

**APPENDIX A**

**David W. Dilks, Ph.D.**  
**Vice President**  
**LimnoTech**

**Principal Expertise**

- Water Quality-Based Effluent Limits
- TMDL Development
- Exposure Assessment
- Environmental Chemistry
- Mixing Zones

**Education**

PhD	Environmental Health Sciences, 1987 The University of Michigan, Ann Arbor, Michigan
MPH	Water Quality, 1981 The University of Michigan, Ann Arbor, Michigan
BSNR	Aquatic Biology/Biostatistics, 1979 The University of Michigan, Ann Arbor, Michigan

**Experience Summary**

Dr. Dilks is responsible for the assessment of water quality issues, primarily through the development and/or application of mathematical models. A Vice President at LimnoTech, Dr. Dilks has directed modeling studies on more than 250 water bodies and watersheds nationwide. This work has included watershed simulation models, hydrodynamic models, and water quality models for temperature, conventional pollutants and toxic pollutants. He has also directed the development or review of more than 200 Total Maximum Daily Load (TMDL) determinations.

Dr. Dilks has directed and lectured at water quality and mixing zone modeling training workshops for more than 1,000 State and EPA staff. He has co-authored three national technical guidance manuals on water quality modeling and assessment. Dr. Dilks served as a member of EPA's SWAT team, a group of experts providing nationwide support in the development of watershed-based Total Maximum Daily Loads (TMDLs). He also served as co-Principal Investigator for two Water Environment Research Foundation (WERF) research projects evaluating and designing improvements to the TMDL development process.

With respect to professional activities, Dr. Dilks has served as a technical reviewer for EPA guidance documents, professional journals, and research proposals. He has also served as an Adjunct Professor at the University of Michigan College of Engineering and School of Public Health, where he has taught graduate-level water quality modeling courses. Dr. Dilks has authored more than 40 scientific papers and given approximately 100 presentations at national scientific conferences, including more than two dozen invited presentations. He has also provided expert testimony in several cases related to water quality assessment.

**Exhibit**  
**2694**

State of Minnesota v. 3M Co.,  
Court File No. 27-CV-10-28862

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## Professional and Academic Appointments

Vice President, 1996 - Present	LimnoTech
Associate Vice President, 1990-1996	Ann Arbor, Michigan
Project Manager, 1984 - 1990	
Senior Project Engineer, 1983 - 1984	
Project Engineer, 1980 - 1983	
Adjunct Assistant Professor, 1995-2000	The University of Michigan
Adjunct Associate Professor 1997	Ann Arbor, Michigan

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## Professional Activities

### Scientific Reviewer

American Chemical Society, American Geophysical Union, American Society of Civil Engineering, American Water Resources Association, Environmental Protection Agency, Great Lakes Research Consortium, Water Environment Research Foundation.

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## Selected Experience

**Comprehensive Plan to Address PCBs in the Spokane River.** 2013 – Present. Directing development of a “direct to implementation” TMDL for PCBs in the Spokane River basin for the multi-stakeholder Spokane River Regional Toxics Task Force. Designed monitoring surveys, directed mass balance assessment, served as primary author of Comprehensive Plan, and currently directing implementation activities.

**Evaluation of Data Needs for Nutrient Target-Setting Using the Nutrient Modeling Toolbox.** 2017-present. Principal Investigator for this Water Environment & Reuse Foundation project to define the amount of data necessary to apply models in the Nutrient Modeling Toolbox to the level necessary to support regulatory decisions. This work will also define how the uncertainty in model predictions can be practically quantified, and how much certainty in model results is needed to support a management decision for setting nutrient targets.

**Expert Witness Support on PFOS Contamination in the Mississippi River.** 2012 - present. Providing expert witness support regarding perfluorooctane sulfonate (PFOS) contamination in the Mississippi River.

**Technical Review of NPDES Permit Limits.** 2013 – Present. Conducting a technical review of draft NPDES permit limit for four wastewater treatment plants operated by the City and County of Honolulu.

**Cannon River Watershed TMDL Development.** 2015-present. Serving as senior technical advisor providing support to the Minnesota Pollution Control Agency through application of HSPF/BATHTUB watershed and water quality models. Directed BATHTUB model calibration for numerous lakes in the Cannon River watershed, and applied the models to define load reductions necessary to attain water quality standards.

**Expert Witness Support Regarding Management of Phosphorus Discharges from Ibis Lakes to Grassy Waters Preserve.** 2017 – present. Providing expert witness support to the North Palm Beach County Improvement District. Activities to date have included development of a management plan to address Ibis Lakes’ sediment phosphorus release, and review of South Florida Water Management District comments about effects of alum treatment and elimination of copper sulfate application.

**Evaluation of Thermal Limits for Two Nuclear Power Plants.** 2016 - 2017. Project Officer and senior technical reviewer for evaluation of potential options for future compliance with thermal limits for two nuclear power plants in Illinois. The study included determining the ambient conditions that could result in exceedances of thermal limits; evaluating the potential benefits of adding mechanical “helper” cooling towers; evaluating potential opportunities for obtaining alternative thermal limits via a 316(a) variance; and conducting a high-level cost examination of potential response options.

**Lower Great Miami River Water Quality Model, Dayton, OH.** 2016 - 2017. Senior technical advisor for development of a water quality model of the Lower Great Miami River, for the evaluation of nutrient control alternatives, on behalf of the Miami Conservancy District partnered with public Water Resource Recovery Facility (WRRF) partners.

**Water Quality Modeling in Support of Lake Prespa Watershed Management Plan.** 2014-2107. Directing development of a BATHTUB model that will be linked to a SWAT model to assess the water quality benefits of watershed management activities in Macedonia.

**Review of Water Quality Model of Mousam Estuary.** 2016. Conducted peer review of WASP water quality model application to Mousam Estuary in Maine, on behalf of the Kennebunk Sewer District.

**Development of Mercury and PCB TMDL for Illinois Nearshore Waters of Lake Michigan.** 2014 – 2016. Project Officer directing all phases of TMDL development. Developed a QAPP for secondary data, conducted a data gap assessment, developed and applied a modeling approach, prepared TMDL for EPA Region 5 and Illinois EPA.

**Development of Nutrient TMDLs for Two Wisconsin Reservoirs.** 2014 – 2016. As senior advisor, directed water quality modeling in support of phosphorus TMDLs for Castle Rock and Petenwell Reservoirs for EPA Region 5 and Wisconsin DNR.

**Development of a Hydrodynamic and Water Quality Model in Support of Management of Lake San Marcos.** 2014-2016. Directed development of a fine-scale, 3-dimensional hydrodynamic model, (EFDC) a lower food web model (A2EM) to be used to evaluate potential lake management alternatives for Lake San Marcos, CA.

**TMDL Development for Lac Courte Oreilles.** 2012-2016. Managed EFDC and BATHTUB model development in support of the development of a TMDL for Lac Courte Oreilles near Hayward, WI. Lac Courte Oreilles is a highly valued recreational lake that is impacted by excessive phosphorus loading. Adjacent cranberry bogs are a key source of phosphorus.

**Feasibility Assessment of Aquaculture in the Great Lakes.** 2015. Project Officer directing an assessment of feasibility of conducting net pen aquaculture in northern Lake Huron.

**Reasonable Potential Determination for DC Water:** 2015. Senior advisor directing the conduct of reasonable potential assessment for metals and volatile organic compounds in support of NPDES permit renewal for DC Water.

**Development of a Watershed Implementation Plan on Behalf of the Fox River Study Group.** 2014-2015. Provided technical expertise to support the development of a watershed implementation plan on behalf of the Fox River Study Group (FRSG). The focus of the plan was to “resolve the dissolved oxygen (DO) and algal impairments of the Fox River” in Illinois. Work has application of the QUAL2K water quality model to assess the impacts of nutrient load reductions.

**Lake Erie Thermal Mixing Zone Study.** 2012-2015. Project officer directing monitoring and modeling activities assessing the size of the thermal mixing zone of the Avon Lake Power Generating Station for GenOn Energy, Inc.

**Assessment of the Environmental Benefits of the San Antonio and Austin Aquifer Protection Initiatives.** 2014 – 2015. Directed assessment of impacts, efficiencies, and return on investments of land conservation activities on the San Antonio and Austin aquifer protection.

**Technical Review of Metals TMDL and Resulting Permit Limits.** 2013 – 2014. Conducted technical review for a confidential client in a watershed influenced by historical mining activities.

**Evaluation of Modeling Approaches for the Developing Site-Specific Nutrient Criteria.** 2012-2013. Directed the development of a modeling tool box and associated guidance document designed to assess nutrient impacts on water quality for the Water Environment Research Foundation.

**Water Sustainability Assessment for Altria.** 2012 – 2013. Conducted assessment of water risks associated with agricultural activities in five target watershed in the eastern United States.

**Technical Review of CREMS Phase 4 Models.** 2012-2013. Directed review of the Phase 3 of the Lower Colorado River Authority's (LCRA) long-term Colorado River Environmental Models (CREMs) watershed and reservoir modeling program. The review is focused on ensuring the SWAT watershed model and the CE-QUAL-W2 model applications will be scientifically sound so that the models will have utility for evaluating future water quality conditions in response to various watershed management activities.

**Development of Statewide TMDLs for Mercury and PCBs – Michigan.** 2011 – 2013. Senior advisor for statewide TMDLs for mercury and PCBs in Michigan. Developed a QAPP for secondary data and modeling, developing TMDLs and monitoring recommendations, participation in public meetings and ongoing coordination with EPA Region 5 and Michigan DEQ.

**Expert Witness Support on Proposed Florida Water Quality Standards.** 2011-2012. Provided expert witness support to Clay County Utility Authority as an intervenor on behalf of the Florida Department of Environmental Protection regarding a petition to invalidate proposed statewide water quality criteria for nutrients.

**Development of Watershed Protection Plan for Lower Dunkard Creek.** 2011- 2012. Developed draft watershed plan and water quality models designed to remediate acid mine drainage in Lower Dunkard Creek, Pennsylvania.

**Water Quality Modeling of Little Black Creek Watershed.** 2011-2012. Directed application of a linked LSPC-WASP model to determine effluent limits compliant with numeric nutrient criteria for two water reuse facilities in Clay County, FL.

**Assessment of Alternate Approaches to TMDL Development for PFOS in the Mississippi River.** 2011. Reviewed available data related to impairment of the Upper Mississippi due to perfluorooctane-sulfonic acid (PFOS) and provided a range of alternate TMDL approaches to the Minnesota Pollution Control Agency.

**Review of Water Quality Impacts for Inland Empire Paper.** 2011. Reviewed phosphorus bioavailability data and directed CE-QUAL-W2 simulations defining dissolved oxygen concentration in Lake Spokane resulting from different levels of phosphorus removal.

**Review of Minnesota Watershed Management Plans.** 2011. Directed review of 40 watershed management plans for the Minnesota Pollution Control Agency to determine the extent to which they would satisfy review requirements for serving as total maximum daily loads.

**Water Sustainability Assessment for Ocean Spray.** 2010 – 2011. Conducted assessment of water risks associated with Ocean Spray facilities nationwide. Directed assessment of contribution of Ocean Spray to water quality impairment in the Wisconsin River.

**Mixing Zone Assessment for Vallejo, CA.** 2010 – 2011. Principal investigator modeling the mixing zone required for municipal wastewater discharges into Mare Island Strait and Carquinez Strait near Vallejo, California.

**Review of Zone of Inhibited Mixing Relative to Dissolved Oxygen Standards in Gulf Island Pond,** 2010 – 2011. Directed review of temperature and dissolved oxygen profiles and calculated vertical diffusivity coefficients to determine depth at which inhibited mixing precluded compliance with dissolved oxygen standards.

**Quantifying Benefits and Costs of Watershed Restoration near PepsiCo Facilities Worldwide.** 2010-2011. Conducted pilot assessments to provide information on the benefits and costs of a variety of watershed restoration activities, in support of PepsiCo's pledge to achieve a net positive water impact. This work is being conducted in the vicinity of existing PepsiCo bottling facilities in North America, Europe, India, and China.

**Technical Review of CREMS Phase 3 Models.** 2010-2011. Directed review of the Phase 3 of the Lower Colorado River Authority's (LCRA) long-term Colorado River Environmental Models (CREMs) watershed and reservoir modeling program. The review focused on ensuring the SWAT watershed model and the CE-QUAL-W2 model applications will be scientifically sound so that the models will have utility for evaluating future water quality conditions in response to various watershed management activities.

