

DEVELOPMENT AND USE OF
RECEIVING WATER QUALITY CRITERIA
AND STANDARDS

A Report of the Ad Hoc Task Group
on Water Quality Criteria and Standards,
Government Affairs Committee,
Water Pollution Control Federation

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"So we beat on, boats against
the current, borne back ceaselessly
into the past." From The Great
Gatsby by F. Scott Fitzgerald.

Summary

The Government Affairs Committee (GAC) of the Water Pollution Control Federation (WPCF) established the Task Group on Water Quality Criteria and Standards to prepare a proposed position paper for the WPCF on the development and use of receiving water quality criteria and standards. The summary, conclusions and recommendations in this report constitute the proposed WPCF position paper.

Initially, the Task Group helped organized a session on "Current Views on Water Quality Criteria and Standards" at the March 25, 1980, WPCF Government Affairs Seminar. The presentations by participants representing the U.S. Environmental Protection Agency (USEPA), state agencies, industry, environmentalists, consultants, municipalities and congressional staff have provided valuable background for preparation of the report. In addition, the Task Group reviewed the history of water quality criteria and standards in the United States, compiled information on recent developments in the USEPA, extracted applicable information from commentary by organizations and individuals outside the USEPA, and collected previous WPCF statements of policy and

recommendations related to the subject. This information is included in the body of the report.

In the evaluation process leading to the preparation of the report, the Task Group found that information and suggestions in papers presented at a June, 1980, Symposium on the Development, Use and Value of Water Quality Criteria and Standards in Washington, D.C., were especially useful. The proceedings of the symposium will be published by George Washington University later in 1980.

In essence, the conclusions and recommendations in this report have been gleaned from information and ideas obtained from many sources, all of which are identified in the list of references at the end of the report. The Task Group acknowledges with gratitude these many valuable contributions but accepts sole responsibility for the judgements about their use in the report. Without reservation, the Task Group feels the sifting and selection process has been rational and has resulted in conclusions and recommendations which have great merit for adoption by the WPCF.

First, however it is essential to understand precisely the meaning of the terms "criteria" and "standards" as used in this report. "Water quality criteria" refers only to narrative and numerical information on the basis of which a

judgement can be made, but which are not enforceable under any law. "Water quality standards" denote designated uses of receiving water bodies along with water quality "limits" derived from "criteria" which define the conditions necessary to maintain and protect the designated water uses. "Water quality standards" are enforceable under federal and state laws. The Task Group understands that these are the definitions of these terms in the Federal Water Pollution Control Act, as amended, commonly referred to as the Clean Water Act.

Conclusions and Recommendations

Water Quality Criteria Development and Use

1. Water quality criteria developed by the USEPA to comply with the requirements of Section 304(a)(1) of the Clean Water Act should include the latest scientific knowledge and understanding of all aspects of the effects of significant contaminants on the variety of water uses to be protected by water quality standards. As specified in the Act, they should be published as up-to-date and scientifically valid information to serve only as guidance for the development, adoption and enforcement of water quality standards. Criteria which include ranges of values for different levels of protection under varying environmental conditions will enhance the ability of those

responsible for standard-setting to consider the varying site-specific local conditions, such as site-specific water body characteristics, cost-effectiveness, benefits, and other social and economic impacts.

2. The USEPA should separately identify criteria values developed in accord with Section 304(a)(1) of the Clean Water Act, as described above, from those developed as required by the consent decree in the case of the Natural Resources Defense Council vs. Train (Administrator of USEPA). Whereas the former are guidance based only on valid scientific data and judgement, the latter must include recommended maximum permissible concentrations which in part reflect policy judgements. However, this difference may disappear as a result of a suit asking the court to set aside the consent decree because its essentials were included in the 1977 Clean Water Act amendments.

3. Data bases for criteria should be selected only after comprehensive and complete searches of the relevant scientific literature. All data sources should be thoroughly validated and documented. Only statistically significant data should be used. Peer review and consensus in this process is essential to gain and maintain credibility.

4. The USEPA, in employing extrapolation of animal and human health effects data to derive human health criteria, should use validated scientific methods to obtain parameter estimates. Likewise, measures of the uncertainty of the extrapolation of the parameter estimates should be presented. The size, nature, quality, and significance of data bases should be taken into account in deriving technically valid estimates of risk, and all relevant data should be included. Appropriate statistical significance levels should be used. Exposure from other sources must be taken into account in deriving criteria. The setting of an interim target risk level is appropriate, but objective methods must be used if a meaningful target level is to be achieved.

5. Assuming that in regard to human health criteria for contaminants exhibiting non-threshold effects, the best current scientific judgement is that:

- a. it is not possible with present knowledge to suggest a no-effect level, and
- b. the evaluation of all meaningful human experience or laboratory animal tests to provide relationships between the dose of a contaminant and its effects would, when translated and extrapolated to different doses and/or species,

yield ranges of effects which are not apparent but capable of developing later (latency) and the degree of the effects (incidence values), because of the spread of data and the variety of models used.

The USEPA should broaden the discussion and demonstrate the use of all plausible translation and extrapolation techniques along with appropriate corrections for metabolism, the action and effects of contaminants, and other exposure sources as well as proper consideration of effects which are not apparent but capable of developing later. Only in this manner will the results reflect accurately the latest scientific knowledge as required by the Act. To meet the needs for a reasonable amount of information as a basis for standard-setting, the USEPA should provide non-threshold-effect ranges of concentrations associated with several levels of effects.

If in the case of a contaminant exhibiting a threshold effect, a no-effect level is assessed and then arbitrarily reduced by a factor based on the amount and quality of data, the best scientific knowledge on the no-effect level should be published as the criteria along with any appropriate expression of the limits of scientific knowledge. In each

case, the listing of multiple risk levels will provide users of the criteria with needed flexibility in standard-setting.

