**Summary Minutes**
**U.S. Environmental Protection Agency**
**Science Advisory Board**
**Lake Erie Phosphorus Objectives Review Panel**
**Public Meeting**

**Date and Time:** Wednesday, December 10, 2014, 8:00 a.m. – 4:30 p.m. (Central Time)

**Location:** Ralph H. Metcalfe Federal Building, Lake Michigan Room (12th floor), 77 West Jackson Boulevard, Chicago, IL 60603

**Purpose:** To receive overview briefings from invited experts from Canada and develop responses to charge questions on the ensemble modeling approach the EPA is using to develop preliminary bi-national phosphorous objectives and loading targets for the nearshore and offshore waters to achieve the Lake Ecosystem Objectives for Lake Erie.

**Attendees:**

Lake Erie Phosphorus Objectives Review Panel (See Panel Roster[1])

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| Members: | Dr. Schlesinger, Chair | Dr. Heath |
| | Dr. Alber | Dr. Johnson |
| | Dr. Ammerman | Dr. Klump |
| | Dr. Bartell (via teleconference) | Dr. La Point |
| | Dr. Carrick | Dr. McLaughlin |
| | Dr. Chen | Dr. Reckhow |
| | Dr. Connolly | Dr. Reddy |
| | Dr. Di Guilio | Dr. Rosi-Marshall |
| | Dr. Diaz | Dr. Smith |
| | Mr. Endicott | Dr. Stubblefield |
| | Mr. Fitzpatrick | Dr. Valett |

SAB Staff Office: Mr. Thomas Carpenter, Designated Federal Officer
Mr. Christopher Zarba, Director,

Others Present: Members of the public attending meeting are listed in Attachment A

**Meeting Materials:** All meeting materials are available on the SAB Web site at the Lake Erie Eutrophication Indicators - Ensemble Modeling Approach web page at: http://yosemite.epa.gov/sab/sabproduct.nsf/a84bfee16cc358ad85256ccd006b0b4b/574c02ee59d8aacc85257d81007834eb!OpenDocument&Date=2014-12-10

**Convene Meeting**

The meeting was announced in the Federal Register[2] and proceeded according to the meeting agenda, as revised. Mr. Thomas Carpenter, Designated Federal Officer (DFO) for the Lake Erie Phosphorus Objectives Review Panel, hereafter referred to as the Panel, convened the meeting at

8:00 a.m. on December 10, 2014. He stated that the EPA Science Advisory Board (SAB) was a chartered federal advisory committee and reviewed Federal Advisory Committee Act (FACA) requirements. He stated that the members of this this Panel are in compliance with Federal ethics requirements and noted that the SAB Staff Office has determined[3] that there are no issues with conflict of interest or appearance of a loss of impartiality for any of the panel members.

He stated that this Panel will be providing early advice, through the SAB, on the appropriateness of modeling approaches to meet the Great Lakes Water Quality Agreement Lake Ecosystem Objectives. The Panel is conducting a consultation to provide expert advice on the technical questions before EPA begins substantive work on the ensemble modeling approach. The SAB Staff Office convened a panel that includes members of the Ecological Processes and Effects Committee and subject matter experts to review the development of preliminary phosphorus objectives. This Panel will develop responses to the Charge[4] for this consultation. Mr. Carpenter stated that as DFO, he would be present during the Panel's meetings and deliberations. He stated that summary minutes of the meeting would be prepared and certified as accurate by the Chair.

**Welcoming Remarks**

Mr. Christopher Zarba, Director of the EPA SAB Staff Office, welcomed the Panel members and thanked them for providing advice to EPA on the agency's ensemble modeling draft technical approach.[5]

**Introduction of Members, Purpose of Meeting, and Review of the Agenda**

Dr. William Schlesinger, Chair of the Panel, provided introductory remarks.

