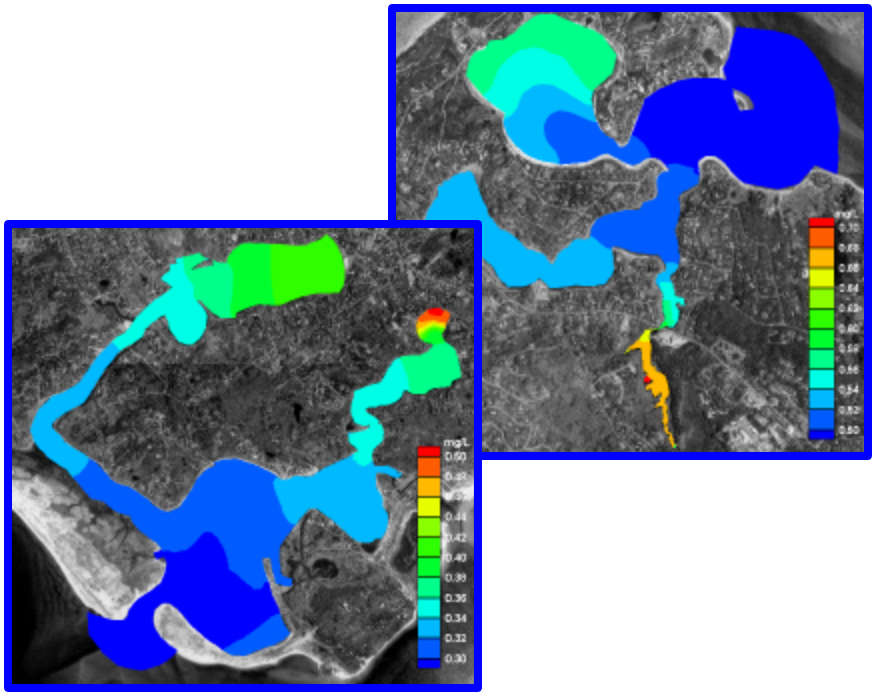
Massachusetts Estuaries Project

Responses to USEPA, Massachusetts DEP, and
Town of Chatham Comments Regarding:

Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Stage Harbor, Sulphur Springs, Taylors Pond, Bassing Harbor, and Muddy Creek, Chatham, Massachusetts



FINAL REPORT – December 2003

Massachusetts Department of
Environmental Protection

University of Massachusetts Dartmouth
School of Marine Science and Technology

SMAST University of Massachusetts Dartmouth
The School for Marine Science and Technology

Massachusetts Department of Environmental Protection

THE MASSACHUSETTS ESTUARIES PROJECT

RESPONSE TO COMMENTS RECEIVED FROM:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA)
AND
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (MADEP)

Relative To:

Massachusetts Estuaries Project Technical Report:
Linked Watershed-Embayment Model
To Determine Critical Nitrogen Loading
Thresholds for Stage Harbor, Sulphur Springs,
Taylors Pond, Bassing Harbor, and Muddy Creek,
Chatham, Massachusetts

Submitted to the Massachusetts Department of Environmental Protection

By

The Massachusetts Estuaries Project Technical Team

December 2003

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MEP Response to Comments from the USEPA

Reviewer, Mr. Phil Calarusso - USEPA:

1. It would make an enlightening comparison, to compare current eelgrass coverage compared to potential eelgrass habitat. Potential eelgrass habitat would include all areas within a waterbody of sufficient depth, sediment type and protected nature that meet the physical requirements for eelgrass growth.

Yes, this would be both interesting and enlightening. At present, for Chatham the major embayments (Stage Harbor and Bassing Harbor) had coverage in the 1951 record from Costello's analysis (not ground-truthed). This recorded coverage was used as evidence that the bulk of these basins could support eelgrass if the water quality were improved. In other embayments where coverage under low watershed N loads is unknown, the use of light attenuation/basin depth would be a very useful analysis.

2. The treatment of the eelgrass change analysis in a quantitative fashion is tenuous at best. The photographs from 1951were not ground-truthed and even the 1995 and 2000 photographs have limited ground-truthing. Additionally, the collection methods for each survey differed, so some variation can be attributed to data collection methodology. I do think the information is useful in a qualitative sense to document that eelgrass does appear to be declining through time.

We constructed a numeric table, but as you indicate uncertainty makes it useful really as a qualitative indicator of eelgrass distribution change. The general approach is to look at areas that clearly had coverage and now do not. For example, Oyster Pond in Stage Harbor, clearly has lost eelgrass. Given the uncertainties that you state, we have never made quantitative associations between acres of bed loss versus any biogeochemical parameter (like nitrogen).

We did use the table as a rough way to determine if the bed coverages (as approximate as they may be) were changing to the extent that would be above the "noise". The large changes in some areas do appear to be above the "noise".

3. It appears inappropriate to target total nitrogen thresholds for the Stage Harbor system based on the Oyster River, which has eelgrass and an ecological status that is on the decline.

The Oyster River as a whole ecological unit is declining. Using an average for the Oyster River or the whole of the data for the Oyster River (extending from Oyster Pond to Stage Harbor) would likely yield a nitrogen level above the "actual" threshold. We did not do this. Instead, we selected the station which is at the interface between the Oyster

River and Lower Stage Harbor. This station was originally selected as the Mouth of Oyster River. This station is not showing declining ecological health (both in terms of eelgrass, benthos, and water quality data) most likely because during the flood tide, it has virtually unaltered Nantucket Sound water flowing through it. In addition, this station was only used as a comparative station for the developed threshold.

4. The general premise of this effort is that nitrogen is the sole driving determinant for eelgrass distribution in these systems. I do agree that it is the likely dominant stressor in these particular systems, but it is not the only stressor. There were a few anecdotal references to areas of heavy boating and the presence of Botrylloides as potential stressors. It would be enlightening to have some discussion of other stressors that may be affecting eelgrass distribution, such as dredging, pier construction, moorings, and recreation or commercial shellfish harvesting.

Good Idea. Additions have been made to the text to reflect the points made here. In addition, text on the pattern of eelgrass loss was added.

5. It would have been nice to have some other eelgrass data that may provide additional support for nitrogen stress, such as the biomass of epiphytes or looking at the deep edge of eelgrass distribution. High epiphytic biomass has been suggestive of areas of high nitrogen loading. The deep edge of any meadow is the most sensitive area to changes in light, thus the most sensitive to nitrogen loading.

We agree. We would like to be able to collect epiphyte data as well as additional sediment type data. Equally important, we would like to be able to collect quantitative light data coupled to our bathymetry surveys to help determine potential bed areas.

6. More detail on the benthic infaunal sampling would be nice. How were sampling locations chosen? How many replicates? Year-round sampling?

The infaunal samples are collected in the Fall, after the summer stress period. The concept is not to determine the annual cycle of settling, growth and die-off, but to capture the “survivors” of the summer stresses. The sampling locations were distributed throughout the major basins of each embayment, typically following the general sediment distribution. However, the high velocity regions of the tidal channels (like a thalwag in a river) were not sampled. In addition, obviously disturbed patches associated with moorings or other small physical features were avoided. Generally, 2 replicate samples are collected for sorting and a third for archive. Note that these Chatham embayments had pre-existing benthic data collected by MEP staff. In all future embayments under MEP the pattern of collection is a sub-set of the benthic regeneration sites.

7. Quantification of macroalgal abundance by species and biomass in each system is also important to understanding nitrogen dynamics in each system. Additionally, studies done at URI suggest that there may be a threshold quantity of macroalgae that will preclude eelgrass growth.

At this point, the best that we can do in this regard is to look at relative coverage (by quartile) and to note the qualitative density of macro-algae. The problem is that the macroalgal coverage and density is not constant within a basin, but changes through the season and with storms etc. In other studies, we have expended great efforts in quantifying the macroalgal density and distribution. This level of effort was not possible for the embayments of Chatham.

Reviewer, Mr. Dave Pincumbe – USEPA:

1. On pg. 51, there is some discussion of the shifting of the Lovers Lake outflow between Stillwater Pond and Frost Fish Creek. It would be helpful if some further discussion of the designated and existing aquatic life uses of these two systems could be provided.

Some text has been added. The Stillwater Pond system is a freshwater kettle pond with a shallow outflow (possibly artificial). There is a herring run which needs to be maintained in any modification. Frost Fish Creek is a microtidal salt marsh with waters in the 20 ppt. The additional freshwater flow would not alter the salinity significantly.

The major points are that this is (1) a reestablishment of a shift done without any analysis and (2) the reestablishment should not alter the systems in question and (3) nitrogen impacts to Ryders Cove should be reduced both by possible attenuation and by input relocation.

2. On page 168, there is a discussion of the measured data used in the model calibration. It would be helpful to include a figure showing the location of each sampling site and a table(s) with the sampling results. Does all of the available data reflect conditions during ebbing tides?

The station location figure has been included.
The data table has been included.

3. The model appears to be significantly underestimating measured total nitrogen in Stage Harbor while providing good predictions for the upper portions of the Stage Harbor System. Some discussion of the reason for this and the practical implications relative to projected nitrogen reductions based on the sentinel subsystems.

The single station within Stage Harbor that the model does not match cannot possibly be representative of this basin's nitrogen level. It is not possible, under the physical and biological conditions of Stage Harbor for the lower basin to have higher nitrogen levels than the basins both above and below it. Since the general basin nitrogen level is the admixture of water from the inlet and from the upper reach of Stage Harbor, there is simply no way that Stage Harbor can be so much higher than either of these other basins. It is possible that this station is located in the immediate vicinity of an outfall or other localized source related to the active harbor (that we and the Town are unaware of). We are unfamiliar with any similar situation in a shallow tidal estuary, without a point source.

4. Some additional explanation of why DON is high in the Bassing Harbor system should be provided and whether or not a reduction in total nitrogen loadings could result in a shift in the refractory DON ratio relative to total nitrogen.

Text has been added as requested.

5. It is not clear what is represented by "frequency" in table VII-2.

Definitions have been added to legend and table headings have been clarified. Frequency is the number of events above the noted chlorophyll a level. When compared to the duration, the mean length (days) of a bloom can be calculated.

6. How were the benthic flux rates associated with the reduced watershed loading scenarios determined?

As the nitrogen loading is reduced the rate of organic matter deposition is reduced and the rate of sediment metabolism is reduced. At the present time, the best estimate of reduction in benthic regeneration is that it will be reduced proportionally with the total nitrogen input (which includes atmospheric deposition). The likely reality is that benthic regeneration will be reduced more than indicated. Under eutrophic conditions (seen in most of the upper regions of Chatham's embayments) sediment and water column conditions tend to reduce the fraction of sediment regenerated nitrogen that is denitrified. As conditions become less organic matter rich and water column oxygen levels improve, denitrification garners an increased amount of the regenerated nitrogen thus reducing the amount of regenerated nitrogen that is released to the overlying waters.

7. Total nitrogen threshold targets for the Bassing Harbor system are based on data from Bassing Harbor. The current condition of Bassing Harbor however is identified as having an intermediate infaunal community, moderate nutrient stress, and moderate habitat quality. The current conditions in Bassing Harbor would not appear to reflect the classification for the Bassing Harbor system.

The infaunal community is but one of the criteria. For example, Bassing Harbor basin has extensive dense eelgrass beds that appear to be "stable" and based upon the mooring data have high habitat quality based upon oxygen and chlorophyll a.

"The outer-most basin is Bassing Harbor which receives tidal exchanges with Pleasant Bay. Bassing Harbor currently supports high habitat quality and based upon the eelgrass records has been relatively constant since 1951. The infaunal community is consistent with high habitat quality as is the maintenance of oxygen levels and moderate to low chlorophyll a levels (typically 5-10 ug L-1. The

Bassing Harbor sub-embayments appear to be a relatively stable high habitat quality system, with demonstrated good eelgrass and infaunal communities."

8. Total nitrogen threshold targets for the Stage Harbor system are based on data from the Oyster River. The current condition of Oyster River is identified as having moderate eelgrass coverage that is on the decline and an ecological status that is on the decline. The current condition in Stage Harbor would not appear to reflect the classification for the Stage Harbor system.

The specific Oyster River site used in the threshold analysis is located at the mouth of the River to the Stage Harbor Basin. This region has eelgrass and generally high water quality and habitat. This region is very near the System's inlet and therefore receives high quality water on each flood tide. However, the upper portion of this long system is losing eelgrass and appears from a variety of factors to be on the decline, but this region was not used to set the threshold.