**Water Quality Modeling Assessment of Fountain Lake.** 2010. Developed lake eutrophication model and conducted simulations to determine effectiveness of different management measures to control algal growth in Fountain Lake.

**Review of Missouri Nutrient TMDLs.** 2010. Reviewed, and provided formal comment on, a series of total maximum daily loads for nutrients prepared by the Missouri Department of Natural Resources.

**Mixing Zone Assessment for Marin, CA.** 2010. Directed mixing zone modeling required for municipal wastewater discharge into San Francisco Bay.

**Review of Proposed Nutrient Standards for State of Florida.** 2010. Conducted technical analyses and prepared formal comments on EPA's "Water Quality Standards for the State of Florida's Lakes and Flowing Waters; Proposed Rule" for the Everglades Agricultural Area, Environmental Protection Division.

**Reasonable Potential Assessment for Nonylphenol:** 2010. Conducted reasonable potential assessment for nonylphenol and nonylphenol precursors for DC Water.

**Expert Review of Thermal Mixing Zone in the Ohio River.** 2010. Provided expert support in reviewing the assessment of the impact of a cooling water discharge to the Ohio River in terms of mixing zone size.

**Expert Review of Thermal Mixing Zone in the Hudson River.** 2007-2009. Provided expert support in reviewing the assessment of the impact of a cooling water discharge to the Hudson River, in terms of mixing zone size and impact on biota.

**Technical TMDL Evaluation Framework for the Electric Power Research Institute.** 2009. Directed development of a protocol for use by the power generation community to evaluate the calculation, allocation, and implementation of a draft TMDL. The report helps power generators navigate the TMDL review process in the context of a "road map" by describing potential pathways and illustrates key elements of a TMDL that must be evaluated during a review.

**Hayward Marsh Mixing Zone Assessment.** 2009. Principal investigator modeling the mixing and water quality impacts of municipal wastewater discharged into a treatment wetland and subsequently into South San Francisco Bay.

**Development of Lake Ontario PCB TMDLs.** 2009-2011. Developed Margin of Safety approach and Implementation Plan in support of TMDL development for EPA Region 2 and New York State Department of Environmental Conservation.

**Expert Consultation on Cutler Reservoir TMDL.** 2009. Retained to assist in the revision of the draft Cutler Reservoir TMDL to address comments that were raised during the public comment period.

**Review, Evaluation, and Proposal of Watershed Methodologies for Cross-Pollutant Trading, for the Electric Power Research Institute.** 2009. Directed the evaluation of methods used or proposed for cross-pollutant water quality trading. The report formulated recommended methods for trading to achieve greatest environmental benefit. Case studies and modeling focused on ammonia, and reductions in loads of other contaminants to achieve the same water quality benefits as reductions in loads of ammonia.

**Assessment of Water Quality Impacts of Increased Wastewater Discharge to Fox River.** 2009. Directed calibration and application of QUAL2K model to assess chlorophyll a and dissolved oxygen impacts of increased wastewater flow from the Fox River Water Reclamation District's West WWTP on the Fox River.

**Water Pollution Control Training for the Chinese Ministry of Environmental Protection.** 2009. Dr. Dilks conducted a weeklong training seminar at the Chinese Research Academy of Environmental Sciences in Beijing, designed to inform the Ministry and its respective provincial agencies on the methods used in the U.S. to address problems of transjurisdictional pollution.

**Expert Witness Support Related to Interbasin Water Transfer.** 2008 – 2009. Provided expert testimony for the State of North Carolina to verify the State's conclusion that the proposed interbasin water transfer from the Catawba River Basin would not cause adverse hydrologic or water quality impacts.

**Litigation Support for a Food Processor in the Illinois River Watershed.** 2008-2009. Provided technical support to an expert witness pertaining to phosphorus impacts in the Illinois River watershed and transboundary watersheds in eastern Oklahoma and other states.

**Chicago Area Waterways Habitat Evaluation and Improvement Study, Chicago, Illinois.** 2008 - 2009. Provided senior technical review of ecological study of the Chicago Area Waterways, nearly 90 miles of heavily modified urban waterways, to evaluate the present ecological condition and determine the potential for improvement of physical habitat to support fish. Project included development and application of a customized habitat index for the system.

**Water Quality Assessment Services for Updating the CSO LTCP for the Louisville Jefferson County Metropolitan Sewer District.** 2007 – 2009. Project officer for development of a water quality data report, Ohio River model update, and development of a water quality compliance strategy.

**Beaver Slough *Sphaerotilus natans* TMDL.** 2008. Project Officer for a TMDL to reduce slime in a 16-mile segment of the Mississippi River, which includes Beaver Slough. Oversaw development of a QAPP and Baseline Data Research Report. Provided guidance on field sampling and assisted with TMDL development. TMDL has been approved.

**Consent Decree Response using Adaptive Watershed Management, Sanitation District No. 1 (SD1) – Kenton, Campbell, Boone Counties, KY.** 2006 – Present. Project Officer responsible for comprehensive tools for the assessment and ranking of watershed pollutant sources, including sewer overflows, to develop 14 watershed plans for a three-county area. Work is being conducted to satisfy the terms of the country's first wet weather consent decree based on the principles of adaptive watershed management.

**Expert Review and Litigation Support for Reservoir TMDL.** 2005- 2010. Provided technical review of QUAL-2E and WASP water quality modeling conducted in support of the Gulf Island Pond, ME, dissolved oxygen TMDL. Identified errors in existing WASP model and conducted calibration of the

corrected model. Provided expert testimony regarding these modeling issues and their effect on the TMDL.

**Savannah Harbor Dissolved Oxygen TMDL Review.** 2004-2009. Directed review of the EPD-RIV1 model, a variation of the U.S. Army Corps of Engineers CE-QUAL-RIV1 model, EFDC, and WASP7 to the Savannah River and Savannah Harbor.

**Total Maximum Daily Load Development for the Truckee River, Nevada.** 2003-Present. Directing TMDL development for the City of Reno, Nevada. LimnoTech is revising the current TMDL to include new data, water quality modeling, river restoration projects, and potential river operation scenarios. The goal of the project is to determine a scientifically defensible TMDL for the Truckee River and to develop an economically feasible Waste Load Allocation that is protective of water quality criteria and beneficial uses for the Truckee Meadows Water Reclamation Facility.

**Peer Review of Grand River Water Quality Modeling.** 2009. Provided external peer review of water quality monitoring and modeling being conducted in support of treatment plant expansion for the municipalities of Kitchener and Waterloo, Ontario.

**Reasonable Potential Determination for District of Columbia Water and Sewer Authority:** 2007-Present. Conducted reasonable potential and required monitoring frequency assessment for metals and volatile organic compounds in support of NPDES permit renewal for the Blue Plains AWWTP discharge to the Potomac River

**Litigation Support for Alleged Impacts of Proposed Wastewater Treatment Plant Discharges on Cincinnati's Water Supply.** 2004 – 2008. Provided expert testimony to demonstrate that a new advanced wastewater treatment plant discharge upstream of Cincinnati, Ohio's water intake would be sufficiently mixed to minimize risk of contaminating the city's drinking water supply.

**Anacostia River Daily TMDLs.** 2006 – 2008. Assisted EPA Region 3 in converting TSS, BOD and nutrient TMDLs from seasonal load allocations to daily allowances, in accordance with a District Court ruling that TMDLs must be expressed on a daily basis. Developed a range of approaches that could be used to convert TMDLs to a daily basis, worked with the regulatory agencies to select the specific approach(es) to be applied to the Anacostia, and oversaw their implementation.

**Development of TMDLs for Watersheds in Illinois.** 2003-2008. Directed the compilation of information to support watershed characterization, modeling recommendations, and assessment of data adequacy to support the modeling for numerous watersheds in central and southern Illinois. Subsequent project phases will involve development of TMDLs for each watershed. This work will conclude with public meetings in each of the project watersheds, to share and solicit feedback on the TMDL implementation plan.

**Total Maximum Daily Load (TMDL) Development for Utah Reservoirs.** 2007. Project Officer for development of TMDLs for the Brough, Steineker, and Redfleet reservoirs in Utah, on behalf of the State of Utah.

**Phase 2 of the Lake Travis (Texas) Model Development.** 2004-2007. Senior technical reviewer providing technical assistance to the Lower Colorado River Authority (LCRA) for the development of watershed and reservoir water quality model(s) for Lake Travis, a major water supply source in central Texas as part of the LCRA's long-term Colorado River Environmental Models (CREMs) effort program. LimnoTech is specifically assisting the LCRA with the second phase of model development and application, including a hydrologic and water quality model of the watershed and the linkages required to simulate water quality conditions in Lake Travis.

**Development of Integrated Watershed Monitoring Plan and Watershed Health Index.** 2004-2006. Served as Project Manager for this project that integrated stormwater, receiving water quality, and biological monitoring into a coordinated monitoring plan. Developed a Watershed Health Index for the

Tualatin River watershed that integrated riparian habitat, physical condition, water quality, and biological health.

**Watershed Characterization Process.** 2005-2006. Project Officer. Developed conceptual processes to characterize watersheds for ranking, to determine priority watersheds for implementation activities. Developed a conceptual process to identify specific data needs to support watershed ranking. Applied the conceptual processes to a data-rich and data-poor watershed to illustrate how the characterization and data needs assessment would proceed.

**Lake and Watershed Water Quality Evaluation, Houston, Texas.** 2004-2005. Directed assessment of factors affecting water quality at a water treatment plant intake on a lake in Houston, Texas. The assessment included a review of watershed sources of solids and organic carbon, a review of historic lake water quality, and an evaluation of hydrodynamic factors affecting lake circulation and contributing to irregular water quality at the plant intake. The study provided guidance for the plant owners concerning major sources of water quality impedances, and recommendations for further monitoring to serve as an “early warning system” for future adverse impacts on water quality.

**Water Quality Modeling in Support of Total Maximum Daily Load (TMDL) Development for Two Watersheds in Texas.** 2004-2005. Oversaw the development of water quality models for bacteria and dissolved oxygen on Sandies and Elm Creeks and the Atascosa River outside San Antonio, Texas. LimnoTech provided technical support to the Conrad Blucher Institute for Surveying and Science (Texas A&M University) for both receiving water and watershed modeling to support the development of TMDLs for the Texas Commission on Environmental Quality (TCEQ).

**Application of a Hydraulic Model for Superfund Site.** 2004 – 2005. Directed application of HEC-RAS hydraulic model to address management questions related to the feasibility of potential remedial design options for a Superfund site located in the eastern U.S.

**Water Quality Modeling of Columbia Slough, OR.** 2004. Developed and applied water quality model to determine the impact of airport deicing loads on dissolved oxygen concentrations in the Columbia Slough in Portland, Oregon.

**Water Supply Suitability Assessment.** 2004 – 2005. Directed assessment of watershed erosion potential, sources of disinfection byproduct precursors, and reservoir circulation patterns for a confidential client.

**Water Quality Modeling Training for City of Reno and Sparks, Nevada.** 2003. Provided the cities with extensive training on the Truckee River modeling framework. Day 1 topics included an overview of the Truckee River HSPF model and its suitability for use as a management tool, and Day 2 provided a detailed look at the model’s development and calibration. The training was conducted over a two-day period in Reno, Nevada. Over 30 stakeholders attended the training session.

**Estuarine Dilution Analysis to Support EPA Policy Evaluation.** 2003 – 2004. Directed the evaluation of alternate estuary water quality models for suitability to assess benefits of regulation and policy changes.

**Development of the Rock Creek Watershed Toxics TMDLs.** 2002 - 2004. Provided senior technical review of a project for EPA Region 3 to develop TMDLs for metals and organics in the Rock Creek watershed.

**H.L. Mooney Wastewater Treatment Plant Permit Review.** 2003 - 2005. Supervised review of the Virginia DEQ Permit for this facility, including a detailed investigation into the ammonia limits calculated for a complex estuary environment.

**Spokane River/Long Lake Use Attainability Analyses in Response to TMDL Development.** 2003-2005. Directed several series of scenarios for the Spokane River and Long Lake using the calibrated CE-QUAL-W2 model of the river in Washington in conjunction with a separate CE-QUAL-W2 application for the river in Idaho to provide upstream boundary conditions. Work included hydraulic and loading

modifications to the model, developing post-processing programs, and compiling comparisons of model results versus criteria. Prepared time series and profile analyses at critical modeling locations.

