

Evaluating Water Quality Best Management Practices for Reservoirs in North Central Texas

Texas Water Resources Institute
FY 03 Federal Appropriated Funds
Project # X7-9764801-0

Quarter no. 9 From 10/8/05 Through 1/7/06

Progress in Meeting Project Milestones and Output Commitments

Task, Deliverables and Schedules

The Texas Water Resources Institute (TWRI) along with the Texas A&M University Spatial Sciences Laboratory (SSL), Alan Plummer Associates, Inc. (APAI) and Espey Consultants, Inc. (EC) have been diligently working to complete project deliverables. Project efforts during the ninth quarter focused on modeling activities. The SSL and EC have collaborated on efforts to interact SWAT, QUAL2E and WASP models to predict nutrient and sediment loadings of Cedar Creek and Eagle Mountain Watersheds. SWAT, QUAL2E and WASP have successfully been integrated. APAI has begun collecting data from wastewater treatment plants within Richland Chambers Watershed and will begin inputting this data into an Access database. TWRI continues to update its Web site containing water quality information, specifically related to project efforts, for scientists and the general public, and sponsored a Watershed Management Training in North Central Texas.

In looking forward to the next quarter, work will continue as it relates to running BMP scenarios through SWAT seeking a 30 to 40 percent reduction in loadings. Making BMP scenario runs through the newly developed SWAT/QUAL2E/WASP model and computing the economic cost associated with these BMPs will be the focus of the tenth quarter as well as modeling activities for Eagle Mountain Reservoir Watershed. Additionally, work will continue of developing a draft of the watershed protection plan for Cedar Creek watershed. The process will begin to gather stakeholder input for the watershed plan. The watershed protection plan will include EPA's nine elements. Work associated with Eagle Mountain Reservoir modeling activities will continue.

The status of tasks, milestones and deliverables will be defined using the following terms:

Pending	Work has not started on the deliverable
Initiated	Work has started
Completed	Objectives were achieved and deliverables are finished
Deferred	Work has started, but further action is delayed pending other information, the completion of another objective, staff restraints, etc.
Ongoing	Work will continue throughout the term of the contract

Task 1 SWAT Modeling

Due Date	Status	Deliverables
1/1/04	Completed	1. Complete model calibration and validation for Cedar Creek
4/1/04	Initiated	2. Development of Watershed databases
10/1/04	Initiated	3. Development and Evaluation of Different BMP strategies for Cedar Creek Watershed
1/1/05	Initiated	4. Model calibration and validation for Eagle Mountain Watershed
9/1/05	Pending	5. Development and evaluation of different BMP strategies for Eagle Mountain Watershed
9/1/05	Initiated	6. Development of ArcGIS/ArcHydro interface for SWAT and WASP
9/1/05	Pending	7. Development of interface for using NEXRAD weather information for SWAT
7/1/06	Pending	8. Model calibration and validation for Richland Chambers Watershed
10/1/06	Pending	9. Development and evaluation of different BMP strategies for Richland Chambers Watershed

Comments:

- The Spatial Sciences Lab (SSL), in cooperation with Blackland Agricultural Research and Extension Center, has completed the validation and calibration of the SWAT model for Cedar Creek Watershed. This deliverable is 100 percent complete.
- SSL has been in contact with state and federal agencies (TCEQ, TRWD, NRCS and USGS) to obtain GIS data for the watershed database. The Access database, once complete, will contain information on land use, soils, elevation, weather and watershed delineation data. This deliverable is currently 90 percent complete.
- The research team has identified BMPs which will be beneficial in reducing loadings in stream segments and Cedar Creek Reservoir. SWAT runs have been made to get estimates as to the type of reservoir loadings (point or non point sources) and sources of contamination (stream segments, tributary flow or resuspension of reservoir sediments). These model runs have helped focus BMP selection.
- The research team has begun to run BMP scenarios through the SWAT/QUAL2E/WASP model to look at plausible BMPs to implement and at which locations, as well as the overall reduction these BMPs will have on nutrient and sediment loading into Cedar Creek Reservoir. This deliverable is 75 percent complete.
- SSL has collected water quality data and weather station data for Eagle Mountain Reservoir. Basins and sub-basins have been delineated for the SWAT model and the process is under way to calibrate and validate the model. The SWAT model has been calibrated for flow at this time. Water quality parameters are being evaluated.

