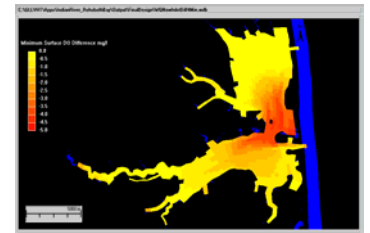


Combined 1- and 3-D Modeling for TMDL Studies

Delaware Department of Natural Resources and Environmental Control, Indian River Estuary, Delaware



Situation

The Inland Bays of southern Delaware, comprised of Rehoboth Bay, Indian River and Bay, and Little Assawoman Bay, have historically been subject to periods of eutrophication due to excessive levels of nitrogen and phosphorus. Establishment of Total Maximum Discharge Loads (TMDLs) for these nutrients was required in order to prevent future exceedances of the water quality criteria. Sophisticated modeling was required to integrate non-point source runoff modeling with 3-D water quality modeling, as well as to include Little Assawoman Bay and the surrounding rivers and ponds to form a unified modeling analysis

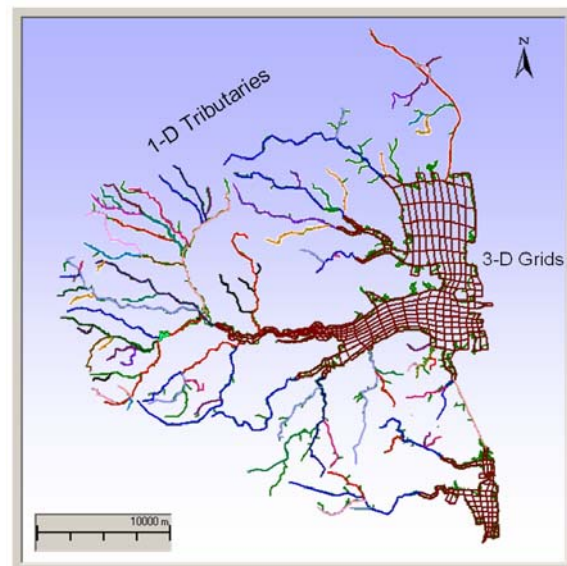
Approach

Partnered with ENTRIX, Inc., ERM constructed for the Delaware Department of Natural Resources and Environmental Control (DNREC) a combined 3- and 1-D hydrodynamic and water quality model, GEMSS® (Generalized Environmental Modeling for Surfacewater Systems). This TMDL study expanded a previous flushing study model by incorporating the surrounding tributaries and ponds within the Inland Bays watershed and forging a link with Little Assawoman via the Little Assawoman Canal.

The TMDL study region consisted of the three major water bodies, five ponds, and 19 river networks each with up to ten tributaries, all listed as impaired waters under Section 303(d) of the Clean Water Act for nutrients or dissolved oxygen. The combined modeling system accepted watershed model outputs from HSPF as time varying non-point source nutrient loadings in the rivers, based upon the

surrounding land use.

The model application was calibrated for 1998 and 1999 then verified for 2000 using a composite database. Calibration and verification included comparisons of spatial and temporal velocities for hydrodynamics, salinity and temperature for transport and 14 constituents for the water quality.



Results

The model results were used to validate TMDL load recommendations, and then establish new TMDLs for the Little Assawoman Bay watersheds. The analysis and the resulting recommended load reductions for each watershed were accepted by the State, and presented at a technical workshop and a public hearing in 2004.