9. Are achieving the targeted threshold in Little Mill Pond considered to be non attainable?

No. Little Mill Pond was just not used as the sentinel system since it is so small (and is the terminal basin) that the nutrient gradients across it in the model output are relatively steep. The result is that it is difficult to predict future nitrogen conditions under changing watershed loads. In contrast, adjacent larger Mill Pond did not present these difficulties and therefore was used. The use of Mill Pond also increases the certainty of the predictions. It is virtually certain that meeting the threshold in Mill Pond will result in the restoration of Little Mill Pond. However, it should be noted that Little Mill Pond is a drown kettle pond which can periodically stratify. Therefore, full colonization of its bottom by eelgrass is unlikely. Shellfish and fish habitat restoration in the depths and eelgrass at the margins is a realistic goal.

MEP Response to Comments from the MADEP

Compiled Mr. Steve Halterman - MADEP:

OVERVIEW:

The staff of SMAST, and participating scientists from Applied Coastal Research and Engineering, are to be commended for the excellent job of preparing the subject report. It is evident that a substantial amount of effort was expended in completing the monitoring described in this report, as well as the enormous amount of data analysis and modeling that was conducted, as well as the time and effort required to arrive at the conclusions presented, and the recommendations provided.

Although a great number of comments and suggestions are provided by the DEP and EPA (under separate cover), the vast majority of those comments are of an editorial nature ranging from typos and spelling errors to suggested consistencies in style and grammatical corrections.

A smaller subset of the comments presented by DEP and the EPA relate to the need for the authors of the report to better explain specific parts of the report, including but not limited to data presentations, interpretation of data and information presented in the report or referred to in the report, and in some cases, the interpretation of State and Federal policies and regulations (including the Massachusetts Water Quality Standards).

Finally, there are a few major points of concern, such as the need to include raw data in the report, and the need for more detailed explanations of some very basic ecological and mathematical modeling assumptions on which this entire effort was based.

The DEP feels strongly that once these issues are addressed and additional information is presented, we will be in possession of a document that will not only serve as a valuable template for future TMDL reports, but will stand up to the rigorous scrutiny surely required of a process with such far-reaching environmental, legal, and economic consequences.

GENERAL COMMENTS

The acknowledgement of DEP and EPA staff, for assistance with the preparation of the report is appreciated. However, the list should include Sharon Pelosi, Ron Lyberger, and Brian Dudley. In addition the spellings of the names Art Clark, Arleen O'Donnell, Russ Isaac, and Mike Rapacz should be corrected. It might be appropriate to include Brian DuPont and Ed Eichner as authors on the title page.

Sharon Pelosi and Ron Lyberger have been added to list of people acknowledged. Spelling of names has been corrected and Brian Dudley has always been presented on the inside cover page as a contributor. Ed Eichner has always been presented as an author and Brian Dupont has always been presented as a contributor (not an author as he did not write text).

The report needs a detailed and comprehensive executive summary. It should include reference to the QAPP, the Linked Model Document, other data sources, and the Interim Thresholds Document. An explanation of how the Thresholds Document connects to this report and to future TMDL reports.

A detailed executive summary has been developed with input from the DEP and is provided along with the revised Final Report. The Executive Summary was reviewed separately by DEP.

An overall map of the Chatham estuaries would be helpful.

Figure III-1 shows all the Chatham estuaries relative to each other and each Chatham embayment is depicted in Figure V-1 in aerial photograph format.

The report would be improved by careful editing to assure that chapters, which are written by different authors, flow more evenly than they do in this report. While this does not detract from the technical content, it does make it harder to read, especially for the layperson. It would also be helpful if Chatham's five major systems were more clearly depicted/identified on the figures, maps and tables that show the breakout of sub-systems.

In producing this revised report an effort has been made to clarify text as best as possible. Given the comments received to date on the Chatham Report, future reports for other embayment systems will be written keeping concerns of unified voice and flow in mind. Regarding flow of information presented in the report, the structure of the report has been discussed with the DEP and it was agreed that the science underlying the establishment of the nutrient thresholds drives the format. As such, the flow of information presented in the executive summary has

been modified to better suit DEP staff TMDL needs, but not the content of the actual report.

The report should include raw data appendices, as well as appropriate data summaries throughout (including locations of data collections), as required. This is especially true of nitrogen concentrations on which the modeling was based (including model verification), benthic fauna species lists, and values of chlorophyll concentrations. The locations of water column sampling sites, the time of day, and the time within the tide cycle are extremely important factors to be considered in evaluating the overall approach and conclusions, and especially in evaluating the modeling efforts.

Based on the consensus reached during the DEP/SMAST November 25, 2003 meeting in Worcester, land use data sets will be provided electronically and agreed upon data summaries will be presented within the document itself. Note that the water column monitoring sites are included in a new figure. These data were collected under a DEP approved QAPP.

Hydrodynamic Model

Hydrodynamic model seems to capture the physics of the various embayments well. The results range from excellent based on simulating water flow (Stage Harbor) to good. Since not all embayments had flow measured, their hydrodynamics are accepted on the basis of reproducing stage measurements, which usually is the most easily matched variable in these models, so the uncertainty in the simulations is greater, but should be acceptable.

It does not necessarily follow that the uncertainty is greater in the smaller embayments. The accepted practice in the Coastal Engineering and Research community validating these types of hydrodynamic models is with independent stage data (that not used in the calibration step). MEP has added an additional validation test, direct volumetric flow comparisons (observed versus modeled). Since in those cases where both validation procedures were used, good agreement to the model was found, it is likely that when only stage data is available good agreement does not necessarily mean more statistical uncertainty. Note that the MEP Technical Team is keeping a "running" comparison of model versus each type of validation which will provide additional insight as the Project progresses through more embayments.

The main question concerning hydrodynamics is how sensitive are the water quality assessments to uncertainties in the hydrodynamics?

The uncertainties in the system hydrodynamics are probably the smallest source of errors in the approach. Based on the calibration/validation data developed for

the Chatham systems, potential errors associated with tidal exchange estimates appear to be less than 5%.

Why were current measurements conducted only in Stage and Bassing Harbors?

As required in the QAPP, current measurements are only required in larger estuarine systems. For the five Chatham estuarine systems evaluated in this report, only Stage and Bassing Harbors were considered large systems. The major reason for this centers on the capabilities of the ADCP. In small inlets and shallow waters the variability of the ADCP measurements can degrade.

Water Quality Model

WQ model---need to plot variation in field data

More information regarding the total nitrogen variability (e.g. standard deviations) is being provided in the final version of the report. However, "yearly data means" were provided in the calibration plots to indicate typical variability within each system.

Why are the annual averages so variable in many cases? What does this do to confidence in predictions?

Due to the high natural variability in environmental conditions (rainfall, temperature, water clarity, wind, etc.), the "high" variation in annual averages should be expected. It should be noted that the "yearly data means" are developed from a relatively small number of measurements; therefore, the inter-annual variability appears to be high. Lower variability (or at least a larger number of similar measurements that would decrease the standard deviation) could be achieved by taking numerous measurements during every ebbing tide; however, this would be prohibitively expensive. Instead, the measurements derived from the estuarine systems provide the range of conditions observed. The model predicts long-term (period of days) steady state values, without the influence of additional short-term environmental factors (period of minutes or hours). This variability should be anticipated and has a negligible effect on the confidence of model predictions.

Figures showing concentrations based on current loads should have average of field data plotted by station.

The calibration plots (e.g. Figure VI-5 for Muddy Creek) contain the average of field data and average concentrations predicted by the model. Contour plots of the embayments (e.g. Figure VI-13 for Muddy Creek) do not show water quality measurement stations or mean TN values. However, the MEP team feels that

this would unnecessarily complicate the figures without providing any more meaningful information.

Eelgrass

The different methods of data collection include the 1951 historical view,1995/2000 photo interpretation (with extensive groundtruthing, geo-referenced with GPS, and conducted with identical NOAA C-CAP methods) and separate Fall of 2000 shallow boat observations in the Town of Chatham. These need to be described more fully, with discussions of the accuracy and compatibility of the data types, as well as the strengths and weaknesses of the different methodologies.

Some discussion of the methods was added to the text. Text was also added to focus on how the data usage was tailored to the data sets available (i.e. different methodologies).

The graphics can be somewhat confusing, and to some extent misleading. Possibly the 1951 data should be displayed individually to avoid any comparison of this data to the later 1995/2000 data which are more accurate and field-verified. Also, more explanation is needed for the graphics displaying percentages or density or cover.

Given that the eelgrass data is used primarily as presence/absence, we have left the maps as in the original report. However, we are always looking for was to clarify the presentation and will see what can be done in future reports.

Text was added as requested on the density/cover etc.

Improvements to this section could include:

1. ***complete description of the different data collection methods and the strengths/limitations of each***

   In QAPP, not for synthesis report

2. ***clearer graphics displaying the 1995/2000 aerial coverage including field verified points within polygons and located at the outer edge (when available).***

   The field validation points on the DEP maps are shown, the SMAST 2000 data were “continuous transects”.

3. ***a standard protocol of mapping conventions, symbols and relationships which will be adhered to for the entire Embayment Program.***

The Chatham report is one of the “transitional report” in that some of the data precedes the MEP. The decision in these cases was to use the data as long it meets MEP QA. But the maps in this report will not likely be the format for all future reports.

4. a possible mapping of potential suitable habitat as limited by the existing bathymetry and substrate data.

This is something that MEP Technical Staff have wanted to do, but is currently “out of scope”. This may be done basins where the supporting data is available in the future.

We recognize that DEP provided much of the information that is used to address the eelgrass-related issues. The above issues might be addressed by increased communications between Charles Costello and SMAST.

Costello is a member of the MEP Technical Team and is privy to discussions at the meetings that he attends. Also, all of the MEP email communications. The maps that this reviewer has issue with were prepared by C.Costello. However, communication is always sought within the MEP, but this point by the reviewer does not seem to be the underlying cause that he/she seeks (in this case).

TMDL Development

It is difficult to understand the development of the target nitrogen loads from the discussion and the tables. The section addressing this is critical, and it should be clear and coherent to the readers. It would be also be useful if there was a specific discussion of how the target levels relate to the water quality standards as presented in the Thresholds document.

The threshold for Bassing Harbor and Muddy Creek systems is 0.529-0.552 - which the Thresholds Document defines as "moderately impaired" water quality. This threshold seems to preserve the status quo given the existing total nitrogen levels listed at Table VII-3. Yet the discussion of target nitrogen loads indicates that removal of 30-50% of the septic load in Bassing Harbor, and 50-60% of the load in Muddy Creek would attain this threshold. Does this mean that the septic load reductions are not worthwhile because they do not result in an improvement in the total nitrogen levels? Would we be proposing a TMDL that could not be attained? Is this one of the referenced situations that cannot be returned to a "pristine system"? This needs a better explanation in the narrative.

The nitrogen levels in the Thresholds document are only as examples, as indicated by DEP (and in the text itself). The Pleasant Bay systems are direct confirmation that there is no generalizable nitrogen threshold. The Bassing Harbor sub-basin of the Bassing Harbor System has high quality habitat. As discussed, the reason is that there is a high dissolved organic nitrogen background, which inflates the total nitrogen number. The MEP Technical Team

believes that the nitrogen target (for restoration) in the Bassing Harbor System is attainable. (Table VII-3 is eelgrass coverage).

It is difficult to see how the load reductions for the areas tributary to Pleasant Bay can be set until there is a more definitive analysis of what the target level for Pleasant Bay will be. It is understood that the argument presented in this document is based on the logic that only the DIN plus PON matters, but until this is clearly agreed to as part of the Pleasant Bay work to be conducted in the future, it might be necessary to consider these recommendations as "preliminary", or "interim". Possibly, this TMDL will have to be considered final for the non-Pleasant Bay area only, and then possibly wait for the resolution of the Pleasant Bay TMDL. This issue will need to be discussed fully.

We agree, but the threshold levels should be the same. Only the means to achieve them should change, due to the lowering of the boundary condition (inflowing tidal water nitrogen).

Overall approach

The approach integrates several metrics to assess an embayments health. These variables include extent and condition of eel grass beds, extent of macro algae, minimum dissolved oxygen concentration, and organisms in the sediment (macro invertebrates). This integrated approach reflects a reasonable framework given the dearth of numerical criteria. The only question that arises is defining at what point each of these indicators, other than minimum dissolved oxygen, reflects undesirable conditions. The concern is for defensible as well as consistent breakpoints. The first point relates to the soundness of the divisions to determine health or lack thereof of the system and the second relates to the reproducibility of the assessment.

Also, how is "current load" defined? Everything currently in the watershed, no matter its vintage? All plumes transit surface features? What is background N in groundwater? How accurate is TN test in coastal waters? Summer average TN the standard?

The current watershed load description in Chapter IV has been clarified (including time of travel). The TN questions are unclear.