**Development of a Model Sediment TMDL Protocol.** 2003 – 2004. Directed development of a technical protocol for the development of sediment-related TMDLs, with particular focus on controlling the impacts of construction stormwater sources.

**Water Quality Modeling Analysis and TMDL Review, Spokane River, Washington.** 2001-2005. Directing application of near-field and far-field water quality models to evaluate attainment potential for metals, ammonia, CBOD and temperature as part of planning for a proposed municipal wastewater discharge to the Spokane River. Providing technical review of CE-QUAL-W2 modeling of Spokane River and Long Lake in support of TMDL development efforts.

**Assessment of Water Quality Issues Associated with the Deepening of a Water Supply Reservoir.** 2003. Directed water quality assessment, including development of a CE-QUAL-W2 hydrodynamic/water quality model for a confidential client.

**Development and Testing of a Watershed Protocol for Implementing Wet Weather Controls in Northern Kentucky.** 2001 – 2004. Directing the development of a protocol for assessing wet weather water quality impacts on streams located in three counties in Northern Kentucky. The protocol was tested on Banklick Creek, which has known wet weather impacts. The final report presented the protocol and a summary of the application of the protocol.

**Assessing the Feasibility of Effective Watershed Management in Northern Kentucky through the NPDES Permitting Process.** 2002 – 2004. Directed development of a conceptual model for a watershed-based permitting approach for Sanitation District No. 1 of Northern Kentucky provided integrated management of stormwater, combined sewer overflows, and wastewater treatment plant discharges. Project activities included assessing the feasibility of future implementation of the conceptual model.

**Watershed and Water Quality Modeling to Support a Watershed Assessment for Newton County, Georgia.** 2002 – 2004. Directing development of a modified version of the Generalized Watershed Loading Functions (GWLFL) model to simulate daily flow, phosphorus, sediment and fecal coliform bacteria. The outputs from this model were used to simulate the impact of future development and BMP implementation on in-stream water quality. The results of the modeling were used as the basis for the watershed protection and implementation plan.

**Platte Lake, Michigan Watershed Modeling Study.** 2000 - 2004. Directed development of monitoring and modeling recommendations. Directed development and calibration of the BASINS watershed model for the Big Platte Lake watershed to estimate flows, sediment loads and phosphorus loads at multiple locations throughout the watershed. Other work on this project involved model calibration using event data and scenario model runs.

**Monte Carlo Modeling of Mixing Zone Impacts in the Sacramento River.** 2000-2003. Directed Monte Carlo analysis using the DYNTOX model and the results of a three-dimensional hydrodynamic model to predict water quality impacts in the Sacramento River.

**Water Quality Modeling in Support of Discharge Feasibility Analysis for Manistee Lake, Michigan.** 2002-2003. Directed modeling analysis of proposed industrial wastewater discharge to the Manistee Lake. Project involved assessment of nutrient impacts to lake under various discharge location alternatives and phosphorus loading scenarios.

**Development of Computer Tool to Calculate Sediment Erosion from Development.** 2002 – 2003. Directed development of an assessment tool to calculate sediment erosion from new development. The tool contains an interactive user-friendly interface that developers and planners can use to calculate sediment erosion from a site, based on the site plan, soil properties and the application of various combinations of best management practices. The resulting sediment load from the site was calculated by

the tool and compared to a sediment load criterion that is expected to be protective of aquatic life in the nearby receiving water bodies.

**Assessment of TMDL Results for Buxahatchee Creek, Alabama under Various Levels of Model Complexity.** 2002 – 2003. Conducted TMDL modeling of the Buxahatchee Creek using the Alabama DEM SWQM model and the QUAL2K model. The models were applied at four levels of complexity, ranging from simple Streeter-Phelps kinetics to full simulation of phytoplankton and periphyton, to determine how effluent limitations varied in response to uncertainty in each level model of model application.

**Evaluation and Design of an Improved TMDL Process.** 2000 – 2003. Served as project manager of a three-year study for the Water Environment Research Foundation designed to evaluate the existing TMDL development process and develop and test improved approaches.

**Method Development for Addressing Narrative Criteria in TMDLs.** 2001 – 2003. Directed review and assessment of existing approaches to incorporate narrative criteria into TMDL process for the Water Environment Research Foundation. Developed a series of guiding principles to improving upon existing methods, with a focus on determining impairment, defining causes of impairment, and selecting TMDL endpoints.

**Water Quality Modeling and Assessment in Support of the Southerly District CSO Phase II Facilities Plan.** 1999–2003. Providing technical direction for the development and execution of the monitoring plans (both biological and conventional pollutants) for the CSOs and receiving waters, which include several small creeks and culverted systems, the Cuyahoga River, and Lake Erie. Directing development of the receiving water modeling work plans.

**U. S. EPA BASINS Training.** 1999-2002. Instructor for course sponsored by U.S. EPA Office of Science and Technology, conducted at the University of Texas, Austin, Texas. Lectured on water quality modeling and TMDL development using EPA's BASINS software.

**Assessment of Wet Weather Water Quality Impacts on the Ohio River.** 1998-2004. Directed development of a water quality model of the Ohio River in the vicinity of Louisville, Kentucky. Providing technical oversight for the development of a river monitoring program to assess the impacts of wet weather pollutant loading.

**Easterly District CSO Phase II Facilities Plan.** 1997–2003. Provided technical direction for the development and execution of the monitoring plans (both biological and conventional pollutants) for the CSOs and receiving waters, which include several small creeks and culverted systems, the Cuyahoga River, and Lake Erie. Directed development of the receiving water modeling work plans.

**Development of TMDL Work Plans for Massachusetts.** 2001 – 2002. Directed the development of work plans for conducting 13 types of TMDLs for the Massachusetts DEP. The 13 types of TMDLs include bacteria (lake, river, coastal); chlorine (river, coastal); phosphorus (lake, river); nitrogen (coastal); un-ionized ammonia (river, coastal); and low DO/organic enrichment (lake, river, coastal). The purpose of these work plans was to summarize the steps involved in conducting each TMDL and the associated cost for each, assuming a low, medium, and high level of complexity.

**Pumpkinvine Creek, Georgia Watershed Modeling and Assessment.** 2000 – 2002. Directed the development of a linked watershed and water quality model for the Pumpkinvine Creek watershed. Model development involved watershed characterization; water quality, flow and climatic data analysis; and calculation of point source loads. This model simulates flow as well as phosphorus, nitrogen, and sediment loads. The model was calibrated using data collected during 2000-2001, and was applied for future conditions to simulate the impact that future development, increased point source loads, and Best Management Practices will have on receiving water quality.

**Review of Models Being Used for Development of Total Maximum Daily Loads (TMDLs) and NPDES Discharge Permits.** 2000-2002: Conducted technical review of models being used and considered for development of Total Maximum Daily Loads (TMDLs) and NPDES discharge permits for the American Chemistry Council.

**Final Bacteria TMDL for the Shawsheen River, Massachusetts.** 2001 – 2002. Project Officer. Reviewed the Draft Bacteria TMDL prepared by LimnoTech for the Shawsheen River and responding to comments from the EPA and Massachusetts Department of Environmental Protection to finalize the bacteria TMDL.

**Shawsheen River Sediment TMDL.** 2000-2002. Directing development of TMDLs for sediment and habitat for the Shawsheen River, Massachusetts.

**Mississippi River Literature Review in Support of Sediment TMDL Development.** 2001. Directed review of water quality standards, identification of potential indicators of impairment, and review of information in support of an EPA work assignment to assist the State of Iowa and EPA in determining whether sediment or turbidity is causing impairment of the designated uses assigned to the Mississippi River in Iowa.

**Mixing Zone Study, Willamette River, Wilsonville, Oregon.** 2001. Directed analysis of the water quality impacts of municipal wastewater discharge to the Willamette River, as part of NPDES permit development.

**Permit Limit Development for Blue Plains AWWTP, Potomac River, Washington, District of Columbia.** 2001. Project officer for mixing zone analysis of municipal wastewater discharges to the Potomac River, District of Columbia. Applied mixing zone models to the tidal Potomac environment and reviewed results to support development of discharge limits for ammonia and metals from the largest advanced wastewater treatment plant in the world.

**Lake Okeechobee Water Quality Model Uncertainty Analysis.** 2000-2001. Directing development of water quality model uncertainty analysis to support calculation of a Margin of Safety for the Lake Okeechobee TMDL.

**Newport Bay TMDL Review.** 1997-2001. Provided expert external review of TMDLs for nitrogen, phosphorus, sediments, and bacteria for Newport Bay, California.

**Expert Assistance for Lake Mead Water Quality Planning.** 2000-2001. Participated in expert panel to review scientific data and provide guidance to local stakeholders regarding water quality ramifications of various outfall relocation issues in the Las Vegas area of Lake Mead.

**Mixing Zone Study, Tualatin River, Oregon.** 1999-2000. Provided technical planning, direction and oversight for mixing zone analysis of a proposed municipal wet weather overflow to the Tualatin River, near Portland, Oregon.

**Development of Nationwide TMDLs.** 1999-2000: Directed development of TMDLs at three sites nationwide to serve as case studies for the National Wildlife Federation.

**Application of a GIS Decision Support Tool to Urban Watershed Management in Fulton County, Georgia.** 1999-2000: Directed watershed and water quality modeling using the BASINS interface to HSPF for several urban watersheds located within the City of Atlanta.

**Kanawha River Dioxin TMDL.** 1999-2001. Directed development of TMDLs for dioxin in the Kanawha River, Armour Creek, and Pocatalico Creek, West Virginia. Defined TMDL targets based upon available water quality and fish tissue data; directed source assessment activities and water quality modeling. Selected final TMDL allocation and developed implementation/monitoring plan.

**Alcovy River Basin, Georgia Water Supply Watershed Protection Study.** 1999-2001. Directed development and application of BASINS to simulate water quality within the Alcovy River watershed in

Georgia. The calibrated model was applied for multiple future scenarios to forecast the impact that different development scenarios and BMPs will have on water quality within the Alcovy River watershed. Watershed model outputs were linked with a model of the Alcovy arm of Lake Jackson to simulate the impacts of phosphorus loads on this reservoir. Authored a report section summarizing the watershed and water quality modeling. The modeling section is part of a watershed management plan that was developed for the Alcovy River basin.

**Cherokee County Watershed Assessment.** 1999-2001. Directed development and application of the GWLF watershed model to the Little River watershed, located primarily within Cherokee County, Georgia. The model simulated flow as well as sediment, phosphorus, fecal coliform, cadmium, lead and zinc loads from numerous subwatersheds. The model also simulated in-stream water quality. Model development involved the analysis of water quality and flow data, current and future land-use data, watershed characterization, the development of model inputs and calibration to flow and water quality data collected during the study. The calibrated watershed and water quality model was applied using future land use and point source loads for the year 2020 to simulate future in-stream water quality. The results of this study were presented to the Georgia Environmental Protection Division in a watershed management plan.

**TMDL Development for Standing Bear Lake, Nebraska.** 1999-2000. Recommended a watershed and water quality modeling approach for use in TMDL development for the Standing Bear Lake reservoir located in Omaha, Nebraska. Assisted with watershed and reservoir water quality modeling for development of a TMDL for sediment and TSI indicators. Provided training in model use for NDEQ staff.

**Platte Lake, Michigan Watershed Modeling Study.** 2000. Directed review of available data and reports as a basis for providing client with monitoring recommendations. Recommended a watershed model for application to the Big Platte Lake watershed for the estimation of total phosphorus, flow and sediment at multiple locations throughout the watershed.

**Columbia Slough Discharge Evaluation and TMDL and Permitting Support for the Portland International Airport's Long-Term Deicing Control Plan.** 1999-2000. Directed the use of CORMIX modeling to evaluate the extent of discharge-induced mixing from a stormwater outfall.

**Proposed Bacteria TMDL for the Shawsheen River, Massachusetts.** 1999. Directed development of a fecal coliform TMDL case study for the Shawsheen River, Massachusetts. Acquired and evaluated existing water quality data; coordinated with both the Merrimack and Shawsheen River Watershed Councils, as well as the Massachusetts Department of Environmental Protection; identified and evaluated potential sources of fecal coliform; assessed water quality impacts from point and nonpoint sources; developed recommendations for additional data collection to develop a more rigorous TMDL; co-authored the TMDL.

