Memorandum

To: Chatfield Watershed Authority Board

From: Dan DeLaughter, Leonard Rice Engineers, Inc.
Graeme Aggett, Lynker Technologies, LLC

Date: September 11, 2015

Project: Chatfield Watershed Model

Subject: Model Selection Recommendation

Chatfield Watershed Model Selection Recommendation

This memorandum summarizes the recommendation of Leonard Rice Engineers, Inc. and Lynker Technologies, LLC, for the modeling platform for the Chatfield Watershed Model, including the basis for the recommendation. **The final recommendation to the Chatfield Watershed Authority is use of the HSPF Model.**

Background

The Chatfield Watershed Authority (CWA) requires the development of a non-proprietary watershed model to help determine nutrient loading, particularly phosphorus, from the watershed to Chatfield Reservoir. To select an appropriate model for this project, the modeling team researched in detail a comprehensive array of watershed models in order to narrow down the possibilities and finally to recommend the best model for the project.

Hydrologic and water quality models are commonly divided by their structural, spatial, and temporal framework as listed below. This project focused on deterministic, semi-distributed, continuous models for application to the Chatfield watershed.

Model Selection Overview

Ten watershed models were reviewed for modeling of the Chatfield watershed (AGNPS, GWLF-E/Mapshed, HEC-HMS, HSPF, LSPC, N-SPECT, PLOAD, SWMM, SWAT, and WARMF). This list was quickly reduced to the three best candidate models which were determined to be HSPF, SWAT, and WARMF (Figure 1).

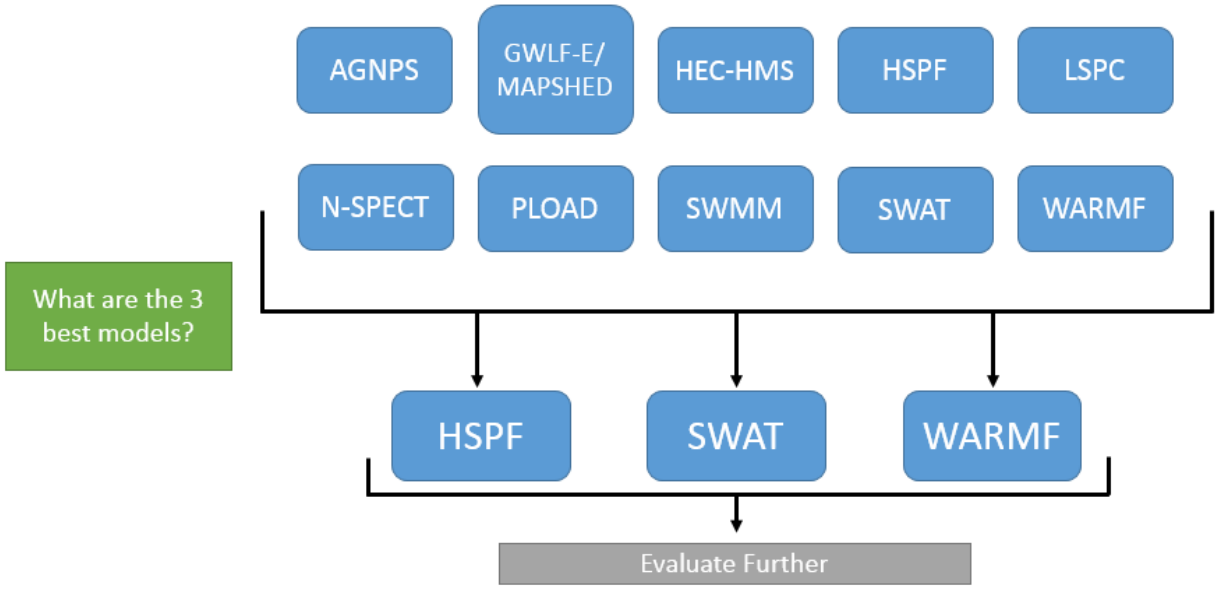

Figure 1: Initial Model Selection

After careful review of the modeling documentation it was determined that the HSPF and SWAT models offered a level of increased functionality over the WARMF model. This was particularly clear when the final use of the model output was considered; the CWA needs to be able to analyze phosphorus output at a level of detail beyond the subwatershed. HSPF and SWAT provide model output that can be analyzed by subwatershed, HRU and ultimately traced to the land use types whereas WARMF does not (Figure 2).