The assessments are aimed at evaluating the clauses in Massachusetts' Water Quality Standards which themselves are descriptive rather than quantitative:

(c) <u>Nutrients</u> - Shall not exceed any site specific criteria, contained in an applicable TMDL, or as otherwise established by the Department pursuant to these Standards, necessary to control accelerated or cultural eutrophication (see also 314 CMR 4.04(6)). ***The Department may establish nutrient criteria on a site specific basis based on concentrations or loadings deemed to result in adverse impacts as measured by chlorophyll concentrations, diurnal variation in dissolved oxygen, or other appropriate measures as determined by the Department.*** **(EPA 25)**

314 CMR 4.04(6) <u>Control of Eutrophication</u>. There shall be no new or increased point source discharge of nutrients, primarily phosphorus and nitrogen, to any surface water that would cause or contribute to cultural eutrophication or the growth of weeds or algae in any surface water. Any existing point source discharge containing nutrients in concentrations which cause or contribute to cultural eutrophication or growth of weeds or algae in any surface water shall be provided with the highest and best practical treatment to remove such nutrients. Activities which result in the nonpoint source discharge of nutrients to any surface water shall be provided with all cost effective and reasonable best management practices for nonpoint source control. (EPA 25) (See also 314 CMR 4.05(5)(c).)

DETAILED COMMENTS

p. 4: Field data are mentioned. As suggested in the overall comments, above, all data used should be in an appendix.

As previously discussed above, based on the consensus reached during the DEP/SMAST November 25, 2003 meeting in Worcester (and in previous meetings as well), land use data sets will be provided electronically and agreed upon data summaries will be presented within the document itself.

p. 5, 2nd full paragraph: Is "propagating" the correct word here? If so, we would appreciate a definition.

In re-reading the sentence and considering the definition of the word, propagating is the appropriate word. From Webster's Dictionary: propagate – To cause (e.g. a wave) to move through a medium.

p. 8, 4th paragraph: we shouldn't be saying "…the determination of threshold nitrogen concentration remains somewhat subjective", especially if this report will evolve into a TMDL which will need to be defensible.

The text has been expanded and clarified. The word "subjective" no longer appears.

p. 12, 1st paragraph, last sentence: The amount of atmospheric deposition must be determined not only on the embayment surface area but also on it's watershed area.

0.05 mg/l is the nitrogen concentration of recharge from undeveloped land within a watershed

p. 12, 3rd line from bottom: Should indicate that ORW-N limit is a Buzzards Bay Program's recommendation only.

Section has been modified
ORW-N limit is a CCC modification of the BBP limit based on observations that systems with meeting the BBP ORW limits seemed to have worse conditions that allowed by the ORW classification in the state surface water standards. Although BBP attempted to link recommended nitrogen limits to descriptive state surface water standards, this effort pointed out the limitations of using a single standard for the wide variety of impacts and responses seen in estuarine ecosystems and reinforced the need to develop comprehensive estuary-specific assessments.

p.14 Last paragraph line 5: The State does not have limits yet. This may be a Buzzards Bay Program recommended limit.

Paragraph has been reworked to clarify (see below).

As additional monitoring and habitat information has been developed for individual estuaries in the MEP study area, it has become increasingly clear that development of estuarine nitrogen loading limits requires comprehensive site-specific assessments. For example, water column nitrogen data from Chatham's coastal systems are over the corresponding recommended limits developed by the BBP and the modified limits proposed by the Cape Cod Commission. More significantly, the high quality regions within Pleasant Bay are over these thresholds as well, indicating the need for site specific thresholds. The MEP approach presented in this report develops site-specific critical nutrient thresholds for all of the Town of Chatham embayment systems.

p. 15, 2nd paragraph: A 10 year time-of-travel is mentioned. Was current watershed N loads assumed to come only from all activities within this boundary? It is not clear how current load was developed, i.e., does all development regardless of when instituted contribute to current loads? If not, how were distinctions made and what about loads from further away in travel time? Explanation needs to be a little clearer and the rationale explained.

Changes in the text (Section IV) have been made to clarify.
During the initial conceptualization of the linked model, there was a concern that due to the relatively rapid pace of development on the Cape there would be certain areas where watershed loads beyond the groundwater 10 year time of travel band to the estuaries will not have arrived at the systems. A review of development patterns in Chatham found that no significant developments occurred in the greater than 10 year watershed areas within the last 10 years. Nitrogen modeling confirmed that existing nitrogen concentrations could not be achieved without loading from these greater than 10 year areas. Thus, while the greater than 10 year loads will take at least 10 years to reach the estuaries, the majority of the development within these areas has existed for at least 10 years.

p 16, 3rd paragraph: a) please explain how the new 26" recharge rate was derived from USGS data since this differs from the current "accepted" recharge rates.
b) please explain how the 15% consumptive loss was verified.

a) These data were provided by the US Geological Survey and is the current accepted recharge rate.
b) The fraction of pumping that supports wastewater flow was empirically derived. The consumptive use and irrigation analysis was conducted to support the value (which it does).

p. 23, Figure lll-3: needs a fuller explanation as to what it is showing.

Figure III-3 caption can not be made more explicit.

p. 24, 1st paragraph: The need to confirm transported load has reached the embayment at the time of analysis is mentioned. Was this done and how? (It seems not be explained.)

see p.15 comment above

p. 24, 2nd paragraph: it is not clear what the "region nitrogen load factors" or the "primary regional factors" are. Could they be listed, or in some way explained?

See Table IV-2

p. 25-27: land use categories are not consistent between the text, map, and table.

Text and map (Figure IV-1) are consistent. Figure IV-2 has been corrected to be consistent. Unclear what table this comment is referring to.

p. 33 and 36, The information on nitrogen loads found in Table IV-2 and Table IV-3 is somewhat inconsistent. The categories of sources should be defined, e.g., does wastewater in Table IV-2 only Title 5 systems? What category of sources do golf courses fall under?

Table IV-2 presents nitrogen loading factors, while Table IV-3 presents nitrogen loading results for Chatham. Table IV-3 has been modified to more clearly present system-specific loads and notes have been added further clarify the categories. Wastewater treatment in Chatham occurs either through the town's treatment plant or Title 5 systems and this is reflected in the two columns included in Table IV-3. Effluent nitrogen concentrations for both wastewater sources are listed in Table IV-2. Fertilizer loading from the two golf courses in the study area is included in the lawn fertilizer column in Table IV-3.

p. 33, What is the MEP Lawn Study and who funded this?

The Lawn Study was completed and funded by the Coastal Systems Program – SMAST, as part of an on-going effort to refine nitrogen coefficients in support of the MEP. The Coastal Systems Program Staff have been conducting estuarine research for almost 30 years throughout S.E. Massachusetts, much of it relating to the effects of nitrogen enrichment, nitrogen cycling and transport. The lawn study is merely part of this ongoing effort.

p. 36, Table IV-3: It is not clear how calculations were done. Also, some round-off errors are present in adding the lines.

Text on p. 34 has been clarified to further describe the nitrogen loading summary.

p. 50, 5th paragraph: Did the measurements confirm the freshwater balance?

As discussed in detail on following pages and figures, the flow data confirmed the freshwater flow for Lovers Lake (and Frost Fish Creek), but not for Stillwater Pond. The apparent cause is that the outflow stream from Stillwater Pond does not carry all of the discharge (i.e. other discharges, groundwater and possibly surface water) are occurring.

p. 55, Table IV-5: It is striking and perhaps fundamentally important in terms of nutrient availability that nitrate is only ~30% of TN. Is the rest organic?

Yes, most of the remainder is organic.

p. 61, I would have expected most of the TOC and TN to be algal in nature. Why are the ratios so far from the usually quoted Redfield numbers?

The value given is POC (particulate organic carbon) not TOC, so the ratio of POC to TN will look low. However, going into data not used in this report, the POC/PON ratio is generally about 6 so it is close to the 6.7 of Redfield.

p. 65:Would like sediment N flux and SOD data in an appendix.

Sediment flux data is in the data tables in report as per final discussions with DEP.

p. 68, 69: Please explain why Figure IV-15 depicts 45 sediment core sites while Table IV-7 reports data collected from 17 sites.

The 45 cores sites are shown in Figure IV-15. The flux rates for the 17 basins (total flux per basin) are found in Table IV-7. Note that the cores are not replicates, but are distributed within each basin. The variance information is now in the table.

p. 67, 2nd paragraph: The frame of reference for the sediment mass balance is a little confusing. If the sediment is releasing nitrogen gas, wouldn't that be an "out" term? Or is the mass balance built around the bioavailable nitrogen? Clarifying this point would be helpful.

It is, but in this balance the out is the release of fixed nitrogen.

P 68, figure IV-16, Please identify, on the curve, where the flux measurements were actually determined.

MEP flux measurements target July and August.

p. 74: Why were currents measured only in Stage and Bassing Harbors?

Section B.2 Hydrodynamic Modeling of the QAPP indicates the protocol utilized to determine appropriate locations for current measurements. Mill Creek, Muddy Creek, and Sulphur Springs all are too shallow for effective use of the ADCP.

p. 92: All the figures showing bathymetry should identify the year that depth contours were made.

This will be added to the final report.

p. 100: The formula and its explanation on this page raises a question. From the description and the equation, it appears that Q_T is the flow through one vertical column of water and that the flow through the entire cross section of the waterway is the sum of the flows through each vertical section. If that be so, then it seems that Q_T needs to be summed over all of the columns, say M of them, to arrive at the total flow (Q_T):

$$Q_T = \sum_{\substack{i=1,N \\ j=1,M}} V_i A_i$$

where, Q_T s the flow in the entire cross section, V_i is the velocity in cell i and A_i is the area of cell i, N is the total number of layers j is the column number and M the total number of locations for the vertical profiles (i.e., number of columns).

This will be corrected in the final report.

p.104: What would be the aural equivalent of the output of the harmonic analysis? If run through a synthesizer would match a Keith Emerson patch?

This from DEP's project manager!?! Comparative harmonic analysis indicates the statistical best fit with a recording of a whale yawning in McMurdo Sound. But on a serious note, it is directly related to the oz-z, Oz, as found in the hydrodynamic analysis for the Town of Bourne.

p.131, last paragraph: Not many of the errors were on the order of 0.1 ft. Would it be worth comparing to the median or the mean?

Since the errors were of similar magnitude to the accuracy of the tide gages, it likely would not be appropriate to compare to the mean.

p. 145, 2nd paragraph: Does the model assume no return of bay water once it exits the boundary?

Yes, this is true for the hydrodynamic model and likely is the reason that the results of this modeling alone should not be used to assess estuarine health (as stipulated by the Buzzards Bay Project and utilized by Stearns & Wheler for the Chatham Needs Assessment Report). However, the water quality model utilizes a boundary condition developed from long-term data offshore of the estuarine systems. In effect, the water quality model does not assume "no return of bay water", since the local offshore measurements would include typical dilution of estuarine waters with the "more pristine" offshore waters.

Last 3 lines of this paragraph: Shouldn't the volume of the sub-embayment replace that of the entire system to calculate the local residence time?

Yes, that is what the equation on p.145 indicates. This question is unclear.

p. 165, Water Quality Model Setup: Is TN treated as a conservative substance?

Within the model, TN is a conservative substance. However, the boundary conditions contain all of the assumptions regarding sources and sinks (i.e. the non-conservative aspects of the nitrogen cycle).

p. 166, Last line: How was "best fit" determined?

For the case of TN modeling, "best fit" can be defined as minimizing the error between the model and data at all sampling locations, utilizing reasonable ranges of dispersion coefficients within each sub-embayment. We will add a sentence to this paragraph to clarify the term "best fit".

p. 168, 1st paragraph: Presumably the highest TN concentrations would be at low tide. Correct?

Without benthic flux, it would be true that the highest TN would be at the end of the ebb cycle (at low tide). However, at locations where there is a negative benthic flux (e.g. Muddy Creek – lower), this may not be the case.

Figures VI-3 through VI-8: What accounts for the variability of annual concentrations? Overall range should be plotted as well.

Due to the high natural variability in environmental conditions (rainfall, temperature, water clarity, wind, etc.), the "high" variation in annual averages should be expected. It should be noted that the "yearly data means" are developed from a relatively small number of measurements; therefore, the inter-annual variability appears to be high. Lower variability (or at least a larger number of similar measurements that would decrease the standard deviation) could be achieved by taking numerous measurements during every ebbing tide; however, this would be prohibitively expensive. Instead, the measurements derived from the estuarine systems provide the range of conditions observed. The model predicts long-term (period of days) steady state values, without the influence of additional short-term environmental factors (period of minutes or hours). This variability should be anticipated and has a negligible effect on the confidence of model predictions. Again, to make the plots as legible (and simple) as possible, the yearly data means were selected. Additional information regarding the range of data will be provided in Section IV of the final report.

Figures VI-9 through VI-13: Average TN concentrations from field data should be plotted on figures.

The calibration plots (e.g. Figure VI-5 for Muddy Creek) contain the average of field data and average concentrations predicted by the model. Contour plots of the embayments (e.g. Figure VI-13 for Muddy Creek) do not show water quality measurement stations or mean TN values. However, the MEP team feels that this would unnecessarily complicate the figures without providing any more meaningful information.

p. 170, Figure VI-4, FF Cr. (out) is not a very good match. Why?

