (0.207) = 14,792 lbs N/year, rounded to 14,800 lbs N/yr.

[17] Cost to implement a nitrogen ban are estimated planning level costs to prepare outreach materials, conduct public education and outreach, outreach to the residential and commercial landscaping companies and lawn care suppliers, and consulting fees for updates to local regulations. The operation and maintenance fees are associated with an annual cost to enforce the ban (i.e., outreach flyers and fines).

maintenance cost of approximately $2,500. It is estimated, based on best engineering judgement, that the program would result in a 15% reduction of the initial pet waste load from lawns and impervious area or a 1.4% reduction (1,280 lbs N/yr[18]) in the total baseline delivered load.

F. Structural Stormwater BMP Retrofits

In accordance with the MS4 Permit, the City will need to update and enforce its stormwater regulations which require the use of structural stormwater BMPs optimized for the nitrogen reduction in both new development and redevelopment. **Table 2** below presents a wide range of nitrogen reduction efficiencies for various structural stormwater BMPs based on data included in the MS4 Permit. The ultimate effectiveness for each BMP depends on the underlying soil type (i.e., rate of soil infiltration) and the capture depth of the BMP (i.e., the size of the practice compared to the drainage capture area). Infiltration practices (i.e., trenches, basins, rain gardens and bioretention) are suitable for soils capable of infiltrating a minimum of 0.17 inches per hour which is characteristic of soils with a hydrologic soil group (HSG) of A or B. Therefore, in areas of the City with underlying soils in HSG A and B, infiltration BMPs will be most suitable when optimizing for nitrogen. For areas of the City with underlying soils in HSG C and D, gravel wetlands or enhanced biofiltration systems with internal storage reservoirs will be most suitable when optimizing for nitrogen removal.

Using a literature review together with best professional engineering judgment estimates for the cost to implement structural stormwater BMPs in Rochester are provided in **Table 3**. These costs include both construction and pre-construction costs (i.e., design and permitting) (which typically range from 10 to 40 percent of the BMP construction cost) by impervious acre treated. Since structural BMPs will be selected based on their nitrogen load reduction capability (**Table 2**), the average cost per impervious acre treated for infiltration practices and wetland/enhanced biofiltration were averaged.

Table 2. Range of Cumulative Nitrogen Load Reduction for Structural Stormwater BMPs[19]

Stormwater Structural BMP Practice	Range of Cumulative Nitrogen Load Reduction*
Infiltration Trench	56% - 100%
Surface Infiltration Practices (i.e., basins, rain gardens and bioretention)	52% - 100%
Bio-filtration Practice	9% - 40%
Gravel Wetland System	22% - 79%
Enhanced Bio-filtration with Internal Storage Reservoir (ISR)	22% - 79%
Sand Filter	9% - 40%
Porous Pavement;	76% - 79%
Wet Pond or wet detention basin;	9% - 40%

[18] Initial pet waste load from lawn and impervious cover (16,440 lbs N/yr) * 15% estimated load reduction = initial load removed (2,466 lbs N/yr). The delivered load removed = initial load removed (2,466 lbs N/yr) * weighted average delivery factor (0.518) = 1,277 lbs N/year, rounded to 1,280 lbs N/yr.

[19] Data taken from 2017 NH MS4 Permit.

Stormwater Structural BMP Practice	Range of Cumulative Nitrogen Load Reduction*
Dry Pond or detention basin; and	1% - 23%
Dry Water Quality Grass Swale with Detention.	1% - 23%

**Range based on underlying soil infiltration rate and/or BMP capacity*

It is also assumed that structural stormwater BMPs will be installed to treat 2,103 acres of impervious area in the City, of which includes 100% of the City (683 acres) and State-owned impervious area (276 acres) and 60% of the private impervious area (1,144 acres). Since the cost of infiltration and enhanced biofiltration BMPs are similar, a cost of $56,000 per impervious acre treated will be used for this planning level analysis with an annual operation and maintenance cost of approximately 3% of the cost per impervious acre. Further, it was assumed that infiltration BMPs would be applied to 50% of the impervious area and enhanced biofiltration BMPs to the remaining 50%. A nitrogen load reduction of 90% per impervious acre was used for infiltration BMPs and 53% per impervious acre for enhanced biofiltration BMPs.

Table 3. Planning Level Unit Cost for Structural Stormwater Best Management Practices[20]

ROW ID	Structural Stormwater BMP	Initial Costs Per Impervious Acre Treated[1]		
		Pre-Construction Costs[2]	Construction Costs[3]	Total Initial Costs
A	Wet Ponds	$ 21,333	$ 42,665	$ 63,998
B	Dry Extended Detention Ponds	$ 22,500	$ 45,000	$ 67,500
C	Infiltration Practices w/o Sand, Veg.	$ 16,700	$ 41,750	$ 58,450
D	Infiltration Practices w/ Sand, Veg.	$ 17,500	$ 43,750	$ 61,250
E	Filtering Practices (above ground)	$ 14,000	$ 35,000	$ 49,000
F	Filtering Practices (below ground)	$ 16,000	$ 40,000	$ 56,000
G	Bioretention	$ 9,375	$ 37,500	$ 46,875
H	Vegetated Open Channels	$ 4,000	$ 20,000	$ 24,000
I	Bioswale	$ 12,000	$ 30,000	$ 42,000
	Rounded Average Cost – Infiltration Practices (Rows C, D, and G)	**$15,000**	**$41,000**	**$56,000**
	Rounded Average Cost –Enhanced Bio (Rows E and F)	**$15,000**	**$38,000**	**$53,000**

Notes:

[20] University of Maryland Center for Environmental Science (UMCES). 2011. *Cost of Stormwater Management Practices in Maryland Counties.* Prepared for Maryland Department of the Environment Science Services Administration.

