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Harvard School of Public Health

June 18, 2009

Mr. Lek Kadeli
Acting Assistant Administrator
Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC 20460

Dear Mr. Kadeli:

The Board of Scientific Counselors (BOSC) has completed a mid-cycle review of the Office of Research and Development's (ORD) Water Quality Research Program (WQRP), focusing on Agency efforts to enhance the program following the 2006 BOSC program review.

A seven-member BOSC Committee (including one consultant) was formed to conduct the mid-cycle review. Six of these members also participated in the 2006 program review. The mid-cycle review was accomplished through two teleconferences and a 1-day face-to-face meeting of the Committee with the National Program Director for Water Quality, Dr. Chuck Noss, in Arlington, Virginia, on September 23, 2008. The draft report was reviewed and approved for transmittal to ORD by the BOSC Executive Committee in February 2009.

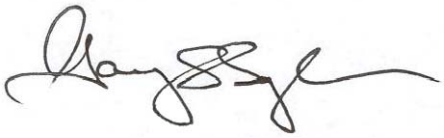
One area where the Program appears to be serving its clients well is in critical research to meet the regulatory mandates of the Clean Water Act. The WQRP also has made progress on recommendations for transparency of prioritizing research and enhancing partnerships. The report offers additional advice on areas where this can be improved. In addition, the report offers some suggestions for improving the next iteration of the Program's Multi-Year Plan (MYP). The WQRP is making an exceptional effort to obtain client input, but more effort is needed to establish a mechanism for quantifying long-term outcomes of the Program.

The progress made by the WQRP in response to the BOSC review was assigned an overall rating of Meets Expectations. It was noted in the review that the Program was exceeding expectations in several areas with respect to quality of research.

The BOSC concluded that the WQRP has been responsive to the recommendations from the 2006 program review, although there are several recommendations that have yet to be fully addressed. The BOSC is confident, however, that the WQRP will make progress toward meeting the remaining recommendations in future MYPs, and in doing so, will move forward in filling critical research needs to help the Agency meet its regulatory mandates.

This BOSC report is anticipated to further assist ORD in longer term program enhancement, comparative analysis with other programs, and intermediate research investment decision making. We expect the report will assist ORD in continuing to improve its science, and assist and inform clients within and outside the EPA of the significance of its research and its utilization. On behalf of the BOSC Executive Committee, it is my pleasure to transmit this mid-cycle review report to you.

Sincerely,



Gary S. Sayler, Ph.D.
Chair, BOSC

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BOARD OF SCIENTIFIC COUNSELORS

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MID-CYCLE REVIEW OF THE OFFICE OF RESEARCH AND DEVELOPMENT'S WATER QUALITY RESEARCH PROGRAM AT THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FINAL REPORT

BOSC WATER QUALITY MID-CYCLE SUBCOMMITTEE

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April 2009

This report was written by the Water Quality Mid-Cycle Subcommittee of the Board of Scientific Counselors, a public advisory committee chartered under the Federal Advisory Committee Act (FACA) that provides external advice, information, and recommendations to the Office of Research and Development (ORD). This report has not been reviewed for approval by the U.S. Environmental Protection Agency (EPA), and therefore, the report's contents and recommendations do not necessarily represent the views and policies of the EPA, or other agencies of the federal government. Further, the content of this report does not represent information approved or disseminated by EPA, and, consequently, it is not subject to EPA's Data Quality Guidelines. Mention of trade names or commercial products does not constitute a recommendation for use. Reports of the Board of Scientific Counselors are posted on the Internet at http://www.epa.gov/osp/bosc.

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I. SUMMARY

I.1 Introduction

The Board of Scientific Counselors (BOSC) Water Quality Mid-Cycle Subcommittee of seven members conducted a mid-cycle review of the U.S. Environmental Protection Agency's (EPA) Water Quality Research Program (WQRP) from August to October 2008. This review included two conference calls and one face-to-face meeting. The review was conducted to evaluate the WQRP's response to the BOSC program review that took place in 2006, and to assess the Program's progress regarding the quality of its research, timeliness of its outputs, and success of its actions in addressing previous BOSC recommendations. As part of the review, the Subcommittee was asked to rate the Program's progress as Exceptional, Exceeds Expectations, Meets Expectations or Not Satisfactory.

I.2 Conclusions and Recommendations

In general, the Subcommittee concluded that the WQRP has been responsive to the BOSC recommendations from the 2006 program review, although there are several recommendations that have yet to be fully addressed. For example, progress has been made in accounting annual outcomes of the Program, such as on-time completion of Annual Performance Measures (APMs), a bibliometric analysis, and a detailed accounting of accomplishments related to completion of Annual Performance Goals (APGs), but this addresses only two of the six outcome measures recommended by the BOSC to be developed. Future BOSC review subcommittees will need, in addition, measures that document: outcomes related to transfer and communication of report results, institutional outcomes, management outcomes, and environmental outcomes as recommended.

The Program also has made progress on recommendations for transparency of prioritizing research and enhancing partnerships. The Subcommittee's report offers additional advice on areas where this can be improved.

The Subcommittee observed that the Water Quality Multi-Year Plan (MYP) has undergone significant revision, some of which is in response to BOSC recommendations. A considerable amount of change, however, appears to be in response to a number of client/Agency needs and priorities. This has, in part, led to a change in the organization of the Program's Long-Term Goals (LTGs) beyond that recommended by the 2006 BOSC program review. Although the Mid-Cycle Subcommittee expressed concern that some important research areas have been deemphasized, it recognized that the Agency's process for updating the MYP annually provides response flexibility within the MYP structure for both the APGs as well as the LTGs. This flexible approach is encouraged by the Subcommittee.

One area where the Program appears to be serving its clients well is in critical research to meet the regulatory mandates of the Clean Water Act. A summary of a recent Partner Survey indicates that satisfaction of end users of WQRP products in this area is high.

The most recent MYP combines some previously separate items under one title of watershed management (LTG 2). The Subcommittee was concerned that some aspects of watershed research were included under other LTGs and may contradict the Program's desire to take a more integrated approach to the research. The setting of water quality criteria (LTG 1) and remediation of wastewater infrastructure (LTG 3) are as much a part of watershed management as any of the items addressed in LTG 2. By separating them from LTG 2, there is the implication that LTG 1 and LTG 3 topics are independent of watershed management. Thus, the WQRP should consider, in its next iteration of the MYP, the organization that characterized the previous MYP, but with slightly more delineation between topics.