Dr. Schlesinger welcomed the panel and members of the public participating in the meeting. He stated that the meeting was convened to respond to the charge provided to the SAB and to consider the data and information that would support approaches to develop phosphorus objectives for Lake Erie. Dr. Schlesinger reviewed the meeting agenda[6] and provided an overview of how the Panel would conduct their deliberations to provide advice in response to the charge questions. He noted that the purpose of this consultation is to provide early advice to the EPA and the SAB anticipates that the Agency will return for an advisory or peer review when they have developed the models and preliminary phosphorus objective. After the panel discussions, a short report would be distributed among panel members for further discussion with the goal of reaching consensus on the recommendations and advice.

Dr. Schlesinger noted that EPA would provide introductory remarks to the Panel and would be available throughout the meeting for clarifying questions as they arose. He also acknowledged the five technical experts on research efforts in Lake Erie that would provide the morning briefings and be available for questions throughout the day. One member of the public requested to provide oral comments for the Panel's consideration. After which, lead discussants and the Panel members would deliberate responses to the Charge questions and discuss their comments. Members of the public were invited to register to provide brief oral comments at the end of the day on the issues raised during the Panel's discussions on responses to the charge questions. Dr. Schlesinger asked panel members if they had any clarifying questions, hearing none he proceeded to the agenda and introduced the Agency staff for presentations.

**EPA Presentation**

Tinka Hyde, Director of the EPA Region 5 Water Division, welcomed the Panel and presented information on the agency's plan to develop preliminary phosphorus objectives for the lake.[7]

She provided information on nuisance algal blooms in Lake Erie, efforts under the Great Lakes Water Quality Agreement (GLWQA), the changing water quality dynamics in the Great Lakes, and a timeline for the project. The most recent GLWQA addresses phosphorus loads and concentration reductions as one factor to maintain water quality in Lake Erie.

This effort will replace the binational nutrient management strategy that was released in 2011 and build on the International Joint Commission Lake Erie report. The agency is using an ensemble modeling approach with existing models developed and calibrated for Lake Erie. Multiple models are being run to look at water quality indicators. The EPA, National Oceanic and Atmospheric Administration (NOAA), and Environment Canada are working together to assess the capabilities of existing models. Following the assessment step the modeling team determined which models could be used.

Members noted the schedule seems to have limited time to incorporate comments from the SAB. The agencies acknowledged the schedule is tight but that they are looking for ways to incorporate comments from the SAB but may not have time to add more models to the ensemble that were identified with the assistance of Great Lake scientists. If there are different models that could be used it may be difficult to add these in the near term but EPA may be able to address model changes in longer term GLWQA initiatives.

Members commented on how the models were going to be combined in the ensemble approach. A skill assessment could be used to look at model assessments that predict the same thing. How do you combine models? The agency noted that the original goal was to do this analysis. Not all the models use the same endpoints and this would be considered in phase 2 of the project.

**Public Comment**

Ms. Laura Campbell – Michigan Farm Bureau.[8] She stated that farmers in Michigan have interest in water quality and are very interested in the Lake Erie phosphorus objectives development. She noted the Farm Bureau has questions that include: can the models be verified; what are the data sources the agency will use; and are the models complete enough to support the preliminary standards? Those kind of questions are vital to do the kind of analysis needed. She provide information on efforts her members are using to reduce runoff, funded with federal Clean Water Act section 319 grants and a program called the Agricultural Insurance program to manage nutrients from livestock.

Members asked about nonpoint contribution of phosphorus from agriculture if additional research is needed to better understand its contribution. Another members asked about coordination across states. Ms. Campbell explained the Michigan Farm Bureau is working with other states and organizations to identify and employ methods to reduce phosphorus runoff, limit phosphorus containing fertilizers in residential and municipal, and increase research in nitrogen:phosphorus (N:P) ratios reactions, algal bloom dynamics and water quality.

**Overview of Lake Erie and the Indicators**

The SAB Staff Office identified and invited five Canadian Lake Erie scientists to present information on the lake, current research, and models identified in the *Draft Technical Approach for Lake Erie Phosphorus Load-Response Modeling* (November 4, 2014).