1. All costs are expressed per acre of impervious area treated, not per acre of BMP. Initial costs are assumed to take place in year T=0; annual costs are incurred from year T= 1 through year T= 20.
2. Includes cost of site discovery, surveying, design, planning, permitting, etc. which, for various BMPs tend to range from 10% to 40% of BMP construction costs.
3. Includes capital, labor, material and overhead costs, but not land costs, and associated implementation.

Using the load reduction estimates, approximately 5,250 lbs N/year of delivered load reduction could be achieved by treating 75% of the total estimated impervious area (2,103 acres) in Rochester with structural stormwater BMPs optimized for nitrogen reduction, as summarized in **Table 4.**

Table 4. Impervious Area Treated by Structural BMPs

Ownership	Acres Treated with Structural BMPs	% of Total Impervious area Treated	One-Time Capital Cost	Annual O&M	20-Yr Present Value Cost
City	653	100%	$37.2 M	$1.1 M	$71.6 M
State	276	100%	$15.0 M	$0.5 M	$28.9 M
Private	1,144	60%	$62.3 M	$1.9 M	$119.9 M
TOTAL	**2,103**	**74%**	**$114.6 M**	**$3.4 M**	**$220.4 M**

Many privately-owned properties are not likely to redevelop during the terms of this permit. The City would need to adopt extremely stringent development and redevelopment standards that would exceed the minimum requirements of the MS4 permit. Even if the City was successful in creating a stormwater utility in the future to help in cost-sharing or create incentive mechanisms, achieving 60% treatment of existing impervious area would still be highly unlikely just due to physical constraint, limited available space and the potential enormous costs as discussed further below.

The load reduction represents 5.6% of the total baseline delivered load (5,250 lbs N/year). The one-time capital cost to implement these BMPs would be approximately $114,590,000 with an annual operation and maintenance cost of $3,437,700.

G. Sewer Extensions

The nitrogen load delivered to a receiving waterbody from a septic system drain field (the 'delivered load') depends on the distance of the system to that receiving waterbody. According to the GBNNPSS, a septic system drain field within 200 meters of a receiving waterbody would deliver approximately 60% of the initial load, whereas a septic system drain field outside 200 meters would deliver approximately 26% of the initial load. Load reductions from septic systems via sewer extensions have a relatively high cost per pound of nitrogen reduced and only result in a net load reduction of nitrogen for septic systems located within close proximity to surface waters.

However, recognizing that Rochester already plans to connect as many as 300 homes to the municipal sewer in the coming years, a certain amount of nitrogen load reduction is expected after these connections are complete. It was estimated that sewer extension would result in a 1.7 lbs N/year/person[21] reduction for every septic system within an approximate 200-meter buffer of a surface water body.

Assuming three people per home, and assuming the 300 homes targeted for connection are located within the 200-m buffer, the potential Nitrogen delivered load reduction was estimated to be approximately 1,540 lbs N/year or 1.6% of the total baseline delivered load. These sewer extensions would cost approximately $17 million[22] in a one-time capital cost with an annual operation and maintenance cost of approximately $5,000. Extending sewer to other septic systems that are not within the 200-m buffer of a water body provides little benefit from a nitrogen reduction benefit as the estimated delivered nitrogen load per capita basis from well-functioning septic systems that are located more than 200-m from a water body is actually less than that estimated to be discharged from the WWTF under its current treatment design according to the assumptions and data used in the GBNNPSS. A potential means to reduce nitrogen loads from septic systems that are outside the 200-m buffer is by using advanced treatment mechanisms for septic systems designed to promote denitrification as discussed below.

H. Advanced Septic System Retrofits

Traditional septic systems are not designed to maximize nitrogen removal from wastewater. Advanced systems are similar to traditional septic systems but have an added component that reduces nitrogen concentrations from the effluent before it is discharged to the ground. They are installed at an individual home or cluster of homes, and usually cost more to operate and maintain than a traditional septic system. The increased O&M costs are due to power needs for the system (e.g., pumps, aerators), required water quality sampling, and other elements that are not needed for a traditional onsite system.

An advanced treatment system refers to a system that includes a septic tank, an aeration system, and a recirculation system in the septic tank. Some systems may also have an additional component for advanced denitrification. Alternative treatment components can be added to a conventional system, often between the septic tank and the drain field, to provide advanced treatment of nitrogen. Advanced treatment of groundwater flow from septic systems can be done through the implementation of permeable reactive barriers and could be considered as an alternative to an advance treatment septic system.

A typical human contributes approximately 10.6 pounds of nitrogen in wastewater to the drain field each year[23]. The nitrogen load delivered to a receiving waterbody from a septic system drain field (the 'delivered load') depends on the distance of the system to that receiving waterbody.

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[21] Based on effluent load estimates per person from the wastewater treatment facility.
[22] Costs provided by the City of Rochester based on engineering estimates
[23] Great Bay Nutrient Non-Point Source Study
(https://www.des.nh.gov/organization/divisions/water/wmb/coastal/documents/gbnnpss-report.pdf)

According to the GBNNPSS, a septic system drain field within 200 meters of a receiving waterbody would deliver approximately 60% of the initial load, whereas a septic system drain field outside 200 meters would deliver approximately 26% of the initial load. According to the 2010 US Census, an average household in Rochester is approximately 3 persons, which results in 338 systems within 200 meters of a waterbody and 5,406 systems further than 200 meters from a waterbody, based on the population served as presented in GBNNPSS. Implementation of an advanced onsite system removes approximately 7 pounds of nitrogen per person per year[24] to the drain field (65% reduction in the initial load).