This figure represents using total nitrogen; however, Figure VI-3 shows the final model calibration using the bio-active approach. As discussed in this section, the bio-active nitrogen approach was selected for the evaluation of the Bassing Harbor system. Figure VI-3 shows good agreement for all stations.

On page 171, Figure VI-6, Stage Harbor is not a very good match. Why?

To be complete, information from all stations was shown. However, there is a problem with the Stage Harbor station. The single station within Stage Harbor that the model does not match cannot possibly be representative of this basin's nitrogen level. It is not possible, under the physical and biological conditions of Stage Harbor for the lower basin to have higher nitrogen levels than the basins both above and below it. Since the general basin nitrogen level is the admixture of water from the inlet and from the upper reach of Stage Harbor, there is simply

no way that Stage Harbor can be so much higher than either of these other basins. It is possible that this station is located in the immediate vicinity of an outfall or other localized source related to the active harbor (that we and the Town are unaware of). We are unfamiliar with any similar situation in a shallow tidal estuary, without a point source.

What implications are there to these differences?

As explained, the FF Creek (out) is not an issue. The implications for the Stage Harbor station are negligible, since this data does not make physical sense. Note that the Stage Harbor station data were "flagged" in the data review prior to the modeling effort. The data were included both for completeness and to prompt investigation as to the cause of these values.

In Chapter VI, and subsequent chapters, there are problems going from the legend on the color maps to the mapped colors themselves. It would be useful if there was some way to have something on the maps themselves that allowed a viewer to be able to calibrate which color was what level.

The main purpose of the contour plots is to provide a visual reference that improves the reader's understanding of the calibration plots (Figures VI-3 through VI-8). We would prefer not to provide more definitive information on the plots, especially since point measurements could be influenced by a local source of nitrogen. In this manner, the reader can see how the system calibrates based on the available data; however, comparisons to actual observed nitrogen concentrations at a given location are avoided. We should keep in mind that the overall goal is for system-wide restoration and not for predicting the exact value of TN at someone's dock.

p. 178 Table VI-10: Some round-off errors.

Table has been revised.

Figures VI-14 throughVI-18: Would plots normalized to target value be more useful if target value were also indicated on the figure? This way, all of the scales would be the same and comparable, relative to the target for that waterbody.

To make the report as simple and understandable to the lay person as possible, TN values were chosen as the basis for plots in the report. Note, even though bio-active nitrogen modeling was used for calibration in the Bassing Harbor system, TN values are used in Figure VI-17 to avoid confusion.

p. 183, Table Vl-14: Does "no load" mean no atmospheric load and a scaled flux? Note should be included in caption.

Yes, this will be added to the final report

P 188: end of 3rd paragraph: "Temporal changes in eelgrass distribution provides a strong basis for evaluating recent increases (nitrogen loading) or decreases (increased flushing-new inlet) in nutrient enrichment."While we all have accepted the role of eelgrass as an arbiter of water quality, there is a lack of literature citations which, specifically support this position. We need some citations from peer reviewed literature.

A separate eelgrass document is being prepared by a parallel DEP study to deal with this and other issues. Since this study is underway, its product will be used in future MEP reports and will be made available to Chatham, as well.

pp: 191-201: Figures Vll-1a through Vll-10: Would like data in a spreadsheet. Also would like tidal stage and insolation data. The wide variation in chlorophyll may be a function of tide, i.e., a water mass with high values oscillating with a water mass with low values. Also would like to see a few examples of plots spread out to see how the patterns in dissolved oxygen and chlorophyll correlate. For Mill Pond (p. 193), diel DO fluctuation is relatively small for the amount of chlorophyll present and the lowest DO concentrations correspond to a peak in chlorophyll concentration. Any insights? It would be helpful if the DO standard was included on the figures depicting DO. Also, a footnote could be included to explain that the red dot indicates QC sample data.

We are not planning to provide tidal stage data other than the information contained within the report. Insolation data is not collected nor is it discussed in the report. The data is reduced to the data needs for this report in the synthesis tables after the figures in this chapter. The plots of the time-series mooring data are only presented for completeness. The TMDL analysis is based upon the synthesis tables. Footnote has been included.

p. 202: Table Vll-1: Should add columns for percentage of deployment time values were <6 mg/L etc. i.e., for a 30 day deployment, how many of the 720 hours were DO concentrations <6mg/L?

We have presented these data for the actual deployment times (which are also given). We have not calculated a % D.O. level specific column (i.e. one normalized to a set deployment). The percent calculation provides this adjustment (i.e. the number of hours per 100 hours of deployment times 100%).

p. 203: Tables VII-2: What do the statistics mean? Also, for columns with (#) > 5 should include all > 10 as well etc., unless between 5 and 10 etc. is being listed. Also, what is the maximum number possible?

Text has been added to the headings for clarification of these points. Since the numbers represent events when levels rise above a certain concentration (5, 10 etc), they do not add up the way that the reviewer suggests. For example if there is a bloom where levels rise above 5 ug/L and stay there for 10 days, but only go above 10 ug/L on 2 consecutive days then the 5 will have an event # of 1 and 10 an event # of 1. However, if the rise above 10 occurs on day 3 then declines and rises again on day 7, then the 10 ug/L will have an event # of 2 (with the 5 ug//L still at 1).

p. 206: How is eelgrass density data used? How low of a density is considered to be "less than a critical mass"?

The density data was only used in as interpretive support. The 1951 to 2000 maps indicating change were then checked to see if the remaining beds were also not dense, which would be expected if bed loss was occurring and continuing (i.e. the data were supportive to the time trend conclusion and not quantitative or fundamental to the conclusions).

pp. 206-209, Section VII Eelgrass Analysis, The discussion is difficult to follow and in some cases is inconsistent with results previously reported. It would help if the results for each year of survey were first presented separately, and then relative to each other. Some of the statements are inconsistent with previous results, e.g., it is stated on page 190, last paragraph, that Mill Pond has lost its eelgrass beds, however, on page 206, 2nd paragraph, the text doesn't say that Mill Pond was one of the several [listed] estuaries where eelgrass was not observed. Statements such as "significant reduction" should be defined. There was virtually no presentation or discussion about the presence or absence of macroalgae associated with the eelgrass. It is not evident if the eelgrass distribution depicted on Figures VII-11- 14 is [maximum] areal coverage or density.

The confusion results from the fact that Mill Pond is not an embayment, but part of the Stage Harbor System, which is referred to in the next sentence in the text referred on p. 206. Text has been added to clarify these points.
Note the eelgrass distribution in Figures VII-11- 14 is the extent of bed coverage as determined by the DEP mapping program.

p. 210, Figure VII-15 (and other similar): Needs some explanation of how to interpret the figures on the same page as the figure.

Text added to figure legend.

pp. 212-213, Tables VII-3 and VII-4 should use similar units (square feet vs. acres). Is the total surface area of 27,856,000 square feet for Stage Harbor system reported in Table VII-3 correct? Does this number include additional sub-systems not identified in the table? What is the available habitat that can support eelgrass colonization? Please explain that Table VII-4 is comparing different methodologies- i.e., "presence/absence" observations in 1951 vs. "density" measurements in 1995 (?) and 2000.

Tables changed. Potential habitat acreage is not part of this study at this time.

p. 213: Table Vll-4: Was there no eelgrass in Sulphur Springs, Muddy Creek, Taylors Pond and Frost Fish Creek in 1951?

There was no data available for 1951.

p. 213, 3rd bullet: Need to elaborate on this point. Specific literature citations would be useful.

Text was added on this point in section above (in response to this and other comments).

p. 214, 2nd bullet: transition to salt marsh indicates shoaling impacts (possibly natural) in addition to any possible nutrient issues. However, if the transition to salt marsh is culturally accelerated, should it be reversed?

There is no evidence that this is significantly culturally influenced (at least in recent times). Under the conditions of the Sulphur Springs basin, this appears to be a natural evolution for a shallow basin which has salt marshes at its margins.

4th paragraph first line: Counted only 15 (not 17) locations depicted on p. 216. Also, should say sampled 4 out of the 5(?) embayments.

Text changed. Yes, 4 of 5 embayments, as stated.

The classification system used to classify assemblages as pristine or healthy, intermediate in stress, highly stressed, etc., needs to be better explained.

Text added. But a document specifically addressing this issue is being developed by the MEP Technical Team for use as the Project develops, since it is difficult to provide sufficient text in the embayment specific summary reports (without becoming a distraction).

p. 214, Section VII-4, A discussion of the metrics and indices used to classify community structure should be presented. Where is G.R. Hampson's indictor assessment presented?

As above.

p. 215: Any citations for "good" and "bad" measures of diversity and eveness? At the least, ranges of "good" values and "bad" values should be provided.

In text

p. 217: Table Vll-5: By what formula are data interpreted to determine levels of stress? Spacing (many hanging "s" as well as Stage Harbor, Bassing Harbor)

as above

p. 218: Were all 5: embayments sampled for macro invertebrates even though some sites were not?

Addressed above

p. 219, Many statements in the text are inconsistent with data summary Table VII-3.

Text has been added. Table VII-3 is based upon yr 2000 data only so that the data are comparable. For example, the water quality data used in the validation are multi-year, while this comparison is only for the 1 year.

p. 220: it is difficult to read the information in Table VIII-1 and relate it to the discussion in the text, and then relate that to the classifications in the Thresholds document. A much clearer explanation would be useful.

Addressed above

p. 222: It is difficult to follow the logic in the rationale for the threshold nitrogen levels. For example, for the Stage Harbor complex, it is hard to understand how the level of .38 was selected and where the supposed data point in Stage Harbor in some area that is "stable" came from. Why was this averaging process done? Please explain the statement that the calibrated water quality model for Stage Harbor gave a level of .40 mg/l in Upper Stage Harbor when there seemed to be some real calibration problems in Stage Harbor. Furthermore, there are concerns with the targets for Sulfur Springs and Taylor's Pond systems because they rely on the Stage Harbor target, which are being questioned.

Additional text has been added. But Stage Harbor did not have calibration problems, the problem was (as discussed above) with the water quality data from one of the Stage Harbor stations. Analysis indicates that the data from this station cannot reflect basin conditions, but possibly a local discharge.

p. 223-224: In the discussion about the Bassing Harbor system, the rationale for the selection of the higher than expected threshold level of .527 to .552 mg/l is based on an argument that there are much higher levels of dissolved organic nitrogen in Pleasant Bay, and that the dissolved organic nitrogen really doesn't matter, so all that one needs to consider is the combination of DIN and PON. What is the basis for this argument? We have been basing everything in the Thresholds document and elsewhere in this report on total nitrogen. How valid is this argument, and if it is valid, why shouldn't it be used consistently for establishing the thresholds? This really needs more discussion.

Some text has been added on the DON issue. Note that a total nitrogen threshold was developed for Bassing Harbor, but that it was based upon an additional step which included an independent analysis of DIN, PON and DON (separately and in concert). This was done to maintain consistency with the Thresholds document.

p. 225: Tables VIII-1 and VIII-2: Caption should read "…watershed septic system N…" and "septic system N" to 2nd and 3rd column titles.

Please add table (or column to an existing table) with target N concentrations.

Changes were made to the column headings as requested. The target N concentrations in this type of table have been found to confuse previous reviewers since the units are not comparable to the loads.

Figures VIII-1 through VIII-10: Add a note to each about scale varying between figures. Could a relative scale be used based on target concentration for each embayment going from better than target to worse than target by set increments with a note as to the target for that waterbody?

The requested change has been made. The reason for the upper and lower graphs with different scales is (a) to allow comparison between Chatham's systems (upper fig) and (b) to give a more detailed view for the specific embayment. This dual graphing is a result of the unique case where MEP had to put 5 embayments into a single report (a result of the start-up transitional process)

p. 234: The discussions on the alternatives for Muddy Creek are hard to follow. The figures and the loading analyses related to the recommendation to recreate the dike midway up Muddy Creek, and turn the Upper Muddy Creek area into a fresh water system, need to be more clear. The argument for relating the results of the loading analyses to only DIN plus PON needs further discussion. Finally, if the proposed solution is to build the dike, the TMDL technical report must address the need to change the water quality classification of Upper Muddy Creek, and discuss whether or not it would meet water quality standards.

The analysis of the dike is not a recommendation. It is an initial analysis that would need to be fully defined and described by MEP if the Town wishes to examine it as a potential restoration alternative. At that point, the questions raised here would be fully explored.