**Expert Eutrophication Model Review for the Truckee River Nutrient TMDL.** 1998-1999. Directed review of eutrophication model and coordination of Blue Ribbon Review Panel activities in support of the Truckee River TMDL. Directing update of existing river model to include detailed periphyton simulation within the HSPF framework.

**Wet Weather Overflow Discharge Feasibility Assessment, Fanno Creek, Oregon.** 1999. Directed technical evaluation of the feasibility of a proposed wet weather overflow outfall to a tributary to the Tualatin River, using hydrologic, hydraulic, and mixing zone analyses. Provided technical planning, direction and oversight, project management.

**Litigation Support for a Commercial Laundry Facility in Caspian, Michigan.** 1999. Conducted assessment of the relative environmental impacts of acid mine drainage and a commercial laundry in preparation for expert testimony.

**Lee/Rickett Road Drainage Study.** 1999. Directed evaluation of water quality impacts from proposed storm drainage alternatives. Evaluated impacts from flooding and from phosphorus loads on the Huron River and Strawberry Lake.

**Peer Review of Draft Ohio River Dioxin TMDL.** 1999. Conducted a scientific review of draft modeling and TMDL development efforts for dioxins in the Ohio River.

**Updated Water Quality and Phosphorus Loading Analysis of the Coldwater Chain of Lakes.** 1997-2000. Provided project oversight and technical assistance to a study of the watershed and point source nutrient loads and impacts to the Coldwater chain of lakes.

**Westerly District CSO Phase II Facilities Plan.** 1997–1999. Provided technical direction for the assessment of the impacts of combined sewer overflows (CSOs) for the Westerly district of the Northeast Ohio Regional Sewer District's (NEORS) combined sewer overflows (CSOs) in Cleveland, OH. Managing the application of receiving water modeling to assess the impacts of CSO, stormwater, and upstream pollutant loads on the Cuyahoga River, Rocky River, and Lake Erie, and documented results. Developing the recommended water quality modeling options for assessing the water quality benefits of a Long-term Control Plan.

**Water Quality Modeling for Silver and Brush Creeks, Oregon.** 1997-1998. Directed water quality modeling, using QUAL2E, of Silver and Brush Creeks, Oregon, in support of an increased wastewater discharge permit application.

**EPA Nutrient Criteria Guidance.** 1998. Authored chapter on use of models in assessing nutrient criteria for estuaries.

**Expert TMDL Assistance.** 1998. Conducted expert review of Hillsdale Lake phosphorus TMDL as part of EPA's TMDL SWAT team.

**Spokane River Water Quality Management Plan: Supporting Studies and Analyses.** 1997–1998. Managing the application of eutrophication models CE-QUAL-W2 and QUAL2E to the Spokane River, and Quality Control/Quality Assurance planning for monitoring and additional modeling.

**Mixing Zone Model Review and Guidance for the Ohio River.** 1997-1999. Directing review and evaluation of mixing zone model procedures currently applied by states issuing permits to the Ohio River, and developing recommendations for consistent mixing zone analyses across states.

**Guidelines for Determining Background Water Quality Conditions.** 1997-1999. Managed development of statistical procedures for guidance for determining in-stream water quality conditions for the Ohio River in development of WQBELs.

**Eutrophication and Salinity Model Review in Support of the Tampa Water Resource Recovery Project.** 1996-1998. Conducted eutrophication modeling assessment of the water quality impacts of a reclaimed water discharge on the Tampa Bypass Canal.

**Evaluation and Refinement of Fox River and Green Bay Models.** 1997-Present. Technical review and evaluation of PCB fate and transport models in the Fox River/Green Bay system in support of the feasibility study. Directing model uncertainty analyses.

**Nitrate and Sediment Modeling of the Lake Decatur Watershed in Illinois.** 1996-1997. Project Manager. Coordinated the analysis of nitrate loads to and concentrations within Lake Decatur, Illinois, in response to alternative fertilization practices in the watershed.

**Lake Lanier Water Quality Modeling Study.** 1995-1998. Directed the development of a linked watershed/water quality model and mixing zone models for the Lake Lanier basin in Georgia. This model will be used to predict loads to the reservoir under various future development scenarios.

**Assessment of Wet Weather Quality Impacts on the Ohio River.** 1996-1998. Directed the development of a linked watershed/water quality model for the 10,000-square-mile watershed near Cincinnati, Ohio, as part of a U.S. EPA demonstration project

**Mathematical Modeling of PCB Fate and Transport in the Hudson River in support of Reassessment of Remedial Alternatives.** 1996-1998. Provided project oversight on PCB modeling activities.

**Consulting Services to Toxaphene Investigation of the Great Lakes.** 1996-1998. Provided project oversight and investigation into the sources and modeling regarding the fate of toxaphene in the Great Lakes.

**Las Vegas TMDL Assessment.** 1996-1998. Reviewed modeling activities and future TMDL scenarios for Las Vegas Watershed and Bay.

**Monte Carlo Discharge Analysis for Storm Water Retention Pond on Tittabawassee River to Ensure Water Quality Standards.** 1996-1997. Provided project oversight on probabilistic modeling analysis of stormwater impacts.

**Preparation of Case Studies for EPA Guidance Manual of Nutrients/Eutrophication Assessment.** 1995-1996. Managed the development of two case studies to be included in the EPA technical guidance manual for performing TMDLs for nutrients.

**Revision of EPA's DYNTOX Model for TMDL Guidance.** 1996. Directed revision of EPA's DYNTOX Model and User's Manual to facilitate its use in development of Total Maximum Daily Loads.

**Dissolved Oxygen Model Calibration for Spokane River in Support of Wastewater Facilities Plan.** 1996. Calibrated water quality model of the Spokane River.

**Development of a Watershed Management Plan for Lake Varner.** 1996. Directed watershed and reservoir modeling in support of a watershed management plan to protect a drinking water supply.

**Application of a Coupled Primary Productivity-Exotic Species Model for Saginaw Bay, Lake Huron.** 1995-1996. Revised zebra mussel bioenergetic model to account for selective rejection of blue-green algae.

**Preparation of a Mixing Zone Guidance Manual for the American Petroleum Institute.** 1995-1996. Directed preparation of technical chapters of guidance manual on mixing zone assessment for American Petroleum Institute.

**Assessment of WASP Modeling of the North Saskatchewan River for the City of Edmonton, Alberta, Canada.** 1995-1996. Directed review of WASP modeling used for wasteload allocation purposes in the North Saskatchewan River.

**Enhancement of the Simplified Method Program - Toxics (SMPTOX) to Predict Non-Ionic Organic Concentrations in Sediments.** 1995. Directed development of Windows<sup>TM</sup>-based model predicting toxics concentrations in the water column and sediments.

**Revision of DYNTOX and DESCONE Models in Response to EPA's Revision of Aquatic Life Metal Criteria.** 1995. Directed revisions of DYNTOX and DESCONE model codes and User's Manual to conform with EPA guidance regarding bioavailability of metals.

**Review of Spokane River TMDL in Support of Facilities Planning.** 1995-1996. Directed review of water quality modeling and nonpoint assessment for Spokane River ID/WA and eutrophication assessment of Long Lake, Washington.

**Wasteload Allocation Modeling for the City of Lincoln, Nebraska Wastewater Treatment Plants.** 1994-1996. Evaluated and applied a range of water quality models to define effluent ammonia limits for the City of Lincoln, Nebraska that are protective of water quality.

**Mathematical Modeling of PCB Fate & Transport for Hudson River PCB in Support of Reassessment of Remedial Alternatives.** 1993-1995. Managed application of physicochemical and food chain PCB models for the Lower Hudson River to determine system response to remedial alternatives.

**An Ecosystem Modeling Study of Saginaw Bay: Impacts of Long-Term Loading Reductions and Invasion by the Zebra Mussel.** 1991-1995. Developed and applied zebra mussel bioenergetic model to estimate potential change in trophic response to nutrient loads caused by zebra mussels.

**EPA Regional Training Workshops on Development of Total Maximum Daily Loads.** 1993-1995. Managed and served as lead presenter for a series of nationwide technical training workshops explaining the development of TMDLs.

**Evaluation of Mixing Zone Models for Produced Water from Oil and Gas Operations in the Gulf of Mexico.** 1993-1994. Provided expert review of the applicability of several models to determine which would be most appropriate for general NPDES permit development. Resolved dispute between EPA and industry consultants.

**Development of Caloosahatchee Estuary Salinity Model.** 1993. Managed WASP model application to predict estuarine salinity distribution in response to a wide range of freshwater inflows.

**Documentation of CORMIX Mixing Zone Model Revisions for U.S. Environmental Protection Agency.** 1993. Reviewed applicability of DRBC-sponsored changes to the model CORMIX designed to facilitate estuarine mixing zone analysis.

**Development of a Multi-Branched Stream Toxics Model for Wasteload Allocation Purposes for Pennsylvania DER.** 1993. Managed development of C-language watershed-based expert system for performing water quality simulation and effluent permitting

**Testing the Use of Computer Models for NPDES Permit Development to Protect Sediment Quality.** 1992-Present. Directed application of water and sediment quality models for four hydrophobic organic chemicals in a Louisiana estuary and six metals in a Massachusetts/Rhode Island river.

**Water Quality Analysis and Modeling in Support of NPDES Requirements for the Expansion of the Lower Potomac Pollution Control Plant, Fairfax Co., Virginia.** 1992-1993. Managed application of hydrodynamic, toxic pollutant, conventional pollutant/eutrophication, and mixing zone models to determine water quality impacts of alternate discharge locations.

**Development of a Demonstration Total Maximum Daily Load for Silver Creek, Arizona for Use in EPA Training.** 1992-1993. Managed development of watershed and receiving water quality models in support of TMDL development.

**Development of a Demonstration Total Maximum Daily Load for Paradise Creek in the Northwest in Support of EPA Training.** 1992-1993. Managed development of watershed and receiving water quality models in support of TMDL development.

**Development of the User Friendly PC-Based DYNTOX Probabilistic Toxics Model for Use in NPDES Development.** 1992-1993. Managed conversion of mainframe-based DYNTOX probabilistic model to user-friendly, PC-based platform.

**Determination of Mixing Zones for Three Dischargers in the Missouri River for EPA Region 7.** 1992-1993. Project manager for mixing zone model calibration to field dye survey data.

**Enhancements to Multi-SMP Surface Water Toxics Model for EPA Use in Assistance to States.** 1992-1993. Managed update of the Multi-SMP model to include refined user interface and additional modeling capabilities.

**Expert "SWAT Team" Assistance to U.S. EPA and States in Development of Total Maximum Daily Loads.** 1992. Provided expert assistance to numerous states in developing total maximum daily loads.

**Eutrophication Modeling of Providence River and Upper Narragansett Bay, Rhode Island in Support of Dissolved Oxygen Restoration.** 1992. Managed application of a eutrophication model to determine nutrient loading reductions required to restore dissolved oxygen to desired levels.

**Survey of Existing TMDLs for PCBs.** 1992. Managed literature review of existing PCB modeling applications in support of proposed Great Lakes PCB TMDL.

**Presentation of Total Maximum Daily Load Modeling Approaches at EPA National Planning Workshops.** 1992. Presented technical approaches to watershed-based water quality control at a nationwide series of EPA workshops.

**Development of Phase II Screening Model for TCDD (Dioxin) in the Columbia River.** 1991-1992. Directed application of a screening-level mass balance model to support development of a total maximum daily load (TMDL) for dioxin in the Upper and Lower Columbia, Snake and Willamette River Basins.

**Development of Draft Technical Guidance Manual for Performing TMDLs, U.S. EPA Office of Science and Technology.** 1991-1993. Authored draft guidance manual containing TMDL case studies, along with expanded outline of guidance describing the TMDL development process.

**Development of a Modeling Protocol to Support NPDES Permit Limits to Protect Sediment Quality.** 1991-1992. Managed development of a range of sediment quality models to be used for evaluation of Sediment Quality Criteria (SQC). Examined the nationwide impact of promulgation of SQC.