The most recent MYP provides a better framework for identifying/quantifying Program Assessment Rating Tool (PART) performance measures; however, the terms performance, process efficiency, and investment efficiency need to be clearly defined as per the National Academy of Sciences report (2008) and used by the Program to aid review panels and experts in the PART process. The WQRP makes good use of outside review of program relevance and quality, but further definition of performance relative to Office of Research and Development (ORD) investment is warranted.

In summary, the Subcommittee believes that the Program is making reasonable progress toward implementing the BOSC's recommendations from the 2006 program review. Given that this was a mid-cycle review, the Subcommittee did not expect all of the BOSC's recommendations to have been implemented completely. The Subcommittee, however, is confident that the WQRP will make progress toward meeting the remaining recommendations in future MYPs and in doing so will move forward in filling critical research needs to help the Agency meet its regulatory mandates.

I.3 WQRP Summary Assessment

The Subcommittee unanimously rated the progress by the WQRP in response to the BOSC review as **Meets Expectations.** The Subcommittee members thought this rating was reasonable given that the Program has had to respond to numerous recommendations in addition to those from BOSC. These have impacted the speed and progress of program actions. The Subcommittee believes, however, that the Program is making an exceptional effort to obtain client input. The Program needs to dedicate more effort to establishing a mechanism for quantifying long-term outcomes of the WQRP. Regarding the quality of research, the Subcommittee expressed the view that the Program was exceeding expectations in areas such as the application of molecular approaches to water quality issues and the development of tools to use weight-of-evidence approaches to assess causes of water quality impairment (e.g., Causal Analysis/Diagnosis Decision Information System [CADDIS]).

II. INTRODUCTION

The U.S. Environmental Protection Agency's (EPA) ORD enlists the BOSC to conduct independent expert reviews of ORD's environmental research programs every 4 to 5 years. Mid-cycle reviews, scheduled midway through the review cycle, are a critical step in this process. Narrower in focus than the in-depth technical evaluation that constitutes a full program review, the objectives of a mid-cycle review are to gauge the program's progress and to offer advice and feedback with respect to future direction and performance and accountability.

A seven-member BOSC Subcommittee completed a full program review of the WQRP during an open meeting held in Washington, DC, January 25-27, 2006. This program review culminated in a BOSC report that was transmitted to ORD on July 11, 2006. The ORD response to the report was transmitted to the BOSC on October 16, 2006.

Six of the members of the original Subcommittee that conducted the 2006 BOSC WQRP review were enlisted to conduct the mid-cycle progress review. The Mid-Cycle Subcommittee included one additional member who had not served on the 2006 Subcommittee. The Mid-Cycle Subcommittee members are listed in Appendix A. The Water Quality Mid-Cycle Review Subcommittee held one organizational teleconference, followed by an open, face-to-face meeting held in Arlington, Virginia on September 23, 2008, and a final teleconference held on November 3, 2008.

In addition to the 2006 BOSC program review and the ORD response to that review, the WQRP provided the Mid-Cycle Subcommittee with a Progress Report (September 2008), the August 2008 draft MYP, a report of progress on APGs, a bibliometric analysis, a summary of a Partner Survey, and a number of other documents. Following the face-to-face meeting, a draft report was prepared by the Subcommittee, edited by the Chairman, and returned to the Subcommittee members for their review. The members discussed and approved the report for submission to the BOSC Executive Committee during the November 3 teleconference.

The Mid-Cycle Subcommittee was asked to address the following seven charge questions in its review of Program progress:

- ✧ Charge Question 1: Do the currently planned revisions to the Water Quality Research Program adequately address the 2006 BOSC review recommendations?

- ✧ Charge Question 2: Do the revised LTGs provide a coherent framework for presenting research needs?

- ✧ Charge Question 3: Does the Water Quality Research Plan adequately address critical research to meet the regulatory mandates of the Clean Water Act?

- ✧ Charge Question 4: Does the proposed research adequately support watershed management and contaminant source control programmatic needs?

- ✧ Charge Question 5: Does the Water Quality Research Program provide an appropriate balance among its three LTGs?

- ✧ Charge Question 6: Do the existing Program Assessment Rating Tool (PART) performance measures provide appropriate and quantifiable indices of progress? What improvement does the panel recommend?

- ✧ Charge Question 7: Please rate the progress made by the Water Quality Research Program in moving the program forward in response to the BOSC program review of 2006 by assigning a qualitative score as exceptional, exceeds expectations, meets expectations, or not satisfactory.

The complete charge to the Subcommittee is provided in Appendix B.

III. RESPONSE TO CHARGE QUESTIONS

III.1 Response to Charge Question 1

Charge Question 1: Do the currently planned revisions to the Water Quality Research Program adequately address the 2006 BOSC review recommendations?

The 2006 BOSC program review of the WQRP identified six major recommendations and another 25 actions that the BOSC suggested to enhance program efficiency and performance.

Recommendation 1—In response to the first recommendation to enhance transparency in identifying research priorities, a Water Research Coordination Team (RCT) was formed to clarify the linkage between regulatory needs and research, the criteria for deciding what research should be done, and the paths leading from APGs to Annual Performance Measures (APMs) to Long-Term Goals (LTGs). In addition, highly productive workshops with stakeholders were held to identify criteria to be used in APG prioritization that focus on relevance, timeliness, and outcome. These criteria primarily address the linkage between research and regulatory needs. In meetings with stakeholders, three other factors were identified and used to select high-priority research topics in the draft MYP: (1) information to meet short-term needs (e.g., criteria development), (2) research to address high visibility issues, and (3) science to meet future needs. The Program has made great progress in working with stakeholders to identify research priorities (see response to Charge Question 4 for examples). Additional activities are planned that will enhance coordination of research prioritization among laboratory and center management and Office of Water (OW) program and regional management.

