Docket No. _____
Exh. TDI-AT-1

# Andrew J. Thuman, PE

Vice President, Water Quality Practice Lead

**Education**
ME Environmental Engineering, Manhattan College, 1990

BE Civil Engineering, Manhattan College, 1988

**Professional Registration**
Professional Engineer: New Jersey

**Professional Affiliations**
Water Environment Federation (WEF)

American Society of Civil Engineers (ASCE)

National Council for Air & Stream Improvement (NCASI)

## Professional Experience

Mr. Thuman has 24 years experience conducting water quality modeling studies in rivers, lakes, estuaries and their associated watersheds. The majority of these projects were completed to develop point source effluent limits (i.e., water quality based effluent limits - WQBEL) as part of NPDES permitting but have also included TMDL development to address nonpoint sources. These efforts have included water quality modeling to assess the impact of point source discharges, determining allowable effluent limits, assisting in negotiating permit limits, providing litigation support as part of permit challenges, and the preparation of technical reports/presentations to support the permitting process.

The water quality modeling frameworks used on these projects range from systems involving pathogen fate and transport; BOD oxidation, nitrification and diurnal algal impacts on steady-state dissolved oxygen (DO) concentrations; to state-of-the-art, time-variable coupled hydrodynamic and water quality models to investigate pathogens and nutrient related eutrophication issues. Mr. Thuman has used the QUAL2E/K, DIURNAL and CE-QUAL-W2 river/lake water quality models to develop wasteload allocations (WLA) as well as more complicated estuarine hydrodynamic and water quality models (EFDC/WASP, ECOM/RCA) as part of TMDL development and facility planning projects. In addition, he has used the following watershed models to address nonpoint sources: HSPF, LSPC and GWLF.

Mr. Thuman has been involved in TMDL development and review in the States of Delaware, Florida, Pennsylvania, New Hampshire, Mississippi, New Jersey, New York, Maine, Washington, Virginia, Georgia, North Carolina, South Carolina, Utah, Minnesota, Wisconsin, Indiana, Montana, California, Connecticut and Puerto Rico. These projects have involved the various aspects of TMDL development ranging from problem identification, source assessment and identification, water quality modeling, TMDL development, documentation and public (stakeholder) participation.

Mr. Thuman also has experience in conducting mixing zone studies and in the application of the initial dilution models CORMIX and Visual PLUMES. These studies included the determination of mixing zones for a variety of toxic pollutants and thermal inputs for existing and proposed discharges as well as for the design of outfall diffusers. He has also been involved in developing field sampling programs, time of travel and reaeration studies in support of water quality modeling projects and has completed compilation, analysis and graphical presentation of riverine and estuarine surface water quality, sediment and hydrodynamic data.

**Alternate Effluent Limits for Wisconsin Electric Power Company Valley Plant (Milwaukee, WI):** *Project Director* for a thermal modeling study to develop alternate effluent temperature limits as part of a successful thermal variance request to the Wisconsin DNR. The hydrothermal model (ECOM) include the Milwaukee, Menomonee and Kinnickinnic River, Milwaukee Harbor and near shore Lake Michigan. The hydrothermal model results were used together with a biothermal assessment to

show protection of representative important species (RIS) and balanced indigenous community (BIC) as part of the thermal variance documentation.

**Thermal Discharge Modeling for Wisconsin Electric Power Company (Lake Michigan, WI):** *Project Director* for a thermal discharge study to investigate the thermal discharges from two power plants (Oak Creek/Elm Road) along the shoreline of Lake Michigan. As part of construction of the second power plant and installation of an offshore intake structure, biological monitoring was required to assess impingement and entrainment requirements as part of the 316 permitting process. The thermal modeling completed was used to guide sampling location selection for the biological monitoring.

**Thermal Discharge Modeling for Great Lakes Cheese Facility, Adams, NY:** *Project Director* for a thermal modeling study of Sandy Creek (trout stream) as part of a SPDES thermal variance request for the thermal discharge from the facility. The time-variable, 2D hydrothermal model MIKE was used to complete the temperature modeling and to develop thermal projections as part of developing alternate effluent temperature limits as part of the thermal variance request to NYSDEC.