Dr. Douglas Haffner, University of Windsor, Dr. William Taylor, University of Waterloo and Mr. Charlton Murray, Environment Canada, Retired presented information on Lake Erie and the indicators EPA is using to establish the phosphorus objectives.[9]

Dr. Haffner explained the unique morphology of the lake with its shallow gradient in depth and the differences between the western and eastern basin. He introduced the chlorophyll *a* indicator and noted that chlorophyll *a* does not provide information on community composition and toxicity. Primary production has not changed in western Lake Erie since 1972, but chlorophyll *a* has been changing possibly due to more light penetration with zebra mussels adding filtration to the biologic community.

Dr. Taylor discussed the issues with measuring planktonic species as chlorophyll *a* which does not address toxicity. In the western basin the issue is cyanobacteria blooms. The EPA is proposing to use cyanobacterial biomass as an indicator; While it is an issue of water quality, some of the algae are toxic so cyanobacterial biomass it is indicator for potential of toxicity. He also noted that this indictor includes non-harmful cyanobacteria as well as toxic species. Therefore it is only an indicator of some the risk. He noted that the data are limited because it requires microscopy.

Cladophora is a water quality indicator for near shore zones. There are cladophora growth models. Newer versions are driven by reactive phosphorus. However a weakness is that the models require data that may not be available. While cladophora is a major problem in the eastern basin, they are not a problem in the western and central basin because of habitat. This is an oligotrophic basin with low total phosphorus (TP) and we still get algae. For example TP data for near shore zone are becoming more available yet conditions on the deeper strata and bottom differ.

Mr. Charlton addressed the hypoxia indicator. In the summertime when there are calm days, warm surface waters stratify and inhibit mixing. Deeper water does not contact the atmosphere and thus limit oxygenation. Oxygen concentrations decrease every couple of weeks. Oxygen depletion is easily measured. There is variation in the mixed layer that introduces fundamental variability that makes it one of the least effective indicators. Hypoxia is affected by weather, nutrients, vertical mixing, and date of stratification. Early stratification can increase hypoxic conditions and zones.

Members noted that there are studies through time since the early 1900s and that hypoxia started to increase and is it a long term phenomenon?

Member asked which cyanobacteria species are toxic and in present Lake Erie. Blooms in western Lake Erie are dominated by *Microcystis* and some data shows a correlation with toxicity. There has been high abundance of *Lingia* that produces a neurotoxin.

Members discussed that over the past years much has been learned about what makes phytoplankton grow. Algal –bacterial associations and response to N:P ratios. There may be concern that the indicators chosen may be incomplete because they don't take into consideration these factors, that is, more attention should be given to nitrogen and bacterial activities.

**Overview of Lake Erie Models**

Dr. George Arhonditsis, University of Toronto, and Dr. Jan Ciborowski, University of Windsor, presented background information on the nine models identified by the EPA for the ensemble approach.[10] Dr. Arhonditis presented the first six models and Dr. Ciborowski the remaining three models.

Dr. Arhonditsis provided an overview of water quality models and the ensemble modeling approach.[11] He discussed a survey study and noted there are 153 peer reviewed publications looking at how well models work. For nutrient models the median error was 40% (that is 40 percent of models worked). Error was higher for other endpoints. 172 watershed models were reviewed in the survey. Drs. Arhonditsis and Ciborowski presented each of the nine models selected in the technical approach and discussed the limitations and strengths of the models.

*Overview of the models*

1. Chapra TP mass balance model. This model has been updated. It does not account for inshore/offshore exchange. Structure of model is straightforward advective load between segments, diffusion, and sedimentation. The results are consistent with what we know from the literature. The model accounts for diffusion and net sedimentation.

2. Ecole Model. This two dimensional model has one of the most advanced ecological factors. It accounts for multiple nutrients and three functional groups. There is an additional submodel. The model cannot account for interplay between inshore and offshore areas and has low performance for zooplankton. The model includes mathematical equation including all nutrients and dynamics of phytoplankton driven by light availability.

