BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	
EFFLUENT LIMITATIONS FOR THE	)	R08-9
CHICAGO AREA WATERWAY SYSTEM	)	(Rulemaking - Water)
AND THE LOWER DES PLAINES RIVER:	)	
PROPOSED AMENDMENTS TO 35 Ill.	)	
Adm. Code Parts 301, 302, 303 and 304	)	

PRE-FILED TESTIMONY OF PAUL L. FREEDMAN, P.E., BCEE

INTRODUCTION

This summary report presents the opinions that I, Paul L. Freedman, am submitting related to IEPA's proposed aquatic life standards including beneficial use designations and associated dissolved oxygen criteria for the Chicago Area Waterways (CAWS) in R08-9.

I am the founder and President of LimnoTech, an environmental consulting firm with headquarters in Ann Arbor, Michigan. I am an environmental engineer with 35 years of experience on water quality projects throughout the United States. I am currently the 2007-2008 Vice President of the Water Environment Federation (WEF), an educational and professional association representing more than 80,000 water quality professionals.

My areas of expertise are focused on surface water quality issues, including water quality analysis, watershed management and TMDLs, pollutant fate and transport, computer water quality modeling, Use Attainability Analyses (UAAs), and environmental regulations and compliance. In the course of my research and consulting practice for EPA, states, municipalities and industries, I have had involvement with hundreds of projects in more than three dozen states and I have over 200 technical presentations and publications on water quality issues. Of particular significance is a recent two-year research study that identified factors for success in UAAs based on examination of over 200 case studies (see Attachment 2 for reference), as well

as extensive research on the TMDL program as it relates to achieving water quality standards. I have also worked extensively for the U.S. Environmental Protection Agency providing technical assistance and training on wasteload allocation, TMDL, NPDES, and water quality standards topics.

Provided on the following pages is a summary of my professional opinion in the matter of IEPA proposed water quality standards for dissolved oxygen for the Chicago Area Waterway System (CAWS). My resume and a complete text of my opinion with references are attached (Attachment 1 and Attachment 2, respectively).

DISCUSSION

It is my professional opinion that IEPA proposed inappropriate aquatic life standards for the CAWS that in certain critical aspects employ the same dissolved oxygen criteria as the General Use waters classifications recently adopted in Illinois. The Agency did not adequately account for the unique characteristics of the CAWS that significantly differentiate it. In addition, IEPA did not consider the significance of wet weather impacts and unique flow considerations in developing the proposed standards that could prevent their attainment.

It is also my professional opinion that IEPA in its R08-9 regulatory proposal and subsequent testimony by Agency staff did not clearly define the beneficial aquatic life uses that the Agency recommends to protect, did not adequately justify the relationship between the proposed beneficial uses and specific proposed criteria, and did not demonstrate that it properly assessed the attainability of either these criteria or the beneficial uses.

It is my professional opinion that the proposed standards (both uses and criteria) for the CAWS are inadequately justified and therefore premature. Further, there are several ongoing studies that will provide important scientific data that would support a more proper and rigorous development of appropriate standards. I recommend that the Board defer approval of the

proposed standards until such time as the IEPA incorporates the additional studies, and supplements its assessment with other necessary analyses to complete a more rigorous and appropriate Statement of Reasons. Summaries of my opinions are provided below.

1. The proposed dissolved oxygen criteria for the CAWS are similar in important aspects to the General Use criteria, ignoring the unique characteristics of the CAWS.

IEPA appropriately recognizes some of the important differences between the CAWS and General Use waters; rightly, certain criteria recently adopted for General Use waters are not proposed for CAWS Aquatic Life A and/or B waters (e.g., for most General Use waters, a 7-day mean of daily means of 6.0 mg/l applies for early life stages present -March through July - but no such criteria has been proposed for the CAWS). However, the proposed minimum dissolved oxygen criteria for the CAWS are in most respects identical to the General Use criteria, and therefore do not appropriately reflect the dramatic differences between the CAWS and other General Use waters, which the Agency itself has acknowledged. IEPA has not justified its decision to apply the General Use daily minimum and 7-day mean of daily minima to the CAWS. The table below compares the minimum dissolved oxygen criteria proposed for the CAWS with those recently adopted for General Use Waters.

Comparison of Selected Proposed Dissolved Oxygen Criteria and Corresponding General Use Criteria

IEPA Proposed Designated Uses	**Early Life Stages Present** (March-July)	**Early Life Stages Absent** (August-February, except January-December for CAWS and Brandon Pool Aquatic Life Use B Waters)	
	Daily Minimum (mg/l)	Daily Minimum (mg/l)	7-Day Mean of Daily Minima (mg/l)
General Use Waters[1]	5.0	3.5	4.0
CAWS Aquatic Life Use A Waters	5.0	3.5	4.0
CAWS Aquatic Life Use B Waters	-	3.5	4.0

[1]Recently adopted; does not include selected subset of General Use waters

The CAWS is a unique system, with no other comparable waterway in the State of Illinois. This system has very different characteristics from the other General Use waters, for which IPCB recently adopted standards. The following table provides a simple summary of key differences between the CAWS and broad characteristics of General Use Waters. The combination of different factors found in the CAWS is unique and very different from typical free flowing streams and rivers, which are more characteristic of Illinois General Use waters. None of these characteristics used to describe the CAWS are included within the General Use water descriptions, nor are they typically characteristic of other General Use waters in Illinois.

Characteristics of General Use Waters in Illinois Compared to CAWS

Parameter	General Use Waters	Chicago Area Waterways
Water sources	-Stream flow from rain runoff, natural drainage and groundwater recharge	-Effluent & CSO dominated, controlled Lake Michigan diversions
Morphology	-Variable depth -Variable bottom, pools & riffles -Natural meandering -Floodplain connection	-Deep, non-wadable -Dredged -Channelized -No floodplain, riparian
Hydraulics	-Free flowing -Flows downstream, -Natural mixed and turbulent,	-Regulated flow -Bi-directional flow, -Areas stagnant & density stratified
Primary Function	-Natural hydrology, aquatic life and wildlife	-Convey waste waters, flood control, navigation
Land Use	-Mix of forested, rural, suburban, urban and industrial uses	-Primarily urban and industrial
Form	-Meandering	-Largely straightened, channelized
Habitat	-Variable and abundant	-Limited
Substrate	-Variable	-Fine sediments

The differences highlighted above have a significant impact on attainable uses and water quality in affected waterways. The available literature is replete with recognition of how altered conditions impact water quality and potential biologic uses. For example, as described in my report (Attachment 2), the Army Corps of Engineers describes navigation channels as having altered flow, limited mixing and stratification, and sediment effects that all can lead to low dissolved oxygen and unstable bottom substrate. USEPA also states that the physical and

hydrological characteristics of man-made waterbodies are not conducive to the establishment of a balanced population of aquatic biota. Many other scientific publications document the negative ecological effects of navigation and man-made channels, including mortality of fish eggs, larvae, and adult fish, prevention of effective spawning, and severe limitations on the growth and development of fish larvae and young of year (YOY) fish.

Despite these obvious differences, IEPA still proposes minimum dissolved oxygen criteria for aquatic life protection that, where specified, are identical to criteria for General Use waters, without providing adequate justification. Further, General Use waters are designed to protect "communities predominantly composed of pollution-sensitive species" whereas the CAWS proposed aquatic life uses are designed to protect tolerant or intermediately tolerant species, which presumably could be supported by less stringent criteria.

IEPA, with no explanation, also does not include relevant exceptions to standards that were explicitly included in the R08-9 standards for General Use waters. Specifically, an exception is made for the General Use dissolved oxygen criteria with respect to stagnant and stratified waters. This exception is not explicitly included in the proposed standards for the CAWS, yet IEPA documents numerous sites within the CAWS that experience low flow, stagnant conditions, flow reversals, and stratification.

In addition, IEPA did not document that it considered the significant effects in the CAWS of wet weather impacts, and how the extreme flow variations would affect attainable aquatic life uses and related dissolved oxygen criteria. The CAWS has unique hydrologic and hydraulic dynamics impacted by wet weather and flow management. In anticipation of a major rain event, the water level in the CAWS is rapidly lowered by a controlled release of water at the Lockport Powerhouse to accommodate overflows from large storms and avoid over bank flooding. In

response to a storm, the CAWS can receive enormous inputs of stormwater, CSO and pump station wet weather flows. This can result in significant pollutant loads and a dramatic rise and fall of water levels, with extreme changes in flow. These rapid fluctuations in flow in the CAWS can result in substrate scouring, sediment resuspension throughout the water column, drying of littoral aquatic habitats, and a sudden decrease in dissolved oxygen below the standard.

The significance of wet weather is particularly and uniquely evident in Bubbly Creek. During dry weather, Bubbly Creek is stagnant and has no flow. In contrast, during wet weather the Creek receives significant CSOs and discharges from the Racine Avenue Pump Station that also suspend sediments with high oxygen demand and associated pollutants. When conditions return to zero flow, the system stagnates and oxygen is depleted for days. This unique cycle is expected to continue indefinitely (albeit less frequently after TARP completion), but IEPA did not document that it was considered in establishing standards.

2. IEPA did not document that it considered alternative classifications or dissolved oxygen criteria for the CAWS similar to those that have been employed by other states for severely modified waterways, nor justify why these approaches might not apply to the CAWS.

In the section above, I highlighted the unique characteristics of the CAWS and some of the water quality consequences of these conditions. Recognizing these conditions, IEPA should have considered alternative ways of addressing wet weather conditions and the applicability of standards from other states for altered waterways.

In light of the significance of wet weather impacts and uncertain future conditions, the proposed IEPA standards are inadequate because they fail to consider wet weather non-compliance. Wet weather water quality standards, or variance provisions, would have been an important approach for IEPA to consider, but no mention is made of this as an alternative component of the proposed standards. For example, the States of Indiana, Maine, and

Massachusetts all have provisions for wet weather standards or variances that consider the significant challenges in controlling wet weather and CSO impacts on water quality in highly urbanized areas. In its water quality standards for the Ohio River, the multi-state Ohio River Valley Water Sanitation Commission allows for development of alternative criteria if CSO communities have submitted a long-term control plan and a UAA.

IEPA also did not document that it considered alternative classifications or criteria for the CAWS similar to those employed by other states for severely modified waterways, nor justify why such approaches might not apply to the CAWS. For example, the UAA report described the CAWS as functionally similar to the Cuyahoga River Ship Channel in Cleveland, Ohio, yet IEPA did not discuss the use of a similar classification and associated criteria. The Cuyahoga River Ship Channel is significantly altered and has a federally maintained navigation channel, not unlike the CAWS. Based on analysis of attainable dissolved oxygen and habitat, Ohio created a unique limited resource water dissolved oxygen criterion for the Cuyahoga River Ship Channel of 1.5 mg/l minimum.

There are other examples of waterways that have been significantly modified with unique classifications, criteria, or variances. Louisiana has criteria for "man-made waterbodies" including minimum DO warm weather criteria of 2.0 mg/l for the New Iberia Southern Drainage Canal (and ancillary waters), and 2.5 mg/l for the W-14 Main Diversion Channel. In Wisconsin, the minimum DO criterion (under a variance) for the Milwaukee River downstream of North Avenue Dam and the entire Kinnickinnic River is 2 mg/l. In the Houston Ship Canal, Texas, the minimum criterion for the 1006 HSC Tidal segment is 2.0 mg/l, and the minimum criterion for the 1007 HSC/Buffalo Bayou Tidal segment is 1.0 mg/l. In Maryland, the minimum DO criterion

for federal navigation channels located in the tidal portions of the Patapsco River (designated "deep channel seasonal refuge use") is 1.0 mg/l.

In addition, given IEPA's reliance on Ohio's biological assessment methods, the Agency should have documented that it considered Ohio's dissolved oxygen criteria for modified and limited resource waters. For example, Ohio's daily minimum criterion for limited resource waters is 2.0 mg/l, and for modified warmwater habitat waters the minimum criterion is 3.0 mg/l. Many other states have considered unique man-made conditions when setting dissolved oxygen criteria, as listed above, and it is my opinion that these examples highlight reasonable criteria for significantly altered waterways that should be considered by IEPA.

3. IEPA did not explicitly provide scientific justification for both the aquatic life use classifications and the associated criteria. In addition, the Agency's documentation was inadequate to demonstrate the attainability of water quality and beneficial uses.

USEPA in its Water Quality Standards Handbook defines a UAA as a "structured scientific assessment of the factors affecting the attainment of a use which may include physical, chemical, biological, and economic factors..." It is my professional opinion that while the Statement of Reasons and supporting documents provide information related to the necessary steps, they do not provide explicit and specific justification for all of the necessary components. It is not unlike a connect-the-dots picture, with some dots missing, some misplaced, and others faded, and the picture hard to fully recognize without all the proper dots connected by lines.

The Statement of Reasons also lacks a description, or even mention of, the weight of evidence approach described by IEPA staff during cross examination. Without such documentation, it is unclear how IEPA considered all lines of evidence in developing the proposed standards.

The first deficiency in the IEPA documentation is the lack of a clear justification for the two proposed use classifications. The proposed designated CAWS Aquatic Life Uses A and B

appear to be physically segregated based on the presence or absence of "*deep-draft, steep – walled shipping channels,*" yet the Calumet-Sag Channel, which has deep draft and steep walls is classified as Use A, which seems inconsistent. The IEPA proposed aquatic life uses also appear to roughly correspond to uses described in the CAWS UAA report. These uses were determined by an arbitrary 75 percentile statistical IBI value. In both cases the justification is never explicitly described. Further, neither source explains how the existing or improved habitat supports or could support the proposed designated aquatic life uses. Even more so, the UAA QHEI and IBI scoring and analysis has been characterized by others as fraught with error.

Fundamental to establishing beneficial uses and criteria in the CAWS is the need to identify the aquatic species that must be supported. The Statement of Reasons is vague in this regard. The Statement of Reasons differentiates Aquatic Life Use A and B waters based on whether they are capable of maintaining aquatic-life populations of either tolerant or intermediately tolerant types. However, it does not define "tolerant" nor identify the specific target species for each use that would be required to determine the appropriate protective criteria. If IEPA relied on the UAA assessment (albeit with its significant failings), the Agency did not say so. Further, the IEPA proposed criteria for Use A waters are designed to protect early life stages, a protection not mentioned in the UAA; no data are presented on early life stages in the CAWS, and an explicit justification on how the Aquatic Use A waters can or could support these early life stages is missing.

Another question is how IEPA links the proposed dissolved oxygen standards for the CAWS to objectives for protection of the target biology. IEPA chose a daily minimum dissolved oxygen criteria of 3.5 mg/l, which it says was based on the USEPA dissolved oxygen criteria guidance document. However, USEPA recommends 3.0 mg/l as the national 1-day minimum

criterion for warmwater, other life stages. The USEPA guidance provides other values for various levels of protection for both warm water and cold water, but in all cases these values were developed "to protect the more sensitive populations of organisms." In contrast, the CAWS proposed aquatic life uses are designed to protect tolerant" or "intermediately tolerant" organisms, which one would reasonably assume could be supported by less stringent dissolved oxygen criteria, reflecting their higher tolerance.

There exist examples of UAAs where a thorough scientific assessment for establishing the appropriate criteria has been conducted. For example, the process conducted for Chesapeake Bay included comprehensive examination of the target species and necessary criteria unique to various zones in the Bay, including a proposed "deep channel seasonal refuge" designated use to protect bottom sediment-dwelling organisms, with an instantaneous minimum dissolved oxygen criterion of 1 mg/l. In addition, the UAA for the Cuyahoga River ship canal clearly identified the limitations in water quality, habitat, and biologic uses for protection, which resulted in a criterion of 1.5 mg/l minimum for June thru January.

Overall, IEPA did not carefully and explicitly link the physical, chemical and biological conditions to the specific beneficial uses and associated criteria. Without this connection, there is not a clear structured and scientific justification that the beneficial uses and criteria are appropriate.

IEPA also did not document in the Statement of Reasons that it rigorously considered whether the proposed regulatory proposal will result in attainment of the aquatic life uses and corresponding dissolved oxygen criteria. A fundamental question in establishing a new standard is whether there is a realistic potential that this proposed standard can be attained, hence the term "use attainability analysis." This is a significant inadequacy of the Statement of Reasons. IEPA

not only did not demonstrate that the water quality criteria can be attained using modeling or data, but also did not show that the proposed beneficial uses can be attained in the foreseeable future.

The UAA and Statement of Reasons give some attention to attainability, but the focus is on existing conditions where the criteria are not being met because of various factors including wet weather and stagnant conditions. IEPA, on page 61, states that it is highly likely that conditions will continue to violate standards "at least until the Tunnel and Reservoir Project is complete..." and that it may be necessary to implement flow augmentation and aeration. However, IEPA did not provide an actual analysis of water quality under future conditions, which will include requirements for reduced inflows from Lake Michigan. Conditions under a completed TARP will still include stormwater inputs from 41 communities, periodic pump station discharges, and remaining CSOs.

Putting water quality aside, IEPA also did not provide an adequate justification that the proposed beneficial uses can be reasonably attained. Both the UAA and the Statement of Reasons are very clear that beneficial uses cannot be attained until a strategic plan is completed that includes several significant actions beyond effluent limits, several of which have no assurance that they will be realized. This includes habitat restoration, for which the UAA was unable to identify any specific plans for habitat restoration in any of the CAWS reaches. The UAA Strategy also called for removal of contaminated sediments, another costly remediation and restoration effort for which neither the UAA nor the Statement of Reasons is able to point to existing or proposed plans.