**Hydrothermal Model Review and Selection (Niantic Bay/Long Island Sound):** *Project Director* for the review of six hydrothermal models (including MIKE3D), selection of the most appropriate model and development of a modeling workplan for the Dominion Millstone Power Station (CT) as part of the permit requirements with the Connecticut Department of Energy and Environmental Protection.

**Plant Crist Nutrient Discharge Assessment, Pensacola, FL:** *Project Director* for a nutrient discharge assessment to support a beneficial water reuse project between Gulf Power and Emerald Coast Utilities Authority (ECUA). A modeling framework of Escambia Bay was used to complete the nutrient assessment for the proposed nutrient discharge from Plant Crist to the lower Escambia River. Based on the modeling completed and assessment of the proposed GP nutrient discharge options to upper Escambia Bay, water quality impacts was negligible and will have little impact on the biology of the bay, as based on the assessment parameters of chl-a, TN and TP.

**Plant Smith Nutrient Discharge Assessment, Bay County, FL:** *Project Director* for a nutrient discharge assessment to support operation and installation of a selective non-catalytic reduction (SNCR) system at Gulf Power's Plant Smith to more effectively remove nitrogen oxides (NOx) from its atmospheric releases, which results in a nitrogen loading increase from the cooling water discharge to West Bay. A modeling analysis was completed for the assessment and determined that water quality impacts were negligible and have little to no impact on the biology of the bay due to the calculated TN or chl-a increases.

**Discharge Improvement Study (Kankakee River, IL), Exelon:** *Project Director* for a near- and far-field discharge study to investigate options for improving mixing and dilution of the effluent in the river. The near-field model, CORMIX, and far-field model, ECOMSED, were used to investigate whether improvements to the current bank discharge or installation of a multi-port diffuser in the main flow of the river will achieve complete mixing of the effluent with the river.

**AES Company Thermal Discharge Modeling and Permitting Support for Three NY State Plants:** *Project Director* for thermal criteria studies at three AES plants in NY State: Westover (Susquehanna River); Somerset (Lake Ontario); and Cayuga (Cayuga Lake). These studies included thermal field studies, hydrothermal modeling (ECOM), SPDES permitting support and general consulting services. The studies were designed for compliance with NYSDEC thermal and CWA 316(a) regulations.

**Escambia Bay Nutrient TMDL/Criteria Development, Escambia Bay TMDL Coalition, FL:** *Project Director* for the development of a nutrient TMDL and nutrient criteria development efforts in the Escambia/Pensacola Bay system. Upper Escambia Bay was listed by FDEP as nutrient impaired for "historic chlorophyll-a" and, therefore, requiring a TMDL. The initial TMDL completed for the bay was reviewed and comments provided as part of the public comment process. Our comments focused on the specification of the chlorophyll-a target and linkage between nutrient loads and water quality effects in the bay. We completed updates to the existing hydrodynamic (ECOM) and water quality (RCA) modeling system of the Escambia/Pensacola Bay system for use in developing a nutrient TMDL and also assisting FDEP in developing nutrient criteria for the bay as part of their response to EPA nutrient criteria development efforts. Our nutrient criteria development approach focused on nutrient response variables such as available light for seagrass, DO and phytoplankton levels.

**Development of a Coupled Hydrodynamic/Eutrophication Model for Pensacola/ Escambia Bay, International Paper, FL:** *Project Manager* responsible for the development of a time-variable, three-dimensional, coupled hydrodynamic and eutrophication model of Escambia River & Bay, Pensacola Bay, Blackwater Bay and East Bay to assess the impact on water quality due to a proposed nutrient discharge to the Escambia River from a paper mill near Pensacola, FL. The calibrated model was used to assess the impact of the proposed discharge of nutrients on ambient phytoplankton and DO levels. Proposed nutrient discharge levels were established that maintained the designated uses of the proposed receiving waters.

