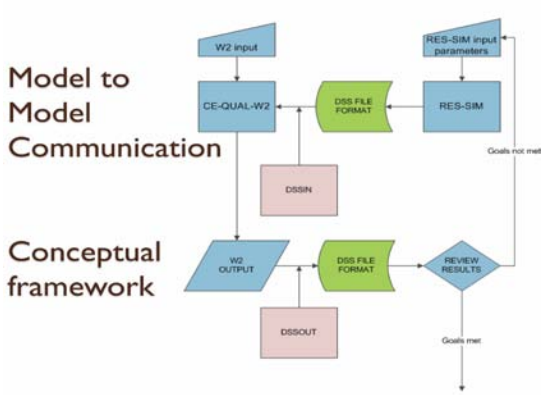
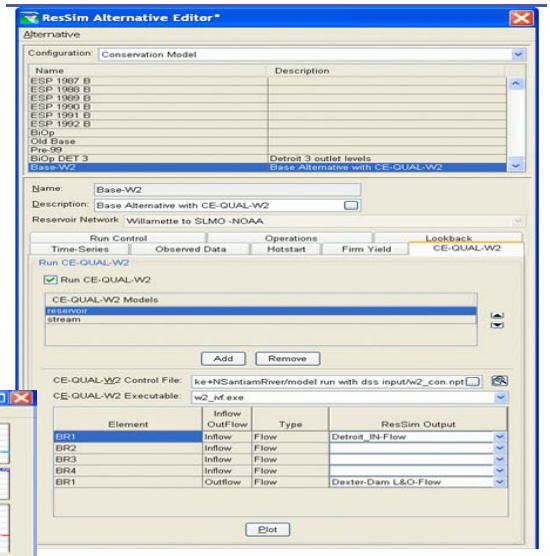
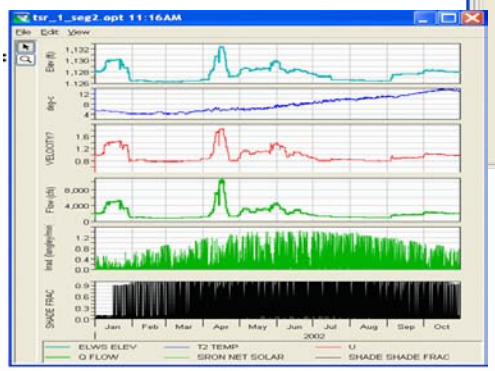
System-Wide Water SWWRP Resources Program

Hydrologic Engineering Center-Reservoir Simulation-W2 (ResSim-W2)

Description: A coupled analysis system is being proposed that combines the water quality simulation strengths of the Corps of Engineers-Water Quality (CE-QUAL)-W2 numerical model with the management strengths of the Hydrologic Engineering Center-Reservoir Simulation (HEC-ResSim) operations model. CE-QUAL-W2 is a water quality and hydrodynamic model in two-dimensional (2-D) (longitudinal-vertical) for rivers, estuaries, lakes, reservoirs, and river basin systems. W2 models basic eutrophication processes such as temperature-nutrient-algae-dissolved oxygen-organic matter and sediment relationships. HEC-ResSim is a rule based simulation program that manages reservoir operations to achieve specific flow, pool elevation, or power goals. By combining these two programs, a more complete operational scenario can be simulated so that additional environmental parameters such as temperature, dissolved oxygen, and phosphorous can be taken into account. The first phase, sequential simulation, will link W2 and ResSim such that the two models run independently in the following sequence (Figure 1): 1) First ResSim simulates a set of reservoir releases 2) then by turning on the W2 simulation within the ResSim alternative editor environment (Figure 2) the releases are prepared for use in W2, and finally 3) W2 uses the release data and simulates the water quality conditions (Figure 3) resulting from the operational decisions of ResSim.







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HEC-ResSim-W2

Application: To test the integration of the two models, common sites where both models have been applied were identified. Test sites identified were sites having varying system complexities (e.g., river system – reservoir –river system). These sites included: Savannah River model, GA; Shasta Reservoir, CA; Cougar on the Willamette, OR; Cumberland, KY; Millerton Lake, CA; Detroit on the Willamette, OR. Two test demonstrations (Demos) have been simulated for Detroit on the Willamette and Lake Lanier on the Apalachicola-Chattahoochee-Flint (ACF) system in Georgia and Alabama. The Detroit Lake Demo will be expanded to include three nearby reservoirs and riverine sections to increase the complexity of the system.

Benefits: There is an increasing demand to include water quality operating objectives for real-time water management as well as planning studies. The districts want to model the physical, chemical, and biological characteristics of water, and to include the impact of water quality in reservoir system decision-making. It is beneficial to integrate the capabilities of these models so the user community can use the models to evaluate a full suite of objectives in a coordinated fashion to perform near real-time operations and multi-objective planning studies.

Data Requirements: Any successful application of the W2 requires many different types of data. These data are grouped as follows: initial conditions, which include bathymetry, water-surface elevation, temperature, and water quality constituents; boundary conditions, which include inflow/outflow, temperature, water quality, and meteorology; and in-pool conditions, which include temperature, water quality, and water-surface elevations. These data are used to set initial conditions at the beginning of a simulation and provide time-varying updates that drive the model during the simulation. In addition to these data, other data such as outlet descriptions, tributary and withdrawal locations are also required to complete the physical description of the prototype. In-pool (reservoir/lake/river) data including observed water-surface elevations, temperatures, and constituent concentrations are also required during model calibration to assess model performance. Distinction needs to be made regarding the different data types required for calibration. In-pool data have no effect on model performance in that they are only used in assessing model performance. Initial and boundary conditions are of greater importance because they directly affect model performance. For most studies, boundary conditions are rarely collected at a frequency most modelers deem sufficient to accurately describe the forcing functions responsible for the temperature and water quality conditions observed at a project.

Future Capabilities: Future development will link W2 and ResSim such that the two models exchange information iteratively during the simulation. Preliminary design discussions call for a tighter integration of the modeling tool within the ResSim compute engine. This would be based on 1) a user defined time period to check if criteria goals are met, 2) activation of the W2 decision making algorithm to determine new distribution of releases and feed back to ResSim, 3) enhancement of the W2 parser, DSSIN, DSSOUT plug-ins, and (4) refining the W2 model restart capabilities so that there can be tightly-coupled interaction with ResSim in running through multiple forecasting scenarios. Forecasted inflows and meteorological data would be required by both models (ResSim and W2) for the full simulation period, which allows the models to manage releases for a water quality resource or contaminant in accordance with objectives set by the user.

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