3. Lams 9-box eutrophication model. This model accounts for vertical analysis, water exchanges, and wind induced transport with nine box modules. This model has been calibrated and performance was assessed against 20 years of monitoring data. Performance was good. The model was readjusted to look at arrival of zebra mussels.

4. Elcom-Caedym model. This 3-D model has good visualizations, was calibrated with 2002 data and results show good fit of the data. It can assess the interchange between inshore and offshore areas. It is versatile – five functional groups were used for the Lake Erie runs. It may have limitations, as a complex model it is usually better to have independent calibrations of hydrodynamics and biological model.

5. 1-Dimensional Central Basin Hypoxia Model. This model is very basic ecologically. Nineteen years of data were used to run the model and shows quite compelling results when validated. However the run was not a continuous 19 years, it was reset every year. It is essentially a simulation of 19 growing periods. In a two-way factorial experiment ANOVA – the variability

driven by the physical forcing accounts for 5 times more variability than others factors. For the hypoxic areas, the models shows this as a function of depth.

6. WLEEM. This is one of most reliable models. However, it is a complex model and has not yet been peer reviewed. The structure of the model accounts for fine-scale set of factors that are 3-dimensionally linked. The factors include: hydrodynamics, sediment transport, and an advanced eutrophication model for Western Basin. Total chlorophyll *a* is predicted as the sum of three modeled phytoplankton functional groups (diatoms, green algae community, and cyanobacteria). It has been corroborated using data from 2008, 2011, 2012, and 2013.He noted the WLEEM model seems promising.

7. Stumpf: This model is an empirical regression model predicting cyanobacteria index forecasting that results in a bloom severity index. Its key feature is TP predicted as an interannual variability of the water coming from the Maumee River. A strength of this model is that it can forecast summer blooms based on spring data. While cyanobacteria can be remotely sensed this model cannot predict toxicity. It is based only on the condition entering the lake from the Maumee River. He noted that the Detroit River has constant loading and the model doesn't take this data into account

8. Obenour: This is a probabilistic cyanobacteria bloom forecasting model. In addition to using the same metrics for cyanobacteria as in Stumpf. The model adds a collection of information from the University of Toledo Lake Erie dataset. While these data are valid they represent a small number of stations. If you look at relationship for 30-years to compare to more recent years changes in loads of phosphorus has resulted in much larger bloom. The model's use of two independent measures of biomass is a strength. Its limitations are an unidentified recent response modeled as sensitivity factor and the Detroit River, another load to the lake is not taken into consideration.

9. Auer's Great Lakes Cladophora Model: This model applies to Lake Erie along north shore and measures biomass of cladophora. It accounts for light penetration, water temperature, and soluble reactive phosphorus (SRP) to determine cladophora growth. Some limitations of this model may be that zebra mussels create problems with calibration and it uses a relationship between TP and SRP to predict growth– this creates uncertainty because relationship is not very good. Calibrations are weak. If you want to make recommendations about tributary loading you would have a hard time using this model.

Members asked how the models will be combined and discussed possible weighting options to address differences in the models. The models have varying degrees of complexity and uncertainty in the predictions. Members suggested the agency consider weighting approaches to account for the models different results and endpoints. The also noted that there is temporal and spatial variability among the models. The agency noted that they will be working on this question as model runs are completed for the analysis.

Members also asked to what extent is hypoxia driven by the addition of material or material that is already there. Do these models take into account the buildup in conditions? They noted that the hypoxia models reset boundary conditions every year. To what extent to these models take

into account historical legacy? The agency noted that the limited time in the schedule may delay addressing this issue.

One member noted that a missing consideration is a sediment diagenesis model. This may be available from a sediment lean model had sediment diagenesis - based on Chesapeake Bay model.

One member questioned that the loads coming to lake have been kept low. It seems that the internal load is most important. Is this captured? The agency noted that this is not directly captured in the models and the loading into the lake is fairly stable.