**St. Andrews Bay WQBEL for the St. Andrews WWTF, FL:** *Project Director* for the development of a nutrient WQBEL for the St. Andrews WWTF discharge to the main bay segment. The St. Andrews (SA) wastewater treatment facility (WWTF) is in the process of expanding from an effluent discharge flow of 5 to 10 MGD to accommodate future growth. In order to assess the water quality impacts associated with the increased discharge to St. Andrews Bay, a water quality model was used to determine Water Quality Based Effluent Limitations (WQBEL) through the Level II Process. Although St. Andrews Bay is not on the State 303(d) List of Impaired Waters, West Bay is listed for "historic chlorophyll-a" due to TN and TP. Therefore, the water quality impacts associated with the SA WWTF expansion were also assessed in West Bay. Modeling indicated there would be a negligible impact to DO, nitrogen and chlorophyll-a concentrations within the bay from the expansion of the WWTF.

**Bay County/RockTenn Transparency Study, Panama City, FL:** *Project Director* for a transparency study to assess the impacts of the Bay County Military Point Lagoon treatment system color discharge on ambient light levels in St. Andrews Bay. The Florida DEP transparency standard allows for a 10% change from background ambient light conditions and the St. Andrews Bay hydrodynamic and color model was used to assess compliance with the transparency standard. Field studies were completed to

assess current submerged aquatic vegetation (SAV) health and distribution along with providing data for model calibration. The color model was used to show compliance with the transparency standard at the edge of an allowed mixing zone.

**Lafarge Diffuser Design and Thermal Impact Study, Ravena, NY:** *Project Director* for a diffuser design study related to a new TDS discharge to the Hudson River and the associated SPDES permitting with NYSDEC. In addition, a thermal discharge analysis was completed in Coeyman's Creek (trout stream) to assess the thermal discharge from the facility and SPDES permitting of new and re-located outfalls on the site.

**Thermal Discharge Modeling for Empire Plaza, Albany, NY:** *Project Director* for a thermal discharge study as part of NYSDEC SPDES thermal permitting of the discharge from the Empire Plaza cooling plant. The study involved hydrodynamic modeling (ECOM) of the Hudson River, which is still tidal near Albany. The modeling involved field sampling design, calibration to the collected field data and water quality projections to determine the spatial impact of the thermal discharge under permit discharge conditions. Thermal criteria from NYSDEC require assessment of both maximum temperature and temperature rise above background conditions at critical river conditions (low-flow, summer temperature). The resulting thermal modeling projections were used as part of the facilities SPDES permit renewal application.

**American Sugar Refining Inc. (Domino) Thermal Mixing Zone Study, Yonkers, NY:** *Project Director* responsible for responding to a NYSDEC request for information related to intake and discharge SPDES permitting. This involved gathering existing information and developing a Thermal Study Workplan to gather ambient data for assessing potential thermal impacts associated with the Domino discharge. The Thermal Study included field monitoring and CORMIX initial dilution modeling to assess existing conditions, develop a thermal mixing zone and provide a maximum discharge temperature limit for the facilities SPDES permitting efforts.

**Kinnickinnic River Flushing Tunnel DO Evaluation, Milwaukee Metropolitan Sewerage District (MMSD), Kinnickinnic RIver, WI:** *Project Director* for the DO modeling of the Kinnickinnic River to evaluate the effectiveness of the flushing tunnel operation on maintaining or improving DO levels in the lower Kinnickinnic River. The DO modeling included the effects of planned upstream stream restoration, flushing tunnel rehabilitation and supplemental oxygen injection. The modeling results were combined with biological surveys of the river to recommend the potential options for the District related to the flushing tunnel effectiveness and future management plans for improving DO in the lower Kinnickinnic River.

**Jones Island Non-Contact Cooling Water Discharge Permitting, Milwaukee Metropolitan Sewerage District (MMSD), Kinnickinnic RIver, WI:** *Project Director* for the mixing zone/initial dilution modeling to assess temperature impacts associated with the Jones Island WWTP non-contact cooling water (NCCW) discharge to the lower Kinnickinnic River. The initial dilution model CORMIX was used to assess the mixing and dilution of the NCCW discharge for determining allowable effluent temperature limits that will be in compliance with the WDNR temperature standards at the edge of an allowable mixing zone. The modeling results were used to successfully negotiate acceptable effluent limits for the Jones Island NCCW discharge.