The average capital cost per household to install a traditional septic system is estimated to be between $5,000 and $6,000[17]; to be conservative, we have used a value of $10,000 in this analysis. The average advanced onsite treatment system, which includes a septic tank, an aeration system, and an anoxic environment separate from the septic tank, is approximately $10,000 to $15,000. In our analysis, we used a conservative estimate of $20,000 per system for installation, with an annual operation and maintenance cost of $500 per system. These costs assume a new system is being installed and represents an average system with ideal subsurface conditions to treat onsite wastewater. The 20-year life-cycle cost for the replacement of a single septic system is approximately $37,000 per system.

To meet the remaining optional non-point source reduction (assuming full implementation of the nitrogen reduction strategies described in the subsections above), approximately 4,585 septic systems (38 systems within 200-meters and 4,547 systems outside 200-meters), resulting in approximately 80% of the existing septic systems[25] need to be retrofitted. This would result in a delivered load reduction of 16,070 lbs N/year or 17.2% of the total baseline delivered load.

Note, however, that without NH state law mandating such septic system retrofits, Rochester has no authority to require such action.

III. COSTS OF MEETING EPA'S GBTN GP OPTIONAL REDUCTION TARGET

Non-point source load reduction strategies evaluated to achieve a 45% reduction (42,151 lbs N/year) in non-point source delivered load included a variety of structural and non-structural BMPs; sewer extensions; and advanced septic system retrofits. **Table 5** provides a summary of the estimated potential load reductions associated with these various structural treatment and non-structural control measures and the estimated costs to implement to meet the GBTN GP optional load reduction target.

The results of this analysis indicate that to achieve EPA's estimated 42,150 lbs N/year reduction target would require extraordinary structural measures that rely on extensive and determined participation of private property owners with an estimated 20-year life cycle cost of approximately $415.6 Million. The overall annual cost would be approximately $20 Million dollars. This cost would be shared by both the City, State and private property owners, as the load reduction could

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[24] EPA. 2013. *A Model Program for Onsite Management in the Chesapeake Bay Watershed.* Office of Wastewater Management. June, 2013.
[25] 4,585 systems retrofitted/5,744 total septic systems in the City

not be accomplished on City property alone. More specifically, to achieve the reduction target, not only would 100% of the impervious area on City and State property and 60% of impervious area on private property would need to be treated with structural stormwater BMPs, but the City would also have to adopt and enforce a City-wide fertilizer ban and somehow fund and convince approximately 4,600 property owners with septic systems to upgrade their system to an advanced treatment system capable of denitrification. All three of these major undertakings would be required and are clearly unachievable.

The practicality of achieving any one of these measures relies heavily on the willingness of private property owners to participate. Even if the City was to fund the entire upfront cost to implement the various structural measures, the participating private property owners would need to provide the long-term maintenance of the treatment systems to ensure that it would operate as designed.

Regarding potentially retrofitting 60% of the impervious area on private property, under the current 2017 NH MS4 Permit, EPA only requires redevelopment regulations for new and redevelopment projects with an area greater than 1-acre. For redevelopment, the MS4 permit only requires treating 30% of the existing impervious area based on the recent proposed permit changes. In order to implement to the level required to meet the target reduction, the City would need to implement more stringent requirements than other neighboring MS4 and non-MS4 communities.

With respect to septic systems, the City is already working to connect approximately 300 property owners with existing septic systems to sewer. This effort alone bears a very substantial cost to the City ($21.6 Million) and is considered borderline cost-effective from nutrient load reduction perspective. The estimated cost of approximately $92 million (one-time capital cost) to fund and incentivize 4,600 property owners to upgrade their septic systems to an advanced treatment system capable of denitrification is not even close to being cost-effective or practical. The estimated initial upfront cost would be approximately $5,000 per lb N reduction/year. Moreover, the costs and activity associated with maintaining these advanced systems would likely be a major deterrent for homeowners to want to participate. Currently, the City has little control over the design and implementation of septic systems since all septic systems are approved through the State. Retrofits of this scale with alternative treatment systems, which are not currently approved by the State, would be impossible for Rochester to require or enforce property owners to implement. The State would be required to update and enforce their septic system regulations.

EPA has often stated in previous discussions regarding this proposed permit that they expect most of the future load reductions can be achieved through non-structural BMPs and good housekeeping measures. While many of the non-structural BMPs are certainly cost-effective, applying the good housekeeping measures City-wide has only produced a combined total load reduction estimate of approximately 4,500 lbs N/year (5% reduction of the total baseline delivered load) using the load reduction credits contained in the MS4 Permit. EPA has alluded to the fact that the crediting values are likely to increase in the future based upon more recent research. This may well be the case, but the load reduction crediting values or removal efficiencies would have to increase by at least an order of magnitude, if not more, if these measures are going to have a meaningful difference in not having to rely as much on the more costly structural measures described above to meet the optional load reduction targets.