**Discussion of Responses to the Charge Questions**

*Question 1: Eutrophication Response Indicators (ERIs)*

Lead discussants for this Charge question were Drs. Alber, Ammerman, Johnson, Rosi-Marshall, and Valett. Members noted that there are some interesting components to eutrophication that will not be captured by a dose-response curve because doses are not changing. Panelists were not sure how to address the applicability of the chosen metrics. Perhaps the models might show how the metrics relate to some other metrics and how the EPA can we address results. Members also expressed concern in addressing temporal and spatial scales between the indicators and the models. The technical approach does not provide much information on this aspect of the project.

They also found that none of the ERIs address compositional structure. The charge and discussion is lagging behind or is in front of the EPA effort. The indicators will do well to address eutrophication as the models intend them to be addressed. However, members expressed concern that there is too much going on inside the lake for solely external loads to predict the changes.

One member stated that regardless of how the issue is addressed, the eutrophication response indicators are ecological factors that are helpful in thinking about hypoxia. She noted that most of the panelists said that the indicators are useful. She encouraged panelists to think about whether there other things that were not captured and whether there may be other indicators.

Members said that these indicators are all aspect that need to be understood to be able to predict water quality. Yet it is unclear if these indicators were chosen because they had the most robust datasets or others were rejected for other reasons. Were these chosen because these are the things the models can predict? The panel also does no know which models were considered and why the why were rejected. The technical approach document provided the outcome not the process that led to the outcome.

Another member reminded panelists that there are three different objectives, one for each of the basins, the west, east and central basins. There could be more information about how and when to measure these objectives. A different member suggested that the panel should think about meeting the objectives in terms of what EPA can do. The EPA cannot affect internal loading. EPA can change what is going on up in the watershed. It will be important to know how biology is changing in response to internal conditions. The agency may be able to use the biology by

looking at functional traits of benthic, phytoplankton, and zooplankton communities to get to something EPA can do to change the result. The indicators don't get at what EPA can do. They seem to be solely focused on TP load.

The technical panel noted that the discussion is focused on TP because biomass and TP are related. Two things that affect TP are how long it is in the water column and how long it takes it to move up food chain. Residence time in water column is defined as sedimentation velocity. Something about that has changed, perhaps caused by zebra mussels.

Biology of the lakes has changed. Panel members expressed concern that the lakes have changed by regime shift and the models cannot capture that change. Before zebra mussels came to attention we noticed that top predators were at a maximum. This is not the way it was in the 1970s and there skepticism in the scientific community about what is driving the change biologically.

A member noted that the end point has to be a water quality criterion. The agency is looking for endpoints that stakeholders care about, so you might assume that identifying what public cares about has been captured in the criterion. The eutrophication indictors must resonate with the public and provide management with sufficient information to make decisions. The EPA will to be able to say something about how the management decisions will have an impact on things that people care about. Therefore the agency needs to think about what is measurable, what can be predicted with the model and is the endpoint(s) a surrogate(s) for something about which the public cares.

A member noted that there has been talk about TP not changing. But it should be noted that soluble reactive phosphorus (SRP) has increased, particulate phosphorus has decreased and dissolved organic phosphorus has decreased. Microcystis is an aggressive competitor for low phosphorus. Even at low phosphorus it can be an aggressive competitor for phosphorus. EPA should consider the fractions of TP and if those data are available and sufficient.

*Question 2: Models Chosen to Evaluate the Eutrophication Response*

Drs. Bartell, Connolly, Carrick and Mr. Endicott were the lead discussants for this charge question. Members appreciated the detailed presentations on the models. They identified that the key question is "Do the models reflect the best knowledge? That is whether these models are appropriate goes to whether they can predict responses." This question has not been rigorously pursued. Evaluation criteria should be used to look at things like correlation coefficient. This is a low bar. Yet we are looking at these models to make nuanced predictions. The ability to predict may correspond to the effects of 10 – 20% reductions in phosphorus load. The way the models have been evaluated does not answer that. EPA has also not looked at model bias. Some of the models showed significant biases. The biases are most pronounced at the lowest phosphorus loads. They may not account for internal loads. It is important to look at how models perform at the lower end of the loading experience. Members also expressed concern that the projects time line was too tight to allow changes in the models being used, particularly adding new models to the ensemble modeling approach.