**Comparison of Toxic NPDES Permit Limits Developed Using Dynamic and Steady-State Approaches in Support of EPA Training Workshops.** 1991-1992. Managed application of water quality and mixing zone models, and resulting permit derivation, to determine permit limits for toxic pollutants.

**Development of a Solids and Nutrient Demonstration Total Maximum Daily Load for San Luis Obispo Creek as a Case Study for EPA and State Regulatory Staff Training.** 1991-1992. Managed development of watershed and receiving water quality models in support of TMDL development.

**Statistical Analysis of Rainfall Data for Five Cities in Support of EPA Interest in Design Storms for Combined Sewer Overflow Control Plans.** 1991-1992. Managed statistical assessment of observed data on rainfall intensity, duration, and volume; provided guidance on selection of design conditions.

**Review of Mixing Zone NPDES Application for Pago Pago Harbor.** 1991. Managed review for U.S. EPA Region 9 of UDKHDEN mixing zone model application.

**Development of a SMPTOX3 Surface Water Toxic Chemical Model for EPA to Improve Availability and Use of Models for Support of NPDES Permits.** 1991. Managed development and testing of a variable-complexity water quality and sediment toxics model.

**Waste Load Allocation Modeling for Lead Mining Industry Discharges.** 1991. Managed development of a surface water and bed sediment quality model for heavy metals.

**Toxics Modeling and NPDES Permitting Training Workshops for EPA and State Regulatory Staff.** 1990-1992. Managed and served as lead presenter for a series of nationwide technical training workshops explaining the development and application of water quality models for NPDES permitting.

**Support of Total Maximum Daily Load Water Quality Model Development for South San Francisco Bay.** 1990-1991. Managed development of screening-level WASP model application using available data, and provided monitoring recommendations to collect data required to support more rigorous modeling.

**Analysis of Needs and Alternatives for Region 3 Estuarine Waste Load Allocation and Mixing Zone Assessments.** 1990-1991. Reviewed available modeling approaches for estuarine mixing zones, provided recommendations to EPA.

**Toxic Model Update and Toxic Modeling Handbook for EPA.** 1990-1991. Managed development and testing of a steady-state water quality and sediment toxics model.

**Fate and Transport Modeling in Support of the Columbia River Dioxin TMDL, 1990-1991.** Developed and applied an environmental fate and transport model to support the conclusions of the Columbia River Dioxin TMDL, in response to a legal challenge of the TMDL developed by Region 10.

**Technical Guidance for Narragansett Bay Waste Load Allocation Modeling.** 1989-1992. Co-chaired Water Quality Modeling Advisory Board overseeing development of a dissolved oxygen wasteload allocation model for the Providence River and Upper Narragansett Bay.

**Modification and Enhancements to the Pennsylvania DER Water Quality Analysis Model.** 1989-1991. Managed conversion of expert system dissolved oxygen model from Applesoft Basic to C-language.

**Technical Assistance to EPA in Development of Section 303(d) Wasteload Allocation Program Guidance.** 1989-1991. Provided technical assistance to EPA on a wide range of issues related to water quality assessment and modeling.

**QUAL2E-UNCAS Modeling for use in EPA Technical Guidance Manual.** 1989-1990. Managed modeling analysis and authored chapter on QUAL2E modeling for EPA technical guidance manual.

**Preparation of EPA Draft Permit Writer's Guide to Water Quality-Based Toxics Control for Marine and Estuarine Discharges.** 1989-1990. Authored chapter on exposure assessment modeling, describing alternative modeling methodologies.

**Development of Procedures for Waste Load Allocation in Arthur Kill Estuary, U.S. EPA Region 2.** 1989. Developed wasteload allocation guidance manual for New Jersey DEP.

**Toxics Modeling Workshops for Training EPA and State Regulatory Personnel.** 1989. Managed and served as lead presenter for a series of nationwide technical training workshops explaining the development and application of water quality models for NPDES permitting.

**Water Quality Modeling of Walloon Lake and Development of a Basin-Wide Watershed Management Plan.** 1988-1989. Developed and calibrated multi-segment lake eutrophication model to predict the impact of watershed development on Lake Trout habitat.

**Development of Waste Load Allocation Technical Guidance Manual for Estuarine Systems on Behalf of EPA.** 1988-1989. Co-authored two technical guidance manuals on estuarine wasteload allocation modeling.

**Training Workshop for EPA and State Regulatory Staff on Development of Water Quality Based Toxic Effluent Limits for NPDES Permits.** 1988. Managed and served as lead presenter for a series of nationwide technical training workshops explaining the development and application of water quality models for NPDES permitting.

**Assistance to States in Identifying 304(l) Impacted Waterbodies: Candidate Lists for Six States for EPA.** 1988. Managed review of state databases and files to develop lists of impaired waters.

**Development of a Dissolved Oxygen Model of the Bon Secour River and Intercoastal Waterway, Alabama.** 1988. Managed water quality model application and conducted technology transfer training workshop for State and Regional staff.

**Development of a Dissolved Oxygen Model of the Amelia River Estuarine System to Assist in Determination of Effluent Limitations for a Pulp and Paper Mill.** 1988. Managed development of WASP model of hydrodynamics and dissolved oxygen.

**Investigation of Wastewater Treatment Plant Effluents Impacts on Sweetwater Creek in Support of NPDES Permit Development.** 1988. Managed field survey data collection and water quality model application to determine effluent limitations required in response to increased discharge flow.

**Dilution Modeling of Toxic Impairment in U.S. Estuaries due to Toxic Discharges to Develop List of Potentially Impaired Waters as Part of 304(l) Requirements.** 1987-1988. Managed database development and model application for 161 pollutants in 96 U.S. estuaries.

**Water Quality, Runoff and Sewer System Modeling in Support of Planning for Wayne County Combined Sewer Overflow Controls in the Rouge River Basin.** 1980-1982, 1987. Applied water quality models to determine the dissolved oxygen impact of combined sewer overflows to the Rouge River.

**Development of a Screening Model for Lake Toxics Impacts for EPA to Evaluate the Impacts of Hazardous Waste Landfills.** 1986-1987. Developed modeling methodology to determine if landfill controls designed for protecting riverine water quality would also be protective for lakes.

**Dissolved Oxygen Studies of the Potomac Estuary to Evaluate the Need for Wastewater Treatment by Nitrification.** 1986-1987. Managed dissolved oxygen modeling and review; conducted Monte Carlo assessment of variability in algal productivity.

**Development of Prototype Pre- and Post-Processors for EPA Water Quality Models to Improve Use by Regulatory Staff.** 1986. Managed development of user-friendly microcomputer interfaces for the QUAL2E and DYNTOX models.

**Toxics Modeling Workshops for Training EPA and State Regulatory Personnel in Their Use in NPDES Permitting.** 1985-1987. Managed and served as presenter for a series of nationwide technical training workshops explaining the development and application of water quality models for NPDES permitting.

**Development of Interactive Microcomputer Programs on the Simplified Method for Conventional and Toxic Waste Load Allocation for EPA.** 1985-1986. Managed the development of a user-friendly stream dissolved oxygen model.

**Development of a Monte Carlo Dissolved Oxygen Model for Evaluation of Waste Load Allocation for Michigan DNR.** 1985-1986. Managed development of a user-friendly microcomputer model for performing probabilistic modeling analyses of receiving water quality.

**Critical Review of NPDES Effluent Limits for Fairfax County Virginia.** 1983-1987. Developed, calibrated, and applied water quality models for dissolved oxygen and chlorophyll as part of NPDES permit review.

**Evaluation and Expert Testimony on the Impact of Zoning Restrictions on Water Quality in Occoquan Reservoir.** 1983-1985. Developed, calibrated and applied watershed and receiving water quality models to determine the impact of urban development on a drinking water supply. Worked with lawyers during trial to prepare questions for opposition witnesses.

**Water Quality Monitoring and Modeling to Critically Evaluate and Revise NPDES Effluent Limits for the City of Owosso, Michigan.** 1983-1984. Directed and designed field surveys; calibrated and applied dissolved oxygen model to determine appropriate permit limits to protect water quality.

**Modeling and Evaluation of PCB and PBB in Saginaw and Pine Rivers to Assess Needs for Sediment Remediation.** 1983. Assisted in PCB model application to the Saginaw River.

**Concept Paper and Workshop for EPA to Introduce Specialized Uncertainty and Probability Analysis in NPDES Waste Load Allocations.** 1982-1983. Reviewed alternative probabilistic modeling procedures for water quality assessment.

**Studies of Phytoplankton and Dissolved Oxygen Kinetics in Onondaga Lake.** 1982-1983. Developed and calibrated microcomputer eutrophication model for Onondaga Lake.

**Critical Review of Stochastic Modeling Used by Iron and Steel Industry to Characterize Effluent Characteristics and Water Quality Impacts.** 1982. Reviewed and critiqued stochastic water quality model application for U.S. EPA.

**Hydrologic Modeling of Ellsworth Lake to Evaluate Effects of Withdrawals on Lake Levels.** 1982. Conducted hydrographic survey, model development and application to determine cause of beach exposure.

**Evaluation of the Impacts of Grand Rapids Combined Sewer Overflows on Grand River Water Quality and the Need for Controls.** 1980-1982. Developed, calibrated, and applied water quality model to determine dissolved oxygen impact of combined sewer overflows.

**Monitoring and Modeling of Washington, D.C. Impacts on Water Quality in the Potomac and Anacostia Rivers, and Rock Creek to Develop a Combined Sewer Overflow Control Plan.** 1977-1982. Developed and applied hydrodynamic and water quality models for the Potomac and Anacostia Estuaries.

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## Selected Publications

### Journal Articles

- Dilks, D. W. and R. T. James. Parameter uncertainty in a highly parameterized model of Lake Okeechobee. *Lake and Reservoir Management*. 27(4): 376-389. 2011.
- Bierman, V.J. Jr., J. Kaur, J.V. DePinto, T.J. Feist and D.W. Dilks. 2005. Modeling the Role of Zebra Mussels in the Proliferation of Blue-Green Algae in Saginaw Bay, Lake Huron. *Journal of Great Lakes Research*. 31:32-55. 2005
- Dilks, D. W. and P. L. Freedman. Improved Consideration of the Margin of Safety in TMDL Development. *Journal of Environmental Engineering*. 130(6):690-694. 2004.
- Freedman, P. L., A. D. Nemura, and D. W. Dilks. Viewing TMDLs as a Process, not a Singular Value: Adaptive Watershed Management. *Journal of Environmental Engineering*. 130(6):695-702. 2004.
- DePinto, J.V., P.L. Freedman, D.W. Dilks, and W.M. Larson. Models quantify the Total Maximum Daily Load process. *Journal of Environmental Engineering*. 130(6):703-713. 2004.
- Raghunathan, R. K., T. Slaweki, T.D. Fontaine, Z. Chen, D.W. Dilks, V.J. Bierman, Jr. and S. Wade. Exploring the Dynamics and Fate of Total Phosphorus in the Florida Everglades Using a Calibrated Mass Balance Model. *Ecological Modelling*. 142:247-259. 2001.
- Dilks, D. W. and J.F. Pendergast. A Comparison of Dynamic and Steady State Models for Determining Water Quality Based NPDES Limits for Toxics, *Water Environment Research*, Vol. 7, No. 2, pp. 225-229. 1999.
- Freedman, P. L. and D. W. Dilks. A Watershed Event in Water Quality Protection. *Water Environment and Technology*, 6(9), 76-81. 1994.
- Freedman, P. L. and D. W. Dilks. Revised Methods Considered for Aquatic Life Criteria, *Water Environment and Technology*, March 1994.

Dilks, D. W., J. S. Helfand, V.J. Bierman, Jr. and L. Burkhard, Field Application of a Steady-State Mass Balance Model for Hydrophobic Organic Chemicals in an Estuarine System, *Water Science and Technology*, 28:263-271. 1993.

Dilks, D. W. , R.P. Canale and P.G. Meier. Development of a Bayesian Monte Carlo Method for Determining Water Quality Model Uncertainty, *Ecological Modeling*, 62:149-162. 1992.

Meier, P. G. and D. W. Dilks. Periphytic Oxygen Production in Outdoor Experimental Channels, *Water Research*, 18 (9):1137-1142. 1984.

Dilks, D. W. and P.G. Meier. 1981. The Use of Coverslips in Estimating Periphyton Accrual, *Journal of Freshwater Ecology*, 1: 321-326.