**2020 Facility and Regional Planning Study, Milwaukee Metropolitan Sewerage District (MMSD) and Southeast Wisconsin Regional Planning Commission (SEWRPC), Milwaukee Harbor, WI:** *Project Director* for the 2020 Planning study conducted for MMSD and SEWRPC. HDR|HydroQual's role as a modeling sub-contractor on the study was to apply the existing BSTF hydrodynamic and bacteria models (ECOM/RCA), in addition to developing a eutrophication model, to investigate various facility and regional (watershed) planning activities in the Greater Milwaukee area. These management alternatives included various levels of CSO/SSO control, stormwater BMPs, in addition to agriculture and pasture NPS controls. A unique aspect of the project involved the coupling of upstream watershed models (HSPF and LSPC) to the downstream estuary models (hydrodynamic, bacteria and eutrophication). The upstream watershed models were used to assess the impact of population change, NPS controls and stormwater BMPs. In addition, conveyance system modeling provided CSO/SSO discharge information for various facility upgrades that are planned and proposed. The results of these modeling efforts was the calibration and validation to an 8-year period (1995-2002) and application of the models for water quality projections (production runs) to a 10-year period using 1988-1997 rainfall characteristics. The overall end-product of the 2020 Planning Study was management recommendations for both MMSD facilities and SEWRPC long range planning that is based on water quality impacts as well as other society and economic driven factors.

**Bacteria Source, Transport and Fate (BSTF) Study, Milwaukee Metropolitan Sewerage District (MMSD), Milwaukee Harbor, WI:** *Project Director* for the BSTF Study conducted for MMSD to investigate the role of various bacteria sources on the distribution of fecal coliform in the Milwaukee Harbor system. The water bodies involved are the Milwaukee, Menomonee and Kinnickinnic Rivers, inner/outer harbor and near-shore Lake Michigan. Initially the study was focused on the impact of CSO/SSO discharges from the MMSD conveyance system but also included bacteria sources due to upstream watershed runoff (urban, agriculture, pasture) and municipal WWTPs associated with the City of Milwaukee. The main areas of concern are local beaches and the resultant beach closings due to elevated bacteria levels. To properly analyze fecal coliform distribution in the study area, a hydrodynamic model (ECOM) was developed and calibrated to represent water circulation due to river flow, meteorology (wind), thermal discharges and offshore lake effects (water level changes). The hydrodynamic model was coupled with a bacteria model (RCA) that included loadings of bacteria in addition to the various die-off mechanisms of fecal coliform. The study involved an extensive review of available monitoring data supplied by MMSD and others in addition to the development of bacteria loads from CSO/SSO, WWTP, and upstream sources. Phase 2 of the study utilized the results of bacteria source tracking information and lab die-off studies collected by the Great Lake WATER Institute (GLWI) in addition to the inclusion of local stormwater runoff loads to enhance the modeling effort. Ultimately, the goal was to develop a predictive tool to assist managers in assessing the impacts of storm events on bacteria levels in high priority areas such as local beaches.

**Forge River TMDL, Town of Brookhaven, Long Island, NY:** *Technical Advisor* for a DO TMDL in the Forge River to address the listing of the river on the NYSDEC 303(d) impaired waters list. The TMDL model developed included a hydrodynamic model (ECOM) of the river and Moriches Bay that was coupled to a eutrophication model (RCA) for linking nitrogen loadings to algal growth and ultimately DO. A unique aspect

of the project was the linking of a groundwater model to the river model to provide freshwater flow and groundwater nitrogen loads to the river model.

**James River TP Overflow Assessment and Model GUI, Hampton Roads Sanitation District (HRSD), VA:** *Project Director* for a bacteria transport modeling study to assess the potential impacts at area beaches in the James River from an overflow event at the HRSD James River Treatment Plant (TP). HDR|HydroQual's hydrodynamic model (ECOM) of the James River was refined for the analysis and setup to represent the circulation characteristics of the James River around the time of the overflow event. Results from the study indicated that the overflow event had minimal impact on *enterococcus* levels at area beaches and that levels associated with the overflow event were below VADEQ water quality standards. As a follow-on to the project, HDR|HydroQual is developing a model graphical user interface (GUI) to allow HRSD staff to quickly and easily use the pathogen fate and transport model to assess the water quality impact of overflows throughout the James River study area.

