September 30, 1999

EPA-SAB-EEC-99-019

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street SW
Washington, DC 20460

Subject: Review of 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan*.

Dear Ms. Browner:

The Wet Weather Flows and Urban Infrastructure Subcommittee of the Science Advisory Board's Environmental Engineering Committee met on February 25-26, 1999 to review 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan* in a public meeting in Washington, DC. In addition to the technical review of both plans, the Subcommittee considered the overall direction, quality, and coordination of the plans and associated research program and also evaluated coordination with the Office of Water and external research organizations.

The Subcommittee commends the Office of Research and Development and the Office of Water, for developing research plans on wet weather flows. The issue is important because wet weather flows continue to threaten water quality, aquatic life and human health. It is the unanimous view of the Subcommittee that implementing the research plans will generate information critical to improving US water quality. The decision to focus a substantial part of its efforts on investigating methods to reduce stressors such as pathogenic contamination is particularly well-considered because such contamination is the greatest water quality threat to US public health. The Subcommittee also compliments the Office of Research and Development for highlighting key infrastructure issues presently facing the US in the area of water supply and water quality protection.

The Subcommittee's detailed comments appear in the attached report. We would like to highlight several of our recommendations here.

a) Risk managers find it easier to understand and apply research findings when the results of individual projects are clearly integrated into a well-defined framework that assists decision makers. Such decisions

inevitably involve trade-offs between risk reduction and costs. The 1996 *Risk Management Plan for Wet Weather Flows* lacks overarching guidance on how the results from projects are to be used to support the EPA Risk Management Paradigm. Thus, one of the Subcommittee's major recommendations is that ORD develop a plan to ensure that risk reduction and costs are fully addressed within the context of wet weather flow research activities.

The Office of Research and Development should fully address costs and risk reduction in its wet weather flows research activities; this is our most important recommendation.

b) In order to provide a complete basis for regulatory action and decision making, the Agency should extend its present research effort into a variety of additional areas (e.g., differentiation between chemical and biological loadings, real-time data acquisition on WWF quality and quantity, temporal and spatial scaling issues, the role of colloids in WWF, automated control technologies, and WWF in coastal areas). A fundamental approach to research within the context of WWF applications should be undertaken such that the results of the work are broadly extensible.

c) In order to apply its limited resources in a cost-effective manner, ORD should develop a transparent methodology, based on the risk management paradigm, to prioritize its programs and projects.

d) In developing research programs and projects on wet weather flows, the Office of Research and Development, with the Office of Water, should implement the Agency's data quality objective process both earlier and more broadly. The data quality objective process and that incorporates an appropriately broad group of stakeholders will ensure that the relevant issues are identified and can be addressed. The process also conserves resources by ensuring that the data collection activities will be precisely those required to address the water quality decisions that must be made. Subsequently, a prioritization mechanism to ensure the most immediate and effective results should be implemented.

The Subcommittee encourages the Office of Research and Development and the Office of Water to continue coordinating their efforts and to build upon the success they have already enjoyed by gathering data on costs and risk reduction; implementing

the data quality objective process with stakeholder involvement; and considering watershed-specific applications. The Subcommittee looks forward to your written response to its report.

Sincerely,

/signed/
Dr. Joan Daisey, Chair
Science Advisory Board

/signed/
Dr. Hilary Inyang, Chair
Environmental Engineering Committee
Science Advisory Board

/signed/
Dr. Domenico Grasso, Chair
Wet Weather Flows and Urban
Infrastructure Subcommittee
Environmental Engineering Committee

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ABSTRACT

The Wet Weather Flows and Urban Infrastructure Subcommittee of the EPA Science Advisory Board's (SAB) Environmental Engineering Committee reviewed the Office of Research and Development's 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan*. Wet weather flows are one of the largest remaining threats to water quality, aquatic life and human health and the Subcommittee commends EPA for its initiative in developing these two research plans.

The Subcommittee's most important recommendation is that EPA fully address both risk reduction and costs within its wet weather flows research activities.

The five research areas identified in the 1996 *Risk Management Plan for Wet Weather Flows* are appropriate. However, the corresponding research efforts are too narrow and must be couched in the context of risk reduction. The Subcommittee makes specific suggestions for broadening the research program to improve the basis for risk management decisions. The 1997 *Urban Infrastructure Plan -- Water and Wastewater Issues* identified appropriate areas and addressed them in a thoughtful manner.

Keywords: wet weather flows, infrastructure, watershed management

U.S. ENVIRONMENTAL PROTECTION AGENCY
Science Advisory Board
Environmental Engineering Committee (FY99)

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1. EXECUTIVE SUMMARY

At the request of the Office of Research and Development (ORD), a specialized Subcommittee of the Science Advisory Board's (SAB) Environmental Engineering Committee reviewed the Agency's wet weather flow and urban infrastructure research plans. These documents are the 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan*.

In fulfilling its charge, the Subcommittee considered the overall direction, quality, and coordination of the research plans and program; conducted technical reviews of the two research plans; and considered coordination with EPA's Office of Water and with external research organizations. Appendix A contains the full text of the negotiated charge and Appendix B lists the documents reviewed.

The Subcommittee's major findings and recommendations follow.

a) Wet weather flows are one of the largest remaining threats to water quality, aquatic life and human health. The Subcommittee therefore commends NRMRL personnel for their efforts to address the complex problems associated with wet weather flows and for their initiative in developing these two research plans.

b) The 1996 *Risk Management Plan for Wet Weather Flows* has a critical lack of overarching guidance on how the results from projects are to be used to support the EPA Risk Management Paradigm. Thus, the most important recommendation of this review is that a plan be developed to ensure that risk reduction and costs are fully addressed within the context of wet weather flows research activities.

c) The 1996 *Risk Management Plan for Wet Weather Flows* identified five research areas to address various aspects of WWF issues:

1) characterization and problem assessment;
2) watershed management;
3) toxic substance impacts and control;
4) control technologies; and
5) infrastructure improvement.

These five areas are sufficiently broad to cover current and anticipated concerns and as such are appropriate.

d) Pathogenic contamination associated with WWF poses a significant threat to public health. The Agency has properly identified this as a major

area of research. However, additional research thrusts are required to provide a complete basis for regulatory action and better decision making or to develop appropriate technologies for monitoring and control. The Subcommittee therefore suggests the Agency consider more fundamental research initiatives that underpin the application of wet weather flow mitigation in the following areas:

1) differentiation between total loadings of chemical and biological contaminants and their impacts as a basis for setting standards and evaluating improvement;
2) improvements in our ability to obtain real-time information on WWF quality and quantity such as the development of pathogen-specific sensors;
3) the temporal and spatial scaling of physical, chemical and biological processes in wet weather flows and urban watersheds and the interactions with neighborhood, city, county and state institutions;
4) fundamental aspects of colloidal transport, origin, and composition, including a better understanding of the properties of cohesive sediments;
5) focused research on control technologies that can easily be brought on-line during storm events without operator intervention; and
6) impacts of wet weather flows in depressing salinities in coastal estuaries.

e) The 1997 *Urban Infrastructure Plan -- Water and Wastewater Issues* identified and addressed major areas in a thoughtful manner. To strengthen this research plan and sharpen its focus, the Subcommittee recommends that:

1) the purpose and aim(s) of research be clearly defined and linked to research needs on both capacity and integrity issues of infrastructure systems (this will also help prioritize research needs); and,
2) engineering and science issues on infrastructure systems, with regard to sustainable technology development, be clearly identified before developing detailed research needs.