Clearly, the Program is working to establish criteria for prioritizing research, and the criteria used to identify high-priority research topics for the MYP are described in the plan. A more general statement of prioritization of criteria is not yet available. In part, this is because establishing criteria for research prioritization requires agreement from several areas of management. The recently completed draft report from the OW (National Water Program Research Needs and Management Strategy 2008-2013) should enable further progress. The process of reaching agreement on criteria for research prioritization appears to be well underway and should be a centerpiece of the Program as the MYP continues to evolve.

Recommendation 2—The second major recommendation was for an annual accounting of Program outcomes that included six specific metrics: activities completed by a specific date, published research results, transfer and communication of results, institutional outcomes, management outcomes, and environmental outcomes.

Two annual measures have been developed that address the first two types of metrics: the percentage of APMs delivered on time and bibliometric analyses that track the fraction of Program reports that are highly cited. The Program is engaged in several activities to enhance its communication of results. The Partner Survey appears to be a step in that direction, but no

metrics of this effort have been proposed. The Program is working on measures to address the three remaining metrics: institutional outcomes, management outcomes, and environmental outcomes, bearing in mind the advice provided by the recent National Academy of Sciences (NAS) report, *Evaluating Research Efficiency in the U.S. Environmental Protection Agency*.[1]

The Program is proposing to develop a measure of regional use of ORD APMs (presumably this means use of reports or tools developed by the Program) as a possible measure of environmental outcomes. This measure offers promise as a metric of management outcomes rather than environmental outcomes. Although success in this metric is in part a consequence of the actions of others and not directly under the Program's control, it still is important to document such outcomes.

In summary, progress has been made in meeting this recommendation. The Subcommittee was provided documents that showed annual accounting of on-time completion of APMs, a bibliometric analysis, and a detailed accounting of accomplishments related to completion of APGs identified in the 2003 MYP. But future BOSC review committees will need measures that document progress in all six areas.

Recommendation 3—The third recommendation was to reinstate exploratory Science To Achieve Results (STAR) grants, which has not been done. The STAR grants supported by the Program historically focused on harmful algal blooms (Ecology and Oceanography of Harmful Algal Blooms [ECOHAB]), but even this program has been eliminated, largely as a result of budgetary constraints outside of Program control.

Recommendation 4—Enhancing partnerships, particularly with the states, was the focus of the fourth recommendation. The Subcommittee did not receive any specific accounting of partnerships or collaborations developed, although the narrative noted that the Program has been encouraging laboratories and centers to form these collaborative relationships. One very promising development has been the pilot program with the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA). Some accounting of the outcomes from that program should be part of a future review. If it is fruitful, similar programs with other interested groups may prove useful. Seeking input from stakeholders on the development of criteria for recreational waters is another positive development. Progress also has been made in involving individuals from the states in research projects. This is evident from the list of several co-authored publications. This is an effective way to enhance relevance to and acceptance of the Program's products by its clients. This is addressed further under Charge Question 4.

Recommendation 5—Improvements in the MYP to better communicate the goals of the Program were called for in the fifth recommendation. It is clear that the Program continues to work extensively with stakeholders to refine the draft MYP, which is commendable. The draft MYP represents an improvement over the version the BOSC reviewed in 2006. The incorporation of figures such as Figures 1 and 5, which provide overall continuity in the Program and a structure to which changing APGs can be related, has made the MYP a more effective communication tool.

[1] The National Academies. Evaluation Research Efficiency in the U.S. Environmental Protection Agency. Washington, DC: The National Academies Press, January 2008.

One specific BOSC recommendation for making the MYP a more effective communication tool was that Program plans should indicate where a line of inquiry has been, where it is now, and where it is going. This enables a reader to determine if the research is sequenced appropriately and to ensure relevance to current and future needs. The draft MYP is structured somewhat differently in that a desired state is presented, followed by recent accomplishments, and planned research. The Subcommittee still believes that the MYP would be improved by including an assessment of past accomplishments of the Program that have led to the current lines of inquiry. Given that the MYP addresses LTGs, some attention to a longer term perspective clarifying how the Program reached the current set of goals seems appropriate. This could be accomplished by including a couple of paragraphs as part of each LTG description elucidating how past research accomplishments have led to the current research direction.

The MYP also would benefit from a section showing linkages and collaboration with other ORD Programs, perhaps as a section under each LTG or as a stand-alone section. This would enable the reader to understand how the research in the WQRP relates to research being done in other ORD programs and may alleviate reviewer concerns that the Program is not giving adequate attention to certain important topics (e.g., invasive species and climate change).

Further comments on the MYP can be found in the responses to Charge Questions 2, 3, 4, and 5.

Recommendation 6—The sixth recommendation was to incorporate the biosolids program into one of the other LTGs rather than keeping it as a separate LTG. This has been done.

In summary, one of the six major recommendations has been accomplished, one has not been accomplished because of budgetary constraints out of the Program's control, and some progress has been made on the other four.

The remaining recommendations from the 2006 BOSC program review were divided into those dealing with: (1) relevance, (2) quality, (3) performance, (4) scientific leadership, and (5) coordination and communication.

Relevance—In response to the relevance recommendations, the Program has enhanced its interaction with the EPA regions. One specific recommendation was to develop a strategy for evaluating regional use of tools that the Program has developed, and it appears that this has been done largely through a Partner Survey and interactions with ASIWPCA. One shortcoming of the Partner Survey is the limited representation of state partners among the survey participants. A research tracking tool to assess progress toward LTGs (as called for in one recommendation) has been created for recreational water criteria development, although not for other aspects of the research program.

Quality—Neither of the two quality recommendations has been achieved. There has not been an effort for more systematic use of outside reviewers for Requests for Applications (RFAs) and there is no direct link to the grant program Web pages from EPA's main page, although there appears to be a fairly easy way to access Web-based information on open solicitations.

Performance—One performance recommendation was to establish a more systematic approach to communicating with clients, and that has been done by reconstituting a Water RCT and organizing a joint ORD/OW water research priorities meeting. The recent OW draft report on

research needs and management strategy demonstrates progress toward more effective coordination of water-related research in the Agency.

Scientific Leadership—With regard to scientific leadership, the BOSC recommended continued diversification of WQRP's research competence to address emerging issues while maintaining research in support of regulatory mandates. In a highly constrained budgetary climate, the Program appears to have focused its attention on maintaining research in support of regulatory mandates. The Program has been a leader in development of molecular methods, and this leadership should be documented in the metrics and materials provided to future review committees. The accomplishments of the Program were an important component of EPA's Report on the Environment, but here again the Program's leadership in these areas needs to be documented in future reports.

