R-WD-17-01

STATE OF NEW HAMPSHIRE

Response to Public Comment on the Draft 2014 Section 303(d) List of Impaired Waters

MARCH 27, 2017

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

R-WD-17-01

STATE OF NEW HAMPSHIRE

Response to Public Comment on the Draft 2014 Section 303(d) List of Impaired Waters Assessments

STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
29 HAZEN DRIVE
CONCORD, N.H. 03301

CLARK B. FREISE
ASSISTANT COMMISSIONER

EUGENE FORBES, P.E.
DIRECTOR
WATER DIVISION

Prepared by:
Ken Edwardson

MARCH 27, 2017

New Hampshire Department of Environmental Services
PO Box 95, Concord, NH 03302-0095
www.des.nh.gov | (603) 271-3503

Printed on Recycled Paper

TABLE OF CONTENTS

Contents

Table of Figures

INTRODUCTION

On October 14, 2015, the New Hampshire Department of Environmental Services (NHDES) released the Draft 2014 303(d) List of impaired waters for public comments. Downloadable copies of the draft list were made available on the NHDES website for review (http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm). Public comments were accepted through the close of business on December 11, 2015. In addition to posting at multiple locations on the NHDES website, direct notification by email was sent to nearly 1,500 stakeholders including but not limited to:

Federal agencies
State agencies in New Hampshire and abutting states
Municipal officials
DPW Directors of the MS4 Communities
County Conservation Districts
Regional Planning Commissions
Non-profit interest groups
Volunteer monitoring groups
New England Interstate Water Pollution Control Commission
University of New Hampshire

The following sections contain the comments received, NHDES's responses to comments, and supporting information. The sections are organized as follows:

A. Response to Public Comment (Note: This section contains NHDES's responses to all of the comments received. The responses are organized by reference number. A reference number refers to a specific section of a comment letter in Section B.)

B. Public Comment on the Draft 2014 303(d) List of Impaired Waters (Note: This section contains the full text of all comments received. Each individual comment in the letters has been assigned a reference number. The responses in Section A are organized by reference number.)

C. Comments received on the October 14, 2015 Draft and their attachments are on the department's FTP site;

1. Go to this address using a web browser: ftp://pubftp.nh.gov/DES/wmb/WaterQuality/SWQA/2014/Draft_303d_Comments/
2. At the login window, click on the box in the lower left hand corner labeled "Login Anonymously."
3. The user name will then be automatically filled in with the word "Anonymous."
4. Type in your email address in the "Email Address" block.
5. Then click on the "Log On" button.

Table 1. Comment letters received by NHDES and the designated comment letter number.

COMMENTER	RECEIVED	COMMENT #
Toby Stover, EPA Region 1	Dec. 7, 2015	#1

COMMENTER	RECEIVED	COMMENT #
Don Witherill, Maine Dept. of Environmental Protection	Dec. 10, 2015	#2
Ralph Abele, EPA Region 1	Dec. 11, 2015	#3
John B. Storer, City of Rochester	Dec. 11, 2015	#4
Tom Irwin, Conservation Law Foundation	Dec. 11, 2015	#5
Robert J. Robinson, City of Manchester	Dec. 11, 2015	#6
Robert R. Lucic, City of Dover	Dec. 11, 2015	#7
Robert R. Lucic, Great Bay Municipal Coalition	Dec. 11, 2015	#8
Terry Desmarais, City of Portsmouth	Dec. 11, 2015	#9

C. Comments received on the February 3, 2017 changes to the Draft and their attachments are on the department's FTP site;

1. Go to this address using a web browser: ftp://pubftp.nh.gov/DES/wmb/WaterQuality/SWQA/2014/Draft_303d_Comments_20170203-Changes/
2. At the login window, click on the box in the lower left hand corner labeled “Login Anonymously.”
3. The user name will then be automatically filled in with the word “Anonymous.”
4. Type in your email address in the “Email Address” block.
5. Then click on the “Log On” button.

Table 2. Comment letters received on the February 3, 2017 changes to the Draft by NHDES and the designated comment letter number.

COMMENTER	RECEIVED	COMMENT #
John B. Storer, City of Rochester	Feb. 23, 2017	#10
Dean Peschel on the behalf of Great Bay Municipal Coalition	Feb. 24, 2017	#11
Tom Irwin, Conservation Law Foundation	Feb. 24, 2017	#12
Ricardo Cantu, OspreyOwl Environmental, LLC on the behalf of the City of Nashua and on the behalf OspreyOwl Environmental, LLC	Feb. 24, 2017	#13
Ralph Abele, EPA Region 1	Mar. 3, 2017	#14

A. RESPONSE TO PUBLIC COMMENT ON THE OCTOBER 14, 2015 DRAFT

RESPONSE TO COMMENT #1: Toby Stover, EPA Region 1

***DES RESPONSE* to** 1- 1

NHDES understands the importance of nutrients in river systems and that excess nutrient can be detrimental to aquatic ecosystems. The Cocheco and Salmon Falls Rivers are areas that NHDES is watching closely. That close watch includes participating in the Total Maximum Daily Load (TMDL) revisions being undertaken by the state of Maine. NHDES will consider such conditions in the development of the 2016 Draft 303(d).

RESPONSE TO COMMENT #2: Don Witherill, Maine Dept. of Environmental Protection

DES RESPONSE **to 2- 1**

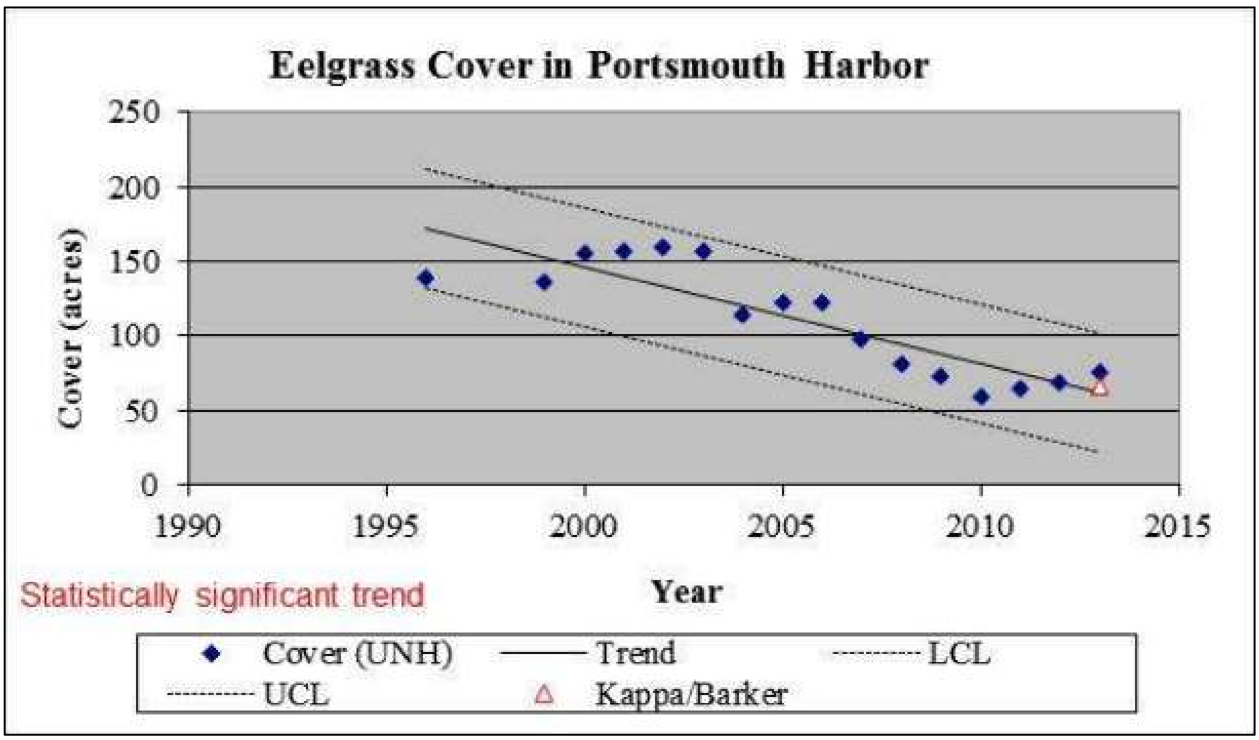
NHDES appreciates the confirmation from Maine Dept. of Environmental Protection that the Portsmouth Harbor assessment zone should be listed as impaired due to eelgrass loss and wishes to make one clarification.

As described and shown in the October 14, 2015 Technical Support Document (NHDES, 2015);

> "The historical extent of eelgrass in this assessment zone was 227.7 acres from the 1948, 1962, 1980, and 1981 datasets. The median current extent of eelgrass in 2011-2013 is 68.5 acres, which is a decrease of 58.2%. Since 1990, the trend in eelgrass cover in this assessment zone is a loss of 35.9%. The thresholds for impairment are either loss of more than 20% of the historic extent of eelgrass or a recent trend of greater than 20% loss."

The Estuarine Bioassessments (eelgrass) assessment for Portsmouth Harbor maintains its impaired status on the Draft 2014 303(d).

Figure 1. Eelgrass cover in Portsmouth Harbor.



The clarification lies in that NHDES proposed the delisting of total nitrogen to insufficient information-potentially not supporting for the assessment zone. While total nitrogen was proposed for delisting from the assessment zone, no change has been proposed for the assessment status for Estuarine Bioassessments (eelgrass). Additional discussion is provided in Table 5.

RESPONSE TO COMMENT #3: Ralph Abele, EPA Region 1

<u>DES RESPONSE</u> **to 3- 1**

In their comments, EPA made reference to their Technical Support Document which provided EPA's rationale for the September 24, 2015 approval of New Hampshire's 2012 303(d) (USEPA, 2015). Further, EPA questioned whether New Hampshire's administrative record provided an adequate basis for the proposal not to list certain Great Bay Estuary segment/impairment combinations for total nitrogen.

NHDES recognizes the concerns raised by EPA regarding the proposed delistings and values the subsequent conversations that occurred. From those discussions it is clear that NHDES cannot make a non-assessment where data is readily available and assessments were previously completed and approved through the 303(d) process. From those discussions and the 2012 303(d) Approval (USEPA, 2015) it is clear that NHDES must have a clear and rational basis to delist any waterbody segments.

A distinction in language is needed. While indeed the Great Bay Estuary in showing, "all of the classic signs of eutrophication, including increasing nitrogen concentrations" (NHDES, 2015), not **all** segments of the estuary are showing **all** of the classic signs of eutrophication. As such, NHDES cannot make a non-assessment where data is readily available and assessments were previously completed and approved through the 303(d) process, each assessment zone is assessed individually based on the data for that zone.

SMAST 2003 (Howes, Samimy, & Dudley, 2003) has been cited by numerous commenters from the Great Bay Municipal Coalition to USEPA in their approval of New Hampshire's 2012 303(d). The authors of SMAST 2003 (Howes, Samimy, & Dudley, 2003) describe an integrated evaluation of multiple parameters that is used to make a final classification of an overall eutrophication condition within an assessment area.

> "The proposed threshold approach by the Estuaries Project will use multiple indicators ranging from chemical and physical indicators to community (biological) features. It is certain that on occasion, various indicators will recommend different habitat classifications. When this situation occurs, the present approach is to weight the biological community indicators or key structuring indicators over some of the more variable indicators. For example, the documented rapid loss of eelgrass, rise of macroalgae and periodic oxygen depletion would be stressed over water column chlorophyll levels suggestive of Excellent Quality Habitat. The general procedure at present is to weight those factors that are more integrative of the environment over those which are more variable and therefore may not be adequately captured by monitoring." (Howes, Samimy, & Dudley, 2003)

In light of the comments regarding SMAST 2003 (Howes, Samimy, & Dudley, 2003), NHDES has applied that methodology to help inform a final determination for total nitrogen in those assessment zones in which the draft 2014 303(d) considered an assessment zone under construction ( ) and those zones proposed for the delisting of total nitrogen. (Also see responses 4- 6, 8- 3, and 8- 6)

The final NHDES "Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report/303(d) List" provides a complete record of NHDES' decisions for the final 2014 303(d). Below we summarize those decisions regarding the final assessment for the proposed changes to the Squamscott River North (Table 3), assessments that were considered under construction on the draft ( ) (Table 5), and the status of waters proposed for the delisting of total nitrogen (Table 4).

Table 3. Comparison of the Final 2012, Draft 2014, and Final 2014 assessment for the Aquatic Life designated use in the Squamscott River North and proposed changes between 2012 and 2014. Assessment category definitions are provided in section 3.1.3 and 3.1.5 of the 2014 CALM.

Assessment Zone	Cycle	Dissolved Oxygen (% Sat)	Estuarine Bioassessments (eelgrass)	Water Clarity (Light Attenuation Coefficient)	Overview
Squamscott River North	2012	2-M	5-P	5-P	While the 1948 map is rough enough that we cannot say that precisely 42 acres of eelgrass were present, its presence was clearly documented. Combined with the application of the Eelgrass Site Selection Model (Short et. al. 2002) and a rudimentary suitability evaluation of temperature and salinity leads one to conclude that eelgrass should be present. Taken in totality, there is insufficient evidence to remove the 2012 "Estuarine Bioassessment" impairment. As such, the impairment for "Estuarine Bioassessments" and "Water Clarity (Light Attenuation Coefficient)" have been retained on the 2014 final 303(d). Additional eelgrass discussion has been provided in response 5- 3.
	Draft 2014	5-M	3-PNS	3-PNS	
	Final 2014	5-M	5-P	5-P	

Table 4. Comparison of the Final 2012, Draft 2014, and Final 2014 total nitrogen assessment where total nitrogen was under construction in the Draft 2014 303(d). Assessment category definitions are provided in section 3.1.3 and 3.1.5 of the 2014 CALM.

Assessment Zone	Cycle	Total Nitrogen	Overview
Lamprey River South	2012	5-P	The median total nitrogen from 2008 through 2013 was 1,055 ug/L (n=1). New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. From the limited available grab samples (none since 2008) for dissolved oxygen concentration and saturation the site appears to meet the dissolved oxygen criteria. The calculated 90th percentile chlorophyll-a in this assessment zone cannot be calculated due to the presence of only one measured value in since 2008 (22 ug/L). The available data for chlorophyll-a indicates concentrations greater than the criteria, although only one sample exists (22 ug/L). The eelgrass beds have been eliminated. The median light attenuation coefficient was not calculated due to no samples collected in the 2008 through 2013 period in this assessment zone, however, both the upstream and downstream assessment zones are impaired due to the poor light attenuation coefficient. This assessment zone is generally characterized by its lack eutrophication indicator data. What it lacks in local data it makes up for in data from neighboring assessment zones. The upstream Lamprey River North assessment zone has extensive datasets demonstration impairments due to high chlorophyll-a and severely depleted dissolved oxygen. The downstream Great Bay assessment zone has marginally chlorophyll-a and dissolved oxygen due to the severely poor condition coming out of the Squamscott River assessment zone as well as degraded eelgrass, poor light transmittance, and evidence of macroalgae. Taken in totality, there is insufficient evidence to remove the 2012 total nitrogen impairment. As such, the impairment for nitrogen has been retained.
	Draft 2014		
	Final 2014	5-M	

Great Bay	2012	5-M	The median total nitrogen from 2008 through 2013 was 391 ug/L (n=62) when considering just the stations in the middle of Great Bay; and 410 ug/L (n=176) when including the boundary stations GRBSQ and GRBAP. New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment. Per the court settlement (Docket No. 2013-0119), NHDES has agreed to revert to using the narrative water quality criteria, which requires the use of an integrated evaluation. This assessment zone has not demonstrated dissolved oxygen exceedences at station GRBGB in the middle of Great Bay. However, when considering all sampling stations of Great Bay there are areas in the southwest that likely exhibit poor dissolved oxygen. Likewise, the calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L (n = 249) which is just below the threshold described in the CALM. Chlorophyll-a experiences peak concentrations annually from 10-69 ug/L in the south western area. The eelgrass beds are degraded and the available light attenuation (median=1.180 m^-1 (n=173)) is poor. For shallow systems, it is expected that changes in macroalgae will precede changes in phytoplankton (McGlathery, Sundbäck, & Anderson, 2007) (Valiela, et al., 1997), as appears to be occurring in the Great Bay assessment zone. There is evidence that macroalgae is impacting eelgrass and changing the species composition and diversity in Great Bay. Using data from Great Bay (Pe'eri, et al., 2008), NHDES determined that macroalgae mats had replaced nearly 5.7% of the area formerly occupied by eelgrass in Great Bay in 2007 (NHDES, 2009) and that replaced area has not been recolonized by eelgrass. Some of the loss of eelgrass in the intertidal zone is consistent with smothering by macroalgae. The foremost authority on macroalgae for this estuary, Dr. Arthur C. Mathieson, commented on the draft 2012 303(d) that he remains concerned about the macroalgae and epiphyte conditions in Great Bay (Mathieson A. , 2012). Some of the classic indicators of nutrient eutrophication are present in this assessment zone and total nitrogen remains elevated in portions of the assessment zone. As the discussion above illustrates, there is a clear nutrient "signature" in the data. It is less clear, at this time, whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to total nitrogen alone. Given that uncertainty, impairment is not warranted under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.
	Draft 2014		
	Final 2014	3-PNS	
Cocheco River	2012	5-P	The median total nitrogen from 2008 through 2013 was 600 ug/L (n=9). New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. This assessment zone experiences occasional dissolved oxygen concentrations below 5 mg/L, however, those apparent exceedences are very short in duration and not frequent. The chlorophyll-a concentration 90th percentile was 36.5 ug/L (n = 14) and a maximum reading of 45 ug/L. Although the probe based chlorophyll-a data (not used in the median above) was qualified as "estimated" per EPA, due to poor correlation between probe and extracted chlorophyll-a grab sample data, the relative biomass is valid and demonstrates that chlorophyll-a biomass can be very high depending upon the timing of the tide cycle. For shallow systems, it is expected that changes in macroalgae will precede changes in phytoplankton (McGlathery, Sundbäck, & Anderson, 2007) (Valiela, et al., 1997), which appears to be occurring in the Cocheco River. Some of the classic indicators of nutrient eutrophication are present in this assessment zone and total nitrogen remains elevated. As the discussion above illustrates, there is a clear nutrient "signature" in the data. It is less clear, at this time, whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to total nitrogen alone. Given that uncertainty, impairment is not
	Draft 2014		
	Final 2014	3-PNS	

			warranted under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen. For this assessment zone; Additional discussion of chlorophyll-a is in responses 4- 5 & 4- 6. Additional discussion of dissolved oxygen is in response 4- 8. Additional discussion of total nitrogen is in response 4- 9.

Table 5. Comparison of the Final 2012, Draft 2014, and Final 2014 total nitrogen assessment where total nitrogen was proposed for delisting in the Draft 2014 303(d). Assessment category definitions are provided in section 3.1.3 and 3.1.5 of the 2014 CALM.

Assessment Zone	Cycle	Total Nitrogen	Overview
Little Bay	2012	5-M	The median total nitrogen from 2008 through 2013 was 390 ug/L (n=78). New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. Although based on only grab samples, the measurements in this assessment zone do not demonstrate dissolved oxygen concentration exceedences and there were occasional grab samples at or below 75 percent saturation. The calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L (n = 95) and a maximum reading of 16.5 ug/L. Like dissolved oxygen, chlorophyll-a is marginally better than the indicator. The eelgrass beds are severely degraded (86.3% reduction from historic) and the available light attenuation (median=0.948 m^-1 (n=60)) is poor. For shallow systems, it is expected that changes in macroalgae will precede changes in phytoplankton (McGlathery, Sundbäck, & Anderson, 2007) (Valiela, et al., 1997), as appears to be occurring in the Great Bay Estuary. At this time there are some of the classic indicators of nutrient eutrophication present in this assessment zone and Total Nitrogen remains elevated. However, there are insufficient response datasets leading to the determine that eutrophication by total nitrogen is alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.
	Draft 2014	3-PNS	
	Final 2014	3-PNS	
Bellamy River	2012	5-P	The median total nitrogen from the very limited 2008 through 2013 data was 557 ug/L (n=3). New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. The limited current grab samples for dissolved oxygen concentration (2008 - 2010) indicate that this assessment zone meets the water quality criteria. However, there are no data to evaluate dissolved oxygen percent saturation. The scarcity of data for this assessment zone is also reflected in the three chlorophyll-a samples collected from 2008 through 2013. While there are only three light attenuation measurements from 2008 through 2013 they were 0.807, 1.235, and 1.613 m^-1, all of which are indicative of poor light transmittance. Eelgrass has been absent from this assessment zone since 1981 with small reoccurrence in 2004 (0.8 acres). No sampling efforts have taken place to evaluate the extent of epiphytes and macrophytes. This assessment zone is generally characterized by its lack of eutrophication indicator data. There are not sufficient datasets to determine that eutrophication by total nitrogen is alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.
	Draft 2014	3-PNS	
	Final 2014	3-PNS	
Upper	2012	5-P	The median total nitrogen from 2008 through 2013 was 454 ug/L (n=53). New Hampshire is

Piscataqua River	Draft 2014	3-PNS	no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. While the Dissolved oxygen data shows that this assessment zone experiences short duration concentrations below the 5 mg/L criteria, they do not support an impairment determination for DO. The 24 hour average dissolved oxygen percent saturation did not fall below 75% in the available dataset. The calculated 90th percentile chlorophyll-a in this assessment zone is 7.2 ug/L (n = 73) and a maximum reading of 24.5 ug/L. Although the probe-based chlorophyll-a data (not used in the median above) collected from the UPR stations was qualified as "estimated" per EPA, due to poor correlation between probe and extracted chlorophyll-a grab sample data, the relative biomass is valid and shows large spikes in chlorophyll-a under certain conditions. The grab sample-based light attenuation (median=1.330 m^-1 (n=53)) is quite poor suggesting strong resuspension in the system. For shallow systems, it is expected that changes in macroalgae will precede changes in phytoplankton (McGlathery, Sundbäck, & Anderson, 2007) (Valiela, et al., 1997), as appears to be occurring in the Great Bay Estuary. The foremost authority on macroalgae for this estuary, Dr. Arthur C. Mathieson, commented on the draft 2012 303(d) that he remains concerned about the macroalgae and epiphyte conditions in Great Bay (Mathieson A. , 2012). At this time there are some of the classic indicators of nutrient eutrophication present in this assessment zone and Total Nitrogen remains high. However, there are insufficient response datasets to determine that the eutrophication by total nitrogen alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.
	Final 2014	3-PNS	
Portsmouth Harbor	2012	5-M	The median total nitrogen from 2008 through 2013 was 266 ug/L (n=56). New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. In the continuous data (2008-2013) there was only one day that had a documented exceedance of the dissolved oxygen concentration and percent saturation criteria. The chlorophyll-a data indicates that this assessment zone meets the chlorophyll-a indicator to protect dissolved oxygen. The eelgrass beds are severely degraded. The available light attenuation data (median=0.600 m^-1 (n=41)) appears inadequate for the 3 m restoration depth but may be reflective the Total Suspended Solids (TSS) load from the Portsmouth WWTF. While total nitrogen is elevated above the estimated offshore total nitrogen concentration of 200 ug/L, the data suggest that Portsmouth Harbor total nitrogen is decreasing. At this time there are some of the classic indicators of nutrient eutrophication present in this assessment zone and total nitrogen remains elevated. However, there is insufficient power in the response datasets to determine that eutrophication by total nitrogen is alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.
	Draft 2014	3-PNS	
	Final 2014	3-PNS	
Little Harbor/Back Channel	2012	5-M	The median total nitrogen from the limited data covering 2008 through 2013 was 465 ug/L (n=4). New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. From grab samples only, the dissolved oxygen concentration data in this assessment zone attains standards however there are no usable percent saturation data available. The limited chlorophyll-a data suggests that this assessment zone would meet chlorophyll-a indicator to protect dissolved oxygen. The eelgrass beds are less than half their historic extent. The limited available light attenuation data (median=1.046 m^-1 (n=2)) is inadequate for the 3 m restoration depth. This assessment zone is generally characterized by its lack eutrophication indicator data. Overall, there is insufficient power in the response datasets to determine that eutrophication by total nitrogen is alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.
	Draft 2014	3-PNS	
	Final 2014	3-PNS	

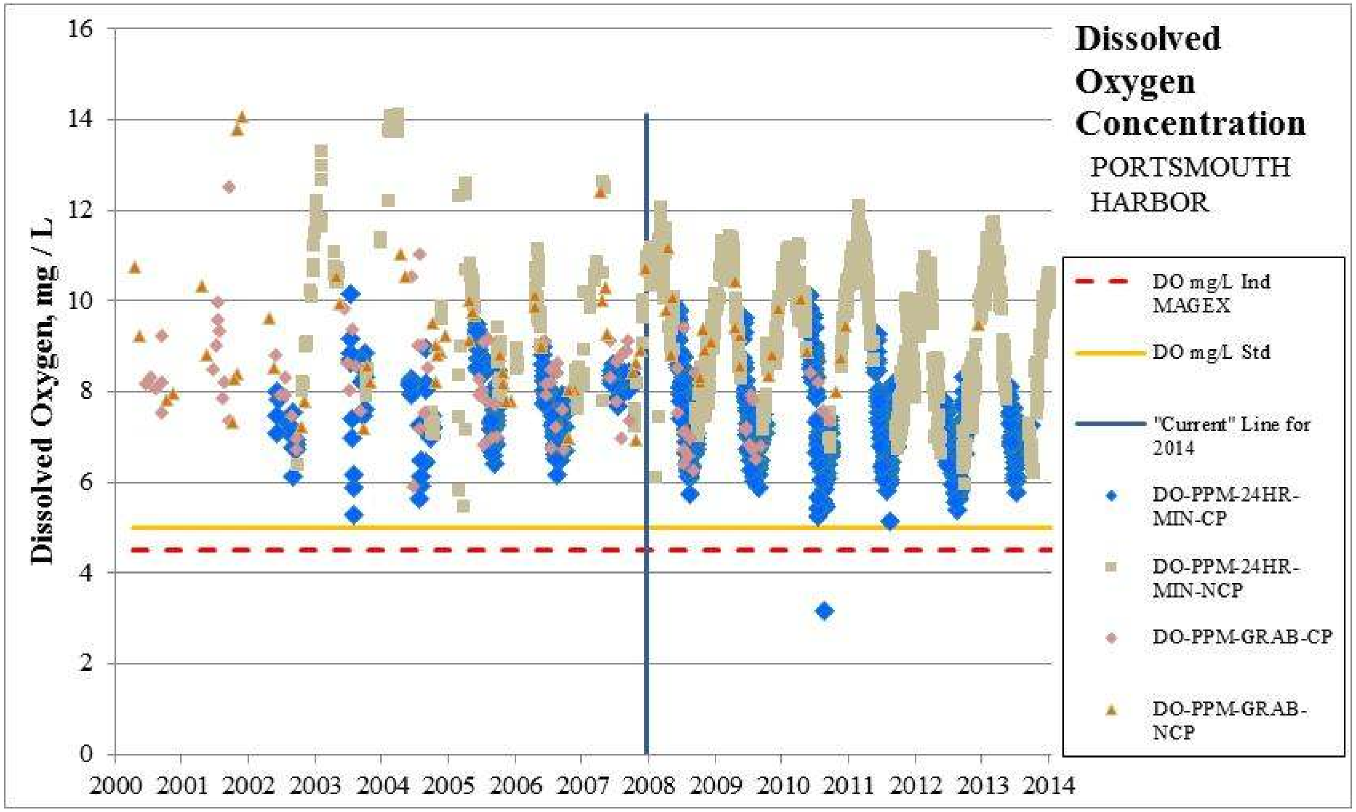
Table 6. Portsmouth Harbor evaluating results utilizing the 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003). Blocks highlighted gray best describe the indicator evaluation category.

Indicator	Current status of Portsmouth Harbor Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
Eelgrass	The historical extent of eelgrass in this assessment zone was 227.7 acres from the 1948, 1962, 1980, and 1981 datasets. The median current extent of eelgrass in 2011-2013 is 68.5 acres, which is a decrease of 58.2%. Since 1990, the trend in eelgrass cover in this assessment zone is a loss of 35.9%.	"Eelgrass beds are present"	"eelgrass is not present (it would still be considered SA water body if historical records document that eelgrass was present in the past or, in the case of insufficient documentation, if potential conditions are such that eelgrass should be present)"	"Eelgrass is not sustainable"	"absence of eelgrass"
Macroalgae	Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016) noted that, "Monitoring results from 2014 show high levels of cover of nuisance green and red algae (*Ulva* and *Gracilaria*, respectively) at all sites except near the mouth of the Estuary." The Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016). The mouth of the estuary site is Four Tree Island, approximately 1 mile upstream from the Little Harbor/Back Channel Assessment Zone.	"macroalgae is generally non-existent but in some cases may be present"	"and macroalgae is not present or present in limited amounts even though a good healthy aquatic community still exists"	"macro-algae accumulations occur in some regions of the embayment."	"macroalgal accumulations"
Benthic animal diversity and shellfish	The area has never been considered a major resource. Detailed benthic animal diversity has not been quantified. Areas of scallops remain. Mussel populations have been disappearing. No historical perspective.	"benthic animal diversity and shellfish productivity are high"	"there is generally a shift away from suspension feeding to moderate depth deposit feeders"	"is loss of diverse animal communities and replacement by smaller, shorter-lived animals of intermediate burrowing capabilities. Shellfisheries may shift to more resistant species."	"loss of diverse benthic animal populations" "benthic communities are dominated by shallow dwelling opportunistic species (e.g. *Capitella, Streblospio, Solemya*, etc).
Chlorophyll-a	The calculated 90th percentile chlorophyll-a in this assessment zone is 3.2 ug/L (n = 52) and a maximum reading of 5.2 ug/L.	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"phytoplankton blooms raise chlorophyll a levels to around 10 µg/L."	"The level of nitrogen related to Significant Impairment supports large phytoplankton blooms

Indicator	Current status of Portsmouth Harbor Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
					(chlorophyll a of approximately 20 µg/L)"
Total Nitrogen	The median total nitrogen from 2008 through 2013 was 266 ug/L (n=56).	"The CCC [Cape Cod Commission] and BBP [Buzzards Bay Project] thresholds are <0.34 mg N/L and <0.39 mgN/L, respectively."	"nitrogen levels are in the 0.39 - 0.50 range"	* >0.40 to 0.70 mg/L	"systems that are "Eutrophic", 0.60/0.70 mg N/L"
Dissolved Oxygen	This assessment zone has datalogger and grab measurements for dissolved oxygen concentration covering 2008 through 2013. Only one sample appears to fall below 5 mg/L. (Figure 3)	"oxygen levels are generally not less than 6.0 mg/l with occasional depletions being rare (if at all)" (as measure by lowest 20% of readings)	"oxygen levels are generally not less than 5.0 mg/l with depletions to <4 mg/L being infrequent" (as measure by lowest 20% of readings)	"Oxygen levels generally do not fall below 4 mg/L"	"periodic hypoxia"

* SMAST (Howes, Samimy, & Dudley, 2003) "Within West Falmouth Harbor eelgrass loss was lost at nitrogen levels about 0.4 mg N/L. Eelgrass within the Great, Green, and Bournes Pond systems is generally lost also at the ca. 0.40 mg N/L level, which is at the SA/SB boundary. The generally high resource quality of SB waters for shellfish, finfish, recreation and aesthetics is generally maintained to the 0.50 mg N/L level. However, in areas of these systems where nitrogen levels exceed 0.5 mg N/L, animal communities decline and macroalgal accumulations begin to effect aesthetic quality. These systems tend to be relatively consistent and still maintain many resource values between 0.50 – 0.70 mg N/L."

Figure 2. Portsmouth Dissolved Oxygen.



Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

DO mg/L Std. = Dissolved oxygen concentration daily minimum water quality criteria.

DO mg/L Ind. MAGEX = Magnitude of exceedence indication for dissolved oxygen concentration.

DO-PPM-24HR-MIN-CP = 24 hour minimum dissolved oxygen from a datalogger deployed during the summer critical period.

DO-PPM-24HR-MIN-NCP = 24 hour minimum dissolved oxygen from a datalogger deployed outside of the summer critical period.

DO-PPM-GRAB-CP = Grab samples of dissolved oxygen collected during the summer critical period.

DO-PPM-GRAB-NCP = Grab samples of dissolved oxygen collected outside the summer critical period.

Table 7. Little Harbor/Back Channel evaluating results utilizing the 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003). Blocks highlighted gray best describe the indicator evaluation category.

Indicator	Current status of Little Harbor/Back Channel Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
Eelgrass	The historical extent of eelgrass in this assessment zone was 68.8 acres from the 1948, 1962, 1980, and 1981 datasets. The median current extent of eelgrass in 2011-2013 is 31.6 acres, which is a 54.1% decrease. Since 1990, the trend in eelgrass cover in this assessment zone is a loss of 33.4%.	"Eelgrass beds are present"	"eelgrass is not present (it would still be considered SA water body if historical records document that eelgrass was present in the past or, in the case of insufficient documentation, if potential conditions are such that eelgrass should be present)"	"Eelgrass is not sustainable"	"absence of eelgrass"
Macroalgae	Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016) noted that, "Monitoring results from 2014 show high levels of cover of nuisance green and red algae (*Ulva* and *Gracilaria*, respectively) at all sites except near the mouth of the Estuary." The Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016). The mouth of the estuary site is Four Tree Island, approximately 0.5 miles upstream from the Little Harbor/Back Channel Assessment Zone.	"macroalgae is generally non-existent but in some cases may be present"	"and macroalgae is not present or present in limited amounts even though a good healthy aquatic community still exists"	"macro-algae accumulations occur in some regions of the embayment."	"macroalgal accumulations"
Benthic animal diversity and shellfish	The area has never been considered a major resource. Detailed benthic animal diversity has not been quantified. 2005 survey for ACOE dredge found few *bivalvia* but many *polychaeta* and *oliiochaeta* (ACOE, 2005). No historical perspective.	"benthic animal diversity and shellfish productivity are high"	"there is generally a shift away from suspension feeding to moderate depth deposit feeders"	"is loss of diverse animal communities and replacement by smaller, shorter-lived animals of intermediate burrowing capabilities. Shellfisheries may shift to more resistant species."	"loss of diverse benthic animal populations" "benthic communities are dominated by shallow dwelling opportunistic species (e.g. *Capitella, Streblospio, Solemya*, etc).
Chlorophyll-a	The calculated 90th percentile chlorophyll-a in this assessment	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"phytoplankton blooms raise chlorophyll a levels to	"The level of nitrogen related to Significant

Indicator	Current status of Little Harbor/Back Channel Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
	zone cannot be calculated due to the presence of only four measured values since 2008 (0.8 to 3.9 ug/L).			around 10 µg/L."	Impairment supports large phytoplankton blooms (chlorophyll a of approximately 20 µg/L)"
Total Nitrogen	The median total nitrogen from the limited data covering 2008 through 2013 was 465 ug/L (n=4).	"The CCC [Cape Cod Commission] and BBP [Buzzards Bay Project] thresholds are <0.34 mg N/L and <0.39 mg N/L, respectively."	"nitrogen levels are in the 0.39 - 0.50 range"	* >0.40 to 0.70 mg/L	"systems that are "Eutrophic", 0.60/0.70 mg N/L"
Dissolved Oxygen	This assessment zone has only grab sample measurements for dissolved oxygen concentration and those measurements were only collected up through 2010. The available data indicates that this assessment zone typically exceeds 6 mg/L dissolved oxygen with occasional dips that remain over 5 mg/L. (Figure 3)	"oxygen levels are generally not less than 6.0 mg/l with occasional depletions being rare (if at all)" (as measure by lowest 20% of readings)	"oxygen levels are generally not less than 5.0 mg/l with depletions to <4 mg/L being infrequent" (as measure by lowest 20% of readings)	"Oxygen levels generally do not fall below 4 mg/L"	"periodic hypoxia"

* SMAST (Howes, Samimy, & Dudley, 2003) "Within West Falmouth Harbor eelgrass loss was lost at nitrogen levels about 0.4 mg N/L. Eelgrass within the Great, Green, and Bournes Pond systems is generally lost also at the ca. 0.40 mg N/L level, which is at the SA/SB boundary. The generally high resource quality of SB waters for shellfish, finfish, recreation and aesthetics is generally maintained to the 0.50 mg N/L level. However, in areas of these systems where nitrogen levels exceed 0.5 mg N/L, animal communities decline and macroalgal accumulations begin to effect aesthetic quality. These systems tend to be relatively consistent and still maintain many resource values between 0.50 – 0.70 mg N/L."

Figure 3. Little Harbor/Back Channel Dissolved Oxygen.

Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

DO mg/L Std. – Dissolved oxygen concentration daily minimum water quality criteria.

DO mg/L Ind. MAGEX – Magnitude of exceedence indication for dissolved oxygen concentration.

DO-PPM-GRAB- CP = Grab samples of dissolved oxygen collected during the summer critical period.

DO-PPM-GRAB- NCP = Grab samples of dissolved oxygen collected outside the summer critical period.

RESPONSE TO COMMENT #4: John B. Storer, City of Rochester

<u>DES RESPONSE</u> **to 4- 1**

This section contains opening remarks by the City of Rochester. References to portions of the Draft 2014 303(d) are discussed in the responses below.

<u>DES RESPONSE</u> **to 4- 2**

Rochester incorporates by reference the comments provided by the Great Bay Municipal Coalition seen in comments set #8.

<u>DES RESPONSE</u> **to 4- 3**

NHDES recognizes the City of Rochester's concerns over permitting work and the assessment process. However, the assessment process has no control over permitting efforts.

<u>DES RESPONSE</u> **to 4- 4 and 7- 6**

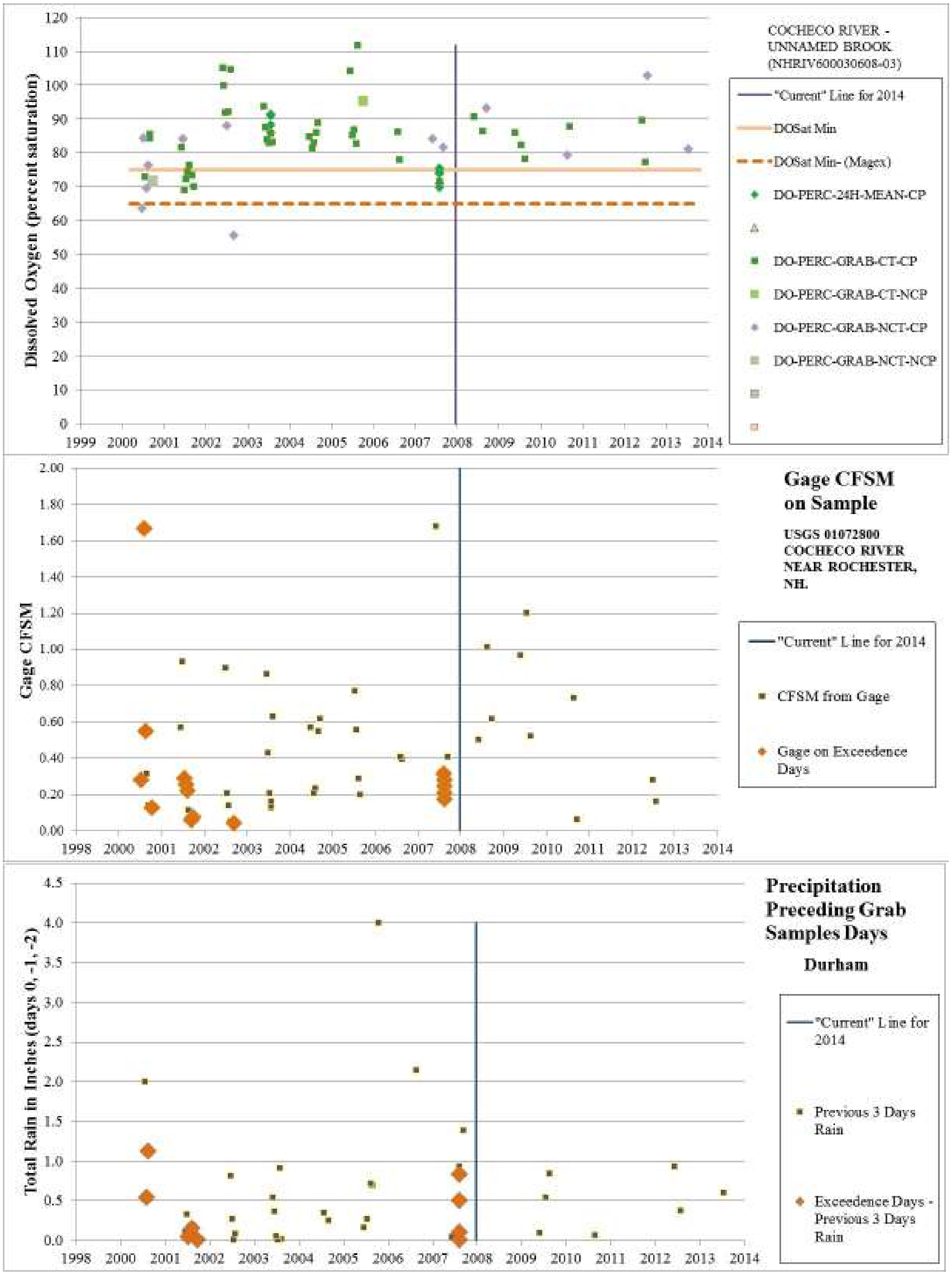
The impairment designation originated from poor dissolved oxygen saturation in grab samples at station 12-CCH in 2000, 2001, and 2002 during low flow periods (<0.3 cfsm). Those earlier poor dissolved oxygen periods were confirmed by a 2007 datalogger deployed one mile upstream of 12-CCH at station 13-CCH at somewhat higher flows than the original impairment samples (0.05 to 0.30 cfsm verses 0.15 to 0.35 cfsm) (Figure 4). Although not measured at as low flow as the earlier low DO readings, the water temperature in 2007 was warmer (>20C). Continuous dataloggers are the most appropriate method to evaluate the 24 hour dissolved oxygen saturation criteria.

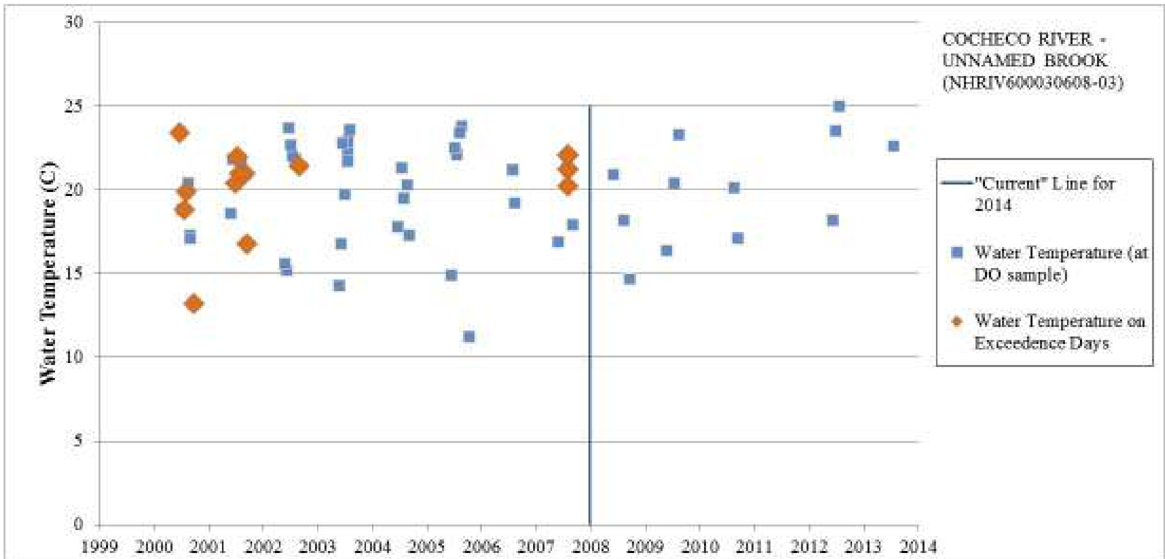
The more recent dataset (i.e. since 2007) includes few samples collected under similar flow and thermal conditions to those that resulted in low dissolved oxygen saturation in 2000, 2001, 2002 and 2007. The data collected since 2007 includes only eight grab samples collected early in the day and no datalogger records. Of those eight samples only two were collected under low to moderately low flows and warm water conditions (Figure 4). While the recent data looks promising, it is insufficient to warrant impairment removal.

For the removal of the impairment, ideally a multiday datalogger should be deployed at station 12-CCH and 13-CCH under warm (>20^{o}C), low flow conditions (<0.1 cfsm at USGS gage 01072800).

The CALM outlines procedures whereby a minimum of ten samples should be collected in the summer period for dissolved oxygen precisely for the reasons above. That is, in a random sampling program, the higher waterbody stress conditions are not often measured. If a smaller dataset were collected, and that dataset could be shown to be collected under the higher waterbody stress conditions, the ten days of data requirement is flexible.

Figure 4. Cocheco River (NHRIV600030608-03) Dissolved oxygen saturation data, associated river flow, preceding precipitation, and water temperature.





Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for additional details.

DO-PERC-24HR-MEAN-CP = 24 hour mean dissolved oxygen satueration from a datalogger deployed during the summer critical period.

DO-PERC-GRAB-CT-CP = Grab samples of dissolved oxygen saturation during the early morning hours of the summer critical period.

DO-PERC-GRAB-CT-NCP = Grab samples of dissolved oxygen saturation during the early morning hours of the summer critical period.

DO-PERC-GRAB-NCT-CP = Grab samples of dissolved oxygen saturation not in the early morning hours of the summer critical period.

DO-PERC-GRAB-NCT-NCP = Grab samples of dissolved oxygen saturation not in the early morning hours and outside the summer critical period.

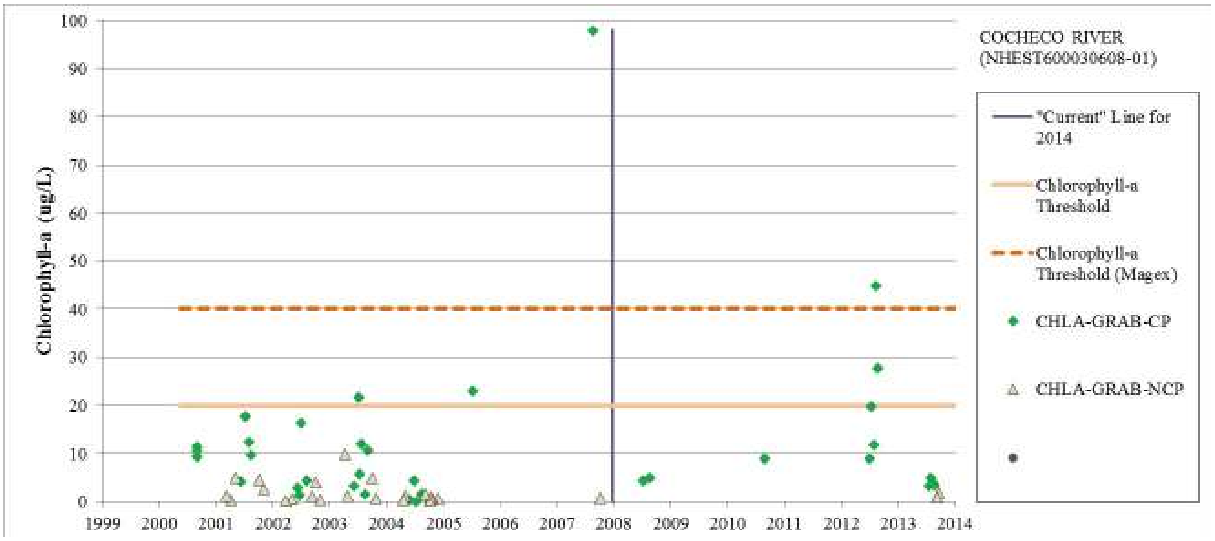
DES RESPONSE **to 4- 5**

The impairment listing of the tidal Cocheco River (NHEST600030608-01) for the impact of excess chlorophyll-a impacts on the primary contact recreation designated use was first on the 2010 303(d) and is not a "…new listing…" As such, to remove the impairment not only must NHDES demonstrate that an impairment does not exist, but that the current samples were collected under the same or more water quality limiting conditions as past exceedences of the indicator. Exceedences of the 20 ug/L indicator have been episodic and at times severe even when considering the long gaps in the sampling efforts. It should be noted that much of the older data is collected under higher inflow and/or lower temperature conditions than those that resulted in high chlorophyll-a. It is the higher temperature and dry (low inflow) conditions that have been demonstrated to trigger the episodic high chlorophyll-a concentration as described in NHDES' 2014 Technical support document (NHDES, 2015),

> *"Although the probe based chlorophyll-a data (not used in the median above) collected from station CR1 (2012) was qualified as "estimated" per EPA, due to poor correlation between probe and extracted chlorophyll-a grab sample data, the relative biomass is valid and shows severe spikes in chlorophyll-a. Those spikes were most pronounced when low tide (maximum freshwater signal and maximum water temperature) occurred at midday to late afternoon (maximum photosynthesis duration period) and when freshwater inflow was at a minimum (0.23 – 0.10 cfsm) (minimum dilution of upstream loading). Under those conditions, the high nutrient water sloshing back and forth in the Cocheco River had the optimum conditions to sustain a large phytoplankton biomass."*

It is those higher temperature and dry (low inflow) conditions that bring the greatest number of residents and tourists to the water for recreational purposes and they respond to the conditions they meet on the day of their visit, not to the average condition over a year. In this way, the instantaneous concentration of chlorophyll-a is important as it relates to recreation (also see response to comment 4- 7).

Figure 5. Tidal Cocheco River (NHEST600030608-01) chlorophyll-a samples.



Notes:

The chlorophyll-a indicator threshold shown in the graphic above is to protect the swimming designated us (i.e. primary contact recreation).

"Current" Line for 2014 - Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

CHLA-GRAB-CP = Chlorophyll-a samples collected during the summer critical period.

CHLA-GRAB-NCP = Chlorophyll-a samples collected and outside the summer critical period.

Further, exceedences of the indicator before 2008 were all corrected for pheophytin yielding an artificially low indicator of the visual impact of the chlorophyll-a blooms. The 20 ug/L indicator is a visual threshold. The visible light spectrum for humans is 400-750nm. Peak chlorophyll-a light absorption occurs at 430 nm (violet-blue) and 663 nm (red), which is why it appears green. Pheophytin principally enhances the absorption at 407 nm (violet) adding an additional green hue to the water and slightly at 510 and 535 nm (cyan-green) blocking some of the green hue. As the commenter's cited reference notes, "Pheophorbide a and pheophytin a, two common degradation products of chlorophyll a, can interfere with the determination of chlorophyll a **because they absorb light and fluoresce in the sample region of the spectrum as does chlorophyll a** [emphasis added]." In their response to a bloom, the eyes of the recreating public make no distinction between active components of chlorophyll-a and its degradation products.

DES RESPONSE to 4- 6

The comments from the City of Rochester purport that the July 2012 and 2013 continuous chlorophyll dataloggers overestimate the chlorophyll-a concentrations during their deployments. The comment included only a subset of the datalogger/grab paired samples. When NHDES looked at the full suite of paired samples in 2012 (Figure 6), we see that in most cases in the Cocheco River the datalogger is underestimating chlorophyll-a and in general there is no discernable pattern. Exploring the 2013 paired samples (Figure 7) one is first struck that there is only a single Cocheco River pair in July 2013 and by the lack of chlorophyll concentration range in the 2013 pairs when compare to 2012 (Figure 6 vs Figure 7). The claim of datalogger overestimation is not supported by the existing data.

Figure 6. Paired chlorophyll-a for dataloggers and chlorophyll from dataloggers at the 2012 EPA sites on the Upper Piscataqua River (UPR) and tidal Cocheco River (CR).

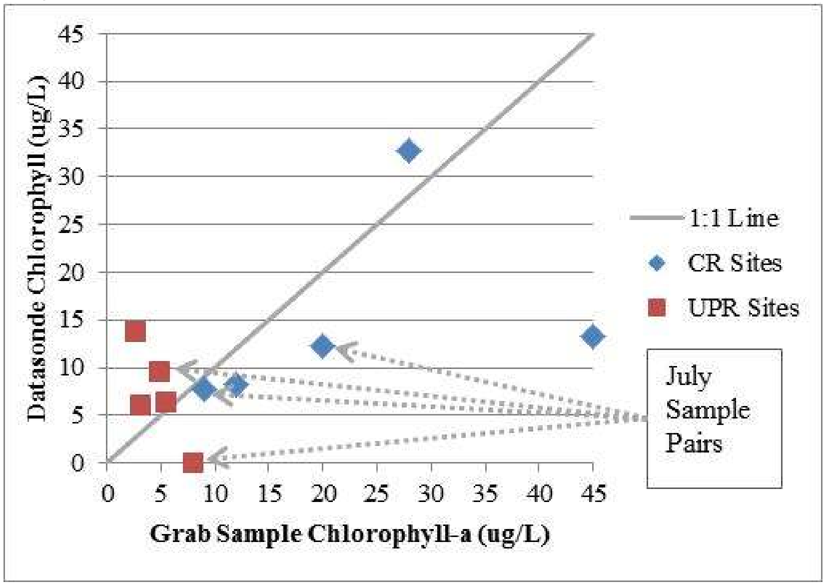
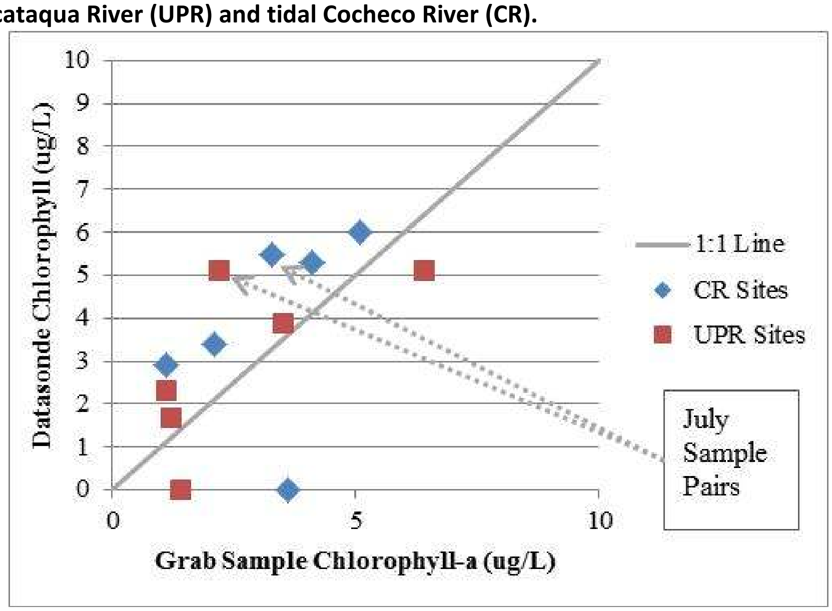


Figure 7. Paired chlorophyll-a for dataloggers and chlorophyll from dataloggers at the 2013 EPA sites on the Upper Piscataqua River (UPR) and tidal Cocheco River (CR).



Accuracy of the datalogger aside, the City of Rochester comments that the dataloggers demonstrate low levels of chlorophyll-a in the Cocheco River. From the valid grab sample data in this assessment zone the calculated median is 9 ug/L, the 90th percentile is 36.5 ug/L chlorophyll-a (n = 14) and there is a peak of 45 ug/L. The City of Rochester calculated a median chlorophyll-a of 7 ug/L and 90th percentile of 18 ug/L from the 2012 and 2013 dataloggers, however, plots of the data (Figure 8 and Figure 9) for four stations (Figure 10) show consistent chlorophyll peaks well over 20 ug/L.

Figure 8. 2012 tidal Cocheco River chlorophyll-a datalogger at stations CR1, CR3, CR5, and CR7.

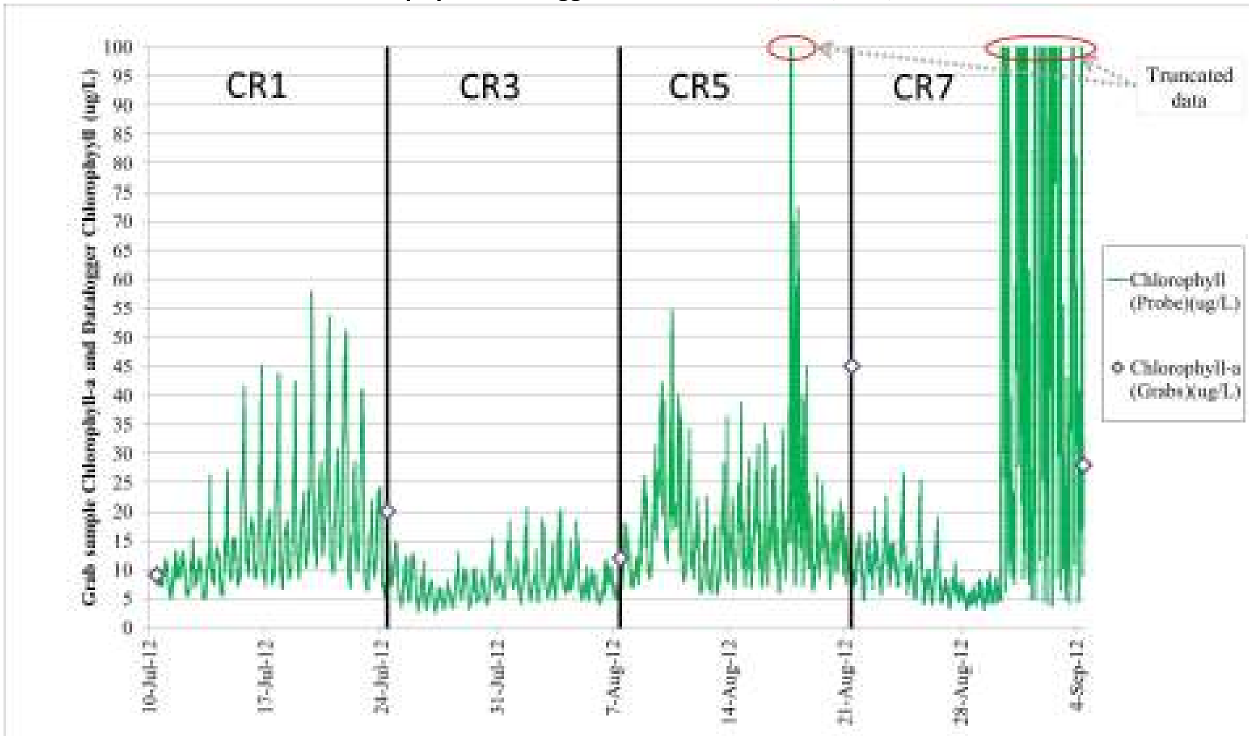


Figure 9. 2013 tidal Cocheco River chlorophyll-a datalogger at stations CR1, CR3, CR5, and CR7.

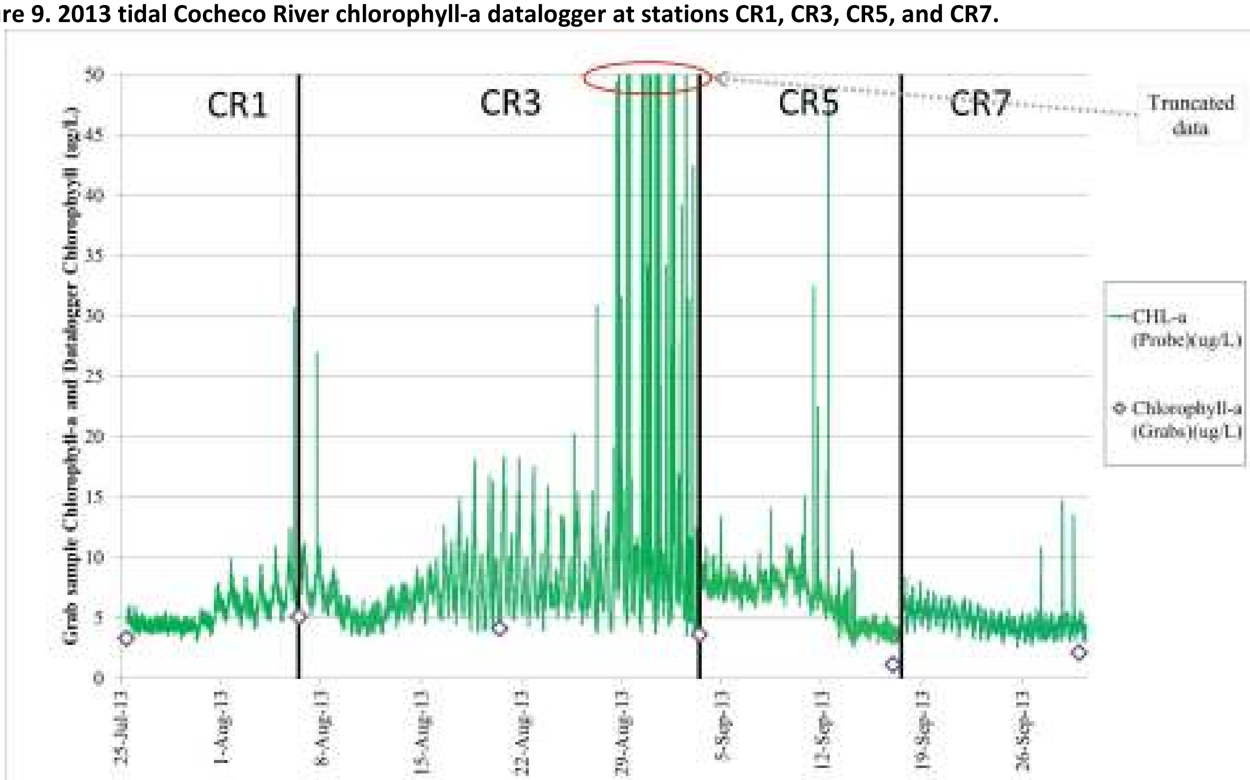
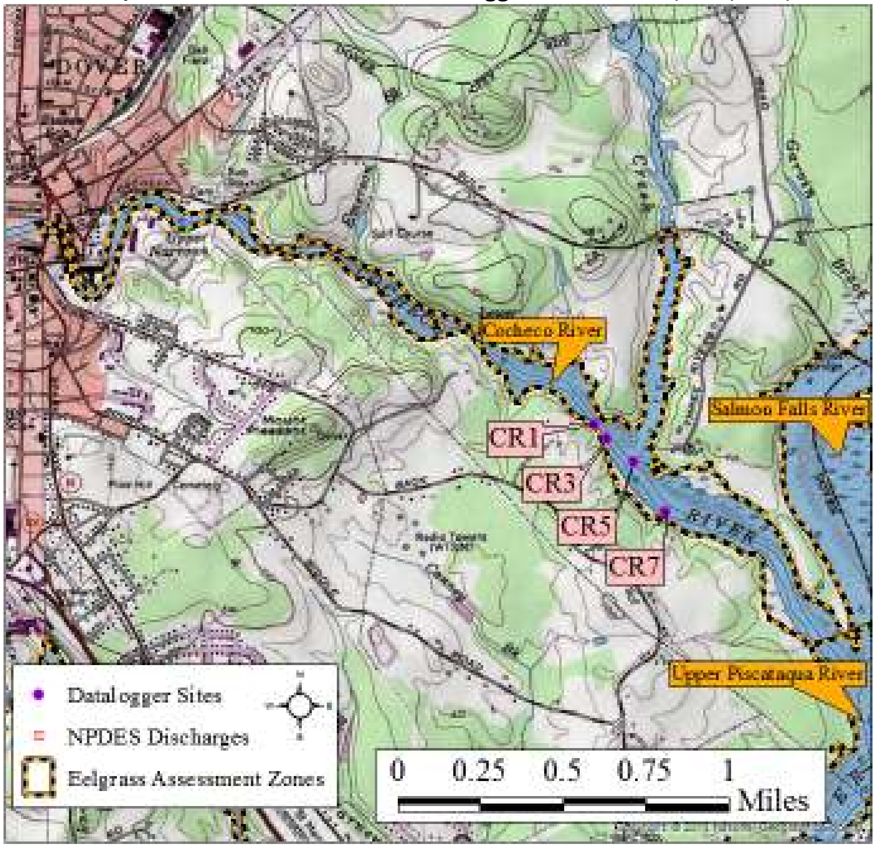


Figure 10. 2012/2013 tidal Cocheco River datalogger stations CR1, CR3, CR5, and CR7.



Applying the SMAST 2003 (Howes, Samimy, & Dudley, 2003) methodology (see 3- 1) to either the grab sample or datalogger chlorophyll-a data to the tidal Cocheco River assessment zone data, places the tidal Cocheco River into the "Significantly impaired" category (Table 8).

Table 8. Tidal Cocheco River as seen through the lens of SMAST 2003. Blocks highlighted gray best describe the indicator evaluation category.

SMAST 2003 Category for Chlorophyll-a	**Description of Category for SMAST 2003Text**
Current chlorophyll-a status of Tidal Cocheco River	The calculated 90th percentile chlorophyll-a in this assessment zone is 36.5 ug/L and the median is 9 ug/L (n = 14).
Excellent to Good health	"chlorophyll-a levels are in the 3 to 5 µg/L range"
SMAST 2003, Good to Fair Health	"chlorophyll-a levels are in the 3 to 5 µg/L range"
SMAST 2003, Moderately Impaired Health	"phytoplankton blooms raise chlorophyll a levels to around 10 µg/L."
SMAST 2003, Significantly Impaired Health	"The level of nitrogen related to Significant Impairment supports large phytoplankton blooms (chlorophyll a of approximately 20 µg/L)"

DES RESPONSE **to 4- 7**

The City of Rochester asserts that the chlorophyll-a indicator to protect the swimming designated use is inappropriate. The indicator used (20 ug/L chlorophyll-a) for 305(b)/303(d) assessments has been in place since 2004. The chlorophyll-a (20 ug/L) is an aesthetic indicator, not a health indicator to identify a threshold at which toxic blooms become likely as the commenter's World Health Organization (WHO) threshold is based upon.

As a maximum value observed over a typical annual cycle Bricker et. al. (Bricker, Clement, Pirhalla, Orlando, & Farrow, 1999) considered 20 ug/L to be "high" chlorophyll-a. More recently, the National Coastal Condition

Assessment of 2010 data (USEPA, National Coastal Condition Assessment 2010, 2015) uses 20 ug/L as the break between Fair and Poor (the lowest rating). When NHDES started using the 20 ug/L indicator one of the points of consideration was the chlorophyll-a concentrations that we traditionally observed in New Hampshire's estuaries. NHDES evaluated all of the available coastal data and found that only 1% of the probabilistically collected data and only 3% of all data exceeded 20 ug/L. Indeed, 20 ug/L chlorophyll-a is a rare occurrence (Table 9).

Table 9. New Hampshire estuarine chlorophyll-a data addressed in cosideration of an indicator to protect the swimming designated use for the 2004 assessment cycle.

Dataset	N	Min	Mean	Median	Max	Percent of samples >20 ug/l
All NH Estuarine Data (1988-2003)	1,040	0.0	4.3	2.3	160.3	3%
NCA Probabilistic Data (2000-2001)	76	0.7	4.5	3.2	20.1	1%

In evaluating all of the chlorophyll-a data used as "current" data for the 2014 assessment (2008 through 2013), we see a similar distribution (Table 10) except that all metrics have increased. As this is not the probabilistic network and there has been added focus on the high nitrogen sections of the estuary in recent years, this suggests that samples exceeding 20 ug/L are still quite uncommon.

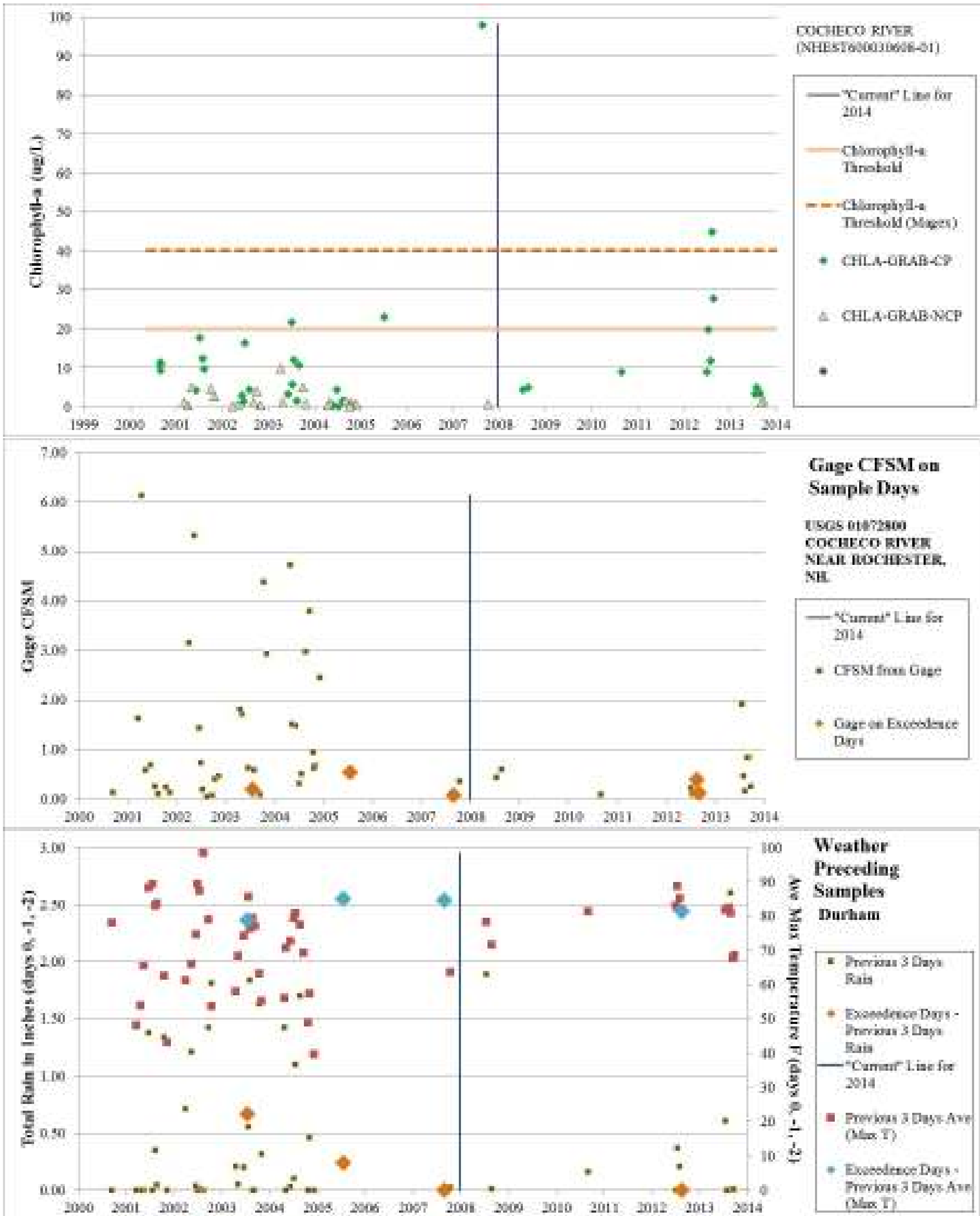
Table 10. Great Bay estuary estuarine chlorophyll-a data considered "current" for the 2014 assessment cycle.

Dataset	N	Min	Mean	Median	Max	Percent of samples >20 ug/l
All Great Bay Estuary Grab sample Data (2008-2013)	766	0.1	7.4	3.0	233.8	6%

The City of Rochester includes references to Stow et. al. (Stow, Roessler, Borsuk, Bowen, & Reckhow, 2003) and VDEQ (VDEQ, Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River, 2005) claiming that "…chlorophyll-a in the 20-40 ug/L range are compatible with full use attainment (Stow and others, 2003; VDEQ, 2005)." Two points are germane here. First, both thresholds are in reference to the aquatic life designated use. Second, regarding the Stow et. al. (Stow, Roessler, Borsuk, Bowen, & Reckhow, 2003) study, it is of the Neuse River estuary in North Carolina where 40 ug/L chlorophyll-a is used as a level not to be exceeded per the North Carolina 303(d) listing methodology to protect the aquatic life use support which in fact reads, "Not greater than 40 µg/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation" (NCDWR, 2015). Regarding VDEQ (VDEQ, Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River, 2005), the comments appear to have pulled the highest proposed concentration for the tidal-fresh portions of the James River, while the segments of the James River, more hydrologically comparable to the Great Bay estuary, the mesohaline and polyhaline, were proposed at 10 ug/L chlorophyll-a (Table 11 in (VDEQ, Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River, 2005)).

It may be helpful to define the concentration at which increased chlorophyll-a is considered a bloom, which is what VDEQ (2005) did in order to reduce the likelihood of harmful algae blooms (HABs). To protect against HABs occurring at a chlorophyll-a concentration of 25-30 ug/L in single samples, VDEQ (VDEQ, Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River, 2005) proposed an average chlorophyll-a of 10 ug/L (Table 11 in (VDEQ, Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River, 2005)). The 2008-2013 average chlorophyll-a of the tidal Cocheco River is 10.9 ug/L (n=14), which includes grab samples up to 45 ug/L chlorophyll-a (Figure 11), and there are likely much higher concentrations if one considers the datalogger records of 2012 and 2013 (Figure 8 and Figure 9 respectively).

Figure 11. Tidal Cocheco River (NHEST600030608-01) chlorophyll-a data, representative river inflow, and preceding precipitation and temperature.



Notes:

The chlorophyll-a indicator threshold shown in the graphic above is to protect the swimming designated us (i.e. primary contact recreation).

"Current" Line for 2014 - Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

CHLA-GRAB-CP = Chlorophyll-a samples collected during the summer critical period.
CHLA-GRAB-NCP = Chlorophyll-a samples collected and outside the summer critical period.

The comments by the City of Rochester make a broad claim without references that the chlorophyll-a targets to protect recreational uses of nine states are seasonal averages and in the range of 15-30 ug/L. Investigation of those nine states' methodologies places the comment into three categories; assessment methodology completely contrary to claim, assessment methodology absent, and assessment methodology claim reasonably substantiated.

The assessment methodology is completely contrary to the commenters claim regarding Wisconsin, Kansas, and Texas.

Wisconsin - The Wisconsin approach (WDNR, 2015) to the recreational use is similar to the NHDES approach.

> "The protocol was changed to better reflect actual impairments of recreational uses, and to better capture the variability of chlorophyll in lakes. The protocol now uses the percent of days during the sampling season that a lake experiences nuisance algal blooms as its benchmark for assessments. Nuisance algal blooms are defined as exceeding 20 ug/L chlorophyll *a*. This was defined based on user perception surveys conducted in Minnesota. For deep lakes, the impairment threshold is 5% of days of nuisance algal blooms during the sampling season. For shallow lakes, the impairment threshold is 30% of days of nuisance algal blooms during the sampling season."

Kansas – The Kansas approach (KDHE, 2016) is two tiered, using a chlorophyll-a concentration of 12 ug/L average or 12 ug/L in one or more sample in the last two years.

> "For lakes not listed in 2014 for eutrophication, if the lake has a designated use of primary contact recreation but is not an active public water supply and the overall chlorophyll *a* average concentration is greater than 12 ppb [ug/L] or if the chlorophyll *a* concentration is greater than 12 ppb [ug/L] for more than one sample since 2000 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5."

Texas – The Texas approach (TDEQ, 2015) to chlorophyll-a is similar to the NHDES approach but has a lower threshold. Texas' assessment is not specifically tied to the recreation designated use but rather an overall "general use" and further a binomial count of individual samples greater than 11.6 ug/L chlorophyll-a is applied.

> "A concern for water quality is identified if the screening level is exceeded greater than 20 percent of the time using the binomial method, based on the number of exceedances for a given sample size (see Appendixes A and B)."