6. So that standard-setters might have the latest scientific knowledge for adoption of site-specific water quality standards in the light of differing characteristics of water bodies, criteria documents should include discussions on the influence of relevant factors such as,

- water hardness effects on ecosystem toxicity;
- pH effects on ecosystem toxicity;
- chemical/physical interaction as they affect aquatic community toxicity;
- the persistence of chemicals and their long-term effects;
- the natural communities in various types of water systems, e.g., oligotrophic lakes, mountain ponds, alkaline streams, snow melt tributaries, etc.;
- segregation of natural processes such as eutrophication from pollution-enhanced acceleration of the processes;

- sedimentation from chemical reaction of pollutants, `e.g., ferric hydroxide precipitation from some acid wastes; and
- the adsorptive properties of sediments -- how sediments remove pollutants from the water column, how the pollutant is modified in the benthos by biological or chemical processes.

7. For each contaminant for which the USEPA publishes water quality criteria, the criteria document should include a thorough discussion of the test method sensitivity, precision and accuracy, possible interferences, and any other pertinent information regarding analytical methodology. Analytical methods should be reviewed by appropriate professional groups.

8. Criteria documents should be brought up-to-date as warranted by the availability of new and valid scientific information. The USEPA should support more and better criteria research and implement a process for updating water quality criteria in consultation with, and with the help of, appropriate reputable scientific institutions and individual scientists. This process is essential if the criteria are to be information "...accurately reflecting the latest scientific knowledge...", as required by the Clean Water

Act, and standards are to be an effective instrument in management of water quality.

Water Quality Standards

Development and Use

1. The USEPA should rescind its policy of "presumptive applicability" of Section 304(a)(1) criteria listed in the Red Book to parameter limits included in any state's water quality standards and should not apply it to any other criteria developed and published under the authority of Section 304(a)(1). The policy has been so inflexible that it has resulted in unrealistic and impractical standards; has created unjustified friction among the USEPA, the states and others; has wasted personnel time and other resources; and has inhibited the use of standards as an effective water quality management tool.

2. Water quality standards should be fixed for a defined period of time and revised only when new data show a clear threat to the goals of the Clean Water Act or when standards for additional substances are required.

3. The USEPA and state agencies should consider defining special water uses designations and develop appropriate criteria for special aquatic habitats, headwaters, intermittent streams, and streams containing

naturally high levels of dissolved solids or other constituents deserve special consideration because of the unique roles they play in the ecosystem.

4. New concepts, such as specifying acceptable frequency of non-compliance with standards, allowable excursions at high flows, or dual standards (enforceable levels and more stringent target levels) should be developed and implemented.

5. Proven or presumptive presence of individual toxic substances should be a significant factor in determining whether such substances should be included in standards. Scientific defensibility, analytical detection and quantification capability, socio-economic and other impacts on the total environment, and voluntary risk factors are other aspects which should be considered in the standards-setting process for toxic substances.

6. Initial water quality standards adopted by some states under the 1965 amendments to the Federal Water Pollution Control Act and confirmed under the 1972 amendments did not consider adequately cost/benefits, cost-effectiveness, and socio-economic impacts. Achievable standards are needed and procedures should be developed for the incorporation of economic analyses in the standards

revision process with the burden of justifying less stringent standards shared by the states and the USEPA.

7. The USEPA guidance memoranda and regulations under the Clean Water Act should be clear and concise. They should clearly identify the desired end result and provide the states with maximum flexibility to achieve that end result within available resources.

8. The USEPA disapproval of state standards should include specific technical and socio-economic justification rather than mere reference to the "Red Book" or unenforceable goals of the Clean Water Act.

9. Each state should be allowed to establish its own list of priority pollutants for which criteria (limits) will be incorporated in the state's standards. One possible approach would include the following steps:

- a preliminary assessment to determine if the pollutant could be present from staff personal knowledge, literature search and an industry or other source survey, followed by a determination whether it actually is present by chemical monitoring; if present, then and only then,
- gather chemical, biological fate, and analytical methods information;

- gather toxicology information;
- determine applicability of above information to local waters in light of ambient temperature, alkalinity, hardness, etc., including the use of bioassays;
- evaluate control capability, i.e., treatability, immobilization, or neutralization of the substance;
- insofar as is practicable, develop contaminant load reduction costs versus water quality and water use benefit relationships for informing the public of the benefits of enhanced water quality levels which will result from costs of certain degrees of contaminant controls, and finally,
- decide, in light of the above, what specific water use designation and associated limit for the pollutant is acceptable and enforceable as a standard.

10. A clear understanding of the role of water quality standards in a water quality management program within the USEPA and the state pollution control agencies is essential to the efficient functioning of the program. For this purpose, it is desirable to have a well-defined and fairly