If the upper portion of Muddy Creek is considered to be a waterbody (a separate "segment") that must be targeted for meeting water quality standards, this TMDL technical report will have to establish the steps necessary for meeting the appropriate nitrogen threshold. The narrative seems to indicate that the area that is being targeted for compliance is the lower portion of Muddy Creek. Assuming no dike (since that hasn't really been proposed by the town) we will either need additional analyses in this TMDL report, to establish what it would take to meet the nitrogen threshold in Upper Muddy Creek, or we have to indicate that the target area of the Muddy Creek "segment" is the Lower Muddy Creek area, such as was done in the Stage Harbor complex in which the target areas were in the upper reaches (the main part of Oyster Pond and Mill Pond), but not the very extreme upper end of the system (the very upper portion of Oyster Pond and Little Mill Pond). Therefore, we would not be trying to define compliance with water quality standards by reaching the nitrogen threshold at the very extreme upper ends of these embayments.

Additional analysis will need to be undertaken if the dike alternative is to be considered. Upper Muddy Creek would then become a freshwater system, most likely with a phosphorus target (not nitrogen). The issues of Muddy Creek targets were the basis for the additional modeling presented in Chapter IX. This indicated the difficulty in reaching high quality conditions in upper Muddy Creek and form the basis for the dike alternative. The specific water column nitrogen target for upper Muddy Creek is the same as presented for the lower. The modeling of loads only relates various scenarios to attain the desired level within embayment waters. Text has been added.

EDITORIAL COMMENTS/SUGGESTIONS

p. 5: What is "a. Monitoring"

Edit has been made to the bullet as suggested.

p. 16 last line: "effects" should be "affect"

Revised accordingly

p. 20 Figure lll-2: The ten year time-of-travel line should be a different color or dashed.

Figure III-2 has been revised in Final Report.

p. 24, 2nd paragraph:should the 53 watersheds be changed to 52? (also see pages 33, and 34)

Text has been revised as suggested.

p. 25,5th paragraph line 11: "This assessment…" needs to be defined. It could be taken to mean the present report, which seems not to be the case. Could be changed to "That assessment…"

Text has been clarified accordingly.

p. 32: Is water use based on meter readings or on the volume supplied by the utility?

Water use was parcel based.

3rd paragraph Is 0.71 the factor used to convert water use to wastewater volume?

The town collects metered readings on an annual basis and 0.71 is the factor used to convert water use to wastewater volume.

p. 34, 4th paragraph 2nd line and following: The sentence needs refinement.

Sentence has been clarified.

p. 36: (Table IV-3): The watershed ID #'s in the table do not match with Fig. IV-6.

Watershed ID numbers have been reconciled with Figure IV-6 and have been adjusted accordingly.

p. 44, 1st paragraph: In 1st sentence, "were determined" should be "was determined

Text has been adjusted as suggested

p 48, last paragraph: Lovers Lake should be Stillwater Cove.

Text has been revised to reflect "(creek between Stillwater Pond and Ryder Cove)"

p. 49, Figure IV-10: Title should include reference to locations for sediment cores used to estimate N flux.

The title did not reference benthic coring locations because the purpose of the figure was to present stream gaging locations, however, the title of the figure has been revised accordingly to satisfy comment.

p. 50, 1st paragraph: 1st sentence should read "…indicated are subject to attenuation."

Sentence revised accordingly.

p. 50, 5th paragraph first line: Might want to say "…and nitrogen flux…"

Sentence adjusted per suggestion.

p. 62, 2nd paragraph 2nd and 3rd lines: apostrophe needs to be moved to next "embayments".

Revised accordingly.

p. 64, 2nd paragraph: Last sentence, add an "r" to "thei"

Revised accordingly.

p. 66, Figure IV-15: Is a station missing or is one overlapping the other? (45 instead of 46 mentioned on p. 65)

Figure IV-15 has been revised to show 46 sediment sample locations.

p. 69, 2nd paragraph line 6: does <10% mean measured values varied at most by 10% from the mean? Needs to be clearer as to how the 10% is calculated.

The differences were less than 10%***.***

p. 122, 2nd paragraph 5th line: an extraneous "a" should be deleted.

Changed

p. 130, 7th sentence: change "keys" to "key".

Changed

p. 146, 2nd paragraph 1st sentence: Should tense be changed to present perfect? "…has been obtained…" for "….will be obtained…"?

Changed

p. 168, 1st paragraph: Should Figure VI-1 be VI-3? Figure VI-4 be VI-6?

Changed

p. 183, Table VI-14, forgot to delineate Muddy Creek as in other systems…just a formatting issue.

Changed

p. 188, 3rd paragraph "…oxygen depletion may occur only…) rather than "…oxygen depletion may only occur…".

Text revised as suggested.

p. 189, 1st paragraph, end of second line "affect" rather than "effect".

Test revised as suggested.

P 189: middle of 2nd paragraph: Would like copy of Taylor and Howes, 1994)

The complete reference is provided in Chapter X (References) of the report and as cited the paper was published in the Marine Ecology Progress Series, Vol. 108: 193-203, 1994.

P190: end of next to last line 5th paragraph: Should >4 mg/L be <4 mg/L?

Text has been corrected to <4 mg/L.

p. 203, ff, table VII-2: it would be helpful to repeat the title of the table on the 2nd and 3rd pages.

Table VII-2 adjusted as suggested.

p. 206, 5th paragraph lines 8 (end) 9 and 10: Incomplete sentence.

Edited accordingly.

p. 207, Figures Vll-11 through Vll-14: Need to add explanation of what % means.

Given that the eelgrass data is used primarily as presence/absence, we have left the maps as in the original report. However, we are always looking for was to clarify the presentation and will see what can be done in future reports.

Text was added as requested on the density/cover etc.

p. 208, Caption for Figure Vll-13 last line: "eelgrass" rather than "ell grass".

Caption revised accordingly.

p. 212: Table Vll-3: Add (density) under the words Eel Grass Coverage. (Also, should it be Eelgrass?).

Table has been adjusted to reflect suggestion and table pertains specifically to eelgrass only.

First bullet second line: "…periodic depletion of oxygen." Rather than "…oxygen depletion's" (N.B. should be no apostrophe in any case.)

Text revised accordingly.

Last paragraph, first line: Should be "the" for "he".

Correction made as noted.

p. 219, 1st paragraph, 8th line: Should be "these" for "this".

Text revised.

p. 220: isn't this Table VIII-1?
Table Vll-3 (?) Please indicate what --- in the table means.

Correct, it is Table VIII-1 and the --- means there is no data in that specific cell.

P. 222: 3rd paragraph end of second line "its" for "their"

Corrected

Line 6 "sufficiently" for "sufficient".

Corrected

Paragraph 5 line 3 "because " for "as"

Corrected

Last paragraph, 7th sentence: add "of" after "reflective"

Corrected

p. 223: 2nd paragraph 2nd and 3rd sentences are meant to be one?

Reads as intended.

p. 224: 1st paragraph: 5th sentence, change "support" to "supported" and last sentence, explain why Pleasant Bay boundary is 0.50 for Muddy Creek but 0.48 for Bassing Harbor.

Edit has been made in text. The inlet to Bassing Harbor is closer to ocean than is the inlet to Muddy Creek which receives water from Little Pleasant. In addition, the boundary conditions are established by samples from offshore stations.

Sulfur versus sulphur: is it always spelled consistently?

Global change will be made to entire document

MEP Response to Comments from the Town of Chatham, MA

Compiled Town of Chatham CAC/TAC:

Comments from Dr. Robert Duncanson

General

1. ***The report needs a well written, concise executive summary. The report is technical/scientific in nature, as a result an executive summary is critical for the benefit of the general public and press.***

Good Point. An Executive Summary was always planned and is now provided.

2. ***The report appears to have had multiple authors and no overall review, as a result there is significant overlap, redundant information, and lack of flow.***

The technical process invoked for the nutrient analysis dictates the flow of the document. This sequence for presentation of information was discussed and agreed upon by the DEP. Information is sometimes presented more than once (in some more abbreviated form) such that the reader need not constantly refer back to other sections of the report.

3. ***Needs glossary.***

Best attempts have been made to spell out acronyms the first time used. A glossary of acronyms may be considered in the future if the DEP believes it is worthwhile.

4. ***Section III, Watershed Delineations, and Section IV Watershed Nitrogen Loading should contain an explanation/discussion of the status of land areas outside of the mapped watersheds.***

Discussion of outside of project area watershed land-use is only done if there is a major source immediately adjacent and therefore would be considered in uncertainty evaluations.

5. ***Section V, Hydrodynamic Modeling should be considered for an appendix.***

The hydrodynamic modeling is an integral element of the overall nutrient analysis process and is therefore presented as its own section placed in the sequence that it is completed.

6. ***Section VI, Water Quality Modeling, needs figure showing the locations of the water quality monitoring stations. The station id's should be consistent with those on the figures in this section.***

7. ***Why is loading data presented using both kg/yr and kg/day in the document, rather than one consistent unit?***

Watershed nitrogen loads are typically delivered in kg/year whereas nitrogen loads from benthic flux are delivered in kg/day.

8. ***What is included in "watershed" loads is not clear throughout the document. In some places/tables runoff, fertilizer, atmospheric deposition and benthic flux are clearly stated as not included, in other places it is not clear.***

Table headings have been changed. However, in some cases the modeling used total watershed load (all land based load), total load (includes atmospheric deposition directly to bay and regeneration).

Specific

1. ***Page 1, last sentence: "Commonwealth of Massachusetts" vs "State of Massachusetts".***

Revised accordingly.

2. ***Page 3, TMDL should be spelled out on first usage. TMDL is not described/explained in general or in the context of this report.***

Revised accordingly.

3. ***Page 5, last bullet: "a. Monitoring" is unclear what this if for/referring to.***

Revised accordingly.

4. ***Page 7, last para., 3rd sentence: "... such as Chatham area ..." -missing word ?***

Revised accordingly.

5. ***Page 9, last para., 3rd sentence: seems the end of the sentence should reference sections Ill and IV.***

Revised accordingly.

6. ***Page 9, last para., 6th sentence: "... from Cape Cod Commission data that and offshore ..." -sentence is incomplete/missing words.***

Revised accordingly.

7. ***Page 10, last para.: last sentence talks about "First," -there is no following material, seems incomplete or redundant.***

Revised accordingly.

8. ***Page 14, last sentence: This report does not cover "all" of Chatham's embayment systems.***

Clarified per suggestion.

9. ***Page 15, 1st para. : number of an acronyms need defining or inclusion in glossary.***

To the best of our ability we have spelled out acronyms when first mentioned in the text. For future reports a glossary of acronyms may be considered.

10. ***Page 15, 2nd para.: "flow cell" needs definition/description.***

Flow cell is a common hydrologic term relative to modeling groundwater aquifers and is not defined additionally. The meaning of flow cell is clear given the context of its use.

11. ***Page 16, last line: poorly worded/confusing.***

Sentence has been clarified per suggestion.

12. ***Page 18, Figure III-1: watershed spelled wrong in legend. Little Mill Pond is shown as Mill Pond.***

Figure III-1 has been revised as suggested

13. ***Page 20, Figure III-2: why is sub-watershed #11 shown in Harwich, but no comparable sub-watersheds are shown for Chatham.***

Aggregation of watershed nitrogen loading has removed this subwatershed from the nitrogen loading analysis since it is completely contained within the watershed to Lower Muddy Creek.

14. ***Page 22, 1st line, should refer to Figure III-3 vs ll-2?***

Citation in text has been checked and is correct.

15. ***Page 25, section IV.l.2: the reference to only 266 parcels connected to sewer in the 5 embayment systems seems low. Figure IV-6 seems to indicate that the majority of sewer accounts (480) are located in target watersheds. Needs clarification.***

The text has been corrected. The correct number of parcels connected to the sewer within the study area is 266; a total of 338 parcels are connected to the sewer in the town. Within these 338 parcels are 480 sewer accounts.

16. ***Page 28, 2nd para.: The relationship shown in Figure IV-5 is refereed to as "... a fairly good linear relationship..." , it is a stretch to consider an R2 value of 0.55 as that good.***

Given the extensive number of variables inherent in the comparison between the pumping rates and precipitation without correction for impact of preceding years or other factors, the simple comparison and the resulting R2 is “fairly good”.

17. ***Page 28, 3rd para.: parcel count (5,690) is not consistent with that on page 25.***

Correction has been made in the report.

18. ***Page 28, Table IV-1: is unclear if the residential category in the table included only class code 101 or others as described in paragraph above (i.e. #101 to 112).***

The text has been clarified. Table IV-1 presents information on only single family residences (state class code 101).

19. ***Pages 28/32: the discussion on the determination of water use is not clear and does not clearly identify the values used in the nitrogen loading calculations. It is also unclear whether the n-loading calculations used actual water use data when available.***

Text has been clarified; wastewater estimates were determined from water use records for all parcels with such records. Discussion on p. 28/32 is for the 14% of the parcels within the study area that did not have water use records.

20. ***Page 34, 3rd para.: 2nd sentence is poorly worded.***

Text has been clarified.