Table 5. Estimated Load Reductions and Order of Magnitude Costs for Various Non-point Source Management Measures

Source/ Program[1]	Method	Potential Estimated Units Treated	City, State or Private Program[2]	Estimated Load Reduction (lbs N/yr)	Percent Reduction of Baseline Load	Estimated One Time Capital Cost	Estimated Annual O&M Cost	Net Present Value (20- year) Life Cycle Cost
Good Housekeeping	Catch Basin Cleaning	4,920 acres of impervious area	City	290	1.3%	$500,000	$160,000	$4,155,000
			Private	810		unknown	unknown	unknown
			State	120		unknown	unknown	unknown
	Leaf Litter Collection	6,909 acres of impervious area, lawn and managed turf	City	690	0.7%	$375,000	$80,000	$2,235,000
	Street Sweeping	4,920 acres of impervious area	City	60	0.2%			
			Private	24		unknown	unknown	unknown
			State	166		unknown	unknown	unknown
Agricultural Nutrient Reduction Program	Slow release fertilizer, cover crops and best management practices for animal waste	2,406 acres of agricultural land	City	1,040	1.1%	$5,000	$19,500	$436,000
Nitrogen Fertilizer Ban	Regulation and Enforcement	1,933 acres of lawn and managed turf	City	14,800	15.8%	$100,000	$10,000	$347,000
Pet Waste Program	Educational workshop and waste collection stations	6,757 acres of lawn and impervious area	City	1,280	1.6%	$25,000	$2,500	$779,500
Impervious Area	Structural Stormwater BMP Retrofits	683 acres	City	1,710	5.6%	$37,232,600	$1,117,000	$71,600,900
		1,144 acres	Private	2,850		$62,343,400	$1,870,200	$119,891,100
		276 acres	State	690		$15,014,000	$450,500	$28,287,100

Source/ Program[1]	Method	Potential Estimated Units Treated	City, State or Private Program[2]	Estimated Load Reduction (lbs N/yr)	Percent Reduction of Baseline Load	Estimated One Time Capital Cost	Estimated Annual O&M Cost	Net Present Value (20- year) Life Cycle Cost
Septic Systems	Sewer Extensions	300 systems	City and Private	1,540	1.6%	$17,000,000	$5,0000	$21,573,000
	Advanced Septic Systems	4,585 systems	Private	16,070	17.1%	$91,700,000	$2,292,500	$166,250,000
			TOTALS	**42,150**	**45%**	**$224.3 M**	**$6.1 M**	**$415.6 M**
			CITY PROGRAMS	19,870	21.1%	$38.2 M	$1.4 M	$79.6 M
			PRIVATE PROGRAMS[3]	19,760	21.1%	$154.1 M	$4.2 M	$286.1 M
			CITY AND PRIVATE PROGRAMS	1,540	1.6%	$17.0 M	$0.05 M	$21.6 M
			STATE PROGRAMS[3]	980	1.0%	$15.0 M	$0.45 M	$28.3 M

Notes:

1. These load reduction and cost estimates are preliminary and will ultimately depend on many site-specific factors. Time required to reach full implementation could range from 1 year for good housekeeping to as much as 20 years for the stormwater retrofit program.
2. City program would be implemented and funded through by the City. Private program would require that private property owners retrofit their properties to meet the load reduction targets. City and private programs would require implementation and funding from both the City and private community. The exact proportion of each party's responsibility can be further evaluated in a future iteration.
3. Private and State program costs do not include the cost associated with catch basin cleaning and street sweeping.

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ATTACHMENT 18

Technical Memorandum

Prepared for:	City of Rochester, New Hampshire
Project Title:	NPDES Great Bay Total Nitrogen Permit
Subject:	Great Bay Ambient Monitoring Program Comments and Recommendations
Date:	April 14, 2020
To:	Blaine Cox, *Rochester City Manager*
From:	Daniel Hammond, *Principal Scientist*
	Stacy Villanueva, *Senior Scientist*
Copy to:	Sherilyn Burnett Young, *Attorney-At-Law*

Executive Summary

Brown and Caldwell (BC), on behalf of the City of Rochester, reviewed the ambient monitoring program proposed by the United States Environmental Protection Agency (EPA) in the recently issued draft National Pollutant Discharge Elimination System (NPDES) general permit for total nitrogen (TN) in the Great Bay estuary (GBE; NHG58A000). The following are the major comments with respect to the program goals and objectives, program management, and data collection requirements as described in the draft permit:

- Program Goal and Objectives
  - The draft permit lacks a clear goal and appears to confuse water quality improvement with a target set for eelgrass protection and restoration. The permit needs to set clear goals that can be measured with data collected by a required monitoring program designed to determine when success is achieved.
  - Without setting success criteria, the monitoring program is not likely to generate the data needed to determine permit compliance or environmental success. This can leave permittees with no clear path to compliance at a great expense.
  - Specific objectives for the general permit should be determined after a clear goal and success criteria have been developed. Then, the specific data and analysis needs of the monitoring program can be developed.
  - The adaptive management program should be developed in conjunction with EPA and the permittees to build consensus for iterative actions that are linked to permit compliance. The lack of adaptive management in the draft permit does not provide confidence to permittees their actions are linked to meaningful management of GBE.
  - Based on the presumption of an eelgrass restoration goal for the general permit, we recommend the monitoring program incorporate additional stressors that may affect eelgrass in addition to nutrients.
- Program Management
  - EPA and the permittees should expect coordination and implementation of the monitoring program to be a significant effort; sufficient time to allow for development and implementation of the monitoring program should be given and written into the permit.
  - As with program management and coordination, sufficient time should be allowed for development of planning documents to guide the monitoring program.
  - The monitoring program has significant overlap with existing data collection in GBE. Permittees need more clarity in the permit language to understand how the required monitoring would be integrated with existing efforts.
  - The cost of this monitoring program should not be imposed solely on the permittees; instead, equitable cost sharing options including all entities responsible for nutrient loads to GBE should be developed.
- Data Collection Requirements
  - The permit should include a specific description of how to adaptively manage several aspects of the monitoring program.
  - There is a lack of clarity regarding the purpose for collecting certain data types (e.g. data sondes, sediment profile imaging [SPI], benthic grabs). Further clarity about how the data fit with the goals and objectives of the program are needed.