Overall, the IEPA has proposed new beneficial uses and criteria for the CAWS, but has not provided an explicit and adequate demonstration that the criteria and uses can be achieved.

4. **It is my professional opinion that the IEPA proposal is significantly premature. The results of ongoing studies can provide IEPA with additional data needed to fill critical information gaps and allow IEPA to conduct a more rigorous analysis.**

The data and information gaps I identified above can be addressed through several ongoing studies. The IEPA proposal is significantly premature without the benefit of results from these studies. These studies can provide very useful scientific, technical, and economic information for better defining attainable uses and appropriate dissolved oxygen criteria.

MWRDGC studies include:

- **Habitat and biological assessment study**: Information from this ongoing study will provide more comprehensive data on CAWS habitat and fish communities, as well as information concerning whether the CAWS habitat is, or potentially could be, conducive to early life stages of fish.

- **Dissolved oxygen modeling**: Improved dissolved oxygen modeling by Marquette University researchers will provide a better assessment of the attainability of proposed dissolved oxygen criteria under a range of future expected conditions including wet weather.

- **Continuous dissolved oxygen monitoring:** MWRDGC is conducting extensive hourly monitoring of dissolved oxygen to better understand the transient effects of wet weather.

- **Water quality monitoring:** MWRDGC is conducting comprehensive sampling of water chemistry, sediment chemistry, sediment toxicity, habitat, fish, and benthic invertebrates. The data supplements studies ongoing since 2001.

- **Water quality and sediment data analysis**: The MWRDGC is completing an analysis of recent water and sediment quality data in the CAWS that will provide additional understanding of existing conditions, trends, and causal factors impacting dissolved oxygen and attainable uses.

- **Integrated water quality strategy**: Studies are now being conducted to examine the feasibility and effectiveness of combinations of actions in the CAWS and analyze the economic costs. Current information does not consider combined effects or costs.

- **Field tests using Sidestream Elevated Pool Aeration (SEPA) Stations:** Tests on the Calumet-Sag Channel will help determine if stations can be operated to comply with the proposed dissolved oxygen standards and additional electricity requirements.

- **Studies assessing improvement measures**: Recently completed studies on the effectiveness of supplemental water quality improvement measures including flow augmentation and supplemental aeration needs to be incorporated into the assessment.

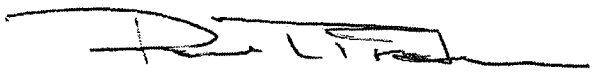
- **Economic and environmental impacts:** In response to the integrated water quality strategy, the MWRDGC is conducting an economic and environmental impact assessment as to the impacts of the integrated treatment and stream improvement projects. Economic affordability will be assessed in the context of the current economic structure, which has certain tax-based limitations. This study will be completed after the integrated strategy is finalized.

- **Hydraulic modeling:** Researchers at the University of Illinois are studying the complex hydraulics of the CAWS under various conditions and will examine issues of stratification, bidirectional flow and stagnation, under a range of dry and wet weather conditions as they relate to water quality. Another outcome of this study will be a better understanding and accounting for the effects of sediment resuspension on dissolved oxygen.

CONCLUSIONS

In my opinion, the current IEPA proposal is insufficiently justified, poorly documented, significantly inadequate, and fails to consider many important factors and alternatives that are critical. It is also significantly premature for IEPA to propose new water quality standards, both uses and dissolved oxygen criteria, to the CAWS until IEPA incorporates results from ongoing studies and develops a rigorous and defensible analysis and justification. However, if the IPCB decides to act (albeit in my opinion prematurely) then I would recommend the following actions at a minimum. First, alternative dissolved oxygen criteria used in other states for heavily altered water bodies like the Cuyahoga River Ship Channel should be considered for the CAWS. I also recommend that IPCB establish a separate use classification for Bubbly Creek, which has conditions distinct from the rest of the CAWS. With respect to use classifications, I recommend that the Calumet-Sag Channel be classified as Use B rather than Use A. Last, I recommend that the Board create a wet weather standard that reflects the documented wet weather conditions in the CAWS, which are expected to continue for the foreseeable future. Nevertheless, I still strongly believe that it is in the best interest of the State to await the completion of the above studies, and then conduct the necessary analyses with this additional information.

Respectfully submitted,



By: Paul L. Freedman
LimnoTech

Testimony Attachments

1. Resume: Paul L. Freedman, P.E., BCEE
2. Written Report: Paul L. Freedman, P.E., BCEE

Attachment 1

Paul L. Freedman, P.E., BCEE

President
LimnoTech

Principal Expertise

- Water Quality
- Watershed Management
- TMDL & UAA
- Pollutant Fate & Transport
- Sustainability & Green Practices
- Water Resource Management
- Computer Applications & Modeling
- Environmental Regulations & Compliance

Education

MSE	Water Resources - Civil Engineering, *Cum Laude* The University of Michigan, Ann Arbor, Michigan, 1973
BSE	Science Engineering, *Cum Laude* The University of Michigan, Ann Arbor, Michigan, 1972

Registration/Certification

Professional Engineer, States of Indiana, Illinois, Maryland, Michigan, Ohio, and District of Columbia

Certified Professional for Ohio Voluntary Action (site remediation) Program

Board Certified Environmental Engineer (Diplomate), American Academy of Environmental Engineers

Experience Summary

Mr. Freedman is founder and President of LimnoTech. Since its inception in 1975, he has provided guidance and leadership for LimnoTech on more than 300 projects, emphasizing the use of advanced science and engineering to help clients make the right decisions to solve their water related challenges. This emphasis continues today through his direction and the efforts of other LimnoTech officers, managers and employees.

In addition to his leadership role, Mr. Freedman also provides LimnoTech with special technical expertise. A cornerstone of his technical career from the outset has been, and continues to be, the development and application of computer simulations for rivers, lakes, estuaries and watershed management. Mr. Freedman is a nationally recognized expert in water quality analysis, conventional and toxics NPDES permitting, TMDL development, watershed management, computer modeling, and fate/transport of toxic pollutants in the environment. He provides expert training and guidance to states and USEPA, and also consults extensively for regulated parties. Mr. Freedman also has broad experience in stormwater and CSO control, including assessment, modeling, conceptualization of control strategies and regulatory compliance strategies. He has also been active on current issues related to water quality standard revisions, TMDL, wet-weather issues, sustainability and green practices. Mr. Freedman also offers 20 years of experience in groundwater contamination, modeling, site remediation, remedial action planning, and regulatory compliance.

Mr. Freedman's extensive professional involvement helps ensure that LimnoTech client needs are served using the most up-to-date technical and regulatory information and are linked to best experts available. He has been active in the Water Environment Federation (WEF), the Michigan Water Environment Association (MWEA), and the American Academy of Environmental Engineers (AAEE). Through these and other professional associations, Mr. Freedman has organized or taught in dozens of technical training seminars, provided approximately 200 technical presentations and papers, been involved in more than two dozen committees and work groups, and chaired five national conferences on TMDL and watershed management. As a demonstration of his active leadership, Mr. Freedman is the 2007-2008 WEF Vice President and has chaired both the WEF Government Affairs and Watershed Management Committees. He is a past president of the Michigan Water Environment Association and past chair of Water Supply and Wastewater Testing and Certification Subcommittee for the American Academy of Environmental Engineers.

Professional and Academic Appointments

President, 1981-Present Vice President, 1975-1981	LimnoTech Ann Arbor, Michigan
Research Associate 1973 - 1975	The University of Michigan Great Lakes Resource Management Program, Civil/Environmental Engineering Department Ann Arbor, Michigan

Professional Affiliations

American Academy of Environmental Engineers (AAEE)

American Society of Civil Engineers (ASCE)

American Water Resources Association (AWRA)

American Water Works Association (AWWA)

International Association for Great Lakes Research (IAGLR)

Michigan Water Environment Association (MWEA, formerly MWPCA)

National Society of Professional Engineers (NSPE)

The Society of American Military Engineers (SAME)

Water Environment Federation (WEF, formerly WPCF)

Awards

International Association for Great Lakes Research, Honorary Lifetime Membership for Important and Continued Contributions to IAGLR, May 25, 2005.

Michigan Water Environment Association, Outstanding Environmental Consultant, 2004.

Charles Alvin Emerson Medal (contributions to the water environment profession), Water Environment Federation, 2002.

Engineering Alumni Society Merit Award College of Engineering (contribution in the field of Civil and Environmental Engineering), University of Michigan, 2002

Chi Epsilon, National Civil Engineering Honor Society, Honor Member, December 2000.

Willard F. Shephard Award, MWEA, 2000

Water Environment Federation Service Award (outstanding contributions to WEF and Watershed Management), 1999

Michigan Water Environment Association, Awardee, Honorary Member, June 1999.

Grand Traverse Bay Watershed Award (contributed to the advancement of scientific research on Grand Traverse Bay), 1996.

Water Environment Federation Service Award (outstanding contribution to Government Affairs), 1996.

Select Society of Sanitary Sludge Shovelers (honorary society for contributions to the Wastewater and Water Quality Profession), 1996.

Arthur Sidney Bidell Award (outstanding contribution to the Profession), Water Environment Federation, 1996.

James R. Rumsey Award, Best Paper, Michigan Water Environment Association, "Great Lakes Environmental Assessment," (with Paul W. Rodgers et al.), 1995.

Michigan Water Environment Association Service Award (outstanding contributions to the Profession), 1994.

MWEA/MWPCF Service Recognition Awards, 1989, 1990, 1991, 1992, 1993.

Professional Activities

Officer: Vice President, Water Environment Federation (WEF), 2007-2008

WEF is a member association representing water quality professionals including over 80,000 members and affiliates worldwide. WEF provides educational and training services and products plus policy advocacy on the water environment. This includes books, journals, workshops, training, and conferences highlighted by WEFTEC, North America's largest water conference and exposition. He serves as a member of the Board of Trustees, the governing body for WEF that has oversight and responsibility for all WEF activities.

As a WEF Officer, Mr. Freedman also promotes the WEF mission and strategic goals to preserve and enhance the global water environment by supporting and advocating WEF policies. He serves as a spokesperson for and representative of WEF to its members, WEF Member Associations, the public, government agencies, policy makers, and water environment leaders throughout the world. During his four year term of service as an officer he promotes interest and active participation within WEF; and raises awareness of issues and priorities of concern to WEF and the water environment profession.

President Michigan Water Environment Association (MWEA), 1993/1994

President-Elect MWEA/MWPCA, 1992/1993

Vice President MWPCA, 1991/1992

As an MWEA Officer, Mr. Freedman provided leadership and direction for a 1,300-member organization of environmental professionals. He managed the activities of over 30 committees and had oversight responsibility for approximately 25 seminars and workshops, and two annual conferences, each involving over 500 attendees over four days. During his leadership term, he focused on strategic planning, government affairs and improvements in technical programming. During the course of his term, he gave dozens of presentations to professional and public groups on issues important to the environment and water environment professionals.

Chair/Director:

WEF Long Range Planning Committee, Member and Vice Chairman Strategic Planning and other strategic tasks. 2004-2007.

WEF Sustainability Task Force Co-Chair: Initiated planning for new strategic emphasis at WEF, involved expanded programs, conference, services and technical products in the topic area of water sustainability. 2007.

Water Environment Federation Board of Trustees, 2003-2005.

Water Environment Federation Director, House of Delegates, 2003-2005.

Sustainable Water Resource Roundtable, under Federal Administrative Committee on Water Information, Steering Committee, 2002-present.

WEF Total Maximum Daily Load Conference Chair, 2002 and 2003.

> Mr. Freedman organized and co-chaired these two national conferences cosponsored by the Water Environment Federation, Association of State and Interstate Water Pollution Control Agencies, United States Environmental Protection Agency, United States Geological Service, United States Department of Agriculture, and other agencies.

Water Environment Federation Board of Directors, Director-at-Large, 2000-2003.

Michigan Water Environment Association (MWEA) Board of Directors, 2001-2003.

AAEE Water Supply and Wastewater Subcommittee, 1998-2001.
(Responsible for development and revision of specialty certification exam for Diplomate Certification.)

WEF Watershed Management Committee Chair, 1996-99

> Mr. Freedman established and chaired a new Water Environment Federation committee focused on Watershed Management. In this capacity, he recruited members, established a committee mission statement and committee goals, developed four subcommittees, and directed/managed numerous committee activities. His committee has organized three national conferences, several technical conference sessions and workshops, and contributed articles to journals, a national summit of watershed organizations, plus numerous other educational and professional activities.

WEF Government Affairs Committee Chair, 1994-96

> WEF Government Affairs - V. Chair, 1990-93
>
> WPCF Regulatory Affairs Subcommittee Chair, 1987-90
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> As Chair of Water Environment Federation Government Affairs Committee and a leading GAC member for over a dozen years, Mr. Freedman helped establish direction of WEF activities related to government policies on water environment issues. He chaired or established over 25 technical work groups to comment on environmental regulatory policies and worked collaboratively with USEPA. He has testified before Congress on environmental legislation, helped develop legislative and regulatory proposals, organized and supervised dozens of technical conference sessions, given dozens of technical presentation, held several government affairs training sessions, written several journal articles, and helped direct and organize a range of professional activities in the government affairs area. He directed the activities of four subcommittees and oversaw the development of a strategic plan for WEF government affairs.

WEF Watershed Specialty Conference Chair. 1994-2000

> Mr. Freedman organized and chaired two national watershed management conferences and one international conference, co-sponsored by as many as 14 Federal agencies and two Canadian agencies. This conference series has involved hundreds of speakers and dozens of workshops and field trips. Each has been unquestionably the premier conference of this nature, drawing national and international experts.

MWEA Past President Committee Chair, 1994/1995

MWEA Audit & Budget Chair, 1993/1994

MWEA Conference Program Chair, 1993/1994

> Mr. Freedman organized and chaired this MWEA annual technical conference and exposition involving three days of concurrent technical sessions as well as an exposition and various association functions.

MWEA Strategic Planning Chair, 1992/1993

MWPCA Time and Place Chair, 1992/1993

MWPCA Technical Conference Chair, 1992/1993

> Mr. Freedman organized and chaired this MWPCA annual technical conference and exposition involving three days of concurrent technical sessions as well as an exposition and various association functions.

WEF Great Lakes Task Force Chair, 1991-94

MWPCA Government Affairs Committee Chair, 1989-91

Committees:

AWWA Source Water Protection Committee, 2004-2007
WEF Publication Committee, Trustee Liaison, 2003-2004
WEF Government Affairs Committee, Trustee Liaison, 2003-2004
WEF Ecology Committee, Trustee Liaison, 2003-2004
WEF Long Range Planning Committee, 2001-Present
WEF Watershed Management Committee, 1996-Present
WEF Specialty Conference, 1994-98
WEF Ad Hoc Legislative Immediate Response Team (ALIRT), 1994-98
WEF Collection Systems, 1994-96
AAEE Water Supply and Wastewater Sub-committee, 1993-2001
AAEE Task Force on Certification Requirements, 1992-93
WEF Task Force on Governance, 1993-94
MWEA Constitution & Bylaws, 1993-1995
MWEA Groundwater, 1992-95
Clean Water Act Reauthorization Committee, WEF, 1992-96
MWEA Membership, 1992-94
MWEA Conference Planning, 1991-94
MWEA Industrial Waste, 1990-94
MWEA Strategic Planning, 1990-94
MWEA Executive Committee, 1991-95

WEF Toxic Substances, 1987-94
MWEA Conference Program, 1986-95
WEF Government Affairs, 1985-98
MWEA Government Affairs, 1985-96
ASCE Impact Analysis, 1985-86
IAGLR, Technical Reviewer, 1988
ASCE, Technical Reviewer, 1984/1985, 2004
World Bank, Technical Reviewer, 1983/1984

Technical Conferences: (Chair/Organizer/Session Manager)

Practical Guidance for Successfully Navigating the UAA Process, Workshop A, Session moderator and workshop organizer. TMDL Sciences 2007, June 24, 2007. Bellevue, WA.

Great Lakes Region Research Priorities Workshop for Sustainable Water Resources. Co-chair, organizer, and speaker, Ann Arbor, MI, April 4-5, 2005.

AWWA, Source Water Protection Symposium Pre-Conference Workshop, TMDLs Relevance to Drinking Water Utilities. Organizer, facilitator and speaker. Palm Beach, FL. January 22-26, 2005.

National TMDL Science and Policy Conference, Chair, organizer, and panel moderator, Chicago, IL, November 16-19, 2003.

National TMDL Science and Policy Conference, Chair, organizer, and panel moderator, Phoenix, AZ, November 13-16, 2002.

WEF Watershed Management 2002, Planning Committee, WEF Specialty Conference, Ft. Lauderdale, February 2002.

WEF Watershed Management 2002. Session Moderator: TMDLs, WEF Specialty Conference, Ft. Lauderdale, February 2002.

TMDL Science Issues Conference, Planning Committee, Co-chaired by WEF and the Association of State and Interstate Water Pollution Control Administrators, St. Louis, MO, March 4-7, 2001.

Michigan Chamber of Commerce, Environmental Issues Forum: A Dialogue with Experts. "Can You Drink the Water?" Panel Member, Lansing, Michigan, October 25, 2000.

WEFTEC 2000, Moderator/Chair, Preconference Workshop, "Tools for Achieving Point and Nonpoint Source Partnerships," Anaheim, CA, October 14, 2000.