Additional research areas that should also be considered include:

1) infrastructure systems for greenfield sites; and

2) impacts of seasonal and regional differences on infrastructure systems and natural and man-made disasters on infrastructure systems, industry specific infrastructure issues, and impacts of natural and man-made disasters.

f) To enhance the value of its research programs to Agency needs, the Subcommittee encourages NRMRL to develop a more formal process through which research programs and projects that address the technical research needs of individual program offices may be identified, e.g., balancing Office of Water technical research needs, which include a strong programmatic focus on nonpoint source pollution issues, with ORD's present emphasis on point source pollution control. In order to apply its limited resources in a cost-effective manner, ORD should develop a transparent methodology, based on the risk management paradigm, to prioritize its programs and projects.

g) ORD should employ the data quality objective process earlier and more broadly in program and project development. The data quality objective process is not for the scientists only; it is a useful way to engage decision-makers in research planning. Implementing the process early and broadly ensures that the interest of all relevant stakeholders are addressed. The process also conserves resources by ensuring that the data collection activities will be precisely those required to address water quality decisions.

h) Although the Office of Water and the multi-agency 1998 Clean Water Action Plan recognize the unique water issues associated with tribal lands, neither research plan addresses tribal issues. The Subcommittee encourages ORD to develop water related research programs that are broad based and whose results would be applicable to tribal lands as well as other areas of the United States. In some instances, water quality issues associated with tribal lands are substantially different from those facing other parts of the US. These differences are particularly apparent when addressing the issues of total maximum daily loads (TMDLs) and drinking water system management. Therefore, substantial research efforts directed specifically at addressing water issues involving Native American communities should be added.

i) Finally, the rural (agricultural), urban, and environmental components of risk from wet weather flows need to be systematically addressed at the watershed level. Establishing surface/ground water interactions is a prerequisite for understanding these relationships and developing protocols for retention and processing of wet weather flows.

2. INTRODUCTION

Wet weather flows remain one of the largest threats to water quality, aquatic life, and human health. The Office of Water's *National Water Program Agenda for 1998-9* relates many of the serious water pollution problems remaining throughout the country directly to polluted runoff. Similarly, ORD's 1996 *Risk Management Plan for Wet Weather Flows* recognizes the seriousness of wet weather flows and addresses three types of untreated urban discharges that occur during storms: combined sewer overflows, stormwater sewer overflows, and sanitary sewer overflows.

The Office of Research and Development's (ORD) National Risk Management Research Laboratory (NRMRL) plans and conducts research on the risk management aspects of urban wet weather flows. This work is largely conducted by NRMRL's Water Supply and Water Resources Division, especially the Urban Watershed Management Branch. ORD requested SAB review of the 1996 *Risk Management Plan for Wet Weather Flows*. After an introductory briefing to the Environmental Engineering Committee on December 1, an expanded charge was negotiated that included review of the 1997 *Urban Infrastructure Research Plan.*

In fulfilling its charge, the Subcommittee considered the overall direction, quality, and coordination of the research plans and program; conducted technical reviews of the two research plans; and considered coordination with EPA's Office of Water and with external research organizations, including the Water Environment Research Foundation and the American Society of Civil Engineers. Appendix A contains the full text of the negotiated charge and Appendix B lists the documents reviewed.

The documents listed in Appendix B were submitted to the Subcommittee at or prior to the review meeting on 25-26 February 1999 at EPA Headquarters in Washington, DC. In preparation for the February meeting, two telephone conference call were held. On the January 15, 1999 conference call, the chair divided the Subcommittee into three working groups (see Appendix C) to address various aspects of the charge. The February 9, 1999 conference call was a publicly announced FACA meeting where additional fact finding was pursued and initial findings discussed. This report presents the consensus comments in response to the charge given to the Subcommittee.

The body of this report is comprised of three sections: a) Directions, Quality, Coordination; b) Review of 1996 *Risk Management Plan for Wet Weather Flow* and the 1997 *Urban Infrastructure Research Plan - Water and Wastewater Issues;* and c) *Office of Water* Needs and Coordination. Each section presents the findings of the Subcommittee and associated recommendations.

3. DIRECTIONS, QUALITY, AND COORDINATION

The ORD asked that the Subcommittee assess the direction, quality and coordination of research being planned and implemented.

ORD's plans are described in the 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan - Water and Wastewater Issues*. Research implemented and research completed were described in additional documents provided by ORD, listed in Appendix B. In considering internal coordination issues, the reviewers relied on the Office of Water's "National Water Program Agenda--1998-1999", interactions with Office of Water staff at public meeting, and the familiarity of some reviewers with the Clean Water Action Plan. In considering coordination with outside research organizations, the reviewers relied on their own experience regarding research funded by the National Science Foundation, the American Society of Civil Engineers, and the Water Environment Research Foundation. Water Environment Research Foundation staff also provided a written summary of twenty-three projects completed, on-going, and initiating along with a description for each of the projects.

The 1996 *Risk Management Plan for Wet Weather Flows* is a balanced research plan, taking a reasonable approach on many important issues. The overall goal of reducing risk from wet weather flows, as stated in 1996 *Risk Management Plan for Wet Weather Flows*, is to protect human health and the environment. While the research plan focuses on the risk management portion of the risk assessment/risk management paradigm, it included elements of risk characterization, dose-response and exposure. The research plan addresses five logical and well-chosen areas. These are:

a) characterization and problem assessment,
b) watershed management,
c) toxic substance impacts and control,
d) control technologies, and
e) infrastructure improvement.

The individual projects represent the Agency's best thinking on research needs while attempting to balance the pragmatic problem of allocating sufficient resources. Resource constraints are relieved somewhat by leveraging research money with funds from other agencies and municipalities.

Portions of the research plan could be better defined. A better definition of the program's destination and a road map outlining how to "get there", would allow the reader both to better understand what this research program intends to achieve and to measure progress along the way. Research needs currently focus on urban wet weather flows issues leaving the many suburban, rural and agricultural wet weather

flows problems unaddressed. The characterization & problem assessment area and the watershed management area can be strengthened.

The research plan is largely implemented by ORD's Urban Watershed Management Branch. The Branch describes its mission as ". . . to research, develop and demonstrate technologies, systems and methods required to manage the risks to public health, property and the environment from Wet Weather Flows. We provide high quality data and information to our clients in appropriate formats." Research program documents included state-of-the-science reviews, a list of research questions, a list of research needs for each question, and a list of in house and extramural projects.

The research program is intended to meet the following eight Branch objectives:

a) Develop and deliver high quality products and support to clients.
b) Implement the 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan*."
c) Present and publish results as much as possible as sole or primary authors in peer reviewed journals.
d) On a voluntary basis, establish individual development plans.
e) Improve branch facilities for conducting research.
f) Maintain and expand ties with universities.
g) Enhance communication with other NRMRL locations and other external contacts electronically.
h) Improve use of diminishing extramural resources.

These eight Branch objectives constitute the core of the research program. The objectives and the associated activities are consistent with the list of projects. The work of the branch connects to the research plans and, thereby, to EPA's watershed and risk management goals. The Subcommittee would like to see the connection with the overarching EPA watershed and risk management goals made more transparent. This is especially important because the plan for meeting these objectives (prioritized and revised) is critical to the success of the ORD's Urban Watershed Management Branch program.

3.1 Findings

3.1.1 Research Quality

The Subcommittee commends the research staff of EPA for publishing on the topic of wet weather flow over the years. In FY98 the research staff published more than a dozen papers relevant to wet weather flows and urban infrastructure; these papers appeared in peer reviewed journals and peer reviewed conference proceedings.

The journals include Water Resources Planning and Management of the American Society of Civil Engineers, Environmental Science and Technology, and Journal of the American Water Works Association. Other years are similar in terms of productivity and journal quality. Branch staff have also summarized the literature on wet weather flow for the annual Water Environment Federation Literature Review. The staff has published their research plan in Water Resources Planning and Management, ASCE May/June 1998.