Section 1: Introduction

The United States Environmental Protection Agency (EPA) recently issued a draft National Pollutant Discharge Elimination System (NPDES) permit for total nitrogen (TN) in Great Bay for 13 municipal wastewater treatment facilities in New Hampshire (NHG58A000). This permit limits the discharge of TN from these 13 facilities in an effort to prevent protect and restore water quality and biological communities (e.g. eelgrass) in the Great Bay Estuary (GBE). Among the requirements listed in the draft NPDES permit is an Adaptive Management Ambient Monitoring Program (Monitoring Program or Program; NPDES Permit No. NHG58A000, Part 2.3). The permit requires each Permittee to participate in the monitoring program and contribute to the cost based on their percentage of design flow to the GBE. EPA is seeking comment on the implementation and cost allocation approach of the monitoring program.

On behalf of the City of Rochester (the City), this Technical Memorandum (memo) provides comments and recommendations on several aspects of the monitoring program proposed by EPA in the draft permit. Notwithstanding any other comments the EPA may receive from the City, this memo is specific to the monitoring program described in Part 2.3 of the draft NPDES permit. The comments and recommendations are organized into the following categories:

- Program Goal and Objectives– identifying what the monitoring program will achieve and defining research/data collection objectives to achieve the goal
- Program Management – logistics, cost, adaptive management and implementation approach, and timing
- Data Collection Requirements – data needs to fulfill program objectives and achieve program goal(s)

Although the City is challenging the appropriateness of the nutrient target set in the perming (100 kg/ha/yr) these comments focus on the monitoring program regardless of the nutrient target selected for inclusion in the final permit. Specific comments and recommendations within each category are discussed below.

Section 2: Adaptive Management Ambient Monitoring Program

The monitoring program described in the draft NPDES permit requires collection of data to characterize head of tide chemistry, estuary chemistry, and estuary biology and is focused on potential TN impacts to GBE resources. The proposed program, however, does not provide details or description of several elements that are necessary to define success, track progress, or relate data collection requirements to program objectives in the context of the NPDES permit. These components are necessary for the permittees to not only secure funding for such a program, but also provide confidence their individual and combined efforts are working toward a common goal that can be measured and attain results. The following sections elaborate on these concerns and provide recommendations for revisions to the program.

2.1 Program Goal and Objectives

The draft NPDES permit (NHG58A000) Fact Sheet states "This monitoring program is intended to provide annual data for nutrients and the response variables to support adaptive management decision making relative to the control of nutrients." The permit goes on to say the program "is not intended to support evaluations of all potential impairment causes but rather is intended to allow for evaluations of the role of nutrient enrichment relative to water quality impairments." The obvious intent of the program is to focus on TN discharges and impacts of TN to GBE, which is not surprising for a TN-focused general permit. However, the stated goal in the permit fact sheet is not clear, nor does it provide enough focus from which to develop a meaningful and robust monitoring program designed to track progress and measure success.

The monitoring program described in the draft permit also fails to outline objectives to achieve a stated goal. In other words, the program fails to address the questions "*Why are we monitoring?*" and "*How will we measure progress and success?*" Given that the monitoring program is required in an NPDES permit and has a compliance target (100 kg/ha/yr), the program needs to address how compliance will be measured, including how the data collected under the program will be used to assess progress toward compliance. In order for the monitoring program to be effective and provide confidence to the permittees that their efforts are meaningful, the program needs a common goal and a measurable pathway to achieving that goal. The following comments should to be considered prior to finalization and implementation of the monitoring plan to ensure proper alignment of monitoring needs and program goals.

2.1.1 Monitoring program needs a clear goal from which to measure success and progress

The draft permit fact sheet does not set a clear goal to define success or guide the monitoring program, but rather appears to conflate two goals: water quality improvement and eelgrass restoration. The nutrient target set in the permit (100 kg/ha/yr) was derived from literature values for eelgrass protection and growth (NHG58A000, pp. 21-24). The permit fact sheet goes on to say, "EPA notes that once water quality standards are met consistently for all nutrient-related parameters throughout Great Bay estuary, no further nitrogen reductions will be necessary" (NHG58A000, p. 24). This statement is the *de facto* goal of the permit, because only when compliance with nutrient-related water quality parameters is achieved will no further reductions be necessary. The permit does not set any eelgrass target as a goal.

The nutrient target for the bay is not linked to the *de facto* goal of attaining nutrient-related water quality standards. The 100 kg/ha/yr is set for eelgrass health, not water quality standard attainment. The permit attempts to link the two with a general statement "given the impacts of overall water quality on eelgrass health, EPA expects that nutrient reductions necessary to effectively restore and protect eelgrass will also bring the Great Bay estuary into attainment of water quality standards for all other nutrient-related impairments (*i.e.*, chlorophyll-a, dissolved oxygen and light attenuation)" (NHG58A000, p. 24). EPA's support for this statement is the Narragansett Bay example, however, the permit does not provide any analysis or evaluation of data to support that achieving the 100 kg/ha/yr target will allow for water quality standards to be attained in Great Bay.

Given that this is a permit with loading limits for each permittee and requirements for compliance, the evidence presented in the permit is insufficient to provide confidence to permittees that they have a clear and achievable path to compliance. With no defined understanding of how the 100 kg/ha/yr target is linked to water quality standard attainment, and no eelgrass restoration goal, the permit lacks an explicit goal and understanding of how permittees will be able to attain compliance. This raises several questions such as:

- *Will permittees achieve compliance if their daily and annual loading limits are met?*
- *Is compliance only achieved when water quality standards are met in the GBE?*
- *What, in fact, are the water quality standards that must be achieved?*
- *Is compliance linked to some restoration target for eelgrass?*

Without answers to these questions, it is not clear what the monitoring program is expected to achieve. Given the significant cost of implementation, the permittees require a clear goal in order to implement an effective monitoring program.