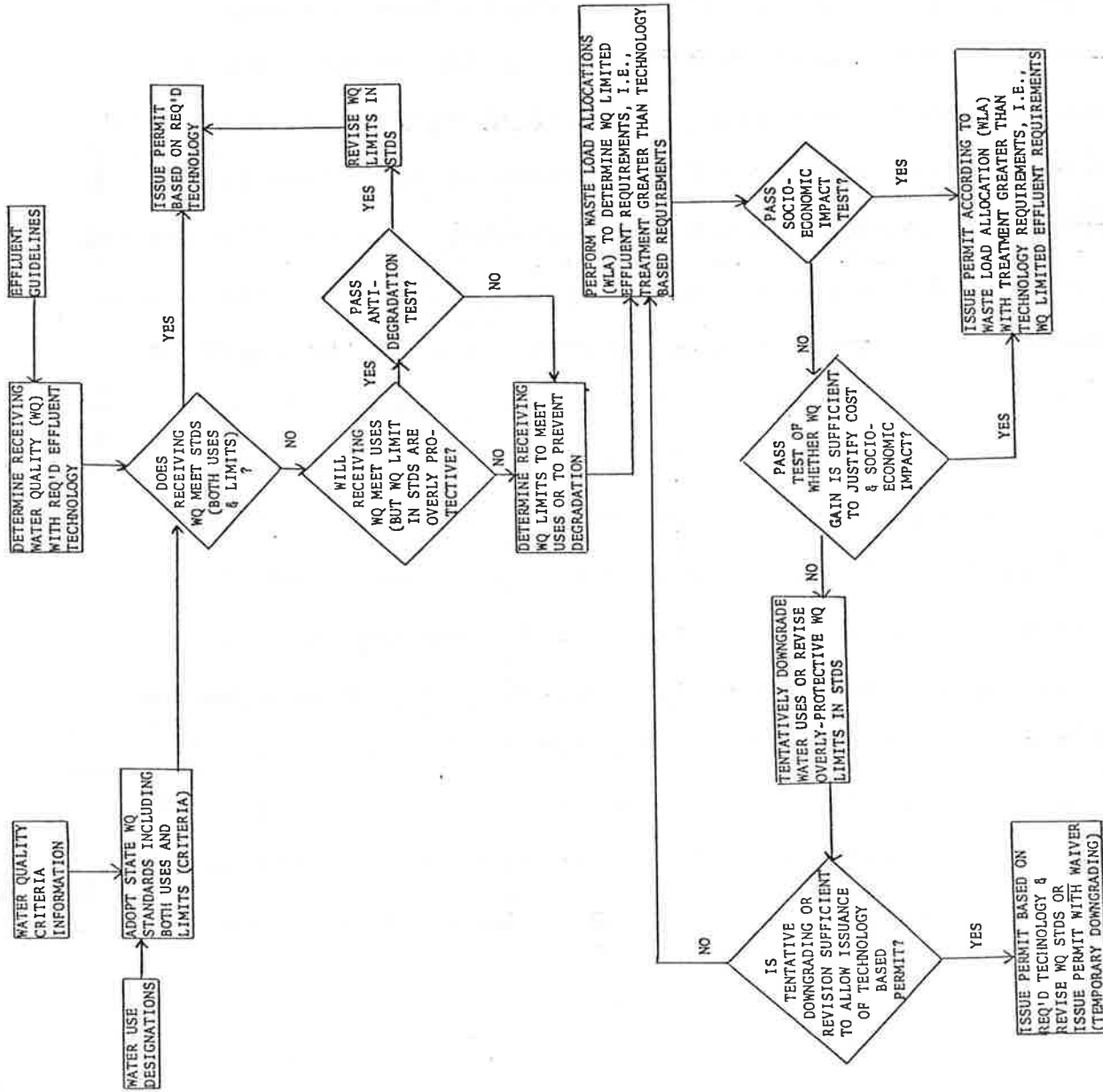
formalized structure that will clearly illustrate tasks to be performed and decisions to be made. Figure 1 shows an example of such a structure.

11. If receiving water quality standards cannot be achieved by implementation of the minimum technology-based requirements for point sources (e.g., secondary treatment for sewage) and best management practices for nonpoint sources, additional controls are essential. A process for allocation of permissible waste loads among the various sources is necessary to determine the degree of required treatment or other controls greater than the technology-based limits. Following are recommendations for the credible establishment of waste load allocations:

- The achievement of a water quality standard should be analyzed by accepted techniques of waste load allocation analysis using calibrated and verified mathematical models or empirical relations;
- In the allocation procedure, some recognition should be given to the establishment of a reserve capacity in the body of water which may result in a temporary water quality standard higher than required in order to account for future growth of incoming waste loads as well as uncertainties in the analysis framework;

- Waste load allocations should be analyzed under seasonal or flow dependent conditions implying time variable uses and resulting time variable water quality standards. Such analyses again should be accomplished with state-of-the-art mathematical models;
- Cost and benefit analysis of the achievement of a water quality standard including the integration of waste load allocations and input/output relations should be an integral part of the standard setting process; and
- Any models used in establishing standards and resulting waste load allocations should be carefully documented and as much as possible indicate calibration and verification to field data. If such data are not available, credible modeling frameworks should be presented that use state-of-the-art techniques and frameworks for establishment of the standards and waste load allocations.

FIGURE 1 - PARTIAL STRUCTURE OF WATER QUALITY MANAGEMENT PROGRAM FOR IMPLEMENTING WATER QUALITY STANDARDS



Preface

In this paper, the term "water quality standard" will be used in the same manner as it is used in the Federal Water Pollution Control Act, as amended, commonly referred to as the Clean Water Act. A standard "...shall consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based on such uses."^{1/} Water quality criteria, on the other hand, are information "...accurately reflecting the latest scientific knowledge (A) on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation which may be expected from the presence of pollutants in any body of water, including ground water; (B) on the concentration and dispersal of pollutants, or their byproducts, through biological, physical, and chemical processes; and (C) on the effects of pollutants on biological community diversity, productivity, and stability, including information on the factors affecting rates of eutrophication and rates of organic and inorganic sedimentation for varying types of receiving waters."^{2/} Criteria include both narrative and numerical information on the basis of which judgements can be rendered.

The Clean Water Act requires that each state adopt water quality standards for all navigable waters which are enforceable under state law. State standards are subject to review and approval by the USEPA. When approved by the USEPA the state standards become federal standards enforceable under provisions of the Clean Water Act. The USEPA must promulgate standards for all navigable waters for which it has not approved state standards.

Water quality criteria are not enforceable unless they are incorporated as specific limiting parameter values or narrative constraints in water quality standards. Hence, the term "water quality standards" denotes both water use designations and water quality limits derived from criteria which define the conditions necessary to maintain and protect the designated water uses.

To recapitulate, "water quality standards", including applicable limits derived from criteria, are always enforceable under state and/or federal law. On the other hand, "water quality criteria" refer only to narrative and numerical information on the basis of which a judgement can be made, but which are not enforceable under any law.

History of Water Quality Criteria and Standards

According to the USEPA's "Quality Criteria for Water" (commonly called the "Red Book"), the genesis of water quality criteria in the United States occurred in the early 1900's.^{3/} It was not until 1952, however, that the California State Water Pollution Control Board produced the first attempt at a comprehensive compilation of water quality criteria with a publication containing 1,369 references.^{4/} California published an expanded second edition in 1963 containing 3,827 references.^{5/} Neither of these publications attempted to reconcile discrepancies in values reported as harmful in the cited references.