Because the publications have appeared in peer reviewed journals, the Subcommittee is satisfied that the articles and citations provided indicate that research completed thus far has been of acceptable quality, applying the following standard:

> *As performed by the technical community, peer review is the expert scrutiny of a technical report by professionals in the same field of expertise for independent confirmation that (1) the report is presented in a technically sound, understandable and internally consistent manner; (2) the observations made were obtained by methods approved by the particular scientific discipline; and (3) the communication as a whole is a worthwhile contribution to the discipline.* (Issues in Peer Review of the Scientific Basis for Regulatory Decisions, p 5)

3.1.2 Research Direction

The ultimate purpose of the 1996 *Risk Management Plan for Wet Weather Flows* is to provide the information managers need to reduce risk. The overall direction, then, is risk reduction.

For almost two decades EPA has used the risk assessment/risk management paradigm to organize many of its activities. ORD, for example, has reorganized itself according to this paradigm. Risk assessment is the characterization of potential adverse effects of exposure to environmental hazards while risk management is the process of evaluating alternative regulatory actions and selecting among them. (NRC, 1983) Just as research is needed to better understand the nature and degree of risk, research is also needed to provide managers with options for risk reduction. The latter generally takes the form of research on sources, source reduction, and control technologies. While risk managers must consider economic, political and social constraints as well as inputs from science and engineering, a sound understanding of the risks and options for reducing them is essential.

In FY96, the Science Advisory Board reviewed the first *Strategic Plan for the Office of Research and Development.* The Board was pleased to note that the *Strategic Plan* was built around the risk characterization/risk management paradigm, as was suggested in the past by various review bodies, and includes communication as a

necessary step. However, while the SAB perceived the use of the risk characterization paradigm as a strength of the *Strategic Plan*, it also cautioned that the paradigm is limited because of its relative inability to detect emerging environmental problems, integrate new approaches and technologies, and address prevention of environmental problems.

The Subcommittee recommends that the revised research plan for wet weather flows make greater use of the risk management paradigm as an overarching framework for linking stressors with effects and determining appropriate endpoints to be measured. The Agency will need to be vigilant to see that research on risk reduction options is not diminished in this process.

Further, the revised research plan should explicitly acknowledge that the paradigm should be applied on a watershed-specific basis. The Subcommittee believes this recommendation is consistent with *The Clean Water Action Plan*. Application of the paradigm means, at a minimum, that risks and the costs and benefits of associated risk reduction options should be quantified.

Upon review of the project mix for wet weather flows research, the Subcommittee remains unsure about whether the current research program identifies various risk reduction options and quantifies various costs and benefits. The Subcommittee views the costs and benefits of the options as very important issues. While eight projects (1.4 through 1.10, 3.5) appear to be directly concerned with risk assessment, these refer principally to “impacts” or “effects”. For example, Project 4.5 (Wet Weather Flows Physical Stressors) will report on impacts such as habitat destruction, sedimentation and bank erosion; Project 1.7 (Small Stream Impacts) refers to receiving water impairment; Project 1.8 (Large River Pollution) looks for impacts within a watershed; and Project 1.9 (Evaluation of Health Risks) focuses on the persistence and fate of pathogens and toxicants. Pathogenic contamination has been identified as the greatest water quality threat to U.S. public health (An SAB Report: Safe Drinking Water, Future Trends and Challenges, EPA-SAB-DWC-95-002, March 1995, First Report from the Science Advisory Board Lookout Panel: Focus on Water Issues, EPA-SAB-EC-LTR-97-003). Consequently the Agency is encouraged to continue and considering expanding its research effort in the area of disinfection and pathogen control. How the information gathered is to be translated into risk, and how these risks are to be compared is not apparent. It appears that neither a common basis for quantifying risk, nor common measures of risk, are being utilized. Moreover, the assessment of costs does not appear to occupy a central position in the research plan. Only Projects 5.1-5.7 refer directly to cost and benefits of various sorts. Those projects which are included in the Control Technologies area (4.1-4.36) -- while interesting as possible wet weather flows control options -- appear to completely ignore costs. Most might more correctly be viewed as projects for technology demonstration, the costs and benefits of which are of secondary importance.

3.1.3 Research Coordination

The Subcommittee commends the Branch on coordinating its programmatic efforts with other organizations such as Water Environment Federation, Water Environment Research Foundation, and American Society of Civil Engineers. This coordination is consistent with the stated goal (page 8) of providing information and products to the end users (the "clients"). The Branch has developed outreach programs to assist its clients; the Subcommittee finds that this effort is continuing at an appropriate level.

The Subcommittee finds the following questions to be useful and suggests that ORD use them to put wet weather flows research into an ecological risk context that can be coordinated with programs managed elsewhere within EPA.

a) What is the current condition of the environment, and what stressors most significantly affect the condition? (monitoring research);

b) What are the biological, chemical, and physical processes affecting the exposure and response of ecosystems to stressors? (process and modeling research);

c) What is the relative risk posed to ecosystems by these stressors, alone and in combination, now and in the future? (risk assessment research); and

d) What options are available to manage the risk to restore degraded ecosystems (management and restoration research).

These questions are all pertinent to wet weather flows research and should be an integral part of programmatic objectives. If wet weather flows research cannot be placed in the ecosystems context, then the benefits of risk reduction will be ambiguous and States and municipalities are unlikely to fund wet weather flow work. Therefore -- whether the research is conducted under the auspices of the ORD's Urban Watershed Management Branch or supplemented by other partnerships -- the wet weather flows research should focus on the achievable and demonstrable risk reduction goals.

ORD emphasizes contaminant control technologies for wet weather flows, but when opportunities for cooperation or collaboration exist, ORD undertakes watershed management-oriented projects such as the Columbus, Georgia combined sewer overflows project (4.26). This project includes assessment of receiving water benefits provided by solids removal and disinfection. Even though such studies do not include all stakeholders within the watershed, valuable information can be attained when

isolated contributing sources of contaminants, and their reduction, can be assessed at full-scale operating facilities.

3.1.4 Summary and Recommendations

The success of a research plan of the size, diversity, and complexity of the 1996 *Risk Management Plan for Wet Weather Flows* depends on transferring the research findings into practice. This means the findings must be understood and applied to reduce risk. While an important sub-set of these risk managers are EPA program and regional staff, managers outside the Agency also make resource, policy, and other decisions relating to reducing risk from wet weather flows. Consequently, the research plan should be constructed such that findings and recommendations are broadly applicable to a variety of end-users.

Risk managers find it easier to understand and apply research findings when the results of individual projects are clearly integrated into a well-defined framework that assists decision makers. Such decisions inevitably involve trade-offs between risk reduction and costs. The 1996 *Risk Management Plan for Wet Weather Flows* lacks overarching guidance on how the results from projects are to be used to support the EPA Risk Management Paradigm. Thus, one of the Subcommittee's major recommendations is that ORD develop a plan to ensure that risk reduction and costs are fully addressed within the context of wet weather flow research activities.

4. REVIEW OF THE *1996 RISK MANAGEMENT RESEARCH PLAN FOR WET WEATHER FLOWS* AND THE *URBAN INFRASTRUCTURE PLAN -- WATER AND WASTEWATER ISSUES*

The 1996 *Risk Management Research Plan for Wet Weather Flows* describes key objectives and research questions under each of the five overarching research areas. The document also describes on-going research that addresses these objectives and research questions. A draft of the 1996 *Plan* was peer-reviewed by the Urban Water Resources Research Council of the American Society of Civil Engineers (ASCE) and the Water Environment Research Foundation (WERF). Comments were also requested of over one hundred members of the Urban Wet Weather Flows Federal Advisory Committee and its subcommittees. ORD considered the comments, incorporating many of them, in the 1996 *Plan* released in November 1996.