Coordination and Communication—The BOSC had three recommendations concerning coordination and communication. The first was to enhance technology and information transfer between STAR grants and ORD laboratories/centers. A brochure describing progress from the ECOHAB STAR grants program and a synthesis document are being prepared. Given the current lack of funding for STAR grants, further efforts to enhance information transfer do not seem warranted.

The second recommendation was to encourage ORD scientists to publish in higher tier journals. The bibliometric analysis shows some progress in this regard. Both percentage of papers considered "highly cited" and percentage in "high impact" journals rose slightly from 2005 to 2008—14.2 to 15.2% and 13.2 to 13.8%, respectively. The more detailed bibliometric analysis shows that first authors of many of the most highly cited papers and that most of the highly cited people were not EPA scientists. This indicates that EPA has been effective in engaging highly productive researchers, which is a positive development. Presumably, researchers in the WQRP were part of the research teams for the papers, although this was not clear in the analysis presented to the Subcommittee. In future bibliometric analyses, it would be useful to indicate the criteria used to determine what papers are included. The Program also may want to consider compiling bibliometric measures in separate categories such as research done by EPA scientists, research done by partners in collaboration with EPA scientists, and research funded by EPA but without direct participation by EPA scientists.

The third recommendation was to develop activities and metrics of success that encourage and track establishment of relationships with users that will result in better technology transfer. The Program has done an exceptional job of surveying user needs and will use those survey results to guide its communications strategy. It appears that the activities called for in this recommendation are being implemented, but metrics to track progress in technology transfer have not been developed.

III.2 Response to Charge Question 2

Charge Question 2: Do the revised LTGs provide a coherent framework for presenting research needs?

Working together, representatives of ORD, OW, and the regional offices identified specific research needs for the EPA WQRP. Three theme areas of client priorities were identified: Water Integrity, Watershed Management, and Source Control and Management. These priorities formed the basis for the revised LTGs. APGs and expected outcomes were developed by linking these priorities with detailed bench and field water quality science that laboratory and center scientists provided. By this approach, the LTGs meshed with the defined APGs.

Overall, the revised LTGs provide a plausible framework for specific research needs and goals required by stakeholders to effectively approach water quality issues. That is, the logical progression from definition of a problem using specific criteria, detection methods and modalities, prediction and causality, management, technological assessment, and measures of success are folded into the revised LTGs. ORD should be applauded for engaging research clients in the formulation of the revised LTGs. This mechanism provides a sound approach for promoting research goals that are in concert with the clients' needs.

Multiple APGs have been crafted to provide stakeholders with a better set of tools for addressing water quality problems. Although specific APGs are focused upon discrete attainable goals and thus contextually dwarfed by the number of issues at hand, the topics described clearly fit within the framework provided by the revised LTGs. It is recognized that the APGs listed may be disproportionately distributed in actual effort due to the breadth of topics and issues applicable to each LTG. For example, the number of issues addressed by LTGs 1 and 2 far exceeds that of LTG 3; however, although limited in number, the wastewater APGs of LTG 3 clearly address issues of critical importance and the potential for large-scale water quality impairment. A minor improvement of LTG 3 might include a clearer delineation of wastewater and biosolids as major, but not exclusive, topics of this LTG (LTG 3 addresses research and tools to characterize, control, and manage sources of water quality impairment in U.S. waters). Clearly, an artificial disconnect exists between LTGs 2 and 3. It is recognized that these LTGs may have come about as representative mandates or priorities of different clients. Future planning by ORD in regard to the MYP and LTGs may benefit from added emphasis on both a spatial and temporal perspective (further relevant discussion is found under the Response to Charge Question 5).

The annual updating slated for the MYP provides response flexibility within the MYP structure for not only the APGs, but potentially for the LTGs. This approach is encouraged. It is hoped that limitations in scope or application, as apparent by the documented APGs, will be balanced during annual revision.

III.3 Response to Charge Question 3

Charge Question 3: Does the Water Quality Research Plan adequately address critical research to meet the regulatory mandates of the Clean Water Act?

ORD makes it clear in the WQRP MYP that the Clean Water Act (CWA) contains the regulatory mandate for its major client, OW and OW's stakeholders. Because ORD's primary mission is to provide targeted research that forms the foundation for scientifically defensible environmental standards and regulations, the needs of OW's regulatory programs such as the National Pollutant Discharge Elimination System (NPDES), Biosolids Program, Total Maximum Daily Loads (TMDLs), and Headwater Streams and Wetlands, set the research agenda for the WQRP.

The Program's MYP focuses research (under LTG 1) on Aquatic Life Guidelines, Biological Assessment Approaches to Biocriteria and Tiered Aquatic Life Use, Nutrient Criteria, Multiple Stressors, Recreational Water Criteria, and Emerging Contaminants, reflecting WQRP's continued commitment to OW's core programs (criteria, standards, TMDLs, and permits). The MYP, however, recognizes that these same programs need fundamental research to change or modify regulatory paradigms. For example, the Recreational Water Criteria could use better microbiological methods and indicators for monitoring recreational waters as identified in the plan. This is but one example that supports the contention that the Program is addressing critical research needs. In addition, the WQRP responds to issues arising on CWA jurisdiction by initiating research on the hydrologic connections between headwater streams and wetlands.

As this Program is undergoing its mid-cycle review, an important indication that the WQRP is adequately addressing critical research to meet CWA regulatory mandates is reflected in the Partner Survey results. When asked about past MYPs (2003 and 2007) respondents were almost unanimous that the plans identified research directions to meet their needs. Respondents were positive about the value of planned research, and more than two-thirds of the respondents acknowledged the positive impacts of ORD research on their regulatory programs—a further indication the plan is addressing critical research needs.

Overall, the Subcommittee is satisfied that the WQRP MYP addresses critical research needed for OW to meet its regulatory mandates under the CWA.

III.4 Response to Charge Question 4

Charge Question 4: Does the proposed research adequately support watershed management and contaminant source control programmatic needs?