WEFTEC 2000, Co-Chair/Co-Organizer, Preconference Workshop, "TMDL Development and Implementation," Anaheim, CA, October 14, 2000.

WEF Watershed Management 2000 Conference, Chair, Vancouver, B.C. July 9-12, 2000.

"Effective Watershed Planning," Moderator, Effective Watershed Management for a Clean Michigan, East Lansing, Michigan, April 1, 1999.

"Water Quality Protection: Scientific Insights for Successful National Policies," Moderator, WEF/USGS Briefing, Alexandria, Virginia, March 5, 1999.

"Watershed Management: Moving From Theory to Implementation," Conference Chair and organizer, WEF Specialty Conference; Denver, Colorado, May 3-6, 1998.

"TMDL's Impact on NPDES," Implementing Watershed Management, Organizer and Presenter, A Workshop for Decision Makers; Atlanta, Georgia, November 8, 1996.

"Washington Briefing," Organizer, Water Environment Federation Workshop, Alexandria, Virginia, March 21-22, 1996.

"What Should the Water Quality Goals be for Urban Streams?" Session Manager, Urban Wet Weather Pollution Controlling Sewer Overflows and Stormwater Runoff, Quebec City, Canada, June 16-19, 1996.

Watershed '96, Moving Ahead Together, Conference Chair and Organizer, An Interagency (14 Federal agencies) Conference and Workshop; Baltimore, Maryland, June 10-14, 1996.

"USEPA Regulatory Update," Moderator and Chair - Committee, WEFTEC 1995; Miami, Florida, October 24, 1995.

"The Watershed Management Approach to Improving The Water Environment," Organizer, MWEA and MDNR; East Lansing, Michigan, May 23, 1995.

Toxic Substances in Water Environments: Assessment and Control, Program Committee Chair, Water Environment Specialty Conference, Sediment Transport Modeling and Assessment Track; Cincinnati, Ohio, May 14-17, 1995.

"EPA Regulatory Update," Chair and Organizer, Technical Session, WEFTEC Conference and Exposition; Chicago, Illinois, October 18, 1994.

"Influent and Effluent Toxic Discharge Limitations for POTWs," Organizer, Preconference Technical Workshop, WEFTEC Conference and Exposition; Chicago, Illinois, October 16, 1994.

"EPA Regulatory Updates," Organizer and Presenter, WEFTEC '94; Chicago, Illinois, October 17, 1994.

"A Global Perspective for Reducing CSOs: Balancing Technologies, Costs and Water Quality," A WEF Specialty Conference: Computer Modeling Session, Louisville, Kentucky, July 1994.

Annual MWEA Technical Conference, Conference organizer and Chair, Lansing, Michigan, June 1994.

"The Great Lakes Water Quality Initiative: A Teleconference," Conference organizer and moderator, MWEA; broadcast from Kalamazoo, Michigan, July 14, 1993.

Annual MWEA Technical Conference, Conference Chair and Organizer; Boyne Highlands, Michigan, June 1993.

"Preparing for Environmental Change: The Clean Water Act, Hazardous Waste Laws andRegulatory Approaches in the New Administration," Presenter, WEF Washington Briefing; Washington, D.C., March 1993.

"Water Quality Based Toxics Control: Federal Guidance and State/Discharger Experience," Organizer, Pre-Conference Seminar, WEF Annual Conference; September 1992.

"Zero Discharge Returns? New Regulatory and Legislative Initiatives," Moderator and Presenter, WEF Washington Briefing; Washington, D.C., 1992.

Annual MWPCA Technical Conference, Conference organizer and Chair, Bellaire, Shanty Creek, Michigan, June 1991.

Air, Water and Waste Conference; Water Quality Session, Water track manager, Engineering Society Detroit, Detroit, Michigan, December 1991.

"Government Regulations," Session organizer and Moderator, at MWPCA Annual Technical Conference, 1990, 1991.

"Future Compliance, What's Next?" Organizer, WEF Washington Briefing, Washington, D.C., March 1990.

"CSO and Stormwater Controls," MWPCA and Michigan Municipal League, Lansing, April 1989.

"Wetlands Permitting and Regulations," Conference organizer and Moderator, MWPCA, Lansing, Michigan, 1988.

"Acid Rain Effects," Session Manager, ASCE, Environmental Engineer Div. Conference., Boston, Massachusetts, 1986.

"Great Lakes Water Quality," Session Manager, ASCE Annual Conference, Detroit, Michigan, 1985

Work Groups/Workshops/Public Meetings (Organizer/Chaired):

Multi-stakeholder Public Meeting on Designated Uses and Use Attainability Analysis, Facilitator, Opening Remarks, and Committee Organization. USEPA/WEF. Atlanta GA, Sept. 20-21, 2005; Chicago, IL, Feb. 8-9, 2006.

Defining an Endpoint for CSO Control, session moderator. CSO LTCP Review Workshop, USEPA, Philadelphia, PA, December 2004.

American Water Works Association Research Foundation, Workshop on TMDLs and Drinking Water Utility Issues, Co-organizer, Co-chair and Facilitator, December 2003.

Navigating the TMDL Process, Critical Analysis & Improvements for the TMDL Program, WEFTEC-Water Environment Research Foundation Workshop. September 28, 2002, Chicago, IL.

WEF MA Leaders Workshop, "Improved Services, Increased Membership and Added Revenues Through Member Association Activities in Watershed Management," WEFTEC, October 1, 2002.

USEPA/WEF TMDL Public Meeting, Moderator and Facilitator, Atlanta, GA and Kansas City, MO, September 22-23 and 29-30, 1999.

USEPA/WEF Experts Workshop on "Implementing the WQ-Based Provisions of the CSO-Control Policy," Organizer, Speaker and Facilitator, Washington, DC, September 24, 1999

WEF Workgroup on "Total Maximum Daily Load Regulations," 1998-2000.

WEF Workgroup on "USEPA ANPRM Water Quality Standards Revisions," 1997-1999.

WEF Workgroup "Urban Wet Weather Issues," 1999.

"Watershed; for the 21st Century,"a summit of national organizations involved in watershed management, Co-organizer and participant, Denver, Colorado, May 2, 1998.

"Workshop on CSO Performance Measures," Facilitator, Chicago, Illinois, USEPA/Association for Metropolitan Sewer Agencies, November 7, 1996.

"Workshop on CSO Performance Measures," Facilitator, Fort Mitchell, Kentucky, USEPA/Association for Metropolitan Sewer Agencies, October 29, 1996.

Wet Weather Steering Task Force WEF, Member. 1995-96

"Pollution Elimination Policy Work Group," WEF, Member. 1993-95

"Analytical Detection Limits," WEF, Member. 1993-95

Pretreatment Streamlining Workgroup, USEPA Regulatory Improvement Project, Participant, Sponsored by USEPA, Water Environment Federation and AMSA. 1996.

Effluent Trading Workgroup, USEPA and Water Environment Federation, Regulatory Improvement Project. 1996-97.

"Ideas for Redefining MDNR's Water Quality Programs, A Workshop for the Regulated Community to Work with the Michigan Department of Natural Resources," Organizer and Chair, MWEA, East Lansing, Michigan, March 16, 1994.

Metals and Aquatic Criteria, WEF, Member. 1992-94

Combined Sewer Overflow Regulations, WEF, Member. 1991-94

Sediment Criteria, WEF, Member. 1991-95

Great Lakes Initiative Regulation, WEF, Chair. 1991-93

Stormwater Regulations, WPCF, Member. 1990-92

"Technical Support Document for Water Quality Based Toxics Control," WPCF, Member. 1989-91

Toxic Exposure Work Group, USEPA, Member. 1984

Presentations/Proceedings at Conferences & Workshops

Hearing before the Subcommittee on Water Resources and Environment, *Comprehensive Watershed Management and Planning*; Committee on Transportation and Infrastructure Rep. James L. Oberstar, Chairman, U.S. House of Representatives, June 24, 2008.

"Needs for Better Promoting Water Sustainability: Opportunities for the Sustainable Water Resources Roundtable," SWRR June 2008.

"Water Sustainability: What it Means to the Water Professional," MWEA Annual Conference, June 2008.

"National TMDL Program: Status and Future Directions," Hawaii TMDL Conference October 2007.

"The Role of Adaptive Watershed Management Concepts in Wet Weather Consent Decrees," (with J. A. Eger, J. P. Gibson Jr., N. Clements, A. D. Nemura) Water Environment Federation Annual Technical Exhibition and Conference. October 2007. San Diego, CA.

"Thermal Electric Power Plant Water Uses; Improvements Promote Sustainability and Increase Profits" with J.R. Wolfe, Canadian/US Water Policy Workshop, October 2, 2007, Washington, D.C.

"Source Water Protection Research Planning Workshop" AwwaRF/WERF joint workshop. August 1-2, 2007, Denver Co.

"21st Century Future for the Water Professional" NACWA Annual Conference, July 19, 2007. Cleveland, OH.

"Factors for Success In Developing Use Attainability Analysis," (with T. Dupuis, P. McGovern, L. Terry, and M. Stewart) WEF TMDL Specialty Conference Session 3B, Bellevue, WA, June 24, 2007.

"Practical Guidance for Navigating the UAA Process, an Overview," TMDL Sciences 2007 Conference, Workshop Presenter, June 24, 2007, Bellevue, WA.

"Watershed Implementation Strategies. Emerging Policies and Programs," Clean Water, Clean Lakes. April 24, 2007. Milwaukee, WI.

"New Approaches to Water Quality Restoration," Clean Water, Clean Lakes. April 24, 2007. Milwaukee, WI.

"21st Century Approaches to CSO & Water Quality Restoration," Wet Weather Partnership & NACWA. April 26-27, 2007. Chicago, IL.

Sustainable Water Resources Roundtable. Sustainable Water Resources Roundtable Workshop. January 25, 2007. Washington, D.C.

Groundwater Sustainability Expert Workshop. Michigan Groundwater Conservation Advisory Council and Grand Valley State University. March 26, 2007. Grand Rapids, MI.

"Future Improvements to the TMDL Program: UAA & Adaptive Management." Faculty Member – Speaker, Clean Water in the Midwest. Law Seminars International. Chicago, IL. September 13, 2006.

The Future of the TMDL Program: New Developments & Research Needs. Speaker, Electrical Power Research Institute (EPRI), Clean Water Act Workshop. Bar Harbor, ME, June 2006.

Duke University and Resources for the Future, NRC/NAS Expert Panel follow-on to "Use of Adaptive Management in TMDL's." 2004-2006.

"Adaptive Implementation for Improved Water Quality Management: When Does it Make Sense? A Follow Up to the 2001 National Research Council TMDL Report" Coauthor with Jennifer Benaman. AWRA Adaptive Management of Water Resources, Missoula, MT, June 27, 2006.

"Model Evaluation of Management Options for Improving Truckee River Dissolved Oxygen." Nevada Water Environment Association Annual Conference, Reno, NV, March 23, 2006.

"Truckee River HSPF Model, History, Calibration, and Application." AWRA 2005 Annual Conference. Seattle WA, November 7-10, 2005.

"Protection of Water Quality in Large Systems: Hard Lessons, Simple Truths." Mississippi River Basin Nutrients Workshop. St. Louis, MO, October 2005.

The Need for Involvement by the Drinking Water Utilities in the TMDL Process, Philadelphia, PA. WEF TMDL, June 27-29, 2005

Adaptive Management and TMDL: Future Urban and Rural Solutions, with T. Slawecki. ASAE Third Conference on Watershed Management to Meet Emerging TMDL Environmental Regulations, Atlanta, GA, March 2005.

"Total Maximum Daily Loads: Relevance to Drinking Water Utilities." AWWA WQTC Conference, San Antonio, TX, November 17, 2004.

"Viewing the Total Maximum Daily Load Requirement as a Process, not a Singular Number: The Call for Adaptive Management." Adaptive Implementation of TMDLs: Interpretation and Application Workgroup, Duke University, Durham, North Carolina, October 25, 2004.

"A Different View of Leadership." Environmental Financial Consulting Group presentation. October 21, 2004, New York, New York.

"Expanding the Role of Drinking Water Utilities in the TMDL Process (with W.M. Larson)," MI-AWWA/MWEA Joint Conference, Grand Rapids, MI, August 10, 2004.

"A Retrospective Look at Watershed Management (with V. Breidenbach, D. Infante, and A. Kuman)," WEF Watershed Management Conference, Dearborn, MI, July 11-14, 2004.

"Watershed-Based Permitting in Northern Kentucky" (with P. E. Moskus, D.W. Dilks, J.T. Lyons and L.S. Wilcher), WEF Watershed Management Conference, Dearborn, MI, July 11-14, 2004.

"Actions Towards a Sustainable Great Lakes" Organizing committee, opening session moderator "A Shared Vision for the Great Lakes: Actions Taken and Actions Needed, session moderator and facilitator, "Human Health." Great Lakes Commission, Cleveland, OH, May 5-7, 2004.

"Future of the TMDL Program and Water Quality Standards Attainment," Nevada Water Environment Association Conference, Reno, NV, March 25, 2004.

"Trends and Future Direction in Water Quality Regulation." Keynote address for Preparing for Regulatory Change, COG Water Resources Workshop, Washington, D.C., February 20, 2004.

"Identifying Knowledge Gaps with TMDLs and Drinking Water Utilities" Co-organizer, speaker and facilitator, AWWARF and WERF, Scituate, MA, December 10-12, 2003.

"WERF's Research Helps Professionals Navigate the TMDL Process," Coauthor, National TMDL Science and Policy Conference, Chicago, IL, November 17-19, 2003.

"Case Studies in the Use of Adaptive Watershed Management For Total Maximum Daily Loads," Coauthor, National TMDL Science and Policy Conference, Chicago, IL, November 17-19, 2003.

"Old and New Methods for Conducting Model Uncertainty Analyses for the TMDL Margin of Safety," Coauthor, National TMDL Science and Policy Conference, Chicago, IL, November 17-19, 2003.

"Linking Agricultural TMDL Implementations to Source Water Protection," Coauthor, National TMDL Science and Policy Conference, Chicago, IL, November 17-19, 2003.

"Refining Water Quality Standards for the Ohio River – Discussion of Strategies," ORSANCO POTW Committee Wet Weather Standards Work Group. Cincinnati, OH. July 25, 2003.

"An Adaptive Management Approach for TMDLs," UCOWR Conference on Water Security for the 21st Century. Washington DC, July 20-31, 2003.

"Navigating the TMDL Process: Evaluation and Improvements," Coauthor, National TMDL Science and Policy Conference, Phoenix, AZ, November 13-16, 2002.

"Need for an Adaptive Watershed Management Approach to TMDLs," Coauthor with A. Nemura and D. Dilks, National TMDL Science and Policy Conference, Phoenix, AZ, November 13-16, 2002.

"Guiding Principles for Modeling in a TMDL Process," Coauthor, National TMDL Science and Policy Conference, Phoenix, AZ, November 13-16, 2002.

"Incorporating Urban Wet Weather Sources in a TMDL: An Improved Approach," Presenter, National TMDL Science and Policy Conference, Phoenix, AZ, November 13-16, 2002.

"Approaching TMDLs Using Aristotle as a Teacher: An Adaptive Watershed Management Approach," Presenter, National TMDL Science and Policy Conference, Phoenix, AZ, November 13-16, 2002.

"Critical Analysis and Improvements for the TMDL Program, WERF Research," Presenter, WEFTEC, Chicago, IL, September 28, 2002.

"WERF: Navigating the TMDL Process: Evaluation – A WERF Project Update," Presenter, WEFTEC, September 27-October 1, 2002.

"Source Water Protection Monitoring – A Case Study," as Alternate Speaker for Dr. Rao Y. Surampalli, Ph.D., P.E., DEE, 8th International Conference on Drinking Water Quality Management and Treatment Technology, Kaohsiung, Taiwan, May 27-29, 2002.

"Watershed Management and Its Importance to Drinking Water Supplies in the U.S.," 8th International Conference on Drinking Water Quality Management and Treatment Technology, Kaohsiung, Taiwan, May 27-29, 2002.

"Model Complexity and Reliability Are Not Synonymous," Watershed 2002 Specialty Conference, Fort Lauderdale, FL, Feb. 24-27, 2002.

National Academy of Sciences, National Research Council Technical Reviewer, "Assessing the TMDL Approach to Water Quality Management," 2001.

"A Critical Analysis of the TMDL Program," Energy and the Environment. PNWIS/A&WMA 41st Annual Conference, Big Sky Resort, MT, Dec. 5-7, 2001.

"Critical Assessment of the TMDL Process," WERF 2001 Subscriber Meeting, Chicago, June 8, 2001, and Washington, D.C., April 5, 2001.

TMDL Science Issues Conference, Panelist for TMDL Science Obstacles, Association of State and Interstate Water Program Administration USGS, USEPA, and WEF, St. Louis, MO, March 5-7, 2001.

"Overview of Simplified Methods for Modeling in the TMDL Process," TMDL Science Issues Conference, St. Louis, MO, March 5-7, 2001.

"Simplified Methods for Modeling in the TMDL Process," Changing Environment Awareness: Societal Concerns and Scientific Reponses. Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting. Baltimore, MD, Nov. 11-15, 2001.

"Models and the TMDL Process: Science or Black Magic? A Guide to Debunking and Demystifying," AWWA 2001 Source Water Protection Symposium, Savannah, GA, January 28-31, 2001.