The Subcommittee's review of the 1996 *Plan* considered the appropriateness of the objectives and research questions categorized by research area. Although the 1997 *Urban Infrastructure Plan* had not received prior peer-review, the researchers did invite the Civil Engineering Research Foundation to review an earlier draft. CERF provided comments which were incorporated into the version of the plan reviewed by the Subcommittee. The *Urban Infrastructure Plan* is more preliminary in nature than is the 1996 *Risk Management Research Plan for Wet Weather Flows* and complements it by detailing objectives and research needs in the fifth research area, wet weather flows infrastructure. Findings and recommendations regarding the 1997 *Plan* also follow.

4.1 Findings and Recommendations: 1996 *Risk Management Research Plan for Wet Weather Flows*

4.1.1 Research Objectives and Questions

The 1996 *Plan* addresses five logical and well-chosen areas. In this section, the Subcommittee's comments correspond to this structure.

4.1.1.1 Characterization and Problem Assessment.

The 1996 *Plan* considers differences in wet weather flows between storm events, differences in contaminants that may originate from different land-use areas, and other sources of temporal and spatial variability. The Subcommittee recommends that the revised plan explicitly consider temporal and spatial scales as they affect loadings, impacts, and management.

The need to "develop and validate chemical-specific sediment quality criteria" is critical. This is expressed under research needs in this section as the need to "Review, improve and develop monitoring methodologies and equipment to measure the

characteristics and impacts, including pathogenicity of wet weather flows." To properly support this goal, specific consideration of chemical speciation, partitioning and transport with the colloidal phases, and the bioavailability of individual species compared with total concentrations is needed. More advanced instrumentation for on-line analysis of pathogens, microcontaminants, and the impacts of these contaminants (e.g., bioavailability) is needed to better quantify wet weather flow sediment characteristics.

Relatively little is known about the origin, composition, transport, and fate of colloids in wet weather flows. Understanding the extent, kinetics, and reversibility of partitioning of chemicals to colloidal phases is central to understanding toxicity, bioavailability, and persistence. Moreover, a better understanding of colloidal processes would contribute to our understanding of "sources of sediment in urban areas as well as the deposition and scour of sediment in sewers and channels." (1996 *Risk Management Research Plan*, p. 13) Descriptions of the deposition, resuspension and mechanics of cohesive sediments remain highly empirical. The higher concentrations of contaminants such as metals per mass of solids that are typically observed in fine-grained sediments suggest that a better understanding of colloidal phases in wet weather flows and the formation of cohesive sediments is needed to better define contaminant speciation

4.1.1.2 Watershed Management

The 1996 *Plan* appropriately identifies the urban component as being dominant in many watersheds, and underscores the need to analyze likely sources and magnitudes of pollutants in a manner that is not only land-based (e.g., run-off), but also tracks specific materials and activities. This is likely to be a productive approach that should be augmented by a consideration of the role of overall urbanization. Issues such as zoning, residential housing, and industrial development, as well as transportation, and other components of the urban infrastructure should be addressed in concert with a materials- and activity-based analysis of the sources of contaminants in wet weather flows. The 1996 *Plan* also appropriately identifies the need for estimating the atmospheric contributions (both wet and dry) of pollutants to a watershed as a key research topic.

The Subcommittee recommends that ORD consider the role of, "non-wet weather flows infrastructure" (e.g., atmospheric deposition), in creating or mitigating wet weather flows and associated contaminants.

The 1996 *Plan* considers the impacts of physical and chemical stressors and the assimilative capacity of urban watershed ecosystems, the interactions between stressors, in particular combinations of physical and chemical stressors require greater attention. An approach that considers the role of a given activity (e.g., residential

construction or the development of non-wet weather flows infrastructure) in stressing ecosystems, for example through changes in the urban hydrograph and accompanying increases in sediment and contaminants, will be helpful in designing management strategies. In coastal areas, a major (often the major) impact of wet weather flows is depressed salinity in receiving estuaries. Such salinity dilution may be equally important as impaired water quality for developing retention capacity for wet weather flows.

4.1.1.3 Toxic Substances Impacts and Control

In this research area the research needs and proposed activities are well-matched. For example, the 1996 *Plan* underscores the need to identify sources of toxic substances as well as effective means or treating wet weather flows or measures to prevent pollution. The importance of dissolved and colloidal materials and the difficulties associated with treatment are appropriately discussed. Again, the importance of the atmospheric sources is highlighted. Although proposed research activities cover appropriate areas, tit is unclear that research work addressing specifically toxic substances merit special consideration apart from other risks in wet weather flows.

4.1.1.4 Control Technologies

The integrative approach of the 1996 *Plan* is appropriate and properly includes control options that integrate with management strategies and system operation. The 1996 *Plan* recognizes that the highest returns in implementing new technologies are likely to include combinations of wet weather flows routing hardware and software, as well as acknowledges the need to develop and demonstrate high-rate treatment technologies.

The technologies currently under investigation include several processes (e.g., high rate sedimentation) that appear to be poorly suited for the stormwater runoff. Because water quality changes rapidly during storms, processes requiring the addition of coagulants or other reactants will be handicapped by the need to determine chemical doses. These processes will be difficult to bring on-line and adapt to changing influent conditions. Research on control technologies should therefore focus on more robust technologies that can be easily automated.

Conspicuously missing from the list of technologies to be evaluated are membrane processes. The ease in automating these processes, potential cost advantages, and the previously stated importance of dissolved and colloidal phases in determining wet weather flows quality, suggest that membrane technologies should also be evaluated.

4.1.1.5 Infrastructure Improvement

Research questions and needs are notably underdeveloped in this section. ORD recognized these weaknesses and addressed them in the 1997 *Urban Infrastructure Research Plan – Water and Wastewater Issues*. The 1997 *Plan* is more preliminary in nature and complements the *1996 Risk Management Research Plan for Wet Weather Flows* in detailing objectives and research needs in the fifth research area, wet weather flows infrastructure. The Subcommittee's review appears in section 4.2 immediately below.

4.2 Findings and Recommendations: 1997 Urban Infrastructure Research Plan -- Water and Wastewater Issues

4.2.1 General Findings and State-of-the-Science Write-Ups

The development and execution of a research plan for wet weather flows infrastructure is complicated by the very nature of the infrastructure. These systems are large, complex, and often inaccessible. Experimental plans to study the system are forced to be designed to minimize (or avoid if at all possible) any disruption of service. Because of this, the area of infrastructure seems to have been studied the least among the major areas identified in the *1996 Risk Management Research Plan for Wet Weather Flows*. Nonetheless, the contents in *the Urban Infrastructure Research Plan – Water and Wastewater Issues* were well thought out and developed to identify and address all major areas of research despite the lack of sufficient background materials. However, the plan needs a sharper focus and clear links between its research purposes and needs, as indicated below.

First, if the authors started with a well-defined research purpose and then developed appropriate research needs that are consistent with the purpose the research plan would be more focused and clear. This could be easily accommodated because most of research needs were well thought out and developed in the plan; it would require revising research questions to both state the purpose of research and identify and develop appropriate research needs. Some suggestions on revising research questions follow in Section 4.2.2 - Research Objectives and Questions

Second, the ultimate aims of this research plan are unclear (i.e., what does this research aim to protect?). The plan mentions "the environment," "public health," and "safety" without defining or prioritizing these objectives. A flow chart showing the relationships among the purpose, aim(s), and needs could clarify this.

Third, this research plan covers a very ambitious range of issues that may require either an expanded extramural research program to supplement its in-house capabilities or a reduction in the scope of the plan consistent with available resources.