Per the methods described in the Texas listing methodology, all of the Great Bay Estuary assessment zones would be considered estuarine waters. The estuarine screening level (set at the 85th percentile of all data) is 11.6 ug/L (Texas CALM Table 3.10 (TDEQ, 2015) & personal correspondence)

The commenter's claimed assessment methodology is absent in Maryland, Virginia, and Arizona.

Maryland – No such methodology to protect the "water contact sports" (i.e. swimming) designated use. ((MDE, 2014) & personal correspondence)

Virginia – No such methodology to protect Virginia's "Recreation (swimming) Use" (VDEQ, 2014) Listing Guidance, Table 1 & personal correspondence).

Arizona – This is a state that has a substantially different geological landscape than New Hampshire. While it is somewhat true that Arizona has a chlorophyll-a criteria in law (Arizona Title R18-11-108.03, Effective January 31, 2009), that section was not approved by USEPA R9, nor are those criteria used in 305(b)/303(d) assessments (communication with AZDEQ staff). For "Full Body Contact" (i.e. swimming) the range of chlorophyll-a averages used in the unapproved rules in lakes is from 10 to 30 ug/L, however, based on the total phosphorus values associated to these chlorophyll-a, it is clear that the hydrology and geology of Arizona is nothing like that of New Hampshire and has a target range that starts at nearly twice the concentration of our most eutrophic lakes.

The commenter's claimed assessment methodology is reasonably substantiated in Oregon, Minnesota, and West Virginia.

Oregon – Partially correct. Oregon uses an average chlorophyll-a concentration in stratified lakes of 10 ug/L, and a 15 ug/L threshold in unstratified lakes, reservoirs, rivers, and estuaries. This pair of thresholds is intended to cover many designated uses; Water Contact Recreation, Aesthetics, Fishing, Water supply, and Livestock watering (ODEQ, 2011).

Minnesota – Partially correct. The summer average chlorophyll-a of less than 3 ug/L to less than 30 ug/L is used as a threshold depending upon region, waterbody class, and designated use. It is worth noting that at a chlorophyll-a concentration of 30 ug/L, the assessment target requires a secchi disk depth of only 0.7 meters (MPCA, 2014).

West Virginia – Partially correct. While the assessment methodology in West Virginia's Integrated Report does not specify a designated use, it does require that the average chlorophyll-a in cool water lakes shall be less than 10 ug/L and less than 20 ug/L in warm water lakes. Although unspecific, personal communications with West Virginia Department of Environmental Quality staff reveal that the criteria are "…intended to protect the aquatic life and water contact recreation designated uses..." (WVDEP, 2015)

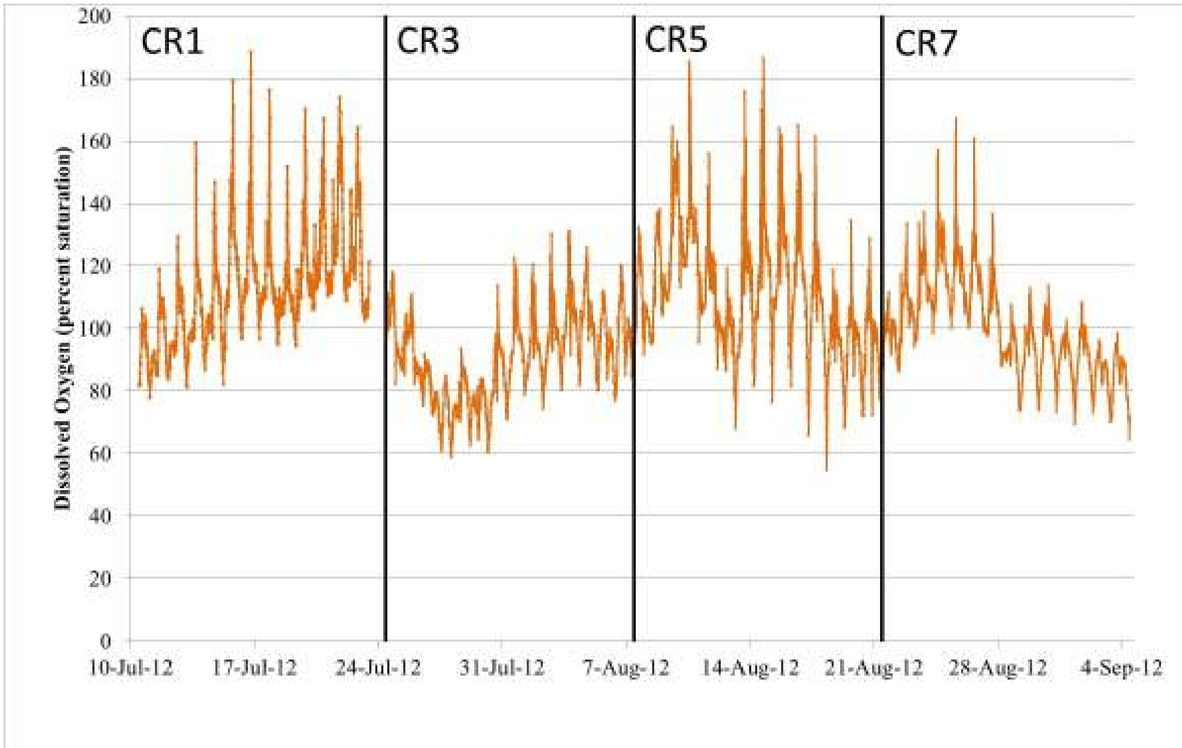
DES RESPONSE to 4- 8

The City of Rochester asserts that the tidal Cocheco River (NHEST600030608-01) should be assessed as fully supporting for dissolved oxygen instead of Insufficient Information – Potentially Not Supporting (3-PNS).

The category known as 3-PNS, Insufficient Information – Potentially Not Supporting, is not an impairment category and therefore Rochester's comment is not a 303(d) comment.

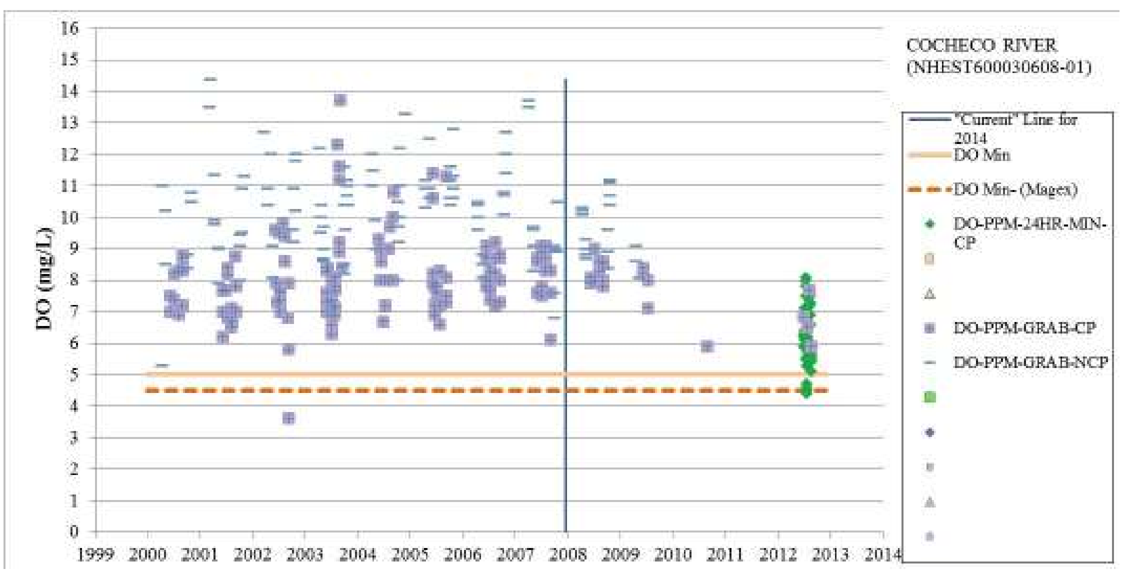
The City of Rochester points out that only one of 88 dissolved oxygen percent saturation daily averages were less than 75 percent. NHDES points out that due to the overgrowth and photosynthesis in the tidal Cocheco River there were multiday periods when dissolved oxygen percent saturation remained super-saturated and was regularly greater that 150 percent of the saturation concentration.

Figure 12. 2012 Tidal Cocheco River (NHEST600030608-01) dissolved oxygen percent saturation.



The available data indicates periods of time where dissolved oxygen in the tidal Cocheco River falls under 5 mg/L and clearly illustrates how poor basic grab sample data can be at documenting the dissolved oxygen regime of a waterbody (Figure 13). In light of the limited frequency, duration, and magnitude of those dips below the water quality criteria as well as recognition that WWTFs in the watershed are activity reducing total nitrogen loads to the waterbody, NHDES determined that the low dissolved oxygen measurements do not rise to the severity that warrants and impairment but that those measurements are cause for concern.

Figure 13. Tidal Cocheco River (NHEST600030608-01) dissolved oxygen concentration summary data.



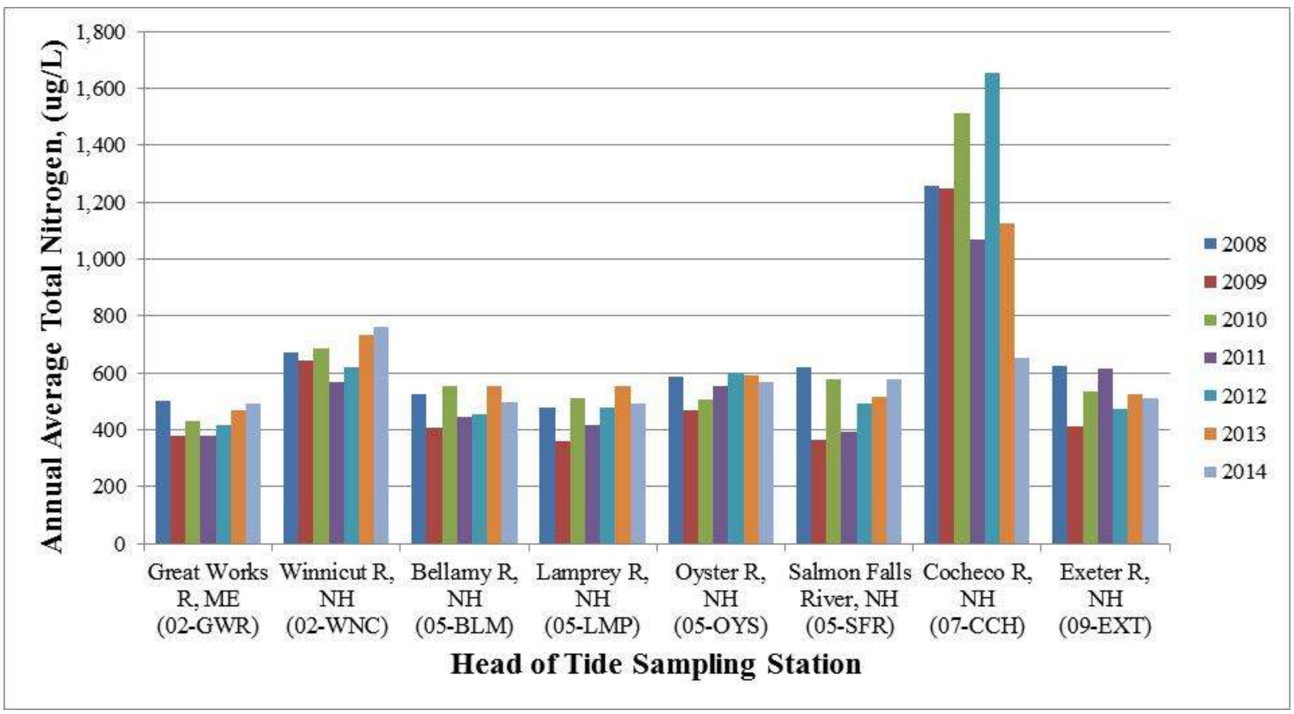
DES RESPONSE **to 4- 9**

The City of Rochester states that the tidal Cocheco River (NHEST600030608-01) should not be listed as impaired for total nitrogen. The final 2012 303(d) identified this assessment unit as impaired for total nitrogen and, the draft 2014 assessment listed it as "under construction."

NHDES must have a rational basis to remove an impairment. As discussed in response to Comment 3- 1 (Table 4); at this time there are some of the classic indicators of nutrient eutrophication present in this assessment zone and total nitrogen remains very high. In line with the indicators, there is a high total nitrogen load in the Cocheco River when compared across the Great Bay Estuary (Figure 14). However, there is insufficient power in the response datasets and the assessment methodology for total nitrogen has changed leading to the determination that eutrophication by total nitrogen is alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard. Further, NHDES is confident that in the years ahead, total nitrogen in the tidal Cocheco River will drop even lower as the loading is reduced and those reductions will be documented as improvements in the ambient system conditions. As such, this assessment zone has been assessed as Insufficient Information – Potentially Not Supporting (3-PNS) for total nitrogen.

See responses to 3- 1, 4- 5, 4- 6, 4- 7, and 4- 8 for additional discussion.

Figure 14. Annual measured total nitrogen concentration at the Great Bay Estuary head of tide dams.



DES RESPONSE **to 4- 10, 4- 9**

Rochester commented that NHLAK600030602-03 (Rochester Reservoir) should not be listed for cyanobacteria. The original impairment is based on microscopic identification conducted on a bloom that revealed "abundant" *anabaena*. NHDES is delighted to find out that Rochester is conducting cyanobacteria screening sampling, would like to see the information they reference, and would like to know more about their sampling protocols. Not all cyanobacteria produce surface blooms. As such, the location and timing of the sampling is critical. Some cyanobacteria will reside deeper in the water column and rise up in the evening hours. A daytime surface grab would miss these species. The current indicator of 77,000 cyanobacteria cells/100mL does not necessarily relate well to the colony forming units per milliliter (cfu/mL) described in the ALGE-BART cells information (http://www.hach.com/asset-get.download.jsa?id=7639982861). Some cyanobacteria produce filaments while others are free floating individuals that do not form colonies. Ultimately species identification and enumeration is needed to determine the likelihood of toxicity. While NHDES appreciates the comments and is comforted to find out that Rochester is conducting cyanobacteria screening sampling, additional information is needed before a delisting is justified.

Rochester commented that because NHLAK600030602-03 (Rochester Reservoir) has clearly posted no trespassing signage and fishing, boating, swimming, or other activities by the pubic are not allowed, the impairment should be removed. The Clean Water Act requires that States include recreation in and on the water as well as protection and propagation of fish, shellfish and wildlife in the list of designated uses for all water bodies. Removal of a designated use can only be done after a use attainability analysis in accord with 40 CFR Part 131 and not part of 40 CFR Part 131 indicates that designated use “X” can be removed to protect designated use “Y.”

NHDES is confident that the watershed protection measures Rochester has been putting in place for NHLAK600030602-03 (Rochester Reservoir) when combined with more detailed sampling information will result in the removal of the cyanobacteria impairment in an upcoming assessment cycle.

DES RESPONSE to 4- 11

Rochester commented that impairments should be removed when the data is greater than 5 years old. NHDES is sympathetic to this concern. The CALM text applies to what the Clean Water Act requires in instances where older data indicates impairment. Removal of an impairment requires the collection of adequate new data under similar or more limiting conditions indicating support. All data and all knowledge of changes in the stressors to a system are considered when deciding whether a waterbody is kept as impaired or shown as fully supporting a particular indicator.

One way to think about this process is the metaphor of an automobile inspection. If a car fails inspection due to bald tires, that failure (i.e. impairment) remains until it is demonstrated that the car has good tires. This requires both the fix (new tires) and the documentation of that fix (re-inspection). Like Rochester, NHDES would also like to have information about both the improved conditions and new monitoring data in order to remove impairments based on old data.

DES RESPONSE to 4- 12

City of Rochester comments on EPA’s approval of New Hampshire’s 2012 303(d). Comments are noted but not as part of the 2014 draft 303(d).

DES RESPONSE to 4- 13

Closing remark, no comments necessary.

RESPONSE TO COMMENT #5: Tom Irwin, Conservation Law Foundation

***DES RESPONSE* to** 5- 1
This section contains opening remarks by the Conservation Law Foundation. References to portions of the Draft 2014 303(d) are discussed in the responses below.

***DES RESPONSE* to** 5- 2
A distinction in language is needed. While indeed the Great Bay Estuary in showing, "all of the classic signs of eutrophication, including increasing nitrogen concentrations" (NHDES, 2015) not **all** segments of the estuary are showing **all** of the classic signs of eutrophication. As such, not all assessment zones warrant total nitrogen impairment designations, each assessment unit is assessed individually based on the data for that unit. (see 3-1).

The Conservation Law Foundation objects to the proposed total nitrogen delistings and the assessment units marked as "assessment unit methodology under development" for total nitrogen, commenting that ceasing to apply the thresholds from the 2009 methodology is not sufficient cause. In fact, the 2009 methodology was intended as a translator for the narrative nutrient criteria found in Env-Wq 1700. While those thresholds are in the range of others found in the region, NHDES determined that the statistical methods to determine those particular values should not be applied to the estuary as a whole. As such, a weight of evidence approach to the narrative criteria on each individual assessment zone is the appropriate assessment methodology at this time.

The Conservation Law Foundation further commented that NHDES should not delist total nitrogen impairments while it is in the process of determining new assessment approaches. As discussed in the Technical Support Document (NHDES, 2015) and the response to comment 3- 1, not all segments of the estuary are showing all of the classic signs of eutrophication and NHDES cannot make a non-assessment where data is readily available and assessments were previously completed and approved through the 303(d) process. New Hampshire has a narrative standard for nitrogen and while NHDES would like more data in some locations, there is overall a wealth of data in some zones of the Great Bay Estuary. As discussed in the Technical Support Document (NHDES, 2015) in some zones there is insufficient power in the response datasets and the assessment methodology for total nitrogen has changed leading to the determination that eutrophication by total nitrogen is alone is not known to be strong enough to warrant impairment under New Hampshire's narrative standard.

***DES RESPONSE* to** 5- 3
The Conservation Law Foundation objects to the removal of the estuarine bioassessments and water clarity impairments from the Squamscott River – North assessment zone. In the 2012 assessment cycle, this assessment zone was listed as impaired for "Estuarine Bioassessments" (i.e. a lack of eelgrass) based on the 1948 survey (Krochmal, 1949) that indicated that roughly 42 acres of eelgrass were present. The Water Clarity (i.e. a high Light Attenuation Coefficient) impairment is contingent upon the Estuarine Bioassessments (eelgrass) impairment and measure poor Water Clarity.

Related to the 1949 Krochmal thesis maps (Krochmal, 1949) regarding Eelgrass and subsequent conversion of that dataset to a GIS layers, Odell et al (Odell, Eberhardt, Burdick, & Ingraham, 2006) stated,

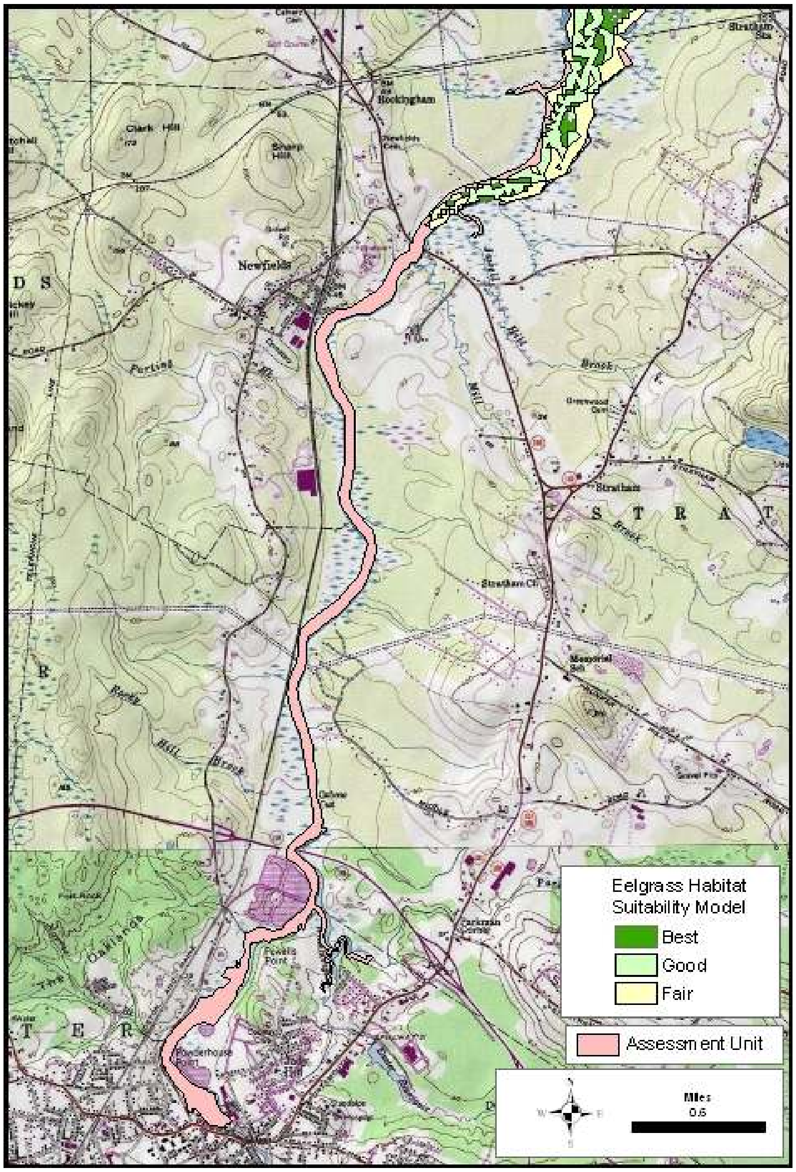
> "A 1949 University of New Hampshire M. Sc. thesis by Stanley Krochmal, contained a carefully drawn eelgrass map that was scanned and rectified to the NHHD 1:24,000 shoreline data. Polygons with density codes were traced onscreen from this image. The original map closely matches modern hydrology data …"

and

> "Krochmal was likely using primarily shore based methods at low tide and the absence of eelgrass beds from deeper areas on his maps should be interpreted accordingly."

The areas of the Squamscott River North assessment zone that appeared to have had eelgrass were described as either, ""P" for present is meant to show isolated patches of zostera" or "S" for scattered should be interpreted to mean one quarter of available area being covered" (Krochmal, 1949). The dividing line between the scattered (25%) and present (patches) is at roughly the midpoint of the Squamscott River North assessment zone. In terms of temperature and salinity suitability as compared to the 2008 to 2013 data, this makes sense. From the datalogger at the north end of the assessment zone, GRBSQ, 87% of the salinity measurements were 10 ppt or higher and only 2% were less than 5 ppt. Again from the GRBSQ datalogger, 95% of the daily medians were 25^{o}C or lower. At the south end of the assessment zone there are no dataloggers but from the 200 measurements between 2008 and 2013, the temperature and salinities, while less than ideal, could support eelgrass. From GRBCL and 01-SQM, both by Chapman's Landing, 60 percent of the salinity measurements were 10 ppt or higher and 26% were less than 5 ppt. Again from the GRBCL and 01-SQM, 87% of the daily temperature medians were 25^{o}C or lower. Finally, Figure 15 shows the 2011 output of the Eelgrass Site Selection Model (Short, Davis, Kopp, Short, & Burdick, 2002) analysis for the Squamscott River as one piece of evidence that was used to justify splitting the Squamscott River assessment zone at Chapman's Landing to EPA and drop eelgrass as an attainment goal in the southern segment. The Eelgrass Site Selection Model (Short, Davis, Kopp, Short, & Burdick, 2002) factors in bathymetry, historic and current eelgrass, water quality data, sediment type, and wind to identify the possible habitat.

Figure 15. Output of the Eelgrass Site Selection Model (Short et. al. 2002) for the 2011 Squamscott River assessment zone split which occurred for the 2012 assessments.



While the 1948 map is too rough to determine that precisely 42 acres were present, its presence was clearly documented. Combined with a rudimentary suitability evaluation of temperature, salinity, and the application of the Eelgrass Site Selection Model (Short, Davis, Kopp, Short, & Burdick, 2002), one must conclude that eelgrass could be present. Taken in totality, there is insufficient evidence to remove the 2012 "Estuarine bioassessments" impairment. As such, the impairments for "Estuarine bioassessments" and Water Clarity (i.e. a high Light Attenuation Coefficient) have been retained on the 2014 final 303(d).

***DES RESPONSE* to** 5- 4
Closing remarks, no response needed.

RESPONSE TO COMMENT #6: Robert J. Robinson, City of Manchester

DES RESPONSE ***to*** **6- 1**

Opening materials by the City of Manchester. NHDES agrees that timeliness is important and will publish a final list as soon as possible.

DES RESPONSE ***to*** **6- 2**

The City of Manchester includes 12 pages of comments on the 2012 Section 305(b) and 303(d) Surface Water Quality Report from their consultant OspreyOwl Environmental, LLC. These comments were reviewed to determine if any of the content related directly to waterbodies and impairments on the 2014 Draft 303(d) that was provided for review. No such content was identified in pages 1 to the middle of page 11. No response is necessary.

DES RESPONSE ***to*** **6- 3**

In the middle of page 11 of comments on the 2012 Section 305(b) and 303(d) Surface Water Quality Report by OspreyOwl Environmental, LLC for the City of Manchester there is a reference to the 2014 Draft 303(d). These comments from the middle of page 11 through page 12 (the end of the consultants comment letter) make no arguments for the listing or delisting of any waterbodies. No response is necessary.

DES RESPONSE ***to*** **6- 4**

The City of Manchester included a copy of the comments that were previously submitted on the Draft 2014 CALM. Comments specifically related to the Draft 2014 CALM were previously responded to and available on NHDES' website at http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/index.htm.
The comments on the Draft 2014 CALM were reviewed to determine if any of the content related directly to the 2014 Draft 303(d) that was provided for review.

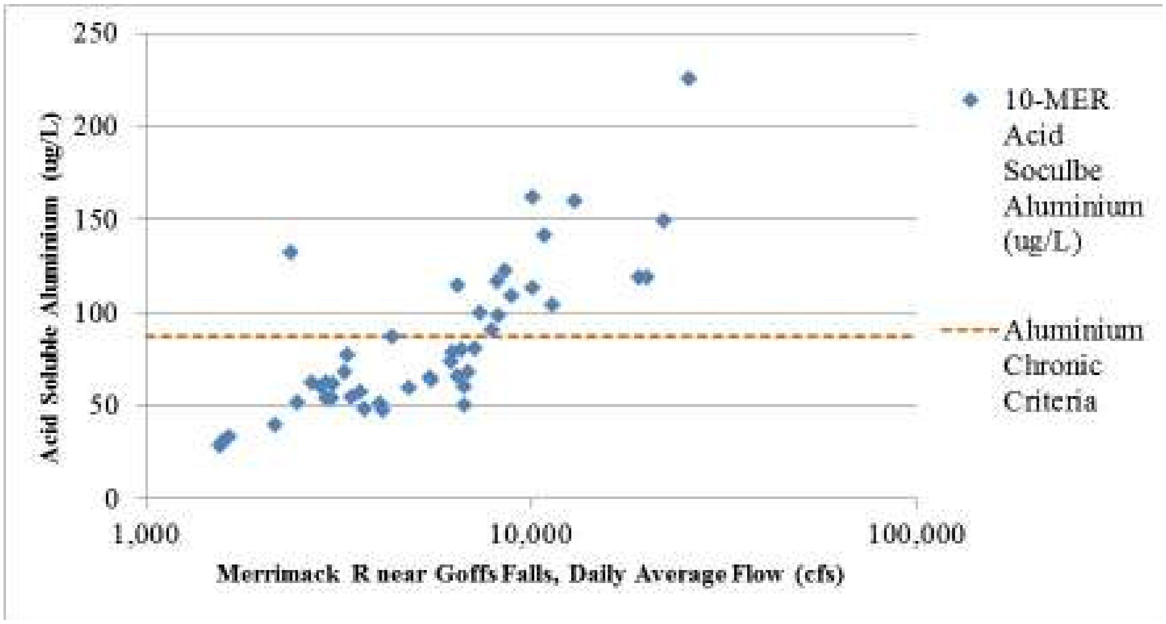
DES RESPONSE ***to*** **Portions of 6- 5, 6- 6, and 6- 10**

In portions of these contents, Manchester cites their 2009-2010 aluminum study and contends that:

a) (6- 5) Aluminum levels in the Merrimack River are below the criteria when river flow is at or below three times the 7Q10 flow at Goffs Falls (USGS gage 01092000);
b) (6- 5) Aluminum in the river increases as flow increases which is likely due to the resuspension of particulate matter originating from chemical weathering in the White Mountains;
c) (6- 6) The aluminum from the White Mountains is natural; and
d) (6- 10) The aluminum criterion is met in the Merrimack River when river flow is at or below 6000 cfs at Goffs Falls (USGS gage 01092000).

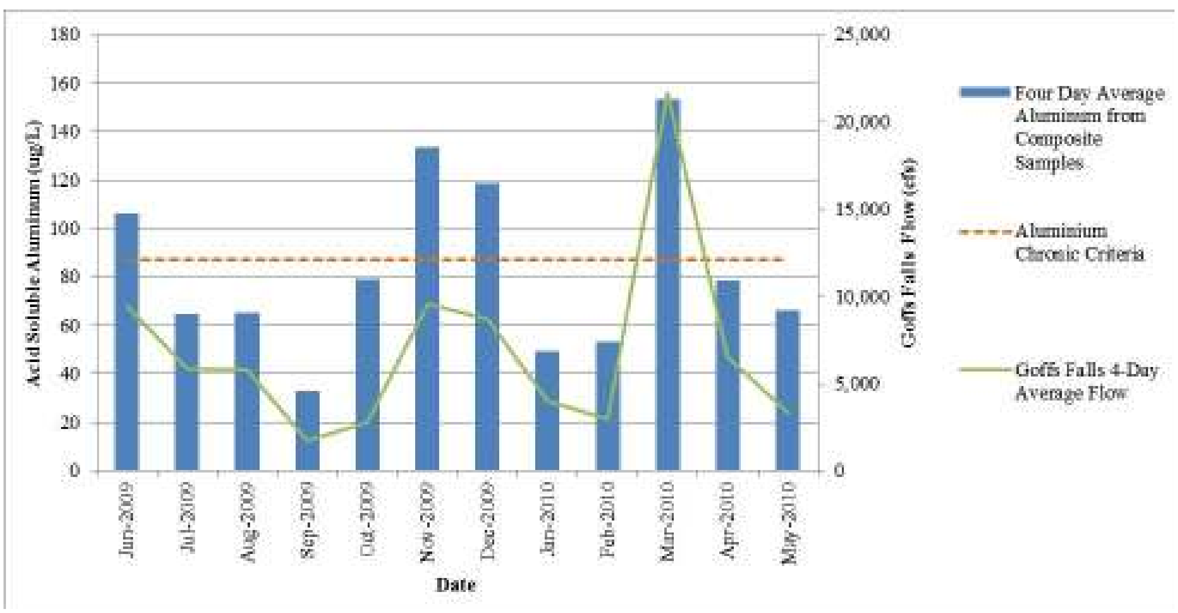
Collectively, these comments may be interpreted as questioning the validity of the Aquatic Life Use Support impairment to the Merrimack River segment known as NHRIV700060803-14-02. The Draft 2014 303(d) NHDES fully utilized the data collected as part of the 2009-2010 Aluminum study. NHDES agrees that the aluminum concentration tends to increase as flow increases (Figure 16). However, since aquatic life exists in Merrimack River at all flow levels, the criteria still applies.

Figure 16. Merrimack River station (10-MER) aluminum grab samples as a function of flow at the Merrimack River at Goffs Falls gage.



The chronic criterion is based on a four-day average condition. The 2009-2010 aluminum study was designed to capture samples once a day for four consecutive days once a month for a full year. When the four-day average acid soluble aluminum is compared to the water quality criterion, the criterion is exceeded in four of the 12 mouths of the study (Figure 17).

Figure 17. Merrimack River station (10-MER) four day average aluminium concentration as a function of four dat average flow at the Merrimack River at Goffs Falls gage.



Even accounting for only the Acid Soluble portion of Aluminum, the Merrimack still exceeds the Aluminum criteria.

Elevated aluminum can be the result of stormwater runoff from paved areas with the primary sources being auto body corrosion and atmospheric deposition. Addition aluminum is often added to facilitate phosphorus removal from wastewater and from the treatment of drinking water. Further, the chemical weathering in the Merrimack River watershed is driven by pH, and that pH has been reduced due to the ongoing impacts of fossil fuel consumption. As such, neither the low pH in parts of the watershed, nor the elevated aluminum caused by increased chemical weathering can be considered completely natural phenomenon. The commenter is reminded that waste water treatment plant effluent limits are set by EPA in NPDES permitting not thought the assessment process.

DES RESPONSE ***to*** **Portions of 6- 5, 6- 6, and 6- 10 as well as all of 6- 7, 6- 8, 6- 9, and 6- 11 through 6- 27**
These comments were previously addressed in the NHDES Response to comments on the Draft 2014 CALM and are available on NHDES' website: http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/index.htm

RESPONSE TO COMMENT #7: Robert R. Lucic, City of Dover

DES RESPONSE ***to*** 7- 1
Opening materials by the City of Dover. No response needed.

DES RESPONSE ***to*** **7- 2**
NHDES notes that the City of Dover incorporates by reference the comments made by the Great Bay Municipal Coalition addressed under comment set #8.

DES RESPONSE ***to*** **7- 3**
The City of Dover supports the NHDES decision to delist several assessment units for total nitrogen and for other units until assessment units delay final assessment until such time as a new approach is determined. NHDES appreciates the support, and the delisting issue is addressed in Response 3- 1.

DES RESPONSE ***to*** **7- 4**
See response to 4- 11.
The remaining comments are part of the 2014 draft 303(d).

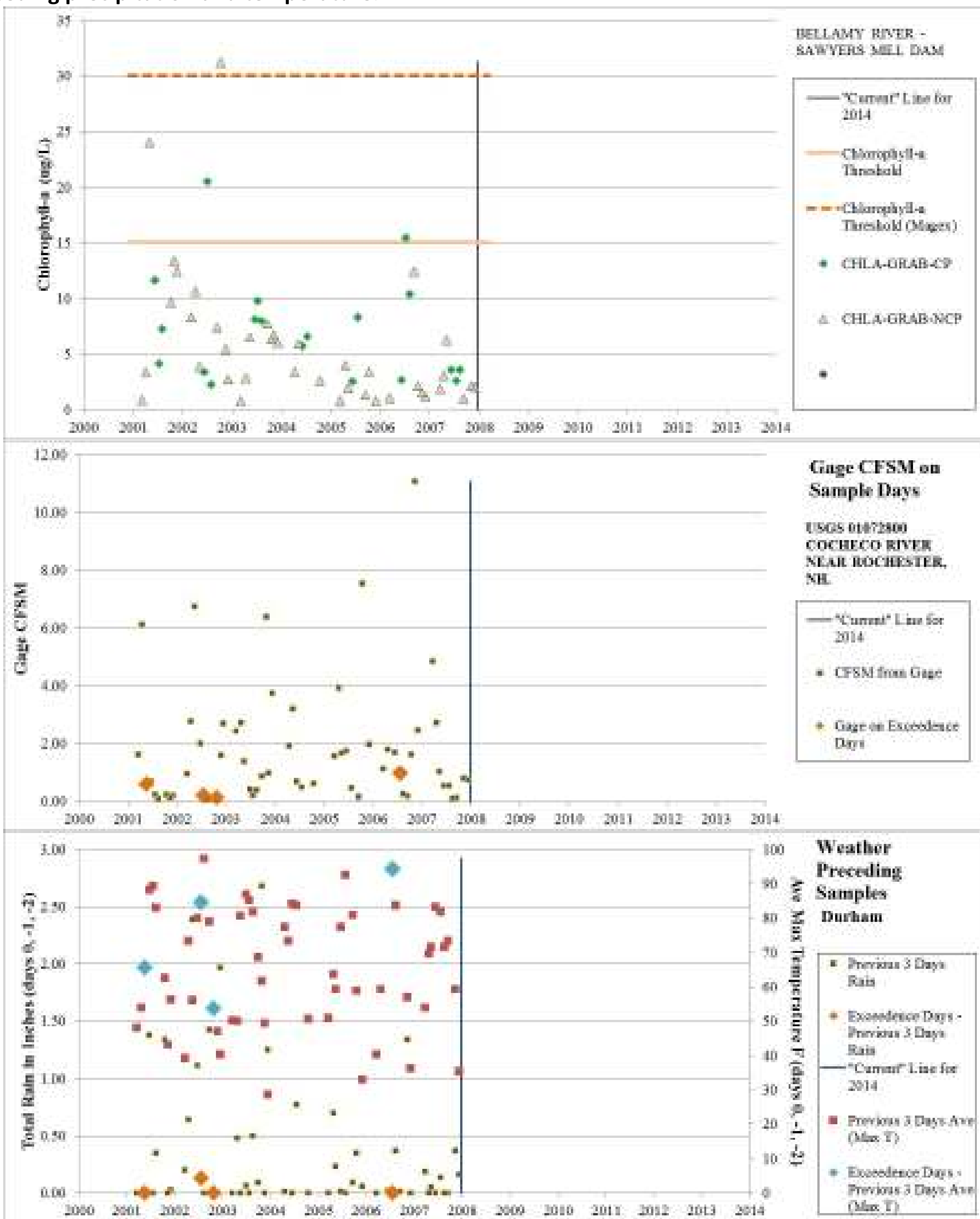
DES RESPONSE ***to*** **7- 5**
The City of Dover incorporates by reference the City of Rochester comments discussed under the responses to comments 4- 5 to 4- 9.

DES RESPONSE ***to*** **7- 6**
See the response to 4- 4

DES RESPONSE ***to*** **7- 7**
See response to 4- 11

The Sawyer Mill Dam (NHIMP600030903-02) was added to the list of impairments during the 2008 assessment cycle. All samples for the site have been collected at station 05-BLM (n=60). Episodic high chlorophyll-a concentrations, sometimes twice the indicator threshold, have occurred largely in years of low flow and following dry periods (Figure 18). Only some of the data collected in 2006 and 2007 appear to have occurred under the low flow conditions seen in 2001 and 2002. The 2006 sample of 15 ug/L chlorophyll-a was not during low flow but rather during very warm conditions. It is unfortunate that sampling at the site ceased in 2008 (See response to 4- 11) as it appeared that the peak concentrations were declining up to that point. Additional sampling should occur at 05-BLM under low flow and warm conditions to determine if that apparent decline in peak concentrations has continued.

Figure 18. Sawyers Mill on the Bellamy River (NHIMP600030903-02) chlorophyll-a, representative river flow, and preceding precipitation and temperature.



Notes:

The chlorophyll-a indicator threshold shown in the graphic above is to protect the swimming designated us (i.e. primary contact recreation).

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for additional details.

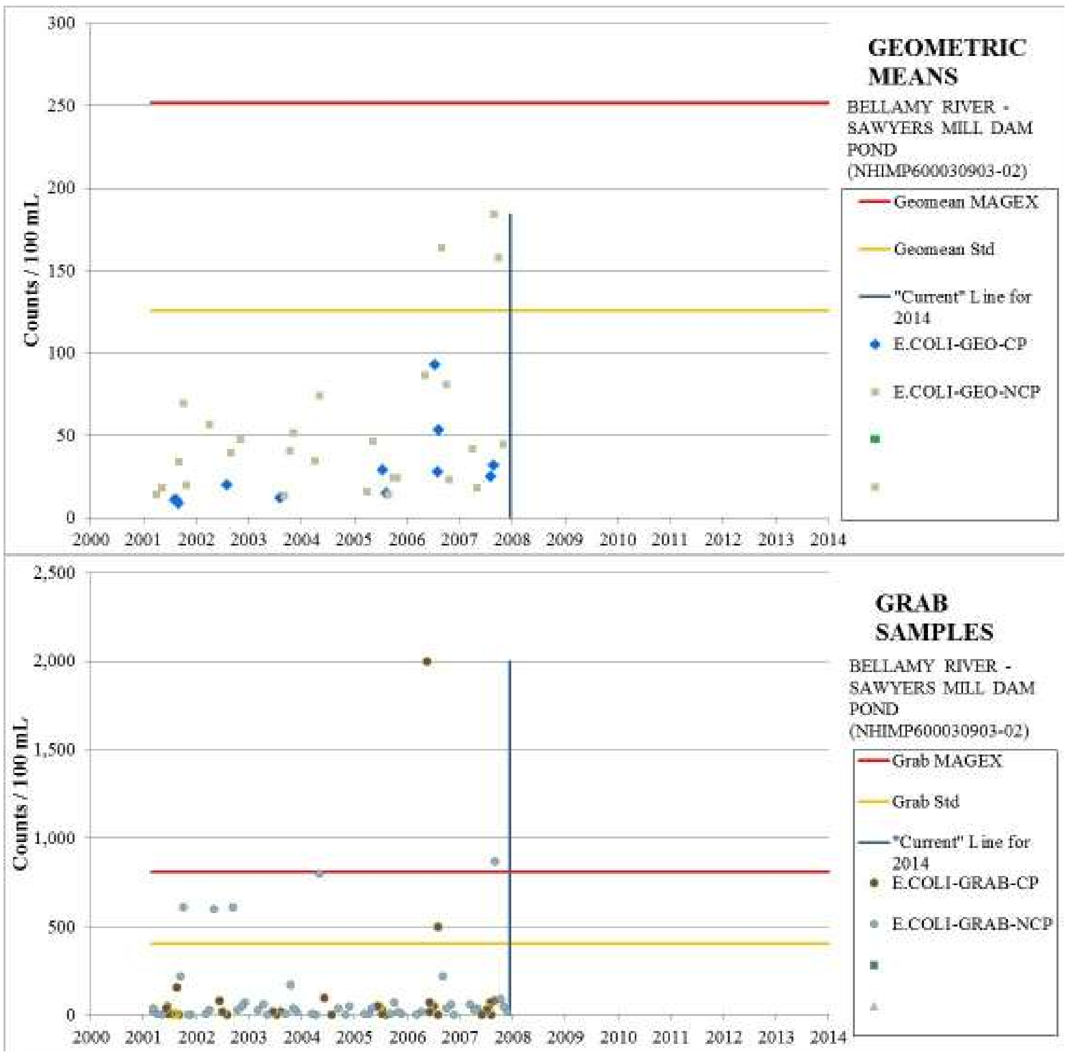
CHLA-GRAB-CP = Chlorophyll-a samples collected during the summer critical period.

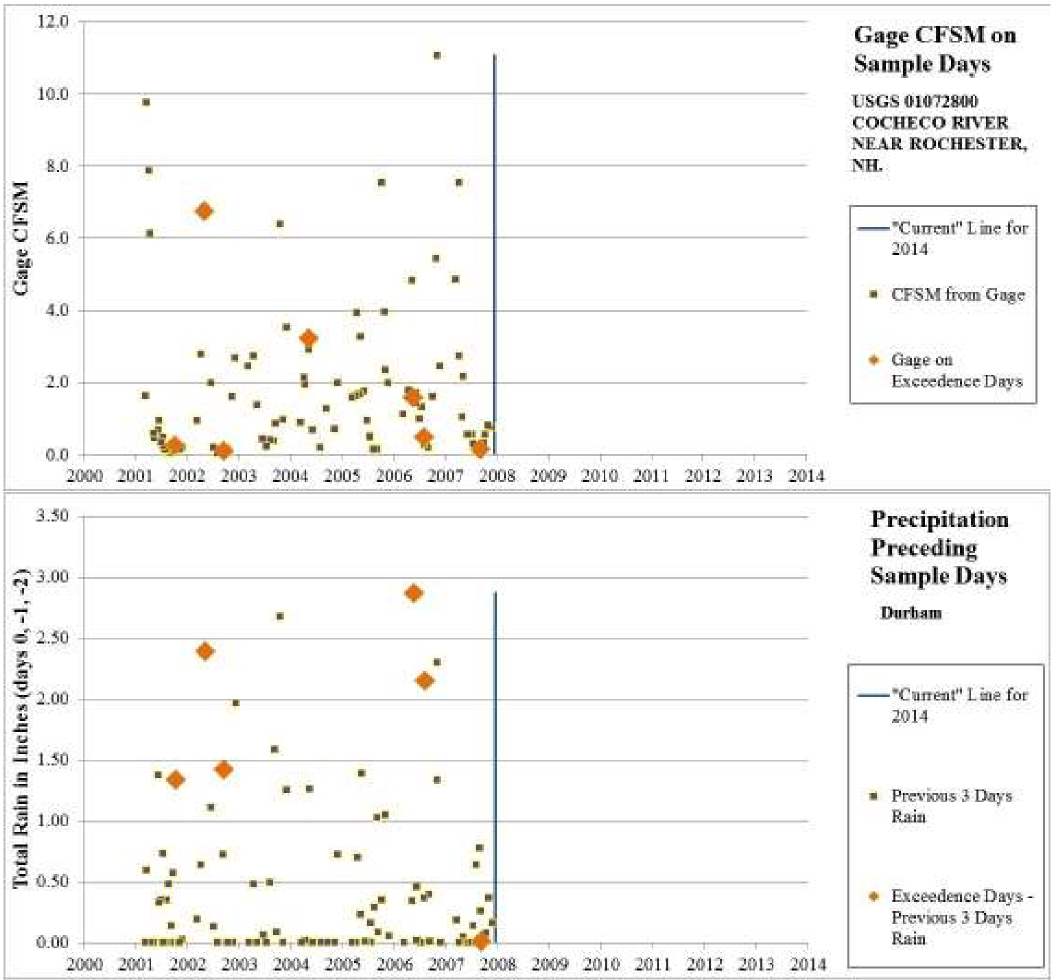
CHLA-GRAB-NCP = Chlorophyll-a samples collected and outside the summer critical period.

The Sawyer Mill Dam (NHIMP600030903-02) was added to the list of impairments for bacteria to protect the swimming designated use during the 2004 assessment cycle. Samples for the site have been collected at stations 04B-BLM and 05-BLM and exceedences of both the grab sample criteria and geometric mean criteria occurred at the latter. While exceedences have occurred under a variety of flow conditions, most have occurred after rainfall events (Figure 19). The City of Dover noted that a great deal of cross-connection removal work has been completed and it is unfortunate that sampling at the site ceased in 2008 (See response to 4- 11) as it would be helpful to have data to document the success of that work by the City. Additional sampling needs to occur at 05-BLM to document the work and remove the impairment.

The City of Dover noted that other samples have been collected at the site from 2008 to 2013. It is worth noting that the monitoring that has occurred since 2008 has been not been by NHDES but rather by the Volunteer River Monitors and the UNH Tidal Tributary monitoring program to whom we are quite grateful.

Figure 19. Sawyers Mill on the Bellamy River (NHIMP600030903-02) bacteria samples, representative river flow, and preceding precipitation and temperature.





Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

E.COLI-GEO-CP = Escherchia coli geometric mean calculated from samples collected during the summer critical period.

E.COLI-GEO-NCP = Escherchia coli geometric mean calculated from samples collected outside the summer critical period.

E.COLI-GRAB-CP = Escherchia coli grab samples collected during the summer critical period.

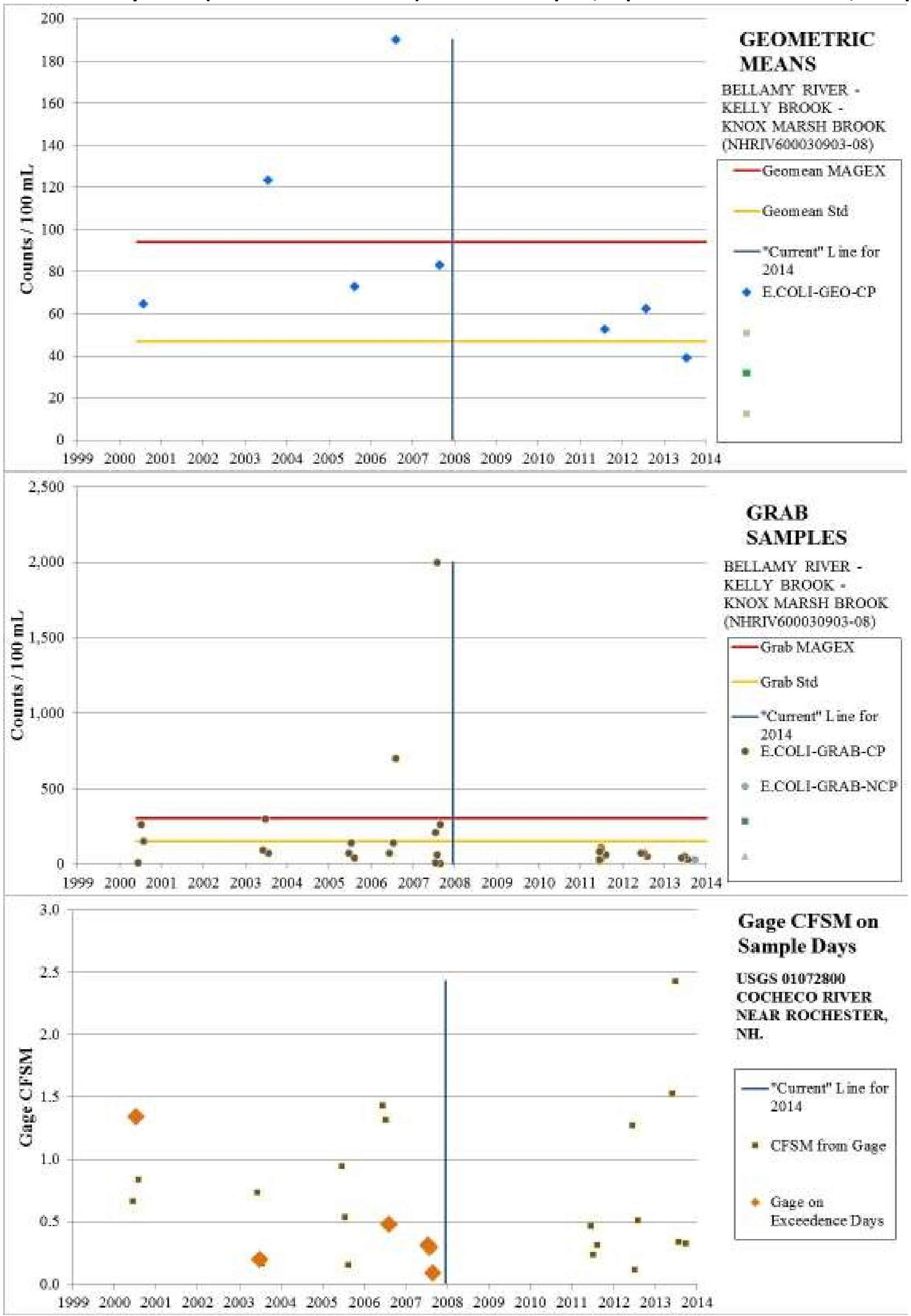
E.COLI-GRAB-NCP = Escherchia coli grab samples collected outside the summer critical period.

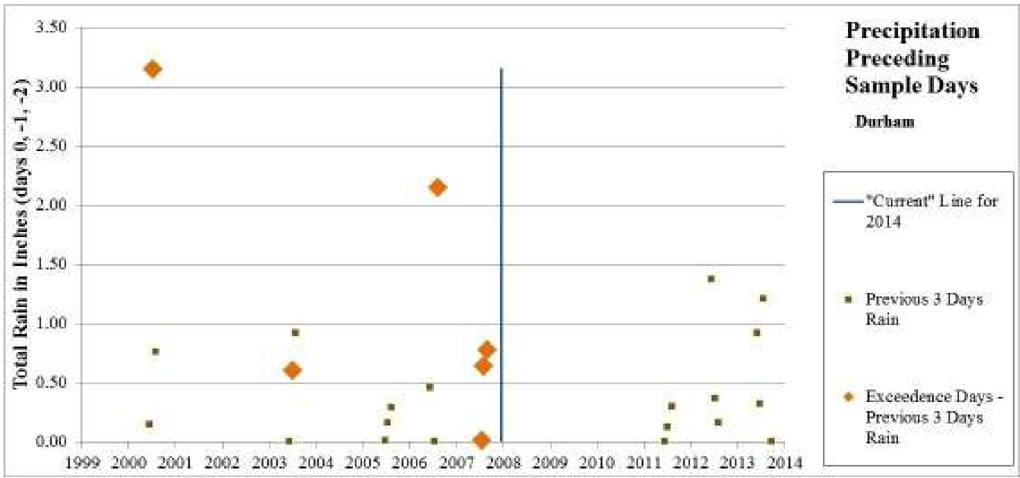
***DES RESPONSE* to 7- 8**

See response to 4- 11

The Knox Marsh / Bellamy River assessment unit (NHRIV600030903-08) was added to the list of impairments for bacteria to protect the swimming designated use during the 2002 assessment cycle. Samples for the site have been collected at stations 07-BLM, 07K-BLM, and 08-BLM which experienced exceedences of both the grab sample criteria and geometric mean criteria, primarily driven by the 07-BLM site. While exceedences have occurred under a variety of flow conditions, most have occurred after rainfall events (Figure 20). In recent years, the grab sample threshold has not been exceeded but the geometric mean threshold has been exceeded. Additional sampling needs to occur at 07-BLM after rainfall events.

Figure 20. Bellamy River (NHRIV600030903-08) bacteria samples, representative river flow, and preceding precipitation.





Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

E.COLI-GEO-CP = Escherchia coli geometric mean calculated from samples collected during the summer critical period.

E.COLI-GRAB-CP = Escherchia coli grab samples collected during the summer critical period.

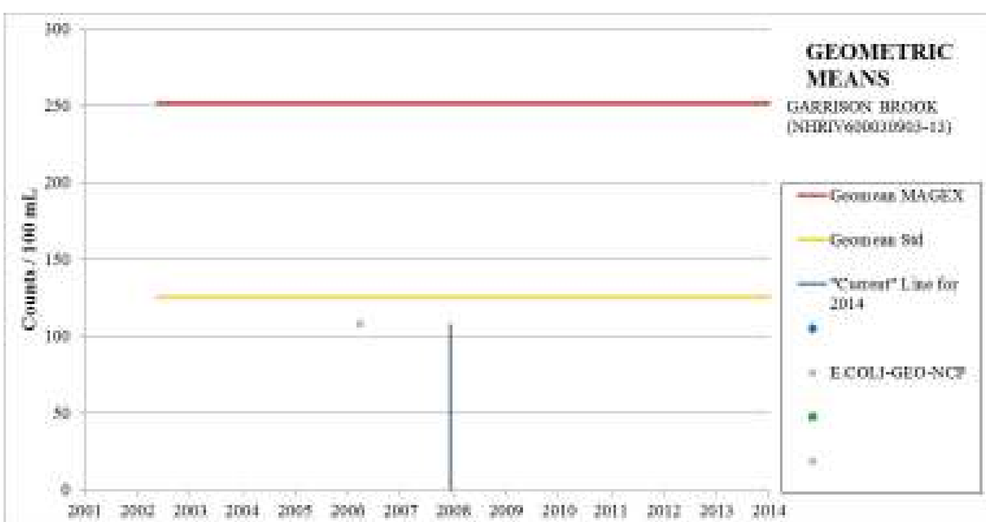
E.COLI-GRAB-NCP = Escherchia coli grab samples collected outside the summer critical period.

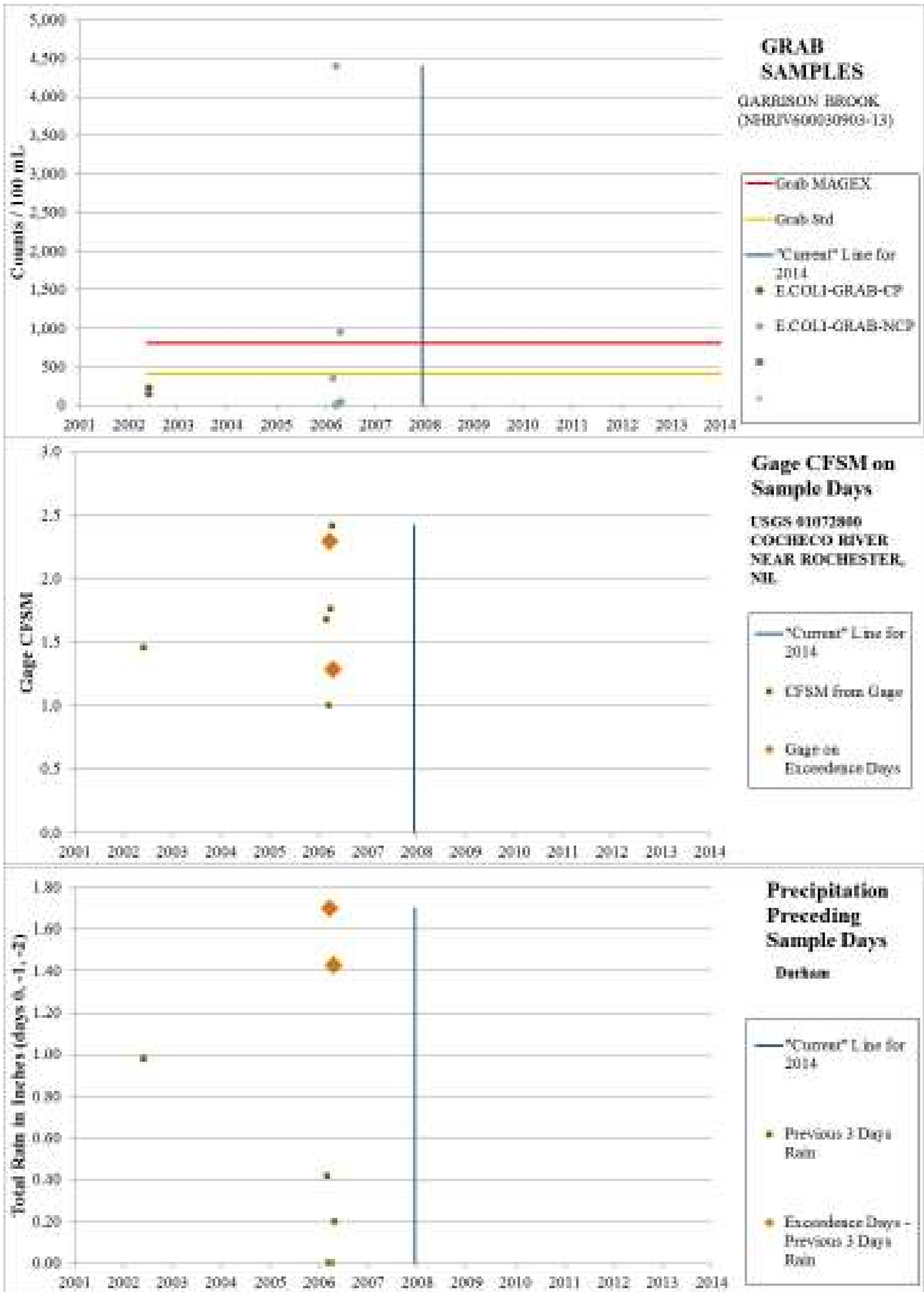
***DES RESPONSE* to 7- 9**

See response to 4- 11

The Garrison Brook assessment unit (NHRIV600030903-13) was added to the list of impairments for bacteria to protect the swimming designated use during the 2008 assessment cycle based on a series of severe exceedences in 2006 after rainfall events (Figure 21). As the City of Dover noted, they partnered with NHDES for an outreach campaign after pet waste was identified as a primary source of bacteria. To remove the impairment and make this a true success story, follow-up monitoring needs to occur after rain events at the same location as the original bacteria exceedences.

Figure 21. Garrison Brook (NHRIV600030903-13) bacteria samples, representative river flow, and preceding precipitation and temperature.





Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.
E.COLI-GEO-NCP = Escherchia coli geometric mean calculated from samples collected outside the summer critical period.
E.COLI-GRAB-CP = Escherchia coli grab samples collected during the summer critical period.
E.COLI-GRAB-NCP = Escherchia coli grab samples collected outside the summer critical period.

***<u>DES RESPONSE</u> to* 7- 10**

See response to 4- 11

NHDES does not have authority over the regulatory actions of the EPA MS4 permit. NHDES does appreciate any information about efforts to improve water quality that could be used to eventually make the case for delisting once data is collected that shows that criteria are met.

***DES RESPONSE* to 7- 11**
Dover's comment here is in regards to the CALM's definitions of independent samples, not the draft 303(d) List. NHDES takes great care to ensure that only the best and highest quality data are used for assessment purposes.

***DES RESPONSE* to 7- 12**
Dover's comment here is in regards to the CALM, not the draft 303(d) List. Thank you for identifying this typo, it has been corrected.

***DES RESPONSE* to 7- 13**
The remaining comments are a copy of those submitted as Robert R. Lucic on the behalf of the Great Bay Municipal Coalition. (See response to comment set #8)

RESPONSE TO COMMENT #8: Robert R. Lucic, Great Bay Municipal Coalition

The first six pages of the Great Bay Municipal Coalition (GBMC) comments (8- 1 to 8- 9) broadly focus on the Great Bay, Little Bay, an undefined portion of the Piscataqua River, and Portsmouth Harbor. These comments were reviewed to determine if any of the content related directly to the 2014 Draft 303(d) that was provided for review.

To clarify, while NHDES has proposed the removal of the total nitrogen impairment from select segments of the Great Bay Estuary, it is not the case that total nitrogen has been removed as a cause of impairment from the entirely of the Great Bay Estuary (8- 2).

In section (8- 2), the GBMC emphasizes a modified quote from NHDES's 2015 impairment removal document which is purported to describe the context for the nitrogen impairments from previous assessment cycles. The supposed quote removes the first five words (bolded below) thereby altering the meaning. The unadulterated quote reads;

> **"<u>However, they [the reviewers] concluded that the</u>** NHDES 2009 report did not adequately demonstrate that nitrogen is the primary factor causing eelgrass decline in the Great Bay Estuary because the report did not explicitly consider all of the other important, confounding factors in developing relationships between nitrogen and the presence of eelgrass." (NHDES, 2015)

When the GBMC removed the first five words (bolded above) of the quote, one is made to believe that the statement is the opinion of NHDES when in fact it is an explanatory statement summarizing the opinion of a third party.

<u>DES RESPONSE</u> to Comments on the Great Bay and Little Bay Assessment Zones
Assessments are conducted by assessment zones, and, in some cases, a water quality sampling station that exists at the boundary of two assessment units is used in the assessment of both zones. Such is the case with the use of the Adams Point sampling station which is part of the overall datasets for both the Great Bay and Little Bay assessment zones. As the GBMC used the data for the Adams Point sampling station, often without reference to the specific assessment zone, NHDES has addressed those comments in the context of both the Great Bay and Little Bay assessment zones.

Chlorophyll–a (8- 3)

The GBMC raised the idea of using the SMAST methodology (Howes, Samimy, & Dudley, 2003) to evaluate chlorophyll-a. Although an interim report, the SMAST methodology (Howes, Samimy, & Dudley, 2003) remains a key element of the Massachusetts Estuary Project methods and continues to be cited by the primary author right up through there November 2015 report "Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the New Bedford Inner Harbor Embayment System, New Bedford, MA (Updated Final Report)" (Howes, et al., 2015).While the GBMC partially applied the method, subsequent to the comments, NHDES has fully applied the SMAST methodology as described in responses 3- 1 and 8- 6. Here we consider GBMC's partial application of the SMAST methodology.

The SMAST methodology (Howes, Samimy, & Dudley, 2003) is described by the authors as an integrative evaluation of multiple parameters to determine an overall eutrophication condition. As demonstrated in Table 10, the GBMC has greatly simplified the SMAST methodology by ignoring the bloom concentrations (Howes, Samimy, & Dudley, 2003). Further by using only the data from the cleanest boundary of Great Bay, the overall chlorophyll-a condition is unrealistic. The calculated 90^{th} percentile chlorophyll-a in this assessment zone is 8.9 ug/L and the median is 3.1 ug/L (n = 249). However, the annual peak concentrations range from 10-69 ug/L in the southwest area. Finally, it must be clear that even though the SMAST methodology (Howes, Samimy, & Dudley, 2003) would likely consider chlorophyll-a impaired, NHDES currently considers chlorophyll-a to be marginally fully supporting (category 2-M) since Great Bay is so large and the severely poor conditions are on the margin.

In regards to Little Bay, the calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L, the median is 2.9 ug/L (n = 95), and a maximum reading of 16.5 ug/L. Even though the SMAST methodology (Howes, Samimy, & Dudley, 2003) might consider chlorophyll-a impaired **(**Table 12**)**, NHDES currently considers chlorophyll-a to be marginally fully supporting (category 2-M) in Little Bay.

Table 11. Great Bay evaluating results utilizing the SMAST 2003 methodology (Howes, Samimy, & Dudley, 2003). Blocks highlighted gray best describe the indicator evaluation category.

Indicator	Current status of Great Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
Chlorophyll-a	The calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L and the median is 3.1 ug/L (n = 249). Annual peak concentrations range from 10-69 ug/L in the southwest area.	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"phytoplankton blooms raise chlorophyll a levels to around 10 µg/L."	"The level of nitrogen related to Significant Impairment supports large phytoplankton blooms (chlorophyll a of approximately 20 µg/L)"

Table 12. Little Bay Bay evaluating results utilizing the SMAST 2003 methodology (Howes, Samimy, & Dudley, 2003).. Blocks highlighted gray best describe the indicator evaluation category.

Indicator	Current status of Great Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
Chlorophyll-a	The calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L, the median is 2.9 ug/L (n = 95) and a maximum reading of 16.5 ug/L.	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"chlorophyll-a levels are in the 3 to 5 µg/L range"	"phytoplankton blooms raise chlorophyll a levels to around 10 µg/L."	"The level of nitrogen related to Significant Impairment supports large phytoplankton blooms (chlorophyll a of approximately 20 µg/L)"

Water Clarity (8- 4)

The GBMC commented that chlorophyll-a causes only a minor impact on water clarity in Great Bay. In making that statement, they reference the predictive equation developed by (Morrison, Gregory, Pe'eri, McDowell, & Trowbridge, 2008) for a particular date in 2007. NHDES agrees that chlorophyll-a is only one factor that limits light penetration and, to that end, has assessed chlorophyll-a as marginally full-supporting in Great Bay. None the less, existing clarity is inadequate for the growth of eelgrass in the deeper waters of Great Bay.

Nitrogen Concentration (8- 5)

GBMC provides a discussion of nitrogen based on the 1988-2012 DIN and 2003-2013 TN as measured at Adams Point. Given that Adams Point divides and provides data to the assessment calculations of both the Great Bay and Little Bay assessment zones, NHDES will consider the discussion in the context of those two assessment zones.

Adams Point is at the better flushed end of Great Bay and provides 70 of the 179 total nitrogen values collected in Great Bay between January 1, 2008 and December 13, 2013 (the date of the data pull for the 2014 assessment). Solely using the Adams Point data to evaluate total nitrogen Great Bay is an oversimplification of the range of total nitrogen conditions.

The commenter has attempted to tie the limited total nitrogen data at Adams Point to the long term data for Dissolved inorganic Nitrogen (DIN) at Adams Point. However, DIN is rapidly taken up by plants and is also rapidly converted to other forms of nitrogen in the estuarine system complicating the trend analysis. Macroalgae is one plant that rapidly takes up DIN, so in fact, if lower DIN exists, macroalgae may be the cause. Further, Adams Point is far from the major sources of DIN to the system. In fact, the 2013 SOE goes on to say that,

> *"In other areas of the estuary besides Great Bay, some trends for total nitrogen and other forms of nitrogen have been observed. Increasing trends for total nitrogen and total dissolved nitrogen were apparent in the Squamscott River, while decreasing trends for DIN were observed in the Oyster River."* (PREP, 2013)

It should be noted that the Town of Durham has been working diligently to reduce the loading from their WWTF and improved operations are in the works for Newmarket and Exeter.

NHDES applauds the projected reductions in nitrogen to the Great Bay Estuary, however, projected reductions in a pollutant are not grounds for impairment removal. Like any assessed water quality parameter, confirmation of ambient water quality post-implementation is necessary.

Compared to Other Estuaries (8- 6)

New Hampshire is no longer comparing ambient total nitrogen data to the total nitrogen numeric indicators used in the 2012 assessment as translators for the narrative water quality criteria. While total nitrogen thresholds for other estuaries may be instructive, one must carefully evaluate the intent, geography, and analysis conditions of those thresholds. The GBMC cited the total nitrogen thresholds of four studies to conclude that the dissolved inorganic nitrogen and total nitrogen in Great Bay Estuary would be considered good to excellent. The GBMC does not specify which part of the estuary they think should be compared here, however, leading up to this comment they provide the dissolved inorganic nitrogen and total nitrogen data for Adams Point. As Adams Point is the dividing line between Great Bay and Little Bay, NHDES has interpreted this comment to apply to those two assessment zones. Table 13 provides a breakdown of the references GBMC provided, the comment, and NHDES' evaluation of those references as well as others from applicable studies in the region.

Table 13. Papers cited by GBMC referencing possible total nitrogen thresholds, the GBMC claims, and NHDES evaluation of those papers.

GBMC Cited Publications	GBMC Comment Text	NHDES Evaluation
SMAST 2003 (EPA also cites SMAST 2003 in their 2012 303(d) approval Technical Support Document, Attachment A, pg 11)	GBMC - "Based on the results of studies conducted on nearby estuaries in Massachusetts (SMAST 2003), the concentration of DIN/TN in the Great Bay Estuary would be considered good to excellent (0.30 - 0.39 mg/L), and not a threat to eelgrass." (GBMC 2014 Draft 303(d) comment)	The authors describe an integrated evaluation of multiple parameters that is used to make a final classification of an areas nutrient health (see Table 14 and Table 15). In NHDES' view, using the SMAST 2003 methodology, most indicators of the Great Bay assessment zone fall into their "Moderately Impaired" category. Regarding only the nitrogen component of SMAST (2003), total nitrogen equal to 300 to 390 ug/L is in both the "Excellent to Good" as well as the "Good to Fair" categories and is only one of the parameters considered in making a final health evaluation. The Great Bay assessment zone median total nitrogen from 2008 through 2013 was 391 ug/L (n=62) (the upper bound) when considering just the stations in the middle of Great Bay; and 410 ug/L (n=176) (above the upper bound) when including the boundary stations GRBSQ and GRBAP. The station most descriptive of the southwestern portion of Great Bay has a total nitrogen concentration of 651 ug/L (n=44) (well above the upper bound). Great Bay would not be considered "good to excellent" (Table 14). The Little Bay assessment zone median total nitrogen from 2008 through 2013 was 379 ug/L (n=79) (near the upper bound) which is principally driven by the Adams Point data. The nine samples not collected at Adams Point have a median of 444 ug/L (above the upper bound). Little Bay total nitrogen would be considered on the edge of "good to excellent" but the other parameters of the integrated evaluation need to be considered (Table 15).
*Benson et al 2013 Fig 2	GBMC - "This study found healthy eelgrass populations existed at approximately 0.40 mg/L TN [400 ug/L] while significant degradation of eelgrass populations occurred at approximately 0.60 mg/L TN [600 ug/L] (Benson et al., 2013, Figure 2)" (GBMC 2014 Draft 303(d) comment)	From the publication abstract (Benson, Schlezinger, & Howes, 2013), "Field surveys indicated that eelgrass survival required bottom light 100 mE/m2/s and healthy **eelgrass existed where tidally-averaged total nitrogen was less than 0.34 mg/L, equivalent to a mid-ebb tide water-column total nitrogen of <0.37 mg/L.**" [emphasis added] By that measure, Great Bay and Little Bay total nitrogen is worse than that required for health eelgrass. "Combining all of the transplant survival data, the percent eelgrass survival

GBMC Cited Publications	GBMC Comment Text	NHDES Evaluation
		was inversely related to the level of total nitrogen (TN) at the transplant location, such that as TN concentration increases, the eelgrass transplant survival decreases (Table 2). **Sites with >75% transplant success had average TN levels of 0.39 mg/L.”** (Benson, Schlezinger, & Howes, 2013) [emphasis added] By that measure, Great Bay total nitrogen is high enough to diminish eelgrass transplant and regrowth success and Little Bay conditions are marginal to successful eelgrass reestablishment.
*Wazniak et al 2007, Table 1	GBMC - “Based upon this study, healthy seagrass populations were associated with TN <0.55 mg/L while degraded seagrass populations occurred at 0.65-1.00 mg/L. TN (Wazniak et al, 2007,Table 1)” (GBMC 2014 Draft 303(d) comment)	The area addressed by (Wazniak, et al., 2007) was the Maryland coastal bays that span from Delaware, through Maryland and into Virginia on the Atlantic side of the Delmarva Peninsula some 400 miles south of Great Bay. The study did not say less than 550 ug/L total nitrogen equals healthy seagrasses but rather less than 550 ug/L total nitrogen was “Better than seagrass objective” (Wazniak, et al., 2007) for the study. From a management perspective, it is not appropriate to set an attained goal at a level that outright degrades eelgrass such as the 650 ug/L total nitrogen. The break point used in Wazniak et al.(2007) was not based on an evaluation of existing data but rather, “based on literature values for seagrass habitat requirements (Dennison et al. 1993, Stevenson et al. 1993, Valdes-Murtha 1997, Lea et al. 2003)” (Wazniak et al 2007). It should be further noted that the areas in the study that had the highest percent seagrass cover also had the lowest chlorophyll-a, the best dissolved oxygen, and the lowest total nitrogen, yet these areas top out at 77% seagrass cover. From such condition one might surmise that their chosen thresholds were not low enough to provide for a fully healthy system as 23% if the cover has been lost. Little can be gathered from the ambiguous threshold used by Wazniak et. al. (2007).
*Gurbisz & Kemp, 2014	GBMC - “A more recent study of Chesapeake Bay in 2014 observed that despite elevated nutrient concentrations, SAV in the Susquehanna Flats, a broad and shallow northern region of the bay, increased significantly from 2001-2010 (Gurbisz & Kemp, 2014). During this period, TN and DIN	None of the submerged aquatic vegetation (SAV) in the study were eelgrass *Zostera* species and most of the other noted species largely inhabit freshwater. In fact the authors did not even analyze salinity because the values around the SAV bed were generally <1.0 ppt (Gurbisz & Kemp, 2014). When the SAV beds were strongly regrowing from 1999-2008, they were significantly correlated with; • - Flow, (R^2=0.76, p=0.002) • - TSS, (R^2=0.75, p=0.021)

GBMC Cited Publications	GBMC Comment Text	NHDES Evaluation
	concentrations averaged 1.5 and 1.2 mg/L, respectively." (GBMC 2014 Draft 303(d) comment)	• - Kd, (R^2=0.61, p=0.013) • + Secchi, (R^2=0.61, p=0.13) • + Temp (R^2=0.67, p=0.007) • - TP (R^2=0.67, p=0.007) and not significantly correlated with, • - TN (R^2=0.20, p=0.223), • - N load (R^2=0.00, p=0.941), • - DIN (R^2=0.14, p=0.313), or • + PN (R^2=0.00, p=0.975). The fact that nitrogen was not the controlling nutrient and not a significant variable in this study further illustrates that the system was more freshwater and less estuarine in nature. Little can be gathered from the total nitrogen concentrations reported by Gurbisz and Kemp (2014).
**Howes et al. 2013	No GBMC comment. The GBMC did not bring up this study.	For the Massachusetts Estuaries Project, Howes et. al. (Howes B. , Samimy, Schlezinger, & Eichner, 2013) found that there was an absence of eelgrass within the Wild Harbor inner basin areas above 354 ug/L total nitrogen and in the outer basin areas high quality eelgrass was lowered when total nitrogen exceeded 304 ug/L. They found that these thresholds were consistent with presence and loss of eelgrass in other southeast Massachusetts estuaries. By this measure, the degradation of eelgrass in Great Bay and Little Bay would be anticipated and regrowth would be difficult at current total nitrogen concentrations.
***SMAST 2006-2015	No GBMC comment. The GBMC did not bring up these studies.	For the Massachusetts Estuaries Project, the School for Marine Science and Technology (UMass-Dartmouth) has produced total nitrogen targets to protect eelgrass habitat in 28 estuarine systems along the Cape and Islands. The total nitrogen target median from those studies is 375 ug/L. Parts of Great Bay are unfortunately well above the common threshold found to protect eelgrass in our neighboring estuaries while other parts of Great Bay and Little Bay are just a bit above the common Massachusetts Estuaries Project target.