"Total Maximum Daily Loads: An Introduction for Water Suppliers Using Surface Water Sources," Instructor, Co-organizer and Speaker, AWWA 2001 Source Water Protection Symposium, Savannah, GA, January 28, 2001.

Water Quality: "Can You Drink the Water?" Panelist, Michigan Chamber of Commerce Environmental Permitting Update, Lansing, MI, October 25, 2000.

"Wet Weather Water Quality Standards for CSO Impacted Waters," WEFTEC 2000, Anaheim, CA, October 16, 2000.

"Surviving a TMDL Project: Practical Advice for Municipalities," Speaker, Preconference Workshop, APWA International Public Works Congress and Exposition, Louisville, KY, September 9, 2000.

"Leveraging Water Quality Assessment Resources – Why TMDLs and SWAPs Should Be Performed Together," Co-Author (with Dan Schechter), WEFTEC 2000, Anaheim, CA, October 16, 2000.

Wet Weather Regulatory Panel: CSO's and Water Quality Standards, Speaker/Moderator, WEF Washington Briefing 2000, Washington, DC, April 11-12, 2000.

Total Maximum Daily Load Modeling – NPDES Permit/TMDL Seminar, Washington, DC, March 23-24, 2000.

"Groundtruthing SSO Abatement Programs," (with Julia Slack), Proceedings for WEFTEC '99, October 1999.

"Wet Weather Water Quality Standards, Framing the Discussion," Preconference Workshop, WEFTEC, New Orleans, LA. October 9, 1999.

USEPA/WEF Experts Workshop "Implementing the WQ-Based Provisions of the CSO-Control Policy," Organizer, Speaker and Facilitator, Washington, DC, September 24, 1999

USEPA Total Maximum Daily Load Public Meeting, Moderator and Facilitator, Atlanta, GA and Kansas City, MO, September 22-23 and 29-30, 1999.

"Watershed Management," USEPA 6th National Drinking Water and Wastewater Treatment Technology Transfer Conference, Kansas City, MO, August 2-4, 1999.

"Total Maximum Daily Loads: A National Perspective," MWEA Annual Conference, Boyne Highlands, Michigan, June 27-30, 1999.

"A Big Picture Look at the Future of Watershed Management," Effective Watershed Management for a Clean Michigan, East Lansing, Michigan, April 1, 1999.

"Concerns Over the Next Generation of Water Quality Standards," NVRAC Virginia Water Environment Association, Luncheon Series, Falls Church, Virginia, February 10, 1999.

"A Watershed Approach to Sustainable Development," Manila, Philippines, January 17, 19, 1999.

Virginia WEA "Wet Weather Woes: Issues & Strategies to Deal with High Flows," Richmond, Virginia, November 17-18, 1998.

"Clean Water Act, 1998 update," Watershed Management Panel Discussion; American Bar Association, Satellite seminar to 75 sites nationwide; broadcast from Washington DC, May 12, 1998.

Pre-conference Workshop, "A Summit of National Watershed Organizations," Co-organizer and Participant, WEF, Denver, Colorado, May 2, 1998.

"Achieving Water Quality Standards Through the Use of TMDL, Models and the TMDL Process," University of Wisconsin Engineering and Professional Development Short Course, Madison, Wisconsin, February 18-19, 1998.

"Issues of Potential Significance with Respect to Wet-Weather Water Quality Standards," WEF Water Quality Standards Work Group, Wet Weather Subgroup, Satellite Teleconference, January 9, 1998.

"Selecting the Appropriate Water Quality Model for Watershed Management," Wissahickon Watershed Partnership, NIER, Philadelphia, Pennsylvania, January 8, 1998.

"TMDLs and the Watershed Approach," Presenter, Chesapeake Water Environment Association and American Water Resources Association Seminar "TMDLs and Effluent Trading: The Key To Healthy Watersheds?" College Park, Maryland, November 20, 1997.

1997 AMSA CSO Permit Negotiation Workshop, "Strategies for Communities to Limit Liability for CSO Discharges," Facilitator, Cincinnati, Ohio, September 25, 1997.

"Wastewater NPDES: Water Quality Based Toxic Effluent Limits," Environmental Permitting and Compliance Course, Michigan Chamber of Commerce, Novi, Grand Rapids, and Lansing, Michigan, May 8, 14, and 28, 1997

"Environmental Permitting" sponsored by the Michigan Chamber of Commerce, Novi, Grand Rapids, and Lansing, May 1997.

"Implementing Watershed Management," A Workshop for Decision Makers, sponsored by Brown and Caldwell and Limno-Tech, Inc. Atlanta, Georgia. November 8, 1996.

"CSO Performance Measures as a Method of Tracking the Success of Control Efforts," sponsored by Association of Metropolitan Sewerage Agencies and Limno-Tech, Inc., Boston, Cincinnati, Chicago, New York/New Jersey, Pittsburgh, October - November 1996.

"Watershed Management - Reinventing EPA's Water Management Program," United States Chamber of Commerce, CWIC Regulatory Forum, Washington, D.C., October 31, 1996.

"TMDLs as a Tool for Watershed Management," Presenter, 34th Annual Fall Conference, Water Resources Association, Valley Forge, Pennsylvania, October 17-18, 1996.

"Pre-treatment Streamlining Workshop," Regulatory Improvement Project co-sponsored by WEF, AMSA, and USEPA, Leesburg, Virginia, August 11-13, 1996.

"Emerging Issues in Environmental Legislation and Regulation," Ohio Water Environment Association 70th Annual Meeting, Akron, Ohio, June 21, 1996.

"Emerging Issues in Clean Water Act Regulation," Presenter, A Seminar on Advancements in Water & Wastewater, The 1996 Borchardt Conference, The University of Michigan, Ann Arbor, Michigan, January 30, 31 and February 1, 1996.

"Six Major Programs of the Clean Water Act" plus "Developing and Challenging Water Quality Based Toxic Effluent Limits," Executive Enterprises, Environmental Regulations Course, Dearborn, Michigan, October 30 - November 1, 1995.

"Great Lakes Initiative: The Water Environment Federation - Perspective," Annual WEFTEC Conference and Exposition, Chicago, Illinois, October 17, 1995.

Legislative and Regulatory Developments Effecting Pretreatment Requirements, Municipal and Industrial Pretreatment Seminar, Indianapolis, Indiana, September 13, 1995.

Great Lakes Initiative, Municipal Industrial Pretreatment Seminar, Indianapolis, Indiana, September 12 and 13, 1995.

"Clean Water Act Legislative and Regulatory Update," Michigan Chamber of Commerce, Environmental Regulations, Traverse City, Michigan, August 17 and 18, 1995.

"Current Issues in the Environment," Michigan Public Radio (WKAR), Lansing, Michigan, May 6, 1994.

"Total Quality Management: A CEO Perspective." The Evolving Organization Conference, Presentation and panel discussion, American Society for Quality Control: Human Resources Division, Washtenaw Community College Business Center, Ypsilanti, Michigan, October 14, 1994.

"Federal Regulatory Update." WEF Member Association Government Affairs Congress, Chicago, Illinois, October 18, 1994.

"Working in Partnership with Government Organizations," WEF Member Association Congress, Chicago, Illinois, October 18, 1994.

"Modeling Requirements for Long Term CSO Control Plans," (with M.P. Sullivan and J.K. Marr), Louisville, Kentucky, July 11, 1995.

GLI: The Water Environment Federation Perspective, at the 67th Water Environment Federation conference, Chicago, Illinois, October 17, 1994.

"A Global Perspective for Reducing CSOs: Balancing Technologies, Costs, and Water Quality," Kentucky-Tennessee Water Environment Association, The CSO Partnership, Louisville, Kentucky, July 10-13, 1994.

"Use of Models to Develop Exposure Assessment" and "Toxic Substances in Water Environments: Assessment and Control Conference," Preconference Workshop, May 14, 1995. Water Environment Federation. Cincinnati, Ohio.

Everglades Mercury Research Workshop: Modeling Expert Facilitator. November 15-17, 1994. West Palm Beach, Florida.

"The Ecosystem Approach and Pollution Prevention," Great Lakes Washington Roundtable, Northeast-Midwest Institute, Washington, D.C., April 25, 1994.

"Great Lakes Initiative - Model Regulation Long Overdue or Government Excess, Short on Need, Long on Cost," Illinois Association of Wastewater Agencies Mini-Conference, Springfield, Illinois, March 10-11, 1994.

"New Directions for Michigan Water Environment Professionals," MWEA Wastewater Administrator's Winter Workshop, Grand Rapids, Michigan, February 17-18, 1994.

"Groundwater Modeling," MWEA Groundwater Remediation Conference, Novi, Michigan, February 23, 1994.

"Water Quality Based Effluent Standards and How They are Calculated," Reauthorizing the Clean Water Act Status and Strategies, Washington, D.C., January 27-28, 1994.

"TMDL Regional Information Exchange Workshop: Including Regulatory Guidance, Modeling and Sampling," USEPA Office of Science and Technology, Exposure and Assessment Branch and Office of Wetlands, Oceans and Watersheds, Watershed Branch:

Region 4 and 5, Atlanta, Georgia, November 30-December 2, 1993
Regions 7 and 8, Denver, Colorado, October 19-21, 1993
Region 1 and 2, Danvers, Massachusetts, September 8-10, 1993

"Clean Water Act Reauthorization: The Michigan Position," a facilitated work group, Michigan Department of Natural Resources, Lansing, Michigan, 1993.

"Critical Water Toxics Issues," Institute of Business Law, California State University, Environmental Regulations in Michigan, Detroit, Michigan, September 29-30, 1993.

"The Toxic Permitting Process," Liquid and Solid Industrial Control Association, Radisson on the Lake, Ypsilanti, Michigan, September 20-22, 1993.

"New Directions for the Michigan Water Environment Professional," MWEA Fall Regional Meeting, Battle Creek, Michigan, September 14, 1993.

"Zero Discharge: A Controversial Debate," MWEA Annual Conference, Boyne Highland, Michigan, June 28, 1993.

"Monitoring CSO Impacts: A Strategy for the Ohio River; Role of Modeling," Ohio River Valley Sanitation Commission, Ft. Mitchell, Kentucky, June 2-3, 1993.

"Water Environment Federation Involvement in Government Affairs," WEF Regional Meeting, Minneapolis, Minnesota, April, 1993.

"How Water Quality Based Effluent Limits are Calculated," Executive Enterprises, The 1993 Clean "Water Update: How Will Reauthorization Impact Your Compliance Strategies," Chicago, Illinois, April 1993 and Washington, D.C., March 4-5, 1993

"Water Quality Based Approaches to NPDES Permitting," AT&T Technology Transfer Conference, Summit, New Jersey, October 22, 1992.

"Toxic Waste Load Allocation," WEF Pre-Conference Seminar, Water Quality Based Toxics Control, Federal Guidance and State/Discharge Experience, New Orleans, September 20, 1992.

"Toxic Permit Development," WEF Pre-Conference Seminar, Water Quality Based Toxics Control, Federal Guidance and State/Discharge Experience, New Orleans, September 20, 1992.

"How Water Quality Based Effluent Limits are Established," Executive Enterprises, Water Quality Standards for Toxic Pollutants, Washington, D.C., September 17-18, 1992, and Chicago, Illinois, October 22-23, 1992.

"Computers and Models for Environmental Regulation and Management," Chemical Manufacturers Association, Washington, D.C., September 14, 1992.

"Great Lakes Initiative Technical and Policy Issues," Motor Vehicle Manufacturers Association, Detroit, Michigan, August 27, 1992.

"Using Simple Models to Evaluate Complex Storm Effects," (with J.K. Marr), prepared for the ASCE Water Forum 92, Baltimore, Maryland, August 4, 1992.

"Design Conditions for Wet Weather Controls," WEF Specialty Conference, Control of Wet Weather Water Quality Problems, Indianapolis, Indiana, June 2, 1992.

"Calculating Water Quality Based Effluent Limits," University of Wisconsin Short Course, The Engineering and Regulatory Aspects of NPDES Permits, Madison, Wisconsin, May 21-22, 1992.

"Water Quality Based Effluent Limits for NPDES," Environmental Regulation Course, Detroit, Michigan, April 7-9, 1992.

"Great Lakes Water Quality Initiative: Its Significance and Controversy," Great Lakes Initiative, A Program for Industry, sponsored by Michigan Water Pollution Association, Kalamazoo, Michigan, March 25, 1992, and Farmington, Michigan, March 18, 1992.

"Phased TMDL Case Study," USEPA TMDL Program Guidance Workshop, Chicago, Illinois, February 19-20, 1992.

"Great Lakes Water Quality Regulations: State/Province vs. National vs. International Jurisdiction," Water Pollution Control Federation, Member Association Congress, October, 1991.

"Waste Load Allocations, Dilution and Biomonitoring," University of Wisconsin Short Course Identifying Effluent Toxicity with Biomonitoring and Toxicity Reduction Evaluations, Madison, Wisconsin, September 11-13, 1990, Madison, Wisconsin, October 21-23, 1990, and Berkeley, California, February 1991.

"TMDL/Mixing Zone and Toxics Modeling Workshop," USEPA Exposure and Assessment Division, Office of Water Regulations and Standards, Ithaca, New York, August 6-8, 1991, and Portland, Oregon, August 13-15, 1991.

"TMDLs and Nonpoint Modeling," Workshop on the Water Quality-Based Approach for Point Source and Nonpoint Source Controls, sponsored USEPA, Chicago, Illinois, June 26-28, 1991.

Government Affairs Session, Session Chair, 66th Annual Conference Michigan Water Pollution Control Association, Harbor Springs, Michigan, June 23-26, 1991.

"Environmental Permitting," Seminar sponsored by the Michigan State Chamber of Commerce, Grand Rapids, Michigan, May 16, 1991.

"Selection of CSO Controls to Minimize Aesthetic," Public Health and Water Quality Impacts, - *Poster Session* on A Storm Brewing; Combined Sewer Overflow and Storm Water Control - Ohio River Valley Water Sanitary Commission Ft. Mitchell, Kentucky, April 23, 1991.

"Great Lakes Water Quality Regulations: State/Province vs. National vs. International Jurisdiction," Water Pollution Control Federation, Member Association Congress, April 1991.

"Comparing Benefits of CSO Controls," - *Specialty Conference* on Combined Sewer Overflow Abatement, Columbus, Ohio, November 28, 1990.

"A Simplified Framework for Toxics Modeling," - WPCF Annual Conference, Washington, D.C., October 11, 1990.

"Waste Load Allocations, Dilution, and Biomonitoring," - Identifying Effluent Toxicity with Biomonitoring and Toxicity Reduction Evaluations, Milwaukee, Wisconsin, September 11-13, 1990.

"Approaches for Evaluating Water Quality Benefits of Combined Sewer Overflow Controls," - 1990 National Conference on Environmental Engineering, Arlington, Virginia, July 8-11, 1990.

"Regulatory News from Lansing and Washington," MWPCA 65th Annual Conference, Sugar Loaf Resort, Cedar, Michigan, June 24-27, 1990.

"Future Compliance - What's Coming Next?" Panel Discussion Moderator, Compliance and Enforcement Seminar, Water Pollution Control Federation, Washington, D.C., March 29, 1990.

"Waste Load Allocations, Dilution and Biomonitoring," Identifying Effluent Toxicity with Biomonitoring and Toxicity Reduction Evaluations, University of Wisconsin-Madison, June 27-29, 1989.

"Waste Load Allocation, Dilution and Biomonitoring," Identifying Toxicity with Biomonitoring and Toxicity Reduction Evaluations, University of Wisconsin-Madison, Berkeley, California, February 12-14, 1990.

"SARA Title III: Alternative Methods for Distributing Required Information," Environmental Issues in Manufacturing for 1990 and Beyond, Lansing, Michigan, November 14, 1989.

"Modeling and Remedial Action Planning," Cuyahoga River RAP and Lake Erie Modeling Seminar, Cleveland, Ohio, October 26, 1989.

"Modeling Nonpoint Source Pollution Impacts in Lakes," Pre-Conference Workshops, Defining Nonpoint Source Pollution, Water Pollution Control Federation, San Francisco, California, October 14-15, 1989.

"Modeling of Toxic Effluents for NPDES Permit Limits," AWWA/MWPCA Joint Meeting, Amway Grand Plaza, Grand Rapids, Michigan, August 1-4, 1989.

"Dynamic Modeling for Toxic Permit Limits," Michigan Coalition for Clean Water, East Lansing, Michigan, October 17, 1988.

"Member Association Involvement in the WPCF Government Affairs Process," Member Association Congress, Dallas, Texas, October 3, 1988.

"Dilution Modeling to Define Toxic Impairment in U.S. Estuaries," Water Pollution Control Federation, 61st Annual Conference, Dallas Convention Center, October 3-6, 1988.

A Review of the Great Lakes Water Quality Agreement as Amended November 18, 1987, Water Pollution Control Federation Annual Convention, Dallas, Texas, October 1988.

"Tracing Groundwater Contaminants Through Microcomputer Graphic Simulation," Water Pollution Control Federation, 61st Annual Conference, Dallas Convention Center, October 3-6, 1988.

"Wetlands Permitting and Regulations," Chairperson and Organizer, Michigan Water Pollution Control Association and Michigan Municipal League, Lansing, Michigan, September 8, 1988.

"Effectiveness of Crop Management Practices for Reducing Pollutant Loads and Improving Saginaw Bay Water Quality," International Association for Great Lakes Research 31st Conference, Hamilton, Ontario, May 17, 1988.