### **Books and Published Reports**

*Modeling Guidance for Developing Site-Specific Nutrient Goals.* (with J. V. DePinto, V.J. Bierman, Jr., P. E. Moskus, T.A.D. Slawewski, C. F. Bell, S. C. Chapra, and K. F. Flynn. Prepared for the Water Environment Research Foundation. WERF Project LINK1T11. 2013.

*Navigating the TMDL Process: Method Development for Narrative Criteria.* (with P. L. Freedman, H. Holmberg, P. Moskus, G. McBride, C. Hickey, D. Smith, and P. Striplin.) Water Environment Research Foundation. 2004.

*Navigating the TMDL Process: Evaluation and Improvements.* (with P. L. Freedman, W. M. Larson, D. Schechter, A. Nemura, T. Naperalala, J. V. DePinto, M.G. Prothro, G. W. Boese, A. Dettelbach, L. Nothman, K. Thornton, D. Ford, P. Massirer, T. Soerens, K. B. Stevens, J. A. H. Sobrinho.) Water Environment Research Foundation. 2004.

Receiving Water Impacts (with P. Freedman) in *The Control and Treatment of Industrial Stormwater*, Van Nostrand Reinhold, 1996.

An Integrated Model of Atmospheric and Aquatic Chemical Fate Useful for Guiding Regulatory Decisions (with P. Rodgers and P. Samson), in *Long Range Transport of Pesticides*, Lewis, Publishers, 1989.

Artificial Substrata for Reducing Periphytic Variability on Replicated Samples, (with P.G. Meier and D. O'Connor) in *Periphyton of Freshwater Ecosystems*, Dr. W. Junk Publishers, The Hague, Chapter 34, pp. 283-286, 1983.

### **Client Reports**

Comprehensive Plan to Reduce Polychlorinated Biphenyls (PCBs) in the Spokane River. Prepared for the Spokane River Regional Toxics Task Force. Plan Accepted by the Task Force November 16, 2016

Model Confirmation & Database Extension for WARMF & TRHSPF to Support the Third-Party Reviews of Truckee River Nutrient Water Quality Standards & TMDLs. Prepared for Truckee River Third-Parties: City of Reno, City of Sparks, Washoe County, and Truckee Meadows Water Authority. 2013.

Final Draft Calibration of the Truckee River HSPF Water Quality Model Prepared for: The Cities of Reno and Sparks, Nevada. January, 2008.

Provisional Buxahatchee Creek, AL (AL/03150107-090\_01) Dry Weather Dissolved Oxygen TMDL. 2003.

DYNTOX User's Manual. Prepared for EPA Office of Science and Technology. September 1995.

DESCON Version 2.0 User's Manual. Prepared for EPA Office of Science and Technology. September 1995.

- SMPTOX4 User's Manual. Prepared for EPA Office of Science and Technology. September 1995.
- Phase 2 Preliminary Model Calibration Report, Hudson River PCB Reassessment RI/FS. Draft report to U.S. EPA, January 1995.
- Performance Report for Caloosahatchee Estuary Salinity Modeling, prepared for South Florida Water Management District, West Palm Beach, Florida, October 1994.
- Development of the Silver Creek Demonstration TMDL, prepared for U.S. EPA Region 9, San Francisco, California, February 1993.
- Development of the Paradise Creek Demonstration TMDL, prepared for U.S. EPA Region 10, Seattle, Washington, February 1993.
- Development of the San Luis Obispo Creek Demonstration TMDL, prepared for U.S. EPA Region 9, San Francisco, California, April 1992.
- Providence River/Upper Narragansett Bay Eutrophication Screening Analysis, prepared for Narragansett Bay Project, Providence, Rhode Island, July 1992.
- Assessment of American Original, Inc. Dissolved Oxygen Impact on Parting Creek, prepared for McGuire, Woods, Battle, and Boothe, Richmond, Virginia, June, 1991.
- South San Francisco Bay TMDL Modeling Task 1: Data Report: Screening Model Application and Recommendations, prepared for California Regional Water Quality Control Board, Oakland, California, November 1990.
- South San Francisco Bay TMDL Modeling Task 2: Report: Screening Model Application and Recommendations, prepared for California Regional Water Quality Control Board, Oakland, California, November 1990.
- Toxics Modeling Handbook, prepared for U.S. EPA, Region 4, October 1990.
- SMPTOX3 User's Manual, prepared for U.S. EPA, Region 4, October 1990.
- Estuarine Dilution Analyses to Estimate Toxic Substance Impairment for 304(1) Identification, for U.S. EPA Office of Marine and Estuarine Protection and Office of Water Regulation and Standards, Washington, D.C, March 31, 1988.
- State of Kansas Identification of 304(l) Waterbodies: Candidate Lists, prepared for U.S. EPA Region 7, Kansas City, Kansas, March 31, 1988.
- State of Nebraska Identification of 304(l) Waterbodies: Candidate Lists, prepared for U.S. EPA Region 7, Kansas City, Kansas, March 31, 1988.
- Evaluation of Critical Conditions for Assessing the Benefits of Increased Nitrification Treatment in the Upper Potomac Estuary, prepared for Metropolitan Washington Council of Government, Washington, D.C., December 1987.
- Impacts of Dale Mabry WWTP Effluent on Brushy Creek Water Quality, prepared for Hillsborough County, Florida, and Greeley and Hansen Engineers, Tampa, Florida, December 1987.
- Preliminary Analysis of the Impacts of Dale Mabry WWTP Effluent on Brushy Creek Water Quality, prepared for Hillsborough County, Florida and Greeley and Hansen Engineers, Tampa, Florida, November 1987.
- Dissolved Oxygen Predictions for Alternative Wastewater Treatment Scenarios in the Upper Potomac Estuary, prepared for Metropolitan Washington Council of Government, Washington, D.C., September 1987.

- Validation of DEM to 1985 and 1986 Data, prepared for Metropolitan Washington Council of Governments, Washington, D.C., August 11, 1987.
- QUAL2E: Prototype IMF Version, User's Manual, for U.S. EPA Monitoring and Data Support Division, Washington, D.C., October 1986.
- Progress Report: Review of the Waste Load Allocations for the Lower Potomac and Little Hunting Creek Wastewater Plants, prepared for Fairfax County, Virginia, July 21, 1986.
- Expanded Definition of Surface Water Component for RCRA Land Disposal Facilities, A Proposed Framework for Lakes, prepared for LimnoSystems, Durham, North Carolina, March 1986.
- Dynamic Toxics Analyses (DYNTOX) User's Manual, for U.S. EPA Monitoring and Data Support Division, Washington, D.C., March 1985.
- Projected Impacts of Lower Potomac Pollution Control Plant on Gunston Cove Water Quality, for Fairfax County, Virginia, December 1984.
- Calibration and Verification of a Water Quality Model for Gunston Cove, for Fairfax County, Virginia, November 1984.
- Evaluation of City of Owosso Wastewater Treatment Plant NPDES Requirements, for Owosso, Michigan, December 1983.
- Potomac Estuary Water Quality Causes and Effects as Related to 1983 Observations, for Fairfax County, Virginia, September 1983.
- Development of a Microcomputer Eutrophication Model for Onondaga Lake, for Calocerinos and Spina, August 1983.
- Review of VIMS Hydrodynamic Modeling of Gunston Cove, for Fairfax County, Virginia, August 1983.
- Review of VIMS Water Quality Modeling of Gunston Cove, for Fairfax County, Virginia, August 1983.
- Analysis of Virginia Effluent Limitations for the Lower Potomac Sewage Treatment Plant, for Fairfax County, Virginia, January 1983.
- Impact of Grand Rapids Combined Sewer Overflows on Grand River Water Quality. Phase II Report, for McNamee, Porter, and Steely, Ann Arbor, Michigan, March 1982.

### **Selected Proceedings**

- DePinto, J.V., S. C. Chapra, C. Bell, D. W. Dilks, K. Flynn, V. J. Bierman, T. Slawecki, and P. Moskus. 2013. Load-Response Models for Establishing Site-Specific Nutrient Goals Based on Water Quality and Biological Response Indicators. Proceedings of the Water Environment Federation, WEFTEC 2013: Session 20 through Session 25, pp. 1614-1626(13).
- DePinto, J.V., S. C. Chapra, C. Bell, D. W. Dilks, K. Flynn, V. J. Bierman, T. Slawecki, and P. Moskus. 2014. A Review of the Research and Data Needs for Improving Load-Response Models in the WERF Nutrient Modeling Toolbox. Proceedings of the Water Environment Federation, WEFTEC 2014: Session 320 through Session 337, pp. 505-517(13).
- Weintraub, L. H. Z., Ceppos, D., Freedman, P. L., Dilks, D. W., and Dennis, G. Third-Party Nutrient TMDL Review and Revision for the Truckee River, Nevada. Proceedings of the Water Environment Federation, TMDL 2009, pp. 105-121(17).
- Wade, R. Scott, D.W. Dilks, V.K.S. Breidenbach, L.A. Fowler, E. Heath, C. Allen, and T. Maxwell. 2004. A Watershed Approach to Support River Protection, Land Use Planning, and Open Space Preservation in a Rapidly Developing Suburban Region. Presented at Watershed 2004, a specialty conference of the Water Environment Federation, Dearborn, Michigan, July 2004.

- Implicit Methods for Addressing Model Uncertainty in Support of the TMDL Margin of Safety. Proceedings of the Water Environment Federation TMDL Sciences 2003, Chicago, Illinois. November 19, 2003.
- Adaptation and Calibration of HSPF to Simulate Periphyton in Support of the Truckee River TMDL. Proceedings of the Water Environment Federation TMDL Sciences 2003 (with T. Naperalala), Chicago, Illinois. November 19, 2003.
- Discharger Led TMDL Study for Findley Lake Watershed, Ohio (How to Get a NPDES Permit for a 303(d) Listed Water When the TMDL is Years Away. Proceedings of the Water Environment Federation TMDL Sciences 2003 (with V. Breidenbach), Chicago, Illinois. November 19, 2003.
- Moskus, P.E., D.W. Dilks, T.A.D. Slawewski, and R.S. Wade. 2003. Lake Lanier, Georgia, Nutrient Load Analysis. Presented at the Joint International Lake Committee (ILEC) and International Association of Great Lakes Research (IAGLR) Conference. Chicago, Illinois, June 2003.
- Development of a TMDL for Nutrients and Sediment for Standing Bear Lake. Proceedings of the TMDL Sciences and Policy Conference (with Kathryn Sweet, Daniel Schechter, and Penelope Moskus.) Phoenix, Arizona. November, 2002.
- Narrative Criteria in the TMDL Process. Proceedings of the TMDL Sciences and Policy Conference (with Hans Holmberg, Graham McBride, and Chris Hickey.) Phoenix, Arizona. November, 2002.
- Improved Methods for Calculating the TMDL Margin of Safety. Proceedings of the TMDL Sciences and Policy Conference. Phoenix, Arizona. November, 2002.
- Guiding Principles for Modeling in TMDL Process. Proceedings of the TMDL Sciences Conference (with DePinto, J.V., W.M. Larson, and P.L. Freedman. Phoenix, AZ. November, 2002.
- Turner, C.L., T.A. Naperalala, D.W. Dilks, J. Heath. "Evaluating CSO Impacts on the Ohio River: Project Overview and Large River Case Study," WEFTEC 2002 Conference Proceedings. September 2002.
- Critical Evaluation of the TMDL Process, Proceedings of the American Society of Engineers TMDL Conference, Fort Worth, Texas, April, 2002.
- Application of Bayesian Monte Carlo Analysis to Determine the Uncertainty in the Lake Okeechobee Water Quality Model. (with R. Thomas James). Proceedings of Watershed 2002 Conference, Fort Lauderdale, Florida, February, 2002.
- Watershed and Water Quality Modeling to Support Watershed Protection in the Pumpkinvine Creek Watershed, Georgia (with Penelope Moskus). Proceedings of Watershed 2002 Conference, Fort Lauderdale, Florida, February, 2002.
- TMDLs: Expeditious or Implementable? Proceedings of Watershed 2000, Vancouver, British Columbia, July, 2000.
- Proposed Bacteria TMDL for the Shawsheen River, Massachusetts. (with P. E. Moskus, K. Dolan, R. Goodno, and K. Laffin). Presented at Watershed 2000, Vancouver, British Columbia, July, 2000.
- Development and Application of a Linked Watershed/Water Quality Model for Evaluating Impacts from Nutrient Loads to Lake Lanier, Georgia. (with T. J. Feist, T.A.D. Slawewski, P.E. Moskus, R.S. Wade, and E.M. Buchak). Presented at the 19th International Symposium of the North American Lake Management Society, Reno, Nevada, December 1999.
- A Coupled phytoplankton - zebra mussel model for Saginaw Bay, Lake Huron. Proceedings of the Workshop on Aquatic ecosystem Modeling and Assessment Techniques for Application within the U.S. Army Corps of Engineers. (with Bierman, V.J., Jr., T.J. Feist, J.V. DePinto, and R.G. Kreis.) U.S. Army Engineers Waterways Experiment Station, Vicksburg, MS. Misc Paper EL-98-1. pp. 43-67. 1998.