21. ***Page 34, 4th para.: Why was data collected in 2002 in the freshwater ponds not used ?***

Although the 2002 PALS data became available during the course of the analysis, the authors had already decided to utilize a conservative 40% nitrogen attenuation in the ponds. The analysis presented on the 2001 PALS data is included as a confirmation of the use of the 40% attenuation rate. It was important to verify these rates for Chatham's ponds.

22. ***Page 34, 5th para.: Freshwater pond data has been collected by the Chatham Water Quality Laboratory, not citizen monitors. The listing of ponds from which data were collected in 2001 is incomplete. Why were only certain ponds included?***

Text has been corrected. Only ponds which have watersheds delineated are listed.

23. ***Page 36/37, Table IV-3: needs extensive review and correction. Watershed ID's are inconsistent with prior figures. Some columns/rows do not add correctly. Accompanying text needs to more clearly explain how values in table were arrived at, especially related to pond outflow and attenuation.***

Table has been simplified, Text added.

24. ***Figures IV-7: Why is a WWTF component shown for each watershed? Are these figures supposed to represent existing conditions, if so, why is a build-out component shown? How does the build-out component relate to the others, i.e. is the vast majority of build-out going to come from septic and thus raise the septic %?***

Table IV-3 and Figures IV-7 have been edited and clarified in the final report. In Figure 7d, the WWTF category is larger and shows up as a wedge with a percent share greater than zero. In all other Figures (7a,b,c,e) the WWTF category is present for consistency but is zero percent. Buildout is contained in one column to simplify presentation; wastewater continues to be generally 70-80% of the overall nitrogen load.

25. ***Page 43, Text and table IV-4: What is basis of statements that Lovers Lake "has full discharge through surface flow" ?***

Comparison between modeled groundwater discharge into the pond and measured flow out of the pond (discussed in Section IV.2.2) indicate that Lovers Lake discharges all outflow through to Stillwater Pond rather than discharging to groundwater.

26. ***Page 43, next to last sentence: incomplete.***

Corrected per suggestion.

27. ***Page 44, Build-out: Was the Chatham Water Resources Protection District taken into account in determining build-out ? This is unclear given that the Chatham WRPD is not shown on Figure IV-9. Was any consideration given to re-development, i.e. existing properties adding bedrooms? Next to last sentence: should it be "build-out" vs "existing"?***

Paragraph has been clarified. All municipal overlay districts with control over number of lots were considered in the development of the build-out scenario. Redevelopment was not included in the build-out assessment as it cannot be quantified at present.

28. ***Page 44: Section IV.2 seems out of sequence given previous discussion of freshwater ponds.***

The Section IV-2 (Attenuation of Nitrogen in Surface water Transport) is in proper sequence relative to Section IV-1 (Watershed Land Use Based Nitrogen Loading Analysis). Watershed land use generates an associated nitrogen load that travels to ponds, is subject to a certain level of attenuation, and then the attenuated load travels through streams to the embayment. No change is being made to the report.

29. ***Page 45: Single sentence is awkward.***

Checked

30. ***Page 47, Figure IV-9: Chatham Water Resource Protection District not shown.***

A revised figure IV-9 is now included.

31. ***Page 48: Paragraphs 1 and 2 are redundant.***

Paragraph 1 on page 48 generally presents how the input of nitrogen to the embayments from surrounding watersheds is determined and that previous studies indicated attenuation may be occurring. Paragraph 2 discusses the revisions of the watershed delineations.

32. ***Page 48, 4th para., 3rd sentence: The connection to Ryder's Cove is from Stillwater Pond not Lovers Lake.***

Revised accordingly.

33. ***Page 50, 1st para.: "... which previous studies...", these are not referenced. End of first sentence is poorly worded/wrong word.***

Revised accordingly.

34. ***Page 50, 3rd para.: Need explanation of why stream outflows "...may serve to decrease their attenuation of nitrogen, ".***

This potentially lower attenuation relates to potential effects on detention time and of the low of nitrogen in particulate form, rather than solely in dissolved form.

35. ***Page 51, 1st para.: How were the differences in precipitation between 2001 and 2002 taken into account when the flow measurements were used to prepare a "composite year" ?***

Since the streams and ponds are groundwater fed and since the concept is to determine general conditions, precipitation adjustment was not considered necessary in this case. In surface runoff dominated systems, precipitation is much more important to consider when conducting this type of analysis.

36. ***Page 51, 3rd para., last sentence: Word missing.***

Sentence reviewed and reads as intended.

37. ***Page 51, 4th para.: Reference is made to the Lovers Lake-Stillwater Pond connection as a "recent phenomenon". This statement is not supported by information provided by the Town, in fact USGS maps from 1943 show the connection between Lovers Lake-Stillwater Pond-Ryder's Cove, as well as the connection from Lovers Lake to Frost Fish Creek.***

The reference to the Lovers Lake-Stillwater Pond connection being a recent phenomenon was information that was provided to the MEP by the Town of Chatham. However, based on the new information provided, the text has been updated. Either way, the requirement to analyze nitrogen attenuation within the system (taking into consideration any cross connections) remains as discussed in the report.

38. ***Page 52, Figure IV-11: Is the straight line section shown between approx. 7/15 and 8/29 due to low flow conditions or instrument failure ?***

Straight line section due to instrument failure.

39. ***Page 53, Figure IV-12: Is the straight line section from approx. 8/29 to 11/10 due to instrument failure or other cause ? The figure legend doesn't match the figure title. Would be useful if the vertical scales for Figures IV-11 and IV-12 were the same for comparative purposes.***

Straight line section in plot due to an instrument failure. Figure legend is as intended. Presented scales are such that details in the trace can be revealed.

40. ***Page 55, TableIV-5: Data sources not correctly identified.***

Checked

41. ***Page 55, end of para./Table IV-6: Given the differences in the results obtained from the July 21,2002 tidal study, especially the significant difference in modeled vs measured tidal flux volumes, why was this data included in further calculations?***

Although the data and the model tidal flux volumes did not match for the July 21, 2002, there is no evidence that the measurements were incorrect. Therefore, all of the data was deemed to be accurate and included in the analysis.

42. ***Page 64, para. 2, last sentence: Misspelled word.***

Corrected.

43. ***Page 69, 1st para. : Poorly worded.***

Paragraph reads as intended.

44. ***Page 70, Figure IV-17: Some data points are obscured by notes. Is difficult to determine to which data points the notes are supposed to match. There are notes ("M-u") which do not appear significantly outside the range and are not discussed in the text. Conversely, there are other points that appear equally outside the range that are not noted.***

Corrected

45. ***Page 163, 3rd para., 2nd sentence; "is" vs "in".***

Checked

46. ***Page 164: The bottom text has several incomplete sentences.***

Checked

47. ***Page 165, last para. : The data used to determine the boundary conditions should be more fully explained, i.e. was surface and bottom data averaged, number of data points used, standard deviation, etc. What stations were used to set the boundary conditions for Bassing Harbor and Muddy Creek ?***

The Stations used for the boundary conditions are those outside of the inlet to the system in question. Both surface and bottom water values were included, as long as there did not appear to be stratification (nutrient) at the boundary sampling location.

48. ***Page 166/Table VI-3 and 4: Text describes a dispersion coefficient "D", tables have longitudinal dispersion coefficient "E", are these the same ?***

Yes, this will be corrected in the Final Report

49. ***Page 168 1st para.: How were the "annual means" of Water Watcher data calculated, time period, surface and bottom, etc ?***

Annual averages and overall averages have now been presented in a table. The data included in the averages has been processed for high and low outliers. The overall mean was used in the calibration and is based upon the average of all of the data over all of the years. This decision was based upon statistical

considerations of weighting and the purpose of the data. Note, other purposes would likely result in other types of averaging schemes.

50. ***Page 168, 1st para.: Wrong Figure references.***

New sentence “This is demonstrated in plots of results from Frost Fish Creek (Figure VI-3) and Oyster River (VI-6).”

51. ***Page 168, 2nd para. : The difficulties in, and possible reasons for, calibrating the model for the Bassing Harbor system should be more fully explained. This is especially important given Figure VI-4 which appears to show good agreement for some stations (Ryder's Cove inner, Frost Fish Creek outer and Bassing Harbor) but poor calibration for the other three stations.***

First, the Frost Fish Creek (out) station did not show good agreement when TN was used (perhaps you were referring to the Frost Fish Creek inner station which showed better agreement). There were a number of reasons for utilizing the “bio-active nitrogen” approach for these systems and this is discussed in more detail later in the report (Section VIII as indicated in this paragraph). To utilize the model as an effective management tool for evaluating alternatives, it is critical that the model and the measurements agree. For these systems, the modeling approach was modified to provide the most appropriate tool for future estuarine nitrogen management.

52. ***Page 171, Figure VI-6: Why does the Mitchell River station appear to show only 2 years of data? Same question for Cockle Cove Creek-mid on Figure VI-7.***

The Mitchell River Station was added after the ACRE/SMAST study in 2001, there is only 2 years of data. Cockle Cove, the symbol for the 3rd year was covered, but was in the mean (as can be seen by the placement of the mean relative to the 2 symbols that show). This display problem has been fixed.

53. ***Page 181, 2nd para., 3rd sentence: Sentence should reference "no load" rather than "buildout".***

Corrected in Final Report.

54. ***Page 188, 3rd para., 6th sentence: Extra word.***

Revised accordingly

55. ***Page 189, 1st para.: No source cited for Chesapeake Bay reference.***

The information presented can be found in the Chesapeake Report and can be obtained from the EPA and can also be found on the Internet

56. ***Page 190, 1st para. : In the discussion, and tables, related to DO and chlorophyll levels above/below certain benchmarks relative to deployment time it is not clear how this was determined. Is a single hit above/below the benchmark enough to "fail" an entire day or is some longer time needed, this should be clarified.***

When “duration” is stated it is the cumulative number of hours/days below the benchmark. When “# events” is stated it is number of excursions relative to the bench mark. For example, if a bloom occurs for 10 days going above 5 ug/L (sustained) and on day 3 (for 1 day) and on day 7 for (a fraction of a day) the level goes above 10 ug/L, the # events above 5 ug/L is 1 and the # events above 10 is 2.

57. ***Page 190, 4th para.: Missing word/phrase in 2nd sentence.***

Fourth paragraph reads as intended.

58. ***Page 190, 4th para.: In last sentence, the section in parenthesis appears to have the wrong greater than/less than sign.***

Correction made as suggested.

59. ***Figures Vll-1a through Vl-10: The red dots present in the traces are not explained.***

The red dots in the traces represent calibration samples. Captions to figures clarified.

60. ***Page 206, 5th para., 6th sentence: Incomplete.***

Sentence clarified in text.

61. ***Page 208/209, Figure Vll-13/Vll-14: Spelling error in caption.***

Corrected as suggested.

62. ***Page 210, Figure Vll-15: Figure does not include Bassing Harbor as shown in title.***

Figure VII-15 is not intended to depict Bassing Harbor. A comparative statement is being presented and Bassing Harbor is depicted in Figure VII-16

63. ***Page 214, section Vll.4, 3rd sentence: Incorrect figure reference.***

Corrected in text to Figure VII-17

64. ***Page 214, last para.: Wrong word. The Eveness (E) and Weiner Diversity (H) used here and in Table Vll-6 needs explanation. What is range of possible values ?***

Text indicates good and bad values

65. ***Page 217, Table Vll-5: Column headings need reformatting. Why are results for Little Mill Pond only listed as "abundant". Some final classifications do not appear consistent with data presented in table, i.e. Little Mill Pond appears to be split between intermediate/stressed and yet is coded as "stressed", similar situation for Frost Fish Creek. Taylors Pond has only healthy and intermediate indicators and yet is coded as "stressed". These need further explanation/clarification. Why is Muddy Creek omitted from Table VII-5?***

Because of the very small individuals and the very high counts. This does not affect the assessment. Little Mill Pond is denoted as “stressed” because there are only 2 species present! Frost Fish and Taylors Pond have only 5 and 6 species, respectively. These values are compared to the >20 species found in the healthier embayments. Muddy Creek data is in table VII-6.

66. ***Page 218, Table Vll-6: Explain difference in numbers (total actual species/individuals) with Table Vll-5.***

Text added.

67. ***Page 222, 3rd para., 5th sentence: Spelling.***

Spell check completed on document.

68. ***Page 223, 1st para., 2nd sentence: Incomplete/poorly worded sentence.***

Corrected per suggestion.

69. ***Page 224, Section VIII-3: Why were only septic effluent loads reduced to reach threshold levels? What is impact of removing fertilizer, and/or runoff, loadings on meeting threshold levels?***

Both exercises were conducted and presented. The reason for the focus on septic inputs was the predominance of this source relative the Chatham's embayments. But all reductions should be considered in developing alternatives.