The passage of the Water Quality Act of 1965, amending the Federal Water Pollution Control Act, more than any other event influenced the development and use of water quality criteria and standards. The act required each state to establish water quality standards applicable to interstate waters within the state.^{6/} Standards were defined in the act to include water quality criteria and a plan for the implementation and enforcement of the criteria. If the standards were approved by the Secretary of Health, Education and Welfare (the federal agency responsible in 1965 for administering the Federal Water Pollution Control Act), they became federal standards. If they were

disapproved, the Secretary was required to promulgate standards for the interstate waters involved.

In May 1966, the President transferred responsibility for administering federal water pollution control activities to the Secretary of Interior. The Federal Water Pollution Control Administration (FWPCA) within the Department of Interior published in 1968 the report on water quality criteria of the National Technical Advisory Committee to the Secretary of Interior (commonly called the "Green Book"). The letter from the Commissioner of the FWPCA transmitting the report states, "This report constitutes the most comprehensive document on water quality requirements to date, and as such, will be used as a basic reference by groups and agencies engaged in water quality studies and standards setting activities. At the same time, the Committee members and I wish to emphasize that this report is not sufficiently conclusive or inclusive to serve as the only guide in determining water quality criteria or requirements. Regional variations in climate, topography, hydrology, geology, and other factors must be considered in applying the criteria offered by the Committee to the establishment of water quality standards in specific localities."7/

In December 1970 the authority for administering the Federal Water Pollution Control Act was transferred to the Administrator of the newly-established United States Environmental Protection Agency (USEPA). Following the passage of the 1972 amendments to the Federal Water Pollution Control Act,^{8/} the USEPA contracted with the National Academy of Sciences and the National Academy of Engineering "...to embellish the concept of the 1968 National Technical Advisory Committee's Water Quality Federal Criteria and to develop a water quality criteria document that would include current knowledge."^{9/} The USEPA reviewed the Academies' report, Water Quality Criteria 1972 (commonly called the "Blue Book"),^{10/} and it was published in 1974 with the statement by the USEPA that the report "...is approved for publication as an important contribution to the scientific literature, but not as the Agency's sole criteria for standards setting purposes. Neither is it necessarily a reflection of the Agency's views and policies."^{11/}

The 1972 amendments to the Federal Water Pollution Control Act required the USEPA to publish within one year and periodically update criteria for water quality.^{12/} To comply with the mandate, the USEPA developed proposed water quality criteria and published a notice of their availability in October, 1973.^{13/} The USEPA published basic

water quality standards regulations in November, 1975,^{14/}
and explained them in guidelines published in November,
1976.^{15/}

Also in 1976 the USEPA published "Quality Criteria for Water", the "Red Book" which according to the Foreword represented "...a revision of the proposed water quality criteria based upon a consideration of comments received from other Federal agencies, State agencies, special interest groups, and individual scientists."^{16/} In the accompanying transmittal letter "To the Reader", the USEPA Deputy Assistant Administrator for Water Planning and Standards stated, "Water Quality Criteria do not have direct regulatory use, but they form the basis for judgement in several Environmental Protection Agency and State programs that are associated with water quality considerations. The criteria presented in this publication should not be used as absolute values for water quality. As it is stated in the chapter on 'The Philosophy of Quality Criteria' there is variability in the natural quality of water and certain organisms become adapted to that quality which may be considered extreme in other areas." He went on to say "It must be emphasized that national criteria can never be developed to meet the individual needs of each of the Nation's waterways--the natural variability within the aquatic ecosystem can never be identified with a single numerical value."

In carrying out its standards review and approval function, the USEPA applied the policy of "presumptive applicability" of the Red Book numerical criteria to state standards. The USEPA explicitly identified it in an statement of existing policy and advance notice of rulemaking in the Federal Register in July 1978 as follows: "EPA feels that the data base for the Red Book numbers is sufficiently broad for the numbers to have presumptive applicability [underlining added]. EPA's policy is that a state may adopt a numerical concentration level for a Red Book pollutant which is less stringent than the Red Book number, but, only if a state provides adequate technical justification for the deviation."^{17/} The USEPA did not define "adequate technical justification", however.

Current Developments within the USEPA

As a result of the 1976 consent decree in the case of the Natural Resources Defense Council vs Russell Train, Administrator of the USEPA,^{18/} and the 1977 amendments to the Federal Water Pollution Control Act,^{19/} the USEPA has been revising criteria and developing new criteria documents, especially for 65 toxic pollutants. Shatzow, the USEPA Acting Deputy Assistant Administrator for Water Planning and Standards, described the process and discussed how the criteria will be used in the water quality standards program at the WPCF Government Affairs Seminar in March

1980.^{20/} The USEPA published the aquatic life criteria development methodology in the Federal Register on May 18, 1978^{21/} and the human health methodology on March 15, 1979.^{22/} After derivation of criteria for the 65 toxic pollutants and internal review, the USEPA published the criteria summaries in the Federal Register; 27 compounds were issued, March 15, 1979,^{23/} 26 on July 25, 1979,^{24/} and the final 12 on October 1, 1979.^{25/} According to the Shatzow in March 1980, the USEPA, after analysis of the approximately 200 comments received, expects to publish the criteria documents for the 65 toxic pollutants in September 1980.

Shatzow stated that the incorporation of the criteria into water quality standards "...is being looked at but has not been firmly established." He added, however, that "Generally, environmental factors may result in a modification to the criterion recommendations now being developed. Economic and technological factors will not influence the criteria directly but will influence our decisions (and the states) on which toxics may be included in state standards." He also discussed specifically how the environmental, economic and technologic factors would be considered. He emphasized that his remarks are "ideas [which] are being discussed within the Agency and at public forums like this..." and invited reaction.