Task 2 In-Stream and Reservoir Modeling

Due Date	Status	Deliverables
4/1/04	Completed	1. Development of In-stream modeling (QUAL2E) for Cedar Creek Watershed
10/1/04	Completed	2. Development of Reservoir Modeling (WASP) for Cedar Creek Reservoir
10/1/04	Initiated	3. Development and Evaluation of Different BMP strategies for Cedar Creek Reservoir
1/1/05	Initiated	4. Data Collection for Reservoir Modeling (WASP) for Eagle Mountain
7/1/05	Initiated	5. Development of Reservoir Modeling (WASP) for Eagle Mountain Watershed
9/1/05	Pending	6. Development and Evaluation of Different BMP strategies for Eagle Mountain Watershed
7/1/06	Pending	7. Assist TRWD in development of In-stream modeling (QUAL2E) for Richland Chambers Watershed
7/1/06	Pending	8. Development of Reservoir Modeling (WASP) for Richland Chambers Reservoir
10/1/06	Pending	9. Development and Evaluation of Different BMP strategies for Richland Chambers Watershed

Comments:

- QUAL2E modeling has been completed and coefficients have been submitted to the SWAT modeling team. This deliverable is 100 percent complete.
- EC completed its work on the Cedar Creek WASP postprocessor, and input data related to nutrient kinetics and sediment sources of nutrients were finalized. The Cedar Creek WASP model has been validated and calibrated. This deliverable is 100 percent complete.
- The research team has begun to identify specific BMPs, which will be beneficial in reducing nutrient loadings in stream segments and Cedar Creek Reservoir. A technical memo with regard to BMP suggestions is in the process of being completed. Preliminary results show a necessary reduction of nutrients entering the reservoir to be within the 30-40 percent range in order to effectively reduce chlorophyll a concentrations within Cedar Creek Reservoir.
- EC has begun collecting data and delineating Eagle Mountain Reservoir segments for WASP modeling. The group is working on the reservoir's mass balance calibration for modeling runs. This task is 25 percent complete.

Task 3 Study of Wastewater Treatment Plants

Due Date	Status	Deliverables
7/1/04	Completed	1. Development of a Database for Wastewater Treatment Plants in Cedar Creek and Eagle Mountain Watersheds
10/1/04	Completed	2. Assessment of Impact of Wastewater Treatment Plants (point source discharges) for Cedar Creek and Eagle Mountain Reservoirs
4/1/05	Initiated	3. Development of a Database for Wastewater Treatment Plants in the Richland-Chambers Watershed
7/1/05	Initiated	4. Assessment of Impact of Wastewater Treatment Plants (point source discharge) for Richland-Chambers Reservoir
4/1/06	Pending	5. Development of a Database for Wastewater Treatment Plants in the Benbrook Watershed
7/1/06	Pending	6. Develop information on biosolid disposal areas in the Benbrook Reservoir watershed

Comments:

- The wastewater treatment database is complete with information from both Cedar Creek and Eagle Mountain Reservoirs. This deliverable is 100 percent complete.
- APAI has developed a database containing all wastewater treatment plants in the Cedar Creek and Eagle Mountain Watersheds. Data contained in these databases include process diagrams of plant's current capacity, as well as diagrams of future upgrades that could be made to make the plant more efficient and to meet operating demands. Also included in the database is information regarding operating capacity, permit information, quality of discharged effluent, fate of released effluent and proximity to water bodies. Cost estimates for all process recommendations are included. This deliverable is 100 percent complete.
- APAI has developed a flow balance program that provides modeling capability within the WASP model that is more compatible with current modeling employed using SWAT model. APAI incorporated the previously developed internal flow balance program into an Access application capable of managing extensive historical flow data and SWAT model output. The group structured the visual basic program to accommodate user-defined time periods, as small as one day (previously set up on a monthly time period), and developed input data for Eagle Mountain Reservoir. This deliverable is 100 percent complete.
- APAI, working with TRWD, has identified all wastewater treatment plants permitted to discharge waste into Richland Chambers Watershed. APAI has begun to collect general data on all wastewater treatment plants for the database, but will only do further analysis on those whose discharge flows into Richland Chambers Reservoir. They include: Corsicana - both plants; Walden Woods (direct discharge); Pelican Isle (direct discharge); Dawson (Richland Creek) and; Ennis (Chambers Creek). This deliverable is 65 percent complete.

Task 4 Administration

Due Date	Status	Deliverables
1/5/04	Completed	1. Write QAPP
1/7/04	Completed	2. Quarterly Progress Reports
4/7/04	Completed	
7/7/04	Completed	
10/7/04	Completed	
1/7/05	Completed	
4/7/05	Completed	
7/7/05	Completed	
10/7/05	Completed	
1/7/06	Completed	
4/7/06	Ongoing	
7/7/06	Ongoing	
10/7/06	Ongoing	3. Final Report

Comments:

- TWRI continually updates the Web site created specifically for the North Central Texas Water Quality Project. The Web site can be accessed at the following address: <http://nctx-water.tamu.edu>
- The North Central Texas Watershed Management Training was held on November 17-18, 2005. The event had over 115 participants. Evaluation results for the conference show that participants gained a better understanding of water quality issues and management strategies.
- TWRI project manager is working to update the project QAPP.
- On January 5, 2006, project participants met at the Blackland Agricultural Research and Extension Center in Temple, TX to discuss project deliverables and outcomes to date.