The draft permit lacks a clear goal and appears to confuse water quality improvement with a target set for eelgrass protection and restoration. While we understand there may be expected linkages between the two, the permit needs to set clear goals that can be measured with data collected by a required monitoring program designed to determine when success is achieved.

2.1.2 Interim and final success criteria are necessary to measure progress

Following the development of a clear goal for the permit and monitoring program, the draft permit needs to establish success criteria that can be measured to provide permittees with compliance targets. The success criteria will guide the types of data to be collected by the monitoring program and allow for tracking of progress toward achieving the permit goal.

While it is premature to set specific success criteria before the goal is determined, we can discuss the types of criteria that could be established. For example, if the goal of the permit is eelgrass restoration, a success criterion could be achieving a specific number of acres of eelgrass in GBE. This goal could then be split among different sections of the estuary based on where eelgrass could be expected to grow. Once success criteria are set, the monitoring program could collect data to characterize sediment and water quality conditions within each estuary segment; establish expectations for where eelgrass recovery could be expected; and track progress toward achieving the goal. The success criteria could also include timelines to serve as interim compliance targets for permittees. These success criteria give permittees confidence the resources they expend are working toward achieving a goal and permit compliance.

The success criteria are the framework for the monitoring program. The specific parameters to be collected and the amount of data necessary are determined by how the data will be used to track progress and determine success. Without setting success criteria, the monitoring program is not likely to generate the data needed to determine permit compliance or environmental success. This can leave permittees with no clear path to compliance at a great expense.

2.1.3 Specific objectives are necessary to guide monitoring needs

In addition to lacking a clear goal and success criteria, the monitoring program in the draft permit lacks objectives from which to determine the needs of the monitoring program. The monitoring objectives describe what data will be necessary and how those data will be used to assess progress toward achieving the success criteria. In this case, an objective could be to "monitor eelgrass coverage and biomass in segments of GBE". This simplistic objective provides the information necessary from which to understand what data need to be collected by the monitoring program. Another objective may be to "assess the trend in eelgrass coverage year over year." Again, this objective characterizes how the data will be used to track progress toward success.

Specific objectives for the general permit should be determined after a clear goal and success criteria have been developed. Then, the specific data and analysis needs of the monitoring program can be developed. Further discussion of specific data needs and the proposed data collection parameters in the draft general permit are provided in section 2.3 below.

2.1.4 Adaptive Management strategy needs to be clearly defined in the monitoring program

The draft permit describes the monitoring program as an Adaptive Management Monitoring Program but fails to discuss any adaptive management strategy. Incorporating adaptive management strategy and criteria will be an important component for the permittees to ensure their efforts toward achieving the goal address inherent uncertainty and allow for program revisions based on environmental outcomes. The draft permit fact sheet states only that "a threshold even lower than 100 kg/ha/yr may be necessary in the future if the system does not fully recover once brought into compliance with this initial threshold. EPA has chosen the least stringent threshold within the "critical range" as a reasonable next step in an adaptive management approach" (NHG58A000, p. 23). This is an overly simplistic view of adaptive management and is insufficient to address the uncertainty in the permit approach to GBE restoration.

The adaptive management approach needs to address the full range of uncertainty in implementing the nutrient target, including what measures should be taken if GBE begins to recover at nutrient levels above the target, not just further reductions if no recovery is observed. The program needs to allow for revisions to monitoring constituents, locations, and frequency if analysis of the data reveals the need to do so. In addition, data from the monitoring program could show that revisions to the success criteria are needed to adequately achieve the restoration goal.

To achieve this, the adaptive management program should be described in terms of the known uncertainty in the permit limits, goals, and success criteria, and describe how and when these changes could be made during permit implementation. This could be completed by setting interim criteria (either interim eelgrass restoration targets or timeframes) from which adaptive management decisions could be made. For example, if after five years of implementation, eelgrass coverage and/or biomass begins to recover at nutrient levels above the target, a "hold the line" approach could be implemented for a certain time period to determine if any further reductions would be necessary. Likewise, if the converse situation occurs (i.e. if nutrient reductions are successful but eelgrass does not respond with increasing coverage and/or biomass), the strategy for identifying other eelgrass stressors could be refined to help determine if or how further nutrient reductions would impact eelgrass (see discussion on additional eelgrass stressors below in Section 2.1.5). As another example, if data collection for a certain constituent does not result in meaningful analysis that links it to a success criterion, the monitoring program can be revised to remove the constituent or change the data collection methodology.

The adaptive management program should be developed in conjunction with EPA, the New Hampshire Department of Environmental Services (DES), other experts, and the permittees to build consensus for iterative actions that are linked to permit compliance. As currently written, the lack of adaptive management in the draft permit does not provide confidence to permittees their actions are linked to meaningful management of GBE.

2.1.5 Monitoring program needs to include additional stressors to understand role of nutrients

The draft permit and fact sheet clearly state the focus of the permit and monitoring program is nutrients and their effect on GBE. However, this is a sort-sighted approach if the goal of the permit is restoration of GBE (eelgrass and/or water quality). Given the nutrient target was chosen from literature values designed for eelgrass restoration, we can assume the EPA general permit is intended to measure restoration by improvements in eelgrass coverage and/or biomass. If this assumption is true, then the general permit must allow for characterizations of factors that affect eelgrass coverage, distribution, and biomass other than nutrients. Factors such as sediment characteristics; suspended sediment concentrations and loads; bioturbation; epiphytic growth; and macroalgal community abundance all play a role in eelgrass distribution and abundance. Data collection for these constituents should be included in the monitoring program if the goal is eelgrass restoration. Only by including these other factors can the monitoring program and analysis truly understand the role of nutrients.