**Mixing Zone and Diffuser Design for the York River TP, HRSD, VA:** *Project Director* for a mixing zone study to establish acute and chronic mixing zones for a new outfall for the York River Treatment Plant (TP). The CORMIX initial dilution model was used to design a multi-port submerged diffuser in the tidal York River following VADEQ regulations and guidelines for mixing zones. The project was completed under a very tight design- build schedule due to the closing of a power plant on the York River where the TP was discharging its effluent into the cooling water discharge canal.

**Mixing Zone and Diffuser Design for the King William and West Point TPs, HRSD, VA:** *Project Director* for two mixing zone studies to establish acute and chronic mixing zones for the existing West Point Treatment Plant (TP) discharge to the Mattaponi River and a new discharge to the Pamunkey River for the King William TP. The initial dilution model CORMIX was used for the dilution analyses with the tidal effects on dilution estimated using the tidal build-up option available in CORMIX. Acute and chronic mixing zones were developed for the existing West Point TP outfall and the newly design King William TP outfall in accordance with VADEQ regulations.

**Initial Dilution Analysis and Diffuser Design for the Army Base TP, HRSD, VA:** *Project Manager* for a diffuser design study for an upgrade of the HRSD Army Base Treatment Plant (TP) outfall from a submerged open-ended pipe (single-port) to a submerged multi-port diffuser. The goal for the outfall upgrade was to provide additional effluent dilution and to develop a acute and chronic mixing zones for the Army Base TP discharge to the Elizabeth River. The PLUMES initial dilution model was used to complete the diffuser design and effluent dilution analyses. In addition, we worked with KCI Technologies in a subsequent effort related to the final design (submerged wye-diffuser) for the Army Base WWTP outfall.

**Ocean Outfall Dilution and Mixing Zone Studies, City and County of Honolulu, HI:** *Project Director* for three mixing zone studies to establish acute and chronic mixing zones for the Honouliuli, Waianae and Kailua WWTP ocean outfalls. The Visual PLUMES initial dilution model was used to calculate effluent dilution under critical ambient and discharge conditions for determining acute and chronic dilution factors for use in NPDES permitting and as part of 301(h) secondary treatment waiver requests/renewals at the three ocean outfalls.

**City of Billings Mixing Zone Study, Montana:** *Project Director* responsible for completing a mixing zone study as a part of MTDEQ permitting of the City of Billings WWTP discharge to the Yellowstone River. Managed the field program design, analysis of data and application of the CORMIX initial dilution model to the field data and determination of site-specific acute and chronic mixing zones for unionized ammonia. Based on the successful application of the CORMIX model to the observed dye study data, it was used to determine final effluent permit limits for the City of Billings WWTP at critical conditions. In addition, this project also entailed developing a TMDL strategy for the City. This TMDL strategy is focused on characterizing water quality in the Yellowstone River below the discharge, reviewing and commenting on a downstream TMDL that MTDEQ is completing, designing and implementing field studies to collect required TMDL data.

**Murderkill River Watershed Nutrient/DO Criteria and TMDL Model Development, Kent County DPW and DNREC, Dover, DE:** *Project Director* for the development of watershed and tidal TMDL water quality models for nutrients and DO for a number of river, pond/lake and tidal estuary segments in the Murderkill River watershed. This new effort was aimed at developing site-specific water quality standards for DO and nutrients as part of a multi-disciplinary team including DNREC, Kent County, HDR|HydroQual, Universities of Delaware and Maryland, Stroud Water Research Center and the USGS. HDR|HydroQual developed models of the watershed (HSPF), tidal river hydrodynamics and water quality (ECOM/RCA) to support this effort. These state-of-the-science modeling tools were supported by an extensive monitoring program that included: tidal salt marsh (nutrient dynamics, temperature, LIDAR), algal production (carbon production), sediment flux (SOD and nutrients) studies; project specific tidal and water quality monitoring; and a working Murderkill River Study Group to provide guidance and local information. As part of the effort, site-specific nutrient and DO criteria were developed along with revisions to the existing TMDL.