4.2.2 Research Objectives and Questions

Research questions and needs should follow from a well-articulated purpose for the research. To define the purpose, several questions should be asked. First, what is this research plan is trying to protect? Is it water quality, public health in general, public safety, natural resources, or if a combination, what is the prioritization? The direction of this research plan depends on the answer to this question. The second question should be "Why is the infrastructure system important to water quality? The answer could be that it is because the infrastructure system stores and conveys potentially harmful contaminants from sources to treatment facilities. Furthermore, if the capacity and integrity of the infrastructure system are not adequate, these contaminants could adversely affect water quality (both surface water and groundwater) through leaks and overflows that may be harmful to human health and the environment. Although the impact of wet weather flows on human health and the environment is not included in the *1996 Risk Management Research Plan for Wet Weather Flows*, clear connections should be made and emphasized more to strengthen the purpose of this research plan. Once, the purpose of the research plan is clearly stated, research questions and needs can be logically developed and prioritized to be consistent with the research purpose. Again, this suggestion does not significantly alter the content of the plan but rather it would help focus and clarify the plan.

4.2.2.1 Building Capacity and Maintaining Integrity.

The following comments relate to the sections:

a) Conveyance Systems -- Petroleum and Chemical
b) Conveyance Systems -- Stormwater and Wastewater
c) Storage Systems -- Potable Water
d) Storage Systems -- Petroleum/Chemical, and
e) Storage Systems -- Stormwater and Wastewater.

These sections of the 1997 *Plan* address the best approaches to build and maintain infrastructure systems. For example, for the section of Conveyance Systems - Potable Water, the research question posed was "What are the best approaches to design, construct, maintain, and rehabilitate water distribution systems and to ensure water quality in urban settings?"

It might be more fruitful to begin with a different statement explaining why water distribution systems are important to the quality of drinking water. This question will lead to other questions addressing the role of the "capacity" and "integrity" of the distribution system on water quality. Then, a series of research objectives (many of them were already described in the plan) can be developed to address these "capacity" and "integrity" issues.

The "capacity" issues can incorporate overflows of chemicals, stormwater, and sanitary wastewater, whereas the "integrity" issues can include leaks, leak detection, groundwater infiltration, chemical and biological reactions in the system, material specifications, construction methods, corrosion, and rehabilitation.

4.2.2.2 Hot and Chilled Water and Steam.

The section of the 1997 *Plan* “Conveyance Systems -- Hot and Chilled Water and Steam” was unclear on how this infrastructure system affects water and wastewater issues other than those related to the conservation of energy and water resources.

4.2.2.3 Sustainable Development.

The 1997 *Plan* struggled to define the meaning of "sustainable development” in the context of urban water and wastewater infrastructure systems. The research question posed in the section “Sustainable Technology Development” was, "What are the parameters associated with “sustainable” water and wastewater systems, and how do we apply these parameters to the design, installation, operation, and maintenance of these systems?" This question only underscores the difficulties in arriving at an appropriate problem definition.

The 1997 *Plan* would benefit from using the classic definition of sustainable development.

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.* (World Commission Environment and Development, *Our Common Future*, Oxford University Press, Oxford, 1987)

Within the context provided by this framework, the plan can first define the role of urban water and wastewater infrastructure in sustainable development and then develop the relevant science and engineering issues associated with the role. Without this framework, it may be premature to discuss infrastructure system research needs. Otherwise, the *Plan* may simply appear to be a repackaging of old issues, such as recycling, reuse, waste reduction, resource conservation, etc., without clearly linking them to sustainable development.

It is important for the plan to address new infrastructure systems. Although the *Plan* mentions infrastructure systems for greenfield sites, it does not discuss them at length. This may be an area where the *Plan* could incorporate some or all of the sustainable development concepts. In revising the *Plan*, the authors should look toward the most environmentally and economically sustainable infrastructure systems that can be built in the future (e.g., in the next few decades). This will define the upper

limit of infrastructure systems. A good example of this planning process is seen in the automotive industry's efforts to develop the next generation of power plants for automobiles (e.g., batteries and fuel cells) replacing internal combustion engines.

Other areas that should also be considered include:

a) seasonal issues (e.g., differences between summer and winter storms);

b) regional issues (e.g., effects of road salts used in winter in the Midwestern and Eastern states on infrastructure systems, regional differences in storms, etc.);

c) industry-specific issues (e.g., industry-specific stormwater runoffs and their control and, possibly EPA-industry cooperative research projects);

d) natural disasters (effects of earthquakes and floods on infrastructure systems);

e) man-made disasters or damages (e.g., impact of possible terrorist activities on infrastructure systems, effects of construction activities on infrastructure systems, etc.); and

f) others (e.g., water quality changes in potable-water storage reservoir, not tanks).

4.3 Summary and Recommendations

The five research areas are sufficiently broad to cover current and anticipated concerns with Wet weather flows and as such are appropriate. However, there are key issues within some of these research areas that have not been sufficiently articulated and do not appear to be the subject of research efforts. There has been considerable work supported under recent EPA/National Science Foundation initiatives dealing with watersheds that should be making its way into the literature. Bibliographies and state of the science write-ups should be updated to reflect these studies where appropriate. Similarly, results from recent NSF initiatives on urban infrastructures should be integrated into the research plan, particularly in the area of Infrastructure Improvement. *In all cases, research plans should highlight the need for long-term, fundamental research that will advance our ability to regulate and monitor based on sound science.*

Because the five designated research areas are so broad, almost any combination of research projects within a limited budget is likely to fall short of meeting all needs within a given research area. Nonetheless, the research efforts represent an inadequate investment in defining wet weather flows problems, providing a sound basis

for regulatory action and better decision making, and developing technologies for monitoring and control. In the 1996 *Risk Management Plan for Wet Weather Flows*, the Subcommittee has identified several areas in which specific research efforts should be considered:

a) Differentiation between total loadings of chemical and biological contaminants and their impacts as a basis for setting standards and evaluating improvement;

b) Improvements in our ability to obtain real-time information on Wet weather flow quality and quantity such as the development of pathogen-specific sensors;

c) The temporal and spatial scaling of physical, chemical and biological processes in wet weather flow and urban watersheds and the interactions with neighborhood, city, county and state institutions;

d) Fundamental aspects of colloidal transport, origin, and composition, including a better understanding of the properties of cohesive sediments;

e) Focused research on control technologies that can easily be brought on-line during storm events without operator intervention; and

f) Impacts of wet weather flows in depressing salinities in coastal areas.

In the 1997 *Urban Infrastructure Plan -- Water and Wastewater Issues* all major areas were identified and addressed in a thoughtful manner. Recommendations are made here to strengthen the plan and sharpen its focus. They are:

a) The purpose and aim(s) of research need to be clearly defined and linked to research needs on both capacity and integrity issues of infrastructure systems (this will also help prioritize research needs);

b) With regard to Sustainable Technology Development, engineering and science issues on infrastructure systems need to be clearly identified before developing detailed research needs; and

c) Additional research areas that should also be considered are infrastructure systems for greenfield sites and impacts of seasonal and regional differences and natural and man-made disasters on infrastructure systems.

5. OFFICE OF WATER NEEDS

Both the 1996 *Risk Management Plan for Wet Weather Flows* and 1997 *Urban Infrastructure Research Plans* were released prior to the development of key Office of Water program documents (*e.g*., 1998 Clean Water Action Plan, 1997-1998 Water Agenda, 1998-1999 Water Agenda, *etc*.). Because of the importance of the more recent documents, the Subcommittee has compared the two research plans with the Office of Water documents to determine if, in fact, the correct research is being conducted to support Office of Water's technical research needs.