*The commenter provided the reference as noted in the table (Benson et al 2013 Fig 2; Wazniak et al, 2007, Table 1; Gurbisz & Kemp, 2014) without full citation in the references leading NHDES to surmise the exact reference.

** (Howes B. , Samimy, Schlezinger, & Eichner, 2013) The GBMC did not cite this study but as a study in a nearby estuary documenting total nitrogen thresholds to protect eelgrass the study was deemed suitable.

*** SMAST = School for Marine Science and Technology (UMass-Dartmouth). The GBMC did not cite these studies but as studies in a suite of nearby estuaries documenting total nitrogen thresholds to protect eelgrass, the studies were deemed suitable. The reports are downloadable from http://www.mass.gov/eea/agencies/massdep/water/watersheds/the-massachusetts-estuaries-project-and-reports.html

As described in the draft 2014 TSD, the final assessment on the Great Bay assessment zone is not a simple case. The GBMC raised the idea of using the SMAST methodology (Howes, Samimy, & Dudley, 2003) to say that the Great Bay is in “Excellent to Good condition” by citing the chlorophyll-a concentration at Adams Point, the more flushed and arguably the clean edge of Great Bay assessment zone. Pulling a single indicator out of the integrated evaluation is an inappropriate use of their methodology. While the GBMC partially applied the method, subsequent to the comments, NHDES has fully applied the SMAST methodology as described in responses 3- 1. The text from SMAST 2003 describes an integrated evaluation of the eutrophication indicators that is used to make a final classification of an areas nutrient health. Evaluating the Great Bay and Little Bay assessment zones considering all of the indicators within the 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003) NHDES sees a less than healthy condition assessment.

In Great Bay (Table 14) and Little Bay (

Table 15), there are cases where it is difficult to place a particular indicator into a single evaluation group for the integrated evaluation. The blocks highlighted gray in Table 14 and

Table 15 describe the best indicator evaluation for the Great Bay and Little Bay assessment zones.

Within the Great Bay assessment zone, most of the indicators span between “Good to Fair Health” to “Moderately Impaired Health” and several indicators fall to “Significantly Impaired Health.” Using the full 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003) as an integrated evaluation tool, NHDES finds further evidence that Great Bay is degraded due to excess total nitrogen.

For Little Bay (

Table 15), fewer of the indicators span multiple categories. Some span between “Good to Fair Health” to “Moderately Impaired Health” and several indicators fall to “Significantly Impaired Health”. Using the full 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003) as an integrated evaluation tool, NHDES finds further evidence that Little Bay is degraded due to excess total nitrogen.

Table 14. Great Bay evaluating results utilizing the 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003). Blocks highlighted gray best describe the indicator evaluation category.

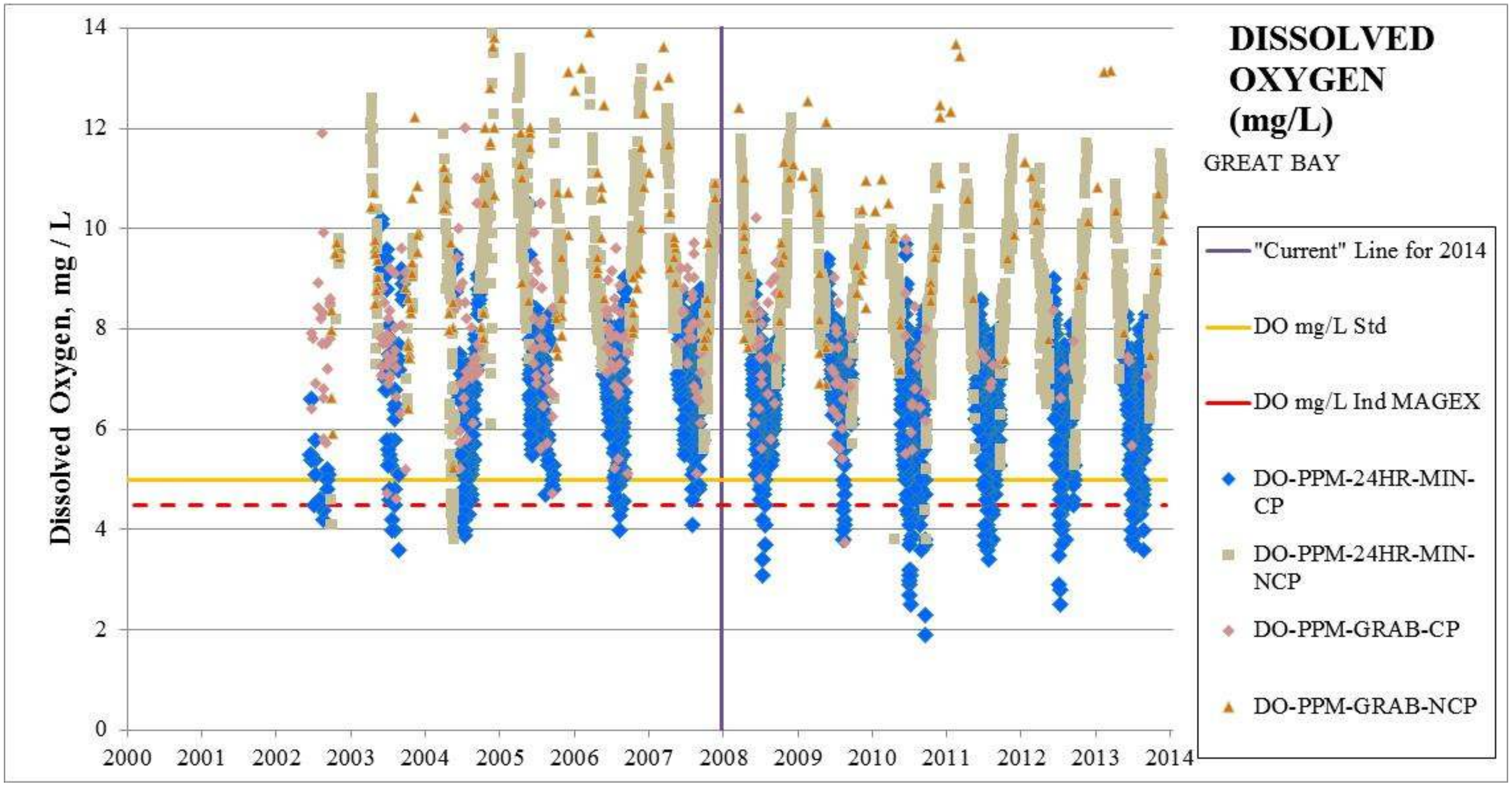
Indicator	Current status of Great Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
Eelgrass	The historical extent of eelgrass in this assessment zone was 2,130.7 acres from the 1948, 1962, 1980, and 1981 datasets. The median current extent of eelgrass in 2011-2013 is 1,598.4 acres, which is a 25.0% decrease. Since 1990, the trend in eelgrass cover in this assessment zone is a loss of 21.5%.	"Eelgrass beds are present"	"eelgrass is not present (it would still be considered SA water body if historical records document that eelgrass was present in the past or, in the case of insufficient documentation, if potential conditions are such that eelgrass should be present)"	"Eelgrass is not sustainable"	"absence of eelgrass"
Macroalgae	Using data from Pe'eri, et al. (Pe'eri, et al., 2008), DES determined that macroalgae mats had replaced nearly 5.7% of the area formerly occupied by eelgrass in Great Bay in 2007 (NHDES, 2009). Dr. Arthur C. Mathieson's comments on the draft 2012 303(d) framed the macroalgae and epiphyte condition well when he wrote (Mathieson A. , 2012), "Extensive ulvoid green algae (*Ulva* spp.) or "green tides (Fletcher, 1996) have begun to dominate many of these estuarine areas during the past 15-20 years, particularly within Great Bay proper (Nettleton et al. 2011). Such massive blooms of foliose green algae can entangle, smother and cause the death of eelgrass (*Zostera marina*) within the low intertidal/shallow	"macroalgae is generally non-existent but in some cases may be present"	"and macroalgae is not present or present in limited amounts even though a good healthy aquatic community still exists"	"macro-algae accumulations occur in some regions of the embayment."	"macroalgal accumulations"

Indicator	Current status of Great Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
	subtidal zones (pers. obs. A C Mathieson). They primarily represent annual populations that can also regenerate from residual fragments buried in muddy habitats." and "Extensive epiphytic growths of seaweeds on eelgrass (*Zostera marina*) have also occurred during the past 15-20 years, particularly within Great Bay proper (pers. obs. A C Mathieson). These epiphytes, which are mostly filamentous red algae and colonial diatoms, may completely cover the fronds of eelgrass, limiting the host's growth and photosynthesis and compromising its viability." Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016) noted that, "Monitoring results from 2014 show high levels of cover of nuisance green and red algae (*Ulva* and *Gracilaria*, respectively) at all sites except near the mouth of the Estuary." The Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016) study included several sites within Great Bay.				
Benthic animal diversity and shellfish	Detailed benthic animal diversity has not been quantified. Oyster populations have crashed.	"benthic animal diversity and shellfish productivity are high"	"there is generally a shift away from suspension feeding to moderate depth deposit feeders"	"is loss of diverse animal communities and replacement by smaller, shorter-lived animals of intermediate burrowing	"loss of diverse benthic animal populations" "benthic communities are dominated by shallow

Indicator	Current status of Great Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
				capabilities. Shellfisheries may shift to more resistant species.”	dwelling opportunistic species (e.g. *Capitella, Streblospio, Solemya*, etc).
Chlorophyll-a	The calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L and the median is 3.1 ug/L (n = 249). Annual peak concentrations range from 10-69 ug/L in the southwest area.	“chlorophyll-a levels are in the 3 to 5 µg/L range”	“chlorophyll-a levels are in the 3 to 5 µg/L range”	“phytoplankton blooms raise chlorophyll a levels to around 10 µg/L.”	“The level of nitrogen related to Significant Impairment supports large phytoplankton blooms (chlorophyll a of approximately 20 µg/L)”
Total Nitrogen	Great Bay exhibits a range of total nitrogen conditions. The median total nitrogen from 2008 through 2013 was 391 ug/L (n=62) when considering just the stations in the middle of Great Bay; and 410 ug/L (n=176) when including the boundary stations GRBSQ and GRBAP. The total nitrogen in the southwest area is 651 ug/L (n=44).	“The CCC [Cape Cod Commission] and BBP [Buzzards Bay Project] thresholds are <0.34 mg N/L and <0.39 mgN/L, respectively.”	“nitrogen levels are in the 0.39 - 0.50 range”	* >0.40 to 0.70 mg/L	“systems that are “Eutrophic”, 0.60/0.70 mg N/L”
Dissolved Oxygen	This assessment zone has not demonstrated dissolved oxygen exceedences at station GRBGB in the middle of Great Bay. However, when considering all sampling stations of Great Bay there are areas in the southwest that experience very poor dissolved oxygen, although not reaching outright hypoxia (< 2 mg/L). (Figure 22 & Figure 23)	“oxygen levels are generally not less than 6.0 mg/l with occasional depletions being rare (if at all)” (as measure by lowest 20% of readings)	“oxygen levels are generally not less than 5.0 mg/l with depletions to <4 mg/L being infrequent” (as measure by lowest 20% of readings)	“Oxygen levels generally do not fall below 4 mg/L”	“periodic hypoxia”

* SMAST (Howes, Samimy, & Dudley, 2003) “Within West Falmouth Harbor eelgrass loss was lost at nitrogen levels about 0.4 mg N/L. Eelgrass within the Great, Green, and Bournes Pond systems is generally lost also at the ca. 0.40 mg N/L level, which is at the SA/SB boundary. The generally high resource quality of SB waters for shellfish, finfish, recreation and aesthetics is generally maintained to the 0.50 mg N/L level. However, in areas of these systems where nitrogen levels exceed 0.5 mg N/L, animal communities decline and macroalgal accumulations begin to effect aesthetic quality. These systems tend to be relatively consistent and still maintain many resource values between 0.50 – 0.70 mg N/L.”

Figure 22. Great Bay Dissolved Oxygen.



Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

DO mg/L Std. = Dissolved oxygen concentration daily minimum water quality criteria.

DO mg/L Ind. MAGEX = Magnitude of exceedence indication for dissolved oxygen concentration.

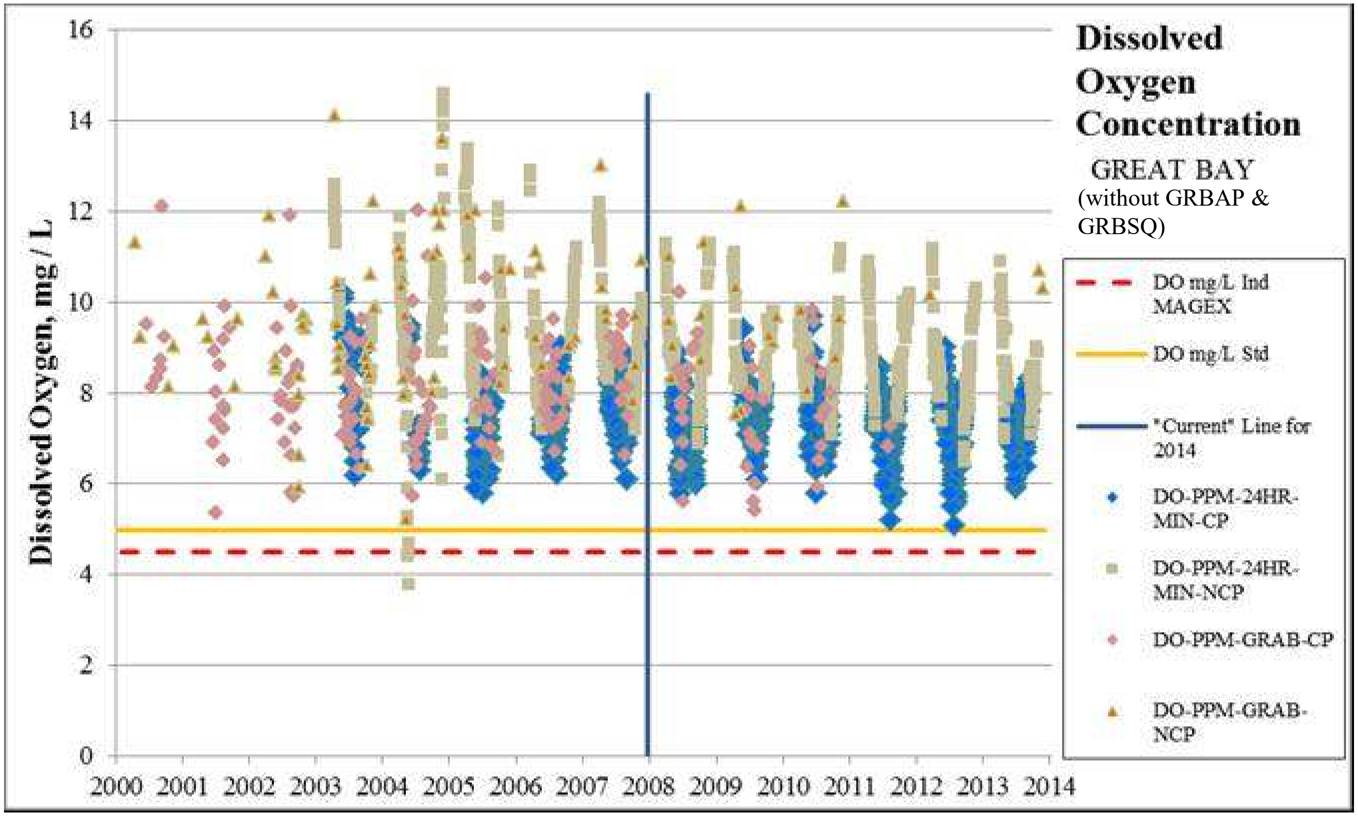
DO-PPM-24HR-MIN-CP = 24 hour minimum dissolved oxygen from a datalogger deployed during the summer critical period.

DO-PPM-24HR-MIN-NCP = 24 hour minimum dissolved oxygen from a datalogger deployed outside of the summer critical period.

DO-PPM-GRAB- CP = Grab samples of dissolved oxygen collected during the summer critical period.

DO-PPM-GRAB- NCP = Grab samples of dissolved oxygen collected outside the summer critical period.

Figure 23. Great Bay Dissolved Oxygen without stations GRBAP and GRBSQ.



Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

DO mg/L Std. = Dissolved oxygen concentration daily minimum water quality criteria.

DO mg/L Ind. MAGEX = Magnitude of exceedence indication for dissolved oxygen concentration.

DO-PPM-24HR-MIN-CP = 24 hour minimum dissolved oxygen from a datalogger deployed during the summer critical period.

DO-PPM-24HR-MIN-NCP = 24 hour minimum dissolved oxygen from a datalogger deployed outside of the summer critical period.

DO-PPM-GRAB- CP = Grab samples of dissolved oxygen collected during the summer critical period.

DO-PPM-GRAB- NCP = Grab samples of dissolved oxygen collected outside the summer critical period.

Table 15. Little Bay evaluating results utilizing the 2003 SMAST methodology (Howes, Samimy, & Dudley, 2003). Blocks highlighted gray best describe the indicator evaluation category.

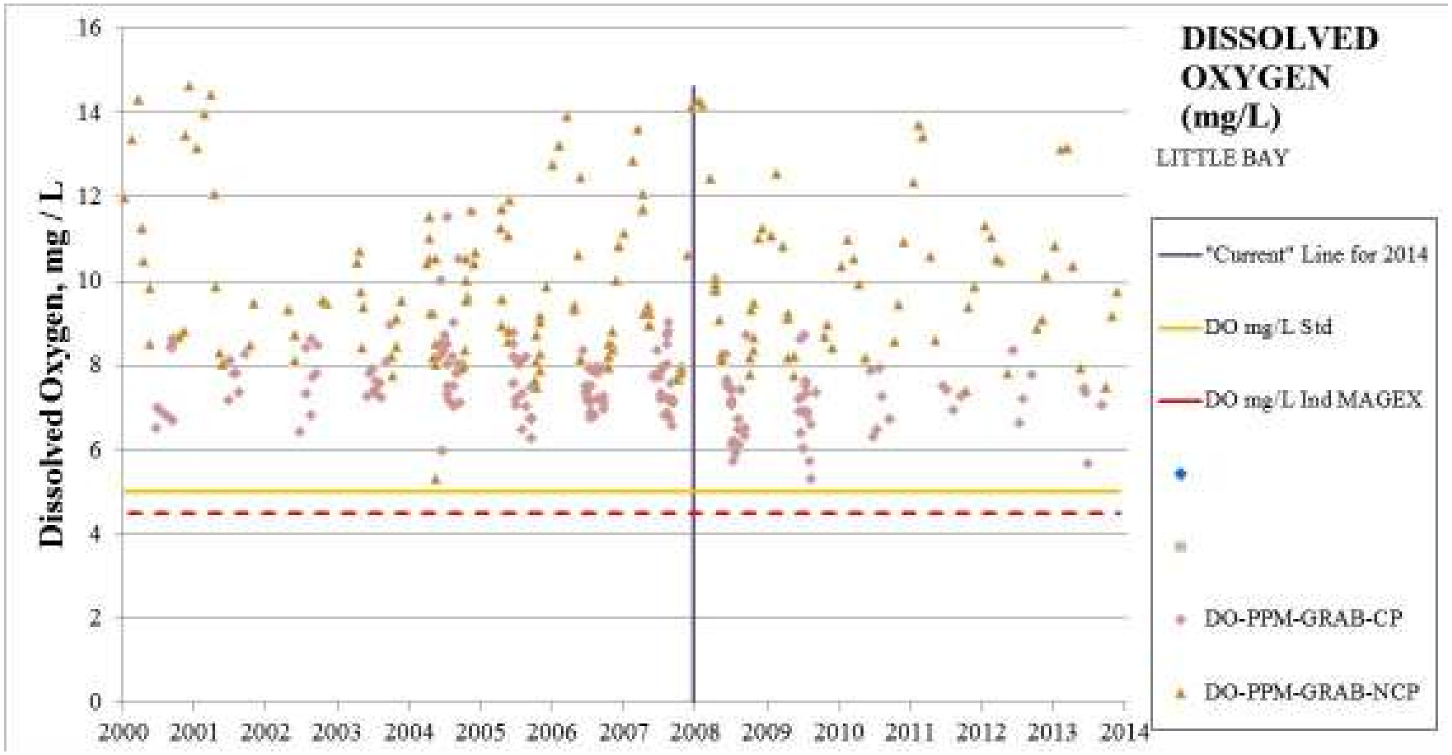
Indicator	Current status of Little Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
Eelgrass	The historical extent of eelgrass in this assessment zone was 252 acres from the 1948, 1962, 1980, and 1981 datasets. The median current extent of eelgrass in 2011-2013 is 34.6 acres, which is a decrease of 86.3%. There is no significant trend in eelgrass cover in this assessment zone since 1990. The thresholds for impairment are either loss of more than 20% of the historic extent of eelgrass or a recent trend of greater than 20% loss.	"Eelgrass beds are present"	"eelgrass is not present (it would still be considered SA water body if historical records document that eelgrass was present in the past or, in the case of insufficient documentation, if potential conditions are such that eelgrass should be present)"	"eelgrass is not sustainable"	"absence of eelgrass"
Macroalgae	Dr. Arthur C. Mathieson's comments on the draft 2012 303(d) framed the macroalgae condition in the Little Bay assessment zone well when he wrote (Mathieson A. , 2012), "The"guanotrophic" green alga *Prasiola stipitata* suddenly appeared in the upper intertidal zone near Dover Point [the eastern end of Little Bay]. It represents a disjunct open coastal taxon that is usually found in high intertidal bird roockeries with large quantities of guano. During the mid 1980's it was not recorded inland from Fort Constitution on the Piscataqua River (Mathieson and Hehre, 1986; Mathieson and Penniman, 1986), and its sudden appearance correlates with the "recent" transfer of Dover's sewage discharges from the Cocheco River to the	"macroalgae is generally non-existent but in some cases may be present"	"and macroalgae is not present or present in limited amounts even though a good healthy aquatic community still exists"	"macro-algae accumulations occur in some regions of the embayment."	"macroalgal accumulations"

Indicator	Current status of Little Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
	Piscataqua River/Little Bay area." and "The Asiatic red alga *Gracilaria vermiculophylla* was recently introduced to the GBES (Nettleton et al. submmitted) and is causing even greater macroalgal blooms than the "green tide" seaweeds. In contrast to Ulva it is a perennial, long-lived taxon that is more tolerant to desiccation than the native species *G. tikvahiae*. As a consequence it now forms extensive wind rows 1-2 feet deep within the low intertidal and subtidal zones of many Little and Great Bay sites (pers. obs. A C Mathieson). Like Ulva spp. its massive blooms can entangle, smother and cause the death of eelgrass within the low intertidal/shallow subtidal zones." Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016)note that, "Monitoring results from 2014 show high levels of cover of nuisance green and red algae (*Ulva* and *Gracilaria*, respectively) at all sites except near the mouth of the Estuary." The Burdick et al. (Burdick, Mathieson, Peter, & Sydney, 2016) study included several sites within Little Bay.				
Benthic animal diversity and	Detailed benthic animal diversity has not been quantified. Oyster populations have crashed.	"benthic animal diversity and shellfish productivity are high"	"there is generally a shift away from suspension feeding to moderate depth	"is loss of diverse animal communities and replacement by smaller,	"loss of diverse benthic animal populations"

Indicator	Current status of Little Bay Assessment Zone	SMAST 2003, Excellent to Good health	SMAST 2003, Good to Fair Health	SMAST 2003, Moderately Impaired Health	SMAST 2003, Significantly Impaired Health
shellfish			deposit feeders”	shorter-lived animals of intermediate burrowing capabilities. Shellfisheries may shift to more resistant species.”	“benthic communities are dominated by shallow dwelling opportunistic species (e.g. *Capitella, Streblospio, Solemya*, etc).
Chlorophyll-a	The calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 ug/L, the median is 2.9 ug/L (n = 95) and a maximum reading of 16.5 ug/L.	“chlorophyll-a levels are in the 3 to 5 µg/L range”	“chlorophyll-a levels are in the 3 to 5 µg/L range”	“phytoplankton blooms raise chlorophyll a levels to around 10 µg/L.”	“The level of nitrogen related to Significant Impairment supports large phytoplankton blooms (chlorophyll a of pproximately 20 µg/L)”
Total Nitrogen	The median total nitrogen from 2008 through 2013 was 379 ug/L (n=78).	“The CCC [Cape Cod Commission] and BBP [Buzzards Bay Project] thresholds are <0.34 mg N/L and <0.39 mg N/L, respectively.”	“nitrogen levels are in the 0.39 - 0.50 range”	* >0.40 to 0.70 mg/L	“systems that are Eutrophic”, 0.60/0.70 mg N/L”
Dissolved Oxygen	The Little Bay assessment zone has only grab sample measurements for dissolved oxygen concentration and those measurements have been collected up through 2013. In recent years, there have been several samples below 6 mg/L but remaining over 5 mg/L. (Figure 24)	“oxygen levels are generally not less than 6.0 mg/l with occasional depletions being rare (if at all)” (as measure by lowest 20% of readings)	“oxygen levels are generally not less than 5.0 mg/l with depletions to <4 mg/L being infrequent” (as measure by lowest 20% of readings)	“Oxygen levels generally do not fall below 4 mg/L”	“periodic hypoxia”

* SMAST (Howes, Samimy, & Dudley, 2003) “Within West Falmouth Harbor eelgrass loss was lost at nitrogen levels about 0.4 mg N/L. Eelgrass within the Great, Green, and Bournes Pond systems is generally lost also at the ca. 0.40 mg N/L level, which is at the SA/SB boundary. The generally high resource quality of SB waters for shellfish, finfish, recreation and aesthetics is generally maintained to the 0.50 mg N/L level. However, in areas of these systems where nitrogen levels exceed 0.5 mg N/L, animal communities decline and macroalgal accumulations begin to effect aesthetic quality. These systems tend to be relatively consistent and still maintain many resource values between 0.50 – 0.70 mg N/L.”

Figure 24. Little Bay Dissolved Oxygen.



Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

DO mg/L Std. = Dissolved oxygen concentration daily minimum water quality criteria.

DO mg/L Ind. MAGEX = Magnitude of exceedence indication for dissolved oxygen concentration.

DO-PPM-GRAB- CP = Grab samples of dissolved oxygen collected during the summer critical period.

DO-PPM-GRAB- NCP = Grab samples of dissolved oxygen collected outside the summer critical period

Evaluation of eelgrass decline (8- 7, 8- 2)

The GBMC contends that water transparency (that is, clarity as measured by the light attenuation coefficient K_d) cannot be contributing to the loss of eelgrass because they believe the shallow areas have been losing eelgrass faster than the deep areas (comment 8- 7). It would appear that the GBMC came to this conclusion by a visual interpretation of the annual eelgrass maps. While visual interpretations can be good, this conclusion required many assumptions about the depth regime of a relatively large waterbody. One of the assumptions is that the spatial resolution and orthorectification of the eelgrass data is suitable to overlay on the bathymetry data. There have been no statistical tests of that assumption. Another assumption is that the eyeball approach to spatial analysis is accurate. In order to test this second assumption, NHDES used GIS mapping to evaluate the distribution of the 1990 to 2013 eelgrass data against the 2009 50 foot bathymetry grid in ArcGIS (see Section C. GREAT BAY EELGRASS DEPTH ANALYSIS). Once the depth information was compiled for each of the eelgrass mapping years, the depths were summarized into three depth regimes. These depth regime categories were derived by updating Table 9 from the 2009 DES Report (NHDES, 2009) to include more recent data for light attenuation from 2008-2013. Table 9 (NHDES, 2009) uses a method from Koch (Koch, 2001) to estimate the minimum (Zmin) and maximum (Zmax) depths for eelgrass survival, assuming that 22% of incident light is required for survival (USEPA, 2003). From the light attenuation and eelgrass depth analysis, three depth ranges are relevant to evaluate the impact of the measured light attenuation. The eelgrass within a given year was categorized into three depth regimes; Intertidal (0 to 1m below MTL), Sub-tidal zone with acceptable light anticipated (1 to 1.3m below MTL), and Sub-tidal zone with unacceptable light anticipated (> 1.3 m below MTL).

That analysis clearly shows that there has been a 31 percent loss of eelgrass from the sub-tidal zone with unacceptable light anticipated (Figure 25), a 10 percent loss of eelgrass from sub-tidal zone with acceptable light anticipated, and a 25 percent loss of eelgrass from the intertidal zone. The visual interpretation reported in the GBMC comment is contrary to this NHDES analysis. The eelgrass growing in the deep sub-tidal zone with unacceptable light (greater than 1.3 meters below MTL) shows a greater rate of decline than either the intertidal or shallow sub-tidal zone with acceptable light. The slope of the regression line for the deep depth zone (>1.3 meters below MTL) is a loss of 29.4 acres/year, approximately three time greater than in the other two depth zones. Further, the deep zone has the greatest percent loss over time. The fact that eelgrass has been lost most rapidly from the deep sub-tidal waters illustrates that eelgrass in Great Bay is sensitive to water clarity, and water clarity can be quantified using the light attenuation coefficient (K_d) for photosynthetically active radiation (Short, Burdick, & Kaldy, 1995). Figure 25 indicates that as light penetration degrades, eelgrass area diminishes more rapidly in deeper areas of the bay. The second greatest zone of loss is from the intertidal zone which illustrates shallow water sediment resuspension and the smothering/displacement impact of the macrophytes as corroborated by the proliferation documented by Mathieson (Mathieson A. , 2012), Nettleton et. al. (Nettleton, Neefus, Mathieson, & Harris, 2011), and Burdick et. al. (Burdick, Mathieson, Peter, & Sydney, 2016).

Figure 25. Great Bay eelgrass depth regime evaluation.

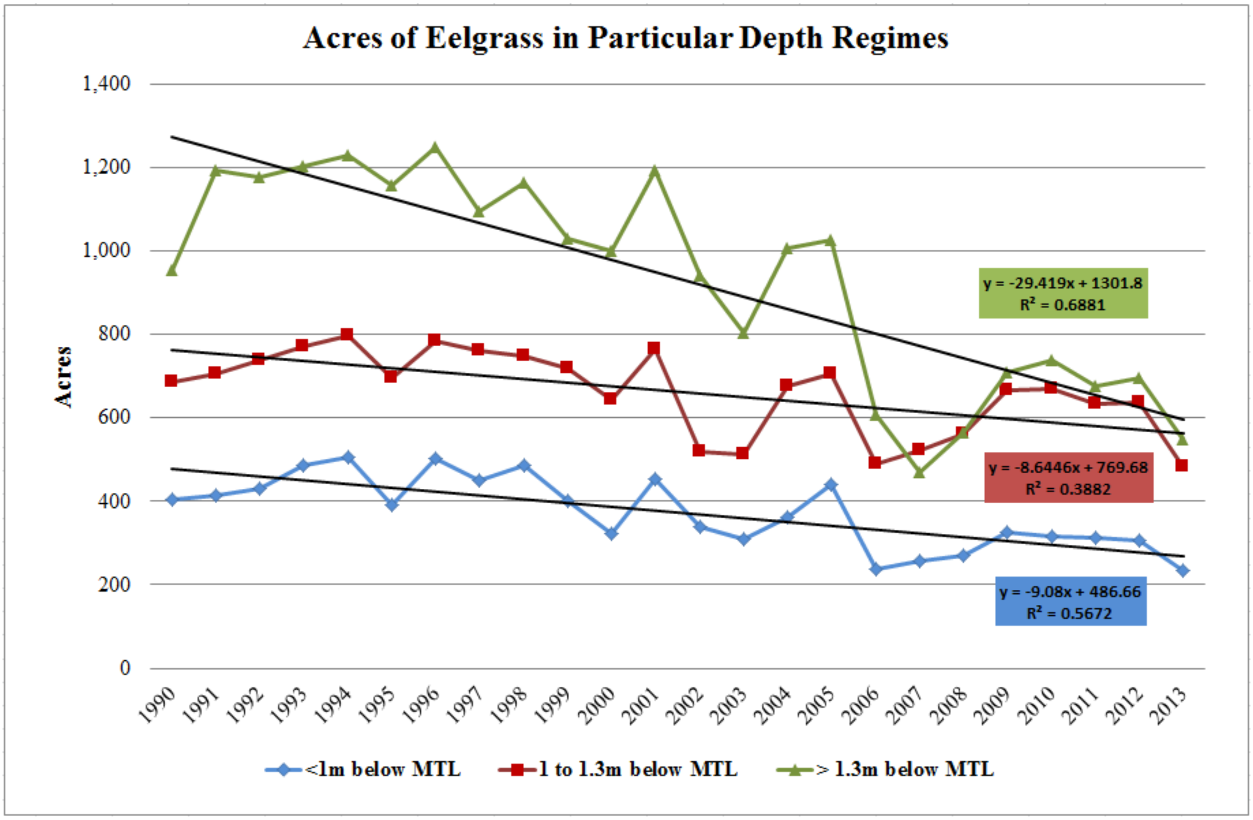


Table 16. Great Bay eelgrass depth regime trends statistics, 1990-2014.

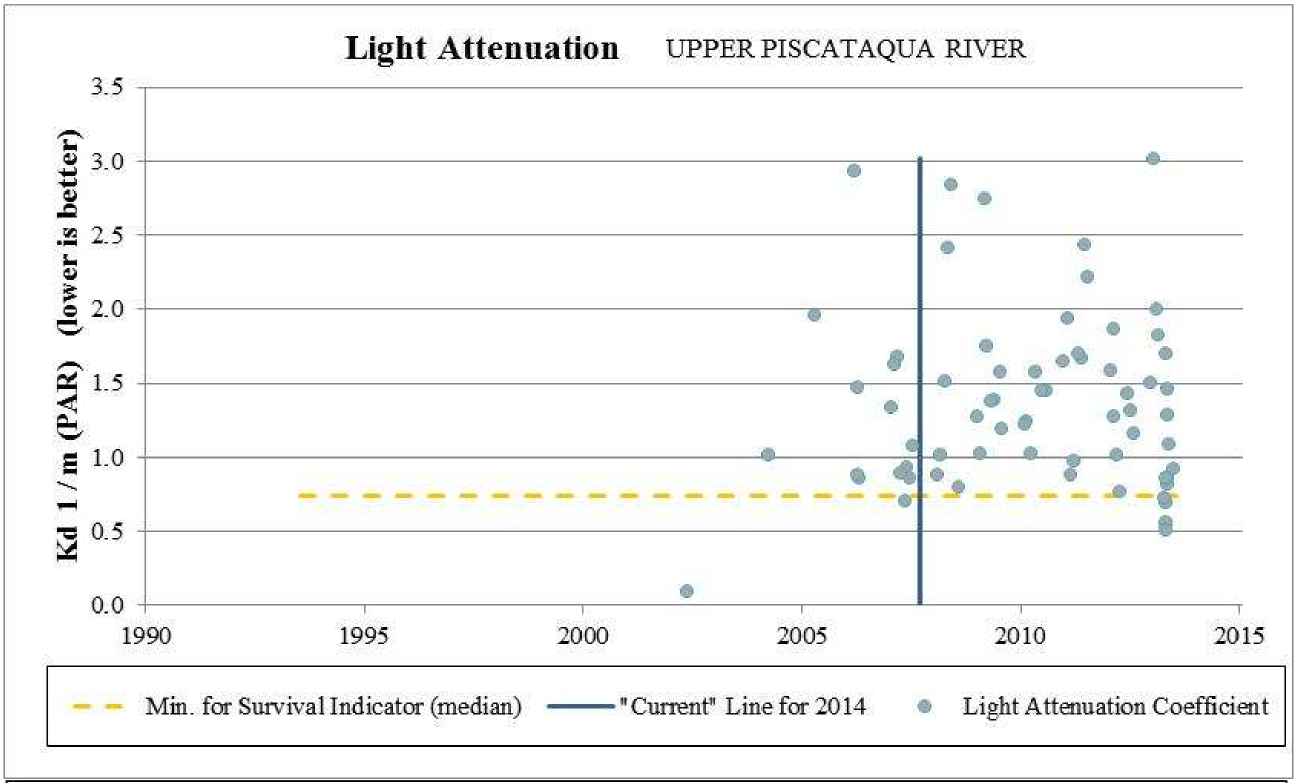
Depth Regime	<1m below MTL, Intertidal zone.	1 to 1.3m below MTL, Shallow Sub-tidal zone with acceptable light.	> 1.3m below MTL, Deep Sub-tidal zone with unacceptable light.
Regression Significance (p)	2.17E-05	1.15E-03	5.42E-07
Regression Coefficient R^2	0.57	0.39	0.69
Trend Significance (p)	2.17E-05	1.15E-03	5.42E-07
Trend Slope (acres/year)	-9.1	-8.6	-29.4
Trend Slope (Percent change 1990-2014)	-25.0%	-10.0%	-30.9%

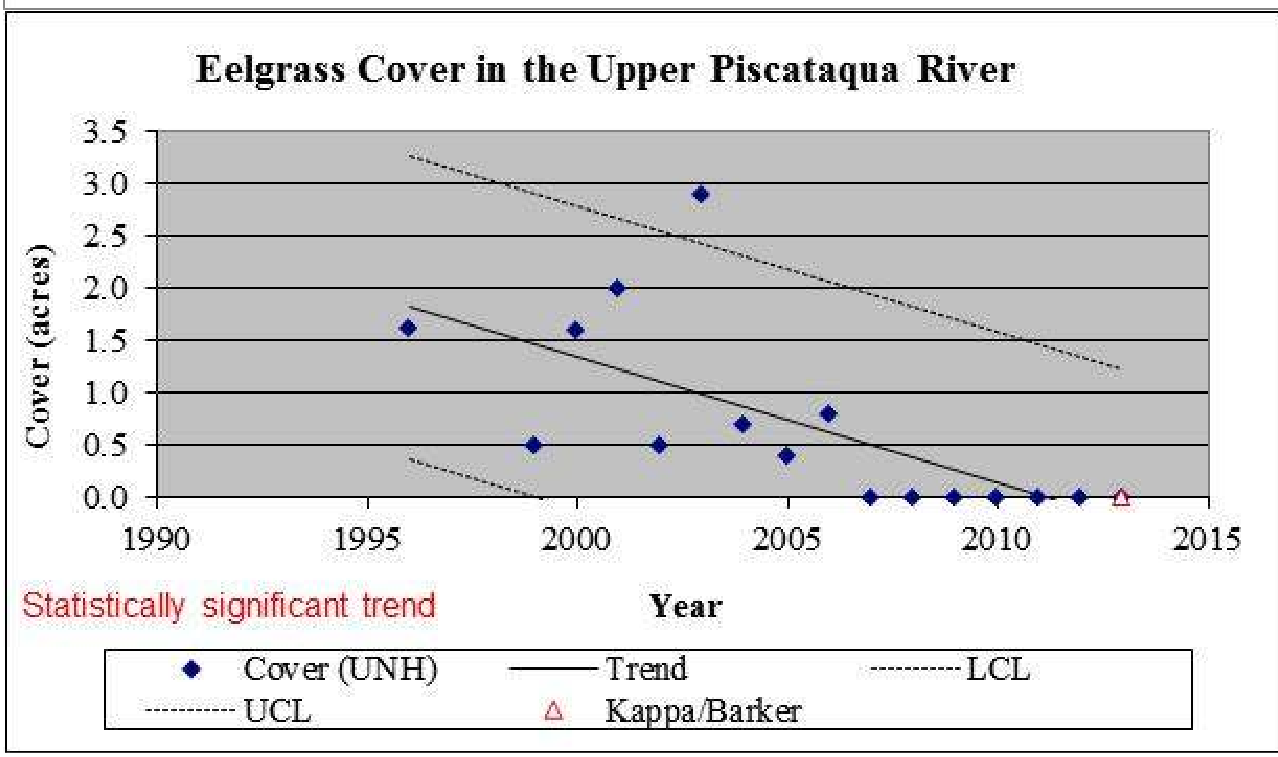
In comment 8- 2 GBMC cites the NHEP 2006 report which stated that eelgrass population changes from 1990 to 2003 could not be related to water quality. In fact, that reports said, "The observed changes in eelgrass cannot be linked directly to a water quality **trend** [emphasis added] in Great Bay, …" (NHEP, 2006). Data requirements for relating multiple trends are much higher since it is not uncommon for sudden shifts in ecological conditions to occur after prolonged periods of subtle environmental changes ((Scheffer, Carpenter, Foley, Folke, & Walker, 2001), (van der Heide, et al., 2007)) and prolonged periods of loading. The 2006 report is only part of the picture, the NHEP Environmental Indicators Report: Water Quality Indicator explicitly documents the increasing trend in total suspended solids (TSS) (NHEP, Environmental Indicator Report: Water Quality Indicator, 2006). The 2006 NHEP State of Our Estuaries report also stated that, "Eelgrass is sensitive to water quality, especially water clarity" (NHEP, 2006). Indeed, eelgrass is being lost from all depth regimes of Great Bay. Poor water column transparency drives deep edge losses. Those eelgrass losses and TSS increases documented back in 2006 (NHEP, Environmental Indicator Report: Water Quality Indicator, 2006) and repeated in the 2013 Estuaries Report (PREP, 2013) have resulted in a shallow area that becomes very turbid every time the tide changes, which limits light in the shallows and deposits detritus on eelgrass leaves impacting eelgrasses ability to grow. This is further exacerbated by smothering by macroalgae. The combined stresses kill some portion of the eelgrass population and in its absence the whole system is that much less capable of stabilizing the sediment on each shift of the tide.

<u>DES RESPONSE</u> to Comments on the Impairments in an undefined portion of the Piscataqua River (8- 4)

The GBMC commented that phytoplankton is not a major driver of light availability in the Piscataqua River by showing chlorophyll-a and K_d measurements at station NH-0057A (Comment 8- 4). While the GBMC comment is general to the Piscataqua River, the river is divided into three Assessment Zones spanning 10 miles; an Upper reach and two Lower reaches (North and South). The Lower assessment zones are not considered impaired due to light attenuation; Lower Piscataqua River-North is assessed as Insufficient Information – Potentially Not Supporting and Lower Piscataqua River-South is assessed as Insufficient Information – Potentially Attaining Standards. The referenced station, NH-0057A, is on the Upper Piscataqua River near the Dover wastewater discharge and that is the only Piscataqua segment considered impaired. The impairment is based on 53 available light attenuation measurements made between 1/1/2008 (the vertical blue line in Figure 26) and 12/5/2013, which illustrates that only on rare occasions is there a survivable quantity of light for eelgrass (Figure 26). The current Median K_d is 1.330 m^{-1} and eelgrass is completely lost. The restoration depth driven K_d for the Upper Piscataqua River is 0.75 m^{-1}.

Figure 26. Upper Piscataqua River light attenuation (K_d) and eelgrass cover over time.





The GBMC rationale as to why phytoplankton as represented by chlorophyll-a is not a major driver of eelgrass loss is derived from the extrapolation of a single survey conducted in Great Bay proper (i.e. (Morrison, Gregory, Pe'eri, McDowell, & Trowbridge, 2008)) to the chlorophyll-a measured at station NH-0057A, which is in the Upper Piscataqua River.

This assessment zone historically had eelgrass growing in both the shallows and some in deeper habitat. For an eelgrass restoration depth of 2 m, the light attenuation coefficient threshold is 0.75 m^{-1}, far clearer than the recent median of 1.330 m^{-1} (n=53). NHDES agrees that chlorophyll-a is only one of the factors that results in degraded light reaching eelgrass but it is nonetheless a factor. As seen in the tidal Cocheco River datalogger deployments (response 4- 6), the spikes in the datalogger records (Figure 27 and Figure 28) for stations UPR2, UPR4, UPR6, and UPR8 (Figure 30) indicate that the periodically high grab samples (up to 24 ug/L in 2012)(Figure 29) are accurate and their frequency and extent are likely underestimated by the grab samples alone. Some of the other human enhanced factors that influence light attenuation are TSS loads from WWTFs, turbid stormwater runoff from developed lands, and the resuspension that material which is exacerbated by the lack of eelgrass.

Figure 27. Upper Piscataqua River chlorophyll-a datalogger at stations UPR2, UPR4, UPR6, and UPR8.

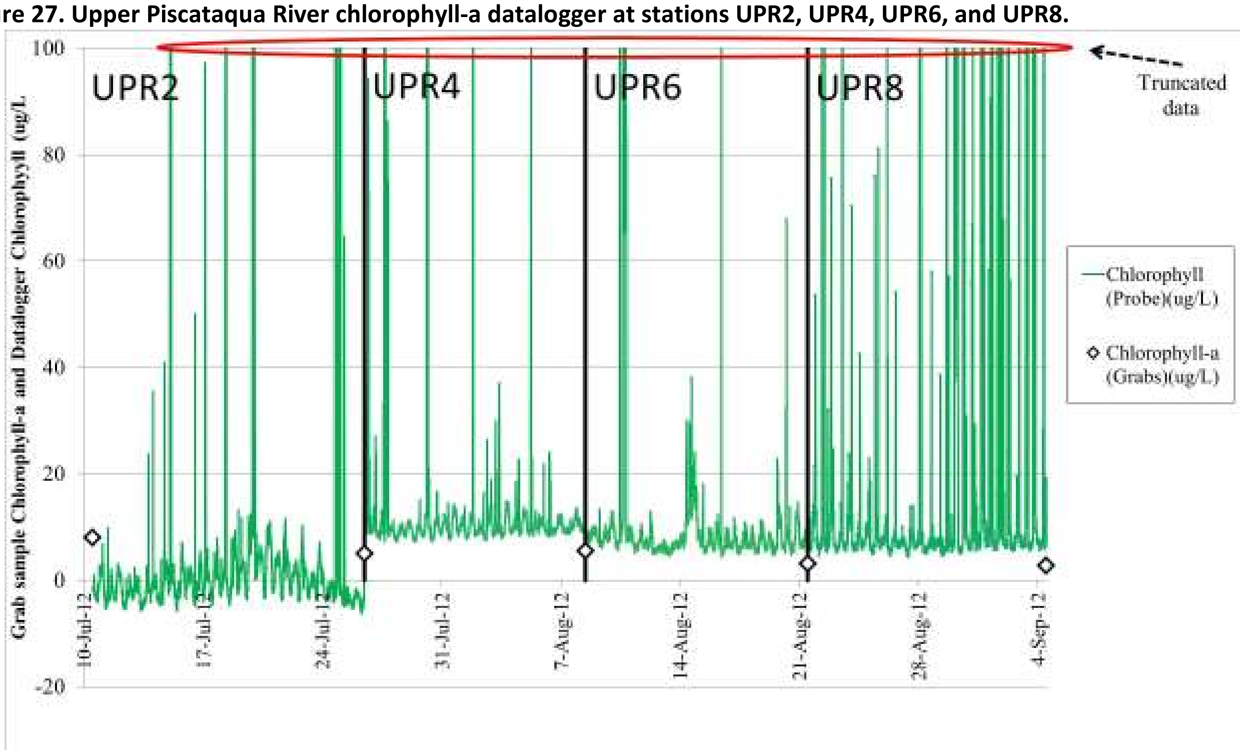


Figure 28. 2013 Upper Piscataqua River chlorophyll-a datalogger at stations UPR2, UPR4, UPR6, and UPR8.

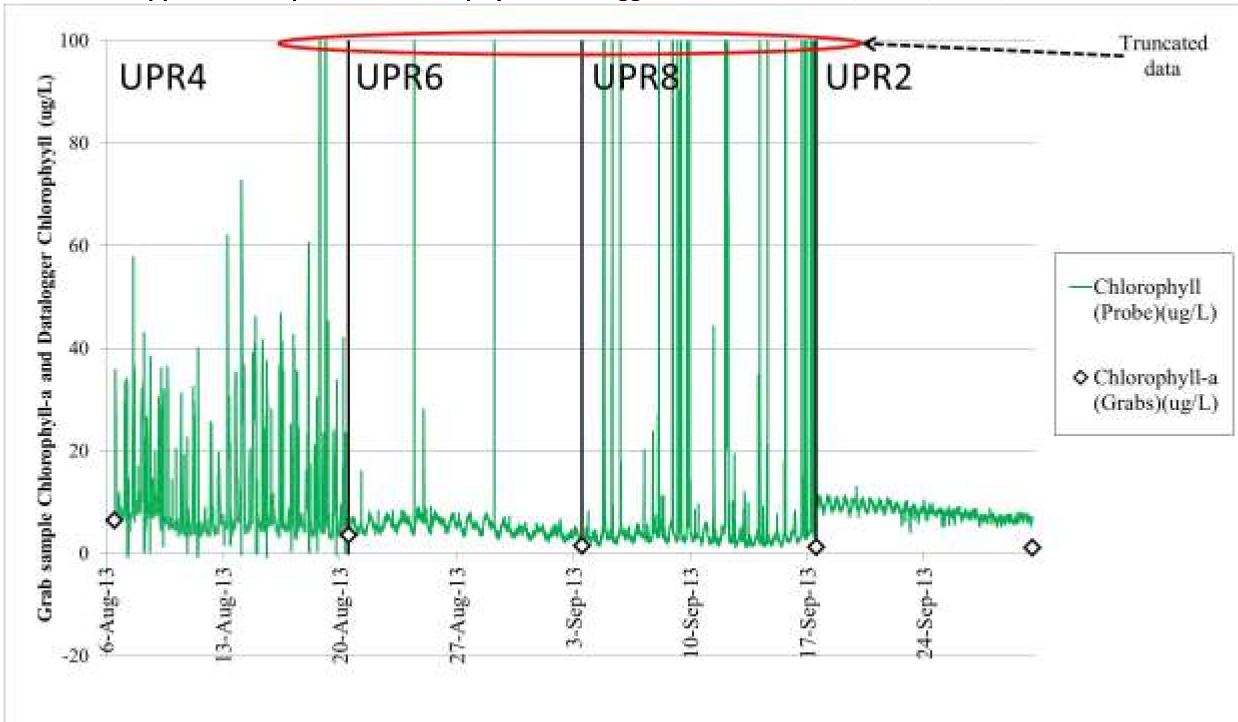


Figure 29. Upper Piscataqua River grab sample chlorophyll-a data.

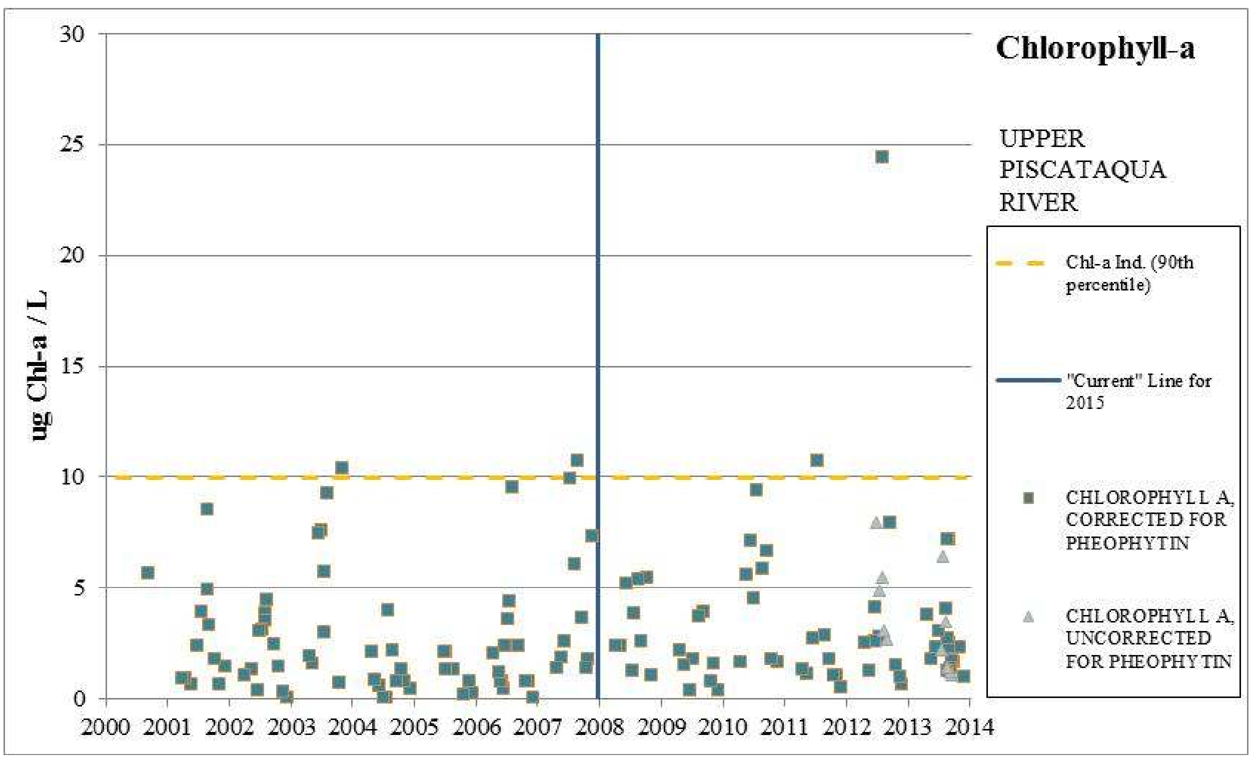
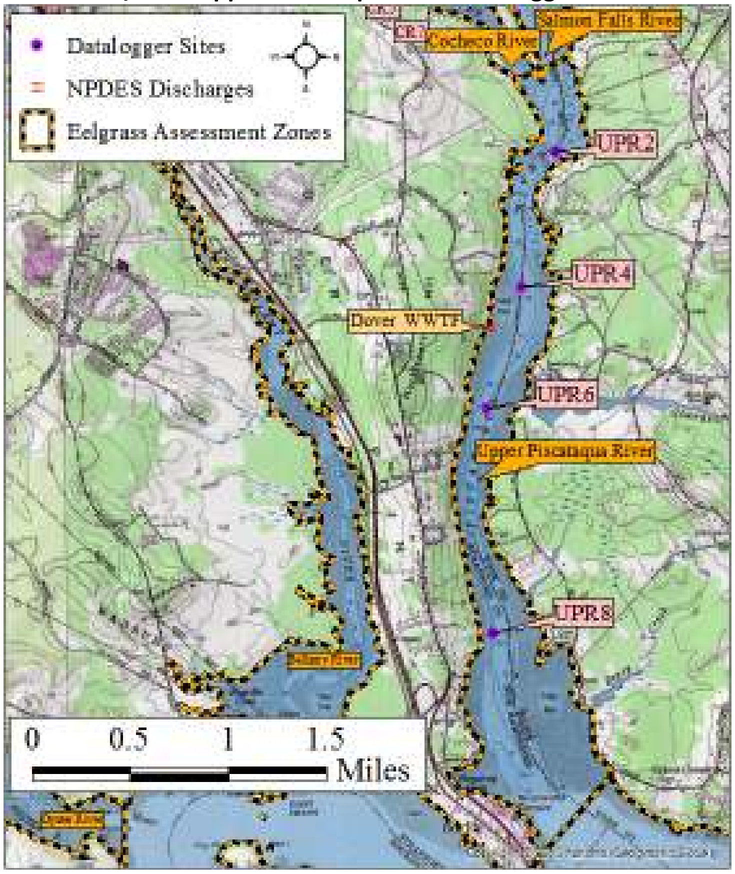


Figure 30. 2012/2013 Upper Piscataqua River datalogger stations UPR2, UPR4, UPR6, and UPR8.

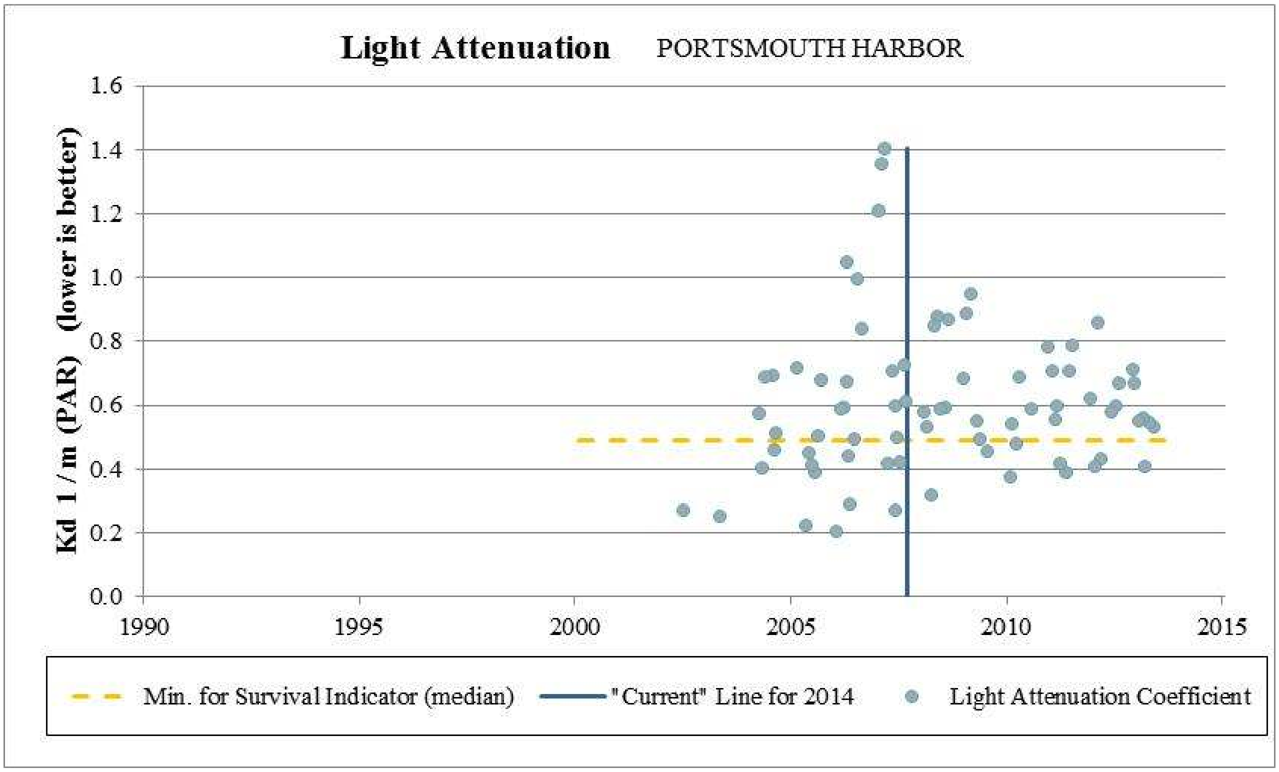


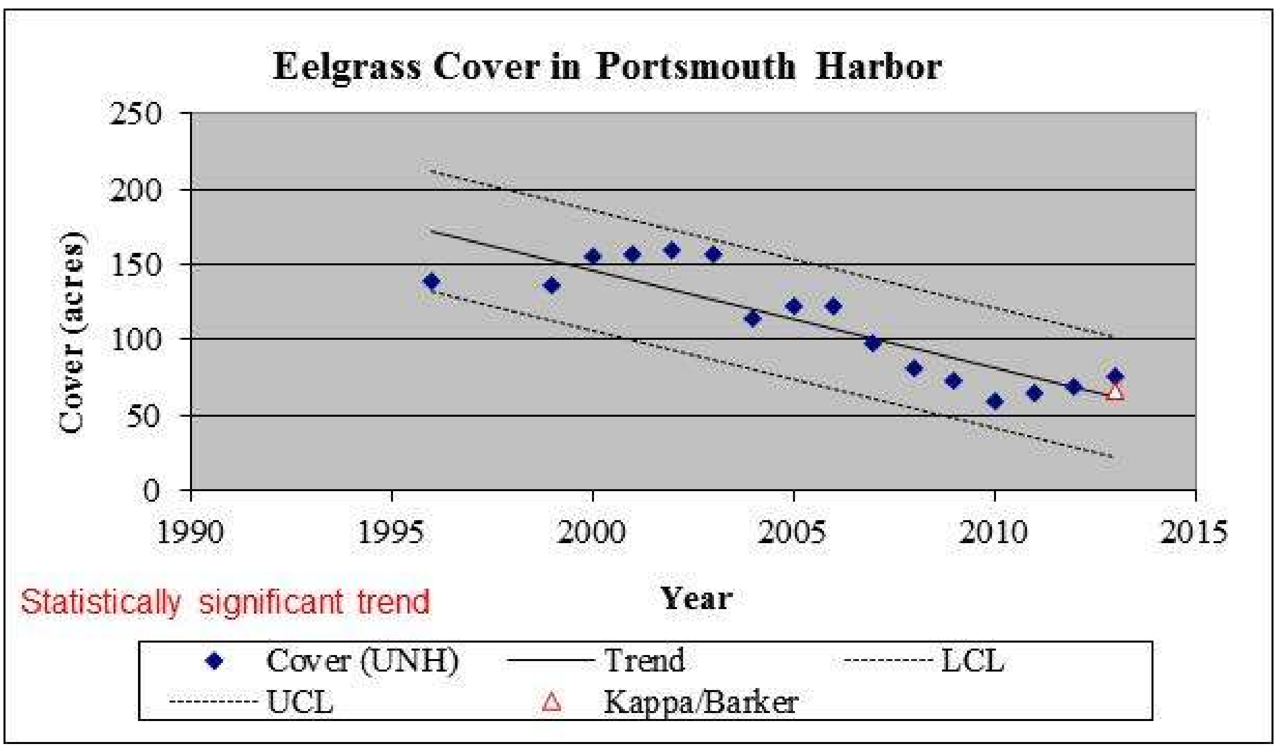
DES RESPONSE ***to*** Comments on the Impairments in the Portsmouth Harbor Assessment Zone 8- 8

At 8- 8, the GBMC comments on the impaired eelgrass cover in Portsmouth Harbor stating that the water is of excellent quality. This would be true but for the poor light availability, as explained in the 2014 Draft Technical Support document,

> "Median=0.600 m^-1 (n=41). For an eelgrass restoration depth of 3 m, the light attenuation coefficient threshold is 0.5 m^-1. This assessment zone historically had eelgrass growing in both the shallows and deeper habitat making the 3m restoration depth a valid target. Further, a review of the location of the deep edge of the eelgrass suggests that the maximum depth of eelgrass survival is not as deep as it was in the past. Due to the proximity of the Portsmouth WWTF, this assessment zone may be experiencing a large portion of light diminishment from the large TSS load out of the discharge. Therefore, the impaired (5-M) listing from the 2012 303d list has been retained."

Figure 31. Portsmouth Harbor light attenuation (K_d) and eelgrass cover over time.





<u>DES RESPONSE</u> to Comments on the Impairments on the 2014 Consolidated Assessment and Listing Methodology

The Great Bay Municipal Coalition (GBMC) comments include 11 pages of comments on the 2014 Consolidated Assessment and Listing Methodology (8- 10 to 8- 21). These comments were reviewed to determine if any of the content related directly to waterbodies and impairments on the 2014 Draft 303(d) that was provided for review.

<u>DES RESPONSE</u> to Comments on the Impairments in the Cocheco River (8- 13) (perhaps they meant the Piscataqua River and Portsmouth Harbor?)

The GBMC commented in section 8- 13 about the low readings in the datalogger set for the Cocheco River citing a report by Jones and Gregory December 15, 2013 (Jones & Gregory, 2013). The study cited sampled locations in the Upper Piscataqua, Lower Piscataqua and Portsmouth Harbor Assessment Zones, not the Cocheco River. As such, the NHDES response pertains to the sites on the Piscataqua River. The comments by the GBMC are based upon a preliminary dataset for which there was considerable subsequent correspondence between the researchers, GBMC, and NHDES that some of the data should not be used. The report by Jones and Gregory (2013) does not illustrate the final state of the data as it was loaded into the Environmental Monitoring Database (EMD) and subsequently used in the draft 2014 assessment process. In fact, the Jones and Gregory December 15, 2013, report (Jones & Gregory, 2013) stated, "Decisions to censor data were not discussed with the clients, so we made note of questionable data and provided the full database, and interpretations that included all data" and despite this wording, invalid data were included in the interpretations by the GBMC. Subsequent to the Jones and Gregory December 15, 2013 memo, NHDES identified in a June 4, 2014 memo, a number of technical issues that needed to be addressed before the data could be uploaded to the EMD (Wood, 2014). Jones and Gregory then replied on September 26, 2014 (Jones & Gregory, 2014) having applied the appropriate corrections. The final corrections to the dataset enabled NHDES to upload the entire dataset into the EMD and mark the erroneous data invalid as described in the NHDES memo to GBMC, Jones, and Gregory on October 9, 2014 (Wood, 2014). That final corrected dataset was then used in the draft 2014 assessment. Further, neither the Cocheco River nor Upper or Lower Piscataqua River or Portsmouth Harbor areas are currently listed as impaired for dissolved oxygen.

<u>DES RESPONSE</u> to 8- 10 ***to*** 8- 20

The GBMC includes several pages of comments on the Draft 2014 CALM. Comments specifically related to the Draft 2014 CALM were previously responded to and available on NHDES' website; http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/index.htm. The comments on the Draft 2014 CALM were reviewed to determine if any of the content related directly to the 2014 Draft 303(d) that was provided for review. No such content was identified in pages therefore no response is necessary.

<u>DES RESPONSE</u> to 8- 21

GBMC references, no comment necessary.

<u>DES RESPONSE</u> to 8- 22

The GBMC included 8- 22 as backup materials for their other comments. NHDES makes no separate comment on this document nor the validity of the material included.

RESPONSE TO COMMENT #9: Terry Desmarais, City of Portsmouth

<u>DES RESPONSE</u> to 9- 1
NHDES notes that the City of Portsmouth incorporates by reference the comments made by the Great Bay Municipal Coalition addressed under comment set #8.

***<u>DES RESPONSE</u> to* 9- 2**
The City of Portsmouth supports the NHDES decision to delist several assessment units for total nitrogen and for other units until assessment units delay final assessment until such time as a new approach is determined. NHDES appreciates the support, and the delisting issue is addressed in Response 3- 1.

***<u>DES RESPONSE</u> to* 9- 3**
The City of Portsmouth suggests that the State allocate additional water quality sampling and analysis resources. NHDES agrees that more data would be helpful.

Also see response to 4- 11

***<u>DES RESPONSE</u> to* 9- 4**
See response to 4- 11

The City of Portsmouth's comments expressed concern that the overall age of the bacteria data used for North Mill Pond (NHEST600031001-10). Further, the City of Portsmouth notes that CSO abatement work has been completed and an effectiveness evaluation is under way. NHDES awaits the outcome of effectiveness evaluation and looks forward to the final report. Such a report will be a great success story for the City and tool for subsequent bacteria delisting of the waterbody.

The City also questioned the NHDES notes from previous assessment cycles anticipating some follow-up sampling by NHDES Watershed Assistance Section (319 Program) staff as related to a discharge of untreated human waste;

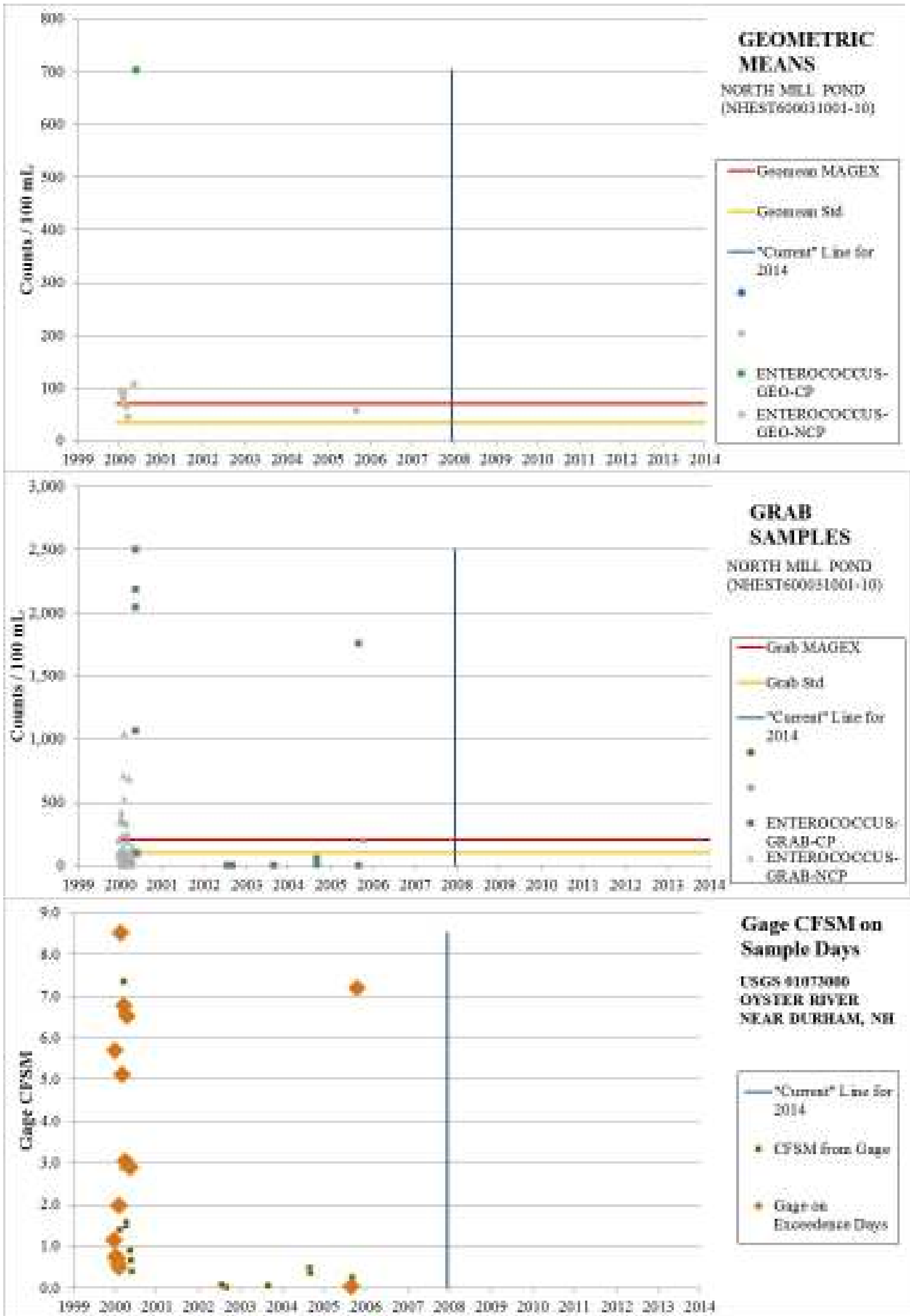
> "2010: Water quality data indicates impairment and discharges of untreated human waste still remain. RL - PM8400 [sampling station ID], Major source was being worked on Late Fall 2009, followup sample has not been done yet, waiting for construction to finish, should be complete now and followup sampling will be done Feb 2010."

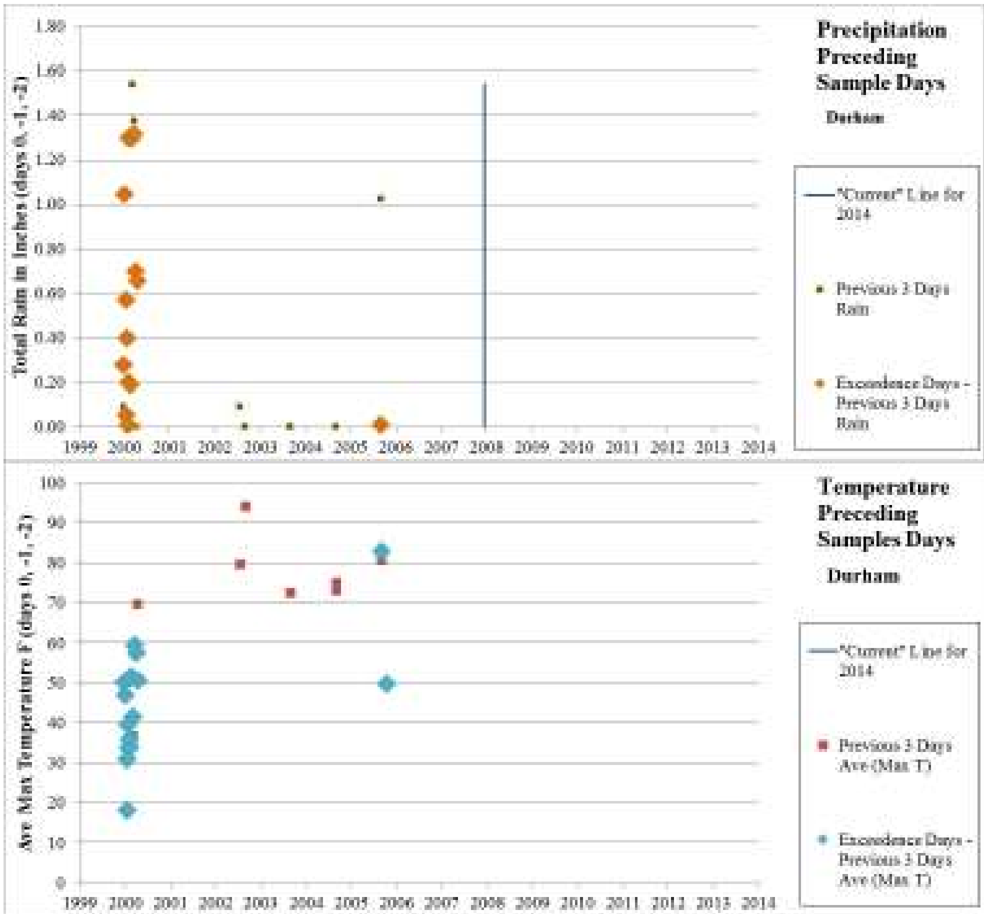
NHDES was unable to allocate resources to sample this location since 2010.
(see also the response to **9- 3**)

Note that the impairment to this assessment unit was based on high bacteria measurements at stations ALB-1 ALB -2, ALB- 3, and NH05-0236A, not just the apparent illicit discharge at the PM8400 station. As part of a future delisting effort, those stations (ALB-1 ALB -2, ALB- 3, and NH05-0236A) should be sampled under the same or more water quality limiting conditions as the original sampling condition. Evaluation of the older data reveals that exceedences occurred under both high and low inflow periods and under both rain event and dry periods. As such, resampling should occur under a range of weather and flow conditions.

NHDES would be happy to work out the details of an appropriate monitoring plan with the City of Portsmouth.

Figure 32. North Mill Pond (NHEST600031001-10) bacteria samples, representative river flow, preceding precipitation, and preceding temperature.





Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

ENTEROCOCCUS-GEO-CP = Enterococcus geometric mean calculated from samples collected during the summer critical period.

ENTEROCOCCUS-GEO-NCP = Enterococcus geometric mean calculated from samples collected outside the summer critical period.

ENTEROCOCCUS-GRAB-CP = Enterococcus grab samples collected during the summer critical period.