**TMDL Studies for Blackbird Creek, Smyrna River, Leipsic River, Littler River, St. Jones and Broadkill River Watersheds, DNREC, DE:** *Project Director* for these approved TMDL projects completed for the Delaware Department of Natural Resources and Environmental Control (DNREC). The projects were completed to develop nutrient, DO and bacteria TMDLs for these six watersheds. As part of these studies, watershed, hydrodynamic and water quality modeling was completed for the ultimate development of TMDLs by the end of 2006. These studies included data analysis (including geographic data from BASINS), watershed (HSPF & LSPC), hydrodynamic (ECOMSED) and water quality (RCA) model development/calibration/validation for a 2-year time period during 2002-2003. Public (stakeholder) meetings were also held throughout the duration of these projects to discuss available data, model development, the TMDL and resulting point source WLAs and nonpoint source LAs.

**Appoquinimink River Watershed TMDL Model Development, DE:** *Project Manager* for the development and expansion of the existing tidal TMDL model for nutrients and DO. HDR|HydroQual was contracted to expand the existing WASP5 hydrodynamic and water quality model of the Appoquinimink River and its tributaries and ponds. The expanded model was used by DNREC to develop TMDLs that included a WLA for Middletown-Odessa-Townsend wastewater treatment plant point source, a load allocation for nonpoint sources and included a margin of safety.

**Opequon Creek Assimilative Capacity Study, VA:** *Project Director* for the Opequon Creek Assimilative Capacity Study whose primary objective was to develop a technically defensible water quality model of Opequon Creek to support subsequent wastewater master planning by the Frederick-Winchester Service Authority (FWSA), County and City. As part of the Opequon Creek Capacity Study, field programs were designed and performed to gather current water quality information in the Opequon Creek watershed in addition to the development of an updated water quality model (DIURNAL) for the creek. Two field surveys of Opequon Creek and major tributaries were completed and an updated water quality model of the creek was used to determine the assimilative capacity of the creek to assist in point source permitting.

**East Canyon Creek TMDL Model Development, Park City, UT:** *Project Director* for development of the East Canyon Creek TMDL model for the Snyderville Basin Water Reclamation District, which operates the East Canyon Water Reclamation Facility. East Canyon Creek provides the primary drainage from the upper East Canyon watershed to the East Canyon Reservoir and is located near Park City. East Canyon Creek has been listed on Utah's 1998 303(d) list of impaired waters for TP and DO from the creek headwaters to the East Canyon Reservoir. As part of the development of the TMDL model, field programs were designed and performed to gather current water quality information in the East Canyon Creek watershed in addition to the development of a water quality model for the creek. A unique aspect of the creek modeling and TMDL was the recommendation of non-traditional implementation strategies to improve DO levels in the creek. These included increased riparian shading, stream channel restoration and flow augmentation in addition to NPS solids control.

**WQBEL for Elevenmile Creek and Perdido Bay, International Paper, FL:** *Project Manager* for developing a WQBEL and associated NPDES permitting support for a paper mill near Pensacola. A QUAL2E model of Elevenmile Creek was calibrated and used to develop effluent limits for the option of maintaining an existing discharge location. The downstream end of the model provided boundary conditions for a WASP eutrophication model of Perdido Bay which was used to evaluate the impacts of wastewater discharge on DO in the bay and considered nutrient induced algal effects, and the effects of CBOD oxidation and $NH_3$ nitrification. These recent studies have included assessing water quality impacts associated with relocation of the discharge along with additional effluent treatment through a natural wetland system. The modeling has also expanded to include a time-variable, 3D model of the Perdido Bay system to assess color impacts associated with the relocated discharge.

**Third Party Nutrient TMDL for the Fenholloway Estuary, FL:** *Project Manager* for a time variable, 3D hydrodynamic/water quality model (ECOM/RCA) of the Fenholloway Estuary and adjacent coastal zone. Initial review of the EFDC/WASP model application indicated model linkage issues and resulted in application of the ECOM/RCA hydrodynamic/water quality model to complete the nutrient TMDL and associated mill discharge permit limits. Involved the continued and successful coordination with USEPA Region 4, FDEP and the discharger.

**St. Andrew Bay, Phase I Hydrodynamic and Water Quality Modeling, FL:** *Project Engineer* involved in the Phase 1 development of a coupled hydrodynamic/water quality model of St. Andrew Bay. The model was used to determine the general

circulation aspects of the bay and to assess the impacts of the Bay County WWTP discharge for WLA development. The water quality model addressed the impacts of DO in the bay due to CBOD oxidation, algal production and respiration.

