
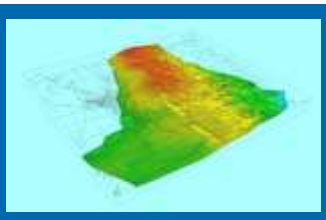


The Little Plover River Groundwater Modeling Project

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Who are we?

- Wisconsin Geological and Natural History Survey (WGNHS), part of University of Wisconsin-Extension
  - *We provide objective scientific information about the geology, mineral resources, water resources, soil, and biology of Wisconsin…These activities support informed decision making by government, industry, business, and individual citizens of Wisconsin.*
- U.S. Geological Survey
  - *The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.*
- Both agencies have expertise and experience in groundwater investigations across Wisconsin

Why are we involved?

- The WDNR requested our assistance
- Project funding comes from DNR, with support from both our agencies
- We are interested as Wisconsin water scientists
- We are interested in providing tools to help decision makers make informed choices
- We have no vested interest in the outcome of the project

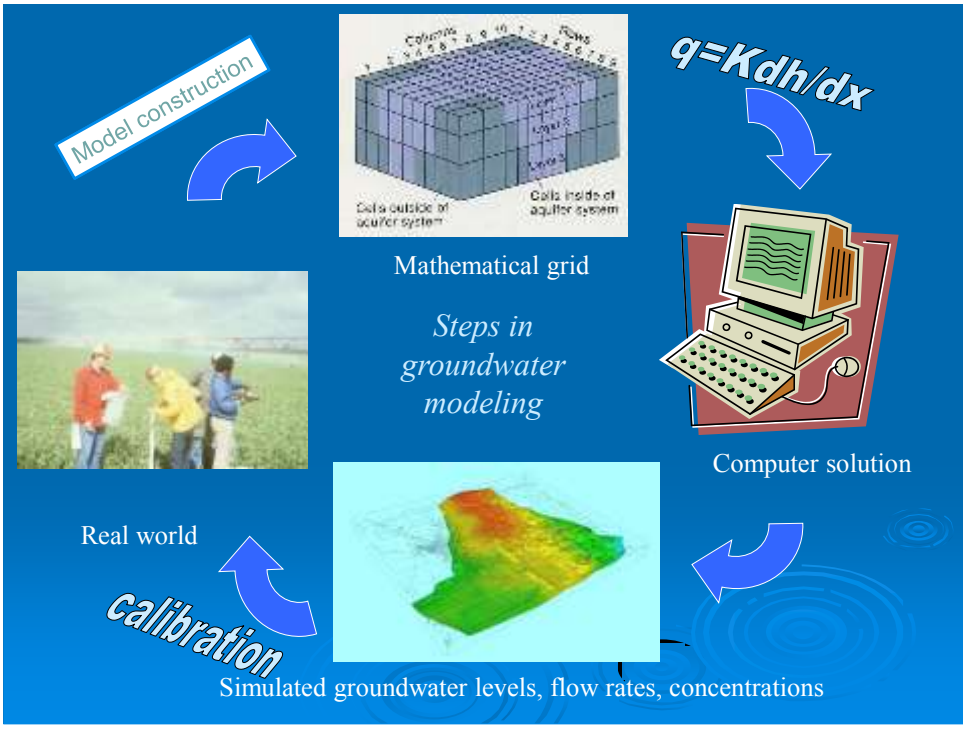
Why the Little Plover River?

Abundant background information already exists:
- groundwater levels
- streamflow
- geology
- aquifer parameters

Recent low flows and river dry-up have raised concerns

Regulatory flow criteria exist

The basin represents an excellent place to develop a modeling approach that can be used to assist decision-makers



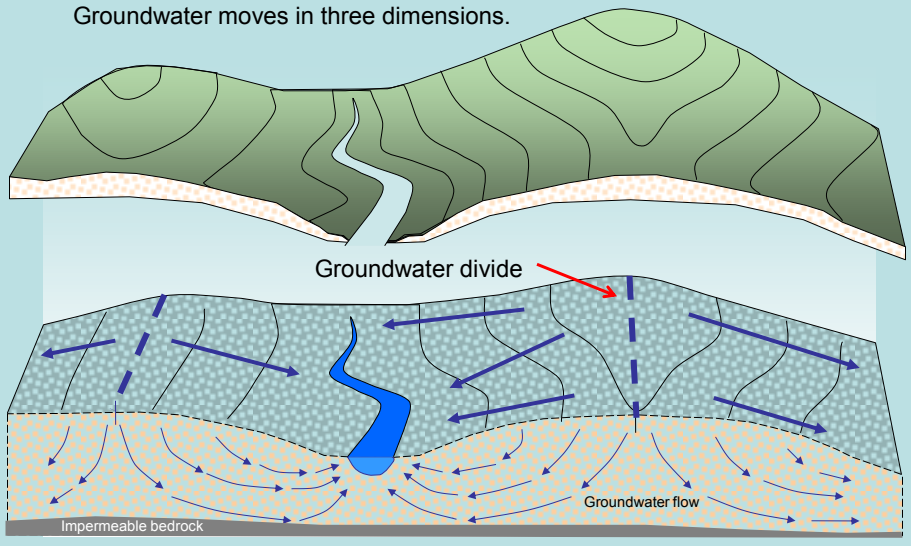
Use of flow models in groundwater management

- Models are the *current standard of professional practice* in hydrogeology
- based on mathematical and physical principles; give objective solutions
- Integrate impacts from multiple stresses (wells)
- Produce a complete water balance
- Contain a database of hydrogeologic information

"Hydrologists are occupied in studying aquifer dynamics. The principal tool for these investigations is the ground water model." John Bredehoeft, 2002

Water budget basics

- Like a bank balance, a water budget includes *all* inflows and outflows of water
- In Wisconsin, the most obvious evidence of "deficit" in the water budget is decreased baseflow to streams, springs, lakes, and wetlands
- Models inherently provide this water budget accounting



Groundwater naturally discharges to surface water