The Subcommittee commends both ORD and Office of Water for having identified and addressed many critical water-related human health and environmental problems. The following statistics provide a sense of the scope of these problems.

a) Forty percent (40%) of the US surface waters currently do not meet water quality goals;

b) Twenty percent (20%) of the US population is being served by drinking water systems that are in violation of health based requirements;

c) Zero net loss rate of US wetlands has not been achieved; and

d) Wet weather flows remains the single largest contributor to water quality impairment of US waters.

The Office of Water also cited both the 1998 Clean Water Action Plan and the 1996 Safe Drinking Water Act Amendments as providing the regulatory framework for establishing four water related research priority areas.

a) Improvement in drinking water safety;

b) Reduction in wet weather flow pollution;

c) Protection of wetlands; and

d) Nurturing and revitalization of core Office of Water programs.

For each of the four Office of Water program priority areas, the Subcommittee differentiated between the strategic objectives and the specific technical research needs supporting those objectives. In many cases these relationships had to be inferred from the very general descriptions of the research programs provided in the Office of Water's annual research agendas. The 1996 *Risk Management Plan for Wet*

Weather Flows and 1997 *Urban Infrastructure Research Plan* were then examined to identify those research programs and projects that specifically address Office of Water technical research needs summarized in Appendix D.

5.1 Findings

The Subcommittee compliments the Office of Research and Development (ORD) for developing two technical research plans whose implementation will generate information critical to improving US water quality. ORD's decision to focus a substantial part of its efforts on investigating methods to reduce pathogenic contamination is particularly well-considered; such contamination is the greatest water quality threat to US public health. ORD also correctly recognized that air deposition can be a significant mechanism of water quality impairment.

The Subcommittee commends ORD for highlighting key infrastructure issues facing the US in the area of water supply and water quality protection. Unfortunately, because the Office of Water has not identified these issues as research priorities, research results may have less immediate impact than might otherwise be the case.

The Subcommittee believes that the Office of Water technical research needs can be better addressed by the following.

a) The 1998 Clean Water Action Plan clearly recognizes the unique nature of water issues associated with tribal lands and intends to expand the efforts of Office of Water's Tribal Strategy to implement the National Water Program in Native American communities. Therefore, substantial research efforts directed specifically at addressing water issues involving Native American communities should be added. In some instances, water quality issues associated with tribal lands are substantially different from those facing other parts of the US. These differences are particularly apparent when addressing the issues of total maximum daily loads (TMDLs) and drinking water system management.

b) The 1996 *Risk Management Plan for Wet Weather Flows* is silent on public involvement. In contrast, Office of Water recognizes that public involvement must be an integral part of all environmental protection decision-making; this commitment is illustrated by the expansion of public access to water quality related information and through citizen's right-to-know activities. Incorporation of the various interests can expand our understanding of potential risks and risk reduction options and otherwise ensure program success. Unfortunately, none of the projects or programs cited in the 1996 *Risk Management Plan for Wet Weather Flows* address this critical issue in either their development or implementation.

The Subcommittee encourages ORD to develop and employ a research planning process that involves all stakeholders (*i.e*., all parties with an interest in the outcome of the research efforts) at the initial phase of research program development. One resource for planning such involvement might be the EPA's Environmental Technology Verification program which has acquired significant experience involving stakeholders on technology issues by involving over 650 stakeholders in fifteen groups. The Data Quality Objectives (DQO) process can facilitate public involvement during the research planning stage. This process is described in *Guidance for the Data Quality Objective Process EPA QA/G-4* (EPA/600/R-96/055) and *Guidance for Quality Assurance Project Plans EPA QA/G-5* (EPA/600/R-98/018). The DQO process outlines the method(s) by which decision-makers can integrate stakeholder concerns within the research program and project development. Employing the DQO process in this manner ensures that the correct research projects will be undertaken to generate the appropriate data of the sufficient quality to satisfy both the decision-maker(s) and stakeholder needs. The application of the DQO process in the overall program management is of critical importance in insuring results that satisfy the broadest and most pressing needs in an economic fashion. The Agency is strongly encouraged to implement the DQO process early and broadly in program and project development.

c) Although the 1996 *Risk Management Plan for Wet Weather Flows* highlights the technical efforts within the watershed restoration and management program, watershed research projects do not sufficiently address non-urban wet weather flow issues. Moreover, while ORD's emphasis on control of point sources of pollution (*e.g*., sanitary sewer overflows, combined sewer overflows, *etc*.) is important to watershed restoration and management, the small number of projects that focus on developing methods to manage and control nonpoint source pollution suggests a potential imbalance in program priorities.

d) From program descriptions included in both the 1998 Clean Water Action Plan and the 1998-1999 Office of Water Agenda, the Office of Water clearly recognizes the importance of managing the discharges of nonpoint source pollution into US waters. To address this issue, Office of Water has expanded its efforts in developing regulatory controls on discharges associated with concentrated animal feeding operations and stormwater together with expressing the need for the development of risk assessment tools for managing environmental quality of watersheds.

5.2 Recommendations

The Subcommittee encourages ORD to use a more formal process through which research programs and projects that address the technical research needs of individual program offices may be identified. Balancing Office of Water technical research needs, which include a strong programmatic focus on nonpoint source pollution issues, with ORD's present emphasis on point source pollution control reflects the urgency for developing a more formal process to coordinate ORD program development with that of the individual program offices. To facilitate the integration of future ORD research plan development with Office of Water technical research needs, the Subcommittee recommends:

a) ORD develop a more formal process by which its research projects and programs can be synchronized with Office of Water technical research needs. The process should be transparent and include timetables that specify submission dates for Office of Water research program technical needs together with a description of the methodology used by Office of Water to prioritize technical needs. Finally, the process should include a mechanism that will enable ORD to characterize measurable progress in order to meet its obligations under the 1993 Government Performance and Results Act (GPRA).

b) In order to apply its limited resources in a cost-effective manner, ORD should develop a transparent methodology to prioritize its programs and projects. The methodology should include an objective rationale for prioritization based on the risk management paradigm.

c) For each research project, ORD should identify the set of metrics that will be employed to evaluate the extent to which progress is being made in addressing Office of Water needs. These metrics should be directly applicable and easily convertible to the reporting requirements of GPRA.

d) ORD should formally adopt the DQO process in its program and project development to ensure that the interest of all relevant stakeholders will be considered. In addition, the DQO process will result in conserving limited ORD resources by ensuring that the data collection activities will be precisely those required to address the water quality decisions that have to be made. Finally, to adequately address the increasing number of challenges the Agency will face regarding the scientific basis for its rulemaking, linking data quality to environmental decisions is paramount.

e) To enable ORD to be more responsive in meeting Office of Water technical research needs, the characteristics of the water problem to be

investigated should be clearly defined by Office of Water and should include technical and/or regulatory decisions that depend on data generated. By identifying technical and/or regulatory decisions associated with particular water issues, ORD may better structure its research programs to determine the specific data types to be collected and the level of data quality required to make appropriate decisions.

f) To correct the omission in its research plan related to tribal issues, ORD is encouraged to develop water related research programs that are broadly based and whose results would be applicable to tribal lands as well as other areas of the US.

g) In an effort to remedy the lack of work related to nonpoint sources, ORD should consider developing research programs that are more comprehensive in scope and that would address both point and nonpoint pollution contributions to watershed impairment. For example, a research program focused on nutrient control must include point source discharges from sanitary sewers, wastewater treatment plants as well as nonpoint source contributions from stormwater and run-off from agricultural fertilizer and animal feed operations.

h) Finally, the relative risk to environmental integrity from wet weather flows must be systematically apportioned at the watershed level between rural (agricultural) and urban components. To facilitate this linkage, research at the watershed level must be directed, in both rural and urban sectors, and at establishing surface water – ground water interactions as a prerequisite to developing protocols for mediating and processing wet weather flows.

