



Hydrologic Evaluation of Berlin Pond

City of Montpelier, Vermont

In 2003, the City of Montpelier, Vermont, hired Stone to investigate the capacity of its water supply reservoir, Berlin Pond, to meet water customers' needs in the decades to come. This seemingly simple question was complicated by several factors:

- The climate appears to be changing, affecting precipitation inputs and evapotranspiration rates.
- Competing uses of the pond (it is a highly visited natural area) restrict permitted drawdown levels.
- The serviced population, hence the withdrawal rate, is growing.
- The pond's outflow may need to be reconfigured to ensure minimum downstream flows are sustained.

Stone conducted a hydrologic analysis to evaluate the effect of varying water withdrawal rates on pond levels under different climate conditions. We developed a water balance model of the pond, the Berlin Pond Hydrologic Model, to perform these estimations, using the Soil and Water Assessment Tool (SWAT) modeling environment.



Berlin Pond is the water supply reservoir for Montpelier, Vermont's capital city.

A great deal of data is required to create a sophisticated, realistic hydrologic model with which one can perform meaningful simulations. We brought together 12 types of primary data, including spatial data (stream network, land use, soils, watershed topography, pond bathymetry), historic weather data (30-plus years of daily records); historic pond levels; daily water withdrawal totals; and flow data at the pond outlet. We estimated daily outflows from pond level readings based on a rating we developed through simultaneous measurements of stream flow and pond stage. The model was calibrated against the observed pond level data.

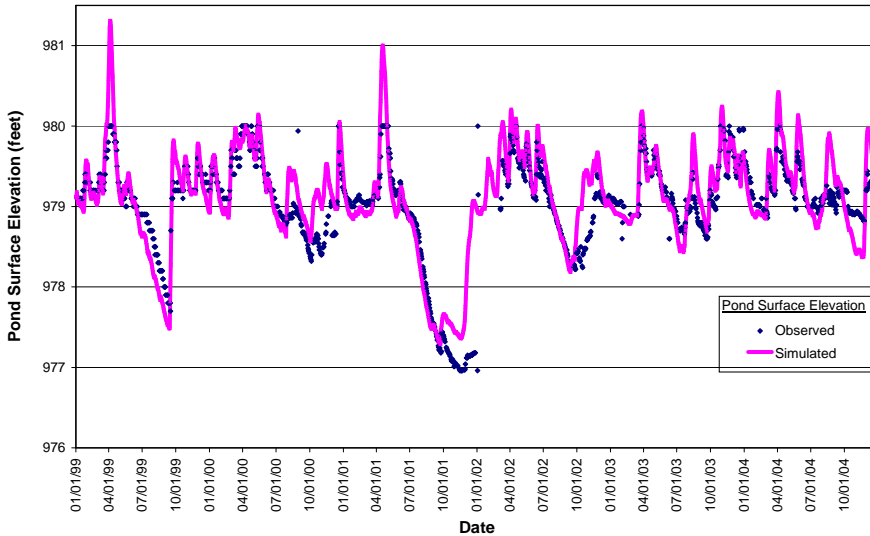
Climate conditions in 2050 were projected for the Berlin Pond watershed based on output from the Hadley Global Climate Change model (GCM). Average monthly minimum and maximum temperatures and precipitation totals were extracted from the model for the period 2045-2055. Seasonal departures from current climate conditions were calculated and the 1975-2004 daily weather data time series was adjusted to be used as the model input.

The Berlin Pond Hydrologic Model is a powerful predictive tool, capable of estimating continuous pond water levels under different combinations of withdrawal rates, weather conditions, and downstream flow requirements. As an example, we determined that at the current average withdrawal rate of 1.43 million gallons per day, there is a 40% probability that the water level will drop to 978 feet or below at some point in a year. This is the level at which voluntary water restrictions are applied. Under the climate scenario for 2050, this probability decreases to 18%.

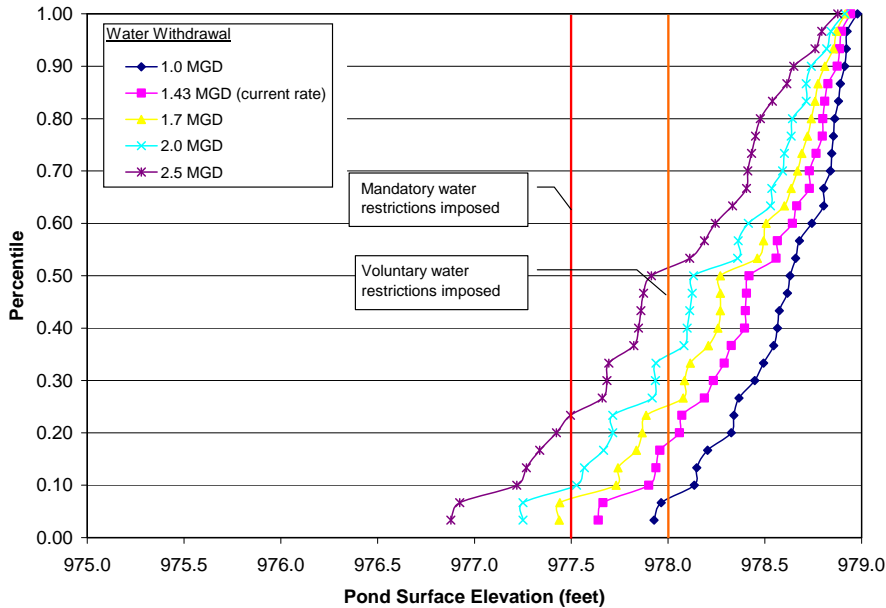
Use of a long-term weather dataset permits this type of probabilistic estimation. We can then make adjustments—modify the weather data to reflect climate change, incorporate minimum downstream flow standards, assume higher withdrawal rates—and rerun it.

Through successive model runs we examined every combination of conditions. The power and flexibility of this modeling tool, combined with the high quality input and calibration data we assembled, enables the City of Montpelier to make informed decisions regarding its Berlin Pond water supply in the coming years.

Berlin Pond Calibration Period Simulation (1999 - 2004)



30-Year Simulation of Yearly Minimum Pond Level, 2050 Climate Projection



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