Members discussed the concept that simpler models may be a more appropriate selection. Models with many state variables seem to be overly complex and exaggerate the goodness of fit of the models. A model with more than a 100 variables can be tuned to give any result. EPA should look at whether what they see is the models innate fit or the ability to fit the model by adding more variables.

Another member noted that using models that have history in the Great Lakes is a good idea. It is also good that the EPA is using an ensemble approach. What would have helped the Panel is a better discussion of the key assumptions used in the model(s) (i.e., differing time and space scales). For example bloom data are different from continuous data. He would have liked to have seen more empirically driven models like neural network used. Neural networks allow the data tell you what is correlated and would allow an internal analysis least one set of models. The complexity of some of the models is daunting and the realism is debatable.

One member stated that it is important to look at selection of models. Process models address most of the indicators. The question becomes does the EPA need all of these models? As long as the EPA can come up with something that is reliable – biogeochemical detail does not matter. There needs to be a clear understanding of the uncertainty and can work backward from there to develop the quantitative load response. He suggested the EPA should identify three or four models to be used. Having a clear understanding of what we need for management decision-making is different from state of the art science. The modeling process is doable. There will most likely be more effort spent in understanding the different projections among the models.

A panelists noted that it would be worth investing time to identify an approach to show how the models would be used. The approach should identify the goal, and where each of these models fits, the agency needs a framework in which to put this.

A member suggested that the agency should consider how the models deal with the unknowns. Which models deal with each of these problems the best, which models do the best job of looking at the poorly quantified factors. Some of these models have these factors built in. Which models were looked to for answers for those questions? Another member suggested that looking at how models predict an indicator such as primary productivity seems like a good change to examine for model selection.

Members discussed the changing biology of the lake and how each of the models may need to account for change. For example, chlorophyll assimilation efficiencies have gone up, sedimentation rates have changed with and the introduction of zebra mussels, and these are all changes that should be considered. Members noted that there is no one model that can account for the role of zebra mussels. The different models came up with different ways to account for that. It might be useful to use this as a way to compare the models.

Members discussed the complexities of internal cycling and phosphorus balance in the lake. They noted that internal cycling is very complicated. One may not get an answer for how this is working. It is hard to understand how the lake works particularly between basins. In the west basin researchers have correlations between blue-green algae and the input from the Maumee River. That may be as far as the data will take you. How far do you need to go to further

understand this? EPA noted that internal cycling and outflow are uncertainties in the models. In addition to the sediment and water column exchange and the biology that facilitates the exchange, the agency needs to consider the exchange between the lake's three basins.

*Question 3: Using an Ensemble Modeling Approach*

Drs. Heath, Reckhow, La Point, Smith and Mr. Fitzpatrick were the lead discussants for this question.

Members generally liked the ensemble approach and found that it is a valid approach. They noted that the models chosen represent a wide range of factors and are built on the past knowledge of Lake Erie. The great asset that this approach has is using the collective data and knowledge that has been gained over the last 30-40 years.

Members noted that each of the models has an uncertainty and discussed the need for a structured uncertainty analysis. Error propagation cannot be done with most of these models. There is the possibility of performing skill assessment(s) on the models. The agency will need to look at the difference between actual and predicted results and use this as a weighting in a validation or verification exercise. The goal should be a reliable set of predictions of what will happen when pollutant loads change. Evaluating the rigor of the model(s) validation is important. There is also a need to take the highly detailed models and figure out what they are giving that would be similar to the statistical (aggregated) models. It is difficult to conduct error analysis with over parameterized models. The agency needs to look at whether models are based on same physics and therefore are not independent.

One member asked how EPA considers "errors in modeling" in the decision and ensemble approach. It is hard for many to understand what a 50% error in modeling results means. The agency responded that error is reflection of uncertainty. Uncertainty can be considered. Need to decide level that you feel most comfortable with. Example – long term value may not show much. But the seasonal average may show useful information.