**A Mixing Zone Analysis for a Proposed Perdido Bay Diffuser, FL:** *Project Engineer* evaluating the mixing associated with various diffuser designs for a proposed wastewater discharge to Perdido Bay. A hydrodynamic model was developed and applied to identify areas of the bay that experienced the greatest mixing. After a site was selected, the CORMIX initial dilution model was used to evaluate the initial dilution for various diffuser designs.

**Mixing Zone Analysis for the Millville WWTP Proposed Diffuser, FL:** *Project Engineer* for completing a mixing zone study for the Millville WWTP proposed submerged diffuser discharge to St. Andrew Bay. The CORMIX model was employed to address the plume dilution of the proposed discharge of effluent metals at critical (low velocity) mixing conditions to meet ambient water quality standards. The impacts of effluent CBOD and nutrients on dissolved oxygen in the bay were determined based on the calculated plume dilutions of the proposed diffuser.

**Review of Proposed USEPA Nutrient Criteria Guidance Documents for AMSA:** The USEPA released separate proposed Nutrient Criteria Guidance documents on Lakes/Reservoirs, Rivers/Streams, and Estuaries/ Coastal Waters during 1999 and 2000. Mr. Thuman completed a technical review of these documents and provided assistance in the preparation of AMSA (now NACWA) comments and in negotiations with the USEPA. Example waterbodies were identified within USEPA eco-regions where the proposed criteria methods appear to produce criteria at odds with the water quality endpoints (e.g., phytoplankton, periphyton biomass, turbidity, and/or DO). This may be due to exogenous or environmental factors other than the nutrients themselves and the review was completed in order to highlight potential problems with the proposed Nutrient Criteria. As an alternative, specific waterbodies were selected for which data existed to estimate the impact that the proposed Nutrient Criteria may have on wastewater treatment and on additional treatment costs. He also investigated the general relationships between biological and nutrient conditions relative to biocriteria values and other accepted biological endpoints.

**Middle River Watershed Water Quality Management Plan, MD:** *Project Manager* for the development of a water quality model of the Middle River near Baltimore, MD. The model was used to assess water quality impacts associated with nonpoint source stormwater pollution, and recommended BMPs for stormwater discharges to the estuarine system. Assisted the County in identifying and evaluating nonpoint source stormwater pollution management measures for the reduction of nonpoint source pollution and water dependent uses in the estuarine system and provided a watershed restoration framework for the County's Capital Improvement Program. The model developed included a three-dimensional hydrodynamic model to determine the estuarine circulation patterns and a water quality model associated with stormwater discharges in the basin for nutrients, suspended sediments and metals.

**Trail Creek Watershed TMDL, IN:** *Project Manager* for the development of an *E. coli* TMDL of Trail Creek, a tributary to Lake Michigan located in northwestern Indiana near Michigan City. This study involved the development of a watershed model (GWLF) and

receiving water quality model (WASP6) for properly representing the sources, fate and transport of *E. coli* in the Trail Creek watershed. Ultimately, these models were used to determine the loads necessary to achieve the water quality standards in the creek. Participated in stakeholder meetings to present and discuss the various components involved in the development of the TMDL.

**San Joaquin River (SJR) DO TMDL Development, Stockton, CA:** *Project Director* for the development of a three-dimensional, water quality model of the SJR and Deep Water Ship Channel (Port of Stockton) to develop DO TMDLs for the California Bay Delta Authority (CBDA). The water quality model consists of an eutrophication model coupled with a sediment flux sub-model capable of analyzing vertical and intra-tidal fluctuations of DO. The coupled sediment flux sub-model provided the ability to assess the impact of algae and organic matter loading on DO levels in the SJR. In addition, upstream water quality projections were completed to assess the effect of upstream flows management and instream DO injection in the DWSC. A web-based post-processor was developed to allow stakeholders access to model output via an interactive GIS-based web browser.