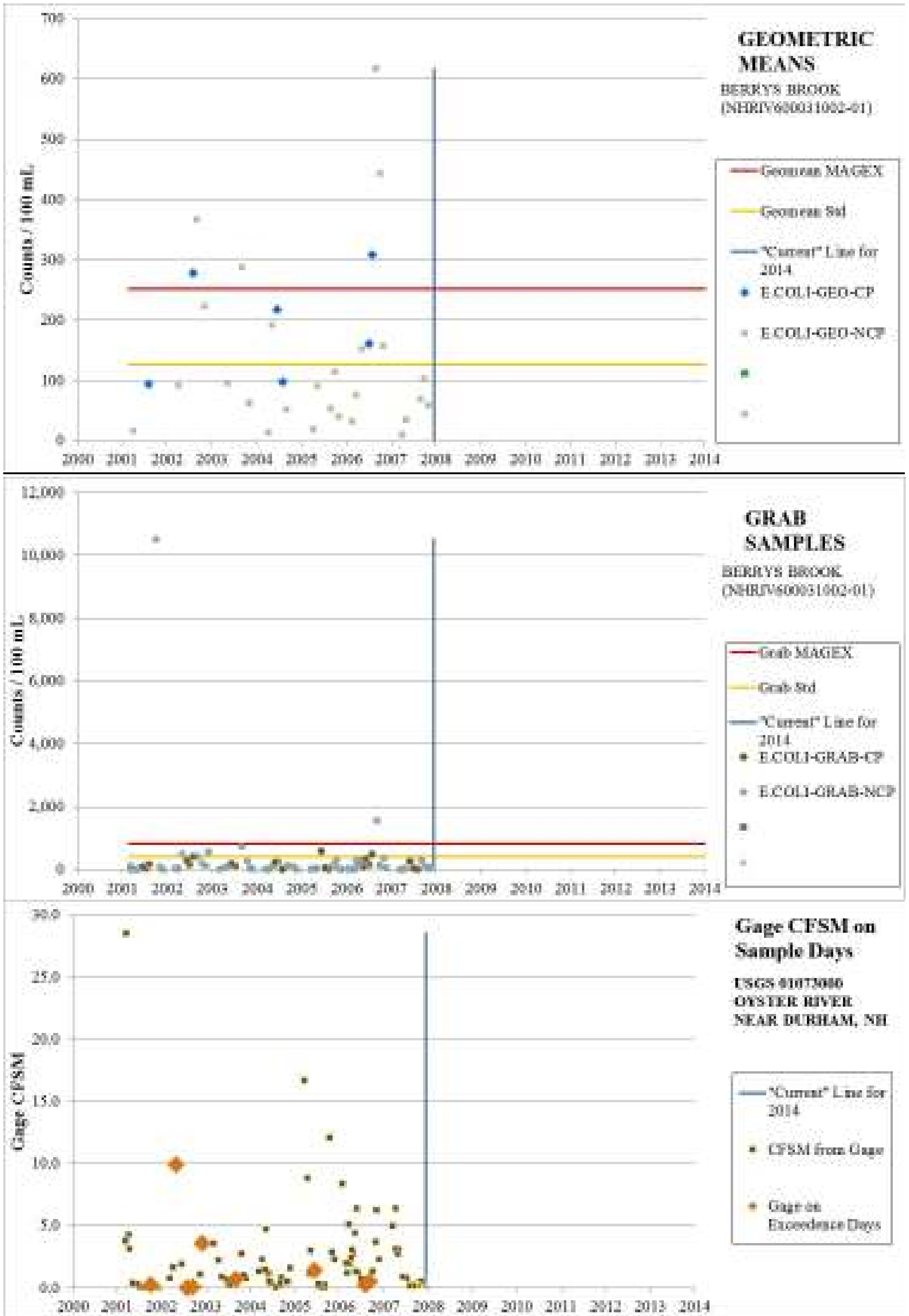
ENTEROCOCCUS-GRAB-NCP = Enterococcus grab samples collected outside the summer critical period.

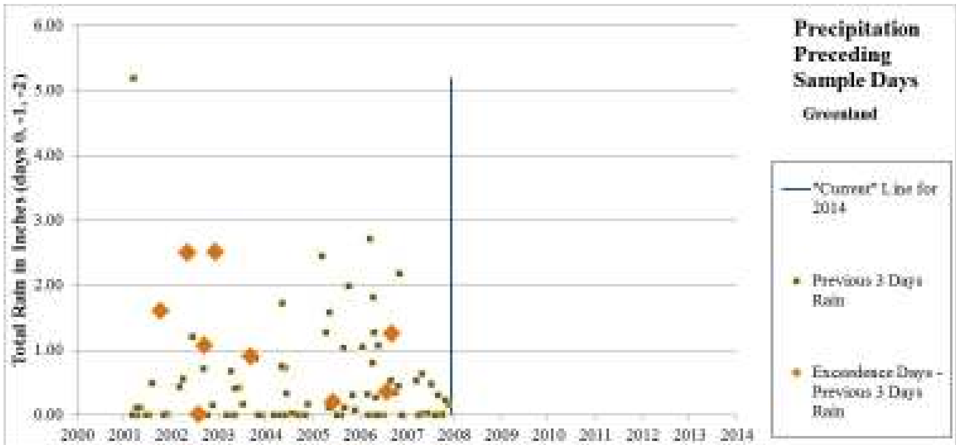
***DES RESPONSE* to 9- 5**

The sampling station used in the assessment process is 05-BER, Berrys Brook at Sagamore Ave Bridge. 05-BER was sampled by the NHDES Ambient Rivers Monitoring Program up through 2007 at which time funding was reduced and sampling at that station stopped. Resampling of 05-BER and additional bracketing work to help detect the source areas would be a wise management decision but one for which there is no current funding source. Evaluation of the older data reveals that exceedences occurred under both high and low inflow periods and under both rain event and dry periods. As such, resampling should occur under a range of weather and flow conditions.

(see also the response to **9- 3**)

Figure 33. Berry's Brook (NHRIV600031002-10) bacteria samples, representative river flow, and preceding precipitation.





Notes:

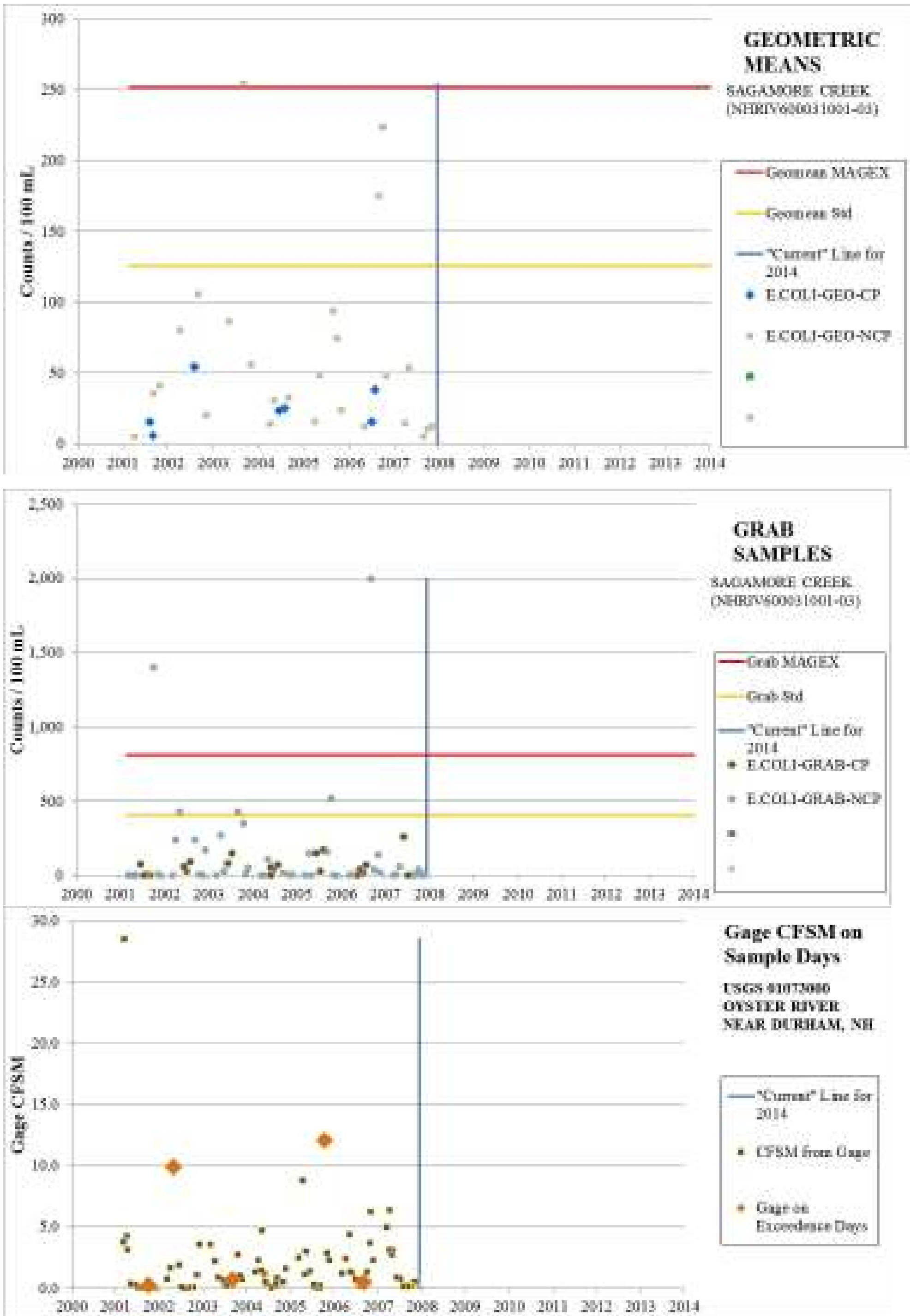
"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.
E.COLI-GEO-CP = Escherchia coli geometric mean calculated from samples collected during the summer critical period.
E.COLI-GEO-NCP = Escherchia coli geometric mean calculated from samples collected outside the summer critical period.
E.COLI-GRAB-CP = Escherchia coli grab samples collected during the summer critical period.
E.COLI-GRAB-NCP = Escherchia coli grab samples collected outside the summer critical period.

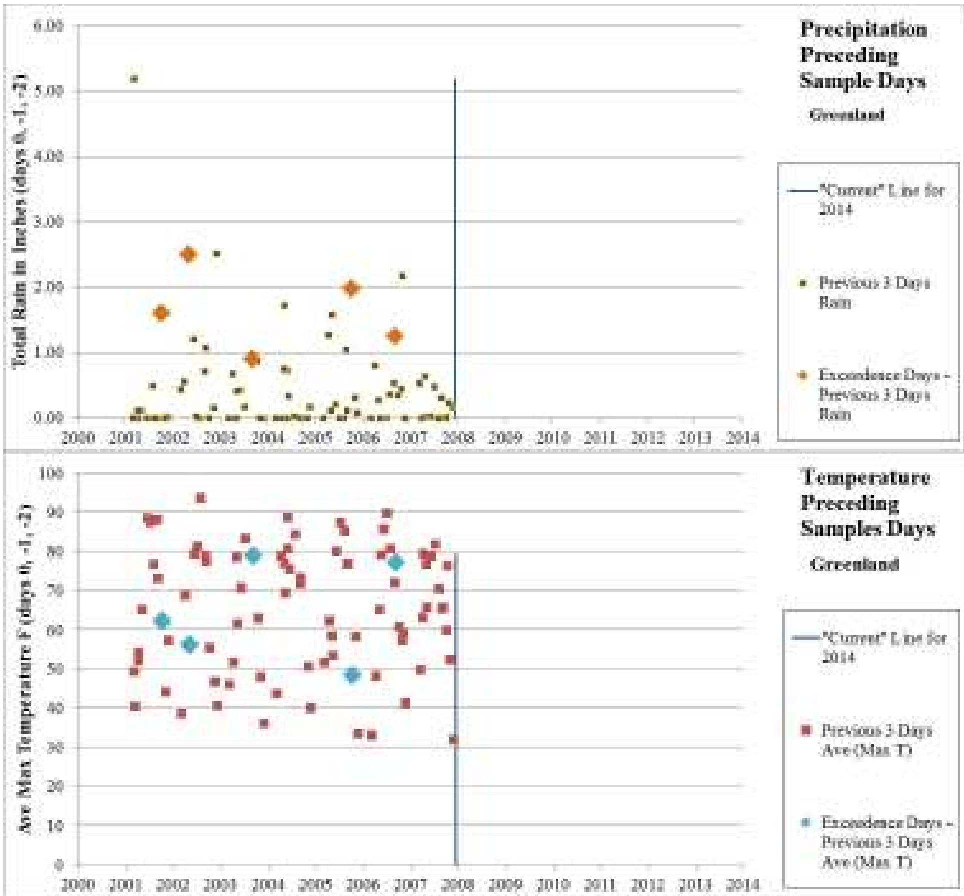
***DES RESPONSE* to 9- 6**

The City of Portsmouth commented that the listing data for Sagamore Creek (NHRIV600031001-03) do not rise to a frequency of criteria exceedences that should result in impairment.

Based on Portsmouth's cited measurements, it is not clear if the correct data was evaluated by the City of Portsmouth. Based on the data available to NHDES (and the public via the NHDES online mapping tool) for Sagamore Creek (NHRIV600031001-03), all data is from station 05-SAG (Sagamore Creek at Peverly Hill Road). On a pure percentage of samples, there do not appear to be many exceedences. However, the examination of exceedences in the context of rain in the previous three days yields a different conclusion. All exceedences follow rain events and most rain events lead to criteria exceedences. 05-SAG was sampled by the NHDES Ambient Rivers Monitoring Program up through 2007 at which time funding was reduced and sampling at that station stopped. Resampling of 05-SAG and additional bracketing work to help detect the source areas following rain events would be a wise management decision but one for which there is no current funding source. (see also the response to 9- 3)

Figure 34. Sagamore Creek (NHRIV600031001-03) bacteria samples, representative river flow, preceding precipitation, and preceding temperature.





Notes:

"Current" Line for 2014 = Per the methodology outlined in the CALM, all data from this referenced data is considered 'current' unless. Available older data is provided for context. See the 2014 CALM for addition details.

E.COLI-GEO-CP = Escherchia coli geometric mean calculated from samples collected during the summer critical period.

E.COLI-GEO-NCP = Escherchia coli geometric mean calculated from samples collected outside the summer critical period.

E.COLI-GRAB-CP = Escherchia coli grab samples collected during the summer critical period.

E.COLI-GRAB-NCP = Escherchia coli grab samples collected outside the summer critical period.

B. RESPONSE TO PUBLIC COMMENT ON THE FEBRUARY 3, 2017 CHANGES

RESPONSE TO COMMENT #10 (on Feb. 3, 2017 Changes): John B. Storer, City of Rochester

DES RESPONSE **to 10- 1**

This section predominantly contains opening remarks by the City of Rochester, the exception being their inclusion of footnote1. The commenter disagrees with the term "delisting" to describe the new assessment status of certain assessment zones for total nitrogen. This is the appropriate term because the methodology for assessment has changed. The 2012 listings were appropriate to the methodologies available at the time. Since that time, the use of numeric translators for total nitrogen has been discontinued because a peer review (Bierman, Diaz, Kenworthy, & Reckhow, 2014) determined that the development of those translators failed to take confounding variables in account (also see (NHDES, 2015)). The 2014 assessment methodology yields, in some cases, a different result than the 2012 assessment methodology, thus, NHDES has proposed to "delist" (per 40 CFR 130.7(b)(6)) those assessment zones for total nitrogen based on the new methodology (also see response to 12- 3).

DES RESPONSE **to 10- 2**

This section summarizes the City of Rochester's major comments on the Cocheco River. See Response to 4- 5, 4- 6, 4- 9, 11- 7, and 11- 12.

DES RESPONSE **to 10- 3**

This comment includes several helpful suggestions regarding the Cocheco River for NHDES to take into consideration. The final document has been changed to reflect many of these suggestions. The commenter also recommends that the total nitrogen status be changed from the proposed category Insufficient Information-Potentially Not Supporting to Category 1 - Attaining all designated uses and no use is threatened. This would be inappropriate given the measured peak chlorophyll-a measurements, high total nitrogen levels in the water, occasionally low dissolved oxygen concentration, and determination from the 2014 peer review that nitrogen is an important factor in the health of the estuary, if not the primary factor. While the peer reviewer concluded that the analysis was not sufficiently robust enough to set a single total nitrogen number for the estuary, they repeatedly stated that nitrogen is an important factor in the health of the estuary (Bierman, Diaz, Kenworthy, & Reckhow, 2014).

- Pg 12, Kenworthy, "…empirical research and modelling studies published in the scientific literature clearly demonstrate that one of the primary symptoms of nitrogen over-enrichment and eutrophication in seagrass systems is the overgrowth of micro- and macroalgae on the leaves of seagrasses (Ralph et al. 2007)"
- Pg 12, Kenworthy, "Eelgrass beds exposed to eutrophication typically exhibit symptoms which include high epiphyte loading."
- Pg 18 Bierman, "Yes, it [nitrogen as related to presence/absence of eelgrass] is an important factor. It is one of the primary factors, not the sole primary factor."
- Pg 18 Diaz, "Yes, overall nitrogen is an important factor for eelgrass growth, but in the context of numeric nitrogen criteria it is the concentration of nitrogen that disrupts the balance of primary producer species that are known to negatively interact with eelgrass (Neckles et al. 1993). With increasing nutrients there is a shift in primary producers from perennial macroalgae and seagrasses toward a dominance of ephemeral macroalgae, epiphytes and phytoplankton (Neckles et al. 1993, Cloern 2001)."
- Pg 26 Diaz, "While declining seagrass in favor of macroalgae or phytoplankton is an all too common response from nutrient driven eutrophication (Burkholder et al. 2007), a causal link between eelgrass and macroalgae in Great Bay is not clear."

- Pg 26 Kenworthy, "It is well documented that the proliferation of ephemeral macroalgae (e.g., Gracilaria and Cladophora spp) from nitrogen enrichment can negatively affect the distribution and abundance of seagrasses in general (McGlathery et al. 2007), and eelgrass in particular (Valiela et al. 1992, Short and Burdick, 1996, Hauxwell et al. 2001, Hauxwell et al., 2003)."
- Pg 48 Reckhow, "Scientific knowledge indicates a causal linkage between TN and DO, due to the growth and decomposition of algae.
- Pg 54, Kenworthy, First of all, there is compelling scientific evidence that eutrophication of estuaries and coastal embayments and loss of eelgrass can be caused by either the loading or delivery of high concentrations of different forms of inorganic, organic, and total nitrogen (e.g., Taylor et al. 1995, Short et al. 1995, Short and Burdick 1996, Kemp et al. 2004, Burkholder et al. 2007, Krause-Jensen et al. 2008, Vaudry et al. 2010, Latimer and Rego 2010, Benson et al. 2013). Several of these studies also make a direct link between nitrogen concentrations, nitrogen loading and water transparency. Likewise, eliminating point source wastewater discharges and reducing nitrogen loading reversed eelgrass losses in a shallow coastal embayment on Long Island Sound, Ct (Vaudry et al. 2010). Lending credence to the argument that nitrogen management can improve water quality conditions (e.g., water transparency) for the protection and restoration (Dennison et al. 1993, Krause Jensen et al. 2008, Vaudry et al. 2010).
- Pg 54 Kenworthy, "DES was correct in considering measurements of water transparency, because it is a very important symptom of eutrophication and one of several factors controlling eelgrass distribution and abundance."
- Pg 60 Bierman, "A caveat to my answer is that improvements in water quality/ecological health in Great Bay Estuary can only be obtained by controlling nutrient loads, not by simply setting numeric nutrient criteria."
- Pg 62 Kenworthy, "There is compelling scientific information that has identified this [addressing nitrogen management and resource protection] problem in many coastal ecosystems, including Great Bay (see citations noted in my responses above)."

DES RESPONSE **to 10- 4**
This section summarizes the City of Rochester's major comments on Great Bay.
See Responses 5- 2, 8- 7, 12- 3, 11- 7, 11- 8, 11- 9 and 11- 11.

DES RESPONSE **to 10- 5**
This comment includes several suggestions regarding the Great Bay. See response to 10- 3, and 11- 7, 11- 8, 11- 9, 11- 10, and 11- 11. The commenter agrees with the NHDES proposed total nitrogen categorization of Insufficient Information – Potentially Not Supporting.

DES RESPONSE **to 10- 6**
This section contains closing remarks, attachment list, and references. No response necessary.

RESPONSE TO COMMENT #11 (on Feb. 3, 2017 Changes): Dean Peschel on the behalf of Great Bay Municipal Coalition

DES RESPONSE **to** 11- 1
The Great Bay Municipal Coalition demands that the "claim of ongoing impairment caused by total nitrogen … must be removed from the 303(d) record." In the 2014 assessment, NHDES has not claimed that the Great Bay or the Cocheco River assessment zones are impaired for total nitrogen. There is nothing to remove since NHDES did not make any such statements.

DES RESPONSE **to** 11- 2
This comment includes many inaccuracies. Staff have neither ignored expert opinions nor abused any scientific knowledge. There are multiple responses throughout this document to the issues described in the comments that clearly respond to all of the expert opinions. Finally, NHDES is not responsible for mandating nutrient reductions. The role of NHDES is to determine the status of the waterbodies relative to water quality standards, not to require any management actions.

DES RESPONSE **to** 11- 3
The commenter notes that NHDES determined that no total nitrogen impairment exists in the Great Bay assessment zone, then suggests that NHDES has determined otherwise. NHDES does not imply in any way that the Great Bay assessment zone is impaired for total nitrogen. On the contrary, NHDES has described in detail that the evidence is not strong enough to determine that it is impaired. See also response to 12- 3.

DES RESPONSE **to** 11- 4
See response in 3- 1, 8- 3, 8- 6
The commenter has misunderstood the way in which NHDES is employing the SMAST methodology. NHDES is not relying on the SMAST approach to reach any conclusions regarding Great Bay total nitrogen assessment status, and NHDES agrees that to use it for that purpose would be inappropriate. SMAST results are shown merely for context. The Massachusetts Bays are the closest estuaries to New Hampshire for which nutrient criteria have been developed and used for assessment purposes. Given their close proximity, it is appropriate to consider the approach. In addition, as noted in Response 3- 1, SMAST was considered based on previous comments from both this commenter and from others. That said, the placement of the SMAST analysis within the assessment summary appears to be confusing, so it has been removed from the summary but remains as part of the response to comments.

DES RESPONSE **to** 11- 5
The commenter incorrectly claims that NHDES has determined that total nitrogen is the cause for eelgrass decline in the Great Bay assessment zone. NHDES makes no such claim. The commenter provides a data graph for Adams Point ostensibly to describe that total nitrogen levels are low and declining. This chart is misleading for two primary reasons. First, as noted in Response 8- 5, Adams Point is located at the extreme edge of the Great Bay assessment unit, and, in fact, the actual sampling point is located in Little Bay. This data would be the "cleanest" (best mixed) part of Great Bay and not indicative of the whole assessment zone. Second, the commenter implies a trend but shows no trend line or statistical analysis of the data. In addition, the chart included data outside the time period of this 2014 303(d) assessment.

DES RESPONSE **to** 11- 6
The commenter incorrectly claims that NHDES has determined that the Great Bay assessment zone is impaired for dissolved oxygen. In fact, NHDES has determined that dissolved oxygen either meets water quality standards or may meet water quality standards. The NHDES statements about poor dissolved oxygen in the southwest part of the Great Bay are substantiated by data from the Squamscott River, which outlets into that part of Great Bay.

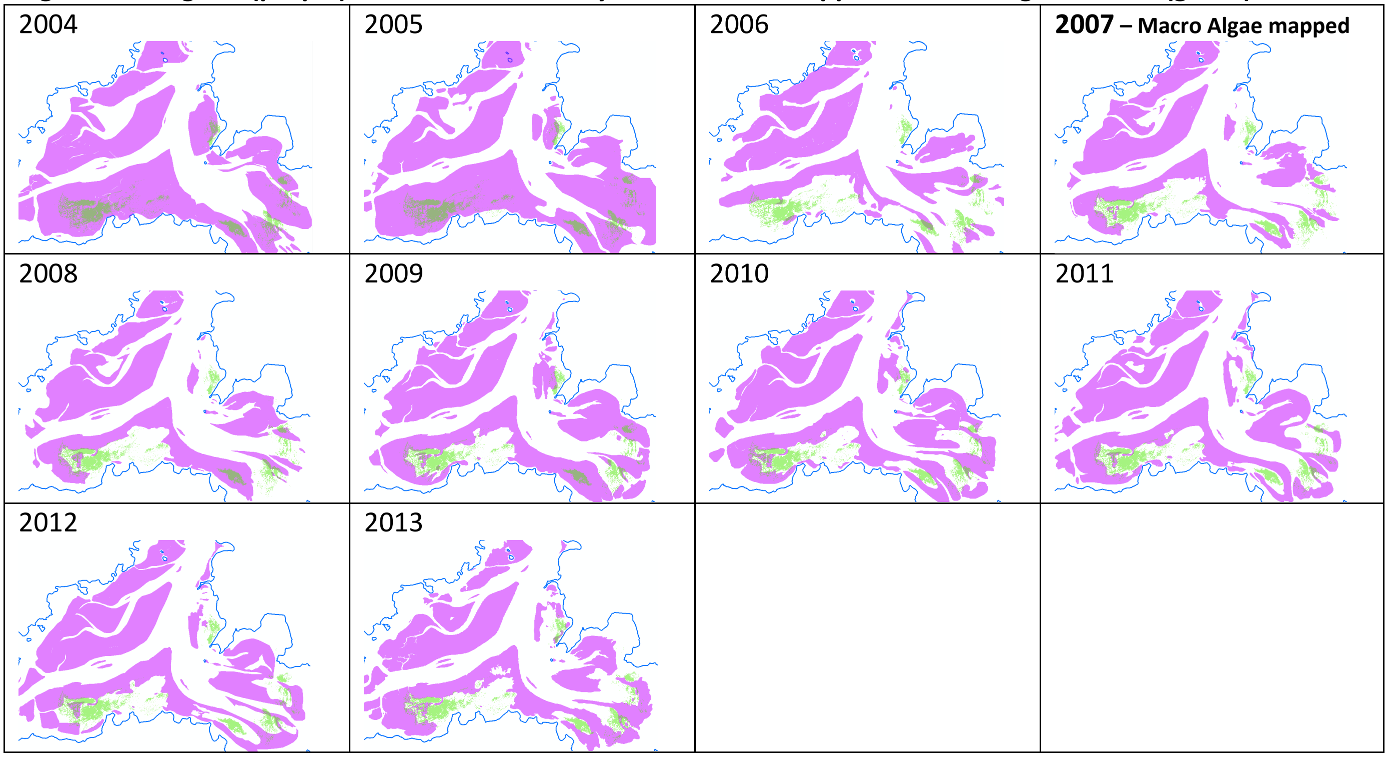
The Squamscott River is impaired for dissolved oxygen. The sampling location for the Squamscott River is on the border of the Great Bay assessment zone (also see response to 8- 5). Given that the water quality does not change instantly from one assessment zone to the next, it logically stands to reason that part of the Great Bay zone also receives low dissolved oxygen water. Once again, this is merely a statement to point out that despite the generally healthy dissolved oxygen levels in Great Bay assessment zone, there remain some reasons to be concerned. These observations bolster the point of the assessment, that despite some potentially nutrient-related effects, there is not enough data to determine that total nitrogen is impairing aquatic life use in the Great Bay assessment zone.

DES RESPONSE **to** 11- 7
The commenter seems to imply that NHDES claims that chlorophyll-a is impacting water clarity in the Great Bay assessment zone. NHDES did not make that assertion. Per the CALM, NHDES is utilizing a weight of evidence approach based on the independent eutrophication variables identified in Section 9. As noted in response to 12-3, NHDES looked at each of those variables and if another eutrophication variable other than eelgrass and light attenuation were impaired, then total nitrogen was clearly implicated. Otherwise, again as noted in other responses, the documentation of some effect does not necessarily rise to the level of impairment unless there is clear and convincing evidence to the contrary. In the case of the Great Bay assessment zone, NHDES did not find that clear and convincing evidence exists and determined that that no total nitrogen impairment exists.

DES RESPONSE **to** 11- 8
The commenter raises an interesting point about available light attenuation. As noted both in the quotes by staff and other experts, it is unlikely that eelgrass in the shallow areas of the Great Bay assessment zone are much impacted by the documented low light availability by the poor water transparency. This is true because the eelgrass leaves are often at the water's surface at low tide. Whether the same phenomena are true in deeper areas of Great Bay is speculative, as noted in Response 8- 7. Based on the data presented in the draft 303(d) list and comments received on the list, NHDES does not, at this time, have robust information linking total nitrogen to light attenuation or eelgrass loss in the Great Bay assessment zone. It should be noted that the amount of chlorophyll-a data is limited in its temporal (mainly grab samples) and spatial (most grab samples are taken at relatively well-mixed locations) extent, which vastly complicated the analysis. Finally, the commenter appears to be making the case that the entirety of system-wide poor light condition is a completely natural phenomena. Aside from algal issues, given the trends in total suspended solids (TSS) at the head-of-tide sampling stations (PREP, 2013), it is unlikely that humans do not play at least some role in light attenuation.

DES RESPONSE **to** 11- 9
The commenter notes that no studies "have demonstrated macroalgae are causing a significant loss of eelgrass in this system." NHDES does not contest this statement. The issue at hand is, "What is significant?" NHDES identified a study that showed that 5.7% of eelgrass had been replaced by macroalgae and eelgrass has not returned to that area (Figure 35). NHDES made no statement that amount was considered significant. The deposition quotes provided by the commenter focus on the Squamscott, Lamprey, and Piscataqua Rivers not on the Great Bay assessment zone, and thus are irrelevant. Finally, as noted in the response to 12- 3 and other responses above, NHDES does not claim that total nitrogen is making such changes in macroalgae as to render it an aquatic life use impairment. The issue of macroalgae is addressed because it is part of the weight of evidence approach documented in the CALM at 9i. NHDES identified all of the evidence that could potentially be used to determine the impairment of Item 9e Macroalgae Indicator. NHDES determined that the evidence was not robust enough to determine impairment. In order to reduce confusion over this issue, NHDES has changed some of the language relative to macroalgae as it relates to the Great Bay assessment zone.

Figure 35. Eelgrass (purple) 2004 to 2013 overlayed with areas mapped as macroalgae in 2007 (green).



DES RESPONSE **to** 11- 10

Given the nature of the narrative standard for nutrient impact to aquatic life, expert opinions and judgment are often necessary to make a final determination. Dr. Mathieson is the foremost authority on macroalgae for this estuary. He has over 50 years of experience and observations. His statements are considered in the analysis to be important and worthy of consideration. Dr. Arthur C. Mathieson's comments on the draft 2012 303(d) framed the epiphyte condition when he wrote,

> "Extensive epiphytic growths of seaweeds on eelgrass (*Zostera marina*) have also occurred during the past 15-20 years, particularly within Great Bay proper (pers. obs. A C Mathieson). These epiphytes, which are mostly filamentous red algae and colonial diatoms, may completely cover the fronds of eelgrass, limiting the host's growth and photosynthesis and compromising its viability."

However, there is not enough evidence to suggest that epiphyte growth is wholly related to nutrient levels. Given this concern, but lack of data about epiphytes, the language has been removed from the assessment status description, but supports the notion of a nitrogen "signature."

DES RESPONSE **to** 11- 11

Statements about nitrogen levels in the past are highly speculative (also see 8- 5). Total nitrogen data has only been collected since 2003, and that data does not show a significant trend. That said, it is clear that the communities around Great Bay are making strides in reducing the nitrogen effluent from their wastewater treatment plants. During the time that the total nitrogen data were collected (2003-2013) for this assessment, the only plants that were making reductions were Rochester and Durham. Since that time, the Dover (2015) facility began making reductions and we expect that, with time, the reductions from the Newmarket (2017), Exeter (2018) and Portsmouth (2019) facilities will present themselves in the data. The commenter suggests that NHDES should determine that the assessment status for Great Bay should be Insufficient Information-Potentially Not Supporting. NHDES agrees with this total nitrogen conclusion.

<u>DES RESPONSE</u> **to** 11- 12

See also Responses 4- 5, 4- 6, 4- 9

The primary comment about the Cocheco River Assessment Zone is about the use of SMAST. Please see Response 11- 4 above. As noted there, the discussion of SMAST will be clarified and remains in the response to comments. NHDES disagrees with the commenter's assertion that the final assessment status of this assessment zone should be "fully supporting" for total nitrogen. There are many reasons, as articulated in the draft, to be concerned and that additional study is needed before making that determination (also see response to 10- 3).

RESPONSE TO COMMENT #12 (on Feb. 3, 2017 Changes): Tom Irwin, Conservation Law Foundation

DES RESPONSE **to** 12- 1
This section contains opening remarks by the Conservation Law Foundation (CLF). No response is necessary.

DES RESPONSE **to** 12- 2
The commenter agrees with the changes to the Lamprey River-South assessment zone. No response is necessary.

DES RESPONSE **to** 12- 3
See Response 5- 2.
The commenter asserts that the draft 303(d) demonstrates that total nitrogen is causing an aquatic life use impairment. NHDES notes that total nitrogen is higher than background and that a nitrogen "signature" is apparent, however, this does not demonstrate an impairment of aquatic life use in this assessment unit as a result of total nitrogen. The fact the nitrogen exists and may have documented effects in a waterbody does not automatically mean that the waterbody is impaired. The narrative criteria for nutrients (Env-Wq 1703.14(b)) states,

> "Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring."

The CALM clearly describes that for total nitrogen assessments, "The assessment zone appropriate weight of evidence shall apply." (Indicator Part 9i, p. 69). NHDES has determined that the weight of evidence does not support impairment given that the only other impairments per the CALM from Indicator Parts 9a-9h (pp. 66-69) are eelgrass loss and light attenuation. At this time, there is no direct numeric linkage between eelgrass loss and total nitrogen, or between light attenuation and total nitrogen. Therefore, the required linkage between nutrient concentration and impairment of a designated use has not been established.

NHDES determines that an impairment exists for total nitrogen when eelgrass is impaired and at least one other eutrophication criteria (DO saturation, DO concentration or chlorophyll-a) is also impaired. The language in the CALM has been clarified on this point. The commenter notes that epiphytes have been identified anecdotally as a potential issue and that macroalgae has also been documented as present in the system. Again, the documentation of these issues is not robust enough to determine if these observed effects are: a) great enough to impair aquatic life use, and b) related to excess total nitrogen in the waterbody. For these reasons, NHDES has determined that not enough data exists to link total nitrogen to those effects. However, there remains the potential that it could be happening which is why the assessment zone has been assessed as Insufficient Information – Potentially Not Supporting.

The commenter also makes the statement that NHDES cannot use the "court settlement" as a reason for de-listing. The commenter has misread this as a rationale. NHDES is not using the court settlement as a reason for delisting, we are merely noting that since that settlement occurred, a different methodology for assessing total nitrogen is being employed. Changing methodology is a rationale for delisting (also see response to 10- 1). In fact, EPA's database for tracking assessments includes in its delisting reason codes, "according to new assessment method." The previously employed numeric thresholds where shown by a peer review (Bierman, Diaz, Kenworthy, & Reckhow, 2014) to be scientifically unsupportable for not taking confounding variables into account, and thus have been withdrawn until there is a better understanding of those variables. NHDES agrees with the commenter that the peer review also found that total nitrogen plays an important role in the health of the estuary (see response to 10- 3), however, we do not have robust enough data at this time to set numeric thresholds to determine how much total nitrogen is necessary to cause an aquatic life impairment.

DES RESPONSE **to** 12- 4
The commenter makes essentially the same points about the Cocheco River as the Great Bay assessment zone. Please see response to 12- 3.

DES RESPONSE **to** 12- 5
This section contains closing remarks and attachments. No response necessary.

RESPONSE TO COMMENT #13 (on Feb. 3, 2017 Changes): Ricardo Cantu, OspreyOwl Environmental, LLC on behalf of the City of Nashua and on behalf of OspreyOwl Environmental, LLC

DES RESPONSE **to 13- 1 and 13- 2**

Ricardo Cantu of OspreyOwl Environmental, LLC provided two sets of comments. One set on the behalf of the City of Nashua and a second set on the behalf OspreyOwl Environmental, LLC. All of the comments relate to waterbodies other than the three for which comments were solicited. No response is necessary.

RESPONSE TO COMMENT #14 (on Feb. 3, 2017 Changes): Ralph Abele, EPA Region 1

<u>DES RESPONSE</u> **to 14- 1**

Ralph Abele on behalf of EPA Region 1 provided a late comment acknowledging the changes made by NHDES, the request for public comments, and EPA’s intent to review the information as part of their obligation to approve or disapprove NHDES’ final decision. No response is necessary.

C. GREAT BAY EELGRASS DEPTH ANALYSIS

MEMORANDUM

To: Ken Edwardson, DES

From: Matthew A. Wood, DES

Date: April 15, 2016

Re: **Great Bay Eelgrass Depth Analysis**

Purpose

The purpose of this memorandum is to document the results of a depth analysis conducted on mapped eelgrass beds in Great Bay between 1990 and 2013, using 2009 bathymetry data collected by UNH.

Bathymetry Data Acquisition

Per the University of New Hampshire (UNH) metadata, bathymetry data was gathered for research purposes by the UNH, Center for Coastal and Ocean Mapping. Bathymetric surveys were conducted over a five month period in 2009using a combination of three survey vessels equipped with single beam echosounders and differential GPS receivers. Two systems were mounted off the port railing of 16-17 foot, flat-bottomed Carolina Skiffs with 20 or 50 Hp outboard motors. The echosounders were 50/200 khz dualfreq, one a Knudson 320BP and the other an Odom CV-200 each sampled at 20 hz. The onboard GPS receivers were Trimble 5700 sampled at 1 hz RTK with transmitted corrections originated from a base station located on the rooftop of Jackson Estuarine Laboratories (JEL). The data were collected at 20 hz and processed using the Hypack software suite. The third system was the Coastal Bathymetry Survey System (CBASS), consisting of a dual-transducer 192 khz single beam echosounder sampled at 17 hz, Sokkia 2300 GPS receiver (and base station also located on the JEL rooftop) post-processed at 5 hz, and custom navigation, data acquisition, and processing system (Lippmann and Smith, 2009). Surveys were intermittently conducted by the three vessels from June-November 2009 along prescribed transect lines separated by 25-100 meters, as well as orthogonal cross lines separated by 300 m. Inter-comparisons between filtered survey data from all three systems showed a mean offset of less than 3 cm and 28 cm RMS differences for all overlapping data within a 0.5 m horizontal radius when the time between data points was less than 1 day.

For questions related to the data acquisition or to request a copy of the bathymetry dataset contact Chris Nash, DES Shellfish Program Coordinator at (603) 559-1509.

GIS Processing of Bathymetry and Eelgrass

Bathymetry

The 2009 UNH bathymetry points were converted to a 50-foot point grid as follows:

1. Converted the 2009 Great Bay bathymetry GIS file (points) from meters referenced to Mean Lower Low Water (MLLW) to feet referenced to Mean Tidal Level (MTL). Both the original dataset and the

converted values are referenced to datum for station 8423898, Fort Point NH (http://tidesandcurrents.noaa.gov/datums.html?id=84238980).

2. Using ArcGIS 3D Analyst, a Triangulated Irregular Network (TIN) was created of the bathymetry.
3. The TIN was then converted to a raster using a 50 foot cell size.
4. The raster was then converted to points in order to derive a cell centroid with a particular depth tied to it.

Functionally, the processing took depth measurements that were irregularly spaced throughout Great Bay and made them symmetrical through a process that included averaging depths between the original observation points (Figure 1 both panels).

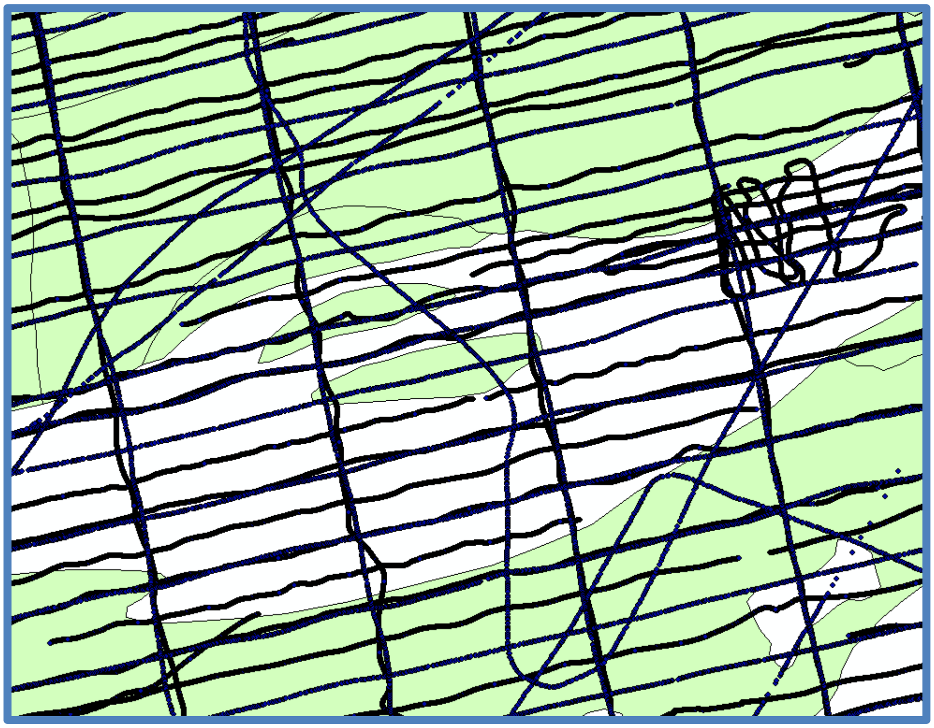
Eelgrass Depth

DES used the aforementioned bathymetry dataset to derive eelgrass depths in Great Bay proper for 1990 through 2013. The steps for determining eelgrass depth included the following:

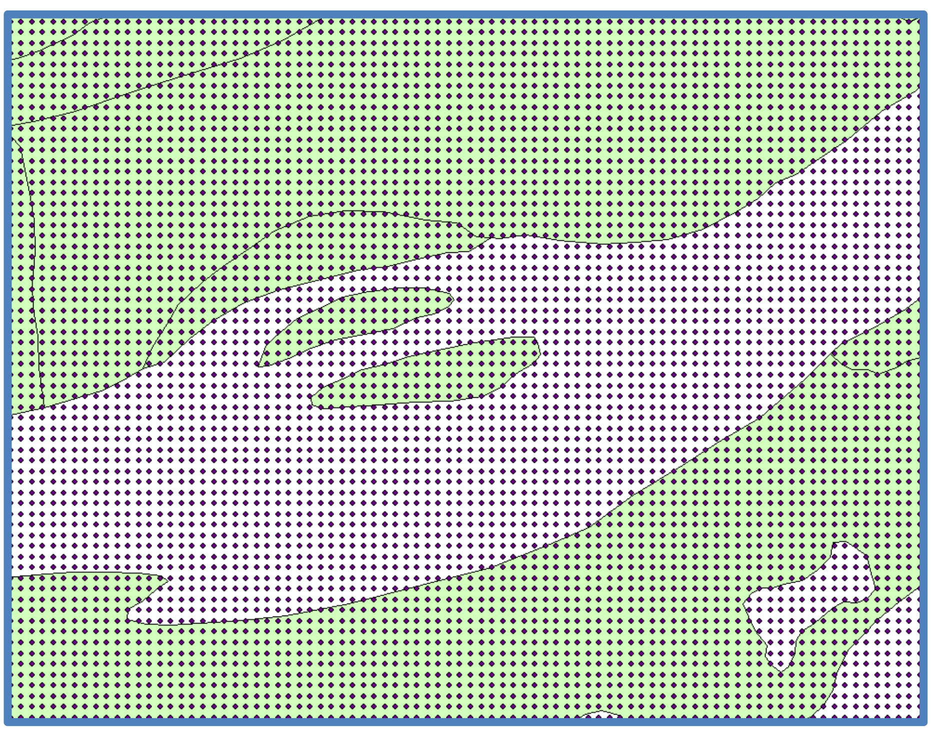
The bathymetry points derived as described above were used to intersect each of the 1990 - 2013 eelgrass GIS files. This process produced an array of depths where eelgrass was mapped in a particular year (Figure 1 lower panel).

Figure 1: Visualization of process to convert raw depth points to equally spaced depths (green is eelgrass).

Original Raw Depth Points



Depth Points Post-Processing



Charting Eelgrass Depth Data Over Time

Once the depth information was compiled for each of the mapping years, the depths were summarized into three depth regimes. These categories were derived by updating Table 9 from the 2009 DES Report ("Numeric Nutrient Criteria for the Great Bay Estuary") with more recent data for light attenuation from 2008-2013. This table uses a method from Koch (2001) to estimate the minimum (Z_{min}) and maximum (Z_{max}) depths for eelgrass survival, assuming that 22% of incident light is required for survival (EPA, 2003) (Table 1).

Table 1: Estimate of the minimum and maximum depths for eelgrass survival.

Assessment Zone	Kd (m^{-1})		Depth (m MTL)		
	N	Median	Z_{min}	Z_{max}	Z_{min}-Z_{max}
GREAT BAY	173	1.18	-1.00	-1.3	0.3

From the light attenuation and eelgrass depth analysis, three depth ranges are relevant to evaluate the impact of the measured light attenuation.

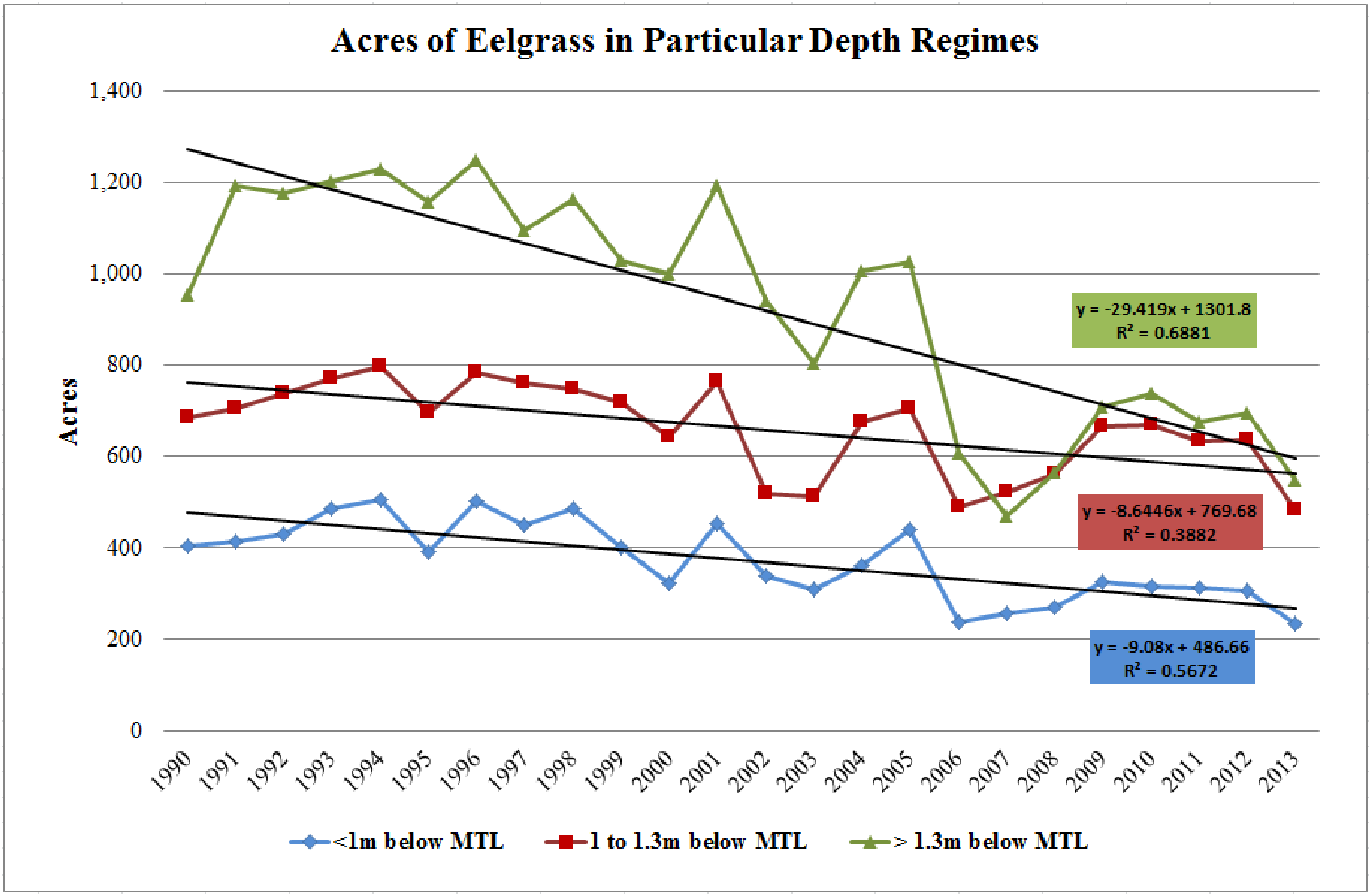
1. Less than 1 meter below MTL – Intertidal zone.
2. Between 1 and 1.3 meters below MTL – Sub-tidal zone with acceptable light anticipated.
3. Greater than 1.3 meters below MTL – Sub-tidal zone with unacceptable light anticipated.

Because each depth point represents the centroid of a 50 foot cell, the data could be converted to an acreage value. This was accomplished by counting the number of points in each depth category. That count was then multiplied by the square footage (2,500 ft^2) and then converted to acres. Those acreages were then plotted by year (Figure 2) and regression analyses were conducted (summarized in Table 2).

Table 2: Great Bay eelgrass depth regime trend statistics, 1990 to 2013.

Depth Regime	**<1m below MTL,** Intertidal zone	**1 to 1.3m below MTL,** Sub-tidal zone with acceptable light anticipated	**> 1.3m below MTL,** Sub-tidal zone with unacceptable light anticipated
Regression Significance (p)	2.17E-05	1.15E-03	5.42E-07
Regression Coefficient R^2	0.57	0.39	0.69
Trend Significance (p)	2.17E-05	1.15E-03	5.42E-07
Trend Slope (acres/yr)	-9.1	-8.6	-29.4
Trend Slope (Percent change 1990-2014)	-25.0%	-10.0%	-30.9%

Figure 2: Acres of eelgrass in Great Bay over time in depth regimes relative to 2009 based bathymetry.



References

Koch, Evamaria W. 2001. Beyond Light: Physical, Geological, and Geochemical Parameters as Possible Submersed Aquatic Vegetation Habitat Requirements. Estuaries Vol. 24, No1, p1-17. February 2001.

New Hampshire Department of Environmental Services. 2009. Numeric Nutrient Criteria for the Great Bay Estuary. WD Doc R-WD-09-12. Watershed Management Bureau, Concord, NH. June 2009. Published Online
http://des.nh.gov/organization/divisions/water/wmb/wqs/documents/20090610_estuary_criteria.pdf.

US Environmental Protection Agency. 2003. Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for Chesapeake Bay and its Tidal Tributaries. EPA 903-R-03-002. U.S. Environmental Protection Agency, Chesapeake Bay Program Office. Published Online
http://www.epa.gov/Region3/chesapeake/baycriteria.htm.

D. PUBLIC COMMENT ON THE DRAFT 2014 SECTION 303 (D) LIST

COMMENT #1: Toby Stover, EPA Region 1

From:	Stover, Toby <Stover.Toby@epa.gov>
Sent:	Monday, December 07, 2015 10:16 AM
To:	DES-303d Comment
Subject:	2014 303d comment

Hi Ken,

EPA Region 1 submits the following comment on the 2014 303d list:

Thank you for the opportunity to review New Hampshire's draft 2014 303(d) list. EPA has carefully reviewed the draft list and has the following comment: EPA highly recommends that NHDES develop an assessment and listing methodology to address cultural eutrophication in freshwater streams and rivers that will compliment NH's narrative nutrient water quality standards. Excess phosphorus and nitrogen have detrimental effects on aquatic life and threaten drinking water sources and recreational opportunities. EPA is aware of conditions that have been documented in the Cocheco and Salmon Falls Rivers where total phosphorus exceeds EPA Gold Book Water Quality values and EPA recommended ecoregion thresholds to prevent cultural eutrophication. There have also been documented violations of the dissolved oxygen water quality standards for both concentration and percent saturation in both rivers. Heavy macrophyte and algae growth has also been documented in the Cocheco River which is indicative of excess nutrient inputs. EPA recommends an approach that incorporates numeric values for phosphorus and nitrogen in combination with appropriate response variables such as dissolved oxygen, pH, chlorophyll-a, macroinvertebrates, macrophyte/algae coverage, water clarity, etc. EPA recommends that NHDES develop this methodology as soon as possible so that this methodology can be incorporated into the next 303(d) assessment and listing cycle. **1- 1**

Toby Stover
Water Quality Branch
US EPA Region 1
5 Post Office Square, Suite 100 (OEP06-2)
Boston, MA 02109-3912
Tel: 617-918-1604
Fax: 617-918-0604
Email: stover.toby@epa.gov

COMMENT #2: Don Witherill, Maine Dept. of Environmental Protection

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

AVERY T. DAY
ACTING COMMISSIONER

December 11, 2016

Ken Edwardson
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive, P.O. Box 95
Concord, New Hampshire 03302-0095

RE: Comments on NH's Draft 2014, 303(d) List

Dear Mr. Edwardson,

Staff from the Maine Department of Environmental Protection has completed its review of New Hampshire's draft 2014 303(d) List of Impaired Surface Waters and the accompanying List of Impairments Removed from the 303(d) List. We focused our review on cross-border waters and have the following comment:

2- 1

The NHDES document, "Impairments Removed (i.e. Delisted) from the 303(d) List of Threatened or Impaired Waters (i.e. Category 5)" indicates on p. 45 that "The eelgrass beds are severely degraded" but does not address magnitude of historical change or supporting information that would precipitate a delisting. The NHDES 2014 CALM indicates on p. 64, Indicator #8 that loss of historical eelgrass cover in excess of 20% or a decreasing trend that shows a loss of 20% of the resource would result in an impaired listing as designated by the term "Estuarine Bioassessments". On p. 65, DES may also consider supplemental information such as declines in eelgrass biomass and/or proliferation of macroalgae. Based on this cited CALM language and at least aerial survey data compiled through 2012, we are wondering if there is sufficient evidence to suggest that eelgrass (Estuarine Bioassessments) is impaired within the Portsmouth Harbor assessment unit (NHEST600031001-11).

In Maine's 2012 303(d) list, a determination was made to list the assessment unit corresponding to NHEST600031001-11 for Marine Life Use Support, Cause Unknown, due to >20% areal cover loss of eelgrass from 1996 to 2010. This 2012 Maine listing was likely based on the same areal information used by DES and therefore comparable eelgrass declines on both sites of the Harbor might reasonably be expected.

Sincerely,

Donald T. Witherill, Director
Division of Environmental Assessment
Bureau of Water Quality

Copy provided: Jennie Bridge, EPA Region 1

COMMENT #3: Ralph Abele, EPA Region 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

December 11, 2015

Ken Edwardson
New Hampshire Department of Environmental Services
Water Division
29 Hazen Drive, Box 95
Concord, NH 03302-0095

Re: New Hampshire's 2014 Draft 303(d) List

Dear Mr. Edwardson,

Thank you for the opportunity to review New Hampshire's draft 2014 303(d) list. By this letter, we intend to alert you to questions and concerns we have about whether the administrative record would support the State's proposal not to list certain water body segment/impairment combinations in the Great Bay Estuary. This letter is not intended to be our final communication with you about your entire draft 2014 303(d) list, but we wanted to convey our concerns about the state's proposal not to list certain segments in the Great Bay Estuary within the established public comment period. We hope to continue to work with your office on these issues before New Hampshire finalizes its 2014 list and submits it to EPA for review and approval or disapproval. **3- 1**

As you know, we approved New Hampshire's 2012 303(d) list on September 24, 2015, including the State's listing of many of the water body segment/impairment combinations in the Great Bay Estuary. EPA's technical support document explained our rationale for approving those particular listings, and our analysis was based on the data and other available information contained in New Hampshire's administrative record. Based on our analysis of the information available to us at this time, including New Hampshire's administrative record for its 2012 303(d) list and the information you provided to us along with the State's draft 2014 303(d) list, we have substantial questions about whether the administrative record provides an adequate basis for the proposal not to list certain Great Bay Estuary segment/impairment combinations.

We would like to work with your staff to better understand the State's rationale for the proposal not to list and to discuss our understanding of the science. Please contact me at 617-918-1629, or have someone from your staff contact Toby Stover at 617-918-1604, so that we may better understand the State's basis for the proposal not to list the waters, with the goal of working out any concerns before New Hampshire finalizes its 2014 303(d) list and submits it to EPA for review and approval or disapproval.

Sincerely,

Ralph W. Abele
Chief, Water Quality Branch

COMMENT #4: John B. Storer, City of Rochester

City of Rochester, New Hampshire
PUBLIC WORKS DEPARTMENT
45 Old Dover Road • Rochester, NH 03867
(603) 332-4096 Fax (603) 335-4352

VIA ELECTRONIC MAIL: 303dcomment@des.state.nh.us

December 11, 2015

2014, 303(d) Comments
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive, P.O. Box 95
Concord, New Hampshire 03302-0095
Attention: Ken Edwardson

RE: City of Rochester, New Hampshire Comments on the Draft 2014 303(d) List of Impaired Surface Waters for New Hampshire **4- 1**

Dear Mr. Edwardson:

These comments are submitted on behalf of the City of Rochester, NH (Rochester) to the New Hampshire Department of Environmental Services' (DES) State of New Hampshire DRAFT 2014 Section 303(d) Surface Water Quality List (hereafter Draft 2014 NH 303(d) List) published for public comment on October 14, 2015 by DES, and found at http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm. Rochester appreciates the opportunity to submit these comments.

Introduction/Reservation of Rights

As an initial matter, Rochester notes that its comments principally concern the proposed 2014 303(d) listings for the Cocheco River along its entire length and extending into the Great Bay Estuary. In addition, these comments concern certain additional waters that remain on the 303(d) list based on old data. Finally, these comments address and correct for the record, certain comments by the Environmental Protection Agency (EPA) as set forth in Attachment A to its letter, dated September 24, 2015, approving NH's 2012 303(d) list, particularly with respect to the significance of the February 13, 2014 Joint Report of Peer Review Panel and the requirements of the March 2014 Settlement Agreement between DES and the Cities of Portsmouth, Rochester and Dover relating to the use of numeric nutrient thresholds in DES's water quality assessments of the Great Bay Estuary.

Rochester is also participating in the Great Bay Municipal Coalition's (Coalition) comments in response to the Draft 2014 NH 303(d) List submitted under cover letter from the Sheehan Phinney law firm, dated December 11, 2015 to the extent the comments relate to matters of common interest and concern. The comments set forth below are in addition to such comments submitted by the Coalition. **4- 2**

Rochester notes that it has discharges to the Cocheco River and the other water bodies listed above, both from its wastewater treatment plant and from its Municipal Separate Storm Sewer System (MS4) that will be significantly and negatively impacted by portions of the Draft 2014 NH 303(d) List. Rochester therefore has a great deal of concern and uncertainty as to future efforts and costs that will be required of it to comply with any permits that result from such 303(d) listings. Moreover, Rochester believes that such required efforts will impose significant burdens and costs on both Rochester and its citizens, without adequate scientific or legal basis and without any reasonably clear evidence that such burdens/costs will in fact result in any meaningful improvement to the waters into which Rochester discharges and/or downstream waters. **4- 3**

Rochester hereby reserves the right to submit additional/supplemental comments on all or any portions of the Draft 2014 NH 303(d) List to the extent necessary, applicable, and/or allowed by law.

Comments on the 2014 303(d) List

Below are Rochester's individual comments on the Draft 2014 NH 303(d) List.[1] For the reasons stated in these comments, and in the Coalition comments referenced above and submitted under separate cover, Rochester believes that certain of the proposed 303(d) listings are without adequate scientific or legal basis and, in fact, are contrary to available scientific evidence. As such, these listings are arbitrary and capricious and contrary to law. Rochester therefore objects to the issuance of portions of the Draft 2014 NH 303(d) and respectfully requests that the Draft 2014 NH 303(d) List be amended consistent with these comments. **4- 4**

1. *Assessment unit NHRIV600030608-03 should be removed from the 2014 303(d) list for DO saturation*. Segment NHRIV600030608-03 (Cocheco River) is listed as impaired for DO saturation. The available data for the 2014 listing cycle include twelve DO saturation observations, and all twelve were greater than 75 percent. Eight of the twelve samples were collected prior to 10 am, when DO is generally lower than at other parts of the 24-hour cycle. There is no basis in these data for the conclusion that low DO saturation is causing an impairment of the aquatic life use in this segment. We request that DO saturation-based listing of segment NHRIV600030608-03 be removed from the 2014 303(d) list.

2. *Assessment unit NHEST600030608-01 (tidal Cocheco River) should be removed from Category 5 of the 303(d) list with respect to chlorophyll-*a. Segment NHEST600030608-01 is listed as not attaining primary contact uses due to chlorophyll-*a*. However, a review of the underlying data indicates that there is insufficient reliable data for this listing, and the preponderance of the available information indicates that this segment does not experience chlorophyll-*a* concentrations that indicate an impairment of primary contact uses. This position is supported by multiple lines of evidence: **4- 5**

a) *The new listing is driven by a very small number of uncorrected chlorophyll-*a *data*. The 2014 CALM (p. 42) states that "chlorophyll-a concentrations in excess of…20 ug/L in salt water are indicators of excessive algal growth…" The 2014 cycle data include only two chlorophyll-*a* samples in excess of 20 ug/L, out of fourteen total samples collected in this assessment unit. Two is the very minimum number of samples that could result in a listing under the 2014 CALM. However, the parameter that was reported is chlorophyll-*a* uncorrected for pheophytin. It has long been known that pheophytin causes erroneously high measurements of chlorophyll-*a*, and that uncorrected chlorophyll-a measurements can be significantly different from corrected measurements (Vernon, 1960; Radojevic and Bashkin, 2006). As stated in *Standard Methods for the Examination of Water and Wastewater* (Rice and others, 2012):

> Pheophorbide a and pheophytin a, two common degradation products of chlorophyll a, can interfere with the determination of chlorophyll a because they absorb light and fluoresce in the same region of the spectrum as does chlorophyll a. If these pheopigments are present, *significant errors in chlorophyll a values will result* [emphasis added].

For this reason, agencies often require that only "corrected for pheophytin" or "free of pheophytin" methods be employed for regulatory purposes (e.g., Florida Dept. of Env. Protection, 2011). The National Coastal Assessment Programs administered by NHDES also use the correction procedure. Likewise, the USEPA standard method for fluoroscopic chlorophyll-*a* determination (Method 445.0) includes a procedure for correcting the chlorophyll-*a* measurements. For some reason, these were apparently not employed for the data collected in segment NHEST600030608-01 for the 2014 listing cycle, except for a single observation that was <10 ug/L.

If the correction procedure had been employed, the single observation of exactly 20 ug/L would certainly have been shown to be less than 20 ug/L. One or both of the values that were reported as exceeding 20 ug/L may likely also have been corrected to less than 20 ug/L, with the higher likelihood associated with the lower uncorrected value (28 ug/L). Therefore, there is a strong likelihood that, at most, only a single grab sample exceeded 20 ug/L, and the true chlorophyll-*a* concentration of even that sample is not known. Even using the excessively conservative chlorophyll-*a* targets of the 2014 CALM, this would be insufficient exceedances to list segment NHEST600030608-01 on the basis of chlorophyll-*a*.

b) <u>*Continuous monitoring data confirm that chlorophyll-a concentrations were only moderate in this segment*</u>. In addition to the 14 grab samples for uncorrected chlorophyll-*a*, continuous monitoring sondes were also deployed for this segment in July 2012 and July 2013. These data should not be directly used for 303(d) listing purposes due to quality assurance issues. However, the quality assurance issues are primarily related to *overestimation* of chlorophyll-*a*, as evidenced by temporally sporadic outliers that do not conform to realistic algal growth patterns. In this regard, the 2012-13 probe data can provide insights into the chlorophyll-*a* distribution in this segment, with the understanding that they are overestimates. Based on the 2012-13 probe data, relevant statistics for segment NHEST600030608-01 were as follows: **4- 6**

- Median chlorophyll-a: 7 ug/L
- 90th percentile chlorophyll-*a*: 18 ug/L

Thus, even biased-high data from the height of the summer growing season indicate only moderate chlorophyll-*a* concentrations in this segment. Due to the high bias, the actual median and 90th percentile are likely lower than values shown above. Applying the 10% rule as described in the 2014 CALM, even the biased-high data would not result in a listing of the segment for chlorophyll-*a*.

c) *The chlorophyll-*a *targets of the 2014 CALM are inappropriate as indicators of primary contact impairments*. For salt waters, the 2014 CALM identifies 20 ug/L as an indicator of algal growth that interferes with recreational activities, and this value is applied as a not-to-exceed target. We are not aware of any documentation of the technical basis of this value. This is not a promulgated water quality criterion, but seems to have been selected as an arbitrary translator of the narrative nutrient criterion. An examination of more rigorously-derived chlorophyll-*a* targets reveals that the 20 ug/L is ill-founded as an indicator of primary recreation impairments.

One potential mechanism by which algae can impact recreational uses is algal toxins. World Health Organization (WHO) guidelines do not indicate a moderate risk of adverse health effects until chlorophyll-a exceeds 50 ug/L *and* is coincident with cyanobacterial dominance (e.g., >100,000 cells/mL). No data from the 2014 listing cycle exceeded this chlorophyll-*a* level, and there is no basis to conclude that the tidal Cocheco River experienced anything other than benign algal assemblages at any time during the listing cycle. For other upper estuarine systems, it has been acknowledged that mean or upper percentile chlorophyll-*a* concentrations in the 20-40 ug/L range are compatible with full use attainment (Stow and others, 2003; VDEQ, 2005).

Many states have developed chlorophyll-*a* targets with the primary goal of protecting recreational uses of water bodies. The targets vary in magnitude based on waterbody type and ecoregion. Many of these targets are somewhat similar in magnitude to NH's 20 ug/L target, but expressed as *seasonal averages* rather than not-to-exceed values. For example, Arizona, Wisconsin, Oregon, Minnesota, Kansas, Texas, Maryland, Virginia, West Virginia, and other states have adopted recreational chlorophyll-*a* targets in the 15-30 ug/L range for selected water bodies, but all are expressed as seasonal averages. 4- 7

Chlorophyll-*a* tends to be lognormally distributed (Thompson and Emery, 2014), such that even healthy systems will experience occasional high values, and seasonal averages are typically much lower than upper-percentile chlorophyll-*a* values. Accordingly, the use of 20 ug/L as a not-to-exceed value is exceptionally stringent as an indicator of recreational impairment and in reality is not useful for that purpose. The uncorrected grab samples confirm that the seasonal mean chlorophyll-*a* concentration in the tidal Cocheco River was relatively low. We are aware of no reports of aesthetically objectionable conditions in tidal Cocheco, algal mats, user complaints, etc. Hence, there appears to be no evidence of primary contact impairments in this segment.

3. *Assessment unit NHEST600030608-01 (tidal Cocheco River) has favorable DO conditions, and should be placed in Category 2 (fully supporting) with respect to DO concentration and saturation*. According to the Technical Support Document (TSD) that accompanied the draft 2014 303(d) list (DES, 2015), DES has proposed to list NHEST600030608-01in category 3-PNS ("potentially not supporting") for dissolved oxygen concentration. This contradicts the data, which shows this segment fully supporting uses with respect to DO. 4- 8

For the 2014 listing cycle, an unusually large number of DO and pH data are available for the tidal Cocheco River. This included the deployment of continuous monitoring sondes in both 2012 and 2013, as well as numerous grab samples. A total of 102 days of continuous DO readings are available. Overall these data show very good DO and pH conditions. Specifically:

- No grab samples are < 5 mg/L DO
- Only 4 out of 105 daily DO minimum values are less than 5 mg/L, and none are less than 4 mg/L.
- Only 1 of out of 88 DO saturation values are < 75.0% (and that measurement was 74.7%).
- No 24-hour pH maximum values are > 8.5.

Based on these data and the 2014 CALM, the segment should be considered to fully meet uses with respect to DO. DES's designation of this segment in Category 3-PNS is not supported by the very small percentage of minor exceedances, contradicts the requirements of the CALM, and disregards the fact that prevailing DO conditions are very favorable. Continuous monitoring sondes are prone to calibration drift and stray readings, which makes it even more important that a small number of minor sonde-based excursions not outweigh the overwhelming majority of the data for listing purposes.

Although DO and pH are primarily measured to assess attainment of aquatic life uses, they also provide corroborating evidence of the lack of impairment of primary contact uses. That is, if the tidal Cocheco River experienced persistent algal blooms that were sufficient to cause aesthetic or human health problems, this would also be reflected in low DO or elevated pH conditions, especially in 24-hour monitoring data. The lack of such DO and pH problems confirms that the segment did not experience adverse algal conditions.

4. *Assessment unit NHEST600030608-01 (tidal Cocheco River) should be removed from Category 5 of the 303(d) list with respect to total nitrogen*. The draft 2014 303(d) report lists the tidal Cocheco River as impaired with respect to total nitrogen. This listing should be removed based on the lack of evidence of nutrient-related impairments, positive evidence of healthy nutrient dynamics, and DES' own acknowledgment that it lacks an appropriate assessment protocol.

The Technical Support Document states that the indicators of eutrophication in this segment are "mixed" and "ambiguous" (p. 52). Some of the related discussion pertains to DO swings, even though the segment is fully attaining uses with respect to DO. In reality, it appears that the total nitrogen listing is almost entirely dependent upon either one or two uncorrected chlorophyll-*a* samples, which are overestimates of the true chlorophyll-*a* concentration as discussed under comment #2. But as discussed in previous comments: **4- 9**

- Chlorophyll-*a* concentrations were actually moderate, and significantly lower than levels that would cause primary contact impairments (see comment #2).

- DO conditions were favorable and corroborated the lack of adverse algal conditions. (see comment #3).
- pH conditions were favorable and corroborated the lack of adverse algal conditions. (see comment #3).
- There is no evidence of nuisance conditions, user complaints, fish kills, toxic blooms, etc.

Overall, this assessment unit appears to be a productive segment that is capable of assimilating nutrients and supporting moderate algal biomass without harmful effects. It is common for upper estuarine segments to support higher planktonic biomass than lower estuarine segments due to a combination of hydrodynamic and physicochemical factors, including proximity to watershed inputs. This does not equate to impairment unless actual harmful effects occur, and the relatively high flushing rate of the tidal Cocheco River (among other factors) appears to prevent such harmful effects from occurring.

Finally, the listing of segment NHEST600030608-01 for nitrogen is in conflict with the Technical Support Document's (TSD) acknowledgement that DES lacks a reliable assessment methodology for nitrogen in this segment (NH DES, 2014). The TSD does not show the segment in Category 5 for nitrogen, but instead cites the assessment methodology as a work in progress. For this reason, it is unclear as to why the total nitrogen listing appears in the main body of the 303(d) report.

The TSD states that the final assessment of total nitrogen will be delayed until such time as a new approach is determined or the eutrophication indicators are less ambiguous. Although we believe that the available data indicate full support of designated uses in this segment, we concur that DES currently lacks a viable technical basis for correctly identifying nutrient-related impairments in this and similar segments. In particular, the 2014 CALM is excessively stringent with regard to chlorophyll-*a* targets, and is incapable of distinguishing productive (but benign) phytoplankton conditions from true use impairments. Until and unless DES develops a valid methodology, this and similar assessment units should not be placed into Category 5 for total nitrogen.

5. *Assessment unit NHLAK600030602-03 (Rochester Reservoir) should be removed from Category 5M of the 303(d) list with respect to cyanobacteria hepatotoxic microcystins*. The draft 2014 303(d) report lists the Rochester Reservoir as impaired with respect to cyanobacteria hepatotoxic microcystins. This listing appears to be based on an algal condition that was observed briefly more than 10 years ago, and has not since re-occurred. Rochester has found no evidence of cyanobacteria-related problems in its water supply monitoring since 2005. The Reservoir lacks visual evidence of cyanobacteria blooms, and regular monitoring for algae/cyanobacteria (using ALGE-BART cells) have all been negative detects. The water supply experiences no taste and odor issues that might indicate cyanobacteria issues. Moreover, Rochester points out that the reservoir is clearly posted with no trespassing signage and no fishing, boating, swimming, or other activities by the public are allowed. The Reservior is not a recreational water body. In summary, Rochester Reservoir should be removed from Category 5M based on the lack of evidence of impairment, positive evidence that such an impairment is not occurring, and the lack of recreational use. **4- 10**

6. <u>*Segments should not be placed into category 5 based on old data*</u>. Several segments within Rochester appear to have been retained in category 5 based on old data (>5 years). The development and implementation of TMDLs for these waters could represent an enormous cost, based on impairments that might no longer exist. If a segment was previously 303(d) listed but no recent data are available, that segment should be placed in category 3. If a segment was previously listed and recent data indicate attainment, that segment should be placed in category 2. Category 5 listings should only be based on recent data that indicate impairments. Examples of water bodies that appear to have been listed based on old include the following: **4- 11**

- Cocheco River – City Dam (NHIMP600030603-01) – DO concentration
- Cocheco River NHRIV600030603-06—Aluminum and lead
- Isinglass River (NHRIV600030607-10) – DO saturation

We request that DES review the basis of these and other category 5 listings into which Rochester discharges, and ensure that no segments are included in category 5 unless recent data indicates an impairment.

Comments on EPA's Approval of the 2012 303(d) List

On September 24, 2015, more than 1 and 1/2 years after the NH DES submitted its proposed 2012 §303(d) list of water quality segments (the 2012 List), EPA approved the 2012 List as submitted by DES.

In its approval letter, EPA included an "Attachment A" entitled "EPA Technical Support Document" that discussed, among other things, the 2014 Peer Review Report jointly commissioned by DES and the Great Bay Coalition, as well as the Settlement Agreement entered into between the State of New Hampshire/DES and the Coalition cities. As a member of the Coalition, the City of Rochester strongly disagrees with several of EPA's comments in its Attachment A, which have relevance to the DES' proposed 2014 §303(d) list that was submitted to EPA on October 14, 2015. **4- 12**

For example, the City strongly disagrees with EPA's conclusory statement that "there is substantial data and other information contained in New Hampshire's administrative record (AR) for its 2012 303(d) list supporting the State's *continued* listing of water body segments in the Great Bay Estuary as being impaired for the State's aquatic life designated use." In support of that statement, EPA relies almost entirely on the NH DES' 2009 Numeric Nutrient Criteria Document which has been discredited by a panel of national experts.

EPA notes that DES and the Coalition jointly undertook an independent Peer Review of the 2009 Criteria Document. However, EPA fails to note that DES and the Coalition *jointly* selected the four national experts who completed the Peer Review, and the questions asked of the Peer Reviewers were also *jointly* developed. Most importantly, EPA fails to note that the final Peer

Review Report, dated February 13, 2014, concluded that the 2009 Criteria Document was not scientifically sound and the conclusions drawn in that document are not reliable.[2]

Based on this Peer Review Report, the State of New Hampshire entered into a settlement agreement with the Coalition that ended litigation brought by the Coalition challenging DES's inappropriate reliance on the 2009 Criteria Document. In the settlement, DES agreed that it would no longer apply the nitrogen numeric criteria developed in the 2009 Criteria Document, and it would modify its approach to listing waters as impaired based on the Criteria Document.