Problems or Obstacles Encountered and Remedial Actions Taken

The Spatial Sciences Laboratory and Blackland Agricultural Research and Extension Center have been working closely with Texas Water Resources Institute (TWRI) towards successful completion of project deliverables. Significant progress has been made in modeling Cedar Creek and Eagle Mountain Watersheds. For the Cedar Creek watershed, hydrology calibration and validation is 100 percent complete, and for Eagle Mountain watershed, hydrology calibration and validation is about 90 percent complete. Efforts continue to complete the calibration during the low-flow periods for Eagle Mountain watershed.

Originally, calibrations for sediment and water quality in the Cedar Creek watershed were completed using SWAT and QUAL2E. However, a few shortcomings of the SWAT model were identified and needed correcting. They are as follows: 1) Overestimation of flow velocity in small sub-watershed downstream of two intersecting big watersheds, 2) Overestimation of stream bank erosion at these small watersheds due to high flow velocity, and 3) Sediment mass balance errors due to stream channel erosion. These problems were identified when the model results for Cedar Creek were spatially mapped to look at the spatial distribution of sediment and nutrient loading to the watershed.

These shortcomings of the model were fixed immediately. The hydrology calibration and validation of Cedar Creek was not affected due to this error. However, the model was predicting less sediment erosion than the measured sediment erosion of 45 million tons during a 30 year period (1965-1994). The 45 million ton estimate is based on the 1995 volumetric lake survey conducted by the Texas Water Development Board (TWDB). This averages to approximately 1.5 million tons of sediment erosion per year and the model prediction was only 1 million tons of sediment erosion per year. Of the 1 million tons, close to 0.45 million tons are predicted to come from stream channel erosion every year.

Field visits and observations also showed considerable channel erosion in some portions of the watershed. Hence, the sediment calibration was put on hold until TWDB conducted another volumetric survey in Cedar Creek Reservoir during the Summer 2005. The results of this study showed surprisingly more lake volume than the 1995 survey, which means less volume loss due to sediment erosion than was estimated in the 1995 survey. TWDB survey only provides the volume loss of the lake due to sedimentation. In order to estimate the mass from this volume, a density of 50 lbs/ft³ is currently assumed for the sediment. However, the sediment density estimate is very uncertain which could lead to errors in quantifying erosion. Hence, we are working with sediment and geology experts at Baylor University to conduct field and watershed surveys to estimate sediment density. The group will use historical air photo analysis to identify the time and locations of erosion. This field study will be conducted during the December 2005 to January 2006 time frame. The information gathered from the field and watershed survey will be of immense use to the extensive modeling efforts of this project and to verify model outputs.

As explained above, sediment from channel erosion is a significant portion (45 percent) of the total erosion in the watershed. However, sediment from the stream channel was assumed not to contribute to the nutrient load of the stream and was not part of the SWAT modeling algorithm. This assumption was viewed as a shortcoming of the model and hence a modeling component was added to SWAT to model nutrient loadings from stream channel erosion. Given that there was no stream bank sediment data available relating to the estimate of nutrient concentrations within the watershed, a field campaign was undertaken by Texas Cooperative Extension Specialists to collect stream bank soil samples and analyze them for Nitrate, Organic N, Organic P, and Labile P. Soil samples were also collected from various land uses and are currently being analyzed for these nutrient concentrations. These nutrient concentrations will be compared with model default values and used to initialize the model. A similar field campaign has been done in the Eagle Mountain Watershed.

The lake and watershed sediment survey and the soil survey was not originally foreseen and planned for this study. However, as the study progressed, modeling issues and discrepancies in lake volumetric results warranted these field surveys to improve the model and increase the confidence in model results. The goal is to have the most accurate information possible to use in developing a scientifically sound watershed protection plan. EPA Project funds were not used to pay for this additional work.

Work Planned for Next Quarter

Task 1: SWAT Modeling

Finalize inputting data for the watershed database. Continue running the SWAT/QUAL2E/WASP model using select BMP scenarios and looking at total load reductions within the reservoir. Finalize which BMP strategies are most effective and least costly at reducing nutrient, sediment and pollutant loadings into Cedar Creek Reservoir. Continue model calibration and validation for Eagle Mountain Reservoir.

Task 2: In-Stream and Reservoir Modeling

Initiate development and integration of WASP reservoir model for Eagle Mountain Reservoir.

Task 3: Study of Wastewater Treatment Plants

Continue evaluating impacts that wastewater treatment plants and their discharges have on water quality of Richland Chambers Reservoir.

Task 4: Administration

Continue working with TRWD, SSL, EC and APAI in moving forward with project deliverables and reporting progress on a quarterly basis. Efforts will be made to publicize the project and raise awareness of water quality issues within the study area. Furthermore, TWRI will work to secure additional funding for this project above the additional federally appropriated funds received in FY 06. TWRI will work with TAES contracts and grants to allocate funds to cooperating entities.

Additional funds currently used to support project activities include federally appropriated monies from USDA-NRCS to conduct economic analysis of BMP scenarios at reducing loadings in North Central Texas Watersheds and to develop educational program materials on watershed management.