APPENDIX A: Expanded Charge for the Review

Project Title/Subject: EPA's Risk Management Research Program for Wet Weather Pollution Control

Expanded Charge: Evaluate the scientific directions (are we doing the right science/engineering research?) and scientific quality (are we doing our science/engineering research right?) of EPA's Wet Weather Flow (WWF) research program, including our Urban Infrastructure research. In doing this evaluation, take into account what research others (including WERF and ASCE) are doing in these areas, what OW's needs are, and ORD/NRMRL's resource constraints.

Review the 1996 *Risk Management Plan for Wet Weather Flows* and the 1997 *Urban Infrastructure Research Plan - Water and Wastewater Issues* with special emphasis on the state of the science writeups, research questions, and research needs. Comment on the appropriateness of having five WWF research areas: characterization and problem assessment, watershed management, toxic substance impacts and control, control technologies and infrastructure improvement. Comment on the completeness and currency of the research plan bibliographies. Determine the adequacy of the infrastructure research program to meet the wastewater infrastructure needs of the OW-OWM and the drinking water infrastructure needs of the OW-OGWDW.

Determine if the projects cited in the research plans fulfil the research needs. Specifically, review the water program's priorities and needs and determine to what extent the ORD research program supports those needs. The OW needs are contained in the 1999 Water Agenda and the materials from the last water program review (where Fred Lindsey, Deputy Director of OWM, expressed OWM's needs). Evaluate ongoing ORD urban infrastructure research projects, especially those of the NRMRL-Water Supply and Water Resources Division, vis-a-vis wastewater systems, drinking water systems and potential public health impacts to determine if they meet the needs of the OW-OGWDW.

Determine the extent to which the EPA research program complements (or competes with) other research programs, such as that embodied in the Water Environment Research Foundation (WERF) "Research Needs in Urban Wet Weather Flows (Feb 98)" plan. Compare the work WERF is doing under the EPA grants they've received for the last two fiscal years with WWF research being done by others. Comment on the concept of using Watershed Management research as a unifying concept/organizing principle for coordinating the research efforts of the applicable National Risk Management Research Laboratory divisions and branches.

APPENDIX B: DOCUMENTS REVIEWED

1. Briefing Outline “BRIEFING FOR SCIENCE ADVISORY BOARD WET WEATHER FLOW RESEARCH PROGRAM, December 1998" with attachments:
   - 1 - “Urban Watershed Management Branch - Branch Plan - FY98", November 18, 1997
   - 2 - WWF Research Plan - “Risk Management Research Plan for Wet Weather Flows”, EPA/600/R-96/140, November 1996
   - 3 - “Urban Infrastructure Research Plan - Water and Wastewater Issues”, January 1997
   - 4 - “FY98 UWMB Operations Plan”, 9/29/98, “FY97 UWMB Operations Plan”, 9/29/98,
   - 5 - UWMB Manning Chart, 11/13/98
   - 6 - “UWMB Active Projects as of July 9, 1998"
   - 7 - “UWMB Progress Report for July-September 1998", November 9, 1998
   - 8 - “Urban Watershed Research Facility - Building and Facilities Project #1 - January 1998" and “Urban Watershed Research Facility - Building and Facilities Project #2 - September 1998"
   - 9 - “Urban Watershed Research Facility - Statement of Work - Support Contractor”, August 1998
   - 10 - UWMB FY98 Publications, September 8, 1998

2. Memorandum, “Wet Weather Project Information” from Jeffrey Moeller at Water Environment Federation, December 22, 1998

3. Note to SAB Review Team re “SAB Expanded Charge”, January 12, 1999

4. Note to SAB Review Team re “Background Materials”, January 11, 1999 with enclosures:
   - B:i - WERF “Research Needs in Urban Wet Weather Flows” Feb 98
   - B:ii - OW 1999 Water Agenda - “National Water Program Agenda, 1998-1999" June 10, 1998 memorandum
   - B:iii - OW 1998 Water Agenda - “National Water Program Agenda, 1997-1998"
   - B:iv - “Water Research Strategic Review - Crystal Gateway Marriott, Arlington, Virginia - January 20, 1998"
   - B:v - Research Needs Article - “Urban Wet Weather Flow Management: Research Directions”, Field et al, Journal of Water Resources Planning and Management, May/June 1998; WEF Literature Review - “1998 Literature Review - Urban wet-weather flows”, Field et al, Water Environment Research, V70, N4, June 1998; WEF Literature Review - “1997 Literature Review - Urban wet-weather flows”, Field et al, Water Environment Research, V69, N4, June 1997; WEF Literature Review - “1996 Literature Review - Urban wet-weather flows”, Field et al, Water

Environment Research, V68, N4, June 1996; and UWMB Publications/Presentations for FY97, FY98, FY99

B:vi - UWMB Description of WWF Internet Home Page

B:vii - List/Short Description of Projects Given under WERF Cooperative Agreement (reference to Grants given under 104b3 program is incorrect) - "Water Environment Research/Demonstration Wet Weather Projects", 12/22/98

4. Widespread Failure to Comply with U.S. Storm Water Regulations for Industry, Part 1: Publicly-available data to estimate number of potentially regulated facilities, and
Part 2: Facility-level evaluations to estimate number of regulated facilities

5. Equalizing, Civil Engineering, January 1999, pages 56-59

APPENDIX C:Wet Weather Flows and Urban Infrastructure Research Plan Review Team Assignments

Overall guidance and direction: D. Grasso, chair

Team Members	Assignment
Chuck Noss Tom Theis	Evaluate Program scientific direction & quality Evaluate coordination with Water Environment Research Foundation (especially EPA grants to Water Environment Research Foundation over last two years) Comment on Watershed Management as a unifying concept/organizing principle
Byung Kim Mark Wiesner	Review *Risk Management Plan , Wet weather flow of Water s & Urban Infrastructure Plan, Water & Wastewater Issues* Specifically for State-of-the-science write-ups Research questions and needs Appropriateness of five areas of research areas Currency of research plan & bibliography Adequacy of infrastructure research program to meet water (Office of Water -OGWDW) & wastewater (Office of Water -Office of Water M) infrastructure needs
L.D. McMullen Mike McFarland	Review Water Program's priorities and needs Do projects meet research needs? Does ORD research program support needs? Do ongoing ORD infrastructure projects meet needs?

APPENDIX D: Summary of Research Programs and Projects that Specifically Address Office of Water Technical Research Needs

Improvement in Drinking Water Safety

The overarching goal of Office of Water with regard to improvement in drinking water safety is the implementation of the 1996 Safe Drinking Water Act Amendments (SDWA). To achieve this goal, Office of Water identified the following priorities:

1. source water assessment and protection
2. coordination of infrastructure financing
3. watershed management
4. citizen's right to know

With regard to source water assessment and protection, the drinking water program has established protecting human health from microbiological contaminants and disinfectant/disinfection by-products as well as from critical chemical contaminants (*e.g*., arsenic and radon) as its most immediate concerns. To address these concerns, Office of Water developed the following strategic objectives:

1. creation of teams consisting of EPA, state officials, tribes and public work groups such as the National Drinking Water Advisory Council (NDWAC) to develop safe drinking water implementation strategies,
2. provide guidance to states on source water protection and assessment,
3. encourage integration of source water protection efforts with watershed management programs and
4. improvement of public water systems management capacity through issuing program guidance for drinking water system training and certification.