In March 1979 the USEPA Administrator authorized the establishment of a Water Quality Subcommittee of the Agency's Science Advisory Board, a public advisory group organized to provide extramural scientific information to the Administrator and other officials of the USEPA. He requested the subcommittee to review and comment on all aspects of the specific pollutants covered in the settlement agreement in the case of NRDC, et.al., vs. Train. The subcommittee responded with a report in April 1980 commenting on the strategies, methodologies, and data base for the criteria under development by the USEPA during 1979 and 1980.26/

For aquatic life criteria, the subcommittee questioned conversion of data to a uniform base which was obtained from different environments or using different species or different techniques; recommended selection of species with key ecosystem roles for bioassay tests at each trophic level with development of criteria for different environmental conditions such as salinity, temperature, hardness, pH, dissolved oxygen, and water flow; encouraged chronic toxicity tests on all life cycle stages of selected organisms; recommended critical review by recognized scientists of all data bases and the discarding of doubtful data; and recommended that estimates of criteria be statistically determined so that the variation is explicit, that combining of dissimilar data be avoided to prevent

propagation of errors, and that the criteria should be given as interim estimates until sufficient information is available for forming statistically reliable conclusions.

For human health criteria, the subcommittee recommended that where numerous test data sets exist, they should be used to provide concentration ranges and confidence levels for different levels of risk; that criteria developed without adequate scientific data should be considered as "interim criteria"; that the probability risk assessment model selected be used only for substances for which it is demonstrated to be applicable and that the mechanism of adverse effects production be considered at all risk levels; that estimated bioconcentration factors be determined experimentally; that the factors governing the choice of risk levels be explicitly presented; that differences between risk-related concentrations of chemicals and the experience with actual human exposure be explored; that both beneficial and adverse effects be considered at observed levels of concern; and that the terms "threshold" and "non-threshold" be used in place of "non-stochastic" and "stochastic" to avoid confusion.

Language approved by Congress in the fiscal year 1979 appropriation act for the USEPA construction grants program for municipal wastewater facilities focused additional attention on water quality standards and their relation to

municipal discharges required to have treatment beyond conventional secondary. The fiscal year 1979 appropriation act allowed grant funds to be used for construction of new facilities providing treatment greater than secondary if the incremental cost of the advanced treatment is \$1 million or less, or if the USEPA Administrator personally determines that advanced treatment is required and will definitely result in significant water quality and public health improvements. (The fiscal year 1980 appropriation act raised the limit to \$3 million). The USEPA's Program Requirements Memorandum (PRM) 79-7, issued in March 1979 outlined the procedure and criteria for the reviews.^{27/}

PRM 79-7 required that the projects be reviewed on the basis of several factors, one of which is the water quality justification (compliance with standards), including a demonstration that the wasteload allocation or other water quality analysis resulting in the discharge permit limitations were supported by intensive field investigations. Many of the reviews resulted in deferment of all or a portion of the advanced treatment aspect of projects, usually pending additional water quality justification. States and municipalities affected by the reviews generally expressed dissatisfaction with the process. In December 1979 Illinois sued the USEPA in a U.S. District Court based on a decision of the USEPA on an advanced treatment project in Galesburg, Illinois.^{28/} The

USEPA and Illinois signed an agreement in April 1980 settling the case out of court which required changes in the review process and also recognized the need for resolution of other issues relating to water quality standards.^{29/} The USEPA acknowledged its commitment to pursue resolution of these issues in conjunction with active participation of the states in a June 1980 Federal Register notice of intent to issue revised guidance for advanced treatment review of construction grant projects.^{30/}

Recent Commentary from Outside the USEPA

A comprehensive review of commentary by affected organizations and knowledgeable individuals on the development and use of water quality criteria and standards is impossible. Some critical evaluations and comments especially are significant, however, and they highlight issues which need to be addressed.

Miscellaneous Organizations

American Fisheries Society

During the period 1977-78 under the sponsorship of the American Fisheries Society (AFS), over 150 members and non-members carried out a detailed critique of the USEPA "Red Book".^{31/} The AFS critique contains many useful comments and recommendations about specific criteria, but its general comments are more germane to this report. The

AFS reviewers were concerned about deficiencies in the Red Book data base, the lack of guidance by the USEPA for the development of standards from criteria, and the definition and use of the word, "criterion". The AFS concluded its review with the opinion that although a collection of national criteria is essential "...a single set of national water quality 'standards' would be inappropriate..."

Barber, one of the AFS editors, at a January 1980 Conference on Water Quality of the Association of Metropolitan Sewage Agencies (AMSA), expressed his personal opinion that "Any proposal to permit a loosening of national criteria must provide for both an intensive on-site research program and review of the results by a scientifically competent panel of judges."^{32/} He added a description of the conditions under which such detailed studies should be conducted and their minimum content to demonstrate that national criteria can be waived. He also suggested that guidance for any particular criterion should be brought up-to-date as soon as new information warranted and described a procedure for the process involving "a series of water quality criteria committees charged with keeping abreast of scientific developments and the literature for a specific group of chemicals."^{33/}

American Academy of Environmental Engineers

The American Academy of Environmental Engineers (AAEE) is another national group concerned with standards. The Academy's Ad Hoc Committee on Concepts for Developing Environmental Standards submitted a report in 1979 which reviewed the underlying philosophies, principles, and approaches used in, or advocated for development of environmental quality standards, particularly as related to three major federal environmental quality control acts (Clean Water, Safe Drinking Water, and Clean Air Acts, as amended).^{34/} The report recognized the uncertainties surrounding benefits, risk estimates and costs around which standards are based, and also the unquantifiable factors which influence the outcome. It recommended that "The AAEE should promote as its contribution towards developing more rational allocation of our national resources an active program towards identifying value judgements, expressed as benefit-cost relationships, where not explicitly stated in the documentation for proposed or existing environmental quality standards," and determine if there is "...a degree of consistency or trend in the benefit-cost relationships."^{35/} The thrust of the AAEE committee report is that, taking into consideration the uncertainties and unquantifiable factors involved, the benefit-cost relationships of existing and future standards for water and other media should be determined insofar as possible and

some degree of consistency within a single medium, e.g., water, and among the different media should be sought and maintained.