Watershed research is addressed in LTG 2, which received a lower level of satisfaction in the Partner Survey than other parts of the MYP. The September 2008 WQRP Progress Report indicates that the Program is substantially revising LTG 2 in response to this feedback. The Progress Report further refers to a workshop to refine LTG 2, with five new, as yet unwritten, watershed research directions that resulted from the workshop. Thus, the Subcommittee response may be of limited, interim applicability.

The most recent MYP represents a substantial change in the Program's approach to watershed research. Historic ORD efforts have focused on assessing the effects of, and the allowable limits for, individual stressors. In contrast, the foundation for watershed research in this MYP is that management priorities are established through assessment of overall conditions using biological response measures and then determining the stressors most responsible for the impairment. This structure leads to management emphasis on the highest priority stressors with a measurable goal of healthy aquatic communities. Embedded in the approach are two key concepts that move EPA in the proper direction. First, it provides a framework for physical stressor research. This is responsive to the numerous studies demonstrating that aquatic biological integrity often is more affected by hydrologic and temperature stress from watershed modifications than by chemical stressors. Second, the approach appropriately considers cumulative impact among multiple stressors, although only one APG addressing this is proposed in the MYP under LTG 1.

These concepts existed in pieces in the previous MYP, particularly the emphasis on biological condition research, but the new MYP logically links them into a conceptual framework that helps the Agency transition from a chemical approach to one that integrates biological assessment and source identification. The conceptual framework described in Figure 3 conveys this concept well to the regional offices, which the Program hopes will make use of the tools developed.

The Subcommittee, however, has some concern with the APGs supporting LTG 2. One of those concerns is that the APGs are at inconsistent levels, with some describing individual projects rather than the high-priority focal areas necessary to achieve the LTG. For example, the Gulf of Mexico hypoxia APG is useful, high-quality research, but the APG would be more appropriately portrayed as development of a national watershed nutrient control strategy, with the Gulf of Mexico being a project under that APG. Other projects in the MYP, such as those on harmful algal blooms, would be grouped naturally under such an APG and should be accompanied by a figure indicating how the projects are linked as a means for developing a national strategy.

There also is concern that several of the APGs appear to be carryovers from previous planning efforts, rather than the highest priority areas for supporting the new LTGs. For instance, the overarching importance of hydromodification as a watershed stressor is recognized in the LTG description, but there is no hydromodification APG and the individual projects still focus on chemical effects. There also is no work on invasive species effects, even though OW identified that as one of its priorities. In addition, there is little work on pesticide effects even though the watershed assessment studies conducted to date would appear to point the Program toward more work on that stressor. It was suggested that some of these project areas fall within the mandate of ORD's Ecological Research Program. If that is the case, the WQRP should present a more complete picture of its watershed research agenda by providing a linkage between this document and supporting programs in the Ecosystem Services Research MYP.

Although some revision of the APGs is still needed, there are several APGs for which the Program should be complimented. For instance, CADDIS, Analytical Tools Interface for Landscape Assessments (ATtILA), and the molecular microbiological tools directly address the need for diagnostic tools in the framework. Several of the best management practices (BMP) effectiveness projects appear to do the same, though with less project detail provided for evaluation. Additionally, the project area regarding headwater streams is a good response to an

immediate Agency concern. This research area deviates slightly from the core approach to stressor identification, but fills a critical Agency need.

The Subcommittee also was pleased to see the continuing technical support for the Environmental Monitoring and Assessment Program (EMAP), as adoption of this program by OW represents one of ORD's successes in technology transfer and is a cornerstone of the conceptual framework for biological assessments. The Subcommittee was concerned, however, that the description of that APG focused only on technical support rather than on continuing innovation in implementing biological assessments. The Subcommittee is aware of research efforts within the Agency focused on these advances, such as research on use of molecular methods for measuring stream invertebrates more rapidly and less expensively than traditional methods, and investigation of benthic cameras as a replacement for traditional benthic sampling in marine environments. Such projects were not described in this APG, however. Again, it is likely that such research is found in the Ecosystem Services Research MYP and the WQRP is advised to make the linkage between these programs apparent in the WQRP MYP.

The WQRP also should be commended for elevating technology transfer of the watershed tools to a high level of visibility. The Subcommittee had two concerns, however, with that part of the MYP. The first is that the only effort described is integrating with OW's proposed Watershed Central Web Site. This is a good project, but does not represent a comprehensive strategy for technology transfer. In particular, the Program should place greater emphasis on conducting its work in partnership with the states and regional offices as a means of effective outreach, as suggested in the 2006 BOSC program review. The Program has expanded its interaction with clientele in the planning process, such as through its interaction with ASIWPCA, but the BOSC program review recommendation was to create greater partnership in the actual conduct of the research. The MYP provides no evidence that this has occurred nor is it a focal point in the description of the Program's technology transfer activities. There also is little evidence of partnership with other federal agencies that can help the Program reach its clientele in this technical area. One example would be to partner with the National Oceanic and Atmospheric Administration's (NOAA) Coastal Zone Management Program, which is focused on many of the same watershed issues. This NOAA program has established effective outreach to many of the local management agencies. There also is little indication of how technology transfer activities would apply to the Program's extramural watershed research. For instance, the MYP places emphasis on the harmful algal bloom research conducted through the STAR Program. This research appears to be of high quality, addressing the underlying physiological factors that lead to blooms and to release of toxins. The MYP, however, fails to link this research to the Program's research on watershed inputs of nutrients; nor does it identify a means for how information from this research will be transmitted to the regional offices. The MYP could be improved by identifying a plan for pairing extramural research with EPA researchers responsible for that APG so that it becomes a more integrated part of the ORD research portfolio and communication strategy.

III.5 Response to Charge Question 5

Charge Question 5: Does the Water Quality Research Program provide an appropriate balance among its three LTGs?

As previously noted, the most recent draft WQRP MYP (August 2008) has been modified extensively from the MYP reviewed by the BOSC in 2006. As a result, three new LTGs replace the original four, and these have been modified, along with the associated APGs and APMs, presumably in response to the most recent OW management strategy (National Water Program Research Needs and Management Strategy 2008-2013), the Critical Path Science Plan for the Development of New or Revised Recreational Water Quality (August 2007), the EPA Planning Workshop on Innovation and Research for Water Infrastructure for the 21st Century, and additional meetings with and comments from stakeholders. The Subcommittee offers the following comments regarding the balance among these new LTGs.