**TMDL Development for the Rio Grande de Loiza and Rio La Plata Watersheds, Puerto Rico:** *Project Director* for TMDL development for PRASA and USEPA Region 2 to support the Watershed Stewardship Program for two watersheds in Puerto Rico to begin the process of studying the causes of water quality impairments and to develop solutions to improve the water quality of Puerto Rico waterbodies. Included in these location specific strategies has been the identification of the water quality problems and sources of these problems, development of water quality models that provide insight into these problems, and their causes and cures. The involvement of the various watershed stakeholders was incorporated as well to ensure that their issues are considered, their support for various strategies garnered, and that a foundation for a lasting support of the program established. The major pollutants of concern in these two watersheds are fecal coliform, total phosphorus related to eutrophication issues in downstream reservoirs, dissolved oxygen (DO) and metals (e.g., copper, selenium).

**Diffuser Design and Mixing Zone Development for the Packaging Corporation of America Discharge to Lake Michigan:** *Project Director* for a diffuser design study to improve mixing and dilution of the mill discharge to Lake Michigan near Filer City, MI. The current outfall is located close to the shoreline and at times causes aesthetic issues associated with effluent color. A new submerged diffuser was designed, located further off-shore, permitted, installed and put into operation to solve the aesthetic issues associated with the effluent color.

**Diffuser Design and Mixing Zone Development for DuPont (Delaware River):** *Project Director* for a diffuser design study to improve mixing and dilution of the discharge in the tidal Delaware River. The current shoreline discharge achieves little mixing and a TIE/TRE study indicated that additional mixing and dilution were required to reduce effluent toxicity in the river. The near-field model, CORMIX, was used to assess various multi-port diffuser configurations so that mixing/dilution were optimized given regulatory mixing zone size constraints. The near-field modeling and mixing zone effort were used as part of NPDES permit negotiations with the regulatory agencies.

**Mixing Zone Study for the Rockwood Pigments Discharge to the Mississippi River, MO:** *Project Manager* for an outfall dilution and mixing zone study to assess the dilution of a surface discharge (above the river surface at low flow) for permitting support. The mixing zone was developed for un-ionized ammonia that included the effects of pH blending and near-field turbulent mixing (CFD modeling).

**Kinnura Bay Diffuser Design and Mixing Zone Study, Japan:** *Project Manager* for the conceptual diffuser design of the relocation of the Pfizer discharge in Kinnura Bay. The diffuser models CORMIX and PLUMES were used to analyze initial mixing for the proposed diffuser. In addition, a far field hydrodynamic model was developed to assess far field mixing and to account for the buildup of effluent constituents in bay water entrained during initial mixing from the diffuser.

**Evaluation of a Mixing Zone Analysis for Papermill Pond, CT:** *Project Engineer* for a study to evaluate compliance with a Connecticut DEP proposed mixing zone for a planned thermal discharge to Papermill Pond. The CORMIX model was successfully calibrated for an existing thermal discharge to Papermill Pond. The CORMIX model was then used to calculate whether the new thermal discharge would produce a delta $40^0$F temperature increase beyond limits of the mixing zone established by CTDEP.

**Evaluation of Recirculation of a Proposed Thermal Discharge Effluent to the Intake Water:** *Project Manager* to compute initial dilution for a proposed thermal discharge from the Iliyan Power Plant in the Philippines. CORMIX was used to calculate temperature increases in the vicinity of the effluent diffuser. The results were incorporated in a far field hydrodynamic model to compute ambient water temperature at the power plant intake.

**Modeling Analysis of a Proposed Thermal Discharge to Gowanus Bay, NY:** *Project Manager* for the evaluation of initial mixing of the thermal discharge for a variety of potential diffuser locations in Gowanus Bay. The CORMIX program was used to compute temperature increases in the vicinity of the proposed diffuser locations. A hydrodynamic model was used to compute far field temperature distributions and the temperature of water that was re-entrained in the vicinity of the diffuser. On the basis of this study, the shortest length of pipe that complied with state temperature criteria was determined.

## Publications and Presentations

Thuman, A.J., C. Fanelli, J. Hallden, R. Isleib, R. Rugabandana and W. Hunley, 2014. James River Overflow Model: GUI Development for Ease of Use. Water Environment Federation Technical Exhibition and Conference.

Thuman, A.J., 2013. An Innovative Approach to 316(a) Thermal Modeling Studies: 316(a) and 316(b) Issues. Electric Power 2013 Conference.

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