Focusing only on nutrients in the general permit will prevent a complete characterization and understanding of effects on eelgrass. For example, if eelgrass coverage continues to decline in GBE even in the presence of declining nutrient inputs, it may appear that nutrients are still too high and additional reductions are necessary for recovery. This is because nutrients are the only constituent being collected and other environmental variables linked to eelgrass decline have not been investigated. The result would be additional strain on already strained resources for each permittee, with no clear understanding of what is causing the decline. However, by including additional potential eelgrass stressors in the permit, the data would be available to assess which stressor(s) may be causing or contributing to the eelgrass decline. By addressing all of the potential stressors to eelgrass, resources can be directed to actions that will have the most impact and create meaningful restoration for GBE.

As stated in previous comments, the monitoring program should be driven and informed by the goal, success criteria, and objectives outlined by the program. Based on the presumption of an eelgrass restoration goal for the general permit, we recommend the monitoring program incorporate additional stressors that may affect eelgrass in addition to nutrients.

2.2 Program Management

The draft NPDES permit (NHG58A000) and accompanying fact sheet state responsibility for the monitoring program is to be split among the 12 permittees, including an annual certification statement that each permittee has participated. This raises several questions regarding the management of a program of this magnitude, along with the logistical requirements needed to implement it, while satisfying requirements of the permit and all permittees. The draft permit and fact sheet are silent on these matters, leaving the permittees to develop the infrastructure of the program management and implementation. This should be expected to be a significant task focusing on permittee involvement and consensus. Comments regarding the necessary program management aspects of the monitoring program are provided below.

2.2.1 Monitoring program will require an existing or new entity to manage all aspects of the program

EPA and the permittees should expect coordination and implementation of the monitoring program to be a significant effort. Given the number of permittees participating, it is reasonable to assume a single entity/organization would take the lead on implementation of the monitoring program. Implementation will include management of sampling entities, scheduling, Quality Assurance/Quality Control (QA/QC), financial responsibilities, analysis and reporting, and coordination among permittees, among others. The draft permit does not address these considerations, nor does it address the time required to develop these items and coordinate involvement with all permittees. The draft permit becomes effective "on the first day of the calendar month immediately following 60 days after signature" (NHG58A000). This timeframe should not be expected to be sufficient to allow for development and implementation of the monitoring program given the number of coordination activities that would need to take place before monitoring would begin. We recommend that the time needed to develop the monitoring program be acknowledged in the permit by including a provision for a timeframe of one year after the effective date of the permit to begin monitoring.

2.2.2 Monitoring program will require planning documents agreed upon by all parties

The monitoring program will require a Sampling Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Standard Operating Protocols (SOPs) to guide consistent collection of quality data over the course of the program. Development of these documents will have the benefit of memorializing the processes and procedures by which the monitoring and analysis will be completed. The SAP, QAPP, and SOPs should be tailored to the specific goals, success criteria, and objectives of the monitoring program. Once agreed upon by all parties, including EPA, all parties will have the confidence of knowing how the data will be collected, managed, and what analyses will be conducted. This will prevent any misunderstandings between permittees and permitting agencies on expectations for the data and permit compliance. As with program management and coordination, sufficient time should be allowed for development of planning documents to guide the monitoring program.

2.2.3 Monitoring program has significant overlap with existing data collection in GBE.

The basis of the monitoring program in the general permit is to collect data to support decision making regarding the control of nutrients (NHG58A000, p. 32). However, the proposed program identifies constituents, locations, and frequencies where existing data are already being collected by other entities. Sonde data collection, grab sample water quality data, and eelgrass monitoring are already conducted annually in GBE at many of the same locations proposed in the general permit. Clarity is needed to understand how this data collection would be integrated with existing efforts. For example, is the permit-required monitoring designed to take the place of existing efforts; is it to be conducted in addition to existing efforts; or would the permittees simply be responsible for the cost of overlapping data collection? Further, if the permittees will be responsible for taking over management of and/or ensuring consistency with existing data collection efforts, it is unclear whether will they be expected or required to engage specific sampling entities to implement monitoring. This will be an important cost and planning consideration for the permittees. The permittees need to understand how the permit-required monitoring would be integrated with existing efforts.

2.2.4 Cost allocation should be agreed upon by all permittees

The draft permit states cost for the monitoring program will be allocated based on the percentage of design flow for a permittee compared to total design flow to the GBE (NHG58A000). First, it is unusual for the details of cost allocation of such an extensive ambient monitoring program to be required by permit, especially when the majority of monitoring requirements are existing and currently being paid by public and non-profit entities. Second, the general permit is restricted to the 12 entities with the highest design flows to the GBE but fails to recognize the many other communities that have discharges to the estuary. Cost sharing options including public, non-profit, and all other entities responsible for nutrient loads to GBE should be considered.