"Kalamazoo River Studies: Environmental vs. Wastewater Loading Impacts on Water Quality," Water Pollution Control Federation, Philadelphia, PA, October 5, 1987.

"A New Way for the Bay," A Workshop for the Future of Saginaw Bay, Bay City, Michigan, March 5, 1987.

Toxics Modeling Workshops: Including Theory, Approach, Regulations, Model Selection and Use, Calibration/Verification, Sampling, Mixing Zones, Probabilistic Techniques, Estuary Modeling, TMDL/WLA and Permitting, USEPA Assessment and Watershed Protection Division, Office of Water Regulations and Standards:

Region 3, Philadelphia, Pennsylvania, December 5-7, 1990
Region 10, Seattle, Washington, January 9-11, 1990
Region 2, New York, New York, September 19-20, 1989
Region 7, Kansas City, Kansas, August 17-18, 1989
Region 9, San Francisco, California, August 8-10, 1989
Region 5, Chicago, Illinois, July 18-19, 1989
Region 3, Philadelphia, Pennsylvania, September 1988

Toxic Modeling and Mixing Zone Assessment: Including Regulations, Model Theory, Selection and Use, Probabilistic Approaches, Permitting, USEPA Assessment and Watershed Protection Division, Office of Water Regulations and Standards:

Region 4, Atlanta, Georgia, October 10-12, 1990
Region 7, Boulder, Colorado, September 12-13, 1989

Toxics Modeling Workshop for E.I. DuPont, Wilmington, Delaware, December 5-6, 1989.

Procedures for Water Quality Based Toxic Effluent Limits, USEPA Office of Water Regulations and Standards, Region 3, Philadelphia, Pennsylvania, 1988.

Conventional and Probabilistic Modeling for Toxic Waste Load Allocation, USEPA Office of Water Regulations and Standards, Waste Load Allocation Branch:

Region 5, Chicago, Illinois, 1987
Region 1, Boston, Massachusetts, 1986
Region 2, New York, New York, 1986

"New Advances in the Use of Microcomputers for Waste Load Allocation," Michigan Water Pollution Control Association/American Water Works Association, Computers in Water Resource Engineering, Ann Arbor, Michigan, February 1985.

Water Quality Modeling Workshop: Including Regulations, WLA/TMDL, Toxics and Conventional Pollutant Modeling Theory, Selection and, Use, Calibration/Verification, Mixing Zone, Probabilistic Approaches, Estuary and Bay, USEPA Assessment and Watershed Division, Office Water Regulations and Standards, Region 2, Atlanta, Georgia, November 28-30, 1989.

"Overview: Microcomputer Graphics Provide New and Innovative Advances for the Water Pollution Control Specialist," 59th Annual Conference - Water Pollution Control Federation, Los Angeles, California, October 6-9, 1986.

"Probabilistic Modeling for Toxic Waste Load Allocation: New Requirements," 59th Annual Conference - Water Pollution Control Federation, Los Angeles, California, October 6-9, 1986.

"Kalamazoo River Water Quality Problems: Causes and Cures," National Council on Air and Stream Improvement, Central-Lake Status Meeting, Chicago, Illinois, September, 1986.

"Shanghai-Drinking Water and Sewage Disposal; Multiple Use Management of the Huangpu River," the American Society of Civil Engineers, Long Beach, California, August 4-6, 1986.

"Water Quality and Facilities Planning for the Upper Potomac Estuary," (with Clyde Wilber, III), 1986 Annual Meeting of the Virginia Water Pollution Control Association.

"Waste: The Global Enigma of the 80's," (with P.W. Rodgers and D.R. Klemans), World Conference on Large Lakes, Mackinaw Island, Michigan, May 18-21, 1986.

"New Advances in the Use of Microcomputers for Defining Effluent Limits," University of Michigan Seminar on Computerization in the Water and Wastewater Fields, Ann Arbor, Michigan, February 5-7, 1986.

"Regional Wastewater Facilities Planning for Shanghai," China, Session No. 20 (Technological and Regulatory Advances Outside the U.S.A.), 58th Annual Conference - Water Pollution Control Federation, Kansas City, Missouri, October 6-10, 1985.

"Use of Computer Monte Carlo Analysis for Waste Load Allocation," (with R.P. Canale and J.K. Marr), Computer Applications in Water Resources, ASCE Conference, Buffalo, New York, June 10-12, 1985.

"Water Resource Planning: Multi-objective Concepts Applied to Rural Water Management," (with J.W. Bulkley and J.K. Marr), 1985 World Congress on Water Resources, ASCE, Brussels, Belgium, June 1985.

"Environmental Solutions through Computer Simulations: Microcomputer Applications," Toward A Transboundary Monitoring Network: A Continuing Binational Exploration, International Joint Commission Workshop, Academy of Natural Sciences of Philadelphia, Pennsylvania, October 10-11, 1984.

"Lake Modeling," presented at the Onondaga Lake Community Symposium, September 15, 1984.

"Defining Waste Load Allocation in Southern Louisiana Streams with Limited Assimilative Capacity," (with M. Khan, J.K. Marr, J.D. Givens and R. Hannah), 57th Annual Conference, Water Pollution Control Federation, New Orleans, Louisiana, October 1-4, 1984.

"Comparison of Three Procedures for Establishing Seasonal Effluent Limitations," (with J.F. Pendergast), 57th Annual Conference, Water Pollution Control Federation, New Orleans, Louisiana, October 1-4, 1984.

"The Use of Simple Versus Complex Models for Planning Combined Sewer Overflow Control Programs," (with J.F. Pendergast, G.E. Bondy and J.K. Marr), 1984 ASCE National Specialty Conference on Urban Water, Baltimore, Maryland, May 28-31, 1984.

"The Shanghai Project - A Preliminary Report," (with J.W. Bulkley), 1984 ASCE National Specialty Conference on Urban Water, Baltimore, Maryland, May 28-31, 1984.

"Cost Benefit Analysis of Point Source Versus Agricultural Controls to Improve Saginaw Bay Water Quality," (with J.K. Marr and P.W. Rodgers), 27th Conference on Great Lakes Research, Brock University, St. Catherine's, Ontario, April 30-May 3, 1984.

"Application of Microcomputers for Uncertainty Analysis Associated with Wastewater Treatment Facilities Planning," (with R.P. Canale and D.W. Dilks), 1st National Conference on Microcomputers In Civil Engineering, ASCE, Florida Section, Orlando, Florida, November 1983.

"Modeling the Risk of Groundwater Contamination," (with J.F. Pendergast, J.K. Marr and S.J. Wright), Association of Ground Water Scientists and Engineers, Eastern Regional Conference on Groundwater Management, Orlando, Florida, November, 1983.

"PCB Distribution in Saginaw River and Model Forecasts," (with P.W. Rodgers, D.L. Heidtke and C.P. Rice), presented at the 26th Conference on Great Lakes Research, Oswego, New York, May 24-26, 1983.

"Use of Models for Evaluating Stormwater Management Alternatives," (with J.F. Pendergast), Huron River Watershed Council Meeting, November 3, 1982.

"Use of Simple Modeling and Probability Analysis To Compare Combined Sewer Overflow Controls," (with J.F. Pendergast and J.K. Marr), 1982 National Conference on Environmental Engineering, ASCE, July 14-16, 1982.

"The Use of Event Simulation Models For the Projection of Long-Term Continuous Impacts in Combined Sewer Overflow Abatement Planning," (with C.B. Murphy, Jr., D.A. MacArthur, G.J. Welter, D.B. Jones, and J.F. Pendergast), 1982 National Conference on Environmental Engineering, ASCE, July 14-16, 1982.

"The Use of Water Quality Models to Determine Nitrification Treatment Requirements for Wastewater Treatment," (with R.B. Brownwell), Central State Water Pollution Control Conference, Delavan, Wisconsin, 1980.

"Modeling of Water Quality for Area-wide Planning," (with R.P. Canale and J.F. Pendergast), National Conference on Environmental Engineering, San Francisco, California, 1979.

"Modeling Storm Impacts on Onondaga Lake Water Quality," P.L. Freedman, R.P. Canale and J.F. Pendergast, National Conference on Environmental Engineering, San Francisco, California, 1979.

Assessing Storm Overflow Impacts on Lake Water Quality, (with R.P. Canale, J.F. Pendergast and P.E. Moffa), International Symposium on Urban Storm Runoff, Lexington, Kentucky, July 22-26, 1979.

"Impact of Combined Sewer Overflows on an Urban Lake," (with P.E. Moffa, J.C. Byron, R.P. Canale, and J.M. Karanek), 51st Annual Conference Water Pollution Control Federation, Anaheim, California, 1978.

"The Use of Receiving Water Quality Models in Urban Runoff Pollution Abatement: Applications to Marginal Benefit-Marginal Cost Analysis," (with C.B. Murphy, G.J. Welter, D.A. MacArthur, and R.P. Canale), Conference on Stormwater Impacts, Orlando, Florida, November, 1977.

"Sediment-Water Interactions and Regeneration of Nutrients in White Lake, Michigan," (with E. Callender, and C. Boatman), International Symposium on Geochemistry of Natural Waters Session III, August, 1975.

Workgroups/Workshops/Short Courses/Panels as a Invited Participant

US/Canada Water Policy Forum, Water and Climate Change and Energy-Water Nexus, Washington, DC, October 2007.

"Source Water Protection Research Planning Workshop" AwwaRF/WERF joint workshop. August 1-2, 2007, Denver, CO.

Groundwater Sustainability Expert Workshop. Michigan Groundwater Conservation Advisory Council and Grand Valley State University. Grand Rapids, MI. March 26, 2007.

Sustainable Water Resources Roundtable. Sustainable Water Resources Roundtable Workshop. Washington, D.C. January 25, 2007.

Duke University and Resources for the Future, NRC/NAS Expert Panel follow-on to "Use of Adaptive Management in TMDL's." 2004-2006.

National Academy of Sciences, National Research Council Technical Reviewer, "Assessing the TMDL Approach to Water Quality Management," 2001.

"Viewing the Total Maximum Daily Load Requirement as a Process, not a Singular Number: The Call for Adaptive Management" Adaptive Implementation of TMDLs: Interpretation and Application Workgroup, Duke University, Durham, North Carolina, October 25, 2004.

"A Different View of Leadership" Environmental Financial Consulting Group presentation. New York, New York. October 21, 2004.

"Actions Towards a Sustainable Great Lakes" Organizing committee, opening session moderator "A Shared Vision for the Great Lakes: Actions Taken and Actions Needed, session moderator and facilitator, "Human Health." Great Lakes Commission, Cleveland, OH, May 5-7, 2004.

"Identifying Knowledge Gaps with TMDLs and Drinking Water Utilities," Co-organizer, speaker and facilitator, AWWARF and WERF, Scituate, MA, December 10-12, 2003.

"Critical Analysis and Improvements for the TMDL Program, WERF Research," Presenter, WEFTEC, Chicago, IL, September 28, 2002.

TMDL Science Issues Conference, Panelist for TMDL Science Obstacles, Association of State and Interstate Water Program Administration USGS, USEPA, and WEF, St. Louis, MO, March 5-7, 2001.

"Total Maximum Daily Loads: An Introduction for Water Suppliers Using Surface Water Sources," Instructor, Co-organizer and Speaker, AWWA 2001 Source Water Protection Symposium, Savannah, GA, January 28, 2001.

Water Quality: "Can You Drink the Water?" Panelist, Michigan Chamber of Commerce Environmental Permitting Update, Lansing, MI, October 25, 2000.

"Surviving a TMDL Project: Practical Advice for Municipalities," Speaker, Preconference Workshop, APWA International Public Works Congress and Exposition, Louisville, KY, September 9, 2000.

Total Maximum Daily Load Modeling – NPDES Permit/TMDL Seminar, Washington, DC, March 23-24, 2000.

USEPA Total Maximum Daily Load Public Meeting, Moderator and Facilitator, Atlanta, GA and Kansas City, MO, September 22-23 and 29-30, 1999.

USEPA/WEF Experts Workshop "Implementing the WQ-Based Provisions of the CSO-Control Policy," Organizer, Speaker and Facilitator, Washington, DC, September 24, 1999.

"Clean Water Act, 1998 update," Watershed Management Panel Discussion; American Bar Association, Satellite seminar to 75 sites nationwide; broadcast from Washington DC, May 12, 1998.

Pre-conference Workshop, "A Summit of National Watershed Organizations," Co-organizer and Participant, WEF, Denver, Colorado, May 2, 1998.

"Achieving Water Quality Standards Through the use of TMDL; Models and the TMDL Process," University of Wisconsin Engineering and Professional Development Short Course, Madison, Wisconsin, February 18-19, 1998.

"Issues of Potential Significance with Respect to Wet-Weather Water Quality Standards," WEF Water Quality Standards Work Group, Wet Weather Subgroup, Satellite Teleconference, January 9, 1998.

1997 AMSA CSO Permit Negotiation Workshop, "Strategies for Communities to Limit Liability for CSO Discharges," Facilitator, Cincinnati, Ohio, September 25, 1997.

"Environmental Permitting" sponsored by the Michigan Chamber of Commerce, Novi, Grand Rapids, and Lansing, May 1997.

"Implementing Watershed Management," A Workshop for Decision Makers, sponsored by Brown and Caldwell and Limno-Tech, Inc. Atlanta, Georgia. November 8, 1996.

"CSO Performance Measures as a Method of Tracking the Success of Control Efforts," sponsored by Association of Metropolitan Sewerage Agencies and Limno-Tech, Inc., Boston, Cincinnati, Chicago, New York/New Jersey, Pittsburgh, October - November 1996.

"Pre-treatment Streamlining Workshop," Regulatory Improvement Project co-sponsored by WEF, AMSA, and USEPA, Leesburg, Virginia, August 11-13, 1996.

"Six Major Programs of the Clean Water Act" plus "Developing and Challenging Water Quality Based Toxic Effluent Limits," Executive Enterprises, Environmental Regulations Course, Dearborn, Michigan, October 30 - November 1, 1995.

"Federal Clean Water Act: New Directions". Annual Environmental Regulations Workshop. Michigan Chamber of Commerce, August 17-18, 1995.

"Use of Models to Develop Exposure Assessment" and "Toxic Substances in Water Environments: Assessment and Control Conference," Preconference Workshop, May 14, 1995. Water Environment Federation. Cincinnati, Ohio.

Everglades Mercury Research Workshop: Modeling Expert Facilitator. November 15-17, 1994. West Palm Beach, Florida.

"Water Quality Based Effluent Standards and How They are Calculated"; Reauthorizing the Clean Water Act Status and Strategies, Washington, D.C., January 27-28, 1994.

"Great Lakes Washington Roundtable: The Ecosystem Approach and Pollution Prevention," Northeast-Midwest Institute, Washington, D.C., April 25, 1994.

"TMDL Regional Information Exchange Workshop: Including Regulatory Guidance, Modeling and Sampling," USEPA Office of Science and Technology, Exposure and Assessment Branch and Office of Wetlands, Oceans and Watersheds, Watershed Branch:

Region 4 and 6, Atlanta, Georgia, November 30-December 2, 1993
Regions 7 and 8, Denver, Colorado, October 19-21, 1993

Region 1 and 2, Danvers, Massachusetts, September 8-10, 1993

"Clean Water Act Reauthorization: The Michigan Position," a facilitated work group, Michigan Department of Natural Resources, Lansing, Michigan, 1993.

"Critical Water Toxics Issues," Institute of Business Law, California State University, Environmental Regulations in Michigan, Detroit, Michigan, September 29-30, 1993.

"Monitoring CSO Impacts: A Strategy for the Ohio River; Role of Modeling," Ohio River Valley Sanitation Commission, Ft. Mitchell, Kentucky, June 2-3, 1993.

"How Water Quality Based Effluent Limits are Calculated," Executive Enterprises, The 1993 Clean "Water Update: How Will Reauthorization Impact Your Compliance Strategies," Chicago, Illinois, April 1993 and Washington, D.C., March 4-5, 1993.

"How Water Quality Based Effluent Limits are Established," Executive Enterprises, Water Quality Standards for Toxic Pollutants, Washington, D.C., September 17-18, 1992, and Chicago, Illinois, October 22-23, 1992.

"Calculating Water Quality Based Effluent Limits," University of Wisconsin Short Course, The Engineering and Regulatory Aspects of NPDES Permits, Madison, Wisconsin, May 21-22, 1992.

"Clean Water Act - Water Quality Based Toxic Effluents," Executive Enterprises Inc., Environmental Regulations Course, Detroit, Michigan, April 7-9, 1992.

"TMDL/Mixing Zone and Toxics Modeling Workshop," USEPA Exposure and Assessment Division, Office of Water Regulations and Standards, Ithaca, New York, August 6-8, 1991, and Portland, Oregon, August 13-15, 1991.

"Waste Load Allocations, Dilution and Biomonitoring," University of Wisconsin Short Course Identifying Effluent Toxicity with Biomonitoring and Toxicity Reduction Evaluations, Madison, Wisconsin, September 11-13, 1990, Madison, Wisconsin, October 21-23, 1991, and Berkeley, California, February, 1990.