Balance Among the Three LTGs

The first LTG is unchanged, and it focuses on the determination of water quality criteria. In the most recent version of the LTG, mention of beneficial uses has been dropped, and specific categories of criteria (habitat alteration, toxic chemical, nutrients, etc.) have been renamed.

The second LTG now contains everything that was in the previous second and third LTGs. Thus, whereas before there was a distinction and separation between watershed assessment and diagnosis of impairment, and protection and restoration of impaired waters and forecasting of future conditions, now they are combined (under the general title of Watershed Management). The resulting large LTG 2 has 33 APMs aimed at nine APGs. Although the reason for this change is not stated explicitly, presumably it was in response to items mentioned in the introduction or related to the previous overlap between the old LTG 2 and LTG 3 (i.e., many of the research products may have been applicable to both questions). Whatever the reason, a seemingly helpful distinction that corresponded to different temporal phases of the TMDL process has been lost with the collapsing of the two LTGs into one.

The former LTG 4 has been eliminated (as recommended by the BOSC), and been replaced by a new LTG 3 which appears to focus mainly on assessment and remediation of impairment related to point sources, particularly publicly owned treatment works (POTWs). The Subcommittee assumes that this decision was driven by programmatic needs and/or budgetary issues.

As it is, there is now considerable imbalance between LTGs 1, 2, and 3, with LTG 2 being considerably larger and broader in scope than the other two, and LTG 3 being extremely narrow. It would appear that the Program is attempting to define LTGs that overlap programmatically with its major clients: OW's Office of Science and Technology (OST), OW's Office of Wetlands, Oceans, and Watersheds (OWOW), and OW's Office of Wastewater Management (OWM). If this is the case, it would be helpful to include such a statement in the next draft of the MYP. The explanation provided on page 5 of the August 2008 draft of the MYP is not sufficient. If the intent is to have multiple LTGs that express different parts of an integrated whole, then the current organization of the MYP does not work as well as the previous incarnation. The setting

of water quality criteria and remediation of wastewater infrastructure are as much a part of watershed management as any of the items already addressed in LTG 2. By separating them out, there is the implication that LTG 1 and LTG 3 topics are independent of watershed management, which would directly contradict the Program's desire "to take a more integrated approach with regard to how research problems are solved by integrating the scientists' efforts to work together…" (p. 5, August 2008 draft of the MYP). Thus, the WQRP should consider, in its next iteration of the MYP, readopting the temporal organization that characterized the previous MYP, but with slightly more delineation between topics (LTG 1—setting of criteria; LTG 2—water body assessment; LTG 3—determination of sources of impairment; and LTG 4—remediation). Point sources should not be broken out as a separate LTG but rather integrated within LTGs 3 and 4. This would be consistent with the outline of watershed management found in Figure 5 of the August 2008 draft of the MYP.

Balance Within Each Individual LTG

LTG 1: Within LTG 1, there are six focus areas that roughly correspond to: (1) chemical criteria for aquatic life, (2) biocriteria, (3) nutrient criteria, (4) multiple stressors, (5) recreational water criteria, and (6) emerging contaminants. The research found in the APMs includes improving monitoring tools, trying to better understand the science (e.g., where certain pathogens are coming from), and properly setting the criteria. A good mix of these three factors might be considered "well-balanced."

Chemical Criteria for Aquatic Life—There are four APMs for aquatic life guidelines research, which focuses on the need to revise and update existing guidelines to reflect today's science and technology and enable the guidelines to be applied validly to a broader range and complexity of water contaminants now and into the future.

Biocriteria—The biocriteria research (four APMs) is a longer-term effort that includes work to establish linkages with various land and water use classifications. This effort will aim to develop integrative indicators that optimize and link to biological condition to adaptive watershed management approaches. Research on developing biological condition gradients will coordinate with nutrient efforts to better interpret how nutrients cause a biological response.

Nutrient Criteria—Nutrient research (four APMs) is aimed at developing and evaluating approaches to support nutrient criteria development for coastal receiving waters. It will extend the focus to include development and application of process-based ecosystem models at watershed and regional scales to support improvements in criteria development and watershed-based nutrient management in coupled watershed-estuarine-coastal ecosystems. It is not clear why this APG focuses so closely on coastal receiving waters, because nutrients are surely an issue in many inland waterbodies. This may be because past projects already have addressed parts of the LTG, or because budgets preclude certain activities.

Multiple Stressors—Multiple stressors research is a longer-term effort to develop broadly applicable methods and guidance to support the assessment of population-level risks. Only one very specific APM is provided. This suggests that the Program is not addressing this topic relative to the magnitude of the problem, as surely most waterbodies are affected by multiple stressors.

Recreational Water Criteria—Recreational water quality criteria studies and timelines were identified in the Critical Path Science Plan (CPSP) as the research that EPA needs to conduct in order to develop national criteria by 2012. Scientific studies identified in an August 2008 consent decree and settlement agreement require additional amendments of the research plan. There are six APMs with an emphasis on sewage discharges; however, epidemiological studies on the impacts of stormwater runoff to coastal water quality and human health should be an important issue that does not appear to be addressed under this LTG.

Emerging Contaminants—The last topic under LTG 1 is emerging contaminants research that addresses the long-term need to identify, prioritize, and evaluate new water quality contaminants of concern. Six APMs are directed mainly at pharmaceuticals and personal care products, which seems appropriate.

LTG 2: The section above already noted that this LTG suffers from being large and unwieldy because it combines what had previously been two separate LTGs. In the absence of any greater organization, LTG 2 must be examined APM by APM (indicated by number below). The projects look worthy, and within the subgroups (labeled in italics below), the balance seems reasonable.

Assessing Aquatic Condition

- ✧ APMs 137, 122: Integrative watershed modeling to look at how changing surface water quantity effects water quality at multiple scales.
- ✧ APMs 193, 178, 184, 201, 123, 124: Assessing hydrologic connections in headwater streams, adjacent wetlands, and isolated wetlands.
- ✧ APMs 192, 125, 123, 127, 128: Monitoring framework for assessing biological conditions of the nation's lakes, estuaries, and wetlands (part of the national survey work—wadeable streams has been completed).