2.3 Data Collection Requirements

This section provides specific comments regarding the data collection requirements listed in the draft NPDES permit. We understand the data needs of this program are based on the goals and objectives and may change based on decisions regarding the previous comments presented in this memo. The comments provided here are based on the following assumptions:

- The primary goal of the permit and this monitoring program is eelgrass restoration in GBE, as evidenced by the TN target which was derived from literature-based values of eelgrass protection and restoration
- The program includes monitoring for stressors to eelgrass other than TN
- Monitoring is designed to track progress toward achieving specific goals and objectives, and not ambient monitoring

2.3.1 Head of Tide Chemistry

The draft permit calls for collection of water quality sampling at head of tide stations twice per month. Several aspects of the head of tide monitoring could be modified to create a more informative dataset. First, the permit should include a description of how to adaptively manage the monitoring frequency of head of tide chemistry. Specifically, we recommend an interim analysis after one or two years to determine if sample collection frequency can be reduced from twice per month in March through December to once per month to more closely align with estuary chemistry monitoring. Second, we recommend collection of several additional parameters: flow monitoring near each station to more accurately estimate loads from each tributary; carbonaceous dissolved organic material (CDOM), total suspended solids (TSS), and turbidity grab samples to help clarify the dynamics of other potential eelgrass stressors (as described above); instantaneous sonde measurements of environmental parameters (i.e. dissolved oxygen [DO], pH, temperature, specific conductivity/salinity) with every grab sample to provide context for the water chemistry data. Finally, we recommend revising the permit language to specify this monitoring will only measure loads to GBE from the tributary rivers and will not quantify all loads to GBE.

2.3.2 Estuary Chemistry

Estuary chemistry is to be conducted once per month at 17 stations from April to December according to the draft permit. The draft permit states grab sampling should be conducted once per month from April to December between mid-ebb and low tide at a depth of one meter. Additional clarity is needed to understand how the data generated from this requirement will be used. If the purpose of the monitoring program is to generate data representing nutrient concentrations in GBE, collecting data only on mid-ebb to low tide would bias the data toward the highest concentrations and would not represent the total nutrient regime experienced in the estuary. However, collecting data only at mid-ebb to low tide may be useful if the purpose is to characterize a worse-case scenario for nutrients in the estuary. Either way, the monitoring program needs to justify this requirement by clarifying how these data would be used in the analysis and how these data are linked to achieving the goals of the program.

Additionally, the draft permit needs to provide clarity on the methods for collecting data using data sondes. As written, the requirement appears to be the same as grab sampling. However, the draft permit provides separate parameter lists and shows the data sonde and grab sample locations separately on the map, which leads us to believe the methodology for data sondes should have been different from grab samples. There is also a lack of clarity regarding the purpose of data collection with the data sondes (if they are to be deployed for continuous monitoring) and how the data collected will be used to support the goals of the monitoring program. Given these issues, we can only make the following general comments about the data sonde portion of the monitoring program until more information is provided:

- If the data sondes are to be deployed rather than to be used simply to collect spot samples alongside the water chemistry grab samples, details about the deployment duration, sample collection frequency, maintenance and calibration/verification schedules, etc. should be provided in the permit.
- The permit should include an adaptive management approach where all sonde locations are monitored for 1-2 years and an interim analysis of the data should be conducted to determine if the number of locations can be decreased.
- The requirement to monitor chlorophyll-a with the sondes should be removed from the program until such readings can be demonstrated to be representative of actual phytoplankton concentrations.

For the monthly grab samples, we recommend collection of CDOM, TSS, and turbidity along with the parameters specified in the draft permit to help clarify the dynamics of other potential eelgrass stressors (as described above). In addition, if the data sondes included in the draft permit are meant to be deployed for continuous monitoring, instantaneous sonde measurements of environmental parameters (i.e. DO, pH, temperature, specific conductivity/salinity) with every grab sample will provide context for the water chemistry data.

2.3.3 Estuary Biology

Estuary biology will be assessed using Sediment Profile Imaging (SPI), benthic grab sampling, seagrass surveys (both aerial and field-based) according to the draft permit. The primary concern regarding the biological monitoring is that there are no defined objectives for the SPI and benthic grab sampling, and it is not clear why the data would be collected, how they would be assessed, and how they will be used in the context of this permit. SPI and benthic community analysis can provide useful ecological information but given the high cost and time commitment required to collect data using these methods, great care should be taken in advance to determine the correct number of samples, sample locations, monitoring frequency to suit the project goals and objectives. Specifically, without knowing how SPI and benthic grab sampling fit with the goals of the permit or the conceptual model for nutrient impacts to seagrass in GBE, the following aspects of the monitoring need further scrutiny:

- 100 random locations annually for SPI are too many: SPI can be effective with fewer locations and less frequently (perhaps once every 3 to 5 years)
- Based on sampling objectives, randomized SPI sampling (instead of transects, for example) may not be the most beneficial approach
- Eight rotating locations throughout GBE annually for benthic grab samples is not an effective monitoring methodology and would be costly for little data value
- Collection of benthic grab samples for total organic carbon (TOC) and grain size analysis (to help characterize where in GBE we could expect eelgrass to grow) may be more useful

Eelgrass monitoring has been going on in GBE for many years using established methodology. However, it is unclear from the permit what the expectations are for collecting some of the data as part of this monitoring program. For example, the draft permit includes specific requirements to collect certain types of data but is vague on details of methodology. If the expectation is that methods from an existing monitoring program are to be continued, a reference to that program should be included.

Section 3: Conclusions

As proposed in the draft general permit for GBE, the Adaptive Management Monitoring Program lacks the specifics necessary to develop and implement a robust program for restoration and protection of GBE. The monitoring program needs a clear goal, success criteria, and objectives to provide permittees with the clarity and confidence they have an achievable pathway to compliance. Specifics on the data collection activities need to be tied to the program goals and objectives. The program will require significant resources and planning to implement successfully, and the permit needs to recognize the effort to plan and coordinate with all permittees and provide a sufficient window of time to do so. The cost of the monitoring program should be shared more equitably among all stakeholders including all public entities with potential impact to the estuary, non-profit entities, and state resources.

These comments, recommendations, and concerns should be addressed to develop a robust monitoring program that will benefit the success of the GBE general permit. This will create not only a successful monitoring program to measure and track progress toward achieving restoration in GBE, but also provide permittees with clarity and confidence their efforts are working to achieve that goal.