Toxics Modeling Workshops: Including Theory, Approach, Regulations, Model Selection and Use, Calibration/Verification, Sampling, Mixing Zones, Probabilistic Techniques, Estuary Modeling, TMDL/WLA and Permitting, USEPA Assessment and Watershed Protection Division, Office of Water Regulations and Standards:

Region 3, Philadelphia, Pennsylvania, December 5-7, 1990
Region 10, Seattle, Washington, January 9-11, 1990
Region 2, New York, New York, September 19-20, 1989
Region 7, Kansas City, Kansas, August 17-18, 1989
Region 9, San Francisco, California, August 8-10, 1989
Region 5, Chicago, Illinois, July 18-19, 1989
Region 3, Philadelphia, Pennsylvania, September 1988

Toxic Modeling and Mixing Zone Assessment: Including Regulations, Model Theory, Selection and Use, Probabilistic Approaches, Permitting, USEPA Assessment and Watershed Protection Division, Office of Water Regulations and Standards:

Region 4, Atlanta, Georgia, October 10-12, 1990
Region 7, Boulder, Colorado, September 12-13, 1989

Toxics Modeling Workshop for E.I. DuPont, Wilmington, Delaware, December 5-6, 1989.

Procedures for Water Quality Based Toxic Effluent Limits, USEPA Office of Water Regulations and Standards, Region 3, Philadelphia, Pennsylvania, 1988.

Conventional and Probabilistic Modeling for Toxic Waste Load Allocation, USEPA Office of Water Regulations and Standards, Waste Load Allocation Branch:

Region 5, Chicago, Illinois, 1987
Region 1, Boston, Massachusetts, 1986
Region 2, New York, New York, 1986

"New Advances in the Use of Microcomputers for Waste Load Allocation," Michigan Water Pollution Control Association/American Water Works Association, Computers in Water Resource Engineering, Ann Arbor, Michigan, February 1985.

Water Quality Modeling Workshop: Including Regulations, WLA/TMDL, Toxics and Conventional Pollutant Modeling Theory, Selection and, Use, Calibration/Verification, Mixing Zone, Probabilistic Approaches, Estuary and Bay, USEPA Assessment and Watershed Division, Office Water Regulations and Standards, Region 2, Atlanta, Georgia, November 28-30, 1989.

Selected Publications

Journal Articles

"Don't Debate; Adapt Adaptive implementation can help water quality professionals achieve TMDL goals."(with Len Shabman, and Kenneth Reckhow). Water Environment & Technology. In Press, expected publication August 2008.

"A New Approach to Adaptive Implementation in the TMDL Program," (with Kenneth Reckhow, Leonard Shabman, Jennifer Benaman, Richard Schwer, and Thomas Stiles). Water Practice, Water Environment Federation, Vol 2, No. 1. January 2008.

"Factors for Success in Developing Use Attainability Analysis," (with Tom Dupuis, Hans Holmberg, Patricia McGovern, Lori Terry, and Margaret Stewart). Water Practice, Water Environment Federation, Vol 2, No. 1. January 2008.

"Hard Lessons, Simple Truths," (with Victor J. Bierman Jr. and Joseph V. DePinto). Water Environment & Technology, Vol. 19, No. 6, June 2007.

The Need for Involvement by Drinking Water Utilities in the Total Maximum Daily Load (TMDL) Process (with W. Larson, J. Rosen, and J. Sobrinho). Watershed & Wet Weather Technical Bulletin Water Environment Federation. Sept./Oct. 2006.

Improved Consideration of the Margin of Safety in TMDL Development (with D. Dilks), Journal of Environmental Engineering ASCE Special TMDL Issue, June 2004.

Viewing TMDLs as a Process, not a Singular Value: Adaptive Watershed Management (with A. Nemura), Journal of Environmental Engineering ASCE Special TMDL Issue, June 2004.

Models Quantify the TMDL Process (with J. DePinto and D. Dilks), Journal of Environmental Engineering ASCE Special TMDL Issue, June 2004.

Improving TMDLs (with D. Dilks and W.M. Larson), Water Environment & Technology, June 2003.

CWA's New Clothes, A Critical Review of the TMDL Program, Water Environment & Technology, June 2001.

Urban-Rural Partnerships Needed to Achieve Clean Water, Water Environment and Technology, February 2001.

Old, New Rules Blur Watershed Focus, Viewpoint, Water Environment and Technology, April 1998.

Watershed Management, CWEA Eco Letter, Spring 1998.

Watershed Management: Overcoming the Politics of Pollution, Watershed & Wet Weather. Technical Bulletin, Water Environment Federation, (with L. Wise), June 1996.

Nonpoint Sources, Water Environment and Technology, (with Rick Moore), September 1995.

Great Lakes Initiative: The Water Environment Federation - Perspective, Annual WEFTEC Conference and Exposition Proceeding, Chicago, Illinois, October 17, 1995.

Great Lakes Environment Assessment Annual WEFTEC Conference and Exposition - Proceedings, Chicago, Illinois, October 1995.

A Watershed Event in Water Quality Protection, Water Environment and Technology (with D. Dilks, G. Dukes, B. Kreutzberger), September 1994.

Amending Antidegradation Policy, Water Environment and Technology, (with G. Burk and K. Schroeder), December 1995.

Revised Methods Considered for Aquatic Life Criteria (with D. Dilks), Water Environment and Technology, March 1994.

A Picture is Worth a Thousand Words (with T.A. Slawecki), Special Report on Computer Technology, Industrial Wastes, October/November 1993.

Environmental Market, Clean Water: Trend Toward Zero Discharge Continues (with P. Selig), *Engineering News Record*, February 15, 1993.

Zero Discharge: A Goal Whose Time Has Come? (with D. Blake; L. Ford, J., and L. Melton), *Water Environment and Technology*, October 1992.

Modeling Total Residual Chlorine in the Upper Potomac Estuary, Estuarine and Coastal Modeling Conference, Newport, Rhode Island, November 1989.

The Great Lakes Water Quality Agreement (with Bruce A. Monson), *Water Environment & Technology*, October 1989.

Seasonal Changes and Effluent Limits (with James F. Pendergast, Clyde Wilber III, and Shih Cheng Chang), *Journal Water Pollution Control Federation*, March 1988.

Worth A Thousand Words (with David W. Dilks, Raymond P. Canale, and Theodore A.D. Slawecki), *Civil Engineering*, July 1987.

Water Supply and Sewage Disposal: Shanghai, China, (with J.W. Bulkley, Chen Jiang Tao, Zheng Wei-Min, Kan Chen, and Wang Peibo), ASCE Conference Proceedings, Water Forum, 1986.

Modeling Storm Runoff Impacts on a Eutrophic Urban Lake (with R.P. Canale and J.F. Pendergast), *Journal of the Environmental Engineering Division*, ASCE, 106(EE2):335-349, 1980.

Impact of Wastewater Diversion on Lake Water Quality (with R.P. Canale), *Journal of the Environmental Engineering Division*, ASCE, 105(EE5):867-881, 1979.

Assessing Storm Overflow Impacts on Lake Water Quality, P.L. Freedman, R.P. Canale, J.F. Pendergast, and P.E. Moffa, proceedings of the International Symposium on Urban Storm Runoff, Lexington, Kentucky, 1979.

Aquatic Macrophytes in White Lake, Michigan (with R. P. Canale), *Journal of the Environmental Engineering Division*, ASCE, 103(EE3):431-444, 1977.

Nutrient Release from Anaerobic Sediments (with R.P. Canale), *Journal of the Environmental Engineering Division*, ASCE, 103(EE2):233-244, 1977.

Phosphorus Models for Eutrophic Lakes, (with W.S. Lung and R.P. Canale), *Water Research*, 10(12):1101-114, 1976.

Books and Published Reports

"Factors for Success in Developing Use Attainability Analyses" (with Tom Dupuis). Water Environment Research Foundation 04-WEM-1, 2007.

"Adaptive Implementation of Water Quality Improvement Plans: Opportunities and Challenges" (with L. Shabman, K. Reckhow, M. Beck, J. Benaman, S. Chapra, M. Nellor, J. Rudek, D. Schwer, T. Stiles, and C. Stow). Nicholas School of the Environment and Earth Sciences. 2007

"An Energy/Water Sustainability Research Program for the Electric Power Industry," EPRI Project 062994, May 2007

"Total Maximum Daily Loads (TMDLs) and Drinking Water Utilities" (with J. Rosen, J. Sobrinho and W. Larson). Awwa Research Foundation. 2005.

"Navigating the TMDL Process: Evaluation and Improvements" (with W. Larson, D. Dilks, D. Schechter, A. Nemura, T. Naperala, J. DePinto, M Prothro, G. Boese, A. Dettelbach, L. Nothman, K. Thorton, D. Ford, P. Massirier, T. Soerens, K. Stevens, and J. Sobrinho). Water Environment Research Foundation 00-WSM-01, 2003.

"Navigating the TMDL Process: Method Development for Addressing Narrative Criteria" (with D. Dilks, H. Holmberg, P. Moskus, G. McBride, C. Hickey, D. Smith, and P. Striplin). Water Environment Research Foundation 01-WSM-01, 2003.

Navigating the TMDL Process: Listing and Delisting (with Kent Thornton). Water Environment Research Foundation 00-WSM-02, 2003.

Receiving Water Impacts, Chapter 3 of Control and Treatment of Combined Sewer Overflows edited, Peter Moffa, Van Nostrand Reinhold, 1990, second edition 1996.

Receiving Water Impacts, Chapter 3 of Control and Treatment of Industrial and Municipal Stormwater edited, Peter Moffa, Van Nostrand Reinhold, 1990, second edition 1996.

Technical Writing Manual (with J. Marr), Limno-Tech, Inc., 1986, Revised May 1991.

System Analysis in Different Social Settings: Extension of a Case Study of Water Pollution Control in China (with Kan Chen and Jonathan W. Bulkley), National Science Foundation, Grant No. INT-8212774, 1986.

Applicability of Land Treatment of Wastewater in the Great Lakes Area Basin: Impact of Wastewater Diversion and Spray Irrigation on Water Quality in the Muskegon County, Michigan Lakes (with R.P. Canale and M.T. Auer), U.S. Environmental Protection Agency, EPA-905/9-79-006-A, 260 pages, 1979.

Saginaw Bay Limnological Data (with R.P. Canale, M.T. Auer and J. Sygo), Sea Grant Technical Report No. 54, MICHU-SG-76-207, Michigan Sea Grant Program, 175 pages, 1976.

The Limnology of Grand Traverse Bay, Lake Michigan (with M.T. Auer and R.P. Canale), Sea Grant Technical Report No. 47, MICHU-SG-76-200, Michigan Sea Grant Program, 175 pages, 1976.

Grand Traverse Bay Limnological Data (with M.T. Auer and R.P. Canale), Technical Report No. 48, MICHU-SG-76-200, Michigan Sea Grant Program, 87 pages, 1976.

Saginaw Bay: An Evaluation of Existing and Historical Conditions, U.S. Environmental Protection Agency Publication, EPA-905/9-74-003, April 1974.

Selected Experience

TMDL, Water Quality Standards Attainment & NPDES Permitting. Mr. Freedman is a nationally recognized expert in watershed TMDLs, water quality standards attainment and wastewater NPDES permitting. He has been an industry leader, helping establish the national agenda, hosting national conferences, contributing countless papers and presentations and developing important technical and regulatory innovations. Over the last two decades, he has been involved in more than 250 watersheds where he has developed or critically challenged TMDLs and NPDES permits and evaluated actions for meeting water quality standards. He has worked extensively for EPA and States in developing technical training and models for this purpose, but over two-thirds of his practice has been in representing regulated parties. On behalf of regulated industries and municipalities, he has successfully advocated new or revised permits, and more appropriate TMDLs. Mr. Freedman has also pioneered the use of new techniques and models. Included in this list of innovations are probabilistic evaluations, advances in sediment and toxic modeling, the use of PC-based computer models, the use of adaptive management, and use attainability analysis. Mr. Freedman has authored dozens of articles, lectures and presentations describing advances in water quality-based permitting and TMDL development. Mr. Freedman is a nationally recognized expert in watershed management, a central element in TMDL and NPDES permitting processes. He was chair of the TMDL Science & Policy 2002 and 2003 Conferences, and has directed several comprehensive TMDL research projects important to the wastewater and drinking water industries. Mr. Freedman has also conducted extensive research on the factors for successful completion of Use Attainability Analysis (UAA) and change in water quality standards which has involved the critical review of hundreds of UAA studies.

Watershed & Lake Management Projects. Mr. Freedman has served as senior manager and/or technical expert on more than 75 watershed and lake management projects, including TMDL assessments, linked watershed/water quality assessments, development of basin-wide watershed management plans, and assessment of the impact of water withdrawals, proposed discharges and wastewater diversions. Projects have supported regional long-term land use planning, TMDL and NPDES development, and development of water quality protection best management practices.

Mr. Freedman's professional career began focused on lake restoration and watershed management, including projects on wastewater diversion, basin-wide nutrient management, lake sediment and weed control, and research on the use of agricultural practices for water quality improvements. Over the last quarter century he has expanded that practice through countless projects coast to coast. Mr. Freedman has placed a special emphasis on the development of linked watershed and water quality models designed for easy use in testing alternative management strategies. GIS and graphic interfaces have also been emphasized in his work.

Mr. Freedman has also taken a national leadership role in promoting watershed management. He has chaired four national conferences on watershed management involving cooperation with 14 Federal agencies. He also created and chaired the WEF Watershed Management Committee, which promotes improved education, research and policy. Mr. Freedman has also championed watershed management in numerous legislative and regulatory programs through his leadership role in WEF government affairs.

Mr. Freedman has recently been an innovator in the use of adaptive management in both voluntary and regulatory uses of watershed management. Applications have ranged from TMDL implementation to development of CSO Long Term Control Plans. He as authored several papers and research reports as well as participated and/or led various expert panels on the topic. He has successfully advocated the use of adaptive management and water quality standards review in several innovate applications.

Most recently, Mr. Freedman has been providing consultation and research for Federal, municipal and industrial clients on water sustainability and the use of green development practices.

Wet Weather Studies. Mr. Freedman has provided expertise and leadership to more than 60 wet weather studies over two decades in more than a dozen states. In each of these projects, LimnoTech has assisted the client in evaluating the impact that wastewater CSO, SSO or stormwater has on receiving waters. He provides technical direction and guidance on the innovative applications of modeling and GIS tools to help determine cost-effective means to reduce or eliminate impacts, comply with regulations, and/or negotiate permit conditions. Under Mr. Freedman's leadership, LimnoTech has helped clients develop targeted stormwater, CSO and SSO treatment and control programs that most benefit receiving waters, while saving hundreds of millions of dollars in unnecessary control costs.

Mr. Freedman has been a national leader in pioneering new methods and policies on wet weather and water quality issues, and has authored more than 100 presentations, articles and book chapters on the subject. Mr. Freedman has provided corporate leadership in research and technical support under contract to EPA, industry trade groups, and regional watershed consortia. These include development of a stream monitoring program for national assessment of stormwater impacts and benefits of controls; development of performance measures for the National Combined Sewer Overflow Control Program; development of CSO and SSO fact sheets and case studies; and a Wet Weather National Demonstration Project for the Ohio River. Mr. Freedman has worked directly for U.S. EPA in supporting the development of technical and policy guidance related to a range of stormwater CSO and SSO issues from wet weather water quality standards review to helping develop two reports to Congress on CSO and SSO.

Mr. Freedman also has extensive research and consulting experience in developing innovations to address challenging wet weather issues in urban environments. In the subject area of CSOs and wet weather POTW discharge he has been a key leader in promoting new ideas in the use of watershed permitting, blending, adaptive management, use attainability analysis, wet weather standards and innovative approaches to consent orders, variances and permits.

Environmental Research & Development. For over 30 years, Mr. Freedman has provided project oversight and technical expertise to projects designed to expand the envelope of environmental science and modeling. In the area of modeling these include development of probabilistic models, toxic models, and sediment-toxics models. In addition, Mr. Freedman has guided LimnoTech teams in enhancing, applying, and documenting numerous other environmental models, including WASP, QUAL-2E, CE-QUAL-2E, EFDC, HSPF and CORMIX, among many others. He has also directed or provided expert assistance to teams performing a wide variety of research and development projects for U.S. EPA, including innovative applications of probabilistic sediment quality, and microcomputer models of toxics.

Other research projects on modeling include development of or contributions to technical guidance manuals for waste load allocation and TMDL modeling and water quality-based toxics control for marine and estuarine discharges. In addition, Mr. Freedman has provided project management and/or oversight to research-level projects to support Great Lakes research on eutrophication and toxics, Everglades research on phosphorus and mercury, mixing zone assessments, sediment remediation and several important efforts on TMDL technical and policy innovations, adaptive management, use attainability and sustainability, and the use of green development practices as other examples.

Attachment 2

WRITTEN REPORT
PAUL L. FREEDMAN, P.E., BCEE

In the Matter of:

Water Quality Standards for Dissolved Oxygen for the Chicago Area Waterway System
Proposed Amendments to Standard 35 Ill. Adm. Code

OVERVIEW

It is my professional opinion that the Illinois Environmental Protection Agency (IEPA) proposed inappropriate aquatic life use classifications and associated dissolved oxygen (D.O.) criteria for the Chicago Area Waterways System (CAWS) that are in certain critical aspects the same as the existing Illinois standards for General Use waters. The Agency did not adequately account for the unique characteristics of the CAWS that significantly differentiate it from other waterbodies. In addition, IEPA did not consider the significance of wet weather impacts and unique flow considerations, which could prevent attainment of the proposed dissolved oxygen standards.