Association of State and Interstate Water Pollution
Control Administrators

Because of the states' interest in the subject, the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) appointed a Task Force on Water Quality Standards in 1979. The task force charge was to determine what the problem areas might be in the legislative, administrative, and regulatory elements of the water quality standards program and to recommend improvements. The task force first conducted a survey of the states by mail to determine the status of the water quality standards review process in each state. Remarkably, all fifty states responded, an indication of their deep concern about the subject. After discussion at two ASIWPCA meetings and subsequent task force meetings, the task force submitted its final report to the ASIWPCA membership in June 1980 and it was adopted at the annual meeting in August.^{36/}

Interestingly enough, the ASIWPCA task force found that the states feel that there is no need to recommend at this time legislative changes in the goals or stream standards references in Section 303(c) of the Clean Water Act. To the

contrary, the emphasis suggested by the task force is on constructive improvements in the oversight-regulatory administrative aspects.

The following list briefly summarizes some of the ASIWPCA task force recommendations of special interest:

- Water quality standards should be fixed for a defined period of time and revised only when new data show a clear threat to the goals of the Clean Water Act or when standards for additional substances are required.
- The USEPA and state agencies should consider defining special water uses designations and develop appropriate criteria for special aquatic habitats, headwaters, intermittent streams, and streams containing naturally high levels of dissolved solids or other constituents deserve special consideration because of the unique roles they play in the ecosystem.
- New concepts, such as specifying acceptable frequency of non-compliance with standards, allowable excursions at high flows, or dual standards (enforceable levels and more stringent target levels) should be explored.

- Proven or presumptive presence of individual toxic substances should be a significant factor in determining whether such substances should be included in standards. Scientific defensibility, analytical detection and quantification capability, socio-economic and other impacts on the total environment, and voluntary risk factors are other aspects which should be considered in the standards-setting process for toxic substances.
- Initial water quality standards adopted by some states under the 1965 amendments to the Federal Water Pollution Control Act and confirmed under the 1972 amendments did not consider adequately cost/benefit, cost-effectiveness, and socio-economic impacts. These types of analyses are needed to develop achievable standards and procedures should be developed for their incorporation in the standards revision process with the burden of justifying less stringent standards not placed solely on the states as presently imposed by the USEPA regulations and guidelines.
- Conflicts among the USEPA guidance memoranda, regulations and the Clean Water Act should be

reconciled. Memoranda and regulations should be simplified and shortened to identify the end result clearly and to provide the states with maximum flexibility to achieve that end result within available resources.

- The USEPA disapproval of state standards should include specific technical and socio-economic justification rather than mere reference to the "Red Book" or unenforceable goals of the Clean Water Act.

Recognizing that no quick-fix is possible, the ASIWPCA recommended that a USEPA-State task force be established to assess opportunities and make recommendations for improving the standards. Such a task force operation started in June 1980. Earlier, the USEPA initiated an arrangement for rotating assignments of experienced outsiders to the Office of Planning and Management to advise on standards development. During the first of these assignments, the advisor found a general lack of understanding of how the various pieces of the overall USEPA water pollution control program should fit together. In a report to the USEPA, he stressed the importance of a functional structure for the technical tasks of water quality management, including the use of standards and criteria, in organizing a workable program.^{37/} He also

described an example of such a functional structure.

U.S. Council on Wage and Price Stability

In response to the USEPA's request in 1979, the Council on Wage and Price Stability (COWPS) formally commented on water quality standards following the USEPA's disapproval in 1978 of a portion of the State of Ohio's standards^{38/} and proposed revisions to correct the deficiencies. Briefly, the COWPS expressed concern that USEPA's "...overall approach to reviewing state water quality standards...is inflexible and results in unnecessarily costly and inefficient regulations."^{39/} The COWPS recommended that the USEPA modify its procedures to allow the states to weigh the incremental benefits and incremental costs of cleanup for individual water bodies. Specifically, the COWPS urged the USEPA to consider:

-- modifying the Red Book policy, or the Red Book itself, to provide criteria in the form of a range of values corresponding to different 'levels of protection' within a use level; this modification would permit the States to consider localized conditions and the expected costs and benefits in choosing specific criteria for a given use level;

- expanding the categories of use levels (with attendant criteria) and revising its 'downgrading' policy to permit downgrading whenever justified by a demonstration that costs of attaining a higher use level exceed the potential environmental gain;
- developing explicit guidelines for the required 'adequate technical justification' under the Red Book policy."

Natural Resources Defense Council

Banks, Senior Staff Attorney of the Natural Resources Defense Council, described an environmental lawyer's perspective of the use of water quality criteria and standards at the previously-mentioned 1980 WPCF Government Affairs Seminar.^{40/} He defined a water quality criterion as:

- "1. an official EPA judgement,
2. setting forth an extremely conservative estimate,
3. supported by the most recent data on dose-effect relationships and/or a clearly articulated scientific rationale,

4. of the largest justifiable pollutant concentration which, if incorporated directly into a discharge permit,
5. would absolutely protect a designated water use at the point of discharge,
6. and for which EPA has assessed, and adjusted for, the magnitude of its confidence in the concentration number."41/

He acknowledged, that while a criterion theoretically represents the scientific judgement as to what is necessary to protect water uses, a great deal more is involved before that number (a maximum permissible concentration or MPC) becomes an enforceable requirement. He urged, however, that the USEPA publish its generic judgements on MPCs and begin to see whether the judgements make sense in the real world. His further comments on this subject are especially pertinent.

"The essence of the Red Book policy is a presumption that EPA's criteria will work in the real world. The bridge between theory and reality is made directly unless it can be shown that deviations are justifiable. Thus, the standards approval process is the opportunity to consider one additional factor with respect to concentration numbers: technical reasons why an MPC

makes no sense for a particular water body. This might necessitate changes to the numbers, but since the use designation does not change, the resulting standard still must satisfy the concept of a criterion for that water body -- i.e., protection of the designated use. EPA readily admits that its criteria do not take into account the variability of waters from state to state. They obviously cannot do so, and are not intended to. So if the natural condition of a water body is such that it is silly to apply EPA's MPC, the states and affected dischargers have to make that point, and make it stick. No one else can.