Members discussed possible limitations of the approach due to the models implicitly assuming that they are phosphorus limited and that by changing the loading you will change the responses in the lake. With increasing frequency over the last 20 years the phosphorus limitations have become weaker. While the phytoplankton community may be limited in the spring they are not behaving that way from July on through the remainder of the year.

One member suggested that the agency should consider the lake water quality in a diagnostic framework. That is asking whether it is the same old problem phosphorus loads or a new disease. This may be a new problem with similar symptoms. To treat it as the old problem could be a mistake. It may well be that internal processes that have been discussed – could be the internal loading has changed. Internal processes are not well represented in some of the models. It is difficult to respond to internal loading situation.

Members discussed the modeling in relation to bigger picture objective and implementing an adaptive management approach. It makes sense in light of adaptive management to develop load response curves. The slope of the curves may change if the models are correctly predicting responses to internal loads. This elevates the importance of moving ahead with modeling but also asking whether process elements are reflected in the model. If you look at the output from model, there seems to be a disconnect between model output and lake ecosystem objectives.

Members discussed how does the ensemble modeling approach will fit into adaptive management strategy? They noted that adaptive management is a learning activity. With adaptive management some of the actions address the major uncertainties in the knowledge. They urged EPA to think about whether there are actions that could be taken that are learning activities. Questions posed by the Panel include:

- How are data collection and modeling integrated to support adaptive management?
- Trying to understand how this modeling effort fits into the broader effort at hand.
- Could this model be extended to other lakes in the basin?

EPA staff noted the agency was given a large task with short turn-around time. The concept of adaptive management is broad. The EPA will make recommendations for the phosphorus objectives. The recommendations will be based on best understanding. As they move forward the agency will get feedback on what will need to be done on data collection and modeling. They acknowledged a need to figure out how to manage actions taken, monitor results, collect different kinds of data and determine what adaptation to implement and go in a different direction. That is part of the process that is different from what was done several years ago.

Members noted that the EPA will need to address how this effort fits into ongoing monitoring program. EPA staff told the panel that they have been revising the monitoring program. They are looking at different parameters and nearshore work. For example they are now monitoring as the ship crosses the lake to collect transect data. They are also looking long term to maintain data sets collected. EPA is working with other federal agencies on a data repository. They are using STORET and the water quality portal and are trying to integrate the data.

One member noted the implementation of the phosphorus objective will take place in social and economic environment. The agency needs to consider the likelihood of getting load reductions. He urged the agency to consider behavioral and decision making sciences. There are models that look at decisions and the feasibility of decisions. The science model can have input to these other kinds of models.

*Question 4: Consistency among Phosphorus Concentration and Loading Targets and Eutrophication Response Indicators*

Drs. Chen, Diaz, Di Giulio, Klump, McLaughlin, Reddy, and Stubblefield were the lead discussants for this question

Lead discussants noted that Lake Erie is a heavily event driven system. Between 2011 and 2012 data sets you see a different lake. The issue of internal loading and sediment release and cycling is important as is residence time is important. They noted that with regard to selecting load vs

concentration, loading is more likely to serve as easily measured with confidence bounds. Loadings are valuable as predictors. There is no question both loads and concentrations should be part of what is looked at going forward.

Members noted that loadings are an important factor to consider and concentration is more biologically relevant than loads. The lake ecosystem objectives are like assessment endpoints. EPA needs to identify measurement endpoints to identify things like nuisance endpoints. The healthy aquatic ecosystem does not have measurement endpoints – i.e., cyanobacteria blooms. The agency also needs to consider that not all cyanobacteria produce toxins. We don't have measurement endpoint to get to the assessment endpoints to try to make statements about whether we can get to objectives.

**Opportunity for brief clarifying remarks**

Ms. Campbell, Michigan Farm Bureau noted that the farmers are engaged are interested in process, and want the best results possible.

**Action Items and Next Steps**

Dr. Schlesinger reviewed the points the Panel members identified as key issues and asked the Panel for any additional thoughts. Panel members agreed that the key issues were identified and did not identify any additional issues or comments. Dr. Schlesinger summarized the next step for Panel members to develop the report.