It is also my opinion that IEPA in its R08-9 regulatory proposal and subsequent testimony by Agency staff did not clearly define the beneficial aquatic life uses that the Agency recommends to protect, did not adequately justify the relationship between the proposed beneficial uses and specific proposed criteria, nor did the Agency demonstrate that it properly assessed the attainability of either these criteria or the beneficial uses.

It is my professional opinion that the proposed dissolved oxygen standards (both uses and criteria) for the CAWS are inadequately justified and therefore premature. Further, there are several ongoing studies that will provide important scientific data that would support a more proper and rigorous development of appropriate standards. I recommend that the Board defer approval of the proposed dissolved oxygen standards until such time as IEPA incorporates the additional studies and supplements the Agency's assessment with other necessary analyses to complete a more rigorous and appropriate Statement of Reasons.

Specific opinions are provided below.

1. **The proposed dissolved oxygen criteria for the CAWS are similar in important aspects to the General Use criteria, ignoring the unique characteristics of the CAWS.**

IEPA appropriately recognizes the important differences between the CAWS and General Use Waters, and certain criteria for General Use Waters are not proposed for CAWS Aquatic Life A and/or B waters (specifically as they relate to certain chronic and early life stage criteria). However, while the standards proposed by IEPA are intended to differentiate the unique characteristics of the CAWS, the proposed minimum dissolved oxygen criteria do not reflect these differences, nor does IEPA present justification for using the same criteria, contrary to the dramatic differences the Agency recognizes.

The CAWS is a unique system, with no other comparable waterway in the state of Illinois or in the entire United States. This system has very different characteristics from the other General Use waters.

IEPA appropriately recognizes the unique characteristics of the CAWS through its comprehensive description of the CAWS in both the Statement of Reasons (IEPA, 2007), and in supporting documentation. For example, excerpting specific selected references:

- "... the Chicago Area Waterways are a unique system of man-made canals and modified rivers, there are no regional high quality reference waterbodies that have similar characteristics to as CAWS." (CDM, 2007; pg 5-6)

- "CAWS consists of 78 miles of man-made canals and modified river channels which provide for drainage of urban storm water runoff, treated municipal wastewater effluent and support commercial navigation." (CDM, 2007; pg 3-2)

- "habitat quality of these waterways is reduced by lack of consistent flowing water habitats, straight morphology of waterways... and the large scale of modifications throughout this system." (Rankin, 2004; pg 2)

- "The present flow of the South Branch Chicago River has been reversed relative to its natural state" (IEPA, 2007; pg 28)

IEPA provides numerous other statements in supporting documents about the specialized uses, man-made history of alterations, unique flow management, extensive alterations from navigational use, and permanently altered habitat of the CAWS. None of these characteristics used to describe the CAWS are included within the General Use Water descriptions, nor are they typically characteristic of other General Use waters in Illinois.

The following table provides a simple summary of key differences between the CAWS and broad characteristics of General Use Waters. The combination of different factors found in the CAWS is unique and very different from typical free flowing streams and rivers, which are more characteristic of Illinois General Use waters. The parameters in

the table also represent widely published characteristics of free-flowing, less altered rivers and streams (e.g., Leopold et al., 1995; Gordon et al., 2005) as a comparison to those found within the CAWS.

Characteristics of General Use Waters in Illinois Compared to CAWS

Parameter	General Use Waters	Chicago Area Waterways
Water sources	-Stream flow from rain runoff, natural drainage and groundwater recharge	-Effluent & CSO dominated, controlled Lake Michigan diversions
Morphology	-Shallow -Variable bottom, pools & riffles -Natural meandering -Floodplain connection	-Deep, non-wadable -Dredged -Channelized -No floodplain, riparian
Hydraulics	-Free flowing -Flows downstream, -Natural mixed and turbulent,	-Regulated flow -Bi-directional flow, -Areas stagnant & density stratified
Primary Function	-Natural hydrology, aquatic life and wildlife	-Convey waste waters, flood control, navigation
Land Use	-Mix of forested, rural, suburban, urban and industrial uses	-Primarily urban and industrial
Form	-Meandering	-Largely straightened, channelized
Habitat	-Variable and abundant	-Limited
Substrate	-Variable	-Fine sediments

The differences highlighted above have a significant impact on attainable uses and water quality in affected waterways. The available literature is replete with explicit recognition of how altered conditions can impact water quality and potential biologic uses. For example:

- The Army Corps of Engineers (USACE, 1987) describes navigation channels as follows: Long-term physical effects include particle size changes, flow direction and magnitude. Circulation may be altered and changes may affect the spatial distribution of water quality constituents, flushing rates of contaminants, scour and deposition patterns and vertical stratification. Density stratification inhibits vertical mixing, which can result in depletion of dissolved oxygen in bottom waters.

- The Corps (USACE, 1987) also states that fine grained dredge material slurry results in high dissolved oxygen demanding conditions. Areas of high

concentrations of fluid mud create a layer of low dissolved oxygen and unstable substrate.

- "Channelization effects include stream depth and width, stream length, channel configuration, bedform, velocity and discharge, substrate, cover, inundation and desiccation, streamside vegetation." (US EPA, 1983)

- "Urban development modifies runoff and the rate, volume and timing of streamflow. The structure and composition of lotic communities depend on the source, timing, and rate of streamflow as they regulate both habitat conditions and disturbance regimes." (Konrad and Booth, 2004)

- "The physical and hydrological characteristics of man-made waterbodies are not conducive to the establishment of a balanced population of aquatic biota..." (USEPA, 1988)

Many other scientific publications document the negative ecological effects of navigation and man-made channels, including mortality of fish eggs, larvae, and adult fish, prevention of effective spawning, and severe limitations on the growth and development of fish larvae and young of the year (YOY) fish (Morgan, et al., 1976; Gutreuter, 2003; Arlinghaus, et al., 2002; Wolter, et al., 2004; Knaepkens, 2006; Schramm, 2008).

Despite these obvious differences, IEPA still proposes dissolved oxygen criteria for aquatic life protection that, where specified, are identical to criteria for General Use Waters, without providing adequate justification. Further, IEPA does not provide the same exception for quiescent and isolated waters that are provided for General Use waters.

IEPA designates two new aquatic life uses: CAWS Aquatic Life Use (ALU) A Waters; and CAWS and Brandon Pool ALU B Waters (IEPA, 2007). Aquatic Life Use A is characterized as: *"predominated by individuals of tolerant or intermediately tolerant types..."* while Aquatic Life Use B is characterized as *"predominated by individuals of tolerant types."* In contrast, General Use Waters, which apply to most Illinois streams, are designed to protect "*communities predominantly composed of pollution-sensitive species*." (IEPA Title 35, Part 202, Section 302.105)

The Use Attainability Analysis (UAA) for the CAWS (CDM, 2007) states that an objective of the UAA is development of recommended use designations and associated water quality criteria that are characteristic to the CAWS. IEPA states that the CAWS UAA focused on existing and potential uses occurring in the waterways now, and that are expected to occur in the foreseeable future to reach recommendations for proposed uses for the entire CAWS (IEPA, 2007; pg 23). Yet in the end, the criteria proposed by IEPA for minimum dissolved oxygen are the same as the General Use criteria (see table below). The differences that exist (not shown in the table) relate to chronic criteria and early life stage protection criteria, with certain criteria not applicable to CAWS (e.g., for most General Use waters, a 7-day mean of daily means of 6.0 mg/l applies for early life stages

present -March through July - but no such criteria has been proposed for the CAWS). However, IEPA has chosen to recommend the same minimum dissolved oxygen criteria even though the protected use relates to more pollutant-tolerant aquatic species. IEPA provides no explicit explanation for why the same criteria are used, given the differences emphasized throughout the CAWS UAA and Statement of Reasons as highlighted above.

Comparison of Selected Proposed Dissolved Oxygen Criteria and Corresponding General Use Criteria

IEPA Proposed Designated Uses	**Early Life Stages Present** (March-July)	**Early Life Stages Absent** (August-February, except January-December for CAWS and Brandon Pool Aquatic Life Use B waters)	
	Daily Minimum (mg/l)	Daily Minimum (mg/l)	7-Day Mean of Daily Minima (mg/l)
General Use Waters[1]	5.0	3.5	4.0
CAWS Aquatic Life Use A Waters	5.0	3.5	4.0
CAWS Aquatic Life Use B Waters	-	3.5	4.0

[1]Recently adopted; does not include selected subset of General Use waters

IEPA, with no explanation, also does not explicitly include relevant exceptions to standards that were explicitly included in the IPCB's opinion in the matter of standards for General Use waters (IPCB, 2007; Subpart B, Section 302.206). Specifically, an exception is made for the General Use dissolved oxygen criteria with respect to stagnant and stratified waters, as follows:

> a) General Use waters at all locations must maintain sufficient dissolved oxygen concentrations to prevent offensive conditions as required in Section 302.203 of this Part. Quiescent and isolated sectors of General Use waters including but not limited to wetlands, sloughs, backwaters and waters below the thermocline in lakes and reservoirs must be maintained at sufficient dissolved oxygen concentrations to support their natural ecological functions and resident aquatic communities.

This exception is not explicitly included in the proposed dissolved oxygen standards for the CAWS, yet IEPA documents numerous sites within the CAWS that experience low flow, stagnant conditions, flow reversals, and stratification. For example:

- "...The low DO levels are most likely attributable to low flow stagnant conditions, coupled with CSO input and stormwater discharges." (CDM, 2007; pg 1-9)
- "The South Fork is a stagnant waterbody..." (CDM, 2007; pg 1-8)

- "...on occasion the flow in the NBCR will enter into the Chicago River when the force of the discretionary diversion and lock flow is not sufficient to overcome a density current..." (CDM, 2007; pg 3-6)

- "Flow is generally stagnant upstream of Howard Street in Skokie..." (IEPA, 2007; pg 27)

- "Chicago River flow is generally stagnant but is subject to density currents..." (IEPA, 2007; pg 28)

- "South Fork flow is generally stagnant..." (IEPA, 2007; pg 28)

- "Lake Calumet receives flow from various storm ditches and sewers and from some surrounding remnant wetlands, but is otherwise stagnant." (IEPA, 2007; pg 30)

Recent studies by others confirm that stratified, stagnant and multidirectional conditions exist within the CAWS:

- "Stratified flow events were observed in the Chicago River and North Branch of the Chicago River." (Garcia et al., 2007)

- "Several factors may contribute to these currents including temperature, salinity, and suspended-sediment concentrations." (Garcia et al., 2007)

- "Temperature stratification was observed in the study sites." (Garcia et al., 2007)

It would seem only logical that if these conditions warrant exceptions in the General Use waters, that similar exceptions should be made for the CAWS. It is my professional opinion that the unique flow conditions within the CAWS will impact the attainability of dissolved oxygen criteria and deserve consideration with respect to the proposed criteria.

<u>IEPA did not consider the significant effects in the CAWS of wet weather impacts, and how the unique and extreme flow variations would affect attainable aquatic life uses and related dissolved oxygen criteria.</u>

The CAWS has unique hydrologic and hydraulic dynamics impacted by wet weather and flow management. During normal dry weather operations, the flow in the CAWS is dominated by wastewater treatment plant inputs that contribute approximately 70 percent of the annual flow (CDM, 2007; pg 3-12). Additional streamflows during dry weather conditions are supplemented by the navigation, lockage, and leakage from the Chicago River Controlling Works and O'Brien Lock and Dam facilities (CDM, 2007; pg 3-13). However, before, during and after a rainfall the flow conditions change dramatically. In anticipation of a major rain event, the water level in the CAWS is rapidly lowered by a controlled release of water at the Lockport Powerhouse to accommodate overflows from large storms and avoid over bank flooding (IEPA, 2007; pg 32). In response to a storm,

the CAWS can receive enormous inputs of stormwater, CSO and pump station wet weather flows. This entire process can result in significant pollutant loads and a dramatic rise and fall of water levels in the CAWS, with extreme changes in flow. These changes may include not only velocity but direction and stratification as well (IEPA, 2007; pg 32). These rapid fluctuations in flow in the CAWS can result in substrate scouring, sediment resuspension throughout the water column, drying of littoral aquatic habitats (IEPA, 2007; pg 33), and a sudden and often prolonged decrease in dissolved oxygen below the standard.

The UAA recognizes the complexity of flow in the CAWS (CDM, 2007; pgs 3-16 through 3-18). The authors further recognize that dissolved oxygen levels can be depressed from these storm events and can take several days to recover (CDM, 2007; pg 1-7). Analysis conducted by Marquette University researchers also confirms suppressed dissolved oxygen conditions from wet weather effects of loading and flow dynamics (Alp, 2006).

The significance of wet weather is particularly and uniquely evident in Bubbly Creek. During dry weather, Bubbly Creek is stagnant and has no flow. In contrast, during wet weather the Creek receives significant flows from CSOs and the Racine Avenue Pumping Station that also suspend sediments with high oxygen demand and associated pollutants (CDM, 2007; pg 1-8). When conditions return to zero flow, the system stagnates and oxygen is depleted for days. This unique cycle is expected to continue indefinitely (albeit less frequently after TARP completion), but IEPA did not document that this was considered in establishing standards.

Further, the CAWS UAA states that even in the presence of the treatment technologies, parameters such as dissolved oxygen will not meet the General Use criteria in all areas of the CAWS:

> "However, even with this technology in place, there are still areas of water quality impairment, particularly as it relates to D.O. and temperature. In those reaches where D.O. levels cannot meet General Use criteria, even after treatment technologies have been implemented, a site-specific standard may be more appropriate. (CDM, 2007; pg 1-10)."

Yet in the face of these obvious and well known dynamics, IEPA has not explicitly discussed how these wet weather related flow and pollutant loading dynamics affect the realistic attainability of the proposed dissolved oxygen standards. The Agency did not consider the effect of existing conditions nor explicitly analyzed how these conditions will be changed in the future as the TARP program is further implemented. It is highly probable that wet weather conditions in the CAWS will prevent attainment of the IEPA proposed dissolved oxygen standards under certain conditions for the foreseeable future.

2. IEPA did not document that it considered alternative classifications or dissolved oxygen criteria for the CAWS similar to those that have been employed by other states for severely modified waterways, nor justify why these approaches might not apply to the CAWS.

In the section above, I highlighted the unique characteristics of the CAWS and some of the water quality consequences of these conditions. Recognizing these conditions, IEPA should have considered alternative ways of addressing wet weather conditions and the applicability of standards from other states for altered waterways.

In light of the significance of wet weather impacts and uncertain future conditions, the proposed IEPA standards are inadequate because they fail to consider wet weather non-compliance. Wet weather water quality standards or variance provisions would have been an important approach for IEPA to consider, but no mention is made of this as an alternative component of the proposed dissolved oxygen standards. For example, the States of Indiana, Maine, and Massachusetts all have provisions for wet weather standards or variances that consider the significant challenges in controlling wet weather and CSO impacts on water quality in highly urbanized areas (State of Indiana, 2008; State of Maine, 2008; Massachusetts DEP, 2008). In its water quality standards for the Ohio River, the multi-state Ohio River Valley Water Sanitation Commission (ORSANCO, 2008) allows for development of alternative criteria if CSO communities have submitted a long-term control plan and a UAA.

IEPA also did not document that the Agency considered alternative classifications or criteria for the CAWS similar to those employed by other states for severely modified waterways, nor justify why such approaches might not apply to the CAWS. For example, the Chicago River has been compared as functionally similar to the Cuyahoga River Ship Channel in Cleveland, Ohio (CDM, 2007 (pg 4-69); Rankin, 2004), yet IEPA did not discuss nor consider the use of a similar classification and associated criteria. The Cuyahoga River Ship Channel is a unique segment of the Cuyahoga River that is a federally maintained navigation channel, not unlike the CAWS. It is dredged to a depth of twenty-three feet with vertically sheet pile walls along the vast majority of its length. Analyses showed that dissolved oxygen could not be maintained to meet the Ohio warmwater habitat criteria without dramatically lowering the channel depth, a condition not consistent with federally mandated navigation requirements. The physical habitat of the channel and the prevailing background dissolved oxygen regime was determined to not fully support warmwater habitat aquatic life use designation. As a result, Ohio created a unique limited resource water dissolved oxygen criterion for the Cuyahoga River Ship Channel of 1.5 mg/l minimum (EPA 2008b).

There are other examples of waterways that have been significantly modified and resulted in unique classifications or criteria variances. For example:

- Louisiana: Man-made waterbodies: 1) New Iberia Southern Drainage Canal from headwaters to ICWW: Criteria 3.0 mg/l - November through April, and 2.0 mg/l -

May through October; 2) W-14 Main Diversion Channel from headwaters to Salt Bayou: Criteria 4.0 mg/l - November through March, and 2.5 mg/l – April through October (Louisiana DEQ, 2008).

- Wisconsin: Milwaukee River and Kinnickinnic River in Milwaukee: The river downstream of North Avenue Dam and the entire Kinnickinnic River are subject to a dissolved oxygen variance (criterion= no less than 2 mg/l at any time) (Wisconsin DNR, 2008).

- Texas: Houston Ship Channel – Navigation/Industrial Water Supply: the minimum criterion for the 1006 HSC Tidal segment is 2.0 mg/l, and the minimum dissolved oxygen criterion for the 1007 HSC/Buffalo Bayou Tidal segment is 1.0 mg/l (US EPA, 2008a).

