Charge to the
Science Advisory Board

For the Review of:

PHOSPHORUS LOAD REDUCTION TARGETS FOR LAKE ERIE

Prepared by the
EPA Region 5 Water Division

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Background

EPA Region 5 is co-leading a binational workgroup to develop and implement the Nutrients Annex ("Annex 4") of the 2012 Great Lakes Water Quality Agreement (GLWQA) in accordance with Article 3(b)(i) of the GLWQA. Under Annex 4, the U.S. and Canada committed to address eutrophication issues in Lake Erie by first establishing phosphorus objectives, loading targets and allocations for the nearshore and offshore waters by February 2016, and subsequently develop phosphorus reduction strategies and domestic action plans by 2018. A binational workgroup of Lake Erie scientists used a suite of models to generate a series of load response curves in order to simulate the impact of phosphorus loads to cyanobacteria biomass, hypoxia and *Cladophora* growth, and identify the phosphorus reductions needed to meet the desired ecological condition for the Lake. EPA sought early SAB advice on the modeling approach in December 2014. The SAB's feedback was considered in the subsequent deliberations by the binational workgroup, and resulted in improved documentation of the uncertainties and sensitivities of the models. The U.S. and Canada released the recommended binational phosphorus reduction targets in June 2015 and sought public input during July and August. The phosphorus load reduction targets were accepted by the U.S. and Canada on February 22, 2016, as follows:

> *To minimize the extent of hypoxic zones in the waters of the central basin of Lake Erie: a 40 percent reduction from 2008 loads in total phosphorus entering the western basin and central basin of Lake Erie – from the United States and from Canada – to achieve a 6,000 metric ton central basin load. This amounts to a reduction from the United States and Canada of 3,316 metric tons and 212 metric tons, respectively.*
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> *To maintain algal species consistent with healthy aquatic ecosystems in the nearshore waters of the western and central basins of Lake Erie: a 40% percent reduction in spring total and soluble reactive phosphorus loads from the following watersheds where localized algae is a problem: in Canada, the Thames River and Leamington tributaries; and in the U.S., the Maumee River, the River Raisin, the Portage River, Toussaint Creek, the Sandusky River, and the Huron River, OH.*
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> *To maintain cyanobacteria biomass at levels that do not produce concentrations of toxins that pose a threat to human or ecosystem health in the waters of the western basin of Lake Erie: a 40 percent reduction in spring total and soluble reactive phosphorus loads from the Maumee River in the U.S.*

Further reductions in phosphorus may be necessary to address benthic nuisance algal growth and shoreline impacts in Lake Erie's eastern basin. The Annex 4 Objectives and Targets Task Team will meet later this year to reconsider the viability of developing a target for the eastern basin, given the current state of the science on *Cladophora* and recent updates to the *Cladophora* growth model.

EPA is currently working with other federal, state and Canadian partners to develop a long-term plan that will identify the monitoring, data and analyses needed to support implementation and evaluation of these nutrient reduction goals as part of an ongoing, adaptive management approach. We are also

working to develop a binational phosphorus reduction strategy and domestic action plans which will outline actions to be taken to achieve the targets.

Furthermore, a binational task team was formed under Annex 4 to initiate steps required to develop Lake Ontario nutrient targets. That team is currently assessing the status of nutrients and eutrophication impacts in Lake Ontario, identifying gaps in monitoring and modeling needed to support targets development. The Lake Ontario Nutrients Task Team will benefit from lessons learned and consideration of modeling approaches in Lake Erie.

Charge to SAB:

The EPA requests Science Advisory Board (SAB) review of the current modeling results and other information used to inform development of the binational phosphorus reduction targets. We are seeking a critical review so that we can ensure the Agency's ongoing efforts to develop, implement and evaluate nutrient reduction goals for Lake Erie are based on sound scientific data, analyses, and interpretations. In a spirit of adaptive management, we are most interested in SAB advice on enhancements to the modeling approach, or new approaches to consider, that will help us proactively manage eutrophication issues in Lake Erie in the long term.

Review Documents: The panel will review the following documents, which taken together explain the process followed to develop the binational phosphorus loading targets for Lake Erie:

- The Annex 4 Ensemble Modeling Report and Appendix B
- Recommended Phosphorus Loading Targets for Lake Erie: Annex 4 Objectives and Targets Task Team Final Report to the Nutrients Annex Subcommittee. May 11, 2015

Additional Documents: The following documents (and associated references), provide important context and information related to our current efforts:

- A Multi-Model approach to evaluating target phosphorus loads for Lake Erie. Scavia, DePinto and Bertani. Journal of Great Lakes Research, in press.
- State of Knowledge of *Cladophora* in the Great Lakes. Executive Summary of Workshop held at NOAA-Great Lakes Environmental Research Laboratory January 26-28, 2016

Charge Questions:

Approach for Developing Lake Erie Phosphorus Load Reduction Targets

Nine different Lake Erie models were used to predict the response of selected eutrophication response indicators to different phosphorus load scenarios (see Table 1 in the Annex 4 Ensemble Modeling Report). The eutrophication response indicators evaluated were (1) overall phytoplankton biomass represented by chlorophyll a, (2) cyanobacteria blooms in the Western Basin, (3) hypoxia in the hypolimnion of the Central Basin, and (4) *Cladophora* in the nearshore areas of the Eastern

Basin. Technical evaluation criteria were used to assess the capabilities of each model (see Section 2.3 and Appendix B of the Annex 4 Ensemble Modeling Report) and load-response curves were generated for each eutrophication response indicator (see Section 3 and Appendix B of the Annex 4 Ensemble Modeling Report).

1. Please comment on whether the evaluation of the models was adequate to inform how model results should be interpreted, given differences in model complexity and scale. Please identify any additional analyses that may be needed to improve future development and interpretation of the load-response curves for the eutrophication response indicators.

The document, R*ecommended Phosphorus Loading Targets for Lake Erie* describes the process followed by the Annex 4 Objectives and Targets Task Team to develop phosphorus loading targets for Lake Erie. The document indicates that, to achieve a Western Basin cyanobacteria bloom biomass threshold no greater than that observed in 2004 or 2012, 90% of the time, a spring Maumee River load of 860 metric tons of total phosphorus and 186 metric tons of dissolved reactive phosphorus is recommended. In addition, a 40% reduction in the spring load of total phosphorus and dissolved reactive phosphorus from other Western Basin tributaries and the Thames River is recommended. To meet a threshold of 2.0 mg/L or higher of hypolimnetic dissolved oxygen, an annual total phosphorus load of 6,000 metric tons to the Western and Central Basins is recommended. The Task Team did not recommend new phosphorus concentration objectives for the open waters or the nearshore be identified at this time.

2. Please comment on whether the recommended targets reflect the best available information on the drivers of cyanobacteria growth and seasonal hypoxia in Lake Erie and are appropriate to meet the nutrient Lake Ecosystem Objectives defined in the GLWQA (as reflected in Table 1 on page 7 of the document titled *Recommended Phosphorus Loading Targets for Lake Erie*).

Cladophora Growth

Additional phosphorus load reductions may be necessary to reduce nuisance levels of *Cladophora* in the nearshore waters of the Eastern Basin of Lake Erie. The Annex 4 Objectives and Targets Task team did not recommend a specific phosphorus objective or loading target to address *Cladophor*a growth. EPA and Environment and Climate Change Canada convened a workshop in January 2016 to assess the current state of knowledge of *Cladophora* growth in the Great Lakes and identify potential options for nutrient target development to be considered by the Annex 4 subcommittee. (Please see the background document titled "State of the Knowledge of *Cladophora* in the Great Lakes. Executive summary of Workshop held at NOAA-Great Lakes Environmental Research laboratory, January 26-28, 2016.")

3. Please comment on whether scientifically-sound phosphorus load reduction recommendations to address *Cladophora* growth in the Eastern Basin of Lake Erie could be developed at this time.

Nitrogen Control

While the current strategy focuses on limiting phosphorus loading to the Lake (total and dissolved forms) as the key mechanism for controlling excessive algal growth, it is implied or assumed that nitrogen loading likely will also be reduced through implementation of agricultural best management practices, and the Task Team recommended that tributary nitrogen loads to the Lake be tracked in addition to phosphorus.

4. What recommendations can the SAB provide for development of an approach to help determine whether consideration of nitrogen control, in addition to phosphorus, is warranted in Lake Erie to prevent harmful algae blooms and manage hypoxia? In particular, what questions, relationships, or research priorities related to nitrogen loading (different forms and sources) and in-lake cycling must be addressed?

Evaluation of Nutrient Reduction Targets

The inter-annual loading trends for the Maumee River are greatly influenced by annual variability in flows. The Objectives and Targets Task Team identified a maximum flow below which the target load should be met and recommended the use of flow-weighted mean concentrations (FWMC) as a benchmark for any given tributary target load.

5. Please comment on the use of FWMC and any other approaches that should be considered to account for inter-annual variability in hydrology in assessing progress in reducing tributary loadings of phosphorus to the Lake.

The Task Team recommended development of a comprehensive adaptive management program that would include annual routine monitoring of appropriate load, FWMC, and in-lake nutrient-eutrophication response indicators in conjunction with an intensive monitoring, research, and operational model application program every five years.

6. Please comment on the value of applying the existing eutrophication models on an ongoing basis to periodically evaluate phosphorus loading targets and eutrophication response indicators. What key elements should be included in the adaptive management approach to successfully implement and evaluate our nutrient reduction goals for Lake Erie?