The DFO and the Chair would develop the draft report with the letter to the EPA Administrator. The Panel would review and concur on the report via email. Panel members were asked to revise their individual comments and they would be included in the meeting materials. After consensus, the draft report would be submitted to the chartered Science Advisory Board for Quality Review prior to finalization.

Dr. Schlesinger asked the Panel for any questions or clarifications. He then called upon the DFO to adjourn the meeting.

The Designated Federal Officer adjourned the meeting at 4:45 p.m.

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| Respectfully Submitted: | Certified as Accurate: |
| /Signed/ | /Signed/ |
| _____ | _____ |
| Mr. Thomas Carpenter | Dr. William Schlesinger |
| SAB Designated Federal Officer | Chair |

NOTE AND DISCLAIMER: The minutes of this public meeting reflect diverse ideas and suggestions offered by committee members during the course of deliberations within the meeting. Such ideas, suggestions, and deliberations do not necessarily reflect definitive consensus advice from the panel members. The reader is cautioned not to rely on the minutes represent final, approved, consensus advice and recommendations offered to the Agency.
Materials Cited

All meeting materials for the Lake Erie Phosphorus Objectives Review Panel – Lake Erie Eutrophication Indicators - Ensemble Modeling Approach are available on the SAB Web site. http://www.epa.gov/sab.

The materials cited below for this meeting are available at the following address:

http://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/574C02EE59D8AACC85257D81007834EB?OpenDocument

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[1] Roster Science Advisory Board Lake Erie Phosphorus Objectives Review Panel
[2] Federal Register Notice Vol 79 Number 221 Pages 68441-68442
[3] Determination Memorandum and Biosketches of Candidates
[4] Charge to the Science Advisory Board For the Consultation of: Lake Erie Phosphorus Objectives
[5] Draft Technical Approach for Lake Erie Phosphorus Load-Response Modeling. November 2014
[6] Meeting Agenda
[7] EPA presentation Binational Efforts to manage nutrient inputs to the Great Lakes. Tinka Hyde, EPA Region 5, Nutrient Subcommittee Co-Chair
[8] Written statement from the Michigan Farm Bureau by Ms. Laura Campbell
[9] Overview of Eutrophication Indicators
[10] Overview of Ecosystem Models Selected for the Ensemble Modeling Approach: Part 1
[11] Overview of Ecosystem Models Selected for the Ensemble Modeling Approach: Part 2

**Attachment A**
**Members of the Public Who Requested Call-in Information for the Lake Erie Phosphorus Objectives Review Panel Consultation**
**December 10, 2014**

**Attendees**
Ms. Laura A. Campbell, Michigan Farm Bureau
Dr. Thomas Armitage, US Environmental Protection Agency
Mr. Paul Horvatin, US EPA
Ms. Santina Wortman, US EPA
Dr. Craig Stow, National Oceanic and Atmospheric Administration
Ms. Jean Chruscicki, US EPA
Mr. Peter Swenson, US EPA
Mr. Tim Henry, US EPA

**Attendees (via Phone)**[1]
Dr. Janet Keough, US EPA
Mr. Steve Via, American Water Works Association
Dr. Sue Watson, Environment Canada
Ms. Susan Humphrey, Environment Canada
Mr. Norman Grannemann, U.S. Geological Survey
Ms. Anne Choquette, USGS
Ms. Joanne Volk, Environment Canada
Ms. Gail Hesse, Ohio Lake Erie Commission
Ms. Lara Beaven, Inside EPA
Ms. Véronique Hiriart-Baer, Environment Canada
Ms. Sandra George, Environment Canada
Ms. Carolyn O'Neill, Ontario Ministry of the Environment and Climate Change
Mr. Jon Hortness, USGS
Mr. Norman Grannemann, USGS
Mr. Dan Rucinski, Limno Tech
Dr. Pamela Joosse, Agriculture and Agri-Food Canada

[1] Based on members of the public requesting the teleconference dial in information