70. ***Page 225/226, Tables VIII-1 to VIII-4: Why do the threshold loads change with the addition of fertilizer and runoff ?***

They did not, the tables have been clarified for the reader.

71. ***Page 228, Figures VIII-2, etc: Captions should be on same page as figure.***

Pagination adjusted in final report such that captions exist on same page as figure.

72. ***Page 229, Figure VIII-2 caption: No Figure VII-25 as referenced. Page 230, Figure VIII-4 caption: No Figure VII-29 as referenced. Page 231, Figure VIII-6 caption: No Figure VII-34 as referenced. Page 231, Figure VIII-8 caption: No Figure VII-15 as referenced. Page 232, Figure VIII-10 caption: No Figure VII-20 as referenced.***

Pagination and references to figures have been checked and corrected where necessary.

73. ***Pages 240/241, Tables IX-1/IX-2: These tables are difficult to follow and sometimes appear to be at odds with the text.***

Checked

74. ***Reference list appears incomplete and documents are not properly cited in the text.***

Checked

Comments from Mr. Nathan Weeks, P.E. (Stearns and Wheler)

1. ***The report is a detailed evaluation and we will need to work with the data to provide a complete review. The report appears to be thorough and comprehensive in its approach and reporting.***

2. ***The report is unclear which agency commissioned it and how the findings of the report will be used by the State in the future.***

An explanation is offered in paragraphs 3 and 4 of page 3 in Section 1 (Introduction).

3. ***The contributing area to Harwich's "Muddy Creek Well" is identified. Why aren't similar areas identified for Chatham's wells?***

Aggregation of watershed nitrogen loading has removed this subwatershed from the nitrogen loading analysis since it is completely contained within the watershed to Lower Muddy Creek.

4. ***It is unclear how the median residential water use was used to calculate nitrogen loadings (page 32). Did the Project calculate wastewater flows associated with the septic loadings? Did the Project use actual water consumption at the properties (times the 0.71 factor) to calculate wastewater flows and the resulting nitrogen loading?***

Median residential water use was not used to calculate nitrogen loading except for the 13% of parcels in the study area without metered water use; the discussion on p. 32 is presented to support using the median rather than any other assumption. Wastewater flows were determined from water use by multiplying by 0.71, the basis for which is presented in a discussion on pp. 25-28.

5. ***The watershed identification numbers (Shed ID#) of Table IV-3 are mislabeled.***

Corrected as suggested.

6. ***Large assumptions are made on the benthic flux loadings for future, as well as alternative scenarios. What is the basis to the assumptions? Is it appropriate to base the model output on such a small number of benthic flux analysis? The benthic flux loading terms are typically very large and tend to overwhelm the more detailed (lot by lot analysis) work performed as part of the land use analysis. How confident is the Project team that these assumptions are valid?***

The benthic regeneration terms are an important component of the summer nitrogen balance of this system. More data is always helpful, but the coverage of benthic regeneration data for the 5 systems in Chatham is considered extensive for thresholds analysis. All higher level TMDL models consider benthic regeneration, failure to do so results in large errors in the resultant conclusions.

7. ***Table 7-1 presents a threshold load for the septic component while Table7-3 presents a threshold load for the sum or septic, runoff, and fertilizer. The runoff and fertilizer components in the threshold loads of Table 7-3 appear to be the existing loads of those components. Can the runoff, and fertilizer loads be targeted for remediation?***

Yes.

8. ***Why is the threshold load for Cockle Cove Creek set at the present load? Was nitrogen attenuation observed in the Cockle Cove Creek watershed? Wouldn't it be expected in that wetland system?***

The threshold was set for the sentinel system, Sulphur Springs.

9. ***Presentation of the loadings is broken up between several tables that make data review more difficult. Could the data be summarized more consistently on fewer tables?***

The loadings in the different tables represent different composite loadings. One table has the analysis based upon septic loads, while another conducts the analysis based upon total loads (all sources).

10. ***The findings of Chapter 9 are not clearly presented for the Muddy Creek alternatives.***

- ***The heading on Table 9-2 indicates that the table is a summary of "total N concentrations"; but the units of "kg/day" are listed.***
- ***If Table 9-2 is a summary of concentrations, then item "h" is showing little improvement for Alternative No.2, while Figure 9-9 shows great improvement for that alternative. It appears to be inconsistent***

Final Report revised accordingly. g) should be Alt2, h) should be Alt3, and i) should be Alt4.

- ***Figures 9-9 (Alt. 2) and 9-10 (threshold model results) indicate that Alternative No.2 could provide nearly threshold limit results, but this finding is not clearly stated or recommended.***

The purpose of this report is to show examples of nitrogen management strategies and what affect these strategies would have on an embayment. The MEP does not recommend strategies.

11. ***An Executive Summary is needed to summarize the Project's main findings including:***

- ***Overview of Project methodology;***
- ***New watershed delineations;***
- ***Target loading limits;***
- ***Nitrogen loading that must be mitigated (removed) to meet the limits; and***
- ***Percentage of existing septic loads that need to be removed to meet the limits***

An Executive Summary was always planned and has now been included.

Comments from Mr. Fred Jensen, Chairman, Citizens Advisory Committee (CAC)

To: Bob Duncanson

From: In a letter from Fred Jensen

Regarding: The “MA Estuaries Project Linked Watershed-Embayment Model to ...Chatham, MA ", June 2003.

Bob:
Thanks for providing the CAC members with a copy of the subject report prior to the MEP presentation last week. Overall, I think this report was worth waiting for and that Chatham has received the benefit of a great deal of important work done for Chatham by the MEP project team (at little cost to Chatham).

Here are some comments regarding the report; I've listed them by page number.

Pg 3 TMDL is not explained

TMDL discussion has been expanded and clarified in text.

Pg 26 Fig IV ..1 Similar colors for Public Service and Industrial sites make it difficult to determine where these sites are.

Color scheme has been adjusted

Pg 36 Table IV -3 Watershed assignments are perplexing. Why are watersheds #47 & #48, which are near Crows Pond, shown as nitrogen sources for Taylors Pond? This must be explained or changed.

Watershed numbering and nitrogen loading figures and tables have been clarified.

Pg 68 The reasons for choosing a particle residence time of 8 days vs 4 days are not very clear.

The particle residence times were based upon the tidal velocities and observed sediment types at the sites.

Pg 175 Table VI-5; The Table heading reads "these loads do not include atmospheric deposition and benthic flux loading terms" but the text above Table VI-5 states that atmospheric deposition is included in Table VI.5.

The atmospheric deposition refers to the direct deposition to the embayment surface. This is not in these numbers. Atmospheric deposition to the watershed (land surface) is included.

Pg 224 Section VIII-3; it would help the reader if the current nitrogen concentrations and the target nitrogen concentrations (used to determine threshold loads) for each sub-embayment were shown in a Table similar to Table VIII-5 and Table VI-6. Perhaps they could be added to these tables?

Addressed above.

Section VIII should include a discussion of the likely range of error that exists in the estimates of the nitrogen loading that must be removed in order to achieve the target nitrogen concentrations. In particular, the reader should be told whether these point estimates are more likely to err on the high side or on the low side.

The estimates of loading from the watershed are not underestimates, but target the "actual" loads. Any small errors will tend to overestimate loads.

Comments from Mr. Phil Christophe

To: Bob Duncanson

From: In a letter from Phil Christophe

Regarding: The “MA Estuaries Project Linked Watershed-Embayment Model to ...Chatham, MA ", June 2003.

Dear Bob:

In reviewing the Massachusetts Estuaries Project Final Draft for Chatham I have great difficulty in understanding the rational for the Nitrogen Load Summary Table IV-3 found on pages 36 and 37. The basis for the distribution of nitrogen by System is I believe the watersheds which are identified in that Table. I cannot understand the linkage of watersheds to the Systems. For instance, Oyster Pond has Shed #s 26, 27, 28 and 29, none of which are contiguous to System 33 (Oyster Pond), although #28 is a downstream source. Or in the case of Sulfur Springs the Shed #s are 49 and 50 which are in the Ryder Cove area and Bassing Harbor areas, not #26 which is where Sulfur Springs is located. Or Crows Pond #46 which is shown with watersheds #37 and 38 which are located in upper Stage Harbor and Mill Pond.

Watershed numbering and nitrogen loading figures and tables have been clarified.

Comments from Mr. H. Bernard

To: Bob Duncanson

From: In a letter from H. Bernard

Regarding : MEP Town of Chatham Embayments Threshold Report

Because of the technical nature of the report and its use of and/or validation of a great deal of material I have no critical comments. It should be very helpful in gaining general acceptance of the need for action now.

However it does not address all of our concerns and diverse interests. Chatham Harbor north and south of "the break" are not part of the State's study, but a substantial area and number of homes are in watersheds outside of those numbered on pages 20 and 35. These include Main St. from the lighthouse to Shore Rd. , Shore Rd. to Old Harbor Rd., Much of Old Harbor Rd. Little Beach Rd. and others. The old village could be a particular problem because of its proximity to Little Mill Pond and Main Street's watershed into Chatham Harbor. What are its health considerations? Little beach? Title 5 adequate?

To what extent will the state be involved in what Chatham does where? Sewering? On site systems? Title V only? Health Department regulations? Is the State likely to push for estuary improvements over needs or desires of Chatham voters?

This report is intended as a technical evaluation of the embayment systems that will serve as the basis for development of TMDLs and to assist the Town in developing an integrated water resource management plan. Both these processes will allow for public participation and active, cooperative interaction between the Town of Chatham and the DEP.

Comments from Mr. John V. Payson

To: Bob Duncanson

From: In a letter from John V. Payson

Regarding : MEP Town of Chatham Embayments Threshold Report

There has been insufficient time to review the MEP Report In depth, but I ask that you pass on to the MEP these comments and questions that immediately come to light:

(1) In 1997, (Appendix H of the NAR), the WWTF reported an annual flow of 41.0625 million gallons (not Including 1.059 million gallons of grease and septage) and a nitrogen load of 1935 pounds from an effluent of 42.159 million gallons with a nitrogen concentration of 5.5 mg/L. The 1997 Town Report said this was collected from 433 service connections. Section IV.1.2 of the MEP Report states that the annual influent flow at the WWTF for 2001 was 38.46 million gallons and that the total nitrogen effluent concentration was 7.44 mg/L, resulting in a nitrogen load of 2435 pounds (Table IV-3) to the Cockle Cove sub-embayment. The 7.44 mg/L equates to an effluent flow of 39.219 million gallons. The 2001 Annual Town Report stated that 39.226 million gallons of wastewater (not Including .832 million gallons of grease and septage) was collected from 410 property connected to sewer.

All WWTF flow and performance information was obtained from the Town; this data includes five years worth of monthly flow and average nitrogen concentrations.

Section IV.1.2 states that only 286 parcels with water use data In the study area were connected to the WWTF. All 410 parcels said to be connected to sewer were located in the study area. Does this mean that metered water use data was not available for 144 parcels? What was the total amount of water billed to the 410 parcels referred to in the 2001 Annual Town Report? What was the total amount of water billed to the 286 parcels referred in Section IV.1.2?

The correct number of sewered parcels in the study area is 266; within these parcels 480 sewer accounts exist. The text has been corrected.

(2) The 2001 Annual Town Report advised that, at the end of 2001, the Water Department was providing water to 6176 service connections and that the total water billed was 367,279,968 gallons. Of these 6175 service connectlons, how many of these supplied water to parcels in the study area not on sewer? To how' many unsewered parcels did these service connections provide water? What was the total amount of water billed to all unsewered parcels in the study area?

The Town provided MEP staff with 10 years worth of monthly pumping records. According to this data, total pumping in 2001 was 432.78 million gallons. Within the study area, nearly 5,000 parcels are connected to town water and 771 are not (see p. 28). As stated above, 466 parcels are connected to the WWTF. Total water used by parcels in the study area was determined on a subwatershed basis and was not aggregated.

(3) Section IV.1.2 advises that 771 parcels within the study area did not have water supply accounts. Does this mean that these were developed parcels dependent upon private wells for potable water? Did this include any parcels in the Harwich area? What was the total amount of private well water estimated and how much of that was attributed to the parcels In the Chatham portion of the study area?

All 771 parcels without metered water use are developed parcels. Total water used by parcels in the study area was determined on a subwatershed basis and was not aggregated.

(4) In Table IV-1, what was the source of the data used to derive Average and Median water use per parcel in gallons per day? Was It based on unsewered parcels only? Did this source include Harwich parcels?

Data is from metered water use, both sewered and unsewered, and includes only parcels in Chatham.

(5) I understand that each of the parcels in the study area was coded to show attribution to one or, proportionately in some cases, to other individual sub-embayments. In Tables VIII-1 and VIII-2 what specific procedure was used to calculate these nitrogen loads for each sub-embayment? How was the Wastewater Factor of .71 factored in?

Development of nitrogen loads is described in Section IV.