In fact, DES has honored that commitment, and in the 2014 §303(d) proposed list, has removed Total Nitrogen (TN) as a cause of impairment to the Great Bay Estuary. This is noted in the Department's document summarizing the impairments removed from the 2012 303(d) List "Impairments Removed (*i.e.*, Delisted) from the 303(d) List of Threatened or Impaired Waters (*i.e.*, Category 5); NHDES, 2015." In that document, the DES stated:

> "The [peer] reviewers indicated that there was a reasonable basis for finding some parts of the Great Bay Estuary system impaired for eelgrass loss. The reviewers also agreed that nitrogen is an important factor related to eelgrass and other responses in the estuary. However, they concluded that the NHDES 2009 report did not adequately demonstrate that nitrogen is the primary factor causing eelgrass decline in the Great Bay Estuary because the report did not explicitly consider all of the other important, confounding factors in developing relationships between nitrogen and the presence of eelgrass.
>
> As a result of a court approved settlement agreement, the department will cease using the nitrogen concentration thresholds from the NHDES 2009 Report (NHDES, 2009) to assess nitrogen impairments in its 2014 assessment. The CALM will be changed to reflect that the stressor-response matrix previously used to determine total nitrogen impairment status will not be used. In the 2014 assessment, the department will assess the parameters listed above (dissolved oxygen, chlorophyll-a, light attenuation, total nitrogen, and eelgrass cover) independently relative to their respective numeric or narrative water quality standards.
>
> In the case of total nitrogen, the department is in the process of determining new assessment approaches. Because that process is incomplete, the department will utilize existing data for each assessment unit to make a determination of impairment status. For those assessment units where the data are clear, an assessment status will be determined and documented in the 303(d) list, and a Great Bay estuary addendum which accompanies the list. For those assessment units in which the impairment status is less certain, the approach remains in a development phase and the final assessment of total nitrogen will be delayed until such time as a new approach is determined. Any new

[2] For example, one reviewer commented (and others had similar comments), that "[t]he statistical methods used to derive the numeric thresholds were not based on acceptable scientific methods and the results of these analyses are not reliable for predicting the complexity of responses to changes in nitrogen concentration in the system, including DO, transparency, eelgrass, macroalgae and phytoplankton." (Victor Bierman at p. 35 of Peer Review Report.)

> approach will become part of a future CALM which will be applied after opportunities for public involvement and an official comment period. Id. at pp 42-43."

Despite EPA's apparent dismissal of the significance of the Peer Review Report and the State's settlement agreement, DES does not agree with EPA that there is adequate scientific evidence to conclude that the Great Bay Estuary is impaired for nitrogen. This position is fully supported by the City of Rochester.

Conclusion

Rochester appreciates the opportunity to provide these comments and looks forward to further revisions of the Draft 2014 NH 303(d) consistent with these comments. Please call me at 603-332-4096 if you have any questions or if additional detail would be helpful.

Sincerely,

John Storer, Director of Public Works

Enclosure: Appendix 1 **4- 13**

Cc: Dan Fitzpatrick, City Manager
Terence O'Rourke, City Attorney
Michael Bezanson, City Engineer
Attorney Steve Miano
Attorney Sherry Young
Clifton Bell, BC
Bill Arciero, VHB
Renee Bourdeau, GeoSyntec

APPENDIX 1

REFERENCES TO ROCHESTER'S COMMENTS TO THE NEW HAMPSHIRE DES'S DRAFT 2014 NH 303(d) LIST

Florida Dept. of Env. Protection. 2011. Applicability of Chlorophyll a Methods. DEP-SAS-002/10. 5 p.d

New Hampshire Department of Environmental Services. 2015. Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report/303(d) List. 101 p.

Radojevic, M. and Bashkin, V.N. 2006. Practical Environmental Analysis, 2nd edition. RSC Publishing. 457 p.

Rice, E.W., Baird, R.B., Eaton, A.D., and Clesceri, L.S., eds. 2012. Standard Methods for the Examination of Water and Wastewater, 22nd Edition. American Public Health Association, American Water Works Association and Water Environment Federation. 1496 p.

Stich, H.C. and Brinker, A. 2005. Less is better: Uncorrected versus pheopigment-corrected photometric chlorophyll-a estimation. Archive for Hydrobiology 162 (1). p. 111-120.

Stow, C.A., Roessler, C., Borsuk, M.E., Bowen, J.D., Reckhow, K.H., 2003. Comparison of Estuarine Water Quality Models for Total Maximum Daily Load Development in Neuse River Estuary. Jour. Wat. Res. Plan. & Dev. Jul/Aug 2003. p. 307-314.

Thompson, R.E., and Emery, W.J. 2014. Data Analysis Methods in Physical Oceanography. Elsevier. Waltham, MA. 716 p.

Vernon, L.P. 1965. Spectrophotometric determination of chlorophylls and pheophytins in plant extracts. Anal. Chem. 32. p. 1144-1150.

Virginia Department of Environmental Quality. 2004. Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River. 57 p.

COMMENT #5: Tom Irwin, Conservation Law Foundation

clf
conservation law foundation

For a thriving New England

CLF New Hampshire
27 North Main Street
Concord, NH 03301
P: 603.225.3060
F: 603.225.3059
www.clf.org

December 11, 2015

Mr. Ken Edwardson
NH DES, Water Quality Assessment Program Coordinator
P.O. Box 95, 29 Hazen Drive
Concord, NH 03302

Re: Draft 2014 Section 303(d) List of Impaired Surface Waters

Dear Mr. Edwardson:

Conservation Law Foundation (CLF) appreciates the opportunity to comment on New Hampshire's Draft 2014 Section 303(d) List of Impaired Surface Waters ("Draft 303(d) List"). CLF is a non-profit environmental advocacy organization that works to protect New England's, including New Hampshire's, natural resources for the benefit of all people. CLF has engaged in significant work in New Hampshire to address critical water quality challenges. As set forth below, these comments address the proposed "de-listing" of certain water bodies in the Great Bay estuary. These comments should not be construed as implicitly supporting the proposed de-listing of other surface waters not specifically addressed herein.

5- 1

Proposed Total Nitrogen De-Listings

The Draft 303(d) List proposes to de-list the following assessment zones in the Great Bay estuary for impairments related to Total Nitrogen: Little Bay, Bellamy River, Piscataqua River (Upper), Portsmouth Harbor, and Little Harbor/Back Channel. *See* NHDES, Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report/303(d) List (Oct. 14, 2015) ("Technical Support Document") at 9. Although it is not clear whether it constitutes a de-listing, NHDES also has identified the following Great Bay estuary assessment zones as having an "assessment methodology under development": Lamprey River (South), Great Bay, Cocheco River. *Id.* CLF objects to the above-referenced impairment re-classifications and urges NHDES to retain, for each of the above-referenced Great Bay estuary assessment zones, the same impairment classification as set forth in the recently approved 2012 Section 303(d) List of Impaired Surface Waters.

As NHDES has recognized, the Great Bay estuary

> is one of 28 "estuaries of national significance" [d]esignated by EPA under Section 320 of the CWA. The 2013 State of the Estuaries Report for the estuary (PREP, 2013) showed that the Great Bay Estuary has all the classic signs of eutrophication: increasing nitrogen concentrations, low dissolved oxygen, and disappearing eelgrass habitat.

See NHDES, Response to Public Comment on the Draft Consolidated Assessment and Listing Methodology for the 2014 Section 305(b)/303(d) Surface Water Quality Assessments (Oct. 14, 2015) ("Response to Public Comment on CALM") at 20.

Despite the national significance of the Great Bay estuary, and despite the estuary showing "all the classic signs of eutrophication, including increasing nitrogen concentrations," *id.*, NHDES is proposing the above-referenced de-listings relative to total nitrogen on the basis of its commitment – pursuant to a settlement agreement – to cease using nitrogen concentration thresholds from the NHDES 2009 numeric nitrogen methodology report. *See* Technical Support Document at 5. NHDES's negotiated commitment to cease relying on its 2009 methodology – made as part of a tactical determination to settle litigation – does not provide good cause for, and cannot lawfully form the basis of, its proposed de-listings relative to total nitrogen. Nor should NHDES de-list nitrogen impairments while it "is in the process of determining new assessment approaches." *Id.* at 6. **5- 2**

As NHDES has explicitly acknowledged: "At this time the Great Bay Estuary exhibits many of the classic symptoms of *too much nitrogen*: low dissolved oxygen in tidal rivers, increased macroalgae growth,[1] and declining eelgrass." *See* Response to Public Comments on CALM at 22 (*quoting* 2013 State of the Estuaries) (emphasis added). These facts – i.e., conditions in the estuary – require that NHDES retain Total Nitrogen-related impairment classifications from the 2012 Section 303(d) List and not proceed with its proposed de-listings. Indeed, EPA, in its recent analysis approving the 2012 Section 303(d) List reached this very conclusion. There, in its Technical Support Document specifically addressing the Great Bay estuary, it stated:

> As described in this TSD, there is substantial evidence that the Great Bay Estuary waters in question are impaired for the State's aquatic life designated use as evidenced by eelgrass loss, poor water clarity, and /or low levels of dissolved oxygen. Furthermore, it is reasonable in light of the available data and other information to conclude that total nitrogen is at least a contributing cause to these impairments. No other pollutants have been identified by any other studies or monitoring as contributing to eelgrass loss, poor water clarity, and/or low dissolved oxygen in these waters, while total nitrogen *has* been monitored in these impaired waters at levels that are well above what would be considered natural background levels for an estuarine system. Water chemistry sampling conducted by NH DES in the Great Bay Estuary has shown median values of total nitrogen between 0.312-1.055 mg/L, where natural background levels of 0.2 mg/L would typically be expected for an estuarine system.

---

[1] NHDES specifically acknowledges the link between nitrogen and macroalgae, stating in response to comments by the Municipal Coalition as follows:

> Comments provided by Dr. Art Mathieson of the University of New Hampshire . . . clearly link increases in macroalgae blooms to increased nutrients.
>
> > *"Prior to the 1980s no major algal blooms were apparent and the nutrient levels were much lower than today (cf. Mathieson and Hehre, 1981). During the past 2-3 decades the following macroalgal patterns have occurred along with increased nutrients:*
> >
> > - *"Extensive ulvoid green algae (Ulva spp.) or "green tides" (Fletcher, 1996) have begun to dominate many of these estuarine areas during the past 15-20 years, particularly within Great Bay proper (Nettleton et al. 2011). Such massive blooms of foliose green algae can entangle, smother and cause the death of eelgrass (Zostera marina) within the low intertidal/shallow subtidal zones (pers. obs. A C Mathieson). They primarily represent annual populations that can also regenerate from residual fragments buried in muddy habitats.*
> > - *"Extensive epiphytic growths of seaweeds on eelgrass (Zostera marina) have also occurred during the past 15-20 years, particularly within Great Bay proper (pers. obs. A C Mathieson). These epiphytes, which are mostly filamentous red algae and colonial diatoms, may completely cover the fronds of eelgrass, limiting the host's growth and photosynthesis and compromising its viability."*

Response to Public Comments on CALM at 26 (italics in original).

See EPA Region I, Attachment A (EPA Technical Support Document) to EPA Approval of NHDES 2012 Section 303(d) List of Impaired Surface Waters, provided herewith as Attachment 1, at 1. *See also* 2013 State of Our Estuaries; Opinion Letter of Drs. Ivan Valiela, Erin Kinney, provided as Attachment 2. Of particular importance, EPA, after reviewing all of the available data and information, specifically concluded that even if it were to not rely on the numeric nitrogen criteria developed in the 2009 NHDES methodology, the waters that are the subject of NHDES's de-listing proposal are impaired relative to total nitrogen. *See, e.g., id.* at 7 ("Even if the specific numeric total nitrogen values for assessment and listing purposes contained in NH DES's 2009 report are set aside, there is substantial information in the record to support the listing of the Great Bay Estuary as not meeting applicable water quality standards and that excess nitrogen concentrations are at least a cause of the State's aquatic life use impairments in the estuary."). Indeed, NHDES itself acknowledges that "nutrient levels in the water body only have to 'encourage' or 'contribute to' cultural eutrophication to prompt action in Class B waters," *see* Response to Public Comments on CALM at 21, rendering its decision not to use the 2009 numeric nitrogen threshold not determinative of whether, based on the weight of evidence, the above-referenced Total Nitrogen impairments should be retained.[2]

[2] In describing the history around NHDES|s 2009 numeric nitrogen criteria, NHDES describes the various peer reviews that took place. In describing the most recent peer review, conducted as a result of an agreement reached between NHDES and the cities of Portsmouth, Dover and Rochester, NHDES describes the review as "focused on whether the [2009] report was sufficient to prove that nitrogen was the *primary cause* of ecological changes in the Great Bay Estuary." *See* Response to Public Comment on CALM at 20 (emphasis added). *See also id.* at 21 (stating the peer review panel "concluded that the NHDES 2009 report did not adequately demonstrate that nitrogen is the *primary factor* causing eelgrass decline in the Great Bay Estuary because the report did not explicitly consider all of the other important, confounding factors in developing relationships between nitrogen and the presence of eelgrass.") (emphasis added). It further notes that the reviewers participating in the peer review "agreed that nitrogen is an important factor related to eelgrass and other responses in the estuary." *Id.* at 20. Whether or not total nitrogen is the "primary cause" of, or "primary factor" in, eutrophic conditions in the Great Bay estuary is simply not relevant to whether assessment zones should be listed as impaired relative to total nitrogen. Rather, as NHDES has acknowledged, and as applicable rules provide (*see* Env-Wq 1703.14), total nitrogen need only encourage or contribute to cultural eutrophication – and it does.

Proposed Squamscott River (North) De-Listings

NHDES proposes to de-list the Squamscott River (North) assessment zone relative to Estuarine Bioassessments and Water Clarity. It proposes doing so pending an evaluation of depth regime and 5- 3
other habitat suitability measures relative to eelgrass. CLF objects to these proposed de-listings unless and until the above-mentioned evaluation has been completed and provides necessary and relevant information to warrant de-listing.

Again, CLF appreciates this opportunity to comment. We request that this comment letter, with attachments, be included in the administrative record.

Respectfully submitted,

Tom Irwin 5- 4
Vice President and CLF New Hampshire Director

Encls.

COMMENT #6: Robert J. Robinson, City of Manchester

Kevin A. Sheppard, P.E.
Public Works Director

Timothy J. Clougherty
Deputy Public Works Director

Frederick J. McNeill, P.E.
Chief Engineer

Commission
Raymond Hebert
Hal Sullivan
Rick Rothwell
Bill Skouteris
Toni Pappas

CITY OF MANCHESTER
Department of Public Works
Environmental Protection Division

December 11, 2015

Mr. Ken Edwardson
2014, 303(d) Comments
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive
P.O. Box 95
Concord, NH 03302-0095

Subject: **City of Manchester – Review Comments**
Draft 2014 303(d) List of Impaired Surface Waters for New Hampshire

6- 1

Dear Mr. Edwardson,

The City of Manchester is pleased to submit comments on the Draft 2014 303(d) List of Impaired Surface Waters (List). Please find attached our comments as prepared by our consultant OspreyOwl Environmental, LLC. It is imperative that the list accurately depicts the impairments of our surface waters as these impairments have direct impact on permits issued to communities including the National Pollutant Discharge Elimination System (NPDES) permits and the Small Municipal Separate Storm Sewer System (MS4) permits.

The pollutant loadings in both the NPDES and MS4 permits are based on the impairments of the receiving waters. Therefore, it is important that this List be approved in a timely manner before additional permits are issued to allow communities to be credited with efforts to improve water quality in the state.

If you have any questions in regards to these comments, or this letter please call me at 603-624-6526.

Sincerely,

Robert J. Robinson, P.E.
Plant Superintendent

Cc: Frederick J. McNeill, P.E.

New Hampshire 2012 Section 305(b) and 303(d) Surface Water Quality Report

Comments as Prepared by OspreyOwl Environmental, LLC

The City of Manchester is submitting these comments as part of the review of the 303(d) CWA Program for New Hampshire. These are being submitted in written form as outlined in the Guidance for Submitting Comments.

The City of Manchester had previously commented on the (Consolidated Assessment & Listing Methodology (CALM) a few years back and would like those comments to be part of this record (Attachment 1).

Under A.1, Introduction, last paragraph on pg. 8 it states, "Designated uses for New Hampshire surface waters include… drinking water after adequate treatment and wildlife." The limits set by the NHDES for Human Consumption are drinking water concentrations, before any treatment. These concentrations can be so low as to render every wastewater treatment plant, detention pond, lake, reservoir etc. to discharge waters that meet drinking water standards. An example of this is 2,3,7,8 TCCD and 1,2,3,7,8 PCCD at 1 part per quadrillion (ppq). The NHDES has adopted this standard of 1 ppq as if any discharging waterbody was a drinking water facility. This standard should not apply to any body of water or wastewater treatment facility unless the water produced is being immediately used for potable water on an approved basis. 6- 2

There is conflicting information and a perception problem regarding overall state-wide compliance. Page 10 last paragraph stated, "The ultimate goal is to have all surface waters meet standards and be fully supportive of all uses. In specific, the overall assessment results for each waterbody type show that approximately 26% to 67% of the State's surface waters are fully supporting one or more designated." The large pop-out gray box on pg. 10 reads, "There is much work to be done to restore impaired waters and to monitor waters that could not be assessed due to insufficient information." If one reads no further than this the impression is that the state waters are quite poor and highly polluted.

Page 11, figure 1, illustrates that Rivers, under the specific site assessment (SSA), only have 5.8% impairment and under the probabilistic assessment (PA) 3.2%. Approximately 42% of the rivers have been assessed. Extrapolate this out and it equates to an 85% supportive designation under the SSA and over 90% supportive designation under PA. It would be better public relations for the reader to read these positives to illustrate that much progress has been made rather that the bold statement in the call out box, "There is much work to be done to restore impaired waters."

Table 1, overall use support indicates that 67.2% of the SSA and PA fully meets water quality standards. Yet in the call-out box on pg. 13, Freshwaters it indicated that only 5.2% of the rivers and streams support this use. Table 1 indicates that under SSA 35.9% of the rivers meet this use.

The first paragraph on pg. 13 last sentence needs to be finished as the reader is left hanging at 4.7% with nothing to reference.

On pg. 12 the SSA impoundment indicated that 35.3% fully meets WQ standards. The second paragraph narrative on pg. 13 indicates that only 5.0% is fully supportive. The table and narrative need to be consistent.

Section A.2.2.3, Aquatic Life support, pg. 19 indicates that 0.8% of the river and stream mileage fully supports aquatic life. This one statement leads the reader to believe that 99.2% does not support life due to insufficient information or non-supporting designation. Perceptually this feels like there is no life in any of the state's waters. This could not be further from the truth. Page 100 middle of the first paragraph states, *"67.2% of the rivers and streams met water quality standards and 3.2% were impaired."* It is important to couch these designations in favorable terms for the overall health appearance of the State in regards to environmental matters. Wouldn't it be more positive to read the following paragraph than the paragraph of pg. 13 to enhance a positive perception of the State of New Hampshire?

"The New Hampshire's warm water and cold water fisheries are doing well under the management of the New Hampshire Fish and Game. An economic study done by Nordstrom in 2007 indicated that up to 94% of the recreationalists report high levels of satisfaction with water quality, clarity and purity. The environmental health of NH's waterbodies is paramount in determining the relative health of our aquatic resources. With over 8,700 assessment units, the state is making headway in assessing the health of these waters. To date, 73.2% of these units could not be sufficiently assessed due to limited information from monitoring parameters. The state has determined that 26% of these units are considered non-supporting (onsite assessment of the 26.8% of waters measured) while probabilistic assessment indicate

that 14.3% of the units are non-supporting. The goal is to have 100% of these waters assessed to determine supporting determinations." The perception of the reader is much different after reading this statement than the one included in the current version. Both statements convey the same meaning.

Section A.2.2.6 is concern as a situation was brought up by Manchester at a recent water quality meeting regarding the 1 part per quadrillion limit for receiving waters. This standard is under the Human Health criteria (drinking water) and is based on a person getting cancer if they drink 2 liters of water daily for 70 years. There was discussion as to the relevancy of WWTPs being required to discharge water that met drinking water standards when the verbiage is clear that it pertains to after treatment for a drinking water supply. There was also discussion as to the human health protection criteria (one in 10,000 or one in 100,000) people. Manchester was told that the one in 100,000 criteria was chosen (that gives you a 1 part per quadrillion limit) as it was more conservative and therefore more protective of health. It should be internally discussed by the NHDES and potentially commented upon that this criteria does not pertain to point source or non-point source discharges as community-surface drinking waters always require adequate treatment prior to consumption.

Section A.2.3 lists Causes and Sources of Impairment. This list has 79 assessment units (AUs) impaired for aluminum, 26 impaired for lead, 19 impaired for iron, five for copper, four for zinc, two for cadmium, two for arsenic and one for chromium. This is 138 AUs that demonstrate metals contamination (Table 31 on page 140, illustrates the acreage affected). Recent clean sampling along the Merrimack River indicate that there is little to no copper or lead in the Merrimack. Recent metals samples in Lowell, MA on the Merrimack River, Nashua, NH on the Merrimack and in Manchester, NH (all taken within the heart of the cities industrial zones). The Lowell samples indicated non-detect for Cd, Cr, As and low concentrations well within the water quality limits for Pb, Cu and Zn. These samples were all taken within a 30-mile river travel distance through the most heavily populated and most industrialized areas of New Hampshire where the water quality is anticipated to be at its worst levels. The results of the 12-month Aluminum Study were submitted to the NHDES with many tables and graphs. The 'Clean Sampling' results for copper and lead and also other metals throughout the Lowell area are in the tables of analysis are below.

Manchester, NH – Cu & Pb Results

Location	Date Time	Cu-ug/l Total	Pb-ug/l Total
MERLStadiumRamp	8/18/2014 12:45	0.9	0
MERLAAA	8/18/2014 13:15	0.8	0
MERLStadiumRamp	8/19/2014 13:15	0.8	0
MERLAAA	8/19/2014 13:45	0.8	0
MERLStadiumRamp	8/20/2014 12:15	0.8	0
MERLAAA	8/20/2014 12:45	0.7	0
MERLStadiumRamp	8/21/2014 12:00	0.7	0
MERLAAA	8/21/2014 12:45	0.7	0
MERLStadiumRamp	9/2/2014 12:30	2.8	0
MERLAAA	9/2/2014 13:00	1.8	0
MERLStadiumRamp	9/3/2014 12:45	1.1	0
MERLAAA	9/3/2014 13:30	1.6	0
MERLStadiumRamp	9/4/2014 12:00	2.3	0
MERLAAA	9/4/2014 12:45	2.1	0
MERLStadiumRamp	9/5/2014 12:00	1.9	0
MERLAAA	9/5/2014 12:45	1.1	0
MERLStadiumRamp	9/23/2014 12:45	0	0
MERLAAA	9/23/2014 13:15	0.5	0
MERLStadiumRamp	9/24/2014 12:15	0.06	0
MERLAAA	9/24/2014 12:45	0.06	0
MERLStadiumRamp	9/25/2014 12:30	0	0
MERLAAA	9/25/2014 13:00	0.06	0
MERLStadiumRamp	9/26/2014 12:00	0.06	0
MERLAAA	9/26/2014 12:45	0.6	0
MERLStadiumRamp	10/6/2014 9:00	0.5	0
MERLStadiumRamp	10/14/2014 12:15	0.6	0

MERLAAA	10/14/2014 13:00	0.6	0
MERLStadiumRamp	10/15/2014 12:15	1.4	0
MERLAAA	10/15/2014 13:00	0	0
MERLStadiumRamp	10/16/2014 12:15	2.7	2.8
MERLAAA	10/16/2014 12:45	1.3	0.6
MERLStadiumRamp	10/17/2014 11:15	0.7	0
MERLAAA	10/17/2014 12:15	0.7	0
Averages		0.93	0.10
Median		0.70	0.00
Averages Upstream		1.02	0.16
Averages Downstream		0.84	0.01

Nashua Ambient Metals

Date Time - Goffs Falls	CFS Goff Falls	Corrected Q Nashua CFS	Total Cu in ug/l	Total Pb in ug/l
08/10/2015 10:15 EDT	1,250[P]	1575	0.8	ND
08/11/2015 10:30 EDT	1,300[P]	1638	0.8	
08/12/2015 08:30 EDT	1,340[P]	1688	0.8	
08/13/2015 10:15 EDT	2,690[P]	3389	0.9	ND
08/24/2015 09:15 EDT	1,300[P]	1638	0.7	
08/25/2015 08:15 EDT	1,310[P]	1651	0.9	ND
08/26/2015 10:15 EDT	2,390[P]	3011	0.9	ND
08/27/2015 08:15 EDT	2,640[P]	3326	1.1	
		Average	0.86	ND
		Median	0.85	ND

Lowell, MA Merrimack River

Lowell Flows at time of Sampling

USGS Gage # 01100000 / Merrimack River BL

Date Time - Concord River	CFS USGS 011	Gage height	Total Al in ug/l	Total As in ug/l	Total Cd in ug/l	Total Cr in ug/l
11/03/2015 13:00 EST	5,160^P	15	150	ND	ND	ND
11/04/2015 08:45 EST	4,860^P	15.3	110	ND	ND	ND
11/05/2015 12:00 EST	4,260^P	17.4	100	ND	ND	ND
11/06/2015 11:00 EST	4,140^P	17.5	97	ND	ND	ND
	Averag e		114.25	ND	ND	ND
	Median		105	ND	ND	ND

Lowell, MA Merrimack River

Lowell Flows at time of Sampling

USGS Gage # 01100000 / Merrimack River BL

Date Time - Concord River	CFS USGS 011	Cu ug/l	Total Pb in ug/l	Total Ni in ug/l	Total Ag in ug/l	Total Zn in ug/l
11/03/2015 13:00 EST	5,160^P	1.1	0.6	ND	ND	5
11/04/2015 08:45 EST	4,860^P	0.8	ND	ND	ND	4
11/05/2015 12:00 EST	4,260^P	0.9	ND	ND	ND	5
11/06/2015 11:00 EST	4,140^P	0.9	ND	ND	ND	5
	Average	0.93		ND	ND	4.75
	Median	0.9		ND	ND	5

It may be appropriate to note that much lower levels of metals contamination have been demonstrated with 'Clean Sampling' techniques and that the NHDES has recently moved to the acid soluble faction as the indicator parameter for aluminum compliance. DES points this out in Section D.1 (pg 91) in the three principle strategy of decisions being, *driven by data on a watershed basis, the purpose of data collection should be clearly understood and the data quality should be well documented*. The belief is that a majority of these findings would be reversed with 'Clean Sampling' practices.

It is well to note to that the 17% of acidic waters in high remote ponds are contributing to the higher aluminum waters within the state due to natural weathering from the low pH waters within these ponds.

Page 32, paragraph four indicates that the Great Bay Estuary had increased nitrogen by 42% over the past five years. The Seacoast Coalition has recently had a Peer Review completed regarding the findings of the estuary. The court ruled that the findings of the Peer Review were valid. The verbiage of this section should match the Peer Review for consistency sake. The Peer Review indicated the following:

> *"In practice, application of the DES conceptual model to the Great Bay Estuary failed to address several influencing factors identified by the NEEA protocol and needed to fully evaluate the effects of nitrogen on eelgrass. Many of the factors explicitly indicated by the NEAA, for example; <u>hydraulic flushing and water residence time (Bricker 1999), were not considered in the DES model.</u> These two physical factors (among several others) are especially important in controlling nitrogen loading, processes of nitrogen cycling, and nitrogen concentrations in New England Estuaries (Latimer and Rego 2010). Hydrological modelling of individual embayments is a centerpiece of the Massachusetts Estuaries Program (MEP) for developing TMDLs and one of the tools used to evaluate nitrogen loading and its effect on eelgrass. Even though DES cites the MEP work as influential for developing and implementing their approach in the Great Bay estuary, there was no effort made to consider these other important factors."*

Also, there was a HydroCal Model performed on the flushing rates of the brackish waters of the tributaries discharging into Great Bay and determined that the flush rate was significantly overestimated by the NHDES.

Table 3 on page 44 has a definition for Drinking Water Supply after adequate treatment. A reference should refer back to A.2.2.6 to assure this standard does not apply to point source and non-point source waters required to meet drinking water standards.

Section C.2.6 discusses TMDLs and Lake Diagnostic Feasibility Studies sometimes put the cart before the horse. When there is an extensive amount of data, models can be correlated against this data with a reasonable realistic outcome. Where data is less available, models use default data for typical watersheds, forests, and urbanized acreage and can be out of calibration by over 90%. An adjustment is made to the model to make it fit that is sometimes in excess of 90% (Nutt Pond Model TMDL performed by CEI and AECOM TMDLs). This could mean several hundred thousand dollars in BMP retrofits that may not actually be needed. A TMDL should be based on a historic library of good, accurate data.

In Section C.2.9, second paragraph on page 59 it indicates that whitewater boaters' flow needs were identified by interviewing them on their boating preferences. Unless these interviews were being done to coordinate dam releases (this was not indicated) then there is no way to control what nature sends to New Hampshire. Drought conditions diminish whitewater conditions and rains increase those conditions. The timing of the rain and drought is well beyond a whitewater rafter's preference and the scope of this document.

Page 64 determines that 23% of the mercury coming into the northeast region is from the global atmospheric reservoir. The next paragraph indicates that the interim mercury goal of 75% had been met in 2010 with the long-term goal being the virtual elimination of the man-made mercury releases.

Seeing that 23% is in the global reservoir it seems like it would be impossible to go much beyond the interim mercury goal of 75%. New Hampshire, nor the United States has any control on discharges in South America, Africa, Asia or Europe. This should be noted that the state has reached the limit of control that New Hampshire can influence.

Section C.3.3 Economic Impacts is one of the most important parts of this document to focus upon. The last sentence on page 76 states, *"However, there is also an economic benefit in terms of increase in property value, additional revenue brought in by visitors attracted to our clean waters, lower treatment costs, etc."*

Lower treatment costs may possibly happen on the water treatment side due to a minute reduction in pollutants removed via point source and non-point source controls. There is definitely a sharp increase in treatment costs in regards to the point source and non-point source abatement efforts. This sentence is very misleading and should be adjusted to reflect the higher treatment costs of point and non-point source abatement.

Section 3.3.1 indicates that NH's wastewater treatment plant projects amounted to $838 million over the construction grants era. The next section outlines the 20 to 30 percent state Grant Program and the section after this the State Revolving Fund program. The WWTPs have consumed over $1 billion of funding. Section C.4.7 illustrates that non-point sources (NPS) contribute 83% to water quality impairments to the state. WWTPs effectively are the other 18%. If it has taken a billion dollars to control a portion of the 18% (conventional treatment, but not advanced treatment) it can be extrapolated that the cost for NPS could approach $5.5 billion dollars in direct dollar-for-dollar costs. It is well understood that point source is the low hanging fruit and that the expenditures to tackle non-point contaminants can run as high as three to 10 times the cost of point source treatment.

Section C.4.2 does outline the benefits of sustainability. It continues to outline the money raised by the state due to clean water beyond that in section C.3.3.4. The annual estimate is $1.1 billion to $1.5 billion raised via clean waters. This is an important aspect as the State, in an earlier section on page 61 last sentence of the last bullet states, "*The LMAC and RMAC believe that if adequate resources and information are not made available now, then achieving sustainability of New Hampshire's surface waters will become more difficult, more costly or impossible.*" If the state finds it hard to fund the recommendations from the LMAC and RMAC (mostly management criteria and technical advice exchange) even though Table 7 on page 94 indicates that the shortfall in the 2005 peak year was $1.09 million. How can the state expect municipalities to cover over $5 billion in a 15 year period as currently expected in the draft MS4 Program (over 5,000 times the DES shortfall).

DES has worked with the cities of Dover, Manchester, Nashua and Portsmouth to develop a stormwater utility. This would be an added source of income to begin addressing NPS contamination. To date, no utility has been created as citizens are already highly strapped to meet their currently utility expenses. This situation needs to be better explained in this document

Section C.4.3 Climate Change projects a dismal outlook for NH. The task force is commissioned to reduce greenhouse gas emissions and moving toward renewable energy. The action plan should look at the whole fate analysis from cradle to grave to determine if steps agreed upon are not just shifting the pollutant from the air to the water or the earth, into the aquifer, back to the water and back to the air due to evapotranspiration. EPA's air resources website indicates that as wastewater plants move more towards nutrient removal via advanced treatment that overall atmospheric nitrogen will increase from 2% from WWTPs to 4% contribution across the United States. Methane is also increased along with carbon dioxide. There are off gases due to composting, leaf litter collection, and other forms of recycle. It is important to determine all the effects of byproducts produced due to environmental concerns. These unanticipated results should at least be discussed in this policy.

Section C.4.9 Coastal Issues, paragraph three indicates that 1715 properties were inspected with 830 being potentially identified (52%) as a pollution source. This resulted in 87 properties being confirmed as pollution sources. This equated to 5% of the total potential sources as actual sources. When you consider the time, effort and money it took to perform this effort on 850 acres of shellfish growing areas, think of the effort needed to be expended state-wide for NPS detection. This provides an excellent example of the extent of the effort to bring all waters into full compliance.

Section C.4.9.2 Estuarine Eutrophication indicates that, "Unfortunately, the 2009 state of the Estuaries Report for the estuary (PREP, 2009) showed all the classic signs of eutrophication: increasing nitrogen concentrations, low dissolved oxygen, and disappearing eelgrass habitat." As stated earlier from the Peer Review, not all factors were considered in this determination and the findings from that review should be factored against the PREP, 2009.

Section C.4.10 Mercury in Fish indicate that 14% of the mercury deposition falling in the northeast originates in the northeast (NESCAUM Modeling). On page 64 a statement regarding a 1998 NEG/ECP report states that 47% of the mercury deposition originates in the northeast. This is over a 300% variance by two modeling reports and strongly indicates the inadequacy of modeling in general.

The second to the last bulleted item states that, "*when conducting probabilistic assessments each random sample can, by itself, be used to make a discrete use support decision*." As noted, this is outside the minimum number of samples required by the CALM and no support decision should ever be made on one random sample. The DES further states in the bullets on page 153 that sometimes 20 datasets are needed to make an informed decision.

Page 145, middle of the page states, "*SSAs are usually based on water samples taken at locations and times when water quality violations are most likely to occur. Consequently SSAs are often biased towards impaired waters*." When this condition exists, and a violation occurs, but there is no visual or physical evidence of impairment from algae or submerged aquatic vegetation (high chlorophyll-a above 15 ug/l and high phosphorus above 100 ug/l) it would mean that the arbitrary number of 15 ug/l and 100 ug/l for that particular water body may need to be reconsidered to determine a realistic concentration condition that would cause of actual impairment.

The City could not agree more with the first bullet statement of D.5.3., *"The Ambient Rivers Monitoring Program should consider recording flow at the time of each sample collected. Flow has been shown by the USGS to be a significant covariate for concentration in river samples."* This was very evident in the "Clean Sampling" Aluminum Study performed by the City of Manchester and also the Copper and Lead Study. As flow goes up metals concentration goes up proportionately until you reach the scouring velocity. At this point metals increase significantly in comparison to flows. Manchester has determined that the scouring velocity in the Merrimack is approximately eight to 10 times the river's 7Q10. This would go a long way in determining if the sample should be matched against the chronic criteria (true low summer flow at up to 3X the 7Q10) or the acute criteria (river flow increases beyond the scouring velocity due to rain or an upstream dam release).

The City is questioning the lead limit in clams that was exceeded at the national alert level of 5.0 ppm. We are wondering if this is a typo as the WQ limit for Pb is 0.54 ppb. This is 9,260 times more than the WQ limit.

We have reviewed the impairments removed from the 303(d) list. It is uplifting to see that further investigation was made of trends for the purpose of delisting. There is no differentiation of the 15 ug/l limit for chlorophyll-a between lakes and rivers. A table should be established for flushing rate of lake and detention time in run of river (impoundments). A lake that flushes two to three times a year is much more susceptible to algal blooms than one that flushes once a week at the 15 ug/l limit. A river that is continuously running is minimally affected by a concentration of 15 ug/l and an impoundment that has detention time in hours is much less impacted than a lake that has a flush rate of once per week. A one-size fits all approach to chlorophyll-a is an expensive practice to comply with when it is not necessary and could be adjusted dependent on circumstances.

The font on page 8 of 45 in the sentence, "*Neither program has detected a bloom since 2008*" needs to be enlarged. **6- 3**

The Howard Brook example on page 19 of 45 is an excellent example of how It may be a warm blooded animal or fowl that caused the high e-coli and not a cross connection, or illicit discharge.

The impairment listed on page 15 of 45, Merrimack River (MHRIV700060804-11) for low dissolved oxygen is disconcerting. Grab samples from August of 2002 through September 2005 indicated D.O.s at levels < 5.0 mg/l down to 2.8 mg/l. This AU remained on the impaired listing until this submission. It was only taken off due to the data recorded on a datasonde from 8/29/13 through 9/11/13.

This information poses many questions for the City of Manchester. Was the oxygen meter used between 2002 and 2005 properly certified? Was the meter properly calibrated? Was a standard used to verify accuracy of the probe? Were the water quality staff properly trained in the operation of the instrument? Was the staff properly trained to determine aberrations outside the realm of potential and instructed to investigate further?

In Manchester's certified laboratory our lab manual indicates that all of the instruments are to be inspected and certified annually. In review of the State's Laboratory practices (Attachment 2(a) states the frequency of professional instrument calibration only applies to balances and the thermometers on an annual basis. All other calibration is left to the lab's discretion.

Also included in Attachment 2(b) are Manchester's annual certification of the D.O. meters and the probe. There is also annual calibration of pH meters, turbidity meters, spin centrifuge, drying oven, Idexx incubators, thermometers and balances. Data that is this important and meaningful to communities should have the highest levels of quality controls. A poor outcome can mean hundreds of thousands of dollars in unnecessary expenditures abating phantom problems.

A blank set with Winkler titration should be fixed to determine oxygen content from a known source. When an upstream sample is reading in the 7 mg/l D.O. range and the lower river sample is reading in the 7 mg/l D.O. range, if the middle reading is in the 3 to 4 mg/l range then a sample should be taken and fixed then titrated back at the lab to determine if the meter is correct.

Also noted were some pH violations that were present (Connecticut River, Wilder Lake, Vernon Dam, Kilton Pond, PerryBrook etc.) that seemed to be aberrations, but determined to be appropriate for impairment purposes. The pH reading can be fairly sensitive. At the end of Attachment 2(c) is a listing of buffer solutions. There is a buffer solution that reads 6.87 units and can be purchased for $164 for 20 liters. A small bottle of solution should be dispatched with each sampler and used when there is a reading below the level of 6.5 units. This will inform the sampler of the accuracy of the meter and the reading obtained.

Kevin A. Sheppard, P.E.
Public Works Director

Timothy J. Clougherty
Deputy Public Works Director

Frederick J. McNeill, P.E.
Chief Engineer

CITY OF MANCHESTER
Highway Department
Environmental Protection Division

October 11, 2013

Ms Vicki Quiram and Mr. Ted Diers
NHDES
PO Box 95
29 Hazen Drive
Concord, NH 03301

13-18-PS

RECEIVED
OCT 1 1 2013
DEPARTMENT OF ENVIRONMENTAL SERVICES

Re: Manchester Comments on the CALM

Dear Administrators: 6- 4

The City of Manchester has reviewed the CALM and has the following to offer as comments on this document. Underlined sections in blue are the suggested addition/changes the City offers to the CALM language with a notation at the end of the comment explaining why the City believes this change is warranted.

In Section 1.1.2 – Assessment and Listing Methodology the following addition is suggested, *"Any data submitted to the New Hampshire Department of Environmental Services (the department or DES), is first reviewed against the existing protocols in the CALM document. In the event the CALM does not include protocols to adequately assess a particular data set, DES staff review the data in the context of New Hampshire's water quality standards within six months of receipt and prepare a written summary within nine months of receipt that includes a review of the data, the applicable water quality standards, and a recommendation of attainment status. Nothing in the CALM shall be construed as a basis for not evaluating a submitted dataset."*

Note: Manchester submitted a detailed Aluminum Study that was completed over the 2009 – 2010 time period with final report submitted to the NHDES by March 1, 2011. As of the writing of these comments, Manchester has not heard a response to the report, or has even had any indication that the information has been reviewed. The intent of this section is to review all submitted data. The question is the timeliness. As outlined in the CALM, the collected data is no longer considered in date after five years. The last samples were collected in May of 2010. In June of 2014 the May 2009 data will be outdated (less than a year away). It is imperative that the response be timely.

In Section 1.2.2 – Integrated Approach for 305(b) / 303(d) it is suggested that an item d. be added at the end of section 4.

1. Impaired or threatened for one or more designated uses but does not require development of a TMDL because; 6- 5

   a. a TMDL has been completed, or

b. other pollution control requirements are reasonably expected to result in attainment of the water quality standard in the near future, or

c. the impairment is not caused by a pollutant.

d. the impairment is naturally occurring

Note: This should be done to finalize any Assessment Unit (AU) segment from further scrutiny and to allow the NHDES and communities to focus efforts on other AUs. Manchester, believes the segment of the Merrimack River, from the Queen City Bridge (upstream of the WWTP outfall) and the railroad bridge (downstream of the WWTP outfall) has conclusive proof that the Merrimack River is well below the aluminum chronic criteria of 87 ug/l (<40 ug/l where the measured results) when the 7Q10 was 3X or less. High levels of aluminum in the feeder ponds in the White Mountains (95% of the samples were over 100 ug/l for aluminum) wash out during storm events and inundate the upper reaches of the Merrimack River. This aluminum increased the river loading during storm events and settles out when the storm events happen in the White Mountains and there is no rain in the lower watershed. This aluminum laden sediment is scoured off the bottom the Merrimack when the cfs approaches 7,000 (around 8X the 7Q10) in the aforementioned section of the Merrimack. Countless man hours and several thousand dollars have been spent generating this data and it should have major weight of evidence in reviewing impairment as all the samples were of excellent value and done under clean sampling techniques.

In Table 3-1: Factors used to establish Homogenous and Manageable AUs the following row has and additional qualifier,

Outstanding Resource Waters	Outstanding Resource Waters are defined in the surface water quality regulations (NHDES, 2011) as surface waters of exceptional recreational or ecological significance and include all surface waters of the national forests and surface waters designated as natural under RSA-483-7-a, I, regardless of impairments due to natural occurrence.

6- 6

Note: as previously explained, the White Mountains are a high source of aluminum and the source of aluminum impairment in the Merrimack River. If natural occurrence is causing the impairment, it needs to be referenced in the document. The current statement, without the qualifier, leads one to believe that there is no chance any pollutant can be coming from outstanding resource waters which is not the case.

In Section 3.1.4 - Use Support Attainment Options and Threatened Flag, Manchester would suggest the following changes:

Threatened: For any of the use support options noted above, the ADB allows any parameter in an AU to also be flagged as threatened. For this assessment cycle, threatened waters were defined as follow: **6- 7**

- Waters which are expected to exceed water quality standards by the next listing cycle (every two years). Expectations must demonstrate that the waters have reached 90% of the WQ maximum allowable concentration in at least two samples to meet expectation to exceed and/or,

- Waters that do not have any measured in-stream violations but other data indicate the potential for water quality violations [i.e. see Sections 3.1.20 (predictive models) and 3.1.21 (NPDES permit effluent violations)]. Predictive models must be run with the average of the previous **6- 8** two years of in-stream flow, the average of at least four of the highest pollutant parameters over the past four years and the model validation run must be within 15% of and actual measured run to be considered valid.

Note: Models have demonstrated unreliability and do not demonstrate real world potential. Models are generally based on the highest concentration of pollutant measured, the full capacity of the treatment works, and require several major adjustments to the modeling criteria meet calibration criteria. Manchester's secondary treatment plant is currently designed for 34 mgd, a BOD loading of 96,000 lbs and a TSS loading of 112,000 lbs. This was the 20 year future facility design in 1976 when the plant went into operation. Thirty eight years later, the plant averages 18.47 mgd (54% of design), 12,911 lbs BOD (13.4% of design) and 26,605 lbs TSS (23.75% of design). The plants 2012 data is below. With this history, models and NPDES calculations are still using worse case conditions. The 7Q10 criteria (lowest week in a 10-year period or one occurrence in 520 events (a 99.8% probability of non occurrence) with a 10% assimilative safety factor is a highly protective factor for WQ criteria. Models should be run on rolling average or maximum actual conditions and not future assumptions that rarely if ever transpire. As permits are issued every five years, and there is protective language within the permit to stop violations should they occur, there is no need to base models on anything other than actual plant and in-stream data.

Date **2012**	Plant- Eff Monthly Flow (MG)	Plant Inf. Total BOD lbs	Plant Inf. Total TSS lbs
Jan.	640.80	329,222	741,944
Feb.	516.20	325,839	547,265
Mar.	616.20	334,931	646,828
Apr.	547.30	364,297	833,250
May	657.70	360,937	896,908
June	684.20	350,210	1,013,538
July	452.90	330,518	879,873
Aug.	515.90	244,429	821,980
Sept.	461.50	434,094	838,204
Oct.	543.90	529,185	982,010
Nov.	553.20	527,022	688,401
Dec.	550.00	581,804	820,471
Avg:	**18.47**	**12,911**	**26,605**
Total:	6739.80	4,712,488	9,710,672

In section 3.1.10 – Data Quality, Manchester would offer the following comments in that table:

Level of Information	Description *	Assessment Applicability	Use Support Option(s) that can be used with this level of information
Low	SOPs or QA/QC plan are not available or were not provided. SOPs or QA/QC plan is available but protocols were not followed, Field duplicates and/or blanks were outside the 30% error range. QA/QC results are inadequate, and /or there is inadequate metadata.	Screening Level assessments only	Not Assessed
Fair	SOPs or a QA/QC plan is available; SOPs were used for field and lab; Field duplicates and/or blanks were within the 20% to 30% error range. QA/QC protocols were followed and QA/QC results and metadata are adequate; Samplers had some training;	Final Assessments	"Insufficient Information" "Fully Supporting" "Not Supporting"
Good	An acceptable QA/QC plan is available; SOPs were used for field and lab; Field duplicates and/or blanks were within the 10% to 20% error range. QA/QC protocols were followed and QA/QC results and metadata are adequate; Samplers were well trained.	Final Assessments	"Insufficient Information" "Fully Supporting" "Not Supporting"
Excellent	An acceptable QA/QC plan is available; SOPs were used for field and lab; Field duplicates and/or blanks were within the 1% to 10% error range. QA/QC protocols were followed and QA/QC results and metadata are adequate; Samplers were well trained and audited.	Final Assessments	"Insufficient Information" "Fully Supporting" "Not Supporting"

Note: The CALM gives the same weight of worth to samples within the fair, good and excellent range. Manchester staff was trained in clean sampling techniques, undertook a cleaner sampling

6- 9

technique with effluent sampling and has reviewed results of clean sampling vs. non clean sampling technique. The variations are large enough to warrant a difference in the fair, good and excellent categories. Manchester's NPDEs permit of 2008 has the following data within the fact sheet for aluminum. June 17, 2005 (480 ug/l aluminum), July 15 2005 (110 ug/l aluminum), June 16, 2006 (195 ug/l aluminum) and on July 14, 2006 (334 ug/l). The NHDES would consider these samples taken under the Good to Excellent category. This fact is also recognized in Table 3-32 of the current CALM.

In Manchester sampling of the Merrimack River in the 2009 summer season demonstrated that with the river is at general navigable conditions (usually less than 6,000 cfs) samples were under the 87 ug/l chronic criteria. Nothing is known to have changed the river water quality between 2005 and 2009, yet the difference in results is considerable. The only difference with the quality of the data is the less concentrated samples were taken under clean sampling conditions where the higher concentration samples were not. More thought needs to be given to the weight of evidence and terminology obtained within these three categories. **6- 10**

In Section 3.1.14 - Definition of Independent Samples, the City would propose the following:

"Where there were multiple samples (including samples taken at different depths) taken on the same calendar day and located less than 500 feet horizontally from each other, the worse case value was used as the independent sample for that day and location unless otherwise noted in Section 3.2. For Class B lakes, ponds and large impoundments, it should be noted that only data from the upper layers (i.e., the epilimnion in stratified waterbodies or the top 25% in non-stratified waterbodies) was used for assessment of dissolved oxygen. For all other parameters samples from all depths were considered and an average of the thee highest values were used as the independent sample for that day and location." **6- 11**

Note: If there is a big difference at varying depths, something obviously is going on that may not be representative of that water body. To take a one-time highest snapshot as the only criteria for regulatory compliance is overly conservative. An average of the three highest would smooth out any non representative condition. This would fall in line with the thinking under the 10% rule which states, *"This is consistent with the previously stated premise that an assessment will not be based on just one sample."* The independent sample is the worse case of one sample.

In Section 3.1.17 Minimum Number of Samples - 10 Percent Rule

"The concern was that some water bodies were not being listed which were actually impaired. In response to these concerns DES decided to abandon the binomial approach starting with the 2006 cycle and adopt a 66% more stringent ten percent rule (i.e. 10% rule) for determining use support."

Note: A 66% change in criteria is very stringent, not slightly stringent. An actual percentage change is more accurate than the subjective term less. It would also be welcomed to see a footnote where these instances have occurred to show there was truly a need to change from the binominal to the 10% rule approach and not because of a subjective request without any back up evidence of this actually being the case. **6- 12**

In the next section of the 10% rule the following changes are recommended,

"There are a few exceptions to the 10% rule. The first is for situations where 10% of the total number of samples is less than ten. In cases where the samples were taken in the excellent category, only two

samples are used to determine compliance. In cases where the sampling was in the good category only three samples need to be taken. In samples that fall within the fair category, five samples need to be taken to satisfy the minimum sampling criteria. In such cases, the above enumerated minimum samples is used to determine compliance. This is consistent with the previously stated premise that an assessment will not be based on just one sample. The second exception is for relatively large exceedances of the criterion. In such cases, only two exceedances are needed to assess the water as impaired. This is discussed in more detail in section 3.1.18 "Magnitude of Exceedance Criteria". The third exception is that the 10% Rule is not used for probabilistic assessments (see section 3.1.27). Finally, the fourth exception is that this rule only applies to certain parameters. To determine the parameters which were dependent on the 10% Rule for making assessments, see Section 3.2."

'The 10% rule is primarily intended to address situations where samples violate criterion but not by large amounts (i.e. values are within the accuracy of sampling (fall within the fair, good or excellent range) and method of analysis). For example, consider a data set containing 20 dissolved oxygen (D.O.) samples where the accuracy of sampling and measurement is +/- 0.5 mg/L. Further, assume only one of the samples (less than 10% of the total samples) violates the instantaneous D.O. criterion of 5 mg/L but by less than 0.5 mg/L (assume the value is 4.6 mg/L). Assuming that all 20 samples were collected under critical or near critical conditions, and applying the 10% rule, the AU would be assessed as fully supporting for D.O. and the single 4.6 mg/L value would be interpreted as due to measurement error. If, however, 2 or more of the 20 samples (i.e. greater than or equal to 10% of the samples) had values less than 5.0 mg/L, the AU would be assessed as impaired for D.O. if the sample was considered in the excellent category. It would require three or more samples for the good category and five or more in the fair category. In other words, the fact that 10% or more of the samples exceeded the criterion, and the sample fell within either the fair, good or excellent criteria is reason enough to conclude that the exceedances are not due to measurement error alone and that violations of the water quality criterion actually exist."

Note: This follows the reasoning previously outlined.

In Table 3-2: Sample Size and Minimum Number of Exceedances (10% Rule) the following suggestion is offered

Sample Size	Minimum # of exceedances to assess a waterbody as impaired
1-29	2
30-39	3
30-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-99	9

Note: The 66% reduction from the binominal approach to the 10% rule corrects for minor differences in the error between sample lot rounding. Using the table as proposed in the current CALM actually reduces below the 10% rule in certain sample lot sizes. There is enough protection within the CALM to stick with the true 10% rule.

In Section 3.1.18 - Magnitude of Exceedance Criteria (MAGEXC) the following is suggested.

"The 10% rule discussed in the previous section provides a reasonable tool for determining the minimum number of water quality violations needed to assess a water as impaired under most conditions (i.e. when sample exceedences are generally within the range of sampling and analysis error). It does not, however, account for situations where water quality criteria are exceeded by large amounts and it is obvious that there is an impairment. In such cases, just a few samples should be needed to make an impairment decision when no other reasonable explanation can be made for the large exceedence. "

'To address these situations, "Magnitude of Exceedance Criteria" (MAGEXC) were established for many of the assessment parameters presented in Section 3.2. As shown in Section 3.2, MAGEXC are typically set well beyond the standard water quality criteria or as a function of measurement precision +/- the standard criteria; consequently when MAGEXC criteria are exceeded, one can be reasonably confident that there is an exceedence of the water quality criteria. As a general rule, if two or more samples exceeded the MAGEXC, waters were assessed as impaired (i.e. not supporting), regardless of the total number of samples taken (when no reasonable explanation could be made for the large exceedence e.g construction activity, high flows with river scouring velocities, field fertizilation etc)." 6- 13

Note: As pointed out in Manchester's Aluminum Report, specific construction projects created hot spots when samples were taken within this vicinity. This is an aberration and not the norm and is handled within MS4 permits. These instances should not be the basis for WQ compliance going forward when the source of contaminant is known.

Section 3.1.20 - Use of Predictive Models, the City has the following suggestions:

A waterbody with potential violations based on predictive modeling, was assessed as threatened instead of impaired (not supporting), to reflect the fact that the violation is predicted and not based on actual measured in-stream violations, provided that the following conditions apply:

- The model is calibrated and verified and is considered to be representative of current conditions. The most liberal model shall be used when any parameter of all the reviewed models need adjustment by >25% to either calibrate/validate the model. Any model that requires the adjustment of any parameter by more than 40% shall not be used.
- The model predicts water quality violations under existing loading conditions, and/or under enforceable pollutant loadings stipulated in a NPDES permit.
- All foreseeable activities, abatement strategies and pollutant expectations are entered into the model to provide a reasonable projection of WQ in the future.
- Input parameters have been reviewed by both the affected community and the NHDES and thoroughly vetted for all possible inconsistencies. 6- 14

Assuming that vetted modeling predicts a violation, and assuming that this is the only violation in the waterbody, such waters were assessed as threatened and assigned an Impairment Category of 4A, 4B, 4C, or 5 depending on the cause of the threat (pollutant or nonpollutant), the source(s) of the threat, if a TMDL was necessary or if other controls would result in attainment of water quality standards.

Note: Modeling is never truly accurate at predicting future compliance and should only be assessed as a tool for indication of what direction compliance may take in the future. When data is entered into a model, and the output doesn't calibrate with actually measured criteria, the model input data is changed, and sometimes significantly, to make the model fit the waterbody. Included as Attachment 1 are several key pages from the CEI modeling that was used for the Nutts Pond watershed in 2009. As can be seen from the underlined highlights, the model predicted a outcome of 282 ug/l of TP when the actual in-pond measured TP was 28 ug/l. The model had to be adjusted 91% to meet calibration requirements and is the most liberal model that was used in NHDES five-model average calibration TMDL for Nutt Pond. As can be noted from the modeling effort, this is hardly based on sound science.

In the section 3.1.21 - Probabilistic Assessments, the City would offer the following:

"One of the goals of Section 305(b) of the CWA is to assess all surface waters. To assess a large population such as surface waters, there are two generally accepted data collection schemes. The first is a census which requires examination of every unit in the population. Census sampling will always carry more evidential weight than separate probabilistic assessments. This, however, is usually very expensive and often impractical."

"A more practical and economic approach is to conduct a sample survey which involves sampling a portion of the population through probability (or random) sampling. Random sampling ensures that no particular portion of the population being sampled is favored (or biased) over another. Results of sample surveys can be used to make statistically based inferences (i.e., probabilistic assessments) about the condition of the population as a whole. For example, if a sample survey was conducted on representative lakes that exhibit similar environmental conditions of all NH lakes, and 30% of the random samples indicated aquatic life use impairment, it could be stated that 30% of the all lakes were impaired for aquatic life. Another benefit of sample surveys is that statistical analyses can also be conducted to determine the margin of error or confidence limits in the assessment."

"Probabilistic assessments are most useful for Section 305(b) reporting purposes because they can provide a general overall idea of the condition of an entire waterbody type (i.e., all rivers or lakes) which might otherwise be impossible to do using the census approach. General rules for conducting and using probabilistic assessments for surface water quality assessments in New Hampshire, include the following. 6- 15

- *Probability assessments shall be conducted in accordance with accepted statistical practices.*
- *Sampling shall be based on a random sampling design of similar class waterbodies.*
- *Sample surveys should be designed to produce an estimate of the percent of the resource (e.g. all lakes) in any use support category (e.g. fully supporting, not supporting, etc.) that are no more than +/- 20% at the 95% confidence limits.*
- *Criteria for determining use support shall be in accordance with this document. (All the subsequent text on this bullet removed)*
- *The percentage of discrete random samples meeting each use support category can be used as an estimate of the percentage of the resource meeting each use support category of similar waterbodies. For example, if 20% of the discrete random samples taken in similar lakes indicate full support of aquatic life, then it can be reported that 20% of the similar lakes fully support aquatic life."*

Note: Census sampling is rare, but should be the overriding determination of watershed compliance when available. The lakes should be representative of other waterbodies to which they are being compared. A single random sample should never be used by itself to make discrete use support decisions.

In Table 3-3: Parameters and Thresholds for "Best Possible" and "10% Reserve Tier1/Tier2, the following should be stated before the table. The 10% assimilative capacity will be waived in any non-State controlled waters (e.g. ponds and streams residing solely within municipal borders). The affective community determines if the 10% rule should apply.

At the end of the table a statement should be inserted that says, Chlor-a is the limiting parameter of concern. If Chlor-a is within WQ parameter, TP is not considered as limiting.

Note: Many municipalities would chose to use all the capacity available to them within their town borders and solely owned by the municipality. There is no reason they should pay additional cost for compliance for non-use when it is available and is an arbitrary number set by the regulatory community. There is confusion as to whether or not there is an actual TP limit within the regulated community. Chlor-a is the limiting concentration that drives nutrients. This is outlined in the CALM, but only for ALUS thresholds. To avoid confusion, similar criteria needs to be provided for non ALUS waterbodies. **6- 16**

In the section that has Indicator 3: Chlorophyll-a (Chl-a) the following change is suggested. Excessive algal growth (high biomass and high chlorophyll-a values) can impair the public safety and aesthetic enjoyment of surface waters. The General Water Quality Criteria (Env-Wq 1703.03) require that surface waters be free of substances which: produce color or turbidity making the water unsuitable for the designated use, or interfere with recreational activities (Env-Wq 1703.03 (c)(1) c & e). For assessment purposes, chlorophyll-a concentrations in excess of 15 ug/L with the following turbidities;In Class A waters only natural levels of turbidity and in Class B waters no turbidity in excess of 10 NTU, (see Indicator 21) in fresh water and 20 ug/L in salt water are indicators of excessive algal growth that interferes with recreational activities.

1. Exceedances of the water quality criteria (WQC) are defined as: **6- 17**

   Freshwater: Chl-a $\geq$ 15 ppb (NHDES, 2003c) & NTU Indicator 21

   Tidal Waters: Chl-a $\geq$ 20 ppb (NHDES, 2003d)

Note: Chlorophyll-a impedes light penetration. The expectation is that chlor-a and turbidity go hand in hand. There is a document (Attachment 2) that indicates that chlorophyll-a, when filtered in the laboratory as opposed to field filtering is always higher in content. By using turbidities in conjunction with the chlor-a it rules out the error from laboratory filtering.

Comments regarding Indicator 2: - Discharges of Untreated Sewage area as follows:

FS: There are no known discharges of untreated sewage.

NS: There are known or highly suspected discharges of untreated sewage.

PS: There are known agriculture activities above the sampling location that may contribute to increased bacteria count. **6- 18**

Notes:

1. The primary pollutant of concern in untreated sewage is bacteria (pathogens).

2. Examples of sources of untreated sewage discharges include connections of sanitary sewer pipes to storm drains (i.e., illicit connections), combined sewer overflows (CSOs), sanitary sewer overflows (SSOs),failing septic systems that discharge to surface waters and agricultural activities upstream of sampling location that use animal/human waste as a fertilizing product

3. Investigations may find evidence of discharges of untreated sewage include physical evidence (feces, toilet paper, etc.), odors of sewage, chemical evidence (i.e., chlorine or elevated levels of ammonia in a pipe) and / or elevated bacteria concentrations in the pipe (>=2,000 cts/100mL) and manure spreading activities. An in-pipe concentration of >= 2,000 cts/100mL is an indicator of illicit sewage or waste discharge as it is five times the highest acceptable surface water bacteria listed in RSA 485-A:8, I, II, or V and not likely to result from sampling error. Additionally, such high levels are likely to cause surface water concentrations exceeding the criteria in RSA 485-A:8, I, II, or V. Confirmation of such concentrations shall occur before impairment determinations based on in-pipe bacteria concentrations.

Note: There are many instances in the state where agriculture stock piling of manure impacts the coliform count in a receiving waterbody. In Attachment 3, there is a picture of Army Corps land that is leased to farmers where several hundred ton of manure is stored along the shores of the Contoocook River (coordinates N 043-10-52. W 071-48-01. Alt. 236'). The storage area is approximately the size of a football field and loaded with manure up to two feet deep in most areas. This needs to be factored into any compliance considerations as it contributes immensely to e-coli violations in adjacent brooks.

Under section, Use: Aquatic Life, Manchester recommends a clarification to impoundments.

Definition: Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.

Applicability: All surface waters

Core Indicator(s):

Core Indicator(s)	**Applicable Surface Waters**
Biological based on benthic macroinvertebrates	Rivers/Streams $\leq 4^{th}$ order
Biological based on Fish Assemblage	Applicable Rivers/Streams
Biological based on at least 2 assemblages (fish and benthic macroinvertebrates) **OR** a minimum of dissolved oxygen, pH and documentation by a water quality professional trained in biology that there is no obvious impairment to the biological	All surface waters (fresh and tidal)

6- 19

community	
Chlorophyll-a	Lakes, ponds, & (impoundments if not similar to run of river
Total Nitrogen	Waters of the Great Bay Estuary

Note: This request is a result of the results of the Upper Merrimack River Watershed Study done by CDM and coordinated via the Army Corps of Engineers and the NHDES along with stakeholder communities. All the impoundments within New Hampshire exhibited characteristics of the run of river criteria and none of the characteristics of lakes and ponds. Concord's permit for phosphorus was set of the 25 ug/l limit for lakes for TP as Hooksett Dam was characterized as an impoundment. The study demonstrates that all impoundments act as run of river segments. This may not be true of all impoundments and that is why the wording is qualified.

In Indicator 1: Dissolved Oxygen (DO) the following comments are offered.

a. Samples must be taken during critical times of day (see Note 5c below) and seasons depending on the water type and use:

1) If the surface water is not a cold water natural reproducing fishery), at least 50% of the number of independent samples (i.e. n≥5) needed for FS, shall be taken between June 1 and September 30 (i.e., the critical season) and during the critical time of day. This is when DO is most apt to be lowest due to high temperatures and low flows. The remainder of the minimum number of independent samples needed for FS shall also be collected during the critical time of day but do not need to be collected during the critical season noted above. In cases where there are numerous non-critical season and non-critical time of day samples, the overall sample count will not be used to artificially increase the needed exceedences to exceed the binomial count unless samples were taken by a continuous oxygen data logger with documented calibration events.

2) In surface waters that are cold water natural reproducing fisheries, 100 % of the minimum number of independent samples (i.e. n≥10) needed for FS determination shall be taken between October 1 and May 14. **6- 20**

2. Exceedances of the Water Quality Criteria for DO are defined IN Env-Wq 1703.07 as:

Applicable waters	Daily Average Measurement	Instantaneous Measurement
Class A: Applies to any depth	< 75% saturation	< 6 mg/L (+ 1/2 the meter error concentration in mg/l)
Class B: Applies to any depth in free flowing rivers and tidal waters and in the epilimnion (if stratified) or in the top 25% of depth (if not stratified) in lakes, ponds, impoundments and reservoirs.	< 75% saturation	< 5 mg/L (+ the meter error concentration in mg/l)

Applicable waters	Daily Average Measurement	Instantaneous Measurement
Note that DO in lower depths of lakes, ponds impoundments and reservoirs must support existing and designated uses.		
Class A or B cold water fish spawning areas whose early life stages are not directly exposed to the water (i.e., cold water naturally reproducing fisheries). Applies to any depth in free flowing rivers and tidal waters and in the epilimnion (if stratified) or in the top 25% of depth (if not stratified) in lakes, ponds, impoundments and reservoirs.	From 10/1 to 5/14, a 7 day mean DO based on the daily average of <9.5 mg/L	From 10/1 to 5/14, DO < 8 mg/L (+1/2 the meter error concentration in mg/l)

3. Exceedances of the Magnitude of Exceedance Criteria (MAGEXC) for DO are defined as:

   Class A: DO < 5.5 mg/L (+1/2 meter error in mg/l) or <65% saturation

   Class B: DO < 4.5 – mg/L (+ meter error in mg/l) or <65% saturation

   Cold Water Fish Spawning Area (Class A or B): DO <7.5 mg/L (+1/2 meter in mg/l)

4. Data requirements for determining compliance:

   a Where DO is used as a Core Indicator, there must be sufficient data to indicate that all appropriate DO criteria are met (i.e., instantaneous minimum, daily average and in some cases, the 7 day mean as well) before DO can be assessed attaining water quality standards.

   b Preferred data/conditions for assessing DO:

      1) Compliance with instantaneous minimum DO concentration (mg/L) criteria shall be based on the minimum of a series of dissolved oxygen measurements taken at the same location and a maximum of one hour apart for 24 continuous hours except as noted in 5c below. High frequency datasonde measurements generally provide the most accurate and representative data.

      2) Compliance with average daily DO percent saturation criteria shall be based on the time weighted average of DO measurements taken at the same location and a maximum of one hour apart for 24 continuous hours except as noted in Note 5c below.

   c Other allowable data/conditions for assessing DO:

      1) For lakes, ponds, and impoundments:

         a. Stratification shall be considered present in a profile if the top to bottom temperatures differ by five or more degrees Celsius. Epilimnion waters are those parts of the lake within one degree Celsius of the temperature at, or closest to (within 0.5 meter), the one meter depth. Visual interpretations of temperature profiles may override the automated procedures.

b. In Class B lakes, ponds, and impoundments, if preferred data is not available (see Note 5b), a lake may be assessed for compliance with DO criteria as shown below, provided that minimum value samples from the epilimnion for stratified lakes or upper 25% of depth for unstratified lakes respectively are collected from a profile taken between 10:00 and 14:00. (Source: NHDES, 2003b).

c. In Class A lakes, ponds, and impoundments waterbodies the bottom DO concentration shall not be used in assessments due to natural boundary layer conditions that result in decreased DO at the sediment to water column interface. Where the lake is greater then 3 meters deep, DO readings in the bottom 1 meter are not used. Where the lake is less then or equal to 3 meters deep, the deepest DO reading is not used.

Alternative DO Assessment Criteria for Lakes/Ponds

Use Support	DO Class A (all time periods)	DO Class B (all time periods)	DO Any Class (Cold Water Spawning Period)
FS	≥ 7 mg/L (- ½ meter error in mg/l) and ≥ 85% saturation	≥ 6 mg/L (- meter error in mg/l) and ≥ 85% saturation	≥ 9 mg/L (- ½ meter error in mg/l) and ≥ 85% saturation
Insufficient Information	≥ 6 mg/L but < 7 mg/L (- ½ meter error in mg/l and/or ≥ 75% saturation but < 85% saturation	≥ 5 mg/L but < 6 mg/L(- meter error in mg/l) and/or ≥ 75% saturation but < 85% saturation	≥ 9 mg/L but < 8 mg/L (- ½ meter error in mg/l) and/or ≥ 75% saturation but < 85% saturation
NS	< 6 mg/L (- ½ meter error in mg/l) or < 75% saturation	< 5 mg/L (- meter error in mg/l) or < 75% saturation	< 8 mg/L (- ½ meter error in mg/l) or < 75% saturation

2) For rivers/streams:

a. If preferred data is not available (see Note 5b), rivers/streams and impoundments may be assessed for compliance with the instantaneous minimum and MAGEXC DO criterion based on grab sample taken between 05:00 and 08:00.

b. If preferred data is not available (see Note 5b), rivers/streams and impoundments may be assessed for compliance with the 75% average daily saturation DO criterion based on a single grab sample as shown below, provided that samples are taken within the specified times shown.

c. Source: NHDES, 2003g.

Alternative % Saturation DO Assessment Criteria for Rivers / Streams and Impoundments

Use Support	Time of Single Sample	DO (% saturation)
FS	05:00 – 10:00 or 14:00 – 19:00	≥ 80% saturation or ≥ 90% saturation
Insufficient Information	05:00 – 10:00 or 14:00 – 19:00	> 45% but < 80 % or > 70% but < 100 %
NS	05:00 – 10:00 or 14:00 – 19:00	≤ 45% saturation or ≤ 70% saturation

Note: There is always concern regarding meter error, especially when meters are stored over long winters and not used for months then pressed into almost continual service. If the meter error is incorrect, other factors will manifest to make oxygen concentration secondary. FS saturation was changed from 100% to 90% as there may not be as much oxygen saturation on overcast days, or at times when there is little to no algae in the water body.

Table 3-4: - Use Support Matrix for Benthic Index of Biological Integrity, the City would propose the following changes to the classification table.

• Classification	• Benthic Index of Biologic Integrity	• Use Support
• Mountains	• ≥ 64.8	• FS
	<64.8 & >58.8	• PS
	• < 58.5	• NS
• Hills	• ≥ 58.5	• FS
	<58.5 & >53.1	• PS
	• < 53.1	• NS
• Plains	• ≥ 53.1	• FS
	<53.3 & >48.8	• PS
	• < 48.8	• NS
• Hybrid	≥ Weighted criteria	• FS
	< Weighted criteria	• NS

6- 21

Note: As is indicated in Attachment 3, the IBI is a very subjective index. There is a point where four biologists actually each make their own subjective determination, based on their knowledge and skills then all come together to collaborate on a final IBI value. With this amount of subjectivity it is poor science to make a statement that at 64.8 designation for a water body is fully supporting and at 64.7 it is not supporting. There needs to be a partially supporting IBI designation and it is reasonable to have it fall between different classifications (as these are based on elevation).

Manchester offers the following comments on note 1 regarding the above table.

1. Justification for the classification of macroinvetebrate community types, and respective benthic IBI criteria can be found in NH DES report WD-2011-8 entitled *Site classification using a non-linear predictive model in New Hampshire*, prepared by Benjamin Jessup and David Neils (2011).
2. Assessments shall be based on data collected in accordance with DES biomonitoring protocols, which include the deployment and collection of rock baskets during the summer months. A description of the protocols can be found in *New Hampshire Department of Environmental Services (NHDES) Protocols for Collection, Identification and Enumeration of Aquatic Macroinverterbates for Computation of a Benthic Index of Biotic Integrity (B-IBI)* (Draft June 2005).

Note: In Attachment 4, an inter-department communication from David Neils and Phil Trowbridge discusses the use of the predictive model. The introduction outlines the advantages and disadvantages of the Probabilistic model. The narrative states the advantage as statistics from the model can be used to make inferences about conditions throughout the resource. The method is a generalized flag to determine the probability of non-compliance. It outlines the disadvantage as citing that *"specific locations of water quality violations cannot be inferred from the statistical sample."* Mr. Neils further goes on to point out on page four, third paragraph down the following, *"The private contractor then took this information and constructed an objective non-linear, logic based (Fuzzy Set) model that predicted the BCG tier. The model was calibrated from regional reference and test sites (N-43), then applied to the remaining regional NEWS sites to predict each site's BCG tier assessment. As noted above the results given herein are presented solely for demonstration purposes and not intended for regulatory interpretation."* This quote reinforces the statement regarding the disadvantage of this model use.

The document further outlines some major discrepancies between sample collection methods. *"For aquatic life use support, the DES Biomonitoring Program assessed benthic macroinvertebrate data using a modified index of biological integrity (IBI). Placement of sites into aquatic life use support categories using macroinvertebrates was completed utilizing an assessment tool that differed from standard techniques outlined in the DES Condolidated Assessment and Listing Methodology (CALM; DES, 20006). Deviation from the DES' wadable stream aquatic life use assessment tool, as detailed in the CALM, was necessary because macroinvertebrate samples collected using the NEWS field protocols differed dramatically from standard DES field techniques."* This information is found on page three under Environmental Indicators.

The section continues to discuss calibration and recalibration to force fit the mergence of the models. *"The WSA IBI was subsequently recalibrated using regional reference sites from Maine, New Hampshire and Vermont. The threshold for Fully Supporting or Not Supporting aquatic life use categories was set at 68 out of a possible score of 100.... Low gradient streams for which biomonitoring data were collected were classified as Insufficient Information. The exclusion of low gradient streams from the probabilistic assessment differs from targeted wadeable stream aquatic life use assessments covered under the current DES CALM, but is consistent with the use and recalibration of WSA IBI. DES felt it was more important to be consistent with concurrent probabilistic data collection protocols and assessment indices than the assessment techniques developed specific to DES data collection protocols."* Previous to the writing of this document the CALM was the standard for biomonitoring protocol. After this memo it was the recalibrated

WSA IBI that was the standard biomonitoring protocol. If there is doubt in established models, how can there be such certainty in 68 being the cutoff for Fully Supporting vs. Non Supporting? For this reason it is important that another category of Partially Supporting be established.

Further on in this document there are a series of tables and graphs that establish the basis for the WSA IBI. Series 1, Aquatic Life Use Support outlines error of between 9.3% and 12.9% with Appendix A giving a confidence level of +/- 13%. Series 2 outlines error for Primary Contact Recreation of between 6.4% and 10% with Appendix A giving a confidence of +/- 10%. Series three, Secondary Contact Recreation is the best at 5.6% with an Appendix A confidence of +/- 6%. Almost all, if not all of the WQ criteria in NH is based on Aquatic Life support (as this is always the most stringent parameter). However with a 13% confidence error for this designation, it is hard to understand 68 is the break between Fully Supporting and Non Supporting when the confidence level is +/- 13%.

Also included in (Attachment 5) is the data support page from the 2009 CEI Reckenhow Model for Nutt Pond in Manchester. Include with this is the 2011 AECOM TMDL Model supporting data for Nutt Pond. NHDES staff were pleased with the results of Nutt Pond compliance and were using Nutt Pond as a success story. The AECOM 2011 model indicates the pond is far from compliance and not a success story. What has been the difference? The use of different modeling and different assumptions within the models. As CEI noted a 91% recalibration need in their model, what was the recalibration need in the AECOM model? This is not outlined anywhere, but falls in line with a minimum expectation for modeling as outlined in our 3.1.20 suggestions.

In January of 2004 a report was published titled, Development of the New Hampshire Benthic Index of Biotic Integrity (Attachment 6). This was prepared by the USEPA for NH. The EPA cites that the NHDES was primarily using a qualitative manner to make assessments and encouraged the NHDES to implement plans for developing numeric biological standards.

In this document (page 6) the EPA states use of the NMDS PC-ORD 4.0) MjM Sofware, Gleneden Beach, Oregon using an auto pilot mode. There were test solutions run though six axes to choose the solution with the lowest stress value. Axis 1 accounted for 32% variability and axis 2, 53% of the variability. Classification schemes were based on the U.S. Forest Service bioregions, Omernik Level III ecoregions or the The Nature Conservancy (TNC) scheme. These were evaluated by examining ordination plots and coded by class. It was determined that the TNC scheme provided the most promising classification. Here you have three varying products with three varying results. This is similar to the Five models that were averaged in the recent NH TMDL listings for Manchester's four Urban Ponds. Why were these three schemes not used and average results applied? As NHDES points out above it is more consistent and advantageous to work with one model than three or a composite of the three. This supports Manchester's earlier comments where we suggested that the most liberal predictive model be used for anticipated compliance purposes. This is why there is such a difference between the 2009 CEI model and the 2011 AECOM models for Manchester's Urban Ponds.