Development and Application of a Linked Watershed/Waterbody Model for the Lake Lanier Watershed Study. Proceedings of the WEF Specialty Conference on Watersheds, Denver, Colorado, May, 1998.

Implementation of a Watershed Management Plan for a Georgia Water Supply Reservoir (with P. Moskus). Proceedings of the WEF Specialty Conference on Watersheds, Denver, Colorado, May, 1998.

Development of Alternative Management Scenarios For The Lake Lanier Watershed (with R. S. Wade). Proceedings of the WEF Specialty Conference on Watersheds, Denver, Colorado, May, 1998.

Development of a Probabilistic Depth of Scour Model for PCB-Contaminated Cohesive Sediments in the Hudson River (with J. Helfand). Proceedings of the Water Environment Federation 70th Annual Conference, October, 1997.

The Development and Calibration of an Everglades Nutrient Fate and Transport Model (with R. Raghunathan). Proceedings of the Water Environment Federation 70th Annual Conference, October, 1997.

Modeling Wet Weather Water Quality Impacts on Large Rivers: The Ohio River Demonstration Study. Proceedings of the Water Environment Federation 70th Annual Conference, October, 1997.

A Mass Balance Analysis of the Relationships among Zebra Mussels, Blue-Green Phytoplankton and Sediment Phosphorus Flux in Saginaw Bay, Lake Huron. Contributed paper at 39th Conference on Great Lakes Research, Erindale College, Mississauga, Ontario (with Bierman, V.J., Jr., T.J. Feist, and J.V. DePinto) May 26-30, 1996.

TMDLs as a Tool for Watershed Development (with C. Paulson). Proceedings of Watershed '96, Baltimore, Maryland, June 1996.

Selecting Design Conditions as Part of a Watershed Approach to Water Quality Control, Proceedings of the North American Water and Environment Congress, American Society of Civil Engineers, June 1996.

Conducting Wasteload Allocations in a Watershed Framework: Real World Problems and Solutions, Proceedings of Watershed '96, June 1996.

Development and Application of Models to Determine Sediment Quality Criteria-driven Permit Limits for Metals. WEF Specialty Conference Series Proceedings, Toxic Substances in Water Environments, Cincinnati, Ohio, May 1995.

Sediment Quality Modeling in Response to Proposed Sediment Quality Criteria. Proceedings of the Water Environment Federation 67th Annual Conference, October 15-19, 1994.

Field Application of a Steady-State Mass Balance Model for Hydrophobic Organic Chemicals in an Estuarine System. Proceedings of IAWQ Specialty Conference on Contaminated Sediments, Milwaukee, Wisconsin, 1993.

Development of the San Luis Obispo Demonstration TMDL. Proceedings of Watershed '93, a National Conference on Watershed Management, Alexandria, Virginia, 1993.

Screening Level Modeling in Support of an Estuarine Toxics Management Program, ASCE National Conference on Environmental Engineering, Reno, Nevada, July 1991.

Model Uncertainty in Predicting Eutrophic Impacts on High Quality Lakes. Proceedings of a North American Lake Management Society Specialty Conference on High Quality Lakes, 1990.

GIS - Water Quality Model Linkage, proceedings of the ASCE National Conference on Environmental Engineering, Alexandria, Virginia, 1990.

Determination of Water Quality Model Uncertainty using a Bayesian Monte Carlo Technique. Proceedings of the American Society of Civil Engineers National Conference on Environmental Engineering, 1989.

Application of Microcomputers for Uncertainty Analysis with Wastewater Treatment Facilities Planning, 1st National Conference on Microcomputers In Civil Engineering, 1983.

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## **Expert Witness Support**

**City and County of Honolulu v. Hawaii State Department of Health: Docket 14-CWB-EMD-3.** Prepared Expert Report.

**City and County of Honolulu v. Hawaii State Department of Health: Docket 14-CWB-EMD-2.** Prepared Expert Report.

**Florida Wildlife Federation v FDEP: Case No. 11-6137RP.** Reviewed petitioners claims and provided deposition.

**Kentucky Waterway Alliance, et al. v. Energy and Environment Cabinet, et al. File No. DOW-41106.** 2010. Prepared Expert Report. Petitioners dropped claim prior to testimony.

**Contested Case Proceedings Challenging the North Carolina Environmental Management Commission Issuance of an Interbasin Transfer Certificate to the City's of Concord and Kannapolis.** 2008-2009. Prepared Expert Report. Case settled prior to testimony.

**The City of Cincinnati, v. Environmental and Public Protection Cabinet and Sanitation District No. 1 of Northern Kentucky.** 2007. Prepared Expert Report. Directed verdict issued prior to testimony.

**Maine Board of Environmental Protection. Androscoggin River Waste Discharge Licenses and Gulf Island Pond Water Quality Certification.** 2007. Prepared Expert Report and provided expert testimony.

**Lake Lanier Association, Save Our Communities Now, Inc., Terence D. Hughey, Upper Chattahoochee Riverkeeper Fund, Inc., and Sierra Club, vs. Environmental Protection Division, Georgia Department Of Natural Resources.** 2002. Prepared Expert Report and provided expert testimony.

**Western Carolina Regional Sewerage Authority v. South Carolina Department of Health and Environmental Control. TMDL Development for Nutrients.** 1999. Deposed, case settled prior to testimony.

**Frank J. Kelly, et al v. M.A. Hanna Company v. USX Corp., et al. Ingham County Circuit Court Case No. 94-77813-CE. Environmental Impacts of Acid Mine Drainage.** 1999. Case settled prior to testimony.

**California Regional Water Quality Control Board. Expert Review of Newport Bay Nutrient TMDL.** 1998. Provided testimony at hearing.

**California Regional Water Quality Control Board. Expert Review of Environmental Impact of Irvine Ranch Water District Discharge on Eutrophication in Newport Bay.** 1998. Provided testimony at hearing.

**Virginia State Water Control Board. Assessment of American Original, Inc. Discharge on Dissolved Oxygen in Parting Creek.** 1991. Prepared Expert Report and provided testimony at hearing.

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## **Selected Presentations**

Establishing Methods for Numeric Nutrient Target-Setting,” webinar presentation given on behalf of the Water Environment and Reuse Foundation. April 14, 2017.

“Examining Alternative TMDL Loading Scenarios with CE-QUAL-W2,” invited presentation at the Spokane River Dissolved Oxygen TMDL Advisory Meeting, Spokane, WA, December 6, 2016.

“Spokane River Regional Toxics Task Force: What’s Been Learned, Challenges and Planning for the Future” invited presentation at the Spokane River Forum Conference, Coeur d’Alene, ID. March 24, 2016.

“Filling the Data Gaps: Looking for PCB Sources in the Spokane River.” Presented at the Spokane River Forum Conference, Coeur d’Alene, ID, November 20, 2014.

“Saginaw Bay, Lake Erie & Truckee River: Adapting to Changing Ecosystems, Watersheds, and Economics.” Presented at the San Francisco Bay Nutrients Symposium Series. October 6, 2014.

“A Review of the Research and Data Needs for Improving Load-Response Models in the WERF Nutrient Modeling Toolbox”. Presented at the Annual Conference and Exposition of the Water Environment Federation, New Orleans, Louisiana, October, 2014.

“Application of Load-Response Models for Establishing Site-Specific Nutrient Goals Based on Water Quality and Biological Response Variables.” Presented at EPRI Environment Sector Winter Advisory Meeting, P53 Water Quality and Watershed Protection. February 24, 2014.

“Water Quality Modeling CE-QUAL-W2, TMDLs and Bioavailability.” Presented at the Biologically Available Phosphorus (BAP) Workshop, Spokane County Resource Center. May 3, 2012.

“Evolution of U.S. Water Pollution Control.” Invited presentation at University of Michigan 2011 Global Sustainability Conference: Developing Global Sustainability - U.S./China Partnerships, Ann Arbor, MI. May 2011.

“Nutrient Impacts of Florida APRICOT Act Discharges: Case Study”. Impaired Waters Symposium 2011, Miami, FL, January 2011.

“Multi-Party Negotiations to Resolve Water Quality Issues”. Invited presentation at the University of Michigan Law School, May, 2010.

“Bringing Science and Policy Together to Address Pollution in the Great Lakes Region” Invited Presentation at Building Clean Water Networks in China: Challenges and Opportunities for Protecting Lake Tai, Nanjing University, January, 2010.

“Development of a Linked Hydrodynamic-Eutrophication Model for the Lake Pepin TMDL. Invited Presentation at the Nanjing Institute of Geography and Limnology of the Chinese Academy of Sciences, January, 2010.

“Use of Models to Identify Critical Source Areas” Key Note Address at the Workshop on Approaches to Identifying Critical Source Areas in the Missisquoi Bay Basin. Lake Champlain Basin Program March, 2009. Burlington, Vermont.

“Multi-Party Negotiations to Resolve Truckee River Water Quality Issues” Invited presentation at the University of Michigan Law School, November, 2008.

“Linking Targets and Sources” Presented at WEF Nutrient TMDL Development Workshop. Alexandria, VA. September 4, 2007.

“Linking Targets and Sources” Presented at WEF Nutrient TMDL Development Workshop. TMDL 2007 Pre-Conference Workshop. Bellevue, WA. June 23, 2007.

“Anacostia Example: Conversion of an Existing ‘Long Term’ TMDL into a Daily TMDL.” Presented at EPA’s Joint Monitoring and 303(d) Program National Training Workshop. Washington, DC. March 14, 2007.

“Wastewater Discharge Issues” Present at Water Law Seminar. Grand Rapids, MI. February 27, 2007.

Implicit Methods for Addressing Model Uncertainty in Support of the TMDL Margin of Safety. Presented at the Water Environment Federation TMDL Sciences 2003, Chicago, Illinois. November 19, 2003.

Adaptation and Calibration of HSPF to Simulate Periphyton in Support of the Truckee River TMDL Presented at TMDL Sciences 2003, Chicago, Illinois. November 19, 2003.

Discharger Led TMDL Study for Findley Lake Watershed, Ohio (How to Get a NPDES Permit for a 303(d) Listed Water When the TMDL is Years Away), presented at the Water Environment Federation 2003 TMDL Sciences Conference, Chicago, IL, November 2003.

“Stormwater and Stormwater Modeling in TMDLs” and “Improved Methods For Calculating the TMDL Margin of Safety”, presented at EPA Region 5 TMDL Training Course, Madison, Wisconsin, August, 2003.

Practical Methods for Calculating the Margin of Safety, presented at the University of California at Santa Barbara Workshop on Determining the Margin of Safety for TMDLs, Santa Barbara, California, August, 2003.

Lake Lanier, Georgia Nutrient Load Analysis. Presented at the Joint International Lake Committee (ILEC) and International Association of Great Lakes Research (IAGLR) Conference. Chicago, IL, June 2003.

Overview of National Research Findings on the TMDL Program. Presented at Ohio Water Environment Association Watershed Management Workshop, Newark, OH, April 2003.

Development of a TMDL for Nutrients and Sediment for Standing Bear Lake. TMDL Sciences and Policy Conference. Phoenix, Arizona. November, 2002.

Narrative Criteria in the TMDL Process. TMDL Sciences and Policy Conference. Phoenix, Arizona. November, 2002.

Improved Methods for Calculating the TMDL Margin of Safety. TMDL Sciences and Policy Conference. Phoenix, Arizona. November, 2002.