(6) What was the total number of developed parcels In the study area? How many of these were located in Harwich?

Information is in the electronic data files that are available through DEP.

During his presentation, Brian Howes alluded to the fact that Appendices to the Report were not included In the printed version. I am sure that significant cost considerations would be involved to do so. As an alternative, I would like to obtain a copy of the diskettes, Zip disk or CD containing these Appendices.

Land use data sets will be provided electronically as agreed upon by the DEP and MEP Technical Team and will be available through the DEP. All other summary tables (some additional tables or with data additions) are in the Final Report. DEP can be contacted for data requests for the electronic based data.

Comments from Mr. Paul R. Kelley, Member, Chatham Board of Health

To: Bob Duncanson

From: In a letter from Paul R. Kelley

Regarding : MEP Town of Chatham Embayments Threshold Report

Thank you for the hard work leading to the preparation of the final draft document entitled, "Linked Watershed-Embayment Model to Determine Nitrogen Loading Thresholds for Stage Harbor, Sulphur Springs, Taylors Pond, Bassing Harbor, and Muddy Creek, Chatham Massachusetts" and the excellent presentation at the Chatham High School auditorium. I have been following the details of this project since its inception, stressing the need for accurate wastewater volume calculations along with the use of best practices to process the data in order to arrive at total maximum daily loads for all of Chatham's bays and estuaries. I am comfortable with the processes used to arrive at the thresholds for the five embayments. I hope we will soon have nitrogen thresholds calculated for Pleasant Bay, Chatham Harbor, and accurate background nitrogen concentrations for the Atlantic Ocean waters feeding Pleasant Bay.

However, I was disappointed that the database used to arrive at the total nitrogen load for the five estuaries was not included in the final draft. I was unable to find the detailed water use data used to arrive at nitrogen load. I understand from Dr. Howes' presentation that the data is in Appendices that were not included with the draft provided to me, other members of the BoH, CAC and selectman. I believe the information should have been provided. Certainly, it needs to be included in the final report. The data is very important to the Board of Health and the Comprehensive Long Range Planning Committee. I sit on both boards.

Analysis of Tables VIII-1 and VIII-2 in the final draft indicates a total yearly nitrogen load from septic for Chatham to be 42,705 Kg or 93, 951 pounds. After adjusting for nitrogen removed by sewer treatment and that contributed by Harwich (16%), the nitrogen generated in the study area is about 88,552 pounds. Using the estimate that each person produces 5.86 pounds of nitrogen yearly, the yearly population contributing the nitrogen to the five embayments studied calculates to be 15,111 people. The study area represents about 85% of the town. Assuming similar loads in the non-study areas, the population for the town in 2001 contributing nitrogen load is 17,771 people.

The Comprehensive Long Range Planning Committee desires that the Town of Chatham use water consumption as a means of monitoring property use and population demographics. When the Chatham

Comprehensive Long Range Planning Committee used billed water from the Town's 2001 Annual Report of 367 million gallons plus 47 million gallons from wells after correcting for 10% irrigation loss, we estimated the 2001 population contributing nitrogen at 18,418 people. (See Town Meeting approved Comprehensive Long Range Plan). The number is remarkably close to the 17,771 populations estimated from your data. However, we used 10%, not 30%, to correct for irrigation. I have discussed this with Richard Batchelder, Chairman of The Comprehensive Planning Committee, and we both hope that the data demonstrating how you arrived at the nitrogen loading estimates using Town water will be made available to the Town and our committee. It will help the Town significantly as it uses water consumption to follow Town demographics and estimates population sustainability goals. We view the calculation of population sustainability goals as a prerequisite to finalizing and implementing a comprehensive wastewater plan.

As mentioned in previous comments, data used in the nitrogen loading analysis was largely supplied by the Town (e.g., land use, WWTF performance, water use measurements, etc). The organization of the data into nitrogen loading spreadsheets will be provided to the town upon the release of the final report.

Note the consumptive loss (irrigation in your terms) was calculated for the specific year based upon the pumping and drought analysis described in the text. The calculation that 71% of the pumping contributes to wastewater flow, leaves 29% of which 18% is irrigation and 10% is consumptive use. Note: that the 71% figure was derived empirically from the pumping rates (corrected for the sewered houses) versus the return flow to the WWTF.

Comments from Mr. Michael D. Giggey, P.E., Wright-Pierce

To: Bob Duncanson

From: In a letter from Mr. Michael D. Giggey, P.E.

Regarding : MEP Town of Chatham Embayments Threshold Report

Here are my initial comments on the Howes report. There is certainly a great deal of information compiled in this report and it is quite well done. I have focused my attention on Sections IV, VIII and IX. There are many areas where additional information would be very helpful, and once provided will probably result in more specific comments. Call if you have any questions on my comments.

1. Section IV, Page 25 to 32. The reconciliation of 2001 water use with WWTF flows seems to indicate that the drought conditions of that year led to an abnormally high percentage of consumptive use. Have the flow meters at the WWTF been calibrated recently? Is there any indication of exfiltration in the sewer system? If the 71% figure for 2001 is an anomaly, is the entry in Table IV-2 appropriate, which implies that the 71% figure was used in the model calibration?

Although evaluation of the WWTF function is beyond the scope of the MEP analysis, annual influent flows to the WWTF varied within a 10% range over the five years reviewed (p. 25). This would seem to indicate that any infiltration or exfilitration in the sewer system has not changed significantly. Given that the nitrogen loads are based on 2001 water use and given the observed differences in the sewered area and the drinking water pumping analysis (Figure IV-5), the use of the 71% factor is appropriate and necessary for accurate model calibration.

2. Section IV , Page 32. The description of the analysis of water use and wastewater flow is confusing, especially with respect to seasonality. There seems to be some confusion in the calculations or description between water use and wastewater flow. It is not clear if this information is consistent with the fairly detailed evaluation conducted by Steams & Wheler in its 1999 report.

The text in this section has been clarified. Water use of each individual parcel is the basis for all wastewater estimates (wateruse times 0.71). Since water use from individual parcels includes parcels used on both a seasonal and year-round basis, seasonality is included in the analysis, but not explicitly broken out. This information should be fairly consistent with Stearns and Wheler's water use approach except that a more refined effort has been made to quantify the wastewater component of water use rather than using a standard 10% consumptive loss.

3. Section IV, Page 32 to 33. The results of the lawn fertilization study in Falmouth, Mashpee and Bourne are interesting. The report implies that it was assumed that professional lawn care occurs only on public grass areas. Might the frequency of professional lawn care services be different in Chatham, and shouldn't some fraction of residential lawns be assumed to be subject to the higher loading?

The professional lawn care applications are already incorporated into the factors.

4. Section IV, Page 33. Table IV-2 includes a figure of 26.5 inches per year for natural area recharge. This figure is considerably higher than the 16 to 18 inch-per-year figure commonly used. What is the basis for this choice?

The recharge rate included in Table IV-2 is consistent with the newly refined groundwater modeling completed by the USGS for this section of the Monomoy Lens.

5. Section IV, Page 36 and 37. Table IV-3 is a convenient summary of a great deal of important data. It would be helpful if totals could be shown for all of the significant columns. In that both Chatham and Harwich land is involved, it would be helpful if subtotals were shown for the two towns for the important columns, such as septic effluent loads and total loads under current and build-out conditions. Although not pertinent to the embayments in question, it would also be useful to know the Chatham load that impacts Harwich embayments. Given the report's emphasis on natural nitrogen attenuation, it would also be helpful if the estimated attenuation could be quantified in annual kg, both by specific watershed and in total.

Table IV-3 and Figures IV-7 have been edited and clarified in the final report. Build-out is contained in one column to simplify presentation; wastewater continues to be generally 70-80% of the overall nitrogen load. Once the nitrogen loading spreadsheets are provided to the town upon the release of the final report, further analysis of interest to the Town can be provided.

6. Section IV , Page 36 through 42. Table IV -3 and the associated Figures IV -7 portray the increased nitrogen load expected through build-out. It appears that the added nitrogen load ranges from 4% to 32% of the current year load, depending on the watershed, with an overall average of perhaps 11% or 12%. This added load through build-out is significantly less than was estimated in the 1999 Steams & Wheler work. which has about 50% based on 1997 loads. The basis for the build-out estimates should be better documented, and an explanation provided as to the significant change from one report to the next.

The derivation of estimates for additional buildings is described on p. 44. To reiterate, MEP staff reviewed existing assessors classifications, identified parcels that could be divided into separate parcels based on minimum lot size specifications contained in zoning and various overlay districts, and developed nitrogen loads based on factors associated with existing development.

Although a refined comparison would require extensive work because of the differences in watershed areas, the likely cause of the lower percentages in the MEP analysis is the lower loads caused by the consideration of nitrogen attenuation in freshwater ponds (-40%), the higher fertilizer nitrogen loads assumed by S&W, and the greater buildout wastewater flows assumed by S&W. The S&W method for determining additional lots appears to be similar to the MEP assessment, but the S&W buildout included an assumption increasing the number of bedrooms in town from 18,212 to 26,674 (+46%). Dividing the difference by three and multiplying this by flow from an average single family residence (154 gpd) results in an additional wastewater flow of over 400,000. When this is combined with the S&W higher fertilizer load and the MEP pond attenuation, the overall S&W loads at buildout tend to be much higher than the MEP assessment. This in turn results in greater percentage increases between existing and buildout in the S&W estimates.

7. Section VI, Pages 175 and 181 and Section Vlll, Pages 224 through 227. The text in Section VI describes the process used to select the benthic loads for build-out conditions as a simple percentage increase over current-year estimates. This approach seems reasonable. In Section Vlll, there is little or no description of how the benthic loads were estimated for threshold conditions. In some watersheds, the benthic load is the major load, and the selection of the specific benthic load estimate does not seem to follow any obvious pattern with respect to watershed loads.

It is done the same way.

8. Section VIII. While the depiction of the 10-yr-travel-time sub-watersheds is useful, it would also be helpful if more details were given about the specific areas with very short travel time, so that remediation efforts might be focused there.

The 10 yr time of travel time areas were determined as a model check only. Additional land-use analysis might be conducted as part of Chatham's next step, alternatives development.

9. Section VIII. During Dr. Howes' presentation on 19 June, comments were made about the time needed for the ecosystems to rebound to the predicted healthier status. Such information should be included in the report. It was unclear if the predicted 3- to 5-year period is from the completion of the load reducing measures. or from the reduction of water column nitrogen concentration to the predicted levels.

The 3-5 year numbers were based upon general recovery observations and were given in the presentation to indicate that observable ecosystem recovery is rapid relative to the general amount of time it takes to get a recovery program designed and implemented.

10. Section VIII. The figure captions are confusing (this may be simply a pagination issue).

Figure captions relative to pagination have been shifted accordingly.

11. Section VIII. Are the threshold scenarios based on closure of the breach of Nauset Beach?

No, the scenarios are based on existing hydrodynamic conditions, since these are the conditions utilized for water quality model calibration. For planning purposes, it is realistic to use the timeframe of the Town's Needs Assessment Report (20 years) as a guideline. The periodic breaching of Nauset Beach occurs on the order of every 100 to 150 years; therefore, it will take approximately 100 years for the system to return to its pre-1987 form.

12. Section VIII. The report documents the very substantial amount of data and analysis that have gone into this report. It would be very helpful if the report contained some indication of the confidence intervals for the predicted threshold loads. For example, for Mitchell River, the threshold watershed septic load is 2.66 kg/day. Given all the assumptions that went into the calculation of this figure. is it reasonable to assume that the "true" value lies between say 2.4 and 2.9 kg/day (plus or minus 10%)? Or say 1.3 to 4.0 kg/day (plus or minus 50%)? Further, if other load reduction

scenarios were modeled. as noted on Page 225, is it likely or unlikely that a smaller required load reduction will be predicted?

There are a variety of loads ("threshold" loads) to meet the nitrogen targets which will produce high quality habitat within the embayment. The values are the best estimate. Variability estimates are now in tables.

13. Section Vlll. The percentage reductions in watershed loads are based on current, not build-out. conditions. It would be helpful to Town boards if this approach could be emphasized, with a note that the required load reduction is even higher if new nitrogen loads are allowed to occur as mitigation plans are developed and implemented.

It is correct that the example presented represents one distribution of reduction in present loads. Therefore additional nitrogen loading to the watershed over present loading rates would also have to be removed (i.e. remove the necessary fraction of the present load plus an amount equivalent to the future load after corrections for attenuation etc.)

14. Section IX. Given the emphasis on natural attenuation, it would helpful if the report noted the specific areas where this approach could be effective in addition to Muddy Creek and Frost Fish Creek; see Comment 5 concerning a specific tabulation in Table IV -3 for this factor. While there evidence of a significant nitrogen removal capacity in fresh water resources, the report should also address the potential for phosphorus enrichment.

This is part of the coming MEP and TMDL work with the Town.