A detailed explanation ensues in the Index Assembly and Evaluation section. The results section states, *"Using calibration data, we found that DES were similar between the two scoring schemes, but varied among the index alternatives.... We selected the all sites scoring method because the variability associated with this method was generally lower and was lower with a larger data set."* The description further over views the use of the imhoff method vs. the caton method. The EPA states, *"These results indicate that, although there are differences between methods, using all of the data to set metric thresholds will provide a more conservative estimate* *of condition because the current method will tend to score lower.* ***This means that index scores based on Caton method may tend to indicate that sites are in poorer condition than they actually are."***

The Future Work section states the following, *"At least partial re-analysis of metrics is required in order to incorporate additional Caton data and replace imhoff cone data in the development process. Currently, no repeat visits to sites are available to estimate temporal variability associated with the B-IBI. However, this is an important index feature which should be evaluated in the future. A specific effort to visit a random subset of sites multiple times within a year or over multiple years is necessary to address this issue."*

Note: Table 12 of this report outlines the Caton vs the Imhoff method for the southern region outlining scores worst through Best. Both methods scored 10 on the best (excellent correlation). The Caton scored 28 on the Good with the imhoff scoring 26 (a very good correlation). On the fair category the Caton scored 22 with the imhoff scoring 14 (a 57% variation which is a very poor correlation). Finally the worst category had a 10 for the Caton method and a 2 for the Imhoff method (a 500% difference which is an unacceptable correlation). This further supports the need to closely scrutinize any designation that was placed in the fair or worst category via both methods and to make the necessary field determinations to truly determine if impairment is exhibited. As you can see models and statistics vary widely.

The Caton tendency to designate sites in poorer condition than they actually are can cost municipalities millions of dollars. In Manchester's response to the MS4 permit we clearly demonstrated the financial ramifications from placing a poorer assessment on a water body than actually exists. Also included in Attachment 7 is the cost for Manchester Urban Pond compliance using the StormTreat Systems (a proven system that was very successful at Crystal Lake). The cost for unit installation around the City to meet compliance at all four ponds at 15 ug/l was a capital cost of $571,141,048 with an annual maintenance cost of $2,285,845. When the 20% safety factor is added in and the compliance target is dropped to 12 ug/l the costs increase dramatically to $766,649,420 (a $195 million dollar increase on the capital end) and the maintenance increases to $3,048,253 (an annual $762,408 in maintenance). This is a great demonstration of the cost associated with listing sites in poorer condition than they actually are.

In another NHDES document, NH Benthic Index of Biotic Integrity (B-IDI) for Wadeable Streams, 2006Threshold Modification to Account for natural Variation as prepared by David Neils (Attachment 8) more information is made avail on IBI methods. The introduction enumerates on the NHDES 8 metric index with a north bioregional criteria of 67 and a south bioregional criteria of 45 out of 100. The NHDES modified the index based on the EPA National Exposure Research laboratory to reduce the standard to 7 metrics with a bioregional criteria of 77 for the north region and 66 for the south. This is a 15% variation in the northern region and a 47% change in the southern region. The last sentence reads, *"While the revised B-IBI included the most responsive metrics and proved capable of discriminating between reference and test sites, the index did not make use of direct measures of natural variation within and between reference sites."* As compliance is almost always a site specific condition, it would be prudent to include measures of natural variation within sites.

The methods description details how standard deviation estimates were used to compensate for natural variation. Standard deviation accounts for a 90% confidence level and standard error. The last sentence reads *"The T-test statistic was then multiplied by the overall standard error to produce a 90% confidence interval of =/- 12 B-IBI points. This error was then applied to the B-IBI scores giving a 65 value for northern regions and a 54 value for southern regions (much closer to the NHDES original numbers).'*

Note: This example illustrates how a one-size-fits-all model approach is prone to subjective error. This exhibits a step to compensate for inherent errors in models and statistics for which NHDES should be commended.

Under Indicator 4, Biological Assessments (CWFA-IBI) the following appears as note five.

5. The CWFA-IBI score ranges from 9 – 45 and is the summation of 6 individual metrics including the percentage of generalist feeder individuals, the percentage of coldwater specialist individuals, the percentage of top carnivore individuals, the percentage of brook trout individuals, the number of tolerant species, and the age class structure of brook trout individuals. The threshold use support criterion of 27 was defined as the twenty-fifth percentile score of the reference condition (i.e., minimally impacted). Details of the development of the CWFA-IBI can be found in DES publication #R-WD-07-33 entitled "Coldwater fish assemblage index of biotic integrity for New Hampshire wadeable streams." (NHDES, 2007a)

In review of the Coldwater fish assemblage document (Attachment 9) one reviews statements that seem contrary to scientific interpretation. Page 11 has a statement, "*For Eastern brook trout (EBT) age class metric, a subjective decision was made to override objective measures of success and further consider it for inclusion into the final IBI.*" There is a lengthy discussion metrics prior to this statement and in Table 5 (just below the statement) under discrete metrics for the EBT-age-class metric there were only 33% correct with a 62.5% discrimination efficiency a poor correlation for metric inclusion with reason eing it was included in the VT DEC Coldwater IBI.

Item 4 (Percentage of Eastern Brook Trout) and 5 (Eastern Brook Trout Age Class) on page 14 outline that reduced percentages can be attributable to changes in quantity and quality of habitat, effects of acid deposition, thermal regime or other unknown human impacts. The presence or absence of young-of the- year (YOY) is an important attribute when assessing overall ecological integrity of biological communities. Yet we see from Table 5 that that the correlation is poor. **6- 22**

Page 23, under Summary and Recommendations the following statement is made, "*The observed differences in reference and test site CWIBI scores were considered to be a reflection of locally induced human activities and the resultant impacts to overall ecological integrity of fish assemblage.* "

Note: As referenced earlier, there is a statement of acid deposition, thermal regime, unknown human impacts and in several sections of this document the effects of flooding with resultant sediment deposition from extensive erosion and the straightening of waterway bends where fish habitat.

A study in Alaska may shed some light on the belief that locally induced human activities and the resultant impacts to overall ecological integrity of fish assemblage. Alaska is a pristine environment with little to no impacts from human activity in most of that State. In an article from Alaska on a forum of the environment (Attachment 10) http://napaimute.org/2013/02/14/ak-forum-on-the-environment-middle-kuskokwim-fish-tissue-studies-and-fish-consumption-advisory-edition/ slimy sculpin environmental damage is not mainly caused by 'locally induced human activities', but from a variety of other impacts such as volcanoes, wild fires and pollutant discharge from Asian factories. The attached chart indicates that mercury is found in all tributaries within the area. As mercury is a ubiquitous element throughout NH waters and lakes, it is indeed possibly that it contributes to the YOY absence of EBT more so than 'locally induced human activities.' Page 26 states, "*For both states, (VT and NH) undisturbed coldwater streams have fish assemblages that are species poor….*" Is this due to the same factors as are experienced in Alaska?

Note: The document points out that another exercise is important when discussing top carnivores (trout). Whether or not the trout are a result of stalking or not. Page 25 points out that samplings efforts should make attempts to distinguish stocked from wild fish. As stocked brown and rainbow trout are non-native reproducing species in NH waters, these may be predatory on lower level species reflecting an absence due to perceived 'locally induced human activities' when in fact it is due to numerous top carnivore predators. The document points out that the CWIBI does not distinguish between wild (i.e. naturally occurring) and stocked fish. It states that, *"However, based on experience, this oversight is not believed to be problematic as many of the reference sites are not commonly subjected to regular stocking and in all likelihood are supportive of naturally occurring individuals."* While this statement is subjective, the NH Fish and Game has a site that specifically lists the streams where stocking takes place during the fishing season and should be a point included in the CALM (http://www.wildlife.state.nh.us/Fishing/Stocking/current.html) as a reference source prior to electro-shocking and determination of top carnivore distribution.

When the CWIBI was applied to reference sites five sites fell below recommended criteria (19 percent). Manchester believes that an 81% accuracy is not high enough to establish an absolute IBI without applying a mid-level partially supporting category. The indices are used to determine aquatic life use status for the purpose of completing federally-required water quality reports, state-level regulatory actions, and general water quality planning activities. However, the document does point out what Hughes noted (2004) that *"natural disturbances, unrelated to human activity, can cause temporary impacts to ecological communities, and additional investigation may be warranted before formal aquatic life use, "impairment" listing."* In addition, Langdon (2001) outlines that future work on the CWIBI should include a more rigorous collection of life state (i.e. YOY, adult) data for the Eastern brook trout to improve the discriminatory power of that particular metric. When you consider the vast scouring of the benthic habitat from the Mother's Day flood, the Patriots' Day flood and the severe weather we have had over the past decade, it's hard to believe that natural disturbances have not caused additional natural disturbances

The above considerations should also support the establishment of the partially supporting index for the TWFA-IBI rather than the break off point of 28 or greater being fully supporting and <28 being non-supporting. There is too much approximation in the findings to set such a rigid cut-off point.

Indicator 6, Habitat Assessments Table 3-27 again sets absolute cut-offs for attainment of full use support. Again a partial supporting use should be designated for the gray areas between supporting and non-supporting. Note number one provides enough subjectivity in the process that illustrates a partially supporting criteria is necessary. Note one states, *"Habitat information for habitat scoring is collected when Bioassessments are conducted. Data is based on visual observations (subjective criteria for the viewer) using standard protocols and assessment sheets that address ten specific habitat parameters for low and high gradient streams. Habitat parameters include epifaunal substrate/available cover, pool substrate characterization, pool variability, sediment deposition, channel flow status, channel alteration, channel sinuousity, bank stability, vegetative protection, and riparian vegetative zone width. Each parameter was then given a score from one to twenty."* 6- 23

Note: These values were then compared to table 3-27 to determine use support. There are scores from one to twenty or 5% difference in each numeric separation. There are 10 categories to select from. If one person marks one lower in each of ten categories, it equates to 50% overall subjective variation between two biologists.

Indicator 7 elaborates on Chlorophyll-a (Chl-a) and Total Phosphorus (TP) in Lakes. There is no category or description for rivers, streams or impoundments. Yet increasingly, the lakes criteria is being ascribed to all water bodies. A sub indicator for these separate water bodies should be developed if this continues to be the approach. 6- 24

Indicator 11 outlines Stream Channel Stability. The reference notation is the 2005 "Providional regional hydraulic geometry curves for the State of NH (available in Schiff et.al., 2007). Severe flooding inundated the state on Mother's Day 2006, and Patriot's Day of 2007 along with other lesser severe storms since the 2005 reference date. Manchester noticed several channel erosion conditions **6- 25**
upon inspection and clean ups after these storms in brooks leading to our urban ponds. We do expect that this is the case with numerous hydraulic profiles throughout the state. Has this 2005 reference been adjusted to account for the damage and vast channel changes from these subsequent storms?

Table 3-32 outlines WQC for metals that were not taken with 'Clean Sampling Techniques' (CST). After Manchester's experience with CST during our Aluminum Study data gathering phase, we have seen the significant difference that in concentration between CST and careful non-CST methods. We used a modified method of sample collection for silver in the first decade of the 21st century. Careful wet-testing sample collection, not using all CST resulted in removing silver from Manchester's NPDES' permit. Manchester does applaud this approach as it does acknowledge the difference in results from the differences in sampling methods. Note six has the statement, *"These tables account for moderate levels of contamination (i.e. the Contamination Concentration) that are likely to occur when CST are not implemented."* As you can see in the table the metals range from a low of 0.54
ug/l for chronic freshwater lead to a high of 9,000 ug/l for acute freshwater antimony. Two samples **6- 26**
fall within the range of 15 ug/l (TP limit). Hexavalent chromium has an acute criteria of 16 ug/l and is given an adjustment of 5.72 ug/l to 21.7 ug/l (a 26% adjustment). Lead has a freshwater acute limit of 13.88 ug/l and is given a 4.25 ug/l adjustment 18.1 ug/l (a 23% adjustment).

Note: TP levels are within this threshold, yet no allowance is made for non-CST criteria. If anything, samplers are exposed to much higher levels of TP than they would be to metals. Walking across a lawn that has had fertilizer applied to it is likely to result in residual fertilizer adhering to shoes, pants and all clothing. This residual concentration is likely to go up in windy conditions. This is why an allowance for non-CST sampling should be given for nutrients as it is being given for metals.

Indicator 10, Flow assessments note two, states that, *"Any AU within which there is a designated segment that is not meeting the General Standard in any month in the previous ten years will be assessed as Potentially Non-Supporting."*

Note: As sampling results go back five-years for river segments, there should be some continuity that follows for flows also stating the data will go back five years to be more representative of more current conditions.

6- 27

Respectfully submitted,

Ricardo Cantu
Superintendent

Cc: Fred Mc,Neill, P.E.

COMMENT #7: Robert R. Lucic, City of Dover

SHEEHAN
PHINNEY
BASS +
GREEN
PROFESSIONAL ASSOCIATION

SPhBG
ATTORNEYS AT LAW

MANCHESTER
1000 ELM STREET
MANCHESTER, NH
03101
T 603 668-0300
F 603 627-8121

CONCORD
TWO EAGLE SQUARE
CONCORD, NH
03301
T 603 223-2020
F 603 224-8899

HANOVER
17 ½ LEBANON STREET
HANOVER, NH
03755
T 603 643-9070
F 603 643-3679

BOSTON
255 STATE STREET
BOSTON, MA
02109
T 617 897-5600
F 617 439-9363

WWW.SHEEHAN.COM

Writer's Direct Dial
603-627-8188
rlucic@sheehan.com

December 11, 2015

VIA HAND DELIVERY

2012 303(d) Comments
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive; PO Box 95
Concord, NH 03302-0095

Attn: Ken Edwardson

Re: City of Dover Comments on NHDES draft 2014 303(d) List and CALM 7- 1

Dear Mr. Edwardson:

Enclosed please find the City of Dover's Comments on NHDES' draft 2014 303(d) List and CALM. Please note that the City of Dover also supports the comments submitted under separate cover by the Great Bay Municipal Coalition and the City of Rochester.

Thank you.

Very truly yours,

Robert R. Lucic

Enc.

City of Dover Comments on NHDES draft 2014 303 (d) list and CALM

The City of Dover wishes to thank NHDES for the opportunity to submit comments on the 2014 draft 303 (d) impairment listing and the 2014 Consolidated Assessment and Listing Methodology. Dover is a member of the Great Bay Municipal Coalition (Coalition) and incorporates the Coalition's comments into the City of Dover's comments by reference. A copy of the Coalition comments is attached. 7- 2

The City of Dover supports NHDES's decision to delist several Assessment Units in the Great Bay estuary for total nitrogen and withhold final assessment on others until a new methodology for assessing total nitrogen is developed, as explained in the "Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report and 303(d) List". Refer to the Great Bay Municipal Coalition comments which address this in greater detail. 7- 3

Upon review of the draft 2014 303 (d) list and supporting water quality data on which the listings are determined, it is disappointing to see the number of listings that roll over from previous determinations based on old water quality data. Many of the assessment units have not been sampled since 2008. In some cases, where a limited number of recent samples have been collected, the number of samples are insufficient to qualify for de-listing despite showing good water quality is present. All this points to the inadequate funding allocated to support a robust listing program that reflects current water quality conditions. Up to date sampling results is becoming more important as federal regulatory obligations require local communities to invest more resources in actions to improve water quality. Additional resources need to be found to support the sampling program other than from the local communities. The Cities and Towns are paying to implement the necessary improvements to protect and improve the waters of the State, and the State needs to fund an adequate monitoring program for the 305 (b) and 303(d) program. 7- 4

The following comments address specific assessment unit listing designations on the 2014 draft 303 (d) list based on a review of the available supporting water quality data.

Cocheco River NHEST600030608-01

This assessment unit is the tidal portion of the Cocheco River which extends from the head of tide dam in downtown Dover to where the Cocheco and Salmon Falls rivers meet to form the Piscataqua River.. The City of Rochester engaged water quality experts from Brown and Caldwell to review this impairment listing. Rochester's comment letter provides detailed comments on Assessment Unit NHEST600030608-01 which are incorporated into Dover's comments by reference. 7- 5

Cocheco River NHRIV600030608-03

This assessment unit is impaired for DO. All DO concentration samples taken in the assessment unit meet water quality standards. The listing is based on DO saturation at one location that failed to meet the water quality standards in 2007. Since then all samples have meet the DO concentration and saturation water quality standards and multiple locations in the assessment unit. This assessment unit should be delisted.

NHDES should review its criteria to remove impairment listings. The delisting criteria should be more in line with the criteria used to list an assessment unit. The CALM should either require more sample data prior to listing an assessment unit as impaired, or soften the requirement to delist a unit as water quality shows improvement. The Coalition submitted legislation in the last session of the NH 7- 6

Legislature to have the DO standard modified to meet current EPA guidance which relies on DO concentration as the most reliable way to measure and insure sufficient oxygen in a water body. NHDES supported the review of the DO standard in a letter from the Commissioner to the House Committee, but the Committee elected to have NHDES have the Water Quality Standards Committee review the issue and report back to the House Committee. Dover urges NHDES to make the review of the DO, pH, and chloride water quality standards a priority as the impending NPDES MS4 General Permit will require communities to begin a series of planning and implementation activities to improve water quality discharging from their stormwater systems to meet in stream water quality standards.

Sawyer Mill Dam NHIMP600030903-02

There are 20 Chl-a samples from 2006 and 2007 used in the listing assessment, seven of which were in the critical period. Only one of the seven results in the critical period exceeded the Chl-a water quality standard of 15 up/l, and that was 15.48 ug/l. There were no other exceedances in the other 19 sample results. According to Tables 3-13 and 3-20 in the 2014 CALM, the Use Support should be either Insufficient Information or Not Assessed, not Non Supporting as the 2014 draft list suggests.

The bacteria impairment for this assessment unit are based on 2006 and 2007 sampling data. Dover has performed cross connection removal and sewer line rehabilitation work in this section of the Bellamy watershed. It is likely that the bacterial sources responsible for the water quality violations in 2006 and 2007 have been removed. New sampling for bacteria needs to be performed to confirm current water quality. It should be noted that according to the supporting data, NHDES sampling personnel have collected water quality grab samples for other parameters from the site annually from 2008 through 2013. **7- 7**

Knox Marsh / Bellamy River NHRIV600030903-08

This assessment unit is listed as impaired for bacteria. There are 15 samples during the critical period during 2011 and 2013. None of the samples exceeded the calculated Geometric Mean or Single Sample water quality thresholds established in the 2014 CALM. This assessment unit should be removed from the impairment listing as it is currently attaining bacteria water quality standards based on the supporting water quality data. **7- 8**

Garrison Brook NHRIV600030903-13

This assessment unit is impaired for bacteria as a result of sampling done in 2006. As this area is connected to the public sewer, the city followed up with an investigation to see if there was an issue with the sewer line. The sewer line was found to be in good condition, so additional sampling was conducted and analyzed using DNA to determine the species source of the bacteria. The results showed dog waste was the major component of the bacteria in Garrison Brook. The City in partnership with the NHDES watershed assistance program, Seagrant, and local residents conducted a pet waste education program. The neighborhood survey results done as a part of the pet waste project revealed that some residents were collecting and dumping their pet waste where the brook crossed under Garrison Road. The project outreach and education utilized the survey information to target dog owners by explaining the importance to pick up and properly dispose of their pet waste. Follow up sampling should be done if necessary to remove the impairment; though, knowing it was dog waste creating the impairment and the program targeted and changed the behavior of the dog owners could justify delisting Garrison Brook for bacteria. **7- 9**

The following are comments on the 2014 CALM:

Section 3.1.11 Data Age

The CALM establishes a data age requirement of 10 years for lakes and impoundments and 5 years for rivers and streams. It then allows for older data to be used if new data is not available to prevent former impairments being delisted.

In some of cases where old data is being used, water quality is very likely to have improved as a result of BMP installations, cross connection source removal, or through public outreach and education efforts. Retaining impairments in such cases using old data is unfair and wasteful of community resources as the proposed MS4 permit will require communities to expend resources on potentially unneeded additional actions. Where subsequent actions have been taken that significantly impact pollutant loadings to a water body, DES should specify that assessment of the effect of the improvements should occur before additional regulatory measures are mandated. **7- 10**

At the very least DES should create a new category acknowledging that a waterbody may likely be meeting water quality standards as a result of improvements while sampling has yet to be done to confirm a delisting or continuing impairment is justified.

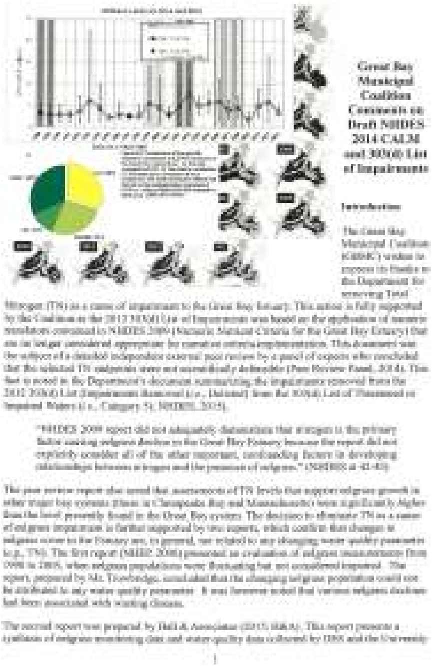
Garrison Brook and Sawyer Mill Dam bacteria impairments described above are examples of this issue.

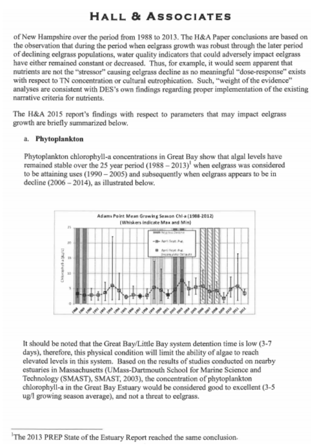
Section 3.1.14 Definition of Independent Samples

The CALM states that when multiple samples are collected at a sample location on the same day the analytical result with the poorest results are to be used in impairment analysis. Great care is required during the collection of samples to avoid the introduction contamination which result in spurious analytical results. In cases where multiple samples are taken, the sample with poorer water quality is more likely the result of the introduction contamination from poor sampling technique, and the sample with the better water quality more likely reflects the stream water quality conditions. NHDES should modify the CALM to avoid unwarranted impairment listings. **7- 11**

Turbidity Indicator 20

Pages 82 and 83 Turbidity thresholds for II-PAS and II-PNS suggests that higher turbidity is supporting and low turbidity is non supporting and conflicts with Note 5 on page 83 which describes the thresholds correctly. The definitions of II-PAS and II-PNS at the bottom of page 82 and top of page 83 need to be reversed to resolve the conflict. **7- 12**





HALL & ASSOCIATES

of New Hampshire over the period from 1988 to 2013. The H&A Paper conclusions are based on the observation that during the period when eelgrass growth was robust through the later period of declining eelgrass populations, water quality indicators that could adversely impact eelgrass have either remained constant or decreased. Thus, for example, it would seem apparent that nutrients are not the "stressor" causing eelgrass decline as no meaningful "dose-response" exists with respect to TN concentration or cultural eutrophication. Such, "weight of the evidence" analyses are consistent with DES's own findings regarding proper implementation of the existing narrative criteria for nutrients.

The H&A 2015 report's findings with respect to parameters that may impact eelgrass growth are briefly summarized below.

a. **Phytoplankton**

Phytoplankton chlorophyll-a concentrations in Great Bay show that algal levels have remained stable over the 25 year period (1988 – 2013)[1] when eelgrass was considered to be attaining uses (1990 – 2005) and subsequently when eelgrass appears to be in decline (2006 – 2014), as illustrated below.

It should be noted that the Great Bay/Little Bay system detention time is low (3-7 days), therefore, this physical condition will limit the ability of algae to reach elevated levels in this system. Based on the results of studies conducted on nearby estuaries in Massachusetts (UMass-Dartmouth School for Marine Science and Technology (SMAST), SMAST, 2003), the concentration of phytoplankton chlorophyll-a in the Great Bay Estuary would be considered good to excellent (3-5 ug/l growing season average), and not a threat to eelgrass.

[1]The 2013 PREP State of the Estuary Report reached the same conclusion.

...

See Comment set #8

7- 13

COMMENT #8: Robert R. Lucic, Great Bay Municipal Coalition

SHEEHAN
PHINNEY
BASS +
GREEN
PROFESSIONAL ASSOCIATION

SPBG
ATTORNEYS AT LAW

MANCHESTER
1000 ELM STREET
MANCHESTER, NH
03101
T 603 668-0300
F 603 627-8121

CONCORD
TWO EAGLE SQUARE
CONCORD, NH
03301
T 603 223-2020
F 603 224-8899

HANOVER
17 ½ LEBANON STREET
HANOVER, NH
03755
T 603 643-9070
F 603 643-3679

BOSTON
255 STATE STREET
BOSTON, MA
02109
T 617 897-5600
F 617 439-9363

WWW.SHEEHAN.COM

Writer's Direct Dial
603-627-8188
rlucic@sheehan.com

December 11, 2015

VIA HAND DELIVERY

2012 303(d) Comments
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive; PO Box 95
Concord, NH 03302-0095

Attn: Ken Edwardson

Re: Great Bay Municipal Coalition Comments on NHDES draft 2014 303(d) List and CALM 8- 1

Dear Mr. Edwardson:

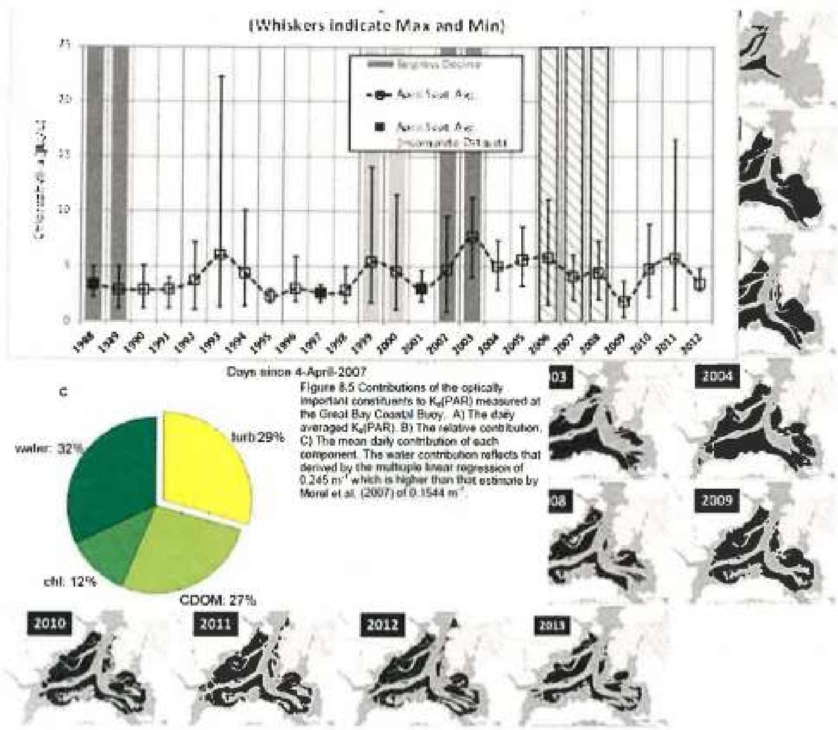
Enclosed please find the Great Bay Municipal Coalition's Comments on NHDES' draft 2014 303(d) List and CALM. Please note that the Great Bay Coalition also supports the comments submitted under separate cover by the City of Dover and the City of Rochester.

Thank you.

Very truly yours,

Robert R. Lucic

Enc.



Great Bay Municipal Coalition Comments on Draft NHDES 2014 CALM and 303(d) List of Impairments

Introduction

The Great Bay Municipal Coalition (GBMC) wishes to express its thanks to the Department for removing Total Nitrogen (TN) as a cause of impairment to the Great Bay Estuary. This action is fully supported by the Coalition as the 2012 303(d) List of Impairments was based on the application of numeric translators contained in NHDES 2009 (Numeric Nutrient Criteria for the Great Bay Estuary) that are no longer considered appropriate for narrative criteria implementation. This document was the subject of a detailed independent external peer review by a panel of experts who concluded that the selected TN endpoints were not scientifically defensible (Peer Review Panel, 2014). This fact is noted in the Department's document summarizing the impairments removed from the 2012 303(d) List (Impairments Removed (*i.e.*, Delisted) from the 303(d) List of Threatened or Impaired Waters (*i.e.*, Category 5); NHDES, 2015), 8- 2

> "NHDES 2009 report did not adequately demonstrate that nitrogen is the primary factor causing eelgrass decline in the Great Bay Estuary because the report did not explicitly consider all of the other important, confounding factors in developing relationships between nitrogen and the presence of eelgrass." (NHDES at 42-43)

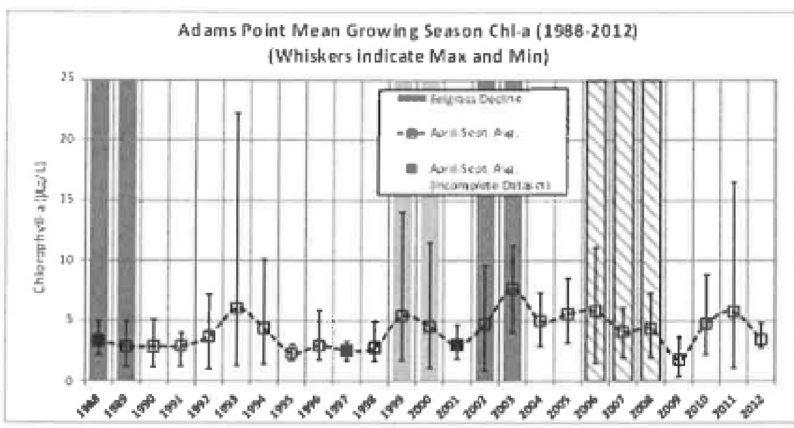
The peer review report also noted that assessments of TN levels that support eelgrass growth in other major bay systems (those in Chesapeake Bay and Massachusetts) were significantly *higher* than the level presently found in the Great Bay system. The decision to eliminate TN as a cause of eelgrass impairment is further supported by two reports, which confirm that changes in eelgrass cover in the Estuary are, in general, not related to any changing water quality parameter (*e.g.*, TN). The first report (NHEP, 2006) presented an evaluation of eelgrass measurements from 1990 to 2003, when eelgrass populations were fluctuating but not considered impaired. The report, prepared by Mr. Trowbridge, concluded that the changing eelgrass population could not be attributed to any water quality parameter. It was however noted that various eelgrass declines had been associated with wasting disease.

The second report was prepared by Hall & Associates (2015; H&A). This report presents a synthesis of eelgrass monitoring data and water quality data collected by DES and the University of New Hampshire over the period from 1988 to 2013. The H&A Paper conclusions are based on the observation that during the period when eelgrass growth was robust through the later period of declining eelgrass populations, water quality indicators that could adversely impact eelgrass have either remained constant or decreased. Thus, for example, it would seem apparent that nutrients are not the "stressor" causing eelgrass decline as no meaningful "dose-response" exists with respect to TN concentration or cultural eutrophication. Such, "weight of the evidence" analyses are consistent with DES's own findings regarding proper implementation of the existing narrative criteria for nutrients.

The H&A 2015 report's findings with respect to parameters that may impact eelgrass growth are briefly summarized below.

a. **Phytoplankton**

Phytoplankton chlorophyll-a concentrations in Great Bay show that algal levels have remained stable over the 25 year period (1988 – 2013)[1] when eelgrass was considered to be attaining uses (1990 – 2005) and subsequently when eelgrass appears to be in decline (2006 – 2014), as illustrated below.

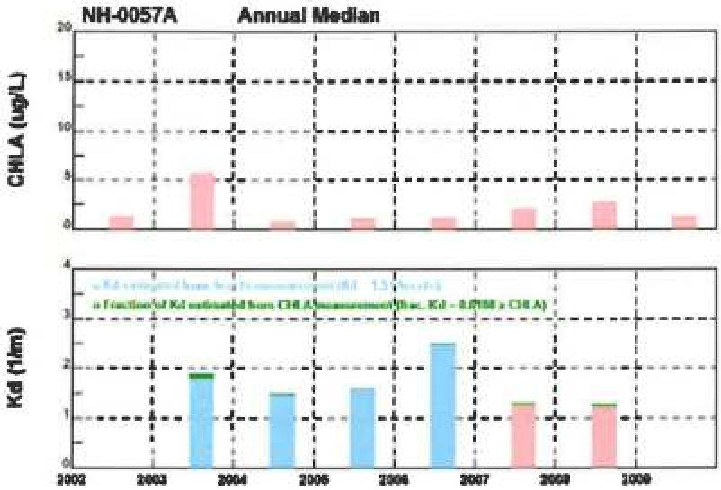


It should be noted that the Great Bay/Little Bay system detention time is low (3-7 days), therefore, this physical condition will limit the ability of algae to reach elevated levels in this system. Based on the results of studies conducted on nearby estuaries in Massachusetts (UMass-Dartmouth School for Marine Science and Technology (SMAST), SMAST, 2003), the concentration of phytoplankton chlorophyll-a in the Great Bay Estuary would be considered good to excellent (3-5 ug/l growing season average), and not a threat to eelgrass. 8- 3

[1]The 2013 PREP State of the Estuary Report reached the same conclusion.

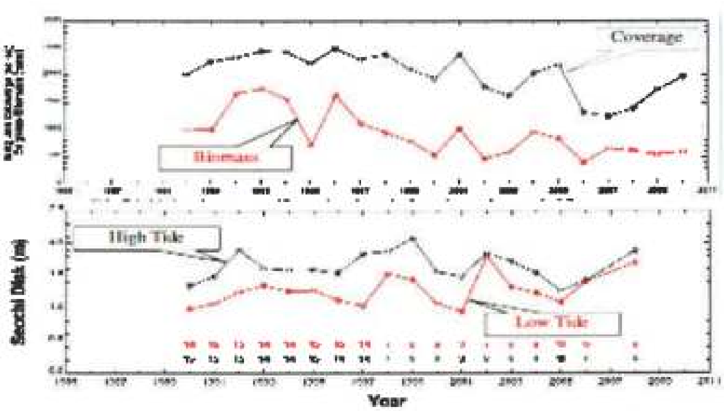
b. **Water Clarity**

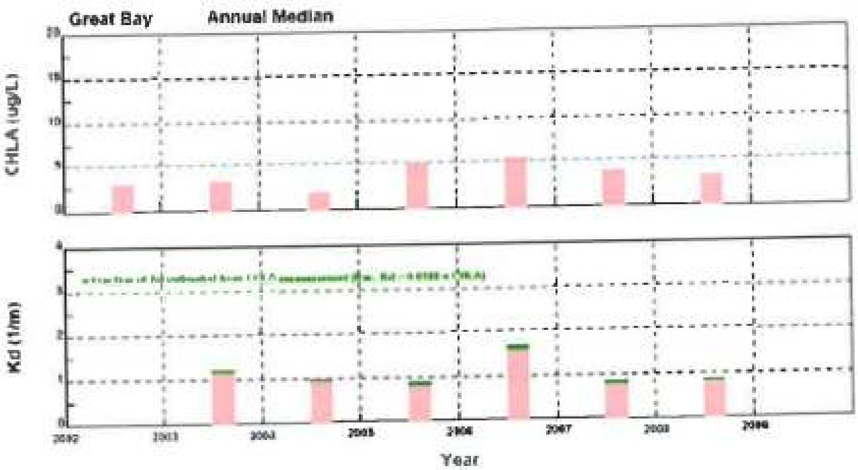
Independent studies by the University of New Hampshire have shown that, at the levels of chlorophyll-a observed in the Estuary, phytoplankton chlorophyll-a has a very minor effect on overall water clarity in Great Bay (Morrison *et al.*, 2008). Analyses of available transparency data by HydroQual have likewise confirmed that phytoplankton have a negligible impact on water clarity in the Piscataqua River.



8- 4

Moreover, other than the major system-wide decline in transparency occurring in 2006 following the Mother's Day storm, water clarity in Great Bay has remained essentially unchanged for the past 20 years and was fairly uniform before and after the 2006 eelgrass population decline.

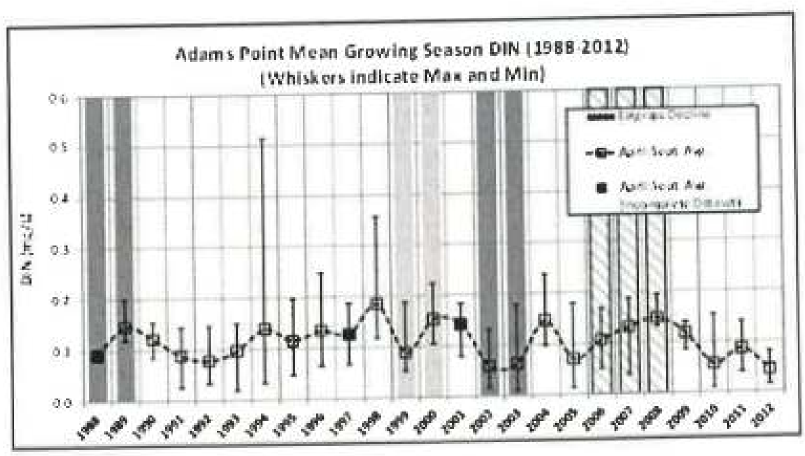


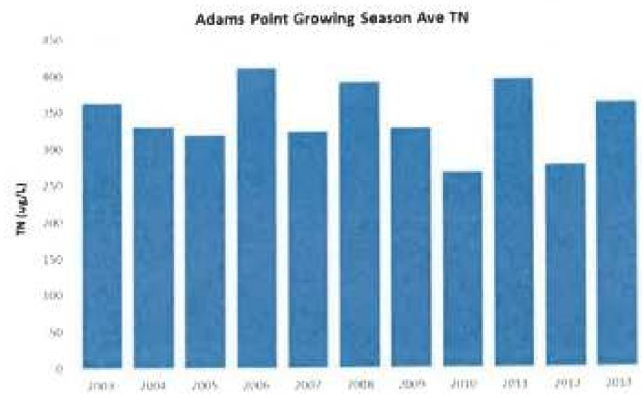


c. Nitrogen Concentration

As illustrated in the figures below, the level of dissolved inorganic nitrogen (DIN) has remained relatively constant or decreased since 1988. Corresponding measures for TN are only available since 2003, but these measurements also show that TN levels are indicative of high quality waters. These levels (only measured through 2012/2013) are projected to decrease further in response to upgrades in treatment at the Dover WWTP and Rochester WWTP, incorporating biological nutrient removal. The decrease is anticipated to be in the range of 0.04 mg/l in TN/DIN. Projected water quality would be a growing season average TN in the range of 0.3 mg/l, well below the range of TN found fully protective for sustaining eelgrass populations in other East Coast estuaries.

8- 5





The data show that DIN and TN levels have not increased above the concentrations observed when eelgrass cover was at its maximum in the mid-1990s. In the mid to late 1990s, DIN averaged between 0.1 – 0.2 mg/L when eelgrass cover was at its highest. Since 2010, DIN concentrations have consistently averaged below 0.1 mg/L when eelgrass cover has remained depressed in comparison with the earlier period. This DIN level is similar to pre-1980 conditions in the system. TN concentrations have remained relatively stable or decreased since 2003, albeit on a decreasing trend due to major WWTP reductions. These observations support a conclusion that factors other than DIN/TN are responsible for variations in the eelgrass population.

d. **Other Estuary Studies**

A comparison of the nitrogen levels in the Great Bay Estuary with nitrogen levels determined to be protective of eelgrass populations in other East Coast estuaries indicated that these concentrations should not adversely affect eelgrass cover.[2] Based

[2]The potential for nutrient concentration and phytoplankton chlorophyll-a levels adversely affecting seagrasses in East Coast estuaries has been a focus of recent investigations. A detailed evaluation of mid-Atlantic coastal bays in Maryland and Virginia used water quality thresholds based on habitat requirements and a water quality index to compare current distributions of seagrass in different bay segments (Wazniak *et al.*, 2007). The water quality thresholds considered to adversely affect eelgrass were 0.65 mg/L for total nitrogen and 15 μg/L for chlorophyll-a. Based upon this study, healthy seagrass populations were associated with TN <0.55 mg/L while degraded seagrass populations occurred at 0.65-1.00 mg/L TN (Wazniak *et al.*, 8- 6
2007, Table 1). A more recent study of Chesapeake Bay in 2014 observed that despite elevated nutrient concentrations, SAV in the Susquehanna Flats, a broad and shallow northern region of the bay, increased significantly from 2001-2010 (Gurbisz & Kemp, 2014). During this period, TN and DIN concentrations averaged 1.5 and 1.2 mg/L, respectively. These TN and DIN concentrations are several times greater than those observed in Great Bay Estuary. In another recent study of Massachusetts estuaries, the relationship of eelgrass survival and habitat quality to water column nitrogen levels and phytoplankton biomass was assessed in 2007-2009 and again in 2011 (Benson *et al.* 2013). This study found healthy eelgrass populations existed at approximately 0.40 mg/L TN while significant degradation of eelgrass populations occurred at approximately 0.60 mg/L TN (Benson *et al.*, 2013, Figure 2).

on the results of studies conducted on nearby estuaries in Massachusetts (SMAST, 2003), the concentration of DIN/TN in the Great Bay Estuary would be considered good to excellent (0.30 – 0.39 mg/L), and not a threat to eelgrass.

e. **Evaluation of Eelgrass Declines in Great Bay**

An evaluation of the variation in the spatial distribution of eelgrass cover in Great Bay, as presented in Hall & Associates (2015) shows that all major eelgrass losses have occurred in the shallowest areas of the Bay. These areas are the last areas that would be affected if TN-induced changes in water clarity were the cause of eelgrass impairment. Consequently, it is well-documented that system water clarity related to TN has not caused impairment, some other mechanism must be responsible for the observed losses that are reoccurring in the shallow, not deep areas of the bay. 8- 7

f. **Eelgrass Declines in Portsmouth Harbor**

Water quality in Portsmouth Harbor is, by all measures, high quality and representative of oligotrophic conditions. Even so, eelgrass cover has declined in this area of the Estuary. As with Great Bay, some other mechanism unrelated to cultural eutrophication are likely responsible for the observed losses. 8- 8

In summary, there is no credible information showing that TN or DIN is playing any significant role in eelgrass population changes in this system. Nutrient levels are at a 30 year low and, in fact, lower than during the mid-1990s period when eelgrass growth was robust. Delisting the system as TN-impaired is fully supported by the existing data and studies for nearby systems. The "weight of evidence" confirms that DES' proposed action is well supported. 8- 9

CALM Nutrient Indicator Concerns

The following provides comments on the CALM and the revised water quality criteria interpretations to be used for impairment determinations. The Coalition would note that EPA has announced that it will rely on the impairment lists as the basis for imposing more restrictive requirements on MS4 communities in New Hampshire. For this reason, the Coalition urges DES to remove "pollutant impairment presumptions" contained in the revised CALM. Where data and site-specific analyses do not confirm that an impairment is actually due to a specific pollutant or pollutant source, a "*to be determined*" conclusion should be reached which will allow the parties time to assess the situation and determine if MS4 contributions are significant and require reduction to ensure standards can be attained. 8- 10

8- 11

Indicator Part 8: Eelgrass Cover in Great Bay Estuary

The Coalition agrees that eelgrass are a critical ecological component of the Great Bay system. As described in the attached paper evaluating the various factors potentially impacting eelgrass populations (Hall & Associates, 2015), the presence of eelgrass has primarily fluctuated in the Great Bay system and tidal rivers in response to a number of natural conditions: wasting disease infestation (1930s, 1988, 1995, 2003), extreme storm events (2006) and naturally low water clarity due to elevated CDOM found in all of the major tributaries in the system. Some areas of the system never recovered from the wasting disease event of 1988 (in particular, Little Bay, an area of Great Bay near the Squamscott River and most of the tidal rivers). We would note further that elevated water temperature, which is documented to be occurring, further stresses eelgrass populations. As noted earlier, no party has ever demonstrated that a regulated "pollutant" is the cause or a significant contributor of these fluctuating eelgrass levels. (See, e.g., 2006 NHEP Environmental Indicator Report "observed changes in eelgrass cannot be linked to a water quality trend…" at 8).

Indicator 8 specifies that the system will be considered "fully supporting" if eelgrass levels are within 20% of "historic" levels. This metric begs a question that first must be answered. Given the broad natural fluctuation in eelgrass in this system due to wasting disease and other natural events, what should be considered the "historic" level against which eelgrass impairment is assessed? Over time, DES has used a long term average eelgrass population in the range of 2100 (+/- 20%) acres for Great Bay to set expectations for this part of the system. Little Bay, with better water quality than Great Bay, has never recovered from the 1988 wasting disease event (with about 10% of its "historic" eelgrass population now present). Likewise, there are areas of Great Bay that historically supported eelgrass growth that, post-2006 Mother's Day storm, no longer support eelgrass growth (e.g. near the mouth of the Squamscott River). Whether or not the existing habitat allows for eelgrass regrowth in this area is presently unknown.

Consequently, presuming that any decline below the 20% threshold constitutes an eelgrass resource impairment is misplaced – as the significant impact of various "natural" events are well documented in this system, it is improper to simply assert that eelgrass levels must reflect "historic" (1948) conditions or any such changes from historic will be identified on the Section 303(d) list as impairments that may be regulated under the Act.

We would observe further that such a designation is misleading to the public. As noted by EPA "The CWA does not require states…to adopt designated uses to protect a level beyond what is naturally occurring in a water body." 80 Fed. Reg. 51025 (August 21, 2015). Regarding natural conditions, the 2014 CALM notes:

> In New Hampshire, exceedances of most water quality criteria due to naturally occurring conditions are not considered violations of the water quality standards. According to Env-Wq 1702.29 of the State's surface water quality regulations (NHDES, 2011a), naturally occurring conditions means "conditions which exist in the absence of human influences."(CALM at 16).

The CALM provides several examples of what might constitute naturally occurring conditions. Two of these are particularly appropriate in considering conditions in Great Bay:

> Low dissolved oxygen (DO) or pH caused by poor aeration or natural organic materials, where no human-related sources are present or *where impairment would occur even in the absence of human activity.*
>
> Habitat loss or pollutant loads due to catastrophic floods that are excluded from water quality standards or other regulations. (CALM at 16).

Of course, wasting disease events would also fall under "natural" conditions that are beyond the scope of the Clean Water Act and state law. Infrequent low DO caused by stratification should also be considered "natural" for any areas of the system where TN is not significantly increasing algal growth. Given the well documented impact of natural phenomena on eelgrass populations, DES needs to develop a means for distinguishing between changes in eelgrass/DO that are caused by events intended to be regulated under state and federal law, versus those that all agree are not. Declines due to wasting disease, while regrettable, are not to be "regulated" by anyone. Likewise, any losses due to storms or natural habitat changes do not constitute impairment, regardless of how much they differ from "historical" conditions. Therefore, we request that DES takes steps to identify the eelgrass population that may reasonably exist under current conditions and clarify that any changes in eelgrass populations due to the various natural conditions discussed above do not constitute an impairment to be addressed.

Indicator Part 9: TN Concentration and Associated Eutrophication Impacts in Great Bay Estuary

This Indicator includes the following:

> If nutrient levels (as measured by Total Nitrogen concentrations) are *elevated* and adverse responses exist in the same assessment unit, then that assessment unit may be considered to have excess nutrients in violation of Env-Wq 1703.14 *if a preponderance of evidence warrants such a determination*. (at 66; emphasis added).

The Coalition agrees that a "preponderance of the evidence" standard should apply to narrative criteria implementation. Such a demonstration is reasonable for a "stressor-response" analysis that relies upon the interpretation of ambient pollutant and ecological response data. However, the section should be made clear that one may not presume that a pollutant (*e.g.*, TN) caused the "adverse response" condition, under the proper implementation of the state's existing narrative criteria. This has been an issue that has plagued NPDES permitting with EPA Region I. To find a "nutrient impairment" there must be a scientifically valid demonstration that above a specific threshold, nutrients caused excessive algal growth which caused adverse effects and impairments (*e.g.*, low DO); DES should be clear that these causal linkages cannot be assumed. Nor can they be based on "general causation" (*i.e.*, showing a conceptual model of what can occur) it must be based on a "specific causation" analysis (*i.e.*, site-specific evaluation of credible and sufficient data showing that the pollutant is a significant cause of the condition and that the condition is not 8- 12 a result of other "confounding factors"). See, *Ohio Valley Envtl. Coal. v. Fola Coal Co., LLC*, 81 ERC 1519 (S.D. W.Va. 2015) where the court recognized that a specific showing of significant impact must be made in implementing narrative criteria, including an analysis of confounding factors. [3]

As previously noted the level of dissolved inorganic nitrogen (DIN) has remained relatively constant or decreased since 1988. Corresponding measures for TN are only available since 2003, but these measurements also show that TN levels are indicative of high quality waters. These levels are expected to decrease in response to upgrades in treatment at the Dover WWTP and Rochester WWTP, incorporating biological nutrient removal. The lack of effect from of the existing nutrients on the primary indicator of eutrophication (phytoplankton) has long been recognized:

> Any increase in nitrogen concentrations has apparently not resulted in increased phytoplankton blooms. The only increasing trend for chlorophyll-a was observed at a station with very low concentrations already. (Trowbridge, June 15, 2006).

Moreover, it is well-documented that nutrients have played no role in adversely impacting system transparency, yet transparency is still included under the nutrient impairment provision. For the tidal rivers, it is well documented that CDOM and turbidity levels alone create condition that would prevent eelgrass growth. Therefore, discussing how this is an area of concern with respect to eelgrass is not appropriate for any part of this system. At this point, it would be fair to conclude that a demonstrable relationship between TN/DIN levels, transparency and eelgrass has yet to be documented and given the low nutrient concentrations present none would be expected.

The following addresses the individual sub-components of the TN impairment indicator.

[3] In the nearly three hundred page Benchmark study, the EPA reached the conclusion that "salts, as measured by conductivity, are a common cause of impairment of aquatic macroinvertebrates" in central Appalachian streams only after considering and then ruling out the potential confounding effects of habitat, organic enrichment, nutrients, deposited sediments, pH, selenium, temperature, lack of headwaters, catchment areas, settling ponds, dissolved oxygen, and metals. EPA's Benchmark at A-1, B-1; *see also id.* at A-40 In describing a sufficient evaluation for claiming a narrative criteria violation: "This causal assessment presents clear evidence that the deleterious effects to benthic invertebrates are *caused by, not just associated with*, the ionic strength [, i.e., conductivity,] of the water …. When [other potential] causes are absent or removed, a relationship between conductivity and ephemeropteran [, i.e. mayfly,] richness is still evident." (emphasis added)) Id at A-37.

Indicator Part 9a: DO Assessment

The TN/DO connection presented in this section requires amendment. DO evaluations are far more complex than presented. The mere existence of low DO and a 90%ile chl-a above 10 ug/l 8- 13
cannot provide a credible scientific basis for concluding TN is a significant cause of a DO criteria violation. First, the 90%ile concentration is the wrong endpoint for an estuarine

evaluation since it is the system's SOD component (caused by long term detrital deposition), in conjunction with a stratification condition that most typically causes low DO in estuaries. This may be a natural condition that cannot be abated, as recognized by EPA's 2000 Marine DO Criteria. Moreover a number of other factors control the DO regime, such as organic loads from the tributaries. As discussed below (Part 9b indicator) the chosen algal level represents basically "excellent water quality" for an Atlantic Coast estuary (SMAST, 2003). The DO evaluation should not demand the existence of minimal algal growth to conclude algae are not a significant component of a low DO condition, when so many other non-nutrient factors may control this endpoint. Rather this provision should require the assessment of all major factors impacting the DO regime, before concluding that the algal level is a significant component that needs to be regulated.

Another ongoing concern is the plainly dated water quality criteria that are being used to evaluate whether DO levels are impairing the resource. Dissolved oxygen saturation describes the dissolved oxygen in water as a percentage of the saturation level. In the 1970's and 1980's, the United States Environmental Protection Agency (EPA) researched the development of DO water quality standards (WQS) in terms of concentration and percent saturation. Some states eventually included both DO concentration and saturation in their WQSs. Over time, additional research indicated that percent saturation, as a WQS, is not reliably protective of aquatic life. Under certain conditions, the DO saturation may be relatively low, but the DO concentration may be very protective of aquatic life. The contrary is never true; a relatively high DO saturation with a low DO concentration will have adverse impacts on aquatic life. This is because aquatic life depends on adequate DO concentration to survive and remain healthy, regardless of DO saturation. With this more comprehensive understanding of DO impacts on aquatic life, many states have, as recommended by EPA, deleted DO saturation WQSs from their regulations.

EPA's *Ambient Water Quality Criteria for Dissolved Oxygen* (1986)[4] states:

> Expressing the criteria in terms of the actual amount of dissolved oxygen available to aquatic organisms in milligrams per liter (mg/l) is considered more direct and easier to administer compared to expressing the criteria in terms of percent saturation. Dissolved oxygen criteria expressed as percent saturation, such as discussed by Davis (1975a,b), are more complex and could often result in unnecessarily stringent criteria in the cold months and potentially unprotective criteria during periods of high ambient temperature or at high elevations. Oxygen partial pressure is subject to the same temperature problems as percent saturation. (at 1).

This clearly explains that percent saturation criteria are inappropriate to protect aquatic life. Percent saturation is heavily influenced by natural factors (temperature, atmospheric pressure,

[4]USEPA. (April 1986). Ambient Water Quality Criteria for Dissolved Oxygen. Available at http://nepis.epa.gov/Exe/ZyPDF.cgi/00001MSS.PDF?Dockey=00001MSS.pdf.

salinity) which vary by the hour. These dynamic factors overcomplicate the use of percent saturation in aquatic life criteria. Instead, DO concentration criteria have been developed.

> The more simplistic approach to dissolved oxygen criteria has been supported by the findings of a select committee of scientists specifically established by the Research Advisory Board of the International Joint Commission to review the dissolved oxygen criterion for the Great Lakes (Magnuson et al., 1979). The committee concluded that a simple criterion (an average criterion of 6.5 mg/l and a minimum criterion of 5.5 mg/l) was preferable to one based on percent saturation (or oxygen partial pressure) and was scientifically sound […]. Also, the total amount of oxygen delivered to the gills is a more specific limiting factor than is oxygen partial pressure per se. […] The national criteria presented herein represent the best estimates, based on the data available, of dissolved oxygen concentrations necessary to protect aquatic life and its uses. (at 2).

This further emphasizes that extensive research concludes DO concentration is a more appropriate and protective criterion than percent saturation.

According to EPA's *Quality Criteria for Water 1986* ("Gold Book")[5]:

> The dissolved oxygen (DO) criteria section lists no criteria for dissolved oxygen saturation, only DO concentration. The Gold Book states, "[e]ach [DO] criterion may thus be viewed as an estimate of the threshold *concentration* below which detrimental effects are expected" (at 209) (emphasis added).

In deriving the DO criteria, EPA does not discuss ever considering DO saturation. In this section, the word "saturation" is only mentioned in the context of averaging DO concentration values – the maximum DO concentration value used in determining an average "should not exceed the air saturation value." (at 214).

EPA's *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras* (November 2000)[6] states:

> The 2000 marine dissolved oxygen aquatic life criteria were developed after ten years of research, analysis, and technical conferences. This document states, "[t]he criteria presented herein represent the best estimates, based on the available data, of DO *concentrations* necessary to protect aquatic life and its uses." (at 1) (emphasis added).

---

[5]USEPA. (May 1, 1986). Quality Criteria for Water 1986. Available at http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/upload/2009_01_13_criteria_goldbook.pdf.

[6]USEPA. (Nov. 2000). Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras. Available at http://water.epa.gov/scitech/swguidance/standards/upload/2007_03_01_criteria_dissolved_docriteria.pdf.

None of the guidance documents recommend DO saturation values. Therefore, in accordance with EPA's guidance documents and well-understood ecological interactions, DO saturation should be removed as an impairment or an impairment indicator.

Regarding DO conditions in the tidal Cocheco River, the rare low DO concentration data discussed by DES were determined to be anomaly reading due to data sonde interferences and not true readings or a results of nutrient effects:

> *The sondes gave false readings at times, based on existing knowledge and the conditions at the time of the questionable readings.* The data for these readings have been highlighted in yellow in the attached 'PiscRiver sonde data Summary by SITE & rainfall' file. *For example, there were times for all three sondes where the DO concentration and % saturation would drop to 0 for one time reading, then return to the levels found prior to the single-time reading.* This happened 16 times at Site 1, 6 times at Site 2 and 8 times at Site 3 (Table 7). Otherwise, all other DO readings were >79.7 % saturation and 6.55 mg/L (both lows at Site 3). These readings suggest non-limiting DO at all times during the study period. Water temperature and salinity readings also dropped to abnormal low levels at Sites 1 and 3, but only during low depth conditions, and less frequently at Site 1 than at Site 3 (Site 3 was the only site where there were negative depth readings); low pH readings were also associated with low depth events. (Jones at 8; emphasis added).

The reliable data collected for this system show that DO is generally excellent and that ecologically meaningful DO exceedances are not occurring. The final Section 303(d) report should reflect that fact.

Indicator Part 9b: Chl-a Concentration Indicator to Protect DO

The chlorophyll-a concentration indicator sets a threshold of of 10 µg/L as the 90th percentile threshold for assessing use support for the DO water quality criteria. Data collected throughout this system shows that this target value is equivalent to a growing season average of 3-5 µg/L. As discussed previously, a growing season average of 3-5 µg/L chlorophyll-a represents good to excellent health (SMAST, 2003). Consequently, it is highly improbable that this threshold is associated with a dissolved oxygen impairment. The 10 µg/L threshold value was originally derived in the 2009 Criteria document and as discussed in the expert report, this threshold value lacks a scientific basis and should be re-derived based upon a scientifically valid demonstration associating the level of chl-a with DO impairments. 8- 14

Note 3b indicates that the chl-a concentration data should cover "all four seasons of the year." This is scientifically and ecologically inappropriate as algae exhibit substantially reduced growth, if any, in the non-growing season, or roughly half of the year. Moreover, due to reduced oxidation and higher DO saturation levels, "cold weather" DO violations basically never occur.

Consequently, only the growing season data should be assessed if one is to focus on nutrient control during a "growing season" DO concern, as is the accepted practice.

Finally, any assessment for chlorophyll-a concentration must be based on measurements corrected for pheophytin to avoid misapplication of this value. One is concerned with the algae grown in the waters where the measurement is taken (*i.e.*, live algae) not algal or plant detritus that washes into the system. If this is not corrected, one could improperly presume that (1) excessive algae exist and (2) control of nutrients in the estuarine segment will abate the situation (when it cannot).

Indicator Part 9c: Water Clarity (K_d) Indicator

Indicator Part 9c (light attenuation coefficient) is being used to assess support for a balanced, integrated, and adaptive community (*e.g.*, eelgrass). The continued use of transparency targets as an indicator of nutrient impairment in the Great Bay Estuary is not appropriate or relevant as an indicator of eutrophication impacts. A spatial analysis of eelgrass declines and shifts over time in Great Bay shows that perennial eelgrass beds are typically located in deeper waters of Great Bay 8- 15 while inter-annual losses occur in the shallower, peripheral waters (see Hall & Associates, 2015). Likewise, the 2006 Trowbridge NHEP analysis confirmed that eelgrass populations were the most persistent in the deeper areas of Great Bay. If light attenuation were an issue, the *opposite* would be occurring, it is not.

Due to the tidal range and shallow bathymetry, it is estimated that 75% of the eelgrass cover in Great Bay is located in intertidal regions, where plant leaves lie on the water surface at mean low water, rendering the light attenuation coefficient largely irrelevant as a limiting factor to eelgrass condition (Beem & Short, 2008). These realities of the system contradicts any assertion that eelgrass declines are due to insufficient light availability.

Finally, study after study has confirmed that chlorophyll constitutes a negligible component of the light regime and that nutrients have not triggered any observable increase in phytoplankton growth (the form of plant growth affecting water column transparency). For example, a 2010 study concluded that chlorophyll-a does not account for a significant portion of the light attenuation in Great Bay (Morrison et al., 2008). Consequently, linking light attenuation to an impairment caused by nutrients is not supported by site-specific studies conducted for the Estuary.

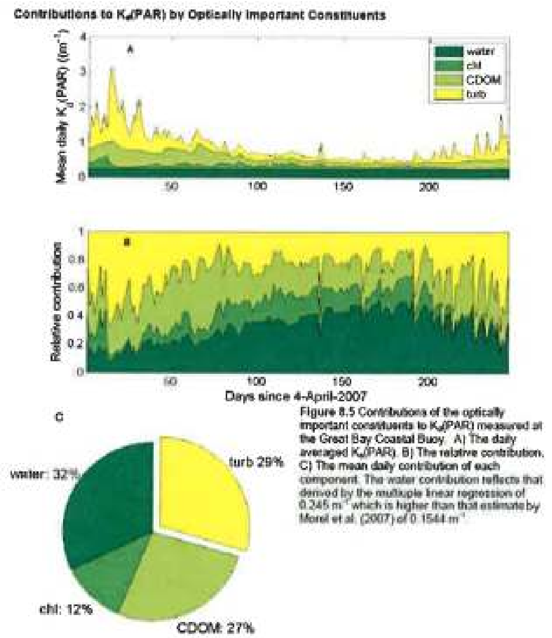


Figure 8.5 Contributions of the optically important constituents to K_d(PAR) measured at the Great Bay Coastal Buoy. A) The daily averaged K_d(PAR). B) The relative contribution. C) The mean daily contribution of each component. The water contribution reflects that derived by the multiple linear regression of 0.245 m^{-1} which is higher than that estimate by Morel et al. (2007) of 0.1544 m^{-1}

Instead, natural conditions (*e.g.*, water, turbidity, CDOM) contribute the greatest to light attenuation throughout the system. GBE is surrounded by forests and wetlands which naturally contribute CDOM in runoff to GBE. As a result, light attenuation is augmented in response to increased runoff (*e.g.*, rainfall). Morrison confirmed this fact when he correlated CDOM and transparency to salinity. Higher runoff produces lower salinity. Thus the CDOM and salinity are highly correlated. This is not a nutrient-mediated impact. It is a natural condition.

Finally, historical data on secchi depth measurements during the period when eelgrass was at its maximum confirm that (1) over time transparency has not changed materially and (2) the recommended target attenuation coefficients were never met in the Estuary, even when eelgrass were at their apex in the mid-1990's.Consequently, the use of these targets appears to have no relationship to use impairment (*i.e.*, eelgrass survival in Great Bay), are a natural occurrence and, therefore, need to be revised (that is, deleted).

Indicator Part 9d: Chl-a Concentration Indicator as a Component of Water Clarity

Indicator Part 9d (chlorophyll-a concentration as an indicator of water clarity) is being used to assess support for a balanced, integrated, and adaptive community (*e.g.*, eelgrass). This indicator sets a threshold as "90th Percentile Chl-a concentrations are not elevated." The term "not elevated" is undefined and as such, subjective in nature. The CALM should define the term "not elevated" in this context consistent with a demonstration of the chl-a concentration at which its contribution to light attenuation causes an impairment. 8- 16

Note 2 indicates that Indicator Part 9b (90th percentile chlorophyll-a > 10 µg/L) may be used as one approximation of peak chlorophyll-a concentrations that reduce water clarity. Comments presented above discuss why Indicator Part 9b is not scientifically defensible. Moreover, due to the relationship between runoff and light attenuation, *maximum light attenuation is expected to occur when inflow to the Estuary is high and chlorophyll-a concentrations are low* (e.g., the spring). Maximum chlorophyll-a concentrations tend to occur in the late summer when water temperature is higher and inflow is reduced. This period corresponds to a period of lower light attenuation (*i.e.*, the best water clarity – see Morrison 2008). As a consequence, the selected indicator is more likely to correspond to a period of improved transparency, which is contrary to the intent of this indicator. For this reason, the selected indicator needs to be significantly revised or eliminated from the CALM.

Indicator Parts 9e and 9f: Macroalgae and Epiphyte Indicators

Indicator Part 9e (macroalgae) and Indicator Part 9f (epiphytes) are being used as part of an overall weight of evidence for cultural eutrophication. These Indicators use the descriptors "little to no" and "moderate to heavy." This is subjective language and should be revised with quantified values. First of all, these values must be demonstrated to represent thresholds at which impairment to a balanced, integrated, and adaptive community (*e.g.*, eelgrass) occurs. Secondly, it must be demonstrated that macroalgae and epiphytes reach this level due to nutrient inputs and not natural conditions (*i.e.*, invasive species). Until these conditions are met, Indicators 9e and 9f cannot be applied in a scientifically defensible manner.

With respect to macrophytes, the CALM notes that macrophytes growth exists in places where eelgrass once existed. While this is a true statement, it gives the implication that macrophytes growth and eelgrass loss are interrelated. In actuality, macrophytes are primarily located in areas that have lost eelgrass. As discussed in Hall & Associates (2015), the areas that have lost eelgrass have been devoid of eelgrass since 2006 (approximately 10 years). This extended period suggests that physical conditions no longer support eelgrass growth. The presence of macroalgae in these areas likely represents an opportunistic use of this habitat by an ephemeral species. Consequently, as there is no objective information showing that that macroalgae have caused a displacement of eelgrass, and given that the nutrient levels are at historical lows, the indicator should discuss the need to confirm the ecological significance of any "excessive" macroalgae growth and also require a demonstration that it is actually caused by nutrients. Opportunistic use of another habitat or invasion by macroalgae that can grow in nutrient poor waters, does not constitute demonstration that nutrients are causing adverse impacts on the ecosystem.

8- 17

Indicator Part 9g: Eelgrass Cover Assessment

Indicator 9g refers to the methodology used in Indicator 8. See comments on Indicator 8. 8- 18

Indicator Part 9h: Calculation of TN Concentration Indicator

Note 1b indicates that the TN concentration data should "cover all four seasons of the year." This is scientifically and ecologically inappropriate as algae, epiphytes and macroalgae exhibit substantially reduced growth, if any, in the non-growing season, or roughly half of the year. The detention time of the system is so low that impacts from system loadings is highly transient. As such, nutrient concentrations in the non-growing season have little to no effect on algal growth. Instead, only the growing season data should be assessed. 8- 19

Out of Date pH Criteria

The pH criteria are seriously out of date, and are leading to numerous impairment listings. The published pH criteria indicate that, in general, pH ranging 6-9 su does not adversely impact aquatic life. At a minimum, the freshwater pH criteria should be updated to eliminate dozens of unnecessary impairment listings. 8- 20

Beem, N.T. & F.T. Short, 2008. Subtidal Eelgrass Declines in the Great Bay Estuary, New Hampshire and Maine, USA. Estuaries and Coasts.

Hall & Associates. 2015. Evaluating the Spatial and Temporal Variability of Eelgrass in Great Bay Estuary, New Hampshire. Unpublished.

Jones, S.H. and Gregory, T.K. December 15, 2013. Pisacataqua River-Portsmouth Harbor Water Transparency Field Study.

Morrison, J.R., T.K. Gregory, S. Pe'eri, W. McDowell & P. Trowbridge, 2008. Using Moored Arrays and Hyperspectral Aerial Imagery to Develop Nutrient Criteria for New Hampshire's Estuaries.

NHDES, 2009. Numeric Nutrient Criteria for the Great Bay Estuary. Available at http://des.nh.gov/organization/divisions/water/wmb/wqs/documents/20090610_estuary_criteria.pdf.

SMAST. December 22, 2003. Massachusetts Estuaries Project – Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators Interim Report. http://yosemite.epa.gov/OA/EAB_WEB_Docket.nsf/Verity%20View/DE93FF445FFADF1285257527005AD4A9/$File/Memorandum%20in%20Opposition%20...89.pdf 8- 21

Trowbridge, P. June 15, 2006. NH Estuaries Project Environmental Indicators. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwjCzcGJy8rJAhVMpR4KHSIHBswQFggiMAE&url=http%3A%2F%2Fwww.prep.unh.edu%2Fresources%2Fnutrient%2F20060615%2520NHEP%2520Indicators%2520of%2520Nutrients.2.ppt&usg=AFQjCNHa0j7wyYAHt5KwfnqPxQgvfeJqwA&sig2=k0y_Q_dgDRFUseCX7avlRA&cad=rja

Trowbridge, P. March 2006. Environmental Indicator Report: Critical Habitats and Species. New Hampshire Estuaries Project. http://www.prep.unh.edu/resources/pdf/env_ind_critical_habitats_and-nhep-06.pdf

Evaluating the Spatial and Temporal Variability of Eelgrass in Great Bay Estuary, New Hampshire

William T. Hall[1], John C. Hall[1], and Benjamin M. Kirby[1]

[1] Hall & Associates, Washington, D.C., 20006

November 2015

ABSTRACT:

INTRODUCTION

Great Bay Estuary, on the border between New Hampshire and Maine, is one of 28 waterbodies designated as "estuaries of national significance" by the United States Environmental Protection Agency (EPA) under Section 320 of the Clean Water Act (CWA). This Estuary has been the focus of study for over 30 years by the Piscataqua Region Estuaries Partnership (PREP) and the University of New Hampshire (UNH) in Durham, NH. Over this time period, eelgrass (*Zostera marina*) within the Estuary has been extensively studied. Eelgrass is at the foundation of the food web in Great Bay Estuary, provides essential habitat for aquatic organisms, and performs other ecosystem services including trapping sediment (Salo & Pedersen, 2014; Short *et al.*, 1993).

Eelgrass is a monoecious seagrass species of SAV that can grow from seed or propagate through vegetative rhizome growth. Depending on various conditions, eelgrass populations typically follow a two-year (perennial) life history but can also exhibit an annual life cycle (Fonseca & Uhrin, 2009). In the first year, seeds from perennial plants germinate at the end of winter and spread through vegetative growth, creating daughter shoots every 2 – 4 weeks during the growing season. The plants enter a slow growth phase during the winter. In the second year, these shoots transform into flowering structures that produce dozens of seeds. The shoot dies after seeding. The seeds tend to stay near the parent plant, although flowering stalks can break off and transport seeds for many miles. In low-stress environments and subtidal habitat, eelgrass tend to behave as perennials while in high-stress environments and intertidal settings, eelgrass tend to behave as annuals (Kuo & den Hartog, 2006; Costa, 1988).

Historical accounts suggest that eelgrass cover was very widespread with eelgrass found throughout the Estuary in the early part of the twentieth century. The eelgrass ecosystem was nearly wiped out in the 1930s due to wasting disease (*Labyrinthula zostera*), but slowly recovered (Short, 1992). Most recently, the primary habitat for eelgrass in the Estuary has been Great Bay, accounting for approximately 80% of the eelgrass cover in the Estuary, with most of the eelgrass beds lost from the tidal rivers. Over the past 30 years, eelgrass levels have fluctuated, reaching a peak in the 1990s but more recently exhibiting reduced distribution in comparison with prior years.

In 2009, the New Hampshire Department of Environmental Services (DES) expressed concern that eelgrass populations in the Estuary appeared to be in decline. This contemporaneous eelgrass decline, in combination with concerns over increasing levels of dissolved inorganic nitrogen (DIN) and the presence of macroalgae (in some areas previously inhabited by eelgrass) led regulatory agencies to conclude that the eelgrass declines were due to excessive amounts of nitrogen entering the Estuary. Consequently, DES prepared draft water quality criteria for DIN, deemed necessary to prevent further deterioration and restore eelgrass in the Estuary (NHDES, 2009). These draft criteria became the subject of an external peer review and were subsequently withdrawn for insufficient scientific justification (Bierman *et al.*, 2014).

This paper presents a review of the available data, with a specific focus on eelgrass cover in Great Bay, to provide perspective on the nature of eelgrass fluctuations in the bay and to assess potential causes for the apparent decline using the historical water quality database. While prior regulatory efforts focused on nutrient pollution as the cause, numerous other factors (*e.g.*, wasting disease, physical conditions) have been demonstrated to negatively affect eelgrass health, survival, and propagation. This paper synthesizes the available data for the Bay to characterize the spatial and temporal patterns of eelgrass changes and to identify possible causes for the observed patterns in annual eelgrass cover in Great Bay.

Study Site

Great Bay Estuary is composed of several hydrologically distinct regions – the tidal rivers (*e.g.*, Lamprey River), shallow bays (*e.g.*, Great Bay), deep bays (*e.g.*, Little Bay), tidal straits (*e.g.*, Piscataqua

8- 22

2

[illegible]

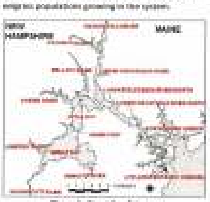


Figure 1: Great Bay Estuary

[illegible]

3

Figure 2: Great Bay Bathymetry (NOAA & Jakobsson, 2000)

SOURCES OF DATA

Eelgrass

[illegible]

4

biomass estimates were not considered sufficiently reliable for analysis and areal cover has been used as the metric for assessing the health of the eelgrass community in Great Bay.

Macroalgae

A consistent monitoring program for macroalgae has not historically existed for Great Bay Estuary. Most of the available data are anecdotal, with only a few actual measurements. Baseline measurements were made by UNH researchers (*e.g.*, A. Mathieson) between 1972 and 1980 for a few locations in Great Bay (NHDES, 2009) adjacent to the shoreline. These limited measurements identified very low levels of macroalgae in 1980 (PREP, 2013) at those sites.

More detailed measurements were made in 2007 via aerial imagery (Pe'eri *et al.*, 2008) and in 2008-2010 by on-site survey (Nettleton, 2011). The Pe'eri study was primarily conducted to evaluate the use of hyperspectral imagery as a tool for mapping macroalgae throughout Great Bay. A PREP study in 2013 sampled macroalgae (*Ulva* spp., *Gracilaria* spp., fucoids (*Ascophyllum nodosum* and *Fucus vesiculosus*)) in transects and made recommendations for a macroalgae monitoring program (Cianciola & Burdick, 2014).

Epiphytes

The available data on epiphytes are more limited than the available data on macroalgae. Reports of excessive epiphyte growth have not appeared in the various annual eelgrass surveys completed by Dr. Short. Dr. Short has further noted that epiphytes historically were not a major problem affecting eelgrass in the Estuary (Jones *et al.*, 2000).

Water Quality Sampling

Water Quality sampling was conducted by the University of New Hampshire and PREP throughout the period of eelgrass monitoring. Data from the UNH Buoy in Great Bay were obtained from the DES Environmental Monitoring Database via the UNH website (UNH, 2014). Water quality samples for nutrients (*e.g.*, DIN), total suspended solids (TSS), and phytoplankton chlorophyll-a (corrected for pheophytin) are collected at Adams Point, at the boundary between Little Bay and Great Bay. Samples are collected at a depth of one half meter below the surface, at high and low tide, once a month, throughout the year. Samples are analyzed using EPA-approved methods. Continuous monitoring (measurements at 30 minute intervals) for salinity and temperature is conducted using data sondes from the UNH buoy in Great Bay. This buoy is located in central Great Bay, about two kilometers due south of Adams Point. Temperature and salinity data for each analysis were averaged into a single daily value.

DISCUSSION

Eelgrass Cover

The eelgrass cover results are illustrated in Figure 3 for each annual eelgrass survey. Eelgrass habitat with essentially continuous cover is located immediately adjacent to the deep forked central channels. This area is characterized with elevations from zero to one meter below mean low water. Less suitable habitat, where eelgrass cover fluctuates from year to year, is typically located in the intertidal mudflats exposed at mean low water, especially along the southern and eastern shorelines of Great Bay. Approximately 75% of the eelgrass in Great Bay is found in intertidal regions, where plant leaves lie on the water surface at mean low water (Beem & Short, 2008). Eelgrass generally does not grow in the central channels with water depths greater than one meter below mean low water.

Figure 3: Annual Great Bay Eelgrass Cover

Periods of Eelgrass Decline

Total measurable eelgrass cover (acres) in Great Bay is plotted by year in Figure 4. Throughout most of the 1990s, eelgrass cover ranged from 2,000-2,500 acres.