- Maryland: The dissolved oxygen criterion for the segment of the Patapsco River shipping channel that is designated "seasonal deep-water fish and shellfish" is 1.7 mg/l as an instantaneous minimum from June – September, and a restoration variance allows lower concentrations up to 7% spatially and temporally (MDE, 2008).

It is also noteworthy, given IEPA's reliance on Ohio's biological assessment methods, that the Agency did not document that it considered Ohio's dissolved oxygen criteria for modified and limited resource waters. For example, Ohio's daily minimum criterion for limited resource waters is 2.0 mg/l, and for modified warmwater habitat waters the minimum criterion is 3.0 mg/l.

It is apparent that many other states have considered unique man-made conditions when setting dissolved oxygen criteria, and it is my opinion that these examples represent reasonable and attainable criteria for significantly altered waterways that should be considered by IEPA.

3. **IEPA did not explicitly provide scientific justification for both the aquatic life use classifications and the associated criteria. In addition, the Agency's documentation was inadequate to demonstrate the attainability of water quality and beneficial uses.**

US EPA defines a UAA as a "structured scientific assessment of the factors affecting the attainment of a use which may include physical, chemical, biological, and economic factors..." (CDM, 2007; US EPA, 1994). It is my professional opinion that the Statement of Reasons does not adequately document and demonstrate a structured and scientific assessment. Although the Statement of Reasons and supporting documents have information related to the necessary steps, they do not provide explicit and specific justification for all of the components. It is not unlike a connect-the-dots picture, with some dots missing, some misplaced and others faded, and the picture hard to fully recognize without the all the proper dots connected by lines. In addition, IEPA does not

provide a clear demonstration on how the proposed dissolved oxygen standards, both water quality and beneficial uses, will be attained.

The Statement of Reasons also lacks a description, or even mention of, the weight of evidence approach described by IEPA staff during cross examination. Without such documentation, it is unclear how IEPA considered all lines of evidence in developing the proposed dissolved oxygen standards.

The Statement of Reasons failed to explicitly provide appropriate scientific justification for both the aquatic life use classifications and the associated criteria.

A UAA provides the scientific justification for a change in a beneficial use and associated criteria. This assessment coupled with other regulatory requirements is designed so that the public can be assured that the changes are justified, protective and attainable. The Statement of Reasons and supporting documents, such as the UAA, have information related to each of the elements, but do not explicitly document the scientific links in the process, and often ignore gaps in the information needed. As such, the Statement of Reasons does not provide the necessary scientific assurance that the proposed dissolved oxygen standards are justified.

A UAA requires a comprehensive assessment of the physical, chemical and biological conditions of a water body, integrated through a scientific assessment to develop proposed revisions to the standards (US EPA, 1994). This assessment should include analysis of physical habitat, flow conditions, temperature, water quality, and resident biology. The purpose of the assessment is to determine whether the existing or feasibly improved conditions can support the proposed change in beneficial use and associated criteria. In my opinion, IEPA did not provide an adequate demonstration.

The first deficiency in the IEPA documentation is the lack of a clear justification for the two proposed use classifications. The proposed designated CAWS Aquatic Life Uses A and B appear to be physically segregated based on the presence or absence of "*deep-draft, steep –walled shipping channels*" (as mentioned in the definition of *Aquatic Life Use B),* yet the Calumet-Sag Channel which has deep draft and steep walls is classified as Use A, which seems inconsistent. The IEPA proposed aquatic life uses also appear to roughly correspond to uses described in the CAWS UAA report. These uses were determined by an arbitrary 75 percentile statistical IBI value (CDM, 2007; page 5-9). In both cases the justification is never explicitly described. Further, neither source explains specifically how the existing or improved habitat supports or could support the proposed designated aquatic life uses. Even more so, the UAA QHEI and IBI scoring and analysis has been characterized by others as fraught with error (Melching, 2008 and Mackey, 2008).

Fundamental to establishing beneficial uses and criteria in the CAWS is the need to identify the aquatic species that must be supported. The Statement of Reasons is vague in this regard. The Statement of Reasons differentiates Aquatic Life Use A and B waters based on whether they are capable of maintaining aquatic-life populations of either

tolerant or intermediately tolerant types. However, it does not define "tolerant" nor identify the specific target species for each use that would be required to determine the appropriate protective criteria. If IEPA relied on the UAA assessment (albeit with its significant failings), the Agency did not say so. Further, the IEPA proposed criteria for Use A waters are designed to protect early life stages, a protection not mentioned in the UAA; no data are presented on early life stages in the CAWS, and an explicit justification on how the Aquatic Use A waters can or could support these early life stages is missing.

Another question is how does IEPA link the proposed dissolved oxygen standards for the CAWS to objectives for protection of the target biology. IEPA chose a daily minimum dissolved oxygen criteria of 3.5 mg/l for CAWS, which it says was based on the US EPA 1986 dissolved oxygen criteria guidance document (US EPA, 1986). However, that document recommends 3.0 mg/l as the national 1-day minimum criteria for warmwater, other life stages. The US EPA guidance provides other values for various levels of protection for both warm water and cold water, but in all cases these values were developed "to protect the more sensitive populations of organisms." In contrast, the CAWS proposed aquatic life uses are designed to protect tolerant" or "intermediately tolerant" organisms which one would reasonably assume have lower dissolved oxygen criteria reflecting their higher tolerance. IEPA's explanation as to its justification for the specific selection of the dissolved oxygen criterion is unclear. IEPA could also have applied the procedures outlined in the US EPA Water Quality Standards Handbook (US EPA, 1994) for developing site specific criteria using acute and chronic research data focused on target species, but apparently the Agency chose not to, again with no explanation.

There exist examples of UAAs that have conducted a thorough scientific assessment for establishing the appropriate criteria. Unfortunately, many past examples of approved UAAs were not all rigorous, but as the experience in this area grows, the clarity of what is required for a structured scientific assessment has improved. Example case studies are provided on the EPA website (US EPA, 2007). For example, the process conducted for Chesapeake Bay included comprehensive examination of the target species and necessary criteria unique to various zones in the Bay, including a proposed "deep channel seasonal refuge" designated use to protect bottom sediment-dwelling organisms, with an instantaneous minimum dissolved oxygen criterion of 1.0 mg/l. In addition, the UAA for the Cuyahoga River ship canal clearly identified the limitations in water quality, habitat, and biologic uses for protection, which resulted in a criterion of 1.5 mg/l minimum for June thru January (Freedman, et al., 2007). Other good examples were cited previously.

Overall, IEPA did not carefully and explicitly link the physical, chemical and biological conditions to the specific beneficial uses and associated criteria. Without this connection, there is not a clear structured and scientific justification that the beneficial uses and criteria are appropriate.

Notwithstanding the questions concerning IEPA justification of the classifications and criteria, IEPA did not rigorously consider whether the proposed regulatory proposal will result in attainment of the aquatic life uses and corresponding dissolved oxygen criteria.

A fundamental question in establishing a new standard is whether there is a realistic potential that this proposed standard can be attained, hence the term "use attainability analysis." This is a significant inadequacy of the Statement of Reasons. IEPA not only did not demonstrate that the dissolved oxygen criteria can be attained using modeling or data, but also did not show that the proposed beneficial uses can be attained in the foreseeable future.

The question of how the criteria relate to potential water quality compliance was not adequately assessed. In the Board's Opinion and Order of the Board for Proposed Amendments to the Dissolved Oxygen Standards for General Use Waters (IPCB, 2007), an analysis was conducted related to how the new criteria will affect potential compliance (attainability); this analysis was not provided in the Statement of Reasons for proposed CAWS standards. Nor did the Statement of Reasons or the UAA provide data showing trends in improvement of dissolved oxygen that might justify the proposed changes.

The UAA and Statement of Reasons give some attention to attainability, but the focus is on existing conditions where the criteria are not being met because of various factors including wet weather and stagnant conditions. For example, for the Upper North Shore Channel, the UAA states:

> "... the Upper NSC suffers low D.O. levels much of the time. These conditions may be attributed to frequent low flow conditions coupled with periodic surges of CSO and storm water discharges. D.O. in this reach often takes several days to recover...."

The Statement of Reasons recognizes these same factors. For example, page 61 states:

> "During periods when wet weather causes CSO discharges to impact CAWS and Lower Des Plaines River, dissolved oxygen levels can drop to zero."

IEPA states that it is highly likely that conditions will continue to violate standards "at least until the Tunnel and Reservoir Project is complete..." (IEPA, 2007; pg. 61) and that it may be necessary to implement flow augmentation and aeration. However, IEPA did not provide an actual analysis of water quality under future conditions. Conditions under a completed TARP will still include stormwater inputs from 41 communities, periodic pump station discharges, and remaining CSOs. Further, TARP is not designed for complete elimination of CSOs and wet weather pump station discharges (CDM, 2007). In light of the significance of wet weather impacts and uncertain future conditions, IEPA should have made provision for wet weather non-compliance, as discussed earlier in this section.

IEPA also failed to consider US EPA water quality standards regulation (40 C.F.R. section 131.10(d)), which states that uses are "considered attainable if they can be achieved by adopting effluent limits required under sections 301(b) and 306 of the CWA

and the implementation of cost-effective and reasonable best management practices for nonpoint source control." Yet IEPA did not conduct such an analysis either for water quality or the beneficial uses. In fact, just the opposite is true. The Statement of Reasons states that additional flow augmentation and aeration treatment technologies may be needed (which is beyond effluent limit requirements of the CWA).

Putting water quality aside, IEPA also did not provide an adequate justification that the proposed beneficial uses can be reasonably attained. Both the UAA and the Statement of Reasons state that beneficial uses will not be attained without additional improvements. For example, page 5-3 of the UAA states:

> "Improvements to water quality through various technologies, like re-aeration may not improve the fish communities due to lack of suitable habitat to support the fish populations."

The UAA is very clear that beneficial uses cannot be attained until a strategic plan is completed which includes several factors beyond effluent limits, several of which have no assurance that they will be realized. This includes habitat restoration, for which the UAA was unable to identify any specific plans by any of the municipalities for habitat restoration in any of the CAWS reaches. The UAA Strategy also called for removal of contaminated sediments, another costly remediation and restoration effort for which neither the UAA nor the Statement of Reasons is able to point to existing or proposed plans.

Last, IEPA has not provided an adequate and explicit explanation on how the various factors that prevent current attainment of water quality and beneficial use conditions will be overcome. In regards to aquatic life, the UAA identifies four regulatory factors preventing attainment of full aquatic life uses (Factor 2, low flow; Factor 3, human caused conditions; Factor 4, hydrologic modifications; and Factor 5, physical conditions). IEPA briefly recognizes these factors, but neglects to include Factor 2, low flow conditions. IEPA has failed to adequately explain to what extent and specifically how these factors will be overcome to ensure that the proposed dissolved oxygen standards will be attained. Furthermore, IEPA does not provide an analysis of the economic and social impacts (UAA Factor 6) that would result from implementation of all of the control measures discussed including improved wastewater treatment, CSO control, habitat restoration, and contaminated sediment removal. Furthermore, with respect to Factor 6, the MWRDGC's current economic structure may also be inconsistent with financing of treatment plant improvements plus stream aeration and flow augmentation. No economic analysis was provided of this potential affordability constraint.

Overall, IEPA has proposed new beneficial uses and criteria for the CAWS, but has not provided an explicit and adequate demonstration that the criteria and uses can be achieved.

4. **It is my professional opinion that the IEPA proposal is significantly premature. The results of ongoing studies can provide IEPA with additional data needed to fill critical information gaps and allow IEPA to conduct a more rigorous analysis.**

The data and information gaps I identified above can be addressed through several ongoing studies. The IEPA proposal is premature without the benefit of results from these studies. These studies can provide very useful scientific, technical, and economic information for better defining attainable uses and appropriate dissolved oxygen criteria.

The MWRDGC is conducting several important environmental studies of their facilities and receiving waters. These studies can provide very useful information for better defining attainable use and appropriate dissolved oxygen criteria.

MWRDGC studies include:

- **Habitat and biological assessment study**: The MWRDGC is now conducting a comprehensive study of the varying habitats throughout the CAWS as well as identification of ambient fish and associated life stages. This information will better define the capabilities of the CAWS to support aquatic life and resolve issues concerning its potential to support early life stages of fish. Existing information on habitat is limited and information on early life stages that is currently non-existent. In addition, the study will develop a habitat index specifically suited to the CAWS, significantly improving on the indices applied in the UAA.

- **Dissolved oxygen modeling**: A state of the art dissolved oxygen model has been developed by Marquette University researchers, but is currently undergoing refinement to improve the calibration, and extend its abilities to simulate a wider range of conditions including wet weather. This improved model will provide a better assessment of the attainability of proposed dissolved oxygen criteria under a range of future expected conditions. Existing available modeling analysis only examined selected conditions, and utilized a model that needed important improvements.

- **Continuous dissolved oxygen monitoring:** MWRDGC is conducting extensive hourly monitoring of dissolved oxygen to better understand the transient effects of wet weather.

- **Water quality monitoring:** MWRDGC is conducting comprehensive sampling of water chemistry, sediment chemistry, sediment toxicity, habitat, fish, and benthic invertebrates. The data supplements studies ongoing since 2001.

- **Water quality and sediment data analysis**: The MWRDGC is completing an analysis of recent water and sediment quality data in the CAWS that will provide

additional understanding of existing conditions, trends, and causal factors impacting dissolved oxygen and attainable uses.

- **Integrated water quality strategy**: The MWRDGC is currently conducting engineering, cost and water quality studies to develop an integrated water quality strategy involving a combination of wastewater treatment, CSO control, and stream restoration strategies. Existing analysis of MWRDGC potential projects only examines treatment and waterways restoration actions independently. This study looks at the feasibility and effectiveness of combinations of actions and then analyzed the economic costs. Current information does not consider combined effects or combined costs.

- **Field tests using Sidestream Elevated Pool Aeration (SEPA) Stations:** Tests on the Calumet-Sag Channel will help determine if stations can be operated to comply with the proposed dissolved oxygen standards and additional electricity requirements.

- **Studies assessing improvement measures**: Recently completed studies on the effectiveness of supplemental water quality improvement measures including flow augmentation and supplemental aeration needs to be incorporated into the assessment.

- **Economic and environmental impacts:** In response to the integrated water quality strategy, the MWRDGC is conducting an economic and environmental impact assessment as to the impacts of the integrated treatment and stream improvement projects. Economic affordability will be assessed in the context of the current economic structure, which has certain tax-based limitations. This study will be completed after the integrated strategy is finalized.

- **Hydraulic modeling**: The MWRDGC is currently supporting researchers at the University of Illinois to study the complex hydraulics of the CAWS hydraulics under various conditions. This research will examine issues of stratification, bidirectional flow and stagnation, under a range of dry and wet weather conditions as they relate to water quality. Currently available information only identifies the existence of stratification, bi-directional flow and stagnation, but does not characterize its extent and occurrence under a variety of conditions. Another outcome of this study will be a better understanding and accounting for the effects of sediment resuspension on dissolved oxygen.

Overall, the results from these studies will substantially improve the scientific, technical and economic information used as the foundation for the current IEPA proposal and can fill important information gaps.

It is premature to assign new aquatic life water quality standards to the CAWS, both uses and criteria, until IEPA incorporates results from ongoing studies and improves the existing analysis and justification to fill important information gaps and more adequately conduct the necessary analysis.

There are several important limitations of the IEPA justification for new standards for CAWS that can be resolved by incorporating results from ongoing studies and supplementing the analysis conducted by the IEPA. These include:

- More explicit justification for beneficial use definition and reach characterization.
- Better characterization of habitat and consistency with proposed beneficial uses
- Identification and cost analysis for habitat improvements needed to achieve beneficial uses.
- Clear identification of target aquatic life species and life stages for each proposed beneficial use designation
- Better scientific linkage of proposed criteria to proposed beneficial uses to be protected.
- More comprehensive understanding of complex water quality dynamics under present conditions and future conditions with TARP implemented and Lake Michigan inflows reduced.
- Better understanding of future improvements and remaining impacts from CSO as it effects attainability, under different stages of TARP implementation.
- Improved analysis of attainability of dissolved oxygen criteria under a range of conditions, controls, and actions assessed in the context of an integrated MWRDGC strategy.
- Better understanding of the complex hydraulics in the CAWS under existing and future conditions that can effect attainability or create a need for exceptions.
- Economic assessment of the integrated strategy and need for other stream improvements such as habitat improvement and removal of contaminated sediments.

In my opinion, the current IEPA proposal is insufficiently justified, poorly documented, significantly inadequate, and fails to consider many important factors and alternatives that are critical. It is also significantly premature for IEPA to propose new aquatic life water quality standards, both uses and dissolved oxygen criteria, to the CAWS until IEPA incorporates results from these ongoing studies and develops a rigorous and defensible analysis and justification. However, if the IPCB decides to act (albeit in my opinion prematurely) then I would recommend the following actions at a minimum. First, alternative dissolved oxygen criteria used in other states for heavily altered water bodies like the Cuyahoga River Ship Channel should be considered for the CAWS. I also recommend that IPCB establish a separate use classification for Bubbly Creek, which has conditions distinct from the rest of the CAWS. With respect to use classifications, I recommend that the Calumet-Sag Channel be classified as Use B not Use A. Last, I recommend that the Board create a wet weather standard that reflects the documented wet weather conditions in the CAWS, which are expected to continue for the foreseeable future. Nonetheless, I still strongly believe that it is in the best interest of the State to

await the completion of the above studies, and then conduct the necessary analyses with this additional information.

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