Identifying Causes of Impairment

- ✧ APMs 38, 68: Molecular methods for microbial source tracking. EPA might consider addressing the larger topic of linking impairments to sources and land use practices.
- ✧ APM 191: Gulf of Mexico science. Although placed in LTG 2, regional case studies such as this have elements of each LTG, and thus are important to demonstrating the linkages between the various lines of research.
- ✧ APMs 358, 359, 43: Tools/models for predicting occurrence and impact of algal blooms.
- ✧ APM 214: Stressor identification (CADDIS).

Optimizing Interventions

- ✧ APM 175: Protocols for watershed restoration.
- ✧ APMs 136, 240, 39, 69, 70: Watershed management models (mainly) and measures in urban and rural settings.
- ✧ APM 100: Functioning of constructed wetlands.
- ✧ APMs 101, 107, 134, 59, 60, 64: Methods, tools, cost, and performance data regarding the geohydrologic processing functions for nutrients, sediment, and pathogens in watersheds. The ultimate goal is proper BMP selection. Under this topic, it is unclear how the proposed projects overlay with the five priority areas listed on page 25 of the August 2008 draft of the MYP (targeting watersheds, evaluating alternative strategies, creating incentives, BMP performance, and measuring results).

A final comment about LTG 2 is that the MYP adopts the terminology "Adaptive Watershed Management" to describe part of water quality management, but this is undefined and does not necessarily have hallmarks of adaptive management.

LTG 3: Two APMs (105 and 106) investigate aging infrastructure issues such as condition assessment and rehabilitation. A third APM (241) deals with "integrated collection system design," which is related to treating both wastewater and wet weather flows (i.e., blending). According to the August 2008 draft of the MYP, this also is supposed to encompass green engineering. The final APM (231) concerns sludge stabilization and involves the ongoing leadership and support of the Pathogens Equivalency Committee. (Note: There may be missing information from the Table of APGs provided to the Subcommittee because the August 2008 draft of the MYP indicates additional projects [3.1.3 and 3.1.4] that are not listed in the table.)

The title of the LTG, Source Control and Management, provides no substantive information and could be relabeled Point Source Control and Management if that is the true intent.

Finally, page 35 of the August 2008 draft of the MYP states that this LTG is supposed to help wastewater and storm water facility managers meet water quality goals, but there is no single project strictly devoted to storm water.

III.6 Response to Charge Question 6

Charge Question 6: Do the existing PART performance measures provide appropriate and quantifiable indices of progress? What improvement does the panel recommend?

The logic diagram in Figure 1 of the August 2008 MYP provides the basis for identifying the outputs and outcomes of the Program by which the success of the research activities in meeting the WQRP's ultimate goals can be assessed. The Program has ongoing activities to quantify the timeliness of its APMs with regard to its APGs and its outputs in terms of the quality, timeliness, and quantity of publications and reports through annual bibliometric analyses. An assessment of client use of tools and advice is obtained through the Partner Survey. These are appropriate and provide a basis for evaluating Program performance. There still is a need to develop metrics, however, for assessing environmental outcomes. The fact that the Program has shifted some research emphasis in its latest MYP draft suggests that priorities have changed, which may indicate that some environmental advances have been made such that specific concerns may have diminished. This type of information needs to be captured along with other indices of improving environmental conditions, controls, etc.

A more extensive Research Logic Model has been used Agency-wide, as described in the NAS report *Evaluating Research Efficiency in the U.S. Environmental Protection Agency* (see Figure 4.1 in the MYP). This very effective model describes research outputs as well as two levels of intermediate outcomes from clients such as OW and other end users of the research. Protection of human health and the environment are the ultimate outcomes with respect to the statutory mission of the Agency. In this context, it may be useful to differentiate intermediate outcomes categorically from: (1) research that has been conducted to meet congressionally or executively

mandated user needs, and (2) research that is anchored in a statutory requirement, such as the CWA.

Two examples can be provided, one of which is the contributions of the WQRP to EPA's Report on the Environment. Clearly, this is an intermediate outcome of research with high merit. The other example is the leadership of the WQRP in developing faster, more sensitive molecular methods for microbiological water quality assessment and the utilization of those approaches by states and water districts to limit beach exposure and reduction of waterborne illness. This latter example is capable of producing quantifiable metrics, if not now, then in the future; it is an excellent example of a user-generated intermediate outcome.

Linking specific intermediate outcomes to the research outputs for the two categorical drivers may make the research prioritization process more transparent, especially if resource allocation and investment decisions can be described clearly. Is it possible to describe the percentage of programmatic R&D funds invested in a research area as a function of research outputs and intermediate outcomes? If so, what parameters are used to guide those front-end investments (past history, executive order, statutory requirement, etc.), in relation to results, to guide further out-year investments (unaccomplished objectives, strong scientific outputs, positive outcomes, emerging issues, etc.)? This question suggests that some form of project life cycle assessment may be an appropriate aid to understanding aspects of process efficiency for the PART process.

The terms performance, process efficiency, and investment efficiency need to be clearly defined as per the NAS report (NAS, 2008) and used consistently across the R&D programs of ORD to aid review panels and experts in the PART process. The WQRP makes good use of outside review of program relevance and quality but further definition of performance relative to priorities is warranted.

III.7 Response to Charge Question 7

Please rate the progress made by the Water Quality Research Program in moving the program forward in response to the BOSC program review of 2006 by assigning a qualitative score as exceptional, exceeds expectations, meets expectations, or not satisfactory.

The Subcommittee had difficulty understanding how an ORD program could be expected to exceed expectations within the timeframe of a mid-cycle review, much less have any chance of being rated as exceptional, based on responding to the BOSC program review (the Subcommittee suggests that the BOSC Executive Committee re-think the criteria for these higher ratings and provide additional guidance to future mid-cycle review subcommittees). With this in mind the Subcommittee unanimously rated the progress made by the WQRP in response to the 2006 BOSC program review as **Meets Expectations.** The Subcommittee members determined that this rating was reasonable given that the Program has had to respond to several additional recommendations that have occurred since the BOSC program review, including a number of workshops (referred to under the preceding Charge Questions), mandates from consent decrees, and changes in client priorities/needs. These have impacted the speed and progress of Program actions that address the BOSC's recommendations. With that said, the Subcommittee does think that the Program is making an exceptional effort to obtain client input.

