Publications

TR-409

North Central Texas Water Quality Final Report

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- Full Text

Tarrant Regional Water District (TRWD) is one of the largest raw water suppliers in Texas, serving about 1.6 million people in ten counties including Fort Worth and the surrounding area. With growing urbanization, the District is expected to serve a projected population of 2.66 million in 2050. TRWD has contracts with 65 cities and is responsible for management of water resources in five major reservoirs in the Trinity basin with a combined storage of 2,384,314 acre feet (ac-ft). These resevoirs are: Bridgeport, Eagle Mountain, Benbrook, Cedar Creek and Richland-Chambers. They have conservation capabilities of 386,420, 190,460, 88,200, 679,200, and 1,135,000 ac-ft respectively.

Average annual precipitation ranges from 28 inches in the northwestern part of the basin to 39 inches in the southeastern portion of the basin. Agricultural land uses dominate the reservoir's watersheds. Soils range from course-textured loamy sands in Cross Timbers area to fine-textured montmorillonitic clays in the Blackland Prairie.

TRWD has been concerned about the recent water quality issues caused by point and nonpoint source pollution sources in the watershed. The District has already initiated efforts to address the water quality issues, developing a water quality monitoring program to collect data for these reservoirs and their associated watersheds. The District has collected water quality data for nearly 40 parameters since 1989.

Effluent discharges from the wastewater treatment plans and nonpoint source pollution from urban and agricultural runoff are reported as the major causes for water quality impairment in the district. Excess nutrient loading to the reservoirs has led to eutrophication, depletion of dissolved oxygen (DO), excess algal growth, and fish tissue contamination. More than 10 river segments in the watershed, including some in reservoirs, are classified under 2000 CWA 303 (d) list for water quality impairment by point and nonpoint sources by the Texas Commission on

Environmental Quality (TCEQ). Examples are: detection of atrazine contamination of water in Richland-Chambers reservoir; depleted DO in and around Bridgeport reservoir, Chambers Creek, and Clear Fork; bacterial counts exceeding standards in Cedar Bayou and Lake Livingston; and chlordane in fish tissue in several river segments. Hence, the District's top priority has been focused on protecting water quality.

The District had made efforts to understand the mechanisms that allow pollutant loads to reach the reservoirs and what hydro-dynamics are taking place within the reservoirs. The District is working with Texas AgriLife Research, through the Spatial Sciences Laboratory (SSL) and Texas Water Resources Institute (TWRI), to develop and use simulation models to identify potential contaminant sources, estimate the potential costs and benefits of best management practices (BMPs) to reduce contaminant loading, and develop plans to improve water quality.

Work conducted through this project was built upon previously conducted work by the project partners in the watersheds of TRWD reservoirs. Exhaustive modeling has been completed in the Cedar Creek watershed and is now under way in the Eagle Mountain and Richland-Chambers watersheds. Previous modeling has resulted in a model that accurately represents conditions in the watershed and is highly capable of predicting the impacts of implementing designed BMPs in the watershed. Coupled with outputs from the modeling effort, an economic analysis has been conducted to evaluate the costs and benefits of implementing various BMPs throughout the Cedar Creek watershed. Educational activities have also focused on engaging local stakeholders and providing materials that are based on modeled outputs about pollutant concerns, impacts of these pollutants, and types of BMPs that address these pollutants in reservoir watersheds. The development of a watershed protection plan for the Cedar Creek watershed has been under development and is a culmination of the modeling, economic analysis, and stakeholder education components of the project. This plan has resulted in a detailed management plan that is tailored specifically to the Cedar Creek watershed and focuses on addressing issues of concern through a voluntary, stakeholder-driven approach.

This project, overall, had four principle components:

- Simulation of the impacts of BMPs on nutrient loading for the watersheds of five major reservoirs in the study area,
- Economic analysis of the cost of implementing the simulated BMPs,
- Educational programs for stakeholders in the watershed, and
- Development of watershed protection plans for the five reservoirs.

First, simulation of current practices and the impacts of BMPs have been conducted by a team lead by Dr. R. Srinivasan, Director of the Texas A&M SSL within the Department of Ecosystems Sciences and Management at Texas A&M University. The team has used SWAT, a physically-based watershed/landscape simulation model developed by the USDA-ARS. Major components of the model include hydrology, weather, erosion, soil temperature, crop growth, nutrients, pesticides, and agricultural management. Additionally, it has the ability to predict changes in sediment, nutrients such as organic and inorganic nitrogen and organic and soluble phosphorus, pesticides, dissolved oxygen, bacteria and algae loadings from different management conditions in large, un-gauged basins. SWAT operates on a daily time step and can be used for long-term simulations. At present, the model output is available in daily, monthly, and annual time scale, although efforts are being made to account for sub-daily time steps. SWAT coding sand subroutines are modular, allowing for addition of new subroutines when necessary.

Model parameters related to (sub) watershed/landscape processes will be adjusted to match the measured and simulated flow, sediment and nutrients key locations in each watershed. All model parameters have been adjusted within literature recommended ranges. After doing so, the model was then validated without adjusting any parameters and a calibration period was chosen. Time series plots and statistical measures such as mean, standard deviation, phosphorus, dissolved coefficient of determination, and Nash-Suttcliffe simulation efficiency were used to evaluate the performance of the models used during calibration and validation.

Another component of this project, led by Dr. Jason Johnson, Associate Professor and Extension Economist for the Texas AgriLife Extension Service, was to conduct a financial and budget analysis to estimate costs and returns by enterprise for alternative best management practices simulated with SWAT. These included a financial analyses, on-site wastewater treatment systems, and urban and agricultural land conservation structures and practices, such as filter strips, gully plugging, terracing, conservation tillage, and fertilizer management. Economic and nutrient loading data have been analyzed to provide TRWD and stakeholder groups with options to reduce nutrient loadings in the study area watersheds .

A team of Texas AgriLife Extension Service educators, led by Justin Mechell, conducted public meetings and targeted educational programs in each of the major reservoirs' watersheds in the project area. They have worked with stakeholders and media to provide appropriate information to the public concerning the past, current, and possible future status of water quality in the watersheds of the major reservoirs used by TRWD. The team closely coordinated its activities with TRWD, the modeling and economics teams, and County Extension Agents throughout the region. County Extension Agents have provided contact with stakeholders, opinion leaders, and the general public for counties in the five major reservoirs' watersheds.

TWRI has been responsible for overall administration of the program, including annual proposal development, report preparation, and administrative and fiscal coordination with Texas AgriLife Research and Extension and USDA-NRCS.

A team led by Mr. Clint Wolfe of the Texas AgriLife Research and Extension Urban Solutions Center has assisted the economic and Extension education teams, as well as worked with stakeholders to develop watershed protection plans for TRWD reservoirs.

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TWRI and the Texas A&M Institute of Renewable Natural Resources are working together to foster and communicate research and educational outreach programs focused on water and natural resources science and management issues in Texas and beyond.

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