"At the same time, it is important to remember that the assumption underlying EPA's policy is that the data base for the Red Book numbers is sufficiently broad to support presumptive applicability nationwide. Obviously, that fundamental premise is open to question with respect to each of the 65 new criteria. If the MPCs are not justifiable in the same sense, EPA should be told that now, not later."^{42/}

Industry (Chemical Manufacturers Association, American Petroleum Institute, etc.,)

Ladd of FMC Corporation presented some personal and some industrial views (Chemical Manufacturers Association, American Petroleum Institute, etc.) on the use of water

quality criteria and standards at the March 1980 WPCF Government Affairs Seminar. He expressed the "...fear that EPA's approach to developing water quality criteria and mandating standards, unless changed, threatens to develop into the most complex and widespread legal tangle of any of EPA's water programs. But does it really have to be this way?"43/

Ladd explained that criteria promulgated by the USEPA to date "...typically reflect 'worst case' conditions, conditions that would exist in aquatic systems only if organisms spent entire life cycles in constant exposure to fixed concentrations of contaminants in their toxic forms - a totally unrealistic, unlikely situation. This approach to setting criteria is overly conservative in that it overestimates the potential for adverse biological impacts of contaminants."44/

Ladd further expressed concern about past USEPA methodologies for developing criteria although he recognized the methodology for aquatic life as described in the May 18, 1978 Federal Register as a very significant improvement. He also criticized the inadequacy of the data base used and the statistical treatment of data by the USEPA, emphasizing that criteria should be "...provided as information to the states and accompanied by guidance as to how they may be implemented into technically valid, enforceable standards.

The actual environmental impact of a contaminant is a matter of availability and duration of exposure in a specific water body and should be considered on a river-by-river, segment-by-segment basis along with societal factors such as cost of implementation and benefits to be derived."45/

Regarding standards, Ladd objected to the USEPA having "...proceeded by regulation to make it virtually impossible for a state to adopt any other, less stringent use designation than 'fishable, swimmable'...", "...attempted to force upgrading of use designations without consideration of technical feasibility or desirability...", and "provided that the criteria set out in the Red Book are presumptively applicable by states without 'adequate technical justification'...Yet, EPA has not provided any guidance as to how states can justify deviation from the federal criteria."46/

Ladd deplored the lack of data which would provide information on existing water quality conditions. He stressed the need for up-to-date assessment of water quality problems (especially those allegedly due to toxic chemicals), the cost of improvements needed, and the benefits to be received. The Clean Water Act requires each state to submit a biennial water quality inventory report to the USEPA by April 1 in even-numbered years; the most recent reports should have been submitted by April 1, 1980. The

act also requires the USEPA to transmit the state reports, together with the USEPA's analysis, to Congress by October 1.^{47/} These reports would be the appropriate place for the needed assessments. He concluded that it would be better--even if legislation, regulations and court decisions have to be changed--to get on with the business of abating real problems that are known to exist on a case-by-case basis and to follow that with the proper monitoring effort to understand additional, less obvious problems.

Symposium on the Development, Use and Value of Water Quality Criteria and Standards, June 23-25, 1980

Participants from throughout the United States and three foreign countries presented a variety of views at a symposium on water quality criteria and standards, June 23-25, 1980, sponsored by the USEPA and co-sponsored by George Washington University and water quality agencies of the District of Columbia, Maryland and Virginia.^{48/} Comments of several of the participants are especially valuable for inclusion in this paper.

Casapieri of the United Kingdom's Thames Water Authority described policies issued by the National Water Council and adopted by the Department of the Environment in 1978.^{49/} These policies include a simple classification of river quality objectives (use designations) and associated

quality standards. The policies include a new concept that recognized variation in surface water quality by applying 95 percentile limits for required compliance with the criteria in the standards, based on what was considered to be an adequate background of monitoring data. According to Casapieri, "The reasoning was that it must be accepted as axiomatic that a specification of river quality requirements cannot be achieved for 100 percent of the time. The only practicable alternative is to seek to specify the maximum levels of contamination of waters at a given statistical level of probability. Experience suggested that in general such maximum limits should not be exceeded for more than 5 percent of the time."

Demayo of the Canadian National Department of the Environment explained the Canadian system of water quality criteria (defined in that country as scientific information used to recommend objectives), objectives (maximum concentrations of water constituents which will protect specific water uses in specific water bodies based on criteria, local natural conditions, and social and environmental considerations), and standards (legally enforceable constituent concentrations or narrative statements).^{50/} According to Demayo, discussions in Canada are continuing on various aspects of the system, with agreement yet to be achieved on some. For example, there is no agreement "...on the values one should use to define the

water quality, e.g., maximums, means, medians or some other percentile. The sampling technique, frequency of sampling; parameters, physical form (e.g., total, dissolved) and chemical species to be measured; and field vs. laboratory measurements are some of the other issues related to the determination of existing water quality which must be considered in order to obtain facts which can be used in the setting and then monitoring of water quality objectives."

Demayo concluded by pointing out that, "In Canada, water quality objectives are viewed as goals and indicators in water resource management and pollution control..." and there is a consensus that "...each body of water represents a particular and unique case. Therefore, the recommendation of water quality objectives for a particular body of water must follow a careful study of that particular system."^{51/}

Cox of the Chemical Manufacturers Association reviewed the Clean Water Act and the history of USEPA's criteria development activities.^{52/} She found the 1976 USEPA Red Book to be generally unacceptable by the scientific community. She noted that, "EPA's own Science Advisory Board rejected the Red Book and fell back to the 1974 Blue Book as the last valid work."^{53/} After citing evidence of invalid approaches by USEPA in the development of toxic criteria beginning in 1976, she recommended that criteria be established for such parameters as fecal coliforms and

biological oxygen-demanding materials and their segregation into water use categories in state water quality standards. For toxics however, she recommended that guidelines, not criteria be developed by USEPA for states, which "...should include discussions on the influence of:

- water hardness consideration on ecosystem toxicity;
- pH effects on ecosystem toxicity;
- chemical/physical interaction as they affect aquatic community toxicity;
- the persistence of chemicals and their long-term effects;
- the natural communities in various types of water systems, e.g., oligotrophic lakes, mountain ponds, alkaline streams, snow melt tributaries, etc.;
- segregation of natural processes such as eutrophication from pollution-enhanced acceleration of the processes;
- sedimentation from chemical reaction of pollutants, e.g., ferric hydroxide precipitation from some acid wastes;