The Program needs to dedicate more effort to establishing a mechanism for quantifying long-term outcomes of the WQRP. Regarding the quality of research, the Subcommittee expressed the view that the Program was exceeding expectations in areas such as the application of molecular approaches to water quality issues and the development of tools to use weight-of-evidence approaches to assess causes of water quality impairment (e.g., CADDIS).

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IV. APPENDICES

Appendix A: Water Quality Mid-Cycle Subcommittee

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Appendix B: Subcommittee Charge

B·O·S·C
BOARD OF SCIENTIFIC COUNSELORS

September 2008

CHARGE
WATER QUALITY MID-CYCLE SUBCOMMITTEE

1.0 Objectives. The objectives of this mid-cycle review are:

- to evaluate the progress made by the Office of Research and Development's (ORD's) Water Quality Research Program relative to the commitments it made following its 2006 review, and
- to obtain advice and feedback on issues related to the future directions of the research program and performance and accountability.

2.0 Background Information. Independent expert review is used extensively in industry, federal agencies, Congressional committees, and academia. The National Academy of Sciences has recommended this approach for evaluating federal research programs.[2]

For the Agency's environmental research programs, periodic independent reviews are conducted at intervals of four or five years to characterize research progress, to identify when clients are applying research to strengthen environmental decisions, and to evaluate client feedback about the research. Mid-cycle evaluations are an important part of this program review process. Scheduled midway through the review cycle, these independent assessments give ORD an opportunity to gauge the program's progress relative to the commitments it made following its last review.

For the upcoming mid-cycle review, the Water Quality Research Program has prepared a progress report that will provide the context for our discussions during the meeting. The report outlines the work implemented by the program in response to the major recommendations from the BOSC 2006 review. The Water Quality Research Program Multi-Year Plan is undergoing revision and a copy of the revised plan is included with the progress report. In general, revisions to the MYP are consistent with the 2006 BOSC recommendations.

This review is not intended to be the in-depth technical evaluation as in a full program review. Presentation time will be minimized to allow discussion.

3.0 Draft Charge Questions for ORD's Water Quality Research Program. ORD is interested in receiving feedback concerning the following questions:

[2] Committee on Science Engineering and Public Policy. Evaluating Federal Research Programs: Research and the Government Performance and Results Act. Washington, DC: National Academy Press, 1999.

- Do the currently planned revisions to the Water Quality Research Program adequately address the 2006 BOSC review recommendations?
- Do the revised LTGs provide a coherent framework for presenting research needs?
- Does the Water Quality Research Plan adequately address critical research to meet the regulatory mandates of the Clean Water Act?
- Does the proposed research adequately support watershed management and contaminant source control programmatic needs?
- Does the Water Quality Research Program provide an appropriate balance among its three LTGs?
- Do the existing PART performance measures provide appropriate and quantifiable indices of progress? What improvements does the panel recommend?
- Please rate the progress made by the Water Quality Research Program in moving the program forward in response to the BOSC review of 2006 as exceptional, exceeds expectations, meets expectations, or not satisfactory.

For this last question, the BOSC Mid-Cycle Subcommittee is being asked to assign a qualitative score that reflects the extent to which the program is making progress in moving the program forward in response to the previous BOSC review. The score should be in the form of one of the adjectives defined below and is intended to promote consistency among BOSC program reviews. The adjectives should be used as part of a narrative summary of the review, so that the context of the rating and the rationale for selecting a particular rating will be transparent. For mid-cycle reviews, the rating should be based on the quality, speed, and success of the program's actions in addressing previous BOSC recommendations. The adjectives to describe progress are:

o **Exceptional**: indicates that the program is meeting all and exceeding some of its goals, both in the quality of the science being produced and the speed at which research result tools and methods are being produced. An exceptional rating also indicates that the program is addressing the right questions to achieve its goals. The review should be specific as to which aspects of the program's performance have been exceptional.

o **Exceeds Expectations**: indicates that the program is meeting all of its goals. It addresses the appropriate scientific questions to meet its goals, and the science is competent or better. It exceeds expectations for either the high quality of the science or for the speed at which work products are being produced and milestones met.

o **Meets Expectations**: indicates that the program is meeting most of its goals. Satisfactory programs live up to expectations in terms of addressing the appropriate scientific questions to meet their goals, and work products are being produced and milestones are being reached in a timely manner. The quality of the science being done is competent or better.

o **Not Satisfactory**: indicates that the program is failing to meet a substantial fraction of its goals, or if meeting them, that the achievement of milestones is significantly delayed, or that the questions being addressed are inappropriate or insufficient to meet the intended purpose. Questionable science also is a reason for rating a program as unsatisfactory for a particular long-term goal. The review should be specific as to which aspects of a program's performance have been inadequate.

Appendix C: List of Acronyms

APG	Annual Performance Goal
APM	Annual Performance Measure
ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
ATtILA	Analytical Tools Interface for Landscape Assessments
BMP	Best Management Practice
BOSC	Board of Scientific Counselors
CADDIS	Causal Analysis/Diagnosis Decision Information System
CPSP	Critical Path Science Plan
CWA	Clean Water Act
ECOHAB	Ecology and Oceanography of Harmful Algal Blooms
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
ESI	Essential Science Indicators
FACA	Federal Advisory Committee Act
LTG	Long-Term Goal
MYP	Multi-Year Plan
NPDES	National Pollutant Discharge Elimination System
NAS	National Academy of Sciences
NOAA	National Oceanic and Atmospheric Administration
ORD	Office of Research and Development
OST	Office of Science and Technology
OW	Office of Water
OWM	Office of Wastewater Management
OWOW	Office of Wetlands, Oceans, and Watersheds
PART	Program Assessment Rating Tool
POTWs	Publicy Owned Treatment Works
RCT	Research Coordination Team
RFA	Request for Applications
SAB	Science Advisory Board
STAR	Science To Achieve Results
TMDL	Total Maximum Daily Load
WQRP	Water Quality Research Program