The following technical research needs were identified by Office of Water to address the strategic objectives for source water assessment and protection:

1. Develop and provide tools to water suppliers and communities to assess the conditions of local water resources and to link clean water and drinking water protection programs (*e.g*., Total Maximum Daily Loads - TMDLs).
2. Develop and promulgate interim water quality standards for microbial contaminants, arsenic and radon as well as regulations for disinfection by-products.
3. Develop a comparative risk framework for assessing microbial disinfection by-products (M/DPBs).

4. Develop tools for small communities to address the new monitoring requirements of the 1996 Safe Drinking Water Act Amendments (SDWA).

In addition to source water assessment and protection, Office of Water identified the coordination of infrastructure financing as critical to the successful implementation of the 1996 Safe Drinking Water Act Amendments. Specifically, the efforts of Office of Water to coordinate infrastructure financing focus primarily on assisting states in developing revolving loan fund programs to support needed drinking water infrastructure projects. In concert with this effort, Office of Water has stated its intent to collaborate with states and interstate agencies to revise the Section 106-grant allocation formula. The formula will be revised to account for the specific characteristics of the drinking water issue in financial resource allocation.

Although no specific technical research needs were identified as necessary by Office of Water to facilitate the coordination of infrastructure financing, any revision of the Section 106-grant allocation formula to reflect specific characteristics of a drinking water issue would involve technical considerations. Therefore, Office of Water is encouraged to provide a description of the method by which the grant allocation formula will be revised and to identify the possible uncertainties for which technical research may be warranted.

With respect to improving drinking water safety through watershed management, Office of Water has adopted a watershed approach to control point and nonpoint source pollutant discharges considering:

1. drinking water sources,
2. ground water protection and
3. protection and restoration of habitat (*e.g.*, wetlands).

Moreover, the watershed approach will be employed as a mechanism for implementing Clean Water Act (CWA) responsibilities. Key elements of the watershed approach include:

1. unified watershed assessments,
2. strong state and federal standards,
3. watershed restoration action strategies,
4. watershed pollution prevention and
5. watershed assistance grants.

Finally, to assist states and tribes in identifying impaired watersheds as required under Section 303(d) of the Clean Water Act (CWA), Office of Water strategic objectives include the evaluation of pollution control tools (e.g., water quality criteria,

risk assessment methods, educational materials *etc*.) that are most appropriate to characterize watershed quality.

To meet its strategic objectives, the following technical research needs were identified by Office of Water:

1. Improvement and evaluation of technical tools for rapid and accurate assessment of watershed pollution loadings through reinvention of the Total Maximum Daily Load (TMDL) program.
2. Assessment of the condition and vulnerability of each of the 2,000 plus US watersheds through the National Watershed Assessment Project.
3. Development of indicators to measure ecological conditions of watersheds and stressors
4. Development of landscape analysis approaches to describe the relationship between land cover and water quality
5. Development of best management practices (BMPs) for key sources of watershed impairment

With regard to improving drinking water safety through expansion of citizen's right to know , Office of Water has stated its intent to promote access to watershed quality information by the general public. Examples of promoting this goal cited by Office of Water include the:

1. continued development of the communications tool *Surf Your Watershed* (located on Office of Water Internet Homepage) and
2. promulgation of regulations requiring annual consumer confidence reports be issued by drinking water suppliers to the public.

No specific technical research needs were identified as necessary by Office of Water to facilitate these efforts.

Reduction in Wet Weather Flow Pollution

Since wet weather flows have been identified as the single largest threat to water quality impairment in the US, Office of Water has stated its intent to work with states, tribes, local government and the Urban Wet-Weather Advisory Council to assure the coordinated development of policies relating to urban wet weather pollution. Office of Water has identified the following strategic objectives as critical to achieving effective urban wet weather pollution control:

1. development of proposed regulations and guidance to streamline the Phase I permit program,
2. publishing a new national policy to improve control of sanitary sewer overflows and

3. integration of stormwater pollution controls with other pollution controls on a watershed basis.

With regard to non-urban wet weather flows, Office of Water has proposed collaborative efforts with other federal agencies (*e.g.,* US Department of Agriculture) to develop strategies further reducing water pollution from nonpoint sources including the development and implementation of Best Management Practices. Furthermore, as agriculture has been identified as the principle source of nonpoint source pollution discharges to US rivers, Office of Water has developed strategic objectives specifically designed to address agricultural pollution abatement including:

1. collaboration with the Office of Compliance and Enforcement Assurance (OCEA) to assess the extent to which concentrated animal feeding operations (CAFOs) are in compliance with the National Pollutant Discharge Elimination System (NPDES) program,
2. evaluation of the necessity to expand permitting requirements to include animal feeding operations that have the potential to significantly impact water quality,
3. strengthening national guidelines to reduce water quality impacts of CAFOs, and
4. developing national minimum standards for water quality assessments of nontraditional sectors such as concentrated animal feeding operations and stormwater.

To achieve these strategic objectives, the following technical research needs were identified by Office of Water:

1. Development of water quality standards (including chemical specific and whole effluent toxicity criteria) to apply to extreme wet weather events
2. Development of site specific water quality criteria techniques for establishing TMDLs
3. Development of better acquisition methods for obtaining reliable land use data
4. Development of monitoring plans to quantify point and non-point sources within watersheds
5. Development and validation of models to address cross media concerns
6. Development of scientific tools to facilitate watershed scale risk assessments (*e.g.,* development of specific water quality indicators)
7. Evaluation of the impact of wet weather flows on the development of hazardous algal blooms

Protection of Wetlands

Office of Water has stated that protection and restoration of US wetlands will be guided by the new Wetlands Program Strategic Plan. Key Office of Water activities to protect and restore wetlands include:

1. developing guidance to ensure the long term success of wetlands mitigation projects including mitigation banking and
2. strengthening partnerships with other federal agencies to increase the rate of wetlands restoration.

Office of Water will continue to facilitate coordination between the US Army Corps of Engineers, states, and tribes in the recently reissued nationwide wetland permit program in order to slow the rate of wetland loss.

Although Office of Water strategic objective for protection of wetlands is to reverse the current trend of net wetland loss, no specific technical research needs to achieve this reversal were cited within the annual water agendas.

Nurturing and Revitalizing Core Programs

Office of Water has recognized the need to provide a balance between increased flexibility in program implementation with continued progress in improving accountability for program results by measuring real changes in the environment. Since the success of the water programs will be measured by the environmental and public health outcomes, Office of Water will continue to work with tribes, states and local governments to create a system of environmental protection based on accountability and measurable progress. The 1993 Government Performance and Results Act (GPRA) and the National Performance Partnership (NEPPs) will provide the necessary framework for planning and accountability.

To achieve measurable progress within the water priority areas, Office of Water has determined that the new initiatives must be integrated within a set of strongly supported core environmental protection programs. The strategic objectives developed by Office of Water to nurture and revitalize these core environmental protection programs include:

1. collaborating with stakeholders to develop a strategy to address toxic pollutants with development and reproductive health effects in conjunction with recommendations from the National Academy of Sciences,
2. publishing national guidelines for state certification programs,
3. working with Office of Water Tribal Strategy to implement the National Water Program on tribal lands,

4. assessing issues related to airborne deposition of pollutants to US waters,
5. developing approaches to control pollution on a watershed basis,
6. working with states to develop regulations for chemical contaminants in drinking water, and
7. supporting water program areas with sound peer reviewed science.

To achieve these strategic objectives, the following technical research need was identified by Office of Water: development of tools to support priority setting, risk assessment and risk management.

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REVIEW BY THE WET WEATHER FLOWS AND URBAN INFRASTRUCTURE SUBCOMMITTEE OF THE SCIENCE ADVISORY BOARD'S ENVIRONMENTAL ENGINEERING COMMITTEE