- the adsorptive properties of sediments -- how sediments remove pollutants from the water column, how the pollutant is modified in the benthos by biological or chemical processes;
- the interactions of combined pollutants to enhance or lower the effects on the aquatic ecosystem; and
- the relative contribution of controllable pollutants (point-source) and uncontrollable (nonpoint sources) pollutants must be considered."54/

Olson of the Illinois Environmental Protection Agency proposed that each state be allowed to establish its own list of priority pollutants for which criteria would be incorporated in the state's standards, a process involving hearings, etc., which takes from one to three years.55/ He suggested an approach for each pollutant which would include the following steps:

- a preliminary assessment to determine if the pollutant could be present from staff personal knowledge, literature search and an industry or other source survey, followed by a determination whether it actually is present by chemical monitoring; if present, then and only then,

- gather chemical, biological fate, and analytical methods information;
- gather toxicology information;
- determine applicability of above information to local waters in light of ambient temperature, alkalinity, hardness, etc.;
- evaluate control capability, i.e., treatability, immobilization, or neutralization of the substance; and finally
- decide, in light of the above, whether the criterion (limit) is enforceable in a standard.

Preliminary assessment by each state would considerably reduce the work load and increase the likelihood that available state resources would be concentrated on the toxic pollutants having the greatest potential for actual harm to water uses in the state on a site-specific basis.

Lee of Colorado State University emphasized that those who implement criteria into standards need to keep in mind (1) enforceability, i.e., the available form of the contaminant must be measured; (2) concentrations vary with time and space, (3) the definition of mixing zones, (4) the economics of the situation, i.e., the costs and benefits of the best possible conditions vs usable conditions, and (5) the need for credibility of all government, particularly

regulatory agencies. He criticized the use in standards of the 1976 USEPA Red Book and other proposed criteria which are based on "worst-case" conditions, i.e., single numerical concentrations based on the results of chronic-lifetime bioassays, or extrapolation equivalent, of organisms exposed to contaminants in 100 percent available forms.^{56/}

Lee described case studies which demonstrate that determining potential zones and magnitude of impact of a particular contaminant or combination of contaminants on given aspects of water quality is desirable. He advocated "...an assessment of the contaminant load-water quality response relationships which could be used to inform the public of the water quality benefits that will be achieved as the result of providing certain degrees of contaminant control for certain amounts of their money."^{57/} This "environmental hazard approach", as discussed by Cairns, et.al, in 1978^{58/} and Lee, et.al, in 1979^{59/} is being developed through the efforts of the authors as well as the American Society for Testing and Materials (ASTM) Subcommittee on Safety to Man and the Environment.

According to Lee, the "...environmental hazard assessment for an aquatic system utilizes the combination of aquatic toxicity and environmental chemistry-fate information to determine the forms and amounts of contaminants present in a particular waterbody that can affect water quality, the zone of potential impact for both

acute and chronic toxicity, and the actual toxicity or other effects that occur in the region. This hazard assessment approach is a tiered approach which enables the user to determine at each level, the need for continued assessment to refine the estimate of the degree of hazard and the acceptability of the hazard that exists for a particular contaminant in a particular system."

Lee stressed that "in some systems it is possible, through relatively simple calculations and without any field work, to determine that there is no hazard or that there may be a very substantial hazard associated with the discharge of a particular chemical. Under these conditions, there is little or no need to proceed with further work to define the hazard more precisely. It is the in-between situations, where the expected environmental concentrations of available forms are near the critical concentrations to cause an adverse effect on water quality, that there is often need for further work beyond initial screening. Considerable emphasis is placed on the use of bioassays of selected reference organisms which can be related to the potential impact on organisms in the region of interest."

Under the Cairns-Lee approach, the increased use of bioassays would eliminate the need to chemically analyze water samples for the potentially significant contaminants from the variety of existing sources. The WPCF Standard Methods for Examination of Water and Wastewater Bioassay

Section Committee has organized a new subcommittee to provide guidance on the approaches that should be used for interpretation and appropriate application of bioassay results in water pollution control programs. Although bioassays can assess the presence of toxic substances not routinely measured and synergistic effects, Lee suggested that their greatest use "...will be to determine what part of the total concentration of many contaminants is available to affect water quality."60/

Thomann of Manhattan University discussed the need for credibility in the prediction of expected water quality by either empirical methods or mathematical models.61/ Either one or the other must be used in any waste load allocation process for linking pollution control measures to compliance with water quality standards.

Previous WPCF Statements of Policy and Recommendations

The revised WPCF Statement of Policy on water pollution control, adopted in 1974, includes the following statements especially germane to the subject of this paper:

1. "The objectives of water pollution control must include preservation of high quality waters for protection of public health; for industrial, agricultural, and recreational uses; for fish and wildlife propagation; and for the maintenance of an aesthetically desirable environment.

2. "The discharge of all wastewater into the waters of the nation must be controlled in a rational manner. Such regulatory control must be based not only on considerations of specific wastewater discharge characteristics but also on additional factors including discharge location, physical, chemical, and biological characteristics of the receiving waters, defined beneficial uses, and appropriate water quality criteria in order to provide adequate protection of the beneficial uses of the environment. After a facility is in operation additional ecological and environmental studies should be carried out to determine the effectiveness of the facility and the need for future modifications of the facility.

3. "The responsibilities for the adequate treatment and control of wastewater must be assumed individually and jointly by industry and local, state, interstate, and federal governments."62/

In December 1979, the WPCF commented on the USEPA's earlier requests for comments on water quality criteria for specific toxic pollutants as well as other issues concerning the development of criteria.63/ The comments represented the efforts of a broad cross-section of WPCF committees: the Plant Operations Committee, the Committee on Marine Water Quality, the Ecology Committee, the Industrial Wastes

Committee, the Technical Practices Committee, and the Government Affairs Committee. This paper will not repeat verbatim the ten pages of comments, however some of them are included in the recommendations, in all or in part.

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