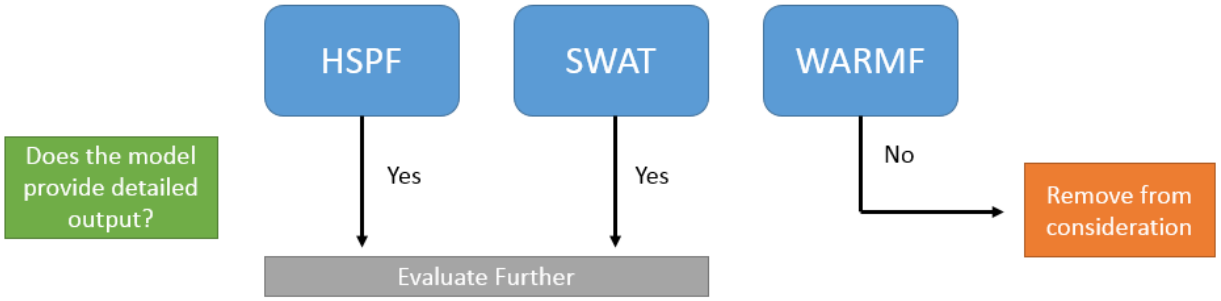

Figure 2: Model Refinement

The final model selection between HSPF and SWAT was predominantly decided by the in-stream portion of the model (***reach module***) rather than the land-based portion of the model (***watershed module)***. Although SWAT has an in-stream module, transport and transformation of nutrients is decoupled from the sediment transport module. The SWAT in-stream modeling structure is not as strong as the in-stream module with the HSPF model. The final model recommended for use in the Chatfield watershed project is HSPF (Figure 3).

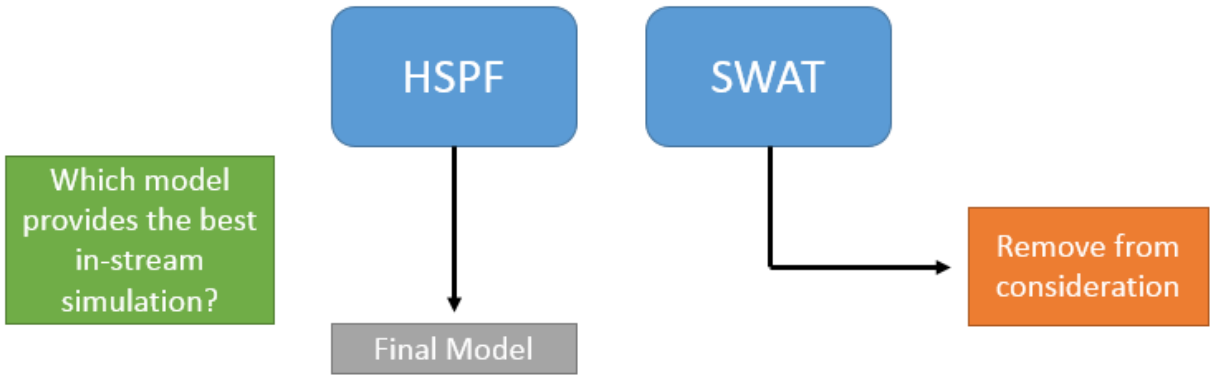

Figure 3: Final Model Determination

Final Recommendation - HSPF

HSPF is a widely used watershed model that is commonly applied to TMDL related studies throughout the Unites States. The model is perhaps best known for its application to Chesapeake Bay water quality issues. HSPF was recommended to the CWA over other watershed models including SWAT and WARMF because it provides the most complete physical representation of a watershed. This includes simulation of land-based hydrologic processes (e.g., infiltration, runoff, sediment mobilization), land-based nutrient processes (e.g., plant uptake, fertilizer application, adsorption to sediment) as well as channel-based (in-stream) nutrient processes (e.g., advection with sediment, deposition, algae uptake).

The model has three main components, PERLND for pervious areas, IMPLND for impervious areas, and RCHRES for stream channels. Within the watershed (PERLND and IMPLND) and channel (RCHRES), HSPF proficiently models hydrologic and water quality processes. Nutrient constituents modeled within HSPF include total phosphorus and orthophosphorus as well as nitrate, nitrite, ammonium, and total nitrogen. HPSF properly accounts for soluble and sediment-bound nutrients transported across the land surface as well as dissolved and adsorbed fractions transported within the channel.

HSPF's modeling routines were determined to provide the CWA with the best potential model for quantifying nutrient loading within the watershed. The model will be built, calibrated, and validated to existing data collected as a part of this project; however, it will also be able to be updated as additional data are collected and best management practices (BMPs) are put into place. In the future, the model outputs can be linked to a reservoir model to determine nutrient processes within Chatfield Reservoir. HSPF will provide the CWA with a tool that will help answer important management questions within the Chatfield watershed now and in the future.