Effects of Nutrient Load Reductions on Hypoxia in the Gulf of Mexico. Science to Support Nutrient-Management Decisions Related to Hypoxia in the Northern Gulf of Mexico and Water Quality in the Mississippi River Basin. St. Louis, Missouri. October, 2002.

Improved Methods for Calculating the TMDL Margin of Safety. Presented at the 75th Annual Conference and Exposition of the Water Environment Federation, Chicago, Illinois, September, 2002.

Navigating the TMDL Process: Evaluation and Design. Invited Presentation to the Federal Water Quality Coalition, Washington, D.C., May, 2002.

Critical Evaluation of the TMDL Process, American Society of Engineers TMDL Conference, Fort Worth, Texas, March, 2002.

Application of Bayesian Monte Carlo to Determine the Uncertainty in the Lake Okeechobee Water Quality Model. Watershed, 2002. Fort Lauderdale, Florida. February, 2002.

A Nationwide Look at TMDLs. Invited Presentation to the Second Annual Advanced Conference on TMDLs and The Clean Water Act, Environmental Law Education Center, Portland, Oregon, February, 2002.

Critical Review of the TMDL Program. Invited presentation to the Annual Conference of the California Water Environment Association. Sacramento, California, April, 2001.

Development of the Newport Bay TMDL. Invited Presentation to the EMAP Coastal Symposium 2001, Pensacola, Florida, April, 2001.

Caveats for Modeling in the TMDL Domain. Invited Presentation to the TMDL Sciences Conference, St. Louis, Missouri, March, 2001.

Practical Considerations in TMDL Implementation. Presented at Watershed 2000, Vancouver, British Columbia, July, 2000.

TMDLs at a Cross-Roads: Expeditious vs. Implementable. Invited presentation to the Annual Conference of the California Water Environment Association. Sacramento, California, April, 2000.

Development and Application of a Linked Watershed/Water Quality Model for Evaluating Impacts from Nutrient Loads to Lake Lanier, Georgia. Presented at the 19th International Symposium of the North American Lake Management Society, Reno, Nevada, December 1999.

Local Approaches to Wet Weather TMDLs. Invited presentation to the Annual Conference of the Association of Metropolitan Sewerage Agencies. Philadelphia, Pennsylvania, July, 1999.

Models for Mercury and Other Contaminants in Support of TMDL Development. Presented to the Ohio EPA TMDL External Advisory Group. Reynoldsburg, Ohio, July, 1999.

Current Issues in Contaminated Sediment Modeling. Presented to U.S. EPA Office of Science and Technology. Washington, D.C., April, 1999.

Development and Application of a Linked Watershed/Waterbody Model for the Lake Lanier Watershed. Presented at the SETAC National Conference. Charlotte, North Carolina, November, 1998.

Development of a Probabilistic Depth of Scour Model for PCB-Contaminated Cohesive Sediments in the Hudson River. Presented at the SETAC National Conference. Charlotte, North Carolina, November, 1998.

Applying Watershed Models. Presented at the Summer Conference of the Michigan Association of County Drain Commissioners, July, 1998.

Newport Bay, California Nutrient TMDL Case Study, Presented at the National Wildlife Federation TMDL Implementation Summit, Burlington, Vermont, June, 1998.

Effects of Nutrient Source Reductions in the Mississippi-Atchafalaya Basin on Water Quality in the Gulf of Mexico. Presented at American Society of Limnology and Oceanography Annual Conference, St. Louis, Missouri, June, 1998.

Development and Application of a Linked Watershed/Waterbody Model for the Lake Lanier Watershed Study. Presented at Watershed Environment Federation Specialty Conference on Watersheds, Denver, Colorado, May, 1998.

TMDL Case Studies, What's Worked and What Hasn't: Technical Perspective. Presented at the Chesapeake Water Environment Association Annual Conference, College Park, Maryland, November, 1997.

Modeling Wet Weather Water Quality Impacts on Large Rivers: The Ohio River Demonstration Study. Presented at the Water Environment Federation 70th Annual Conference, Chicago, Illinois, October, 1997.

TMDLs as a Tool for Watershed Development. Presented at Watershed '96, Baltimore, Maryland, June 1996.

Selecting Design Conditions as Part of a Watershed Approach to Water Quality Control, Presented at the North American Water and Environment Congress, American Society of Civil Engineers, 1996.

Conducting Wasteload Allocations in a Watershed Framework: Real World Problems and Solutions, Presented at Watershed '96, Baltimore, Maryland.

Sediment Quality Modeling of Heavy Metals. Presented at Water Environment Federation Specialty Conference on Toxics in the Water Environment, Cincinnati, Ohio, May 1995.

Sediment Quality Modeling in Response to Proposed Sediment Quality Criteria, Presented at the 67th Annual Conference and Exposition of the Water Environment Federation, Chicago, Illinois, October 15-19, 1994.

Field Application of a Steady-State Mass Balance Model for Hydrophobic Organic Chemicals in an Estuarine System. Presented at the First Annual IAWQ Conference on Contaminated Sediments, Milwaukee, Wisconsin, June 1993.

Screening Level Modeling in Support of an Estuarine Toxics Management Program, Presented at ASCE National Conference on Environmental Engineering, Reno, Nevada, July 1991.

Wasteload Allocation, Presented at Water Quality Based Toxics Control: Federal Guidance and State/Discharger Experience Pre-Conference Workshop, 1992 Water Environment Federation Conference, New Orleans, Louisiana, September 20, 1992.

Permit Development. Presented at Water Quality Based Toxics Control: Federal Guidance and State/Discharger Experience Pre-Conference Workshop, 1992 Water Environment Federation Conference, New Orleans, Louisiana, September 20, 1992.

GIS - Water Quality Model Linkage. Presented at ASCE National Conference on Environmental Engineering, Arlington, VA, July 1990.

Model Uncertainty in Predicting Eutrophic Impacts on High Quality Lakes. Presented at North American Lake Management Society Specialty Conference on High Quality Lakes, Bellaire, Michigan, June 1990.

Water Quality Model of Walloon Lake. Presented at National Conference of the North American Lake Management Society, Austin, Texas, November 1989.

Determination of Water Quality Model Uncertainty Using a Bayesian Monte Carlo Techniques. Presented at ASCE National Conference on Environmental Engineering, Austin, Texas, July 1989.

Dilution Modeling to Determine Toxic Impairment in 93 U.S. Estuaries. Presented at 61st Annual Conference - Water Pollution Control Federation, Dallas, Texas, October 1988.

Use and Abuse of Microcomputers in Environmental Engineering. Presented at the Joint National Conference American Society of Civil Engineers/ Canadian Society of Civil Engineers, Vancouver, British Columbia, July 1988.

Development of a Linked Atmospheric/Water Quality Toxics Model, Joint National Conference. Presented at American Chemical Society/Canadian Chemical Society, Toronto, Ontario, June 1988.

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

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

Application of Microcomputers for Uncertainty Analysis Associated with Wastewater Treatment Facilities Planning, R.P. Canale, P.L. Freedman and D.W. Dilks. Presented at the 1st National Conference on Microcomputers in Civil Engineering, ASCE, Florida Section, Orlando, Florida, November 1, 1983.

## Workshop Presentations

"Nutrient TMDL Development Workshop" Water Environment Federation, Alexandria, VA. September 4-5, 2007

"Nutrient TMDL Development Workshop" Water Environment Federation and U.S. EPA. Bellevue, WA. June 23, 2007

"Total Maximum Daily Load Regulation" Michigan Water Law Seminar. Grand Rapids, MI. February 21, 2006.

"It's Time to Start Talking TMDLs" TMDL Informational Seminar. Greenville Soil and Water Conservation District, et. al. Greenville, SC. May 25, 2004.

Truckee River HSPF Training Session. Presented at the request of the cities of Reno and Sparks, Nevada. December 3, 2003, Reno, Nevada.

BASINS Training Course, Sponsored by U.S. EPA Office of Science and Technology, University of Texas, Austin, Texas, April 29 – May 3, 2002.

BASINS Training Course, Sponsored by U.S. EPA Office of Science and Technology, University of Texas, Austin, Texas, March 4-8, 2002.

BASINS Training Course, Sponsored by U.S. EPA Office of Science and Technology, University of Texas, Austin, Texas, November 12-16, 2001.

TMDL Development. Pre-Conference Workshop on Understanding Total Maximum Daily Loads. 7th Annual Industrial Wastes Technical and Regulatory Conference in Charleston, SC. August, 2001.

TMDL Development. Pre-Conference Workshop on Total Maximum Daily Loads. TMDL Sciences Conference, St. Louis, Missouri, March, 2001.

BASINS Training Course, Sponsored by U.S. EPA Office of Science and Technology, University of Texas, Austin, Texas, December 4-8, 2000.

Which Model Should Be Used? Model Selection Approaches. Pre-Conference Workshop on TMDL Development. WEFTEC 2000, Anaheim, CA, October, 2000.

Overview of Modeling Tools and TMDL Trading: Modeling and Technical Considerations. Pre-Conference Workshop on TMDL Development. Watershed 2000, Vancouver, British Columbia, July, 2000.

Total Maximum Daily Loads (TMDL): Current Issues, Oregon Chapter of the Air & Waste Management Association and the Pacific Northwest Pollution Control Association, Portland, OR, March, 2000

BASINS Training Course, Sponsored by U.S. EPA Office of Science and Technology, University of Texas, Austin, Texas, Feb 28 - March 3, 1999

Watershed and Water Quality Modeling in Support of TMDLs, University of Wisconsin TMDL Short Course, San Francisco, California, December, 1999.

Watershed and Water Quality Modeling in Support of TMDLs, University of Wisconsin TMDL Short Course, Madison, Wisconsin, March, 1999.

TMDL Development Pre-Conference Workshop at WEF Watershed Specialty Conference. Denver, Colorado. May, 1998.

Watershed and Water Quality Modeling in Support of TMDLs, University of Wisconsin TMDL Short Course, Madison, Wisconsin, March, 1998.

TMDL Development Pre-Conference Workshop at Watershed '96. Baltimore, Maryland. June, 1996.

Watershed Assessment Pre-Conference Workshop at American Water Works Association Annual Conference. Toronto, Ontario. June, 1996.

Toxics Modeling Pre-Conference Workshop at Water Environment Federation Specialty Conference on Toxics in the Water Environment. Cincinnati, Ohio. May 1995.

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

- Region 10, Seattle, Washington, December 6-8, 1994
- Region 9, San Francisco, California, November 8-10, 1994
- Region 3, Philadelphia, Pennsylvania, August 30-September 1, 1994
- Region 5, Chicago, Illinois, June 28-30, 1994
- 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

Technical Support Document (TSD) for Water Quality-based Toxics Control, Training Seminars:

- Region 6, Dallas, Texas, December 10-12, 1991
- Region 2, New York, New York, November 19-21, 1991
- Region 5, Chicago, Illinois, October 15-17, 1991
- Region 1, Boston, Massachusetts, August 27-29, 1991
- Region 9, San Francisco, California, July 16-18, 1991
- Region 3, Philadelphia, Pennsylvania, May 12-14, 1991
- Region 8, Denver, Colorado, March 17-19, 1992
- Region 6, Kansas City, Missouri, February 11-13, 1992
- Region 4, Atlanta, Georgia, January 14-16, 1992

TMDL/Mixing Zone and Toxics Modeling Workshop, U.S. EPA Exposure and Assessment Division, Office of Water Regulations and Standards:

- Philadelphia, Pennsylvania, May 12-14, 1992
- Bellevue, Washington, April 14-16, 1992
- Denver, Colorado, March 17-19, 1992
- Portland, Oregon, August 13-15, 1991
- Ithaca, New York, August 6-8, 1991

Toxics Modeling Workshops: Including Theory, Approach, Regulations, Model Selection and Use, Calibration/Verification, Sampling, Mixing Zones, Probabilistic Techniques, Estuary Modeling, TMDL/WLA and Permitting, U.S. EPA 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, U.S. EPA 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 DeMours, Wilmington, Delaware, December 5-6, 1989.

Procedures for Water Quality Based Toxic Effluent Limits, U.S. EPA Office of Water Regulations and Standards:

Region 3, Philadelphia, Pennsylvania, 1988

Conventional and Probabilistic Modeling for Toxic Waste Load Allocation, U.S. EPA 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

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, U.S. EPA Assessment and Watershed Division, Office Water Regulations and Standards, Region 2, Atlanta, Georgia, November 28-30, 1989.