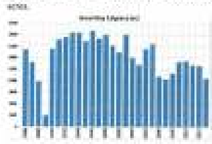


Figure 4: Great Bay Eelgrass Cover Declines

Notable decreases below these levels occurred during four periods: 1987-1989, 1999-2000, 2001-2003, and 2006-2007. Following the areal cover losses in 2007, recovery has not returned to 1990s levels, but had stabilized at about 1,600 acres through 2013. Each of these periods of decline and the available information regarding the causes of the decline are considered below.

1986-1989 Decline

Figure 5 illustrates eelgrass cover prior to the decline in 1986 (black) and afterwards in 1989 (green). By 1989, the coverage of eelgrass in Great Bay fell to 313 acres, with eelgrass lost throughout the entire area of the Bay (PREP, 2012).

Figure 5: 1986 vs. 1989 Great Bay Eelgrass

From 1987-1989, eelgrass populations in Great Bay Estuary were almost completely eliminated due to a widespread outbreak of wasting disease (Burdick, Short & Short, 1993; Short, 2001). Great Bay lost all of the eelgrass cover in the eastern region as well as the shallow areas in the remainder of Great Bay. This constitutes the greatest recorded decline in Great Bay eelgrass cover since the 1930s. Subsequently, eelgrass cover rebounded to 2,000 acres in 1990. This rebound is most likely attributed to reseeding given the dramatic increase since the prior year.

1998-2000 Decline

After a considerable period of stable eelgrass populations from 1990- 1998, a noticeable declined occurred in 1999/2000. Figure 6 illustrates eelgrass cover in 1998 (black) prior to the decline in 1999 and 2000 (green). Great Bay lost approximately 480 acres of measurable eelgrass cover, representing a relatively minor decline to 1,960 acres. Sizeable portions of the large, continuous eelgrass meadow present in the shallow southeastern sector of the Bay in 1998 were thinned out and lost by 2000. In 2001, these beds recovered and eelgrass cover totaled 2,390 acres.

Figure 6: 1998 vs. 2000 Great Bay Eelgrass

The cause of this decline is undetermined. However, the 2002 eelgrass distribution report (Short, 2004) referenced the persistent aftereffects of a wasting disease episode in 2000 as the cause of a decrease in eelgrass density in the Piscataqua River. The relationship between this episode and the downturn in eelgrass cover observed in Great Bay is not known. However, it is clear that wasting disease was present in the Estuary adjacent to Great Bay concurrent with the observed eelgrass decline. Given the location of the losses in the shallow waters, water column transparency cannot be a cause of this reduction as this area has the greatest light regime.

2001-2003 Decline

Figure 7 illustrates eelgrass cover in 2001 (black) prior to the decline in 2002 and 2003 (green). Following the eelgrass recovery in 2001 to 2,390 acres, Great Bay eelgrass cover experienced a moderate decline (-470 acres) from 2001 to 2003 to about 1,920 acres, but rebounded to over 2,200 acres in 2004. Once again, the lost eelgrass beds were located predominantly in the northern and western areas of the Bay.

Figure 7: 2001 vs. 2003 Great Bay Eelgrass

Aside from the late 1980's wasting disease die-off, 2003 was the only year on record when eelgrass was lost along the western shoreline between the Oyster and Lamprey Rivers. The cause for this sudden reduction in Great Bay was attributed to an outbreak of wasting disease (Short, 2004; Short, 2005). Following this decline, eelgrass cover in Great Bay rebounded to over 2,200 acres in 2004.

2005-2007 Decline

Figure 8 illustrates measurable eelgrass cover in 2005 (black) prior to the decline in 2006 and 2007 (green). From 2005 to 2007, Great Bay eelgrass suffered a major decline from over 2,200 acres to about 1,245 acres, a loss of 900 acres. Eelgrass began recovering in 2008 but overall acreage of eelgrass has remained at or below 1,700 acres through 2013. In 2006 and 2007, the majority of lost eelgrass beds were in the southern and eastern areas, predominantly adjacent to the shoreline in the intertidal zone. The cause of this decline has not been associated with wasting disease and is currently undetermined. However, it should be noted that this decline followed an extreme (100 year) storm event and persistent elevated rainfall which may have introduced additional stressors or exacerbated existing stressors (e.g., low salinity, [illegible]).

Figure 8: 2005 vs. 2007 Great Bay Eelgrass

Annual Spatial Variability of Eelgrass Cover

Typical patterns of eelgrass cover in Great Bay are separated by the Estuary's deep channels where eelgrass habitation has never been reported. As such, these channels form distinct natural boundaries to analyze eelgrass cover by geographic areas within the bay. These regions, of roughly equal area, were designated the East, South, and West sectors. The boundaries between sectors are illustrated in Figure 5, shown with the historical maximum reported eelgrass cover in 1996.

Figure 9: Great Bay Eelgrass Sectors

Individual ArcGIS polygons from the eelgrass mapping files were categorized by geographical sector. The total annual eelgrass area for each sector was summed and plotted to visualize localized variations in eelgrass coverage (Fig. 10). Values for 1987-1989 do not represent more typical conditions as a major episode of wasting disease decimated eelgrass in Great Bay.

Figure 10: Annual Great Bay Eelgrass by Sector

Eelgrass cover in the West sector has ranged from 540-815 acres over the period from 1990-2013. Eelgrass in this sector has remained relatively stable, with several downturns followed by recovery. The declines in 2001 and 2002 totaled approximately 21% and 30% of the pre-decline cover. Since 2006 this sector has had the most eelgrass cover of the three sectors. In 2006, when the other two sectors experienced a dramatic decline, the West sector increased slightly and has maintained a relatively stable level of eelgrass cover through 2013.

Eelgrass cover in the South sector has ranged from 300-885 acres over the period of analysis (1990-2013). Eelgrass cover was very stable from 1990-2005, ranging from 750-885 acres. In 2006, the South sector experienced a steep decline to 308 acres (-60% loss), coinciding with a period of very high rainfall and regional flooding. Over the next three years, eelgrass cover increased to 540 acres. Since 2009, eelgrass cover has declined to 500 acres or less. An inspection of the annual eelgrass maps shows that an area along the coast which previously supported eelgrass has also remained barren since 2006 (Fig. 11). The area of this void was estimated in ArcGIS to be 150 acres. Previous eelgrass maps (Fig. 9) indicate that this area was historically continuously covered by measurable eelgrass. In 2007, this region contained large areas of macroalgae. The prolonged period of no measurable eelgrass cover since 2006 suggests that the area may no longer be suitable as eelgrass habitat.

Figure 11: Great Bay Eelgrass 2006-2013

The East sector has fluctuated widely throughout the period of record, ranging from 185-850 acres. Eelgrass cover in this sector was relatively stable in the early 1990s, averaging about 800 acres (768 – 851 acres). Since 1999 eelgrass cover in this sector has exhibited high variability with steep declines followed by rapid recovery, ranging by as much as 500 acres in a two-year span. The periods of decline have been most severe in this sector, with eelgrass losses exceeding 40% in 2000, 2003 and 2007. As with the South sector, this sector experienced a sharp decline in 2006. An area devoid of measurable eelgrass appeared in 2006 (Fig. 11). This void, which routinely supported eelgrass cover prior to 2006,

covers approximately 15 acres and may represent an area no longer suitable as eelgrass habitat.

Causes of Eelgrass Declines

Recent efforts to identify the causes of observed eelgrass declines in Great Bay have included data collection, surveys, wasting disease assessments, and laboratory experiments. General eelgrass studies for other systems have identified major eelgrass stressors, which include wasting disease, nutrient-induced light limitation, and heat stress. Using the available data and studies performed in Great Bay Estuary, potential eelgrass stressors were assessed to determine their roles, if any, in historical Great Bay eelgrass declines.

Wasting Disease

Wasting disease is caused by a slime mold-like protist, *Labryinthula zostera*. Wasting disease initially forms on eelgrass leaves as brown or black lesions. These grow and spread through leaf-to-leaf contact, reducing the vascular transport and photosynthetic capacity in the plants until the plant dies (Sullivan *et al*., 2013).

Nitrogen-Induced Light Limitation (Eutrophication)

In some estuaries, excess nutrients (*e.g.*, bioavailable nitrogen and phosphorus) yield conditions which result in widespread eelgrass die offs by reducing light transmission through the water column. The primary symptoms of nutrient enrichment include phytoplankton blooms measured as chlorophyll-a concentrations and the proliferation of epiphytes and/or macroalgae. As phytoplankton concentrations increase, light penetration through the water column decreases and exerts a negative influence on SAV (*e.g.*, eelgrass) by inhibiting photosynthesis. These effects are typically first seen in eelgrass beds occupying deeper habitats where light transmission is most affected. Secondary symptoms include the loss of SAV and low dissolved oxygen (DO) concentrations. In addition, an increase in DIN loads may support the growth of epiphytes which reside on blades of eelgrass, preventing light from reaching the leaf and ultimately killing off the eelgrass, or promote the growth of macroalgae that compete with eelgrass for suitable habitat.

a) Dissolved Inorganic Nitrogen

DIN (*i.e.*, ammonia, nitrite-nitrate) load data to the Estuary are available for municipal point sources, but the majority of the annual load entering the Estuary is from non-point sources (Swanson, Bilgili & Lynch, 2014). Non-point source loading data are not available. Consequently, water quality monitoring of nitrogen concentrations in the Bay, obtained from PREP, was used as a surrogate for load. DIN concentration data for the growing season are illustrated in Figure 12. The growing season annual average was determined as the average of the daily concentrations. The whiskers indicate the range of the daily average data and periods of eelgrass decline are noted by vertical bars, with different shading to indicate the cause of the decline. The declines in 1988-1989 and 2002-2003 were attributed to outbreaks of wasting disease. The decline in 1999-2000 may be associated with an outbreak of wasting disease, although this is uncertain. The decline in 2006-2008 has no defined cause.

The growing season daily average concentrations were evaluated for significant differences between the years of high growth (> 2,000 acres of measurable eelgrass; 1990-1998, 2001, and 2004-2005), the years of decline, and the years of low

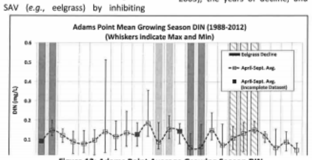


Figure 12: Adams Point Average Growing Season DIN

measurable eelgrass cover (2009 – 2011). The DIN concentrations for these groups were significantly different (F $_{2,20}$ = 5.86, P = 0.028). The significant difference was attributed to the DIN concentrations prevalent during the years of low eelgrass cover, when DIN averaged 0.078 mg/L, which was significantly less than the concentration during the high cover years (0.110 mg/L, P = 0.014) and the concentration during the declining years (0.11 0 mg/L, P = 0.011). There was no significant difference in DIN concentration between the high cover and declining years (P = 0.45).

b) Phytoplankton

Phytoplankton chlorophyll-a concentration data, from the PREP monitoring program at Adams Point (a well-mixed location between Great Bay and Little Bay), are summarized in Figure 13 for the growing season. The chlorophyll-a data were evaluated and presented in the same manner as for the DIN data.

The growing season daily average concentrations were evaluated for significant differences between the years of high growth, the years of decline, and the years of low measurable eelgrass cover. The chlorophyll-a concentrations for these groups were not significantly different (F $_{2,20}$ = 2.07, P = 0.13). Since the probability is close to the significance threshold, comparisons between the individual groups were made. The average chlorophyll-a concentrations for the years of low measurable eelgrass cover (3.87 µg/L) was not significantly different than the average concentration for the period of eelgrass decline (4.06 µg/L, P = 0.39) or for the period of high growth (3.71 µg/L, P = 0.73). However, the period of high growth was significantly different than the period of decline (P = 0.04).

Over this period, median chlorophyll-a concentrations generally remained quite low given the available inorganic nitrogen levels within a

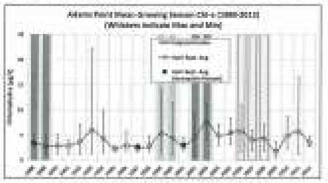


Figure 13: Adams Point Growing Season Chlorophyll-a

narrow range (2-6 µg/L), with no clear trend. The DIN level in Great Bay is capable of supporting 10-20 times the observed level of plant growth (Chapra, S., personal communication). Consequently, some other factor (*e.g.*, system hydrodynamics and short detention time) must be limiting this form of plant growth (PREP, 2013).

These data show that, in 2000, 2002 and 2006, when the eelgrass cover in Great Bay experienced major reductions, phytoplankton levels exhibited a mean concentration around 4 µg/L with no major increases

or decreases in concentration before or after the eelgrass declines. This level of phytoplankton chlorophyll-a is relatively low and falls within the bracket of phytoplankton concentrations prevalent in the 1990s, when the eelgrass cover in the Bay was at its maximum (PREP, 2012). Without any increase in phytoplankton chlorophyll-a, water clarity was not adversely affected by increased phytoplankton populations in the period from 1990 to 2011. Consequently, eutrophication, evidenced by a link between eelgrass loss and a TN-induced increase in phytoplankton, is not supported by the relevant data for this system.

The negative impacts of eutrophication due to increased algal growth manifests as measurably reduced water clarity sufficient to limit eelgrass growth. In 2005, the Great Bay coastal buoy at Adams Point was fitted with instrumentation for colored dissolved organic matter (CDOM) automated monitoring. Using these data and hyperspectral remote sensing data, Morrison *et al.* (2008) developed a multivariate model of water clarity to evaluate the factors contributing to light attenuation in Great Bay. The resulting model related phytoplankton chlorophyll-a, CDOM, and non-algal particles (NAP; *i.e.*, turbidity not associated with phytoplankton) to the measured light attenuation coefficient (K_d, m^{-1}), accounting for 95% of the variability in the data.

Based on data collected in 2007, these researchers determined that phytoplankton were responsible for approximately 12% of the overall light attenuation, with CDOM and NAP responsible for the majority of the observed light attenuation (27% and 29%, respectively; Morrison *et al.*, 2008). Morrison *et al.* (2008) also concluded that the CDOM present in the Estuary originated from terrestrial sources based on a regression of CDOM with salinity. These results suggest that the water clarity in Great Bay was sufficient for the growth of eelgrass in 2007. Based on this analysis, chlorophyll-a levels appear to have a relatively minor contribution to water column light attenuation and therefore, do not pose a major threat to eelgrass, especially given Great Bay's generally shallow eelgrass habitat.

c) Macroalgae

Macroalgae are present in all estuarine waters to varying degrees. In the Great Bay Estuary, the primary areas with considerable macroalgae growth are the more quiescent southern and eastern waters of Great Bay. Excessive macroalgae growth can shade eelgrass beds, thereby reducing light availability and potentially resulting in eelgrass die offs. Macroalgae generally meet their nutrient requirements from water column inorganic nitrogen (Wang *et al.*, 2014). Macroalgae are opportunistic species capable of rapidly colonizing open habitat. It may be that the loss of eelgrass beds in 2006 provided an opportunity for macroalgae to take residence in the Bay in 2007 but this has yet to be demonstrated.

A consistent monitoring program for macroalgae has not historically existed for Great Bay Estuary. Most of the available data are anecdotal, with only a few actual measurements. Baseline measurements were made by UNH researchers between 1972 and 1980 for a few locations in Great Bay (NHDES, 2009). These limited measurements identified very low levels of macroalgae in 1980 (PREP, 2013). More detailed measurements were made in 2007 via aerial imagery (Pe'eri *et al.*, 2008) and in 2008-2010 by on-site survey (Nettleton, 2011). The Pe'eri study was primarily conducted to evaluate the use of hyperspectral imagery as a tool for mapping macroalgae in Great Bay. Results from a survey conducted on August 29, 2007, were used to produce a comprehensive map of eelgrass and macroalgae in the Estuary for that year (Fig. 14; NHDES, 2009).

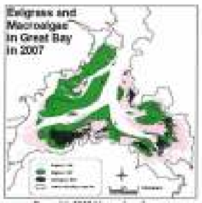


Figure 14: 2007 Macroalgae Survey

Based on this 2007 survey, it was estimated that macroalgae covered 137 acres in Great Bay and encroached into areas previously inhabited by eelgrass as illustrated above. The surveys by Nettleton evaluated percent cover and biomass of critical macroalgae species at five locations in Great Bay that were convenient for access. These locations are not historical eelgrass habitat.

Based on the Pe'eri survey alone, it could not be determined if the macroalgae caused the eelgrass to decline in the Bay or if the 2006 decline provided new areas for macroalgae to proliferate. Inspection of the figures shows that eelgrass losses were not restricted to areas with observed macroalgae beds. Great Bay eelgrass losses between 2006 and 2007 totaled 920 acres, while only 137 acres of macroalgae beds were reported. Subsequent eelgrass regrowth of approximately 250 acres, from 2008–2013, occurred in areas that had elevated macroalgae growth in 2007. Thus, it appears that macroalgae growth, of itself, has not significantly restricted system eelgrass recovery.

However, a PREP study in 2013 sampled macroalgae (Ulva spp., Gracilaria spp., fucoids (Ascophyllum nodosum and Fucus vesiculosus)) in transects. These results indicated that peak macroalgal biomass occurs between 0.5-1.0 meters above MLLW with the highest macroalgal growth of the four transects sampled sites at Oyster Road (PREP, 2013). Random sampling identified the presence of macroalgal growth in most areas of the Estuary, ranging from southern Great Bay to Portsmouth Harbor to more than a mile up the Bellamy, Oyster, and Upper Piscataqua Rivers. The 2013 PREP study also made recommendations for a long-term macroalgae monitoring program that is currently under development.

d) Epiphytes

The potential adverse effects of eutrophication on eelgrass in estuarine environments include reduction in light availability due to epiphytes. However, the available data on epiphytes are more limited than the available data on macroalgae. Reports of excessive epiphyte growth have not appeared in various annual eelgrass surveys completed by Dr. Short. Dr. Short has noted that epiphytes historically were not a major problem to eelgrass in the Estuary (Jones et al., 2000). Based on these observations, it is unlikely that epiphytes played a significant role in the eelgrass losses observed in the Estuary. As with macroalgae, more data are needed to quantify whether epiphytes are adversely influencing eelgrass habitats in the Estuary and to assess the cause and resolution to such problems if they exist.

Non-Algal Water Column Light Attenuation

Light availability is considered the most critical variable for the growth of SAV when other basic habitat requirements (e.g., flow regime, wave exposure, substrate composition) are met (Dennison, 1987). Water column light transmittance can be reduced by numerous non-algal physical factors including CDOM, suspended sediments, or turbidity due to heavy precipitation, high winds, or tidal currents. Long-term negative effects and die-offs have been observed in Chesapeake Bay eelgrass beds which were subjected to periods of high turbidity for less than three weeks (Moore et al., 2012).

Using the multivariate model developed by Morrison et al. (2008), HDR|HydroQual (2011) developed a water quality model to assess light attenuation in Great Bay during the period surrounding the eelgrass

decline in 2006. This analysis (Fig. 15) shows that water clarity in Great Bay and Little Bay was severely reduced over a three month period (May through July) in 2006, in comparison with prior and subsequent years due to record rainfall conditions.

Total suspended solids concentration data, from the PREP monitoring program at Adams Point, are summarized in Figure 16 for the growing season. The TSS data were evaluated and presented in the same

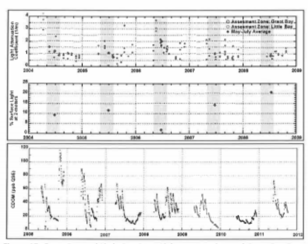


Figure 15: Great Bay and Little Bay Buoy Light Attenuation and Great Bay Buoy CDOM

manner as the DIN data.

The growing season daily average concentrations were evaluated for significant differences between the years of high growth, the years of decline, and the years of low measurable eelgrass cover. The TSS

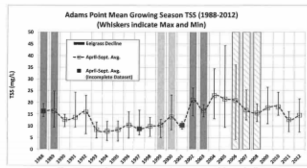


Figure 16: Adams Point Growing Season Chlorophyll-a

concentrations for these groups were significantly different ($F_{2,143}$ = 5.41, P = 0.005). The significant difference was attributed to the TSS concentrations prevalent during the years of high eelgrass cover, when TSS averaged 12.6 mg/L, which was significantly less than the concentration during the declining years (16.4 mg/L; P = 0.003) and the concentration during the low cover years (15.7 mg/L; P = 0.059). There was no significant difference in TSS concentration between the low cover and declining years (P = 0.63).

Extreme Precipitation

Significant increases in precipitation and flooding, particularly immediately prior to or during the growing season, has been identified as a primary driver of seagrass loss and interannual variability in Chesapeake Bay and other estuaries (Wang & Linker, 2005). The timing of extreme precipitation events also affects the severity of impact on submerged aquatic vegetation (SAV). Wang & Linker (2005) concluded that extreme storms prior to peak biomass are detrimental to SAV in polyhaline waters while storms at the end of the growing season have a diminished effect but may reduce the potential for SAV growth in the following year. In May 2006, the Great Bay Estuary and surrounding region experienced a major flooding event. This event was credited with stressing and killing organisms of a variety of species (GBNERR, 2009). This flood also corresponds to a year of severe eelgrass loss in Great Bay with no coinciding definitive evidence of the presence wasting disease. However, the degree to which this flood was responsible for the loss of eelgrass has not been determined.

Salinity

Daily average salinity data are illustrated in Figure 17. Average daily salinity exhibits a seasonal pattern with reduced salinity in the spring, when the river inflow is typically at its maximum, and elevated salinity through the late summer and early fall when stream flows are at their minima.

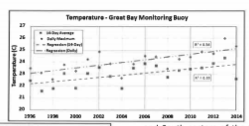
Figure 17: Great Bay Buoy Salinity

The daily salinity results reflect periods of elevated rainfall and extended drought. The 2002 growing season experienced extremely low flows and, as a consequence, the average daily salinity exceeded 30 psu from July 15 through October while most other years rarely exceed 30 psu for a single day. In 2006, April started with relatively low freshwater inflow and daily salinities above 20 psu. However, May experienced major flooding and daily salinity fell below 5 psu, levels stressful for eelgrass, for 7 days with a minimum daily average below 1 psu for two consecutive days (Nejrup & Pedersen, 2008; GBNERR, 2009).

While low salinity may protect eelgrass from wasting disease, low salinity is also a recognized stressor of eelgrass (Nejrup & Pedersen, 2008; Salo & Pedersen, 2014). Eelgrass subjected to a salinity of 5 psu for five weeks has been demonstrated to result in "higher mortality, lower leaf production, lower leaf elongation rate, less standing leaves per shoot and more necrotic tissue" than at salinities of 12.5 psu and 20 psu (Salo & Pedersen, 2014). Fonseca & Uhrin (2009) reported that photosynthesis in eelgrass essentially ceases below 10‰.

Temperature

Daily average temperature is illustrated in Figure 18 for the period from 1996 through 2013. Bay temperatures fall below 5°C at the end of the year and many areas of the bay are covered with ice over the winter. Temperatures rise steadily from April through July, typically topping out between 20 - 25°C by August. Typical water temperatures fall below 15°C by the beginning of October and 10°C by the beginning of November.



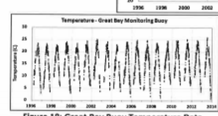


Figure 18: Great Bay Buoy Temperature Data

The observed pattern is fairly uniform over the 18-year period of record. However, over this period the maximum daily and bi-weekly average water temperature reported at the Great Bay buoy has increased (Figure 19).

Figure 19: Great Bay Buoy Maximum Temperature Analysis

It should be noted that the temperature variation occurring in the shallow southeast section of the Bay should have responded more dramatically. The elevated temperatures may have induced thermal stress during portions of the summer, especially in the warmer intertidal regions where the majority of eelgrass was lost. Cumulatively, in 2006, a variety of stressors were observed which may have resulted in the dramatic die off by the August eelgrass survey.

CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

In the past, Great Bay eelgrass remediation efforts have generally focused on total eelgrass coverage losses in Great Bay Estuary. Parsing Great Bay into geographic thirds provides a basis for a more defined assessment of historical eelgrass declines. Historical inter-annual variation in eelgrass cover was primarily associated with shifts occurring in the shallow East and South sectors of the Bay. Significant losses of eelgrass cover occurred from 1987-1989, 1999-2000, 2002-2003, and 2006-2007. These periods of loss are distinct from the inter-annual variability observed throughout most of the 1990s. Any explanation as to the cause of these eelgrass losses in Great Bay must account for the both the temporal and spatial natures of these losses.

The primary cause of eelgrass declines in Great Bay is currently attributed to wasting disease while other declines remain undetermined. Wasting disease exhibits pronounced negative effects in eelgrass at higher salinities and temperatures (Salo & Pedersen, 2014; Sullivan *et al.*, 2013; Bull, Kenyon & Cook, 2012; Short *et al.*, 1993). In addition to laboratory studies, this has been evidenced in multiple wasting disease episodes where eelgrass meadows are decimated except for areas of low salinity (Vergeer, Aarts & de Groot, 1995; Short *et al.*, 1987). Eutrophication has also been suggested as a cause of Great Bay eelgrass declines. However, if nitrogen-induced eutrophication caused or contributed to a major eelgrass loss in Great Bay, there should have been a substantial increase in growing season DIN load and chlorophyll-a concentration and a decrease in transparency in association with the eelgrass decline. The available data do not support a compelling argument that cultural eutrophication is responsible for major eelgrass losses observed in Great Bay. DIN levels have remained relatively uniform over the last two decades in Great Bay, and there has been no change in phytoplankton chlorophyll-a concentrations over the period when eelgrass losses were significant. Moreover, the observed eelgrass losses have been in the shallowest depths while eelgrass beds in deeper (*i.e.*, more light limited) areas have perennially maintained coverage. This suggests that light limitation, due to eutrophic conditions and excess algal growth or otherwise, cannot physically be responsible for major eelgrass declines. In addition, the available data for macroalgae and epiphytes do not support these as causes for eelgrass loss in the system. Consequently, increased plant growth can be responsible for neither changes in light transparency nor major eelgrass bed declines in Great Bay.

Extensive literature provides a number of additional factors with potential to negatively influence eelgrass. Combinations of these conditions have been demonstrated or implicated during eelgrass declines in Great Bay. Improved and increased monitoring efforts are critical in determining the cause of non-wasting disease induced eelgrass declines in Great Bay. Current water quality monitoring is focused at Adams Point, central Great Bay (buoy station), and upstream in the tidal rivers. We recommend that future monitoring efforts extend the focus to areas of fluctuating eelgrass beds, especially in intertidal regions in the South, East, and West sectors to identify significant differences in physical or chemical differences in habitat or water quality associated with healthy eelgrass beds or eelgrass declines. Another focus should be on the causes of 150 acre barren patch in the South sector and the smaller void in the East sector. Monitoring should include water temperature, salinity, macroalgal levels, wasting disease prevalence, sediment chemistry, waterfowl surveys, and ice cover extent to aid in determining significant spatial and temporal differences and the independent and combined contributions of these recognized potential stressors on Great Bay eelgrass. To better understand the predominant eelgrass life cycle in areas of Great Bay, it would be useful to conduct eelgrass surveys early in the growing season as well as at the end of the growing season, as currently practiced. The addition of early season eelgrass surveys would allow for 1) estimation of baseline perennial eelgrass beds, 2) comparison of early growing season eelgrass cover with end-of-season cover, and 3) comparison of baseline perennial eelgrass beds with end-of-season eelgrass cover from the prior year.

REFERENCES

Beem, N.T. & F.T. Short, 2008. Subtidal Eelgrass Declines in the Great Bay Estuary, New Hampshire and Maine, USA. Estuaries and Coasts.

Bierman, V.J., Diaz, R.J., Kenworthy, W.J. & Reckhow, K.H. February 13, 2014. Joint Report of Peer Review Panel for Numeric Nutrient Criteria for the Great Bay Estuary. Available at http://des.nh.gov/organization/divisions/water/wmb/coastal/documents/20140213-peer-review.pdf

Bilgili, A., M.R. Swift, D.R. Lynch & J.T.C. Ip, 2003. Modeling bed-load transport of coarse sediments in the Great Bay Estuary, New Hampshire. Estuarine Coastal and Shelf Science 58: 937-950.

Bull, J.C., E.J. Kenyon & K.J. Cook. 2012. Wasting disease regulates long-term population dynamics in a threatened seagrass. Oecologia 169: 135-142.

Burdick, D.M., Short, F.T. & Wolf, J. 1993. An index to assess and monitor the progression of wasting disease in eelgrass *Zostera marina.* Marine Ecology Progress Series 94: 83-90.

Cianciola, Elisabeth and Burdick, David, "Results of 2013 Macroalgal Monitoring and Recommendations for Future Monitoring in Great Bay Estuary, New Hampshire" (2014). PREP Publications. Paper 41. http://scholars.unh.edu/prep/41.

Costa, J.E. September 1988. Eelgrass in Buzzards Bay: Distribution, Production and Historical Changes in Abundance. EPA 503/4/88-002

Dennison, W.C., 1987. Effects of light on seagrass photosynthesis, growth and depth distribution. Aquatic Botany 27: 15-26.

Erturk, S.N., Bilgili, A., Swift, M.R., Brown, W.S., Celikkol, B., Ip, J.T.C. & Lynch, D.R. 2002. Simulation of Great Bay Estuarine System: Tides with tidal flats wetting and drying. Journal of Geophysical Research 107.

Fonseca, M. S. & A. V. Uhrin. 2009. The Status of Eelgrass, Zostera marina, as Bay Scallop Habitat: Consequences for the Fishery in the Western Atlantic. Mar. Fish. Rev. 71 (3): 21-33.

Great Bay National Estuarine Research Reserve (GBNERR). 2009. Ecological Trends in the Great Bay Estuary.

Green, E.P. & F.T. Short, (2003). *World Atlas of Seagrasses.* Prepared by the UNEP World Conservation Monitoring Centre. University of California Press. Berkeley, USA.

HDR|HydroQual, 11 Nov. 2013. Technical Memorandum: Calibration of Great Bay Estuary Hydrodynamic Model and Incremental Nitrogen Estimation.

Jones, S.H. & Piscataqua Region Estuaries Partnership (PREP), 2000. A Technical Characterization of Estuarine and Coastal New Hampshire. PREP Publications. Paper 294. http://scholars.unh.edu/prep/294.

Kuo, J. & C. den Hartog. (2006). Seagrass morphology, anatomy, and ultrastructure, in Seagrasses: Biology, Ecology and Conservation, edited by A. Larkum, R. Orth, and C. Duarte, pp. 51–87, Springer, Berlin.

Moore, K.A., E.C. Shields & D.B. Parrish, 2012. Eelgrass survival in two contrasting systems: role of turbidity and summer water temperatures. Marine Ecology Progress Series 448: 247-258.

Morrison, J.R., T.K. Gregory, S. Pe'eri, W. McDowell & P. Trowbridge, 2008. Using Moored Arrays and Hyperspectral Aerial Imagery to Develop Nutrient Criteria for New Hampshire's Estuaries.

Nejrup, L.B. & M.F. Pedersen, 2008. Effects of salinity and water temperature on the ecological performance of *Zostera marina.* Aquatic Botany 88: 239-246.

Nettleton, J.C., C.D. Neefus, A.C. Mathieson & L.G. Harris, 2011. Tracking environmental trends in the Great Bay Estuarine System through comparisons of historical and present-day green and red algal community structure and nutrient content.

NHDES, 2009. Numeric Nutrient Criteria for the Great Bay Estuary. Available at http://des.nh.gov/organization/divisions/water/wmb/wqs/documents/20090610_estuary_criteria.pdf.

NOAA. 1995. NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementation. Available at http://coast.noaa.gov/digitalcoast/_/pdf/protocol.pdf.

NOAA, 2013. FAQ - Tidal Current Predictions and Data. https://tidesandcurrents.noaa.gov/faq4.html.

NOAA and Jakobsson, M. 2000. Great Bay Estuary, New Hampshire. JPEG. Available at http://ccom.unh.edu/sites/default/files/data/greatbay/1953_utm_150dpi.jpg.

Pe'eri, S., Morrison, J.R., Short, F., Mathieson, A., Brooke, A. & Trowbridge, P. 2008. Macroalgae and eelgrass mapping in Great Bay Estuary using AISA hyperspectral imagery.

Piscataqua Region Estuaries Partnership (PREP), 2012. Final Environmental Data Report December 2012: Technical Support Document for the 2013 State of Our Estuaries Report. PREP Publications. Paper 265. http://scholars.unh.edu/prep/265.

Piscataqua Region Estuaries Partnership (PREP), 2013. State of Our Estuaries 2013. PREP Publications. Paper 259. http://scholars.unh.edu/prep/259.

Salo, T. & M.F. Pedersen, 2014. Synergistic effects of altered salinity and temperature on estuarine eelgrass (*Zostera marina)* seedlings and clonal shoots. Journal of Experimental Marine Biology and Ecology 457: 143-150.

Short, F.T. 1992. (ed.) The Ecology of the Great Bay Estuary, New Hampshire and Maine: An Estuarine Profile and Bibliography. NOAA – Coastal Ocean Program Publ. 222 pp.

Short F.T. and Burdick D.M. (1996). Quantifying eelgrass habitat loss in relation to housing development and nitrogen loading in Waquoit Bay, Massachusetts. Estuaries, 19:730-739.

Short, F., 2004. Eelgrass Distribution in the Great Bay Estuary 2002. Available at http://prep.unh.edu/resources/pdf/eelgrassdistributionin-unh-04%20.pdf.

Short, F. 2005. Eelgrass Distribution in the Great Bay Estuary 2003. Available at http://prep.unh.edu/resources/pdf/eelgrass_distribution_in-unh-05%20.pdf.

Short, F.T., Burdick, D.M., Wolf, J. & Jones, G.E. 1993. Eelgrass in Estuarine Research Reserves Along the East Coast, U.S.A., Part II: Management of Eelgrass Meadows. Technical Report, Jackson Estuarine Laboratory – UNH.

Short, F.T. & Trowbridge, P. 2003. UNH Eelgrass (*Zostera marina*) Monitoring Program Quality Assurance Project Plan. Available at http://www.prep.unh.edu/resources/qapps/unh_eelgrass_zostera-qapp-unh&des-03.pdf.

Sullivan, B.K., T.D. Sherman, V.S. Damare, O. Lilje & F.H. Gleason, 2013. Mini Review: Potential roles of *Labyrinthula spp.* in global seagrass population declines. Fungal Ecology 6: 328-338.

Swanson, C., A. Bilgili & D. Lynch, 2014. Long-Term Simulations of Wastewater Treatment Facility Discharges into the Great Bay Estuarine System (New Hampshire). Water Quality Exposure and Health 08/2014.

Trowbridge, P. 2007. Hydrologic Parameters for New Hampshire's Estuaries. Available at http://prep.unh.edu/resources/pdf/hydrologic_parameters_for-nhep-07.pdf.

Trowbridge, P. 2013. Great Bay Estuary Eelgrass Monitoring Program for 2013 Quality Assurance Project Plan. Available at http://www.prep.unh.edu/resources/qapps/PREP_Eelgrass_Monitoring_QUAPP_completed.pdf.

Truslow, D.B., Piscataqua Region Estuaries Partnership (PREP) & Mettee Planning Consultants, 2010. Piscataqua Region 2010 Comprehensive Conservation and Management Plan. Available at http://www.prep.unh.edu/resources/pdf/piscataqua_region_2010-prep-10.pdf.

UNH. 2014. Tidal Water Quality Monitoring Program Environmental Data. University of New Hampshire, UNH Jackson Estuarine Laboratory, Durham, NH. Available at http://www2.des.state.nh.us/OneStop/Environmental_Monitoring_Query.aspx.

University of New Hampshire (UNH) & New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT), 2014. Great Bay Estuary Eelgrass, 1981-2013. Available at http://www.granit.unh.edu/data/search?sterm3=eelgrass&fieldname3=themekey.

Vergeer, L.H.T., Aarts, T.L. & de Groot, J.D. 1995. The 'wasting disease' and the effect of abiotic factors (light intensity, temperature, salinity) and infection with *Labyrinthula zosterae* on the phenolic content of *Zostera marina* shoots. Aquatic Botany 52: 35-44.

Wang, C., A. Lei, K. Zhou, Z. Hu, W. Hao & J. Yang, 2014. Growth and Nitrogen Uptake Characteristics Reveal Outbreak Mechanism of the Opportunistic Macroalga *Gracilaria tenuistipitata.* PLoS ONE 9(10).

Wang, P. & Linker, L.C. 2005. Effect of timing of extreme storms on Chesapeake Bay submerged aquatic vegetation. Hurricane Isabel in perspective. CRC Publication 05-160: 177–184.

COMMENT #9: Terry Desmarais, City of Portsmouth

PUBLIC WORKS DEPARTMENT
CITY OF PORTSMOUTH
680 Peverly Hill Road
Portsmouth N.H. 03801
(603) 427-1530 FAX (603) 427-1539

December 11, 2015

VIA E-MAIL (*303dcomment@des.state.nh.us*)
2014 303(d) Comments
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 hazen Drive; PO Box 95
Concord, NH 03302-0095

Attn: Ken Edwardson

RE: City of Portsmouth Comments on NHDES draft 2014 303 (d) list and CALM

9- 1

Dear Mr. Edwardson,

The City of Portsmouth ("Portsmouth") appreciates this opportunity to comment on the 2014 draft 303 (d) impairment listing and the 2014 Consolidated Assessment and Listing Methodology. Portsmouth is a member of the Great Bay Municipal Coalition (Coalition) and incorporates by reference the Coalition's comments which are being separately submitted on this same date.

As an advocate for good science, Portsmouth has invested significant financial and staff resources to the effort to understand better the role of nitrogen in the Great Bay Estuary and the Piscataqua River in particular. Portsmouth is pleased to support NHDES's decision to delist several Assessment Units in the Great Bay Estuary for total nitrogen and withhold final assessment on others until a new methodology for assessing total nitrogen is developed, as explained in the "Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report and 303(d) List". Please see the Great Bay Municipal Coalition comments on this point.

Portsmouth joins the City of Dover in suggesting that the State should allocate additional resources for water quality sampling and analysis. The Environmental Protection Agency is increasingly relying upon water quality data, interpretations and findings in its wastewater and stormwater permitting programs and the State Department of Environmental Services must be resourced to meet this changing regulatory landscaping. Portsmouth and other municipalities cannot be the main funding source because municipalities are charged with making the capital investments and operational changes necessary to meet stricter water quality standards.

9- 2

9- 3

The following comments address specific assessment unit listing designations on the 2014 draft 303 (d) list based on a review of the available supporting water quality data.

North Mill Pond NHEST600031001-10

This assessment unit is the location of the two of the City's permitted combined sewer overflows (CSO) and is impacted by bacteria during and following CSO events. The City has completed the last of its sewer separation projects in the drainage basin tributary to these CSOs. The City is currently evaluating the effectiveness of the sewer separation projects through a Post Construction Monitoring Plan. **9- 4**

The most recent bacteria data for this unit is from 2005 when the unit was impaired for bacteria. By 2008 a leaking sewer main was identified as a significant source. This was repaired in late 2009. Notes in the data indicted follow-up sampling would take place in February 2010 and there is no indication that DES had performed the follow-up sampling. The City will need to determine whether the City will perform this sampling or wait until the DES completes the follow-up sampling.

Berrys Brook NHRIV600031002-01

The upper reaches of Berrys Brook are in Portsmouth. The entire area of the Berry Brook watershed located in Portsmouth is on public sewer. The sampling station is located downstream in Rye where Berry Brook crosses Sagamore Road. There is residential development in Rye that exits between Portsmouth and the sampling station that should **9- 5** be looked as possible sources. We recommend the DES consider establishing a sampling station where Berrys Brook leaves Portsmouth if other sources in Rye are not identified.

Sagamore Creek NHRIV600031001-03

This assessment unit (impaired for bacteria) is the fresh water section of the creek and the sampling station is at the culvert under Peverly Hill Road. Seventeen samples were collected in 2006 and 2007. One sample of 200 counts/100 ml occurred in September 2006. In August and October of 2006 the sample results were 70 counts/100 ml and 40 counts/100 ml respectively. In 2007 August, September, and October sample results were 5 counts/100 ml, 5 counts/100 ml and 40 counts/100 ml respectively. Of 10 geometric means calculated from the available data only one failed the water quality standard. Based on this data, it is unlikely this assessment unit should be considered impaired. The City believes additional sampling would likely result in the impairment listing being removed. **9- 6**

Thank you.

Sincerely,

Terry Desmarais, P.E.
City Engineer, Water and Sewer Division

cc: Suzanne M. Woodland, Deputy City Attorney

COMMENT #10 (on Feb. 3, 2017 Changes): John B. Storer, City of Rochester

City of Rochester, New Hampshire
PUBLIC WORKS DEPARTMENT
www.rochesternh.net
45 Old Dover Road • Rochester, NH 03867
(603) 332-4096 Fax (603) 335-4352

February 23, 2017

2014, 303(d) Comments
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive, P.O. Box 95
Concord, New Hampshire 03302-0095
Attn: Ken Edwardson

RE: Comments on Changes between Draft and Final 2014 303(d) List

Dear Mr. Edwardson:

Thank you for the opportunity to comment on the changes to the draft 2014 303(d) list. The City of Rochester supports the New Hampshire Department of Environmental Services' (DES)
position that the tidal Cocheco River and Great Bay should not be placed into category 5 of the 10- 1
303(d) List for total nitrogen. We agree with the decision not to list these Assessment Zones as impaired for total nitrogen due to lack of scientific evidence that total nitrogen is a stressor in these systems.[1] For the reasons discussed below, however, we continue to strongly disagree with DES's narrative comments. We also incorporate by reference into this letter the Great Bay Municipal Coalition comments to be submitted to you on or before February 24, 2017.

Although the City is in agreement with DES on its decision to not place the tidal Cocheco River and Great Bay in category 5, we object to the DES narrative comments (under the "parameter comments" section of the tables) on these segments. As in the draft 2014 303(d) list, the DES narrative continues to imply potential nitrogen impairments using ambiguous, inappropriate, or unsubstantiated statements, while ignoring the 2014 Peer Review Report and other evidence of the lack of nitrogen-related impairments. The City's and Great Bay Coalition's comments on the draft 2014 303(d) list explained the problems with these types of interpretations, and also provide recommendations for more defensible interpretations. For the sake of brevity, we are including those previous comments as attachments to this letter rather than repeating them in full. However, below is a summary of some of our major comments on the tidal Cocheco River and Great Bay segments:

[1] We disagree, however, that the Cocheco River and Great Bay should be described as "de-impaired" or "delisted" as they were improperly determined to be impaired by total nitrogen in the 2012 303(d) List. Previous listings were based on unreliable methodologies such as application of the discontinued 2009 Numeric Nutrient Criteria Document.

Cocheco River (NHEST600030608-01): Most of the associated "parameter comments" should be removed and replaced with a simpler discussion that there is no evidence that nitrogen is causing impairments of this segment. As discussed by Storer (2015) and Bell (2016), the data available for the listing cycle provide conclusive evidence of favorable DO and pH conditions. Because chlorophyll-*a* is typically lognormally-distributed, periodic chlorophyll-*a* peaks are to be expected in productive estuarine segments, and do not indicate impairment apart from specific impacts (e.g., low DO, elevated pH) that do not appear to be present in this segment. In fact, the available data demonstrate that the 90th percentile chlorophyll-a was below the CALM threshold of 20 ug/L (Storer, 2015). Moreover, algae are unlikely to be limited by nitrogen in this segment; rather, algae are more likely to be controlled by hydraulic/flushing factors and light limitations, that in turn are controlled by TSS and CDOM. The lack of a nitrogen-chlorophyll linkage is borne out by the available data, which demonstrated that the point source nitrogen reductions of 2012-15 were not accompanied by corresponding changes in chlorophyll-a or DO (Hall and others, 2016). **10- 2**

Following are recommendations for specific revisions of the parameter comments for the Cocheco River:

- Add discussion of excellent pH conditions, and specifically point out the lack of DO impairments.
- Revise text on chlorophyll-*a* to reflect the fact that joint consideration of the grab samples and (biased-high) sonde data demonstrate that the median chlorophyll-a concentration was <7 ug/L and that the 90th percentile was <17 ug/L (see Storer, 2015), which would not trigger listing under the CALM thresholds.
- Remove the references to the SMAST nitrogen ranges, which are inappropriate for this segment. The SMAST (2003) values were developed specifically for coastal embayments, not upper tidal rivers, and are not a substitute for the abundant site-specific data on DO, pH, chlorophyll-a, etc. that are available for this segment.
- Remove statements that are biased speculation with no basis in data for the Cocheco River; e.g., **10- 3**
    - Reference to changes in macroalgae and phytoplankton
    - Reference to animal community declines
    - Reference to aesthetic impacts
- Remove vague language such as references to "classic indicators of eutrophication" or a "clear nutrient signature", which are void of informational content, and appear to be biased given the lack of evidence of nitrogen impairments in this segment.

- Revise the misleading statement "It is less clear..,whether the eutrophication effects on designated uses can be attributed to Total Nitrogen alone" to "The available data do not demonstrate any adverse impacts of total nitrogen to designated uses."

In light of the excellent DO/pH, moderate chlorophyll-a, lack of eelgrass issues, and lack of nitrogen linkages in this segment, we recommend that the tidal Cocheco River be placed in Category 1 for nitrogen.

Great Bay (various segments): Most of the associated "parameter comments" should be removed and replaced with a simpler discussion that no linkage between nitrogen and adverse impacts has been established in the Great Bay, citing on the 2014 Peer Review Report. We find it strange and unacceptable that the narrative comments on the Great Bay ignored the 2014 Peer Review Report and its conclusions. DES will recall that the peer review panel was jointly selected by DES and the Coalition, and represented top experts in water quality/estuarine science. The 2014 Peer Review Report concluded that no linkage between nitrogen and eelgrass declines had been established. Many of the review panel's findings directly argued against the concept of nitrogen impairments:

- The Great Bay had lower TN concentrations than those that supported eelgrass in other coastal systems.
- Chlorophyll-a was only a small component of light attenuation, and had no temporal trend over the period of eelgrass decline.
- Eelgrass declines occurred even where nitrogen concentrations were lowest within the system. **10- 4**
- There was no strong association between macroalgae and eelgrass in the Great Bay.

These and other lines of evidence for the lack of nitrogen impairment have been summarized by Lucic (2015), Peschel (2016), Hall and Associates (2015), and Hall and others (2016). Among other lines of evidence, these references demonstrated that periods of eelgrass declines were not accompanied by worsening of water quality parameters, and in fact total nitrogen is currently much lower than pre-2003 period when eelgrass was higher. As expected, recent declines in total nitrogen were not accompanied by major changes in chlorophyll-*a*, water clarity, or DO. The available data on eelgrass and macroalgae do not support a systematic or progressive replacement of eelgrass by macroalgae. For example, the loss in eelgrass acreage was much higher than the observed macroalgae acreage in the Great Bay, and interannual variability (including increases) of eelgrass acreage has been much higher than the documented macroalgae bed acreage.

Following are recommendations for specific revisions of the parameter comments for the Great Bay segments:

- Add discussion of the lack of evidence of nitrogen impairments, directly citing the 2014 Peer Review Report and more recent references.
- Reduce overreliance on the SMAST thresholds, which are no substitute for the site-specific understanding of Great Bay gained by the available data, the 2014 Peer Review Report, and more recent work. To the extent that the SMAST thresholds are referenced, DES should provide a more balanced view that acknowledges favorable conditions based on DO, TN, chlorophyll-a, etc.
- Remove the anecdotal and unsubstantiated statements. Examples:
  - References to changes in phytoplankton
  - Personal observations with no basis in data (e.g., quotes of A. C. Mathieson)
  - The statement that TN "remains elevated".
  - Vague language such as references to "classic indicators of eutrophication" or a "clear nutrient signature", which are biased statements that are void of informational content. 10- 5
- Remove misleading statements that macroalgae or epiphytic growths have been shown to be a major cause of eelgrass decline; qualify discussion of macroalgae/epiphytes with statements that linkages between nitrogen, eelgrass, and macroalgae have not been established for the Great Bay.
- Revise the misleading statement "It is less clear… whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to Total Nitrogen alone." to "It is unclear if total nitrogen is having any adverse impact on designated uses."

Based on a balanced interpretation of the available data, the 2014 Peer Review Report, and more recent data evaluations, the Great Bay should be placed in category 3-PNS (cause unknown).

We appreciate the opportunity to submit these comments and ask that you give them your full consideration. Please call me at 603-335-7577 if you have any questions.

Sincerely, 10- 6

John B .Storer, Director of City Services

Attachments

Attachment A: Storer, J. 2015. City of Rochester, New Hampshire Comments on the Draft 303(d) List of Impaired Surface Waters for New Hampshire. Letter dated Dec. 11, 2015 submitted to Ken Edwardson of NHDES. 10 p.

Attachment B: Lucic, R.R. 2015. Great Bay Municipal Coalition Comments on NHDES Draft 2014 303(d) List and CALM. Letter dated Dec. 11, 2015 submitted to Ken Edwardson of NHDES. 91 p.

Attachment C: Bell, C. 2016. Review of DES Basis for 2014 303(d) Listing of Tidal Segments for Nitrogen. Letter dated Sep. 2, 2016 submitted to Thomas Burack of NHDES. 10 p.

Attachment D: Peschel, D. 2016. Delisting of Impaired Waters. Letter dated Jul. 20, 2016 submitted to Thomas Burack of NHDES. 2 p.

Other References

Bierman, V.J., Diaz, R.J., Kenworthy, W.J. & Reckhow, K.H. February 13,2OI4. Joint Report of Peer Review Panel for Numeric Nutrient Criteria for the Great Bay Estuary.

Hall and Associates. 2015. Evaluating the Spatial and Temporal Variability of Eelgrass in Great Bay Estuary, New Hampshire. 18 p.

Hall, W.T., Hall, J.C., Kirby, B.T., Gallaher, T., and Peschel, D. 2016. Impact of Rochester and Dover WWTF Nitrogen Load Reductions on Water Quality of the Upper Piscataqua River. 21. P.

SMAST. December 22,2003. Massachusetts Estuaries Project - Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators Interim Report.

COMMENT #11 (on Feb. 3, 2017 Changes): Dean Peschel on the behalf of Great Bay Municipal Coalition

Great Bay Municipal Coalition
Comments on NHDES Categorization of Unassessed Waters in the Draft 2014 Section 303(d) List of Threatened or Impaired Waters
February 24, 2017

Introduction

The NHDES Categorization of Unassessed Waters in the Draft 2014 Section 303(d) List of Threatened or Impaired Waters seeks to revise the 303(d) DES Category for Great Bay and the Cocheco River from "Under Construction" to "3-PNS" or Potentially Not Supporting for Total Nitrogen (TN). DES ultimately concludes that "impairment is not warranted under New Hampshire's narrative standard." While DES stops short of declaring these water bodies impaired due to TN, DES' revisions repeatedly state that TN is, in fact, a cause of impairment reflecting a range of adverse conditions in the system. DES makes the following identical claims in both the Great Bay and Cocheco River assessment zones: **11- 1**

> Some of the classic indicators of nutrient eutrophication are present in this assessment zone and Total Nitrogen remains elevated. As the discussion above illustrates, there is a clear nutrient "signature" in the data. It is less clear, as [sic] this time, whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to Total Nitrogen alone.

However, it is clear from site-specific datasets, depositions of NHDES staff, an independent expert peer review panel, and other independent experts that 1) Great Bay and the Cocheco River do not experience adverse eutrophication effects and 2) TN neither causes nor meaningfully contributes to alleged adverse eutrophication effects in these water bodies. Section 303(d) decisions are to be based on reliable information, not unsupported speculation. Therefore, this claim of ongoing impairment caused by total nitrogen, which is utterly false, must be removed from the 303(d) record. Supporting documentation and comments are provided below.

In addition to providing technical comments, we conclude that these draft 303(d) list revisions evidence overt bias and a lack of competent scientific assessment in attempting to suggest, with no objective analyses as support, the opposite of scientifically defensible, expert-backed conclusions with respect to nutrient impacts in these water bodies. Unfortunately, this is not the first occasion that DES has published demonstrably incorrect nutrient impairment claims to be made with respect to this system. The now abandoned 2009 Nutrient Criteria were premised on water clarity impairment that the Technical Advisory Committee for this estuary stated did not exist (i.e., a transparency reduction due to nutrients). Staff ignored that independent expert conclusion and created a document that claimed TN was causing poor transparency in the system, knowing, all along, that the data did not support that assessment. This ongoing abuse of available scientific information to create arbitrary nutrient reduction mandates must cease. **11- 2**

The following provides detailed comments on the scientifically unsupportable assertions in this most recent DES Section 303(d) action.

Great Bay Assessment Zone

The assessment for Great Bay concludes that there is insufficient information to make a finding on aquatic life use support due to TN, but the justification for the revised listing repeatedly overtly states or implies that these units are, somehow, TN impaired. We note the following clear errors with the narrative description for the Great Bay TN delisting: **11- 3**

- **Use of the SMAST 2003 Critical Indicators Report is not scientifically defensible**:

The reliance on the 2003 SMAST *Massachusetts Estuaries Project Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators Interim Report* (Howes, Samimy, and Dudley, 2003) to reach conclusions regarding a Great Bay TN impairment is improper given the findings of the 2014 Peer Review and the language of the SMAST report itself. The 2014 Peer Review stated the following with regard to DES' earlier, flawed attempt to rely on SMAST:

> The 2009 Report failed to acknowledge the relevance of some very important differences between the MEP [Massachusetts Estuary Program] program's approach and the DES approach. Also, important differences in some the physical characteristics of Great Bay and the embayments of Massachusetts were not acknowledged, implying that DES did not consider the relevance of the differences and how they could affect interpretation of water quality monitoring data. Furthermore, by making a simple comparison to the MEP program without a comprehensive evaluation of the status of that program, *DES was irresponsible in making the comparison and implying that it supports total nitrogen criteria proposed for the Great Bay*. (2014 Peer Review, Kenworthy Response at 50).

Moreover, Great Bay does not adhere to the conceptual model upon which the Critical Indicators Report is based. The Critical Indicators Report notes that "[n]itrogen in and of itself does not generally play a significant direct role in habitat health" and presents the following conceptual model where "nitrogen is the driving parameter […] of habitat quality within shallow coastal embayments […] primarily through the trophic sequence" (at 13): 11- 4

N Load → Plant Production → Organic Matter Load → O_2 Uptake → Community Decline

However, Great Bay does not conform to this conceptual model; the algal productivity (*i.e.*, plant production) in Great Bay is very low and there is no DO (*i.e.*, O_2 Uptake) issue anywhere in Great Bay as confirmed by the DO and phytoplankton data for the system. Ephemeral macroalgae growth is primarily documented in the tidal mudflats which causes no apparent DO issue. Moreover, there are no data showing aquatic community decline, other than eelgrass population changes. Those plainly are not linked to TN levels as eelgrass populations were highest when the highest levels of TN were documented in this system and eelgrass have declined even in areas with very low nutrient concentration and excellent water clarity, as noted in the 2014 Peer Review:

> The statistical approach taken by DES is much simpler than the MEP approach and it is difficult to support the proposed criteria because […] eelgrass is still declining in locations (reference conditions) with the lowest concentration of total nitrogen and the most transparent water. This would suggest that there are confounding factors affecting the response of eelgrass to the primary symptoms. (2014 Peer Review, Kenworthy Response at 38).

- **Total Nitrogen Has NO Demonstrated Link to Any Ecological Condition in this Estuary**

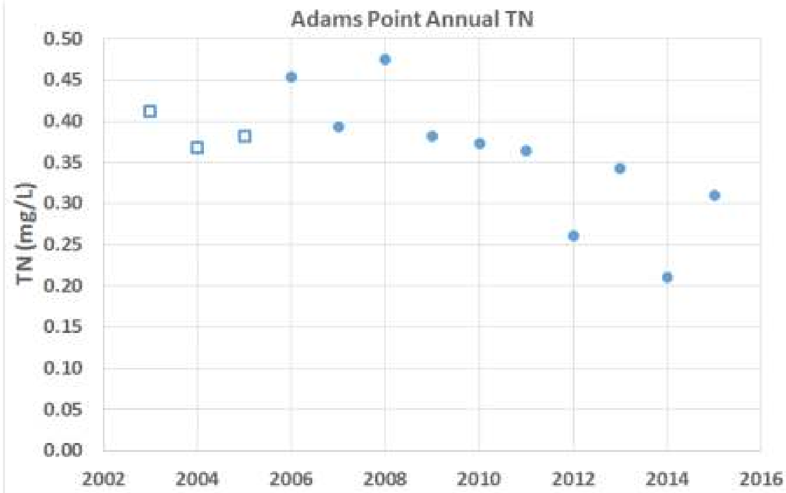
DES' narrative continues the false claim that TN is the causative agent of an alleged cascade of eutrophication impacts: "Some of the classic indicators of nutrient eutrophication are present in this assessment zone and Total Nitrogen remains elevated" (at 3). First, the report fails to document where this "critical indicator" exists in this system. Again, this statement is completely contrary to the 2014 Peer Review which provides that such impairment "indicators" do not exist.

> Since these results suggest chlorophyll-a is responsible for only a small fraction of light attenuation and DES implicates nitrogen as the main factor responsible for eelgrass loss, it would be reasonable to evaluate the effect of epiphytes as a diagnostic symptom of eutrophication in the Great Bay system. In their assessment DES did not explicitly state whether they considered epiphytes as a potential eutrophication problem. If we assume that DES did not simply ignore this factor and epiphytes are not contributing significantly to light attenuation, and chlorophyll-a is only a minor contribution to light attenuation, nitrogen cannot be directly implicated as the major cause of light attenuation and eelgrass declines in the Great Bay estuary. (2014 Peer Review, Kenworthy Response at 12).

11- 5

Second, DES's generalized claim that the "classic indicators of eutrophication exist" fails to recognize that collected annual average TN concentrations at Adams Point have been consistently declining for a decade and they were, as of the time the data for this assessment were collected, at all-time lows (as continues to be so), well below the level even DES originally claimed was necessary to protect system ecological resources

(NHDES Environmental Monitoring Database). That some form of plant growth may be changing over this time frame is interesting (this occurs in all natural systems), but most certainly has not ever been related to TN levels in this system.



These TN reductions can be attributed to voluntary POTW reductions, namely from Rochester and Dover, and potentially reduced rainfall. Third, , the 303(d) report improperly analyzes the data over time, knowing that changes in system inputs have lowered TN levels. The accurate level of TN in the system for the 2014 assessment is almost 0.30 mg/L TN, not 0.39 mg/L. Per federal rules, 303(d) reports should properly account for changes in pollutant loading (see 40 CFR 130.6). DES' analysis plainly skewed the data assessment to fit its claim of TN impairment by ignoring the fact that TN levels have been reduced for a very specific and well known reason – WWTP loads have materially decreased.

All parties understand that the system was not considered impaired for eelgrass in 2003-2005. During this period TN levels were considerably *higher* than they are today. To make the assertion that the lower TN levels are somehow responsible for creating the "classic indicators of eutrophication" was a biased and unsupported claim, akin to those irresponsible claims made as part of the 2009 Criteria document development. In fact, there are no studies that have ever linked TN levels to any form of alleged impairment in this system. DES's implications should be abandoned, just as DES abandoned the 2009 Nutrient Criteria Document.

- **Dissolved Oxygen Impairments Do Not Exist in Great Bay**

  The narrative asserts that "[t]here are areas in the southwest with poor dissolved oxygen" but provides no more specific information as to the precise location or cause of DO concentrations at that location. First, there are no documented low DO areas in the **11- 6** southwest portion of Great Bay proper (see PREP State of Our Estuaries 2013 at 19). Low DO was confirmed in the Squamscott River, a separate assessment zone. Moreover, independent scientific investigations have determined that a cause of low dissolved oxygen is due to stratification in Great Bay Estuary's tidal rivers and is not an indication of systemic eutrophication in Great Bay. (See Pennock, 2007) Moreover, nutrient and chlorophyll-a levels did not appear to have any discernable relationship with DO levels (Jones, S. April 2007. Impacts of Wastewater Treatment Facilities on Receiving Water Quality. Final Report to New Hampshire Estuaries Project). Therefore, the statement on low DO in Great Bay must be struck as completely unsupported. Moreover, the 2014 Peer Review concluded that the overall DO condition in the estuary would not adversely affect the health of benthic communities:

> While impacts from low DO occur over a broad range of oxygen concentrations, for benthic invertebrates, sublethal and behavioral responses to low DO are not obvious above 3 mg O2/l (Diaz and Rosenberg 1995, Vaquer-Sonyer and Durate 2008). Based on the DO data used in the DES 2009 Report, between 2000 and 2012 the minimum DO concentration was 5 mg O2/l or less a total of 20 times in eight of the 22 assessment zones. It therefore seems unlikely that low DO is a controlling factor for benthic community structure. (2014 Peer Review, Diaz Response at 44).

As the DES staff responsible for these latest claims have no supporting analyses and lack the expertise to contradict the findings of the 2014 Peer Review, these inconsistent, unsupported allegations of DO impairment in Great Bay must be expunged from the record.

- **Chlorophyll-a Confirms Eutrophication is Not Occurring and the System is not Nutrient Impaired**

DES notes that "the calculated 90th percentile chlorophyll-a in this assessment zone is 8.9 µg/L (n = 249) which is just below the threshold described in the CALM." First, it does not matter whether this algal concentration is just below the threshold in the CALM or far below the threshold. Plainly, it is below the arbitrary impairment threshold selected by DES. Dr. Robert J. Diaz recognized these low Great Bay chl-a concentrations in the context of eelgrass impairment in the 2014 Peer Review: **11- 7**

> An immediate observation is that not only is chlorophyll-a a small component of Kd, median chlorophyll-a concentrations in Great Bay are low and range between 1-7 µg/l (Table 6). It is unlikely that reductions in nitrogen concentration could cause significant improvements in light by causing reductions in chlorophyll-a concentration. (2014 Peer Review, Bierman Response at 24).

Second, the subsequent discussion concerning SMAST is irrelevant and in any event, misapplied. The values are multi-season averages, not daily maximum levels. The algal assessments are based on growing season averages or medians, not daily maximum values. SMAST classifies "Excellent to Good" water quality in the range of 3-5 µg/l chl-a (at 21). Between January 1, 2008 and November 7, 2014, the NHDES *Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report/303(d) List* (NHDES, 2015) reported the median Great Bay chl-a was 3.1 µg/L, indicative of excellent water quality (at 37). Moreover, the alleged elevated level of chlorophyll-a reported in the southwestern area has been associated with the discharge of algae from a poorly operated wastewater treatment lagoon in Exeter and has nothing to do with blooms of phytoplankton occurring in the receiving water. There is, in fact, no algal related impairment documented anywhere in Great Bay proper.

- **Light Attenuation Impairment Has No Scientific Basis And Must be Eliminated**

The narrative notes that eelgrass beds are degraded and the available light attenuation is poor. Both statements are true, but they are not an indication of cause and effect. Light attenuation has always been poor in the assessment area due to natural conditions (CDOM, non-algal particulates), as determined by Morrison et al. 2008. The following analyses of Squamscott River and Lamprey River transparency confirms that low transparency occurs even when algal growth is minimal: **11- 8**

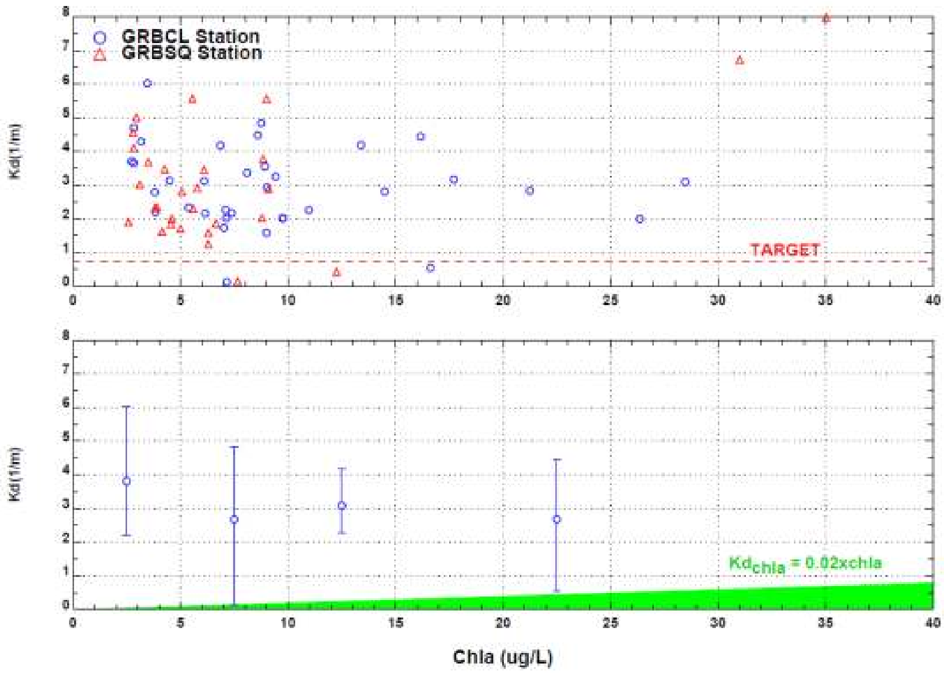
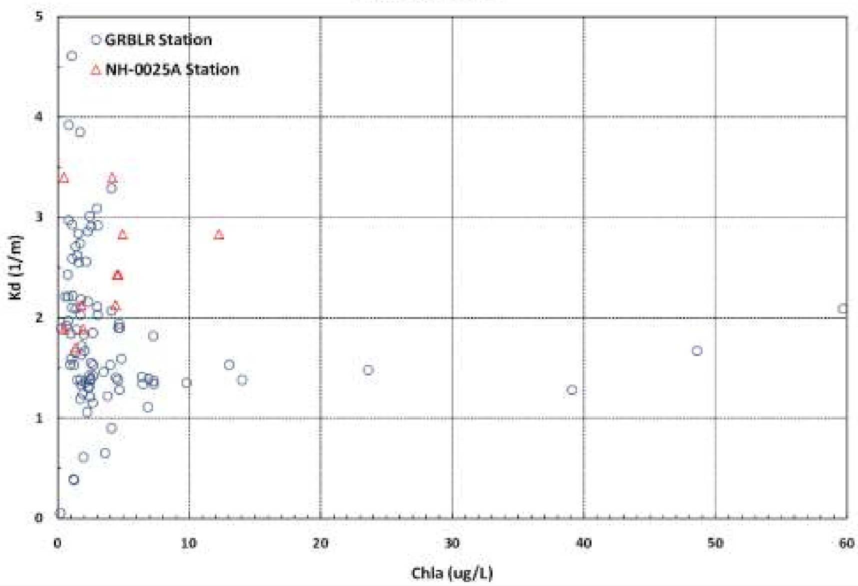


Figure 1. Squamscott River Measured Kd and Chla (2003-2008)

LAMPREY RIVER



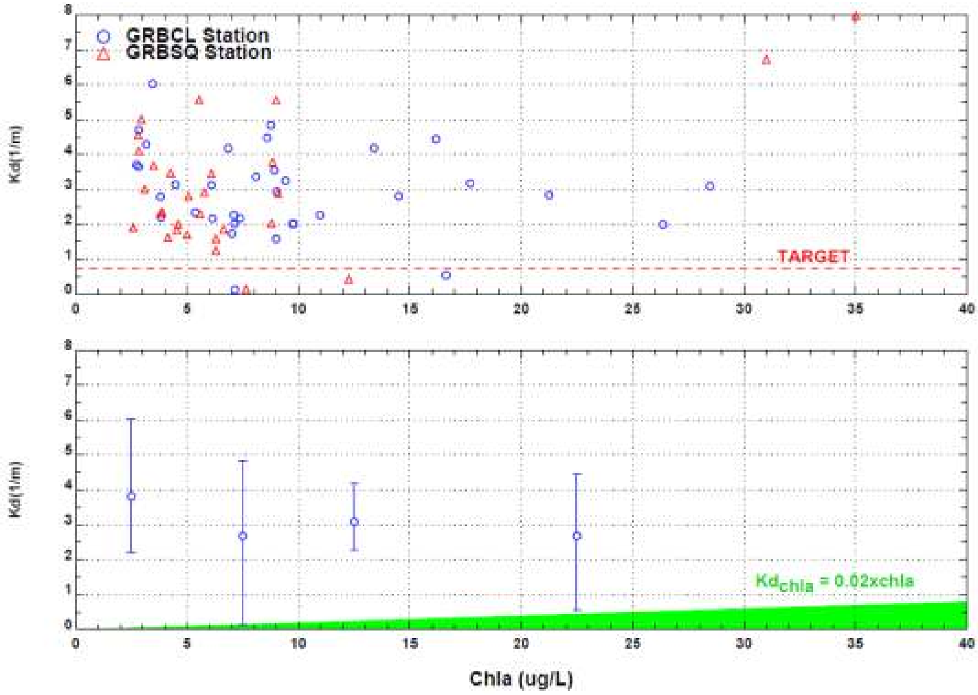
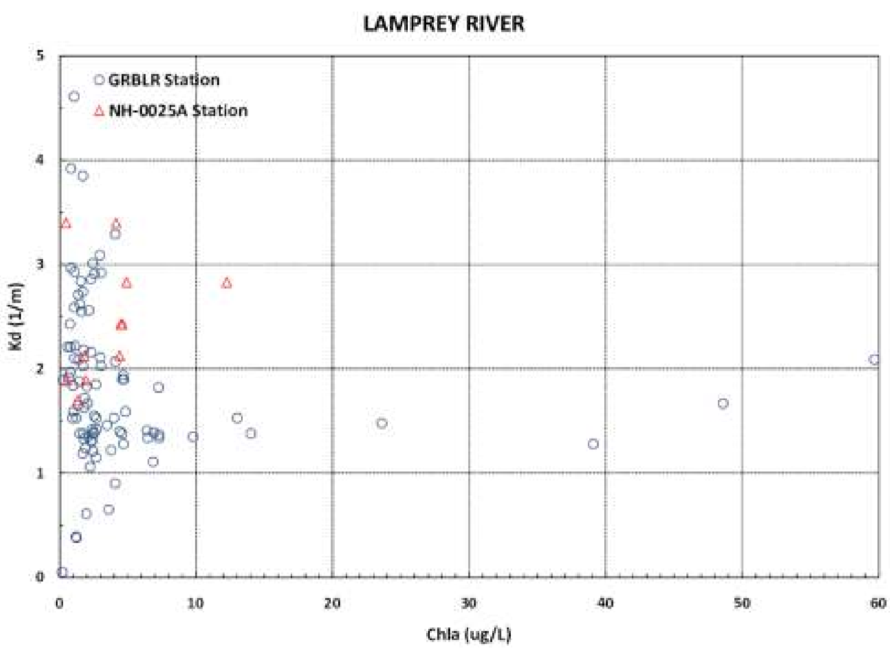


Figure 1. Squamscott River Measured Kd and Chla (2003-2008)



It is well known that the selected transparency targets, created as part of the now abandoned 2009 Nutrient Criteria, cannot be achieved simply because of these natural inputs and therefore one cannot list this as an impairment under state law. Regardless of the "low transparency" that exists in this system, over the period of observation, eelgrass beds have ranged from non-degraded to degraded. Given that light attenuation has always been poor in the assessment area, and the eelgrass beds have ranged from non-degraded to degraded over this same time period, there is plainly no link between the two (absent the extreme condition occurring from floods in 2006 – also a natural condition).

As confirmed by DES under oath, this system does not have a documented transparency impairment. In depositions provided by Mr. Phil Trowbridge on June 23, 2012 and July 11, 2012, he acknowledged that eelgrass beds in Great Bay are mostly intertidal and water clarity is sufficient for eelgrass growth. The reasons for this were explained in an email from Dr. Fred Short (dated November 8, 2007), which stated, "Great Bay is dominated by extensive eelgrass meadows that are intertidal that receive enough light at low tide to satisfy their light requirements." In deposition (at 177), Mr. Trowbridge indicated he had no reason to disagree with that observation by Dr. Short.

29. It was EPA that insisted DES continue to develop the 2009 criteria, despite knowing that the "conceptual model" (transparency decrease due to nutrient induced excessive algal growth) was not applicable to this system.

> **Q.** Do you have a basis to agree with Mr. Liebman that since Great Bay eelgrass community is mostly intertidal, the response is different than the water quality conceptual model that you were applying – I'm sorry – water clarity conceptual model you were applying? **A.** Do I have a reason to object to that? Is that --. **Q.** Is that a – is that statement wrong? **A.** I think it's valid.

Trowbridge Deposition Vol. 1 at 198 ln 8-17.

30. DES simply decided to ignore its own detailed assessments showing transparency was not the issue.

> **Q.** Okay. Was this moored array report part of the studies that you considered in order to determine what was affecting transparency in the system and why? **A.** Yes. **Q.** Did you include this as a reference in that 2009 criteria document? **A.** Yes. **Q.** Okay. I'm going to read it. Are you an author on this study? **A.** Yes. **Q.** I'm going to read you a quote from the report, page 51. The results of the – the results suggest that water clarity in Great Bay, Little Bay, and Lower Piscataqua River were sufficient for eelgrass growth. The virtual absence of eelgrass from all but Great Bay suggests that other processes apart from light restricted growth and are important for limiting eelgrass survival. Is that a false statement in this report? **A.** No.

Trowbridge Deposition Vol. 1 at 235 ln 18 -236 ln 17.

29. It was EPA that insisted DES continue to develop the 2009 criteria, despite knowing that the "conceptual model" (transparency decrease due to nutrient induced excessive algal growth) was not applicable to this system.

> **Q.** Do you have a basis to agree with Mr. Liebman that since Great Bay eelgrass community is mostly intertidal, the response is different than the water quality conceptual model that you were applying – I'm sorry – water clarity conceptual model you were applying? **A.** Do I have a reason to object to that? Is that --. **Q.** Is that a – is that statement wrong? **A.** I think it's valid.

Trowbridge Deposition Vol. 1 at 198 ln 8-17.

30. DES simply decided to ignore its own detailed assessments showing transparency was not the issue.

> **Q.** Okay. Was this moored array report part of the studies that you considered in order to determine what was affecting transparency in the system and why? **A.** Yes. **Q.** Did you include this as a reference in that 2009 criteria document? **A.** Yes. **Q.** Okay. I'm going to read it. Are you an author on this study? **A.** Yes. **Q.** I'm going to read you a quote from the report, page 51. The results of the – the results suggest that water clarity in Great Bay, Little Bay, and Lower Piscataqua River were sufficient for eelgrass growth. The virtual absence of eelgrass from all but Great Bay suggests that other processes apart from light restricted growth and are important for limiting eelgrass survival. Is that a false statement in this report? **A.** No.

Trowbridge Deposition Vol. 1 at 235 ln 18 -236 ln 17.

tHaving confirmed that the Squamscott River and Lamprey River do not have a documented transparency impairmen, DES cannot continue to base system impairments on transparency issues. DES should cease classifying the system as transparency impaired.

- Macroalgae Impairment In This System Has NEVER Been Documented

The narrative indicated there is strong evidence that macroalgae proliferation is impacting eelgrass, and these areas have not been recolonized by eelgrass:

> There is strong evidence that macroalgae proliferation is impacting eelgrass and changing the species composition and diversity in Great Bay. […] NHDES determined that macroalgae mats had replaced nearly 5.7% of the area formerly occupied by eelgrass in Great Bay in 2007 (NHDES, 2009) and that replaced area has not been recolonized by eelgrass. Loss of eelgrass in the intertidal zone as documented in the depth analysis is consistent with smothering by macroalgae. **11- 9**

There are no studies that analyzed this issue or have ever demonstrated macroalgae are causing a significant loss of eelgrass in this system. Macroalgae grow in all estuarine waters. Such plant growth is ephemeral and the available data indicate that macroalgae colonized areas that already lost eelgrass cover, but did not cause that loss or prevent eelgrass recolonization (*e.g.*, opportunistic use of bare intertidal areas). This lack of evidence was confirmed under deposition in 2012 by NHDES staff (see Philip Trowbridge Deposition, 2012).

22. There is no data showing eelgrass loss caused increased macroalgae growth.

> **Q.** … Do you know if in this system the growth of macroalgae is what caused the eelgrass loss? **A.** No. **Q.** Okay. And whatever macroalgae were growing, they apparently did not prevent 500 acres of eelgrass from recovering, did it? **A.** No.

Trowbridge Deposition Vol. 1 at 156 ln 21 – 157 ln 5.

23. There is no macroalgae impairment in Great Bay.

> **Q.** What about macroalgae impairments? Are they – are they documented in the Squamscott River, excessive macroalgae in the Squamscott, have you seen a report on that? **A.** No. **Q.** How about the Lamprey? **A.** No. *** **Q.** What about the Piscataqua, Upper or Lower, excessive macroalgae? **A.** I'm not sure. *** **Q.** … Have any of the indicator reports ever addressed the extent of macroalgae growth in the system and whether or not it's causing an impairment? **A.** No.

Trowbridge Deposition Vol. 1 at 149 ln 21 – 150 ln 4; 150 ln 22 – 151 ln 1; 152 ln 13-16.

22. There is no data showing eelgrass loss caused increased macroalgae growth.

> **Q.** … Do you know if in this system the growth of macroalgae is what caused the eelgrass loss? **A.** No. **Q.** Okay. And whatever macroalgae were growing, they apparently did not prevent 500 acres of eelgrass from recovering, did it? **A.** No.

Trowbridge Deposition Vol. 1 at 156 ln 21 – 157 ln 5.

23. There is no macroalgae impairment in Great Bay.

> **Q.** What about macroalgae impairments? Are they – are they documented in the Squamscott River, excessive macroalgae in the Squamscott, have you seen a report on that? **A.** No. **Q.** How about the Lamprey? **A.** No. *** **Q.** What about the Piscataqua, Upper or Lower, excessive macroalgae? **A.** I'm not sure. *** **Q.** … Have any of the indicator reports ever addressed the extent of macroalgae growth in the system and whether or not it's causing an impairment? **A.** No.

Trowbridge Deposition Vol. 1 at 149 ln 21 – 150 ln 4; 150 ln 22 – 151 ln 1; 152 ln 13-16.

The 2007 survey of Great Bay documented macroalgae in areas that lost eelgrass cover in 2006 (Pe'eri et al., 2008). Subsequent surveys of Great Bay in 2008, 2009, and 2010 showed that several of the areas covered by macroalgae in 2007 were repopulated by eelgrass in subsequent years, contrary to the assertion in the narrative (Short, 2009; Short, 2010; Short, 2011). In addition, a number of areas were not repopulated, but there is no information indicating that this is due to macroalgae as opposed to changes in habitat that preclude eelgrass cover, as noted by Dr. Kenworthy in the 2014 Peer Review Report:

> Furthermore, a single year (n =1) cannot be considered representative of a highly dynamic shallow water macrophyte system consisting of eelgrass and macroalgae. Although DES has the capability to measure variation in eelgrass cover based on annual surveys (e.g., see Table 1), there are no data for variation in macroalgal abundance, so DES cannot determine if 2007 was representative of some average or median value for macroalgae in a longer time series. If 137 acres of macroalgae were having a permanent negative effect on eelgrass abundance in 2007, how do you explain the fact that eelgrass cover increased in Great bay during 2008, 2009, and 2010 (Table 1)? In 2010 there were 477 more acres of eelgrass in Great Bay than present in 2007. This additional eelgrass cover is 3.5 times more eelgrass cover than was allegedly displaced by macroalgae according to the 2007 study. Inconsistency in the definition of what constitutes significance, the data for variation in eelgrass cover, and the extremely limited data for macroalgal cover and abundance renders any conclusions regarding nitrogen thresholds based on macroalgae effects unsupported. (2014 Peer Review, Kenworthy Response at 28).

Finally, it should be noted that the latest macroalgae report by Burdick et al makes no claim and presents no analyses regarding (1) TN impacts on macroalgae growth and (2) the impacts of the documented macroalgae growth on the ecological health of this system. Thus, it is apparent that DES continues to incorrectly assert the alleged relationship and impairment claim. It should be noted that the macroalgae sites assessed by Burdick do not even impact where eelgrass are capable of growing.

- **Epiphytes Are Not Demonstrated to Be Impairing Eelgrass Viability**

Epiphytes ubiquitously and naturally occur at some level on submerged aquatic vegetation. The unquantified and undocumented presence of epiphytes cannot be construed as scientific evidence that these epiphytes are causing or meaningfully contributing to depressed eelgrass cover in Great Bay. Nonetheless, the narrative quoted Dr. Arthur C. Mathieson stating:

11- 10

> Extensive epiphytic growth of seaweeds on eelgrass (*Zostera marina)* have also occurred during the past 15-20 years, particularly within Great Bay proper (pers. obs. A C Mathieson). These epiphytes, which are mostly filamentous red algae and colonial diatoms, may completely cover the fronds of eelgrass, limiting the host's growth and photosynthesis and compromising its viability.

First, the NHDES *Guidance for Submitting Comments on Uncategorized Assessment Zones in the October 14, 2015 'Draft' 2014 303(d) List of Impaired Surface Waters for New Hampshire* requires that submitted "data or information must […] include documentation of quality assurance methods used in the collection, analysis and reporting of data." Yet, NHDES cites to undocumented personal observations from Dr. Mathieson to support suggestions that epiphytes are increasing in Great Bay proper and may be adversely affecting eelgrass growth. This reliance on personal observations, as opposed to published literature or quality assured studies, is not scientifically defensible and even fails to meet the minimum requirements that NHDES imposes upon public comments. Such personal observations may not be used in this manner, especially in lieu of published literature or quality assured studies, as required.

Second, no analyses exist to support claims that epiphytes are adversely affecting eelgrass "viability". Anecdotal observations of the presence of epiphytes in Great Bay does not demonstrate that epiphytes contributed to eelgrass declines or prevented eelgrass from rebounding in Great Bay. Furthermore, no analyses exist that make a causative connection between total nitrogen and epiphytic growth. Therefore, any discussion regarding epiphytes in these 303(d) list revisions are unsupported, misplaced, and completely speculative.

Third, this quote is contradictory to Dr. Fred Short who had separately indicated that epiphytes are not a concern for eelgrass health in the estuary. "With respect to epiphytes, Fred told me that epiphytic growth has historically not been an issue in Great Bay because this growth seemed to be controlled by grazers." (November 18, 2011 phone log by DJA (EPA Region 1) speaking with Dr. Short). Also see 2014 Peer Review, Kenworthy Response at 12 (supra at 3).

Great Bay Assessment Zone Summary: As noted in our review of the narrative accompanying the delisting action, there is no clear "nutrient signature" occurring anywhere in Great Bay. Moreover, subsequent data collected in Great Bay show that total nitrogen concentrations have been reduced significantly to levels well below those that occurred in the early 1990's when eelgrass levels were considered fully supporting the designated use and are below the concentrations determined to fully support designated uses elsewhere (*e.g.*, SMAST, Chesapeake Bay). Concurrent with these lower TN levels, eelgrass beds are apparently still degraded in comparison with prior years, and some forms of macroalgae appear to be expanding into areas that currently do not support eelgrass beds (*i.e.*, the shores of the Piscataqua River), and light attenuation is still considered poor due to natural conditions. As observed by Dr. Kenworthy:

> Eelgrass is still declining in locations (reference conditions) with the lowest concentration of total nitrogen and the most transparent water. This would suggest that there are confounding factors affecting the response of eelgrass to the primary symptoms". (2014 Peer Review, Kenworthy Response at 38).

11- 11

Moreover the 2014 Peer Review expressly concluded that the "weight of evidence" does not indicate TN is causing impairment in this system. Based on these observations and the comments from the 2014 Peer Review, NHDES should conclude that 1) the loss of eelgrass from Great Bay in comparison with prior years is currently unexplained, 2) macroalgae are opportunistic and capable of occupying bare substrate even at the reduced level of TN currently present in Great Bay, 3) poor light transparency is a natural condition, unrelated to TN load, and 4) monitoring data collected over the past 20 years have been unable to demonstrate a clear "nutrient signature" (*i.e.*, elevated phytoplankton chl-a, reduced DO). Consequently, this assessment zone should be assessed as Insufficient Information – Potentially Not Supporting (3-PNS) related to eelgrass declines, due to unknown causes.

Cocheco River Assessment Zone

The assessment for the Cocheco River concludes that there is insufficient information to make a finding on aquatic life use support, but finds that the Cocheco River assessment zone is Potentially Not Supporting for Total Nitrogen, due to speculation akin to that occurring with the Great Bay zone. We note the following issues with the integrated evaluation contained in the narrative:

- **SMAST 2003 Critical Indicators Report is Inapplicable to Tidal Rivers**

  The narrative's reliance on the 2003 SMAST *Massachusetts Estuaries Project Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators Interim Report* (Howes, Samimy, and Dudley, 2003) is scientifically indefensible. On its face, the Critical Indicators Report was based on site-specific Massachusetts embayment data and unsurprisingly applies only to *embayments*:

  > In order to accomplish this goal the Estuaries Project must also provide a means to bridge the gap in the existing water quality standards by providing a translator between the current narrative standard and nitrogen thresholds (*as they relate to the ecological health of each embayment*) which can be further refined *based on the specific physical, chemical and biological characteristics of each embayment*. This report is intended to provide a detailed discussion of this issue […] as well as proposed an acceptable range of nitrogen thresholds that will be used to interpret the current narrative standard. (Howes, Samimy, and Dudley, 2003 at 2; emphasis added). 11- 12

  As such, the Critical Indicator Report thresholds should not be applied to tidal rivers such as the Cocheco River, bearing no resemblance to an embayment. Furthermore, the Critical Indicators Report directs that "[t]hreshold values need to be site-specific, the values presented are for Great, Green and Bournes Ponds in the Town of Falmouth," not the Cocheco River (Howes, Samimy, and Dudley, 2003 at 20). SMAST also cautions that these Critical Indicator Report nitrogen threshold "values are preliminary and need refinement by MEP." (Howes, Samimy, and Dudley, 2003 at 20). In accordance with the instruction of the Critical Indicators Report, the referenced nitrogen thresholds cannot be applied to the Cocheco River, absent additional site-specific analyses demonstrating that a specific nitrogen threshold is needed to achieve the aquatic life use. This concern was precisely addressed in the Peer Review.

> DES failed to acknowledge the relevance of some very important differences between the MEP program's approach and the DES approach. Also, important differences in some the physical characteristics of Great Bay and the embayments of Massachusetts were not acknowledged, implying that DES did not consider the relevance of the differences and how they could affect interpretation of water quality monitoring data. Furthermore, by making a simple comparison to the MEP program without a comprehensive evaluation of the status of that program, DES was irresponsible in making the comparison and implying that it supports total nitrogen criteria proposed for the Great Bay.(Kenworth Response, Peer Review at 50)

Despite this admonition from the 2014 Peer Review, the narrative compares the Cocheco River TN concentration with nitrogen thresholds developed by SMAST – this needs to cease now. Moreover, the SMAST report was based on the protection of eelgrass, which is not a specific concern in the Cocheco River, as noted in the Peer Review.

> According to the DES 2008 report, "Eelgrass is not known to have been present in the Cocheco River. The historic sources did not map and current eelgrass maps do not show eelgrass in this zone. <u>Available chlorophyll-a data indicate compliance with the chlorophyll-a criterion</u>. Since there are no chlorophyll-a impairments in this zone, an impairment for nutrients per Env 1703.14 is not justified." Based on this assessment, I would recommend that the Cocheco River be treated very differently from the tidal Piscatagua which still has eelgrass present, but declining. With respect to eelgrass, it has never been documented in the Cocheco, so it would be irresponsible to set criteria for eelgrass based on any other segments of the Great Bay estuary. (Kenworthy Response, Peer Review at 66) (Emphasis added.)

In addition, the Cocheco River does not adhere to the conceptual model upon which the Critical Indicators Report is based. The Critical Indicators Report notes that "[n]itrogen in and of itself does not generally play a significant direct role in habitat health" and presents the following conceptual model where "nitrogen is the driving parameter […] of habitat quality within shallow coastal embayments […] primarily through the trophic sequence" (at 13):

N Load → Plant Production → Organic Matter Load → O_2 Uptake → Community Decline

As with Great Bay, the Cocheco River does not follow this conceptual model. First, as noted by DES, "there are no documented records of eelgrass presence in the Cocheco River assessment zone" and therefore, there is no documented "community decline" in the Cocheco River assessment zone. Accordingly, SMAST nitrogen thresholds to avoid "community decline" have no documented relevance to the Cocheco River.

Second, there is no documented DO issue in the Cocheco River. Based on data between January 1, 2008 and November 7, 2014, the NHDES *Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report/303(d) List* (NHDES, 2015) reports that "[t]he frequency, duration, and magnitude of those dips [below 5 mg/L] do not rise to the severity that warrants and [sic] impairment." (at 51) (Emphasis added). Therefore, the claims of likely TN impairment must be struck.

Cocheco River Assessment Zone Summary: The DES 303(d) list Cocheco River assessment zone narrative is replete with false statements and inapplicable references as support. Based on the more comprehensive review of DES' 303(d) list revision provided above, DES should conclude that 1) the available data indicate compliance with the chlorophyll-a criteria, and 2) there is no evidence of DO impairment in the assessment zone. Based on these observations, a clear nutrient signature is not apparent and the assessment zone is supporting designated uses.

COMMENT #12 (on Feb. 3, 2017 Changes): Tom Irwin, Conservation Law Foundation

clf
conservation law foundation

For a thriving New England

CLF New Hampshire
27 North Main Street
Concord, NH 03301
P: 603.225.3060
F: 603.225.3059
www.clf.org

Via E-Mail: 303dcomme@des.state.nh.us

February 24, 2017

2014, 303(d) Comments
NH Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive, P.O. Box 95
Concord, NH 03302-0095

Attn: Ken Edwardson 12- 1

Re: Categorization of Unassessed Waters in the Draft 2014 Section 303(d) List of Threatened or Impaired Waters

Conservation Law Foundation (CLF) appreciates the opportunity to comment on the NH Department of Environmental Services' (Department) Categorization of Unassessed Waters in the Draft 2014 Section 303(d) List of Threatened or Impaired Waters (Categorization Document), published by the Department on February 3, 2017. CLF has a strong interest in the health of the Great Bay estuary, including but not limited to Great Bay and the Lamprey and Cocheco Rivers, each of which are addressed in the above referenced "Categorization" document. CLF has previously submitted comments related to the Department's development of the State of New Hampshire's 2014 Section 303(d) List, which we hereby fully incorporate by reference.

As discussed below, CLF supports the Department's final 303(d) categorization of the Lamprey River (South) relative to Total Nitrogen. However, we strongly object to the Department's categorizations of Great Bay and the Cocheco River relative to Total Nitrogen and urge the Department to re-categorize those waters as impaired for such pollutant.

Lamprey River South

As the Department's Categorization Document demonstrates, the Lamprey River South assessment zone has experienced high median Total Nitrogen concentrations from 2008 through 2013; has been measured with a high concentration of chlorophyll-a; has experienced the elimination of eelgrass; and is surrounded by assessment units upstream and downstream that are impaired due to poor light attenuation coefficient. The Categorization document further explains that whereas there is a lack of data specific to the Lamprey River South assessment zone, data from neighboring assessment zones are sufficiently robust:

> The upstream Lamprey River North assessment zone has extensive datasets demonstrate[ing] impairments due to high chlorophyll-a and severely depleted dissolved oxygen. The downstream Great Bay assessment zone has marginally (*sic.*) chlorophyll-a and dissolved oxygen due to the severely poor condition coming out of the Squamscott River assessment zone as well 12- 2
>
> as degraded eelgrass, poor light transmittance, and evidence of macroalgae proliferation. Taken in totality, there is insufficient evidence to remove the 2012 Total Nitrogen impairment.

CLF agrees with this determination and strongly supports the Department's decision to retain the Lamprey River South assessment zone on the 2014 Section 303(d) List as impaired for Total Nitrogen.

Great Bay

The Department's Categorization Document recites compelling data evidencing that Great Bay's aquatic life use is impaired as a result of Total Nitrogen. Such data include:

- Total Nitrogen concentrations acknowledged by the Department to be "elevated."
- Southwestern portions of the bay with poor dissolved oxygen, at a level the Department classifies as "something worse than 'Moderately impaired health' . . . ."
- Chlorophyll-a levels that the Department considers "marginally impaired due to peak concentrations . . . and could even be considered in the group of 'Significant Impaired health' given that the area 'supports large phytoplankton blooms' . . . ."
- "The eelgrass beds are degraded and the available light attenuation . . . is poor."
- "[S]trong evidence that macroalgae proliferation is impacting eelgrass and changing the species composition and diversity in Great Bay."
- Loss of eelgrass in the intertidal zone "consistent with smothering by macroalgae."
- Detailed observations by Dr. Arthur Mathieson about the presence of macroalgae in the estuary, particularly Great Bay proper, and extensive epiphytic growth, as well as a 2016 paper by Burdick et al. noting "Monitoring results from 2014 show high levels of cover of nuisance green and red algae . . . at all sites except near the mouth of the Estuary."

The above data demonstrate that Total Nitrogen is causing impairment of Great Bay.[1] Indeed, the Categorization Document admits this fact, stating: "Some of the classic indicators of nutrient eutrophication are present in this assessment zone and Total Nitrogen remains elevated. As the discussion above indicates, there is a clear nutrient 'signature' in the data." **12- 3**

Despite all of the foregoing, the Department's Categorization Document states: "It is less clear, as (*sic.*) this time, whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to Total Nitrogen alone." On this basis, as well as the basis that it has elected not to employ its previously relied-upon numeric criteria for Total

---

[1] Other data support this conclusion, including recent reports by Dr. Frederick T. Short prepared for the Piscataqua Region Estuaries Partnership, *Eelgrass Distribution and Biomass in the Great Bay Estuary for 2015 (Sept. 22, 2016)* and *Eelgrass Distribution in the Great Bay Estuary for 2014 (Jan. 22, 2106)*, provided herewith; as well as the recent report *Monitoring Magcroalgae in the Great Bay Estuary for 2015*, David M. Burdick *et al.* (Feb. 14, 2017), publicly available at http://scholars.unh.edu/cgi/viewcontent.cgi?article=1364&context=prep; and data and statements by the Department itself relative to eelgrass and Total Nitrogen (note in particular the Department's statement about dissolved inorganic nitrogen as a component of Total Nitrogen) appended hereto (accessed online Feb. 24, 2017). *See also* the Department's February 9, 2017 public statement that "A long-term decline in eelgrass in the #GreatBay threatens survival of many species," appended hereto.

Nitrogen, it proposes to de-list Great Bay's impairment status relative to Total Nitrogen. Such action, if finalized, would be arbitrary and capricious and incorrect as a matter of law for the following reasons:

- The Comprehensive Assessment and Listing Methodology (CALM) makes clear that both indicators of nutrients (e.g., the presence of nitrogen in estuarine waters) and associated eutrophication impacts, namely low dissolved oxygen, eelgrass extent, chlorophyll-a concentrations, macroalgae, epiphytes and water clarity, are relevant factors. *See* CALM at 65-69. The eutrophic conditions described in the Categorization Document, combined with elevated Total Nitrogen levels, do not support de-listing Great Bay relative to Total Nitrogen impairment. To the contrary, they require that Great Bay continue to be listed as Total Nitrogen-impaired.
- The CALM further makes clear that "the most direct link between nutrient inputs to an estuary and eutrophic effects is for (*sic.*) chlorophyll-a concentration in the water and macroalgae growth;" that "elevated chlorophyll-a concentrations and proliferation of macroalgae are primary symptoms of eutrophication;" and that assessment units are impaired for nutrients pursuant to Env-Wq 1703.14 "*if there is an impairment for one of the primary symptoms of eutrophication*." *See* CALM at 43. The strong presence of macroalgae, and certainly the strong presence of macroalgae combined with the presence of chlorophyll-a, establish that Great Bay is impaired for primary symptoms of eutrophication and therefore must be deemed nutrient-impaired. That the above-quoted language pertains to primary contact recreation uses is of no consequence.
- The determination to de-list Great Bay as Total Nitrogen-impaired is erroneous because it is based on the conclusion that there is insufficient data to determine that Total Nitrogen, "*alone*," is the cause of eutrophic conditions. Categorization Document at 3 (emphasis added). First, the Categorization Document fails to support this factual conclusion. Second, and perhaps more importantly, there is no basis in law for establishing that a single pollutant, *on its own*, cause the violation of a water quality standard in order to be the cause of an impairment. The CALM makes clear that the term "cause," as an assessment term, is a pollutant "which is causing, or threatening to cause, a water quality violation." CALM at 15. Nowhere does it require a pollutant – such as Total Nitrogen – to be the *sole* cause of impaired conditions. *See also* CLF's December 11, 2015 Comments on the Draft 2014 Section 303(d) List of Impaired Surface Waters at 2-3, including the EPA New England's Technical Support Document appended thereto.
- The Department cannot properly rely on the referenced "court settlement" (Docket No. 2013-0119) as a basis for de-listing, particularly absent a new methodology for establishing numeric criteria to replace its previous one. *See generally id.*
- To the extent the Department relies on the peer review that resulted from the court settlement as a basis for its determination, such review did *not* conclude that Total Nitrogen is not a factor in the Great Bay estuary's declining health.

Cochecho River

As with Great Bay, the Department's Categorization Document recites compelling data evidencing that the Cocheco River's aquatic life use is impaired as a result of Total Nitrogen. Such data include: **12- 4**

- Median Total Nitrogen from 2008 through 2013 of 600 ug/L, a level acknowledged by the Department to be "elevated," a level well in excess of the 390 – 500 ug/L range "to be in good to fair health or worse depending upon the condition of the other eutrophication indicators," and a level far in excess of the 390 ug/L median Total Nitrogen target established for the Massachusetts Estuaries Project.
- Dissolved oxygen concentrations occasionally below 5 mg/L.
- Chlorophyll-a concentrations that could be considered marginally impaired.
- Chlorophyll-a biomass that can be "very high depending on the timing of the tide cycle."
- Acknowledgment that although there are no documented records of eelgrass presence in the river, systems with Total Nitrogen concentrations exceeding 500 ug/L experience declines in animal communities and macroalgae accumulations that begin to affect aesthetic quality – placing such systems into a "moderately impaired health" category.

The above data demonstrate that Total Nitrogen is causing impairment of the Cocheco River. Indeed, the Categorization Document admits this fact, stating: "Some of the classic indicators of nutrient eutrophication are present in this assessment zone and Total Nitrogen remains elevated. As the discussion above indicates, there is a clear nutrient 'signature' in the data."

Despite all of the foregoing, the Department's Categorization Document states: "It is less clear, as (*sic.*) this time, whether the response datasets demonstrate sufficient power to determine that the eutrophication effects on designated uses can be attributed to Total Nitrogen alone." On this basis, as well as the basis that it has elected not to employ its previously relied-upon numeric criteria for Total Nitrogen, it proposes to de-list the Cocheco River's impairment status relative to Total Nitrogen. For all of the reasons set forth in these comments relative to Great Bay, *see* supra, such action, if finalized, would be arbitrary and capricious and incorrect as a matter of law.

.

* * *

For the reasons set forth above, Lamprey River South, Great Bay, and the Cocheco River should each retain their impairment status with respect to Total Nitrogen. In each water body, there is sufficient evidence that Total Nitrogen is causing or contributing to impairment of aquatic life uses; to the contrary, there is no evidence to reasonably and lawfully support the de-listing of Total Nitrogen as a cause of impairment. We urge the Department to conform its final listing proposal accordingly.

Respectfully submitted,

Tom Irwin
V.P. and CLF New Hampshire Director

New Hampshire Department of Environmental Services

New Hampshire's Environmental Dashboard
Coastal Waters: Eelgrass

Overview

Eelgrass (Zostera marina) is a submerged aquatic vegetation (or seaweed) and is the base of the estuarine food web in the Great Bay Estuary. Healthy eelgrass beds are important because they filter water, stabilize sediments, and provide habitat for fish and shellfish. While eelgrass is only one species in the estuarine community, it serves as critical habitat for the survival of many species. The loss of eelgrass habitat results in a detrimental difference in community structure and function. Where it is lost, it is replaced by habitats, such as macroalgae, that do not have the same beneficial values. Poor water quality and direct physical impacts (such as dredging) are the primary threats to eelgrass health.

Current Condition or Trend

Data indicate a long-term decline in eelgrass since 1996 that is not related to wasting disease (a naturally occurring episodic condition that effects healthy eelgrass tissue with small black spots that rapidly spread, eventually killing the plant). Due to variability, even recent gains of new eelgrass still indicate an overall declining trend.

Explanation of Indicator & Trend

Additional information about eelgrass condition can be found in the Piscataqua Region Estuaries Partnership (PREP) 2013 State of Our Estuaries Report, which states, "In 2011, the total eelgrass cover in the estuary was 1,891 acres, 35% below the PREP goal of 2,900 acres derived from the 1996 eelgrass maps. The total acreage has been relatively steady for the past three years and higher than the previous three years (2006-2008), which were 44 to 48% below the goal. There are also indications, based on estimates of the density of the eelgrass beds, that the remaining beds contain fewer plants and, therefore, provide less habitat." The trend identified in the 2013 report has continued at about the same magnitude over the past year. 12- 5

How Does NHDES Address This?

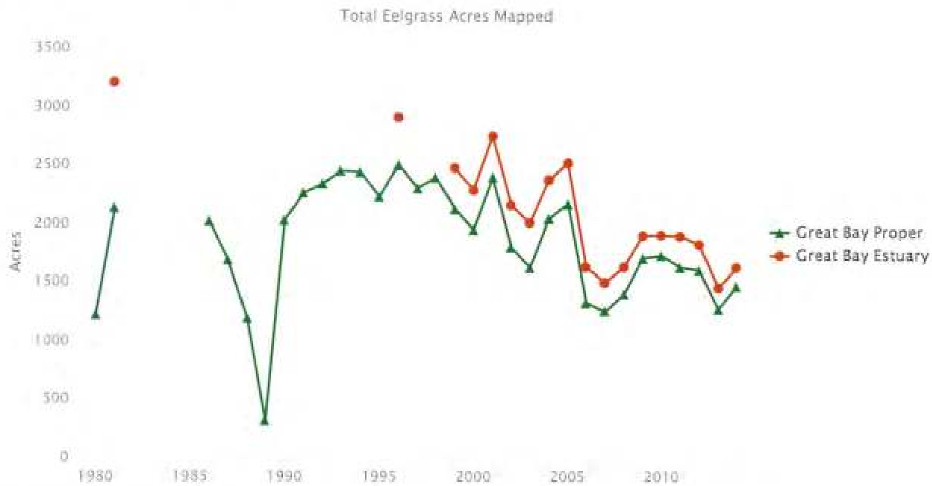
NHDES collaborates with the PREP to study changes in the amount of eelgrass in the Great Bay Estuary over time. NHDES is working in two primary ways to restore eelgrass health, including:

1. conducting research and monitoring to track the health of the habitat; and
2. partnering with coastal communities and organizations to improve water quality.

Some of the activities include:

- research into the non-point sources of nitrogen in the watershed;
- developing efficient strategies to reduce nitrogen loads;
- promotion of both shellfish restoration and aquaculture to help naturally filter the water in the estuary;
- provision of funding to pollution reduction projects; and
- monitoring a wide array of pollutants over time.

New Hampshire's Environmental Dashboard
Coastal Waters: Eelgrass



About the Graph
The UNH Seagrass Ecology Group has mapped the distribution of eelgrass in 1980 and every year from 1986 to 2014 in Great Bay proper. The entire Great Bay Estuary (Great Bay, Little Bay, tidal tributaries, Piscataqua River, Little Harbor, and Portsmouth Harbor) was mapped by these researchers in 1996, and annually from 1999 through 2014. Eelgrass mapped in 1981 was conducted by the NH Fish & Game Department.

Gaps between data points indicate that eelgrass was not fully mapped in the missing years.

Data Citation
UNH Seagrass Ecology Group and NH Fish & Game Department.

New Hampshire's Environmental Dashboard
Coastal Waters: Total Nitrogen Concentration

Overview

Nitrogen is an essential nutrient to life in the estuaries. However, high levels of nitrogen stimulate the excessive growth of plants and algae which can be detrimental to overall estuarine health. The amount of nitrogen present in the water, or the total nitrogen concentration, is an indicator of overall nutrient availability for plants and algae growth in the estuary. NHDES collaborates with the Piscataqua Region Estuaries Partnership (PREP) and the Great Bay National Estuarine Research Reserve (GBNERR) to study changes in the nitrogen concentrations in the Great Bay Estuary over time.

Current Condition or Trend

Recent data considered in the context of long-term data show no pattern or trend.

Explanation of Indicator & Trend

There are three forms of nitrogen that are commonly measured in water bodies: ammonia, nitrates and nitrites. Total nitrogen (TN) is the sum of ammonia, organic nitrogen, nitrate and nitrite. Between 1974 and 2011 data indicate a significant overall increasing trend for dissolved inorganic nitrogen (DIN; sum of ammonia and nitrate) at Adams Point, which is of concern. DIN is the more reactive form of nitrogen that is rapidly taken up by plants or converted to other forms of nitrogen in the estuarine system, vastly complicating the trend analysis. Because plants and algae rapidly consume DIN, concentrations measured in the estuary may appear to be low. In those cases, it is challenging to determine if lower DIN trends are due to excessive algae and macroalgae or successes in controlling DIN loads. For this reason, TN is the preferred indicator to measure estuarine health. To date, there is no trend in TN, however, the data for this parameter has only been collected estuary-wide since 2003. Given the complicated nature of nutrient dynamics in the estuary and the large annual fluctuations, it is not surprising that no clear trend has emerged. Parts of the estuary show a number of the classic signals of too much nitrogen, including low dissolved oxygen, macroalgae blooms, and declining eelgrass habitat. Excess nitrogen along with a number of other environmental variables (such as suspended solids) are likely contributing to those conditions.

How Does NHDES Address This?

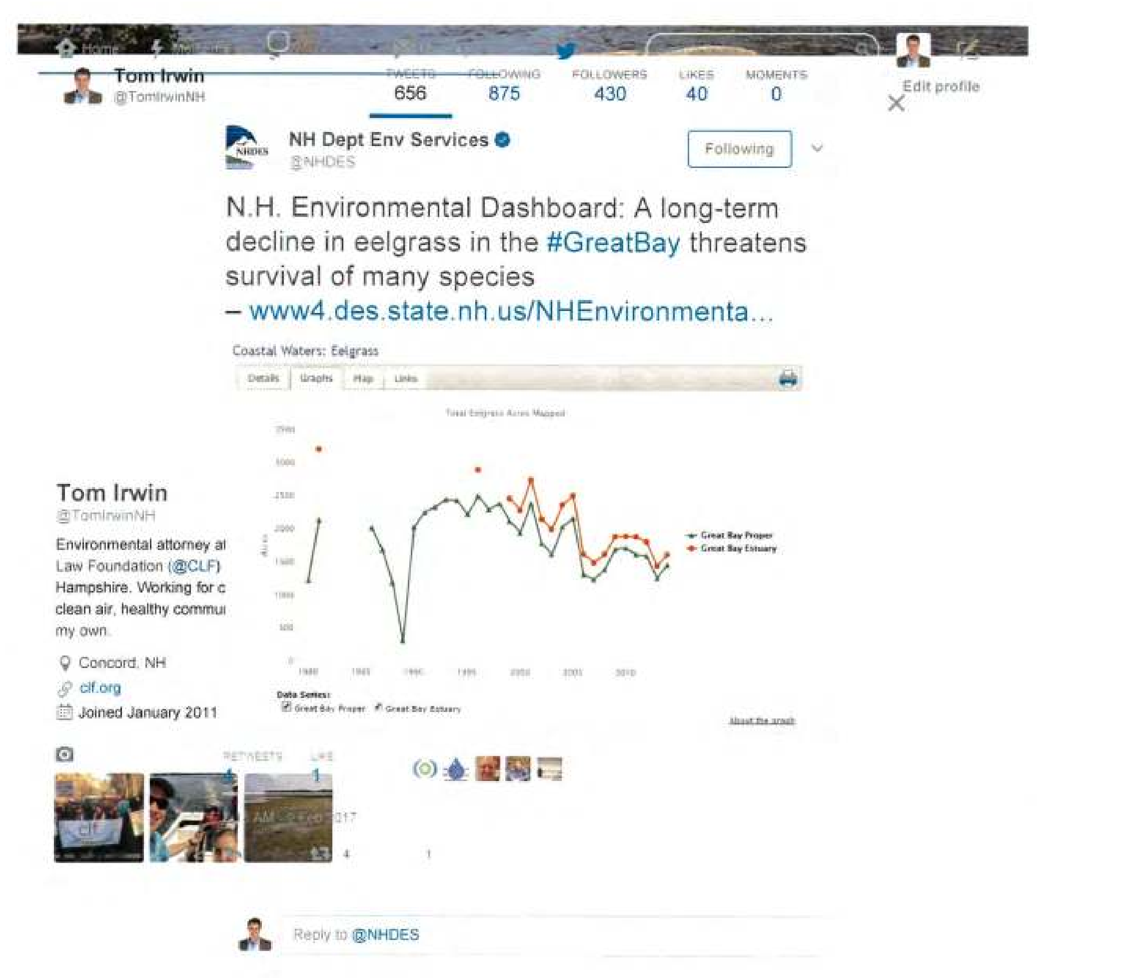
68% of the total nitrogen that ends up in the Great Bay Estuary originates from sources spread across the watershed; the remainder derives from direct discharges of municipal wastewater treatment facilities. These diffuse sources of nitrogen are called non-point sources and consist of atmospheric deposition, fertilizers, human waste disposed into septic systems, and animal waste. NHDES is working to understand the non-point sources of nitrogen in the watershed and develop efficient strategies to reduce nitrogen loads to the estuary. In June, 2014 NHDES released the Great Bay Nitrogen Non-Point Source Study which addresses the amount of nitrogen that is entering the Great Bay Estuary from diffuse sources. NHDES has a number of programs to address total nitrogen. Some communities are utilizing funds from the State Revolving Loan program to upgrade their wastewater treatment facilities to reduce nitrogen, other communities and non-profit organizations have accessed NHDES' Watershed Assistance Grants Program to fund nonpoint source pollution reduction projects such as the installation of stormwater Best Management Practices. In addition, NHDES supports and provides outreach on septic system management and fertilizers.

New Hampshire's Environmental Dashboard
Coastal Waters: Total Nitrogen Concentration

About the Graph
Datasets include grab samples taken year round and at varying tide stages. If total nitrogen concentrations were not measured directly, total nitrogen was calculated from the sum of the various forms of nitrogen (e.g. the sum of total dissolved nitrogen and particulate nitrogen, or the sum of total kjeldahl nitrogen, nitrate and nitrite).

Gaps between data points are when total nitrogen and/or the nitrogen species used to calculate total nitrogen were not collected.

Data Citation
Piscataqua Region Estuaries Partnership, Great Bay National Estuarine Research Reserve, US Environmental Protection Agency, Great Bay Municipal Coalition.


Tom Irwin
@TomIrwinNH
TWEETS 656
FOLLOWING 875
FOLLOWERS 430
LIKES 40
MOMENTS 0
Edit profile
NH Dept Env Services
@NHDES
Following
N.H. Environmental Dashboard: A long-term decline in eelgrass in the #GreatBay threatens survival of many species
– www4.des.state.nh.us/NHEnvironmenta...
Coastal Waters: Eelgrass
Details
Graphs
Map
Links
Great Bay Proper
Great Bay Estuary
Data Series:
Tom Irwin
@TomIrwinNH
Environmental attorney at
Law Foundation (@CLF)
Hampshire. Working for c
clean air, healthy commu
my own.
Concord, NH
clf.org
Joined January 2011
RETWEETS
LIKE
4
1
Reply to @NHDES

COMMENT #13 (on Feb. 3, 2017 Changes): Ricardo Cantu, OspreyOwl Environmental, LLC on the behalf of the City of Nashua and on the behalf OspreyOwl Environmental, LLC

OspreyOwl Environmental, LLC
268 Emerald Drive
Barrington, NH 03825
(603) 978-5109
www.ospreyowl.com

email: RickCantu@ospreyowl.com

Kenneth Edwardson
Water Quality Assessment Coordinator
PO Box 95, 29 Hazen Drive
Concord, NH 03302

February 22, 2017

Re: Comments on the 303(d) Listing

Dear Mr. Edwardson,

The City of Nashua has reviewed the 303(d) listing and noted a few bodies of water that run through Nashua (Muddy Brook, Unnamed Brook to Pennichuck Brook) that are impaired for D.O., pH and Creosote. Nashua also noted the Merrimack River AU, NHRIV700061401-04 as impaired for Al, pH and chlorophyll-a. **13- 1**

In 2009/2010 the City of Manchester (with Rick Cantu as the lead coordinator for the City) had done an extensive study on the Merrimack River regarding Aluminum. Another study for copper and lead (that also included aluminum) was performed in 2014. The data is in a table at the end of these comments. The NHDES, along with the City of Manchester, developed extensive QA/QC protocols for the 2009/2010 study. The protocols used allowed for the development of corrected values (as evidenced by trip blanks, travelling field blanks and duplicates) and values were recalculated numerous times within the body of that report due to the QA/QC criteria. The 2014 data confirmed and supported the findings of that study.
The sampling location and 'Clean Sampling' techniques had been improved in 2014 from the 2009/2010 study, therefor there was no need to use any corrected values in the report.

The study had indicated that the portion of the Merrimack River up stream and down stream of the Manchester outfall was not impaired for this metal. In Nashua's draft permit there was no aluminum limit included in that permit, but there was copper and lead. Subsequently, Nashua contracted with OspreyOwl Environmental (Rick Cantu owner) to do 'Clean Sampling' assessment of these two metals in the Merrimack River in August and September of 2015. The resultant analysis indicated that there was no impairment in the Merrimack River for copper and lead and these metals were removed from the draft NPDES permit. All trip blanks were reported as non-detect and one field blank (August 13, 2015) showed a copper level of 0.8 ug/l. As noted on that chain of custody there was heavy rain that day and rain droplets had fallen in the open field blank. There was also an extensive Quality Assurance Project Program (QAPP) included with this report.

OspreyOwl has provided Nashua with data from Lowell sampling on the Merrimack River. This sampling indicates that when flows are near 7Q10 levels that there is no aluminum impairment in the Merrimack River that is downstream from Nashua. This data is attached is was collected under an extensive a QAPP as was prepared for the Nashua project. The quality of both the Nashua and Lowell projects would fall within the excellent category for QA/QC compliance.

Nashua is sure that the NHDES is using data from Nashua's WET testing from determination of compliance with aluminum. The section in the CALM 3.1.10 indicates four levels of data quality information, low, fair, good and excellent. The CALM document states that only data that is considered fair and above is used to make final assessment decisions.

Nashua has historically gone to the Hudson Bridge on Route 111 (spans the Merrimack River) and has thrown the bucket over the bridge that is tied to a rope. The sample is retrieved and used to fill up the ½ gallon garboys for toxicity sampling and also the metals container for WET test metals analysis. The containers are not acid washed nor double bagged, there is no QA/QC plan that was ever developed for this sampling, no protocols were set and the data obtained is probably much higher in aluminum than background levels within the Merrimack river. These at best are screening level assessments.

As both the sections of the Merrimack River in the vicinity of the Manchester outfall, and in the vicinity of the Lowell outfall were completed using high level QA/QC procedures, it is expected that this data would carry much more weight of evidence than the category 1 data that was collected by Nashua on the Hudson Bridge. Many of the trip and field blanks from the Manchester study were non-detect. All of the field and trip blanks in the Lowell study were non-detect. The continued improvement in quality in the trip and field blanks demonstrates an evolution of increased accuracy with ongoing sampling as performed by OspreyOwl Environmental (Rick Cantu).

Aluminum impairment for this portion of the Merrimack River should be removed from the impairments listing. At the very least, this parameter should have the designation as, "There is some but insufficient data to assess the parameter per the CALM, however, the data that is available suggests that the parameter is Potentially Attaining Standards (PAS)," which would have a designation of 3-PAS.

Respectfully submitted,

Ricardo Cantu
President – OspreyOwl Environmental

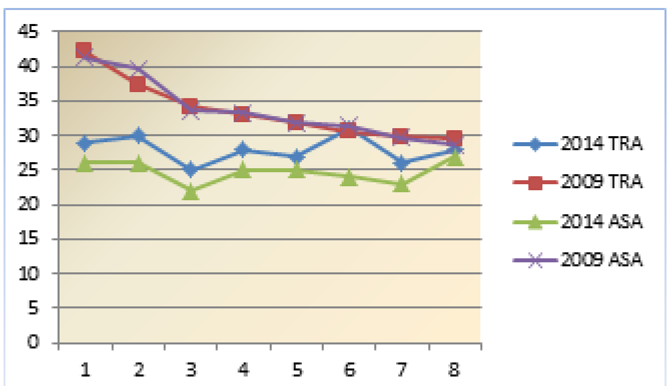
Datasets from the Manchester 2014 Study

The aluminum datasets were then compared to the "Aluminum Study" data from 2009-2010. The datasets from the third week of September, 2009 closely related to the same week's dataset of 2014. Below is a chart from the dataset of 2009 and 2014.

	2014 2009	2014 cfs	2009 cfs	2014 TRA	2009 TRA	2014 ASA	2009 ASA	% dif CFS	% dif TRA	% dif ASA
MERLStadium Ramp	09/23/14-9/21/09	1,630	2,370	29	42.1	26	41.3	31.2%	31.1%	37.0%
MERLAAA	09/23/14-9/21/09	1,580	2,090	30	37.3	26	39.6	24.4%	19.6%	34.3%
MERLStadium Ramp	09/24/14-9/22/09	1,480	1,700	25	34.2	22	33.6	12.9%	26.9%	34.5%
MERLAAA	09/24/14-9/22/09	1,320	1,760	28	33	25	33.3	25.0%	15.2%	24.9%
MERLStadium Ramp	09/25/14-9/23/09	1,470	1,620	27	31.9	25	31.8	9.3%	15.4%	21.4%
MERLAAA	09/25/14-9/23/09	1,380	1,690	31	30.6	24	31.4	18.3%	-1.3%	23.6%
MERLStadium Ramp	09/26/14-9/24/09	1,140	1,570	26	29.8	23	29.7	27.4%	12.8%	22.6%
MERLAAA	09/26/14-9/24/09	1,140	1,570	28	29.5	27	28.7	27.4%	5.1%	5.9%

In plotting out the data from the above chart for TRA and ASA from 2009 dataset and the 2014 dataset the following chart is applicable.

In plotting out the data from the above chart for TRA and ASA from 2009 dataset and the 2014 dataset the following chart is applicable.



OspreyOwl Environmental, LLC
268 Emerald Drive
Barrington, NH 03825
(603) 978-5109
www.ospreyowl.com

email: RickCantu@ospreyowl.com

February 22, 2017

Kenneth Edwardson
Water Quality Assessment Coordinator
PO Box 95, 29 Hazen Drive
Concord, NH 03302

Re: Comments on the 303(d) Listing

Dear Ken,

I have noted that many of the rivers are impaired for several metals. A partial listing is the Lamprey River North, Squamscott, Upper Sagamore Creek, Taylor River Refuge, Rice Dam Pond, and others. The 303(d) listing does refer back to the CALM for determination of how the various waterbody segments were categorized. **13- 2**

The CALM does point out four categories of descriptions for data quality in Table 3-8. The section in the CALM 3.1.10 indicates four levels of data quality information, low, fair, good and excellent. The CALM document states that only data that is considered fair and above is used to make final assessment decisions. The minimum acceptable data is classified as fair (SOPs used in the field or lab, or a QA/QC plan is available and followed and the QA/QC results and metadata are adequate with samplers having some training.

In my wastewater career, which began in 1978, I have worked for 10 municipal wastewater plants spanning the States of NH, ME, MA, CT, NJ and PA. In those 38 years I have never witnessed one plant that had a QA/QC protocol or SOP set up for WET sample testing within their respective waterbodies. Since retiring from wastewater and starting OspreyOwl Environmental, I have worked for nine wastewater plants, one water plant and two industries regarding quality of sampling issues and WET protocols. Again, none of these facilities had a QA/QC plan, let alone a SOP protocol for these sporadic type samples. Yet, I see time and again, in many of the issued draft and final NPDES permits, data that was taken from these very tests that fall within the category of "Low."

The source of data for these metals classifications needs to be reviewed. If there were no SOPs or QA/QC plans associated with the sampling then as per the CALM, these data sets should be used for screening assessment only. These should be categorized within the three (3) category level of, "There is some but insufficient data to assess the parameter per the CALM, however, the data that is available suggests that the parameter is Potentially Attaining Standards (PAS) 3-PAS. The second three (3) category would be, "There is some but insufficient data to assess the parameter per the CALM, however, the data that is available suggests that the parameter is Potentially Not Supporting (PNS) water quality standards (e.g., there is one exceedance), 3-PNS. And finally, the third listing within that category of, "There is no data available for the parameter," 3-ND. This should be the designation upstream from mostly all of the treatment plants, in the event the NHDES or other entity has not taken sufficiently QA/QC or SOP type samples that at least place the data obtained in the fair category or higher.

Another noted area of multiple data concerns are samples that list aluminum along with pH as the impairments. Some of the reasons are listed as unknown and others are listed as atmospheric deposition (acid rain). It appears the areas outside any small urban compact (Four Mile Pond, Dustin Pond, Rock Pond, Three Ponds and Guinea Pond etc.) are listed as two ways, Atmospheric Deposition, Acidity and Naturally Occurring Organic Acids. It is evident the NHDES is leaving the door open for both cases of argument.

In my research, and actually having come upon irrefutable proof in the field, it is becoming evident that the use of "Acid Rain" as a reasoning for high aluminum and low pH no longer holds anywhere the clout it did in the 1980s through the 1990s. The EPA website states that there has been much progress in the reduction of SO_2 (i.e. acid rain component), with an 87% reduction in SO2 from 1980 through 2013. In some of the annual reports it is stated that the land is returning to pre-industrial conditions.

Including acidity from 'Naturally Occurring Organic Acids' is not only a component of non-industrialized areas, but of the State as a whole. While doing a study of metal concentration in the Connecticut River and Cook's Brook, in the Springfield, Massachusetts area, I reviewed information that has been gathered by the Water Plant for NPDES permitting purposes for their backwash discharge to Cook's Brook. This information was extensive and covered over two full years from the two large reservoirs that supply water to the entire Springfield area. The Cobble Mountain Reservoir is the biggest with a capacity of 23 billion gallons. The Borden Brook Reservoir is smaller (but still large by any standard) and has a capacity of 2.4 billion gallons.

In looking over the data I couldn't help but notice the large differences in the total recoverable and acid soluble aluminum levels. Both reservoirs are within the same watershed, both are very close to one another, one rain gage is used to estimate rainfall on both bodies of water (located on the strip of land between the two reservoirs) both are mountain top reservoirs and removed from the population center and all aspects of both watersheds are similar, yet there was a huge discrepancy in aluminum content in both bodies of water.

I did online reviews and found a study that was done in Oslo, Norway on aluminum and the impact on fish. In talking with the local forester, I was informed that both reservoirs were teaming with fish, had numerous amphibian populations and were both home to hunting Eagles, Osprey and other prey. No fish die-off had ever been evidenced on either of the two reservoirs, and for all intent and purposes, both were equal in viability and surrounding flora and fauna.

The data from both the Cobble Mountain and Borden Brook Reservoirs are included below. The yellow highlighted columns are what were studied extensively in the Oslo Study (attached). In this study, it is noted that the fish begin to use sodium to act as a natural protective barrier against the effects of aluminum. It was noted in the report that sodium was a much better predictor of a fish's ability to withstand continual high doses of aluminum and that calcium was only a very secondary supporting cation. In the Region Eight Study done in Colorado by ENSR the findings were that calcium was supportive of keeping fish healthy at higher aluminum concentrations. Sodium was never looked at. As can be seen in the two below tables, pH, Calcium, Sodium, Alkalinity and TRA and ASA are much high on a continual basis in the Cobble Mountain Reservoir as compared to the Borden Brook Reservoir.

DATE	COBBLE MOUNTAIN RESERVOIR								
	TSS (mg/L)	Temperature (°F)	pH (Standard Units)	Calcium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Alkalinity (mg/L)	Total Recoverable Aluminum (ug/L)	Dissolved Aluminum (ug/L)
12/31/12	1	39.4	6.7	2.6	7.6	ND	10	49	---
1/23/13	1	38.1	6.6	3.0	9.5	ND	10	49	30
2/13/13	<1	35.6	6.7	2.6	7.9	ND	9	56	29
3/13/13	<1	35.0	6.5	1.4	3.3	ND	5	99	83
4/10/13	1	38.1	6.5	2.6	8.0	ND	8	53	34
5/22/13	1	67.8	6.8	2.5	8.3	ND	9	42	22
6/12/13	2	66.1	6.9	2.4	7.7	ND	8	33	11
7/17/13	1	84.0	6.6	2.3	7.0	ND	5	31	25
8/28/13	1	77.0	6.5	2.5	8.2	ND	8	22	51
9/18/13	<1	67.8	6.5	2.4	7.1	ND	9	19	ND
10/16/13	1	61.8	6.6	2.4	7.1	4.8	10	21	12
11/6/13	1	53.5	6.6	2.4	7.0	ND	9	24	18
12/11/13	1	40.9	6.4	2.6	7.6	ND	8	38	15
1/15/14	1	33.6	6.3	2.0	5.9	ND	8	69	48
2/12/14	<1	39.7	6.5	2.6	8.3	5.0	9	38	18
3/19/14	<1	32.8	6.2	2.2	6.2	ND	6	42	27
4/16/14	1	39.0	7.1	2.4	8.2	5.5	8	64	37
5/14/14	1	58.5	7.4	2.5	8.4	ND	8	58	35
6/11/14	1	67.7	7.1	2.7	9.5	5.00	8	40	28
7/9/14	1	76.8	7.0	2.5	8.4	5.2	10	28	16
8/13/14	1	73.0	7.0	2.6	8.8	ND	10	22	15
9/17/14	1	69.1	6.9	2.8	9.0	ND	9	24	12
10/8/14	<1	63.8	6.9	2.2	3.2	8.5	9	100	64
11/12/14	1	53.0	7.2	2.7	8.5	5.5	9	30	19
12/3/14	1	45.1	7.0	2.6	9.2	6.0	9	31	23
1/14/15	1	33.3	6.9	2.4	7.4	ND	6	51	29
2/4/15	<1	39.2	7.1	2.6	8.4	5.4	8	28	26
AVERAGE				2.46	7.62		8.33	43.00	

DATE	TSS (mg/L)	BORDEN BROOK RESERVOIR Temperature (°F)	pH (Standard Units)	Calcium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Alkalinity (mg/L)	Total Recoverable Aluminum (ug/L)	Dissolved Aluminum (ug/L)
12/31/12	1	34.5	6.5	1.8	2.7	ND	7	150	---
1/23/13	1	33.8	6.4	1.9	2.6	ND	5	120	98
2/13/13	9	34.5	6.3	1.9	2.3	ND	5	120	99
3/13/13	1	35.1	6.2	1.8	2.9	ND	6	140	97
4/10/13	1	39.4	6.3	1.8	3.0	ND	4	120	92
5/22/13	1	68.0	6.9	1.8	2.5	ND	6	91	66
6/12/13	1	64.4	6.4	1.6	1.8	ND	6	120	80
7/17/13	1	87.2	6.6	1.6	2.0	ND	7	96	90
8/28/13	1	76.0	6.5	1.8	2.6	ND	5	77	50
9/18/13	1	66.0	6.4	1.7	2.2	ND	6	74	49
10/16/13	1	59.8	6.3	1.7	2.0	4.6	7	63	51
11/6/13	1	43.2	6.6	1.8	1.9	ND	7	86	61
12/11/13	1	33.2	6.4	2.1	2.4	ND	5	120	78
1/15/14	1	32.8	5.7	1.8	2.8	5.1	4	110	86
2/12/14	1	33.7	6.2	1.9	3.2	5.3	5	120	82
3/19/14	1	34.0	6.1	2.0	3.0	5.1	6	120	91
4/16/14	1	41.8	6.6	1.7	2.8	5.5	5	130	93
5/14/14	1	67.2	7.3	1.8	3.0	ND	6	120	84
6/11/14	2	69.4	7.2	1.9	3.2	5.2	5	100	77
7/9/14	3	77.7	6.9	1.8	2.4	5.2	6	73	43
8/13/14	10	71.3	7.0	1.8	2.7	ND	6	87	57
9/17/14	2	68.0	6.9	2.0	3.0	5.1	5	96	64
10/8/14	2	63.5	6.9	2.2	3.2	8.5	6	100	64
11/12/14	2	50.0	6.6	1.8	3.0	5.5	7	120	93
12/3/14	2	42.0	6.9	1.8	2.6	7.3	6	96	130
1/14/15	2	33.5	6.4	1.8	2.6	5.5	5	140	99
2/4/15	1	34.7	6.4	1.8	3.0	6.10	6	120	98
				1.83	2.64		5.70	107.74	

In more discussions with the forester it was learned that the wetland coverage area of the Borden Reservoir was extensive and most of the drainage for supply came from wetland sources. The Cobble Mountain Reservoir was mostly fed by a brook with also surrounding wetland contribution, but nowhere near as much the contribution to Borden Brook.

This example is a perfect, "Real World" application of the findings within the Oslo, Norway Study. If acid rain was the main contributing factor to reservoirs, brooks, ponds, or lakes both bodies of water should have relatively the same parameters. There is enough information here to justify that any impairment that couples pH with Aluminum is more than likely, "Naturally Occurring" and not a result of acid rain.

Below are some excerpts from the EPA's Air Quality and acid rain reports. As can be seen great strides have been made in the reduction of SO_2 (acidic portion of acid rain).

Key Points

National SO_2 Air Quality

•Based on EPA's air trends data, the national average of SO2 annual mean ambient concentrations decreased from 12.1 ppb to 1.5 ppb (87 percent) between 1980 and 2013.

•The two largest single-year reductions (over 20 percent) occurred in the first year of the ARP, between 1994 and 1995, and recently between 2008 and 2009, just prior to the start of the CAIR SO2program.

Regional Changes in Air Quality

•Average ambient SO2 concentrations declined in all regions following implementation of the ARP and other emission reduction programs. The most dramatic decline was along the Ohio River Valley and in western Pennsylvania where regional average concentrations declined 86 percent from 1989-1991 to 2011-2013 observation periods.

•Ambient particulate sulfate concentrations have decreased since the ARP was implemented, with average concentrations decreasing by 60 to 65 percent in observed regions from 1989-1991 to2011-2013.

•Average annual ambient total nitrate concentrations declined 47 percent from 1989 -1991 to 2011-2013, with the biggest reductions in the Mid-Atlantic and Northeast.

Chapter 8: Acid Deposition

Acid deposition, commonly known as "acid rain," is a broad term referring to the mixture of wet and dry deposition from the atmosphere containing higher than normal amounts of sulfuric acids and nitric acids. Some of the most dramatic reductions have occurred in the mid-Appalachian region, including Maryland, New York, West Virginia, Virginia, and most of Pennsylvania. Along with wet sulfate deposition, reductions in precipitation acidity, expressed as hydrogen ion (H+) concentration, have also decreased by similar percentages. Reductions in nitrogen deposition recorded since the early 1990s have been less pronounced than those for sulfur. As noted earlier, emission changes from source categories other than ARP and CAIR sources contribute to changes in air concentrations and deposition of nitrogen. **Monitoring Networks** The Clean Air Status and Trends Network (CASTNET) provides long-term monitoring of regional air quality to determine trends in atmospheric nitrogen, sulfur, ozone concentrations, and deposition fluxes (the rate of particles and gases being deposited to a surface) of sulfur and nitrogen pollutants in order to evaluate the effectiveness of national and regional air pollution control programs. Together, these complementary networks provide long-term data needed to estimate spatial patterns and temporal trends in total deposition.

Key Points

Wet Sulfate Map

•The Northeast and Mid-Atlantic have shown the greatest improvement with an overall 64 percent reduction in wet sulfate deposition from 1989-1991 to 2011-2013.•A decrease in both SO_2 emissions from sources in the Ohio River Valley and the formation of sulfates which are transported long distances have resulted in reduced sulfate deposition in the Northeast. The reductions in sulfate documented in the region, particularly across New England and portions of New York, were also affected by lowered SO_2 emissions in eastern Canada.[10]

Regional Trends in Deposition

•Between 1989-1991 and 2011-2013, the Northeast and Mid-Atlantic experienced the largest reductions in wet sulfate deposition, 65 percent and 63 percent, respectively.

•The reduction in total sulfur deposition (wet plus dry) has been of similar magnitude as that of wet deposition with an overall average reduction of 68 percent from 1989-1991 to 2011-2013.

•Decreases in dry and total inorganic nitrogen deposition have generally been greater than that of wet deposition with average reductions of 52 percent and 29 percent, respectively. In contrast, wet deposition from inorganic nitrate reduced by an average of 19 percent from 1989-1991 to 2011-2013.

https://www.epa.gov/airmarkets/clean-air-markets-progress

https://www.epa.gov/sites/production/files/2016-10/documents/2013_full_report_0.pdf

OspreyOwl Environmental believes there is enough evidence to remove the current speculation of acid rain being the cause of low pH and higher aluminum content and either change the impairment designation to 3-PAS or 3-PN, or to simply state that it is "Naturally Occurring."

Respectfully submitted,

Ricardo Cantu
President – OspreyOwl Environmental

COMMENT #14 (on Feb. 3, 2017 Changes): Ralph Abele, EPA Region 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region I – New England
5 Post Office Square, Suite 100
Boston, MA 02109-3912

March 3, 2017

Ken Edwardson
New Hampshire Department of Environmental Services
Water Division
29 Hazen Drive, Box 95
Concord, NH 03302-0095

Re: New Hampshire's 2014 Draft 303(d) List

Dear Mr. Edwardson:

Thank you for the opportunity to review your recent amendments to the State's draft 2014 Clean Water Act section 303(d) list. New Hampshire's Department of Environmental Services (NH DES) decided to seek public comment on three changes to the State's original draft 2014 303(d) list. Those changes involve removing, or delisting, from the State's 303(d) list the Great Bay and Cocheco River assessment zones in relation to total nitrogen, and retaining the Lamprey River South assessment zone on the 303(d) list in relation to total nitrogen. **14- 1**

We are evaluating the scientific rationale included by NH DES for these new decisions, and look forward to receiving any additional information included in the State's final list to support the above-referenced assessment zones. Any such additional information, together with that provided thus far by NH DES, will enable EPA to carry out its obligation to review and to approve or disapprove the decisions the State will make with respect to these and other assessment zones in the Great Bay Estuary and throughout the State. See 40 C.F.R. §130.7.

If you have any questions, please contact me at 617-918-1629, or have someone from your staff contact Toby Stover at 617-918-1604.

Sincerely,

Ralph W. Abele
Chief, Water Quality Branch

E. REFERENCES

ACOE. (2005). *Environmental Assessment, Finding of No Significant Impact,and Clean Water Act Section 404(b)(1) Evaluation (DRAFT), SAGAMORE CREEK Back Channel Portion of the Portsmouth Harbor and Piscataqua River Federal Navigation Project.* Environmental Resources Section, Engineering/Planning Division. Concord, Massachusetts: U.S. Army Corps of Engineers.

AZ. (Effective January 31, 2009.). Arizona Title R18-11-108.03. Retrieved 4 2016, from http://www.azdeq.gov/environ/water/standards/download/SWQ_Standards-1-09-unofficial.pdf

Benson, J., Schlezinger, D., & Howes, B. (2013). Relationship between nitrogen concentration, light, and Zostera marina habitat quality and survival in southeastern Massachusetts estuaries. *Journal of Environmental Management, 131*, 129-137.

Bierman, V., Diaz, R., Kenworthy, W., & Reckhow, K. (2014). *Joint Report of Peer Review Panel for Numeric Nutrient Criteria for the Great Bay Estuary New Hampshire Department of Environmental Services June, 2009.*

Blocksom, K. (2004). Development of the New Hampshire Benthic Index of Biotic Integrity. Retrieved from http://des.nh.gov/organization/divisions/water/wmb/biomonitoring/documents/20040127-benthic-report.pdf

Bricker, S., Clement, C., Pirhalla, D., Orlando, S., & Farrow, D. (1999). *National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries.* Silver Spring: NOAA, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science.

Burdick, D., Mathieson, A., Peter, C., & Sydney, N. (2016). *Monitoring Macroalgae in the Great Bay Estuary for 2014.* Piscataqua Region Estuaries Partnership.

Caton, L. (1991). Improving subsampling methods for the EPA "Rapid Bioassessment" benthic protocols. *Bulletin of the North American Benthological Society, 8*(3), 317-319.

Cloern, J. (2001). Our evolving conceptual model of the coastal eutrophication problem. *Marine Ecology Progress Series, 210*, 223-253.

EPA. (1995, April). Method 1669. Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. *EPA 821-R-95-034.*

Fletcher, R. (1996). The Occurrence of "Green Tides" - a Review. In W. S. Nienhuis (Ed.), *Marine Benthic Vegetation - Recent Changes and the Effects of Eutrophication* (Vol. 123, pp. 7-43). Springer-Verlag. doi:10.1007/978-3-642-61398-2_2

Gurbisz, C., & Kemp, W. (2014). Unexpected resurgence of a large submersed plant bed in Chesapeake Bay: Analysis of time series data. *Limnology and Oceanography, 59*(2), 482-494. doi:10.4319/lo.2014.59.2.0482

Halliwell, D., Langdon, R., Daniels, R., Kurtenbach, J., & Jacobson, R. (1999). Classification of freshwater fish species of the northeastern United States for use in the development of IBIs. In T. Simon (Ed.), *Assessing the sustainability and biological integrity of water resources using fish communities* (pp. 301-337). Boca Raton, Florida: CRC Press.

Hauxwell, J., Cebrian, j., & Valiela, I. (2003). Eelgrass Zostera marina loss in temperate estuaries: relationship to land-derived nitrogen loads and effect of light limitation imposed by algae. *Marine Ecology Progress Series, 247*, 59-73.

Howes, B., Ruthven, T., Ramsey, J., Samimy, R., Schlezinger, D., & Eichner, E. (2015). *Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the New Bedford Inner Harbor Embayment System, New Bedford, MA (Updated Final Report).* Boston, MA: SMAST/DEP Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection.

Howes, B., Samimy, R., & Dudley, B. (2003). *Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators.* The Schoool for Marine Science and Technology, U. Mass. Dartmouth.

Howes, B., Samimy, R., Schlezinger, D., & Eichner, E. (2013, March). *Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Quissett Harbor Embayment System, Town of Flamouth, Massachusetts.* U Mass. Dartmouth, School of Marine Science and Technology. Ecological Society of America.

Jones, S., & Gregory, T. (2013). *Piscataqua River-Portsmouth Harbor Water Transparency Field Study (December 15, 2013).*

Jones, S., & Gregory, T. (2014, September 26). UNH responses to NHDES Memorandum and comments on 2013 Piscataqua River study final report & associated databases. University of New Hampshire.

KDHE. (2016). *METHODOLOGY FOR THE EVALUATION AND DEVELOPMENT OF THE 2016 SECTION 303(D) LIST OF IMPAIRED WATER BODIES FOR KANSAS. February 18, 2016.* Kansas Department of Health and Environment.

Kemp, W., Batiuk, R., Bartleson, R., Bergstrom, P., Carter, V., Gallegos, C. L., . . . Wilcox, D. J. (2004). Habitat requirements for submerged aquatic vegetation in Chesapeake Bay: water quality, light regime and physical-chemical factors. *Estuaries, 27*, 363-377.

Koch, E. W. (2001, February). Beyond Light: Physical, Geological, and Geochemical Parameters as Possible Submersed Aquatic Vegetation Habitat Requirements. *Estuaries, 24*(1), 1-17.

Krochmal, S. (1949). *The ecology of the smelt, Osmerus mordax mordax in Great Bay, New Hampshire. A Master of Science thesis.* University of New Hampshire, Durham, NH. Retrieved July 30, 2008, from http://www.library.unh.edu/diglib/university.shtml

Mathieson, A. (2012, May 21). Nutrients and Macroalgal problems within the Great Bay Estuary System. Retrieved from ftp://pubftp.nh.gov//DES/WMB/WaterQuality/SWQA/2012/Comments_303d

Mathieson, A. C. (1981). A synopsis of New Hampshire seaweeds. *Rhodora, 88*, 1-139.

McGlathery, K., Sundbäck, K., & Anderson, I. (2007, October 25). Eutrophication in shallow coastal bays and lagoons: the role of plants in the coastal filter. *Marine Ecology Progress Series, Vol. 348*, pp. 1-18. doi:10.3354/meps07132

MDE. (2014). *Integrated Report of Surface Water Quality [303(d) List] Assessment Methodologies.* Retrieved from http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/Programs/WaterPrograms/TMDL/maryland%20303%20dlist/ir_listing_methodologies.aspx

Morrison, J., Gregory, T., Pe'eri, S., McDowell, W., & Trowbridge, P. (2008). *Using Moored Arrays and Hyperspectral Aerial Imagery to Develop Nutrient Criteria for New Hampshire's Estuaries.* University of New Hampshire, Durham. New Hampshire Estuaries Project. Retrieved from http://prep.unh.edu/resources/pdf/using_moored_arrays-unh-09.pdf

MPCA. (2014). *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. 2014 Assessment and Listing Cycle. wq-iw1-04.* Minnesota Pollution Control Agency. Minnesota Pollution Control Agency.

NCDWR. (2015). *2016 303(d) Listing Methodology, EMC Approved May 2015.* North Carolina Division of Water Resources. North Carolina Division of Water Resources. Retrieved from http://deq.nc.gov/about/divisions/water-resources/planning/classification-standards/303d/303d-files

Neckles, H., Wetzel, R., & Orth, R. (1993). Relative effects of nutrient enrichment and grazing on epiphyte-macrophyte (Zostera marina L.) dynamics. *Oecologia, 93*, 285-295. doi: 10.1007/BF00317683

Nettleton, J., Neefus, C., Mathieson, A., & Harris, L. (2011). *Tracking environmental trends in the Great Bay Estuarine System through comparisons of historical and present-day green and red algal community structure and nutrient content.* A final report to the National Estuarine Research Reserve System under Graduate Research Fellowship Award NA08NOS4200285, University of New Hampshire, Department of Biological Sciences, Durham, NH.

Nettleton, J., Neefus, C., Mathieson, A., & Harris, L. (2011). *Tracking environmental trends in the Great Bay Estuarine System through comparisons of historical and present-day green and red algal community* *structure and nutrient content. A final report to the National Estuarine Research Reserve System under Graduate.* University of New Hampshire, Department of Biological Sciences, Durham, NH.

NHDES. (2007). *Coldwater fish assemblage index of biotic integrity for New Hampshire wadeable streams (R-WD-07-33).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/biomonitoring/documents/r-wd-07-33.pdf

NHDES. (2008). *New Hampshire's 2012 Section 305(b)/303(d) List, Technical Support Document, Assessments of Aquatic Life Use Support in the Great Bay Estuary for Chlorophyll-a, Dissolved Oxygen, Water Clarity, Eelgrass Habitat, and Nitrogen. (R-WD-08-18).* Retrieved from ew Hampshire's 2012 Section 305(b)/303(d) List, Technical Support Document, Assessments of Aquatic Life Use Support in the Great Bay Estuary for Chlorophyll-a, Dissolved Oxygen, Water Clarity, Eelgrass Habitat, and Nitrogen. New Hampshire Department of En

NHDES. (2008). *Technical Background for the 2008 Update to the New Hampshire Statewide Mercury Fish Consumption Advisory. (R-ARD-08-1).* NHDES. Retrieved from http://des.nh.gov/organization/commissioner/pip/publications/ard/documents/r-ard-08-1.pdf

NHDES. (2009). *Numeric Nutrient Criteria for the Great Bay Estuary. New Hampshire Department of Environmental Services, Concord, NH. June 2009. (R-WD-09-12).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/wqs/documents/20090610_estuary_criteria.pdf

NHDES. (2011). *Site classification for the New Hampshire benthic index of biotic integrity (B-IBI) using a non-linear predictive model. (R-WD-11-24).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/biomonitoring/documents/r-wd-11-24.pdf

NHDES. (2012). *2012 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. New Hampshire Department of Environmental Services, Concord, NH. April 20, 2012. (R-WD-12-2).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/swqa/2012/documents/a04-calm.pdf

NHDES. (2015). *2014 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (R-WD-15-9).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/documents/2014-calm.pdf

NHDES. (2015). *Impairments Removed (i.e. Delisted) from the 303(d) List of Threatened or Impaired Waters (i.e. Category 5), Oct 14, 2015.* NHDES. Retrieved from http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/index.htm

NHDES. (2015). *Response to Public Comment on the Draft Consolidated Assessment and Listing Methodology for the 2014 Section 305(b)/303 (d) Surface Water Quality Assessments (R-WD-15-13).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/documents/2014-rsp-cmts-drft-calm.pdf

NHDES. (2015). *Technical Support Document for the Great Bay Estuary Aquatic Life Use Support Assessments, 2014 305(b) Report/303(d) List (R-WD-15-12).* Retrieved from http://des.nh.gov/organization/divisions/water/wmb/swqa/2014/documents/2014-draft-gbe-tsd.pdf

NHEP. (2006). *Environmental Indicator Report: Water Quality Indicator.* University of New Hampshire, Durham, NH. New Hampshire Estuaries Project.

NHEP. (2006). *NHEP Environmental Indicator Report: Water Quality 2006.* PREP Publications. Retrieved from http://scholars.unh.edu/prep/162

NHEP. (2006). *State of The Estuaries 2006.* New Hampshire Estuaries Project.

Odell, J., Eberhardt, A., Burdick, D., & Ingraham, P. (2006). *Great Bay Estuary Restoration Compendium.* Durham, NH: Piscataqua Region Estuaries Partnership and the New Hampshire Coastal Program. Retrieved from http://prep.unh.edu/resources/pdf/great_bay_restoration-tnc-06.pdf

ODEQ. (2011). *Methodology for Oregon's 2010 Water Quality Report And List of Water Quality Limited Waters (Pursuant to Clean Water Act Sections 303(d) and 305(b) and OAR 340-041-0046). Updated*

May, 12, 2011. Oregon Department of Environmental Quality. Oregon Department of Environmental Quality.

Pe'eri, S., Morrison, J. R., Short, F., Mathieson, A., Brook, A., & Trowbridge, P. (2008). *Macroalgae and eelgrass mapping in Great Bay Estuary using AISA hyperspectral imagery. A Final Report to the Piscataqua Region Estuaries Partnership from the University of New Hampshire, Durham, NH. December 2008.*

PREP. (2013). *State of Our Estuaries.* Durham, NH: Piscataqua Region Estuaries Partnership. Retrieved from www.stateofourestuaries.org

Scheffer, M., Carpenter, S., Foley, J., Folke, C., & Walker, B. (2001). Catastrophic shifts in ecosystems. *Nature, 413*, 591-596. doi:10.1038/35098000

Short, F., Burdick, D., & Kaldy, J. (1995). Mesocosm experiments quantify the effects of eutrophication on eelgrass, Zostera marina. *Limnology and Oceanography, 40*, 740-749.

Short, F., Davis, R. C., Kopp, B. S., Short, C. A., & Burdick, D. M. (2002). Site-selection model for optimal transplantation of eelgrass Zostera marina in the northeastern US. *227*, 253-267.

Stow, C., Roessler, C., Borsuk, M., Bowen, J., & Reckhow, K. (2003, July/August). Comparison of Estuarine Water Quality Models for Total Maximum Daily Load Development in Neuse River Estuary. 307-314.

TDEQ. (2015). *2014 Guidance for Assessing and Reporting Surface Water Quality in Texas (June, 2015), In Compliance with Sections 305(b) and 303(d) of the Federal Clean.* Texas Commission on Environmental Quality. Texas Commission on Environmental Quality.

USEPA. (2003). *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for Chesapeake Bay and its Tidal Tributaries.* Chesapeake Bay Program Office. US Environmental Protection Agency. Retrieved from http://www.epa.gov/Region3/chesapeake/baycriteria.htm

USEPA. (2005, July 29). Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act. Retrieved from http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/2006IRG_index.cfm

USEPA. (2006, October 12). Information Concerning 2008 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions. Retrieved from http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/2008_ir_memorandum.cfm

USEPA. (2015). *Approval of New Hampshire's 2012 303(d) (Sept. 24, 2015).* United States Environmental Protection Agency. Retrieved from http://des.nh.gov/organization/divisions/water/wmb/swqa/2012/index.htm

USEPA. (2015). *National Coastal Condition Assessment 2010.* Washington, D.C.: U.S. Environmental Protection Agency, Office of Water and Office of Research and Development.

Valiela, I., Collins, G., Kremer, J., Lajtha, K., Geist, M., Seely, B., . . . Sham, C. H. (1997). Nitrogen Loading from Coastal Watersheds to Receiving Estuaries: New Method and Application. *Ecological Applications, 7*(2), pp. 358-380.

van der Heide, T., van Nes, E., Geerling, G., Smolders, A., Bouma, T., & van Katwijk, M. (2007). Positive feedbacks in seagrass ecosystems — implications for success in conservation and restoration. Ecosystems. *Ecosystems, 10*, 1311-1322.

Van, T., Haller, W., & Bowes, G. (1976). Comparison of photosynthetic characteristics of 3 submersed aquatic plants. *Plant Physiology, 58*, 761-768. doi:10.1104/pp.58.6.761

VDEQ. (2005). *Technical Report: Chlorophyll a Numerical Criteria for the Tidal James River.* Virginia Department of Environmental Quality.

VDEQ. (2014). *WATER QUALITY ASSESSMENT GUIDANCE MANUAL for 2014 305(b)/303(d) Integrated Water Quality Report. April 2014. Guidance Memo No. 14-2005.* Virginia Dept. or Environmental Quality.

Wazniak, C., Hall, M., Carruthers, T., Sturgis, B., Dennison, W., & Orth, R. (2007). Linking Water Quality to Living Resources in a Mid-Atlantic Lagoon System, USA. *Ecological Applications, 17*(5), S64-S78.

WDNR. (2015). *Wisconsin 2016 Consolidated Assessment and Listing Methodology (WisCALM) for CWA Section 303(d) and 305(b) Integrated Reporting. (March 26, 2015).* Wisconsin Department of Natural Resources. Wisconsin Department of Natural Resources.

Wood, M. (2014, June 4). DES comments on: 1. 2013 Piscataqua River study FINAL report, 2. 2013 Piscataqua River Chlorophyll and Nutrient database, 3. PiscRiver sonde data Summary by SITE & rainfall.

Wood, M. (2014, October 9). Quality Assurance of 2013 Piscataqua River-Portsmouth Harbor Water Transparency Field Study, Field Sampling & Monitoring Report, submitted by Dr. Stephen H. Jones & Thomas K. Gregory, University of New Hampshire, Jackson Estuarine Laboratory. NHDES.

WVDEP. (2015). *WEST VIRGINIA INTEGRATED WATER QUALITY MONITORING AND ASSESSMENT REPORT 2014 (submitted to the U.S. EPA for approval on 4/13/2015).* West Virginia Department of Environmental Protection. West Virginia Department of Environmental Protection. Retrieved 4 2016, from http://www.dep.wv.gov/WWE/WATERSHED/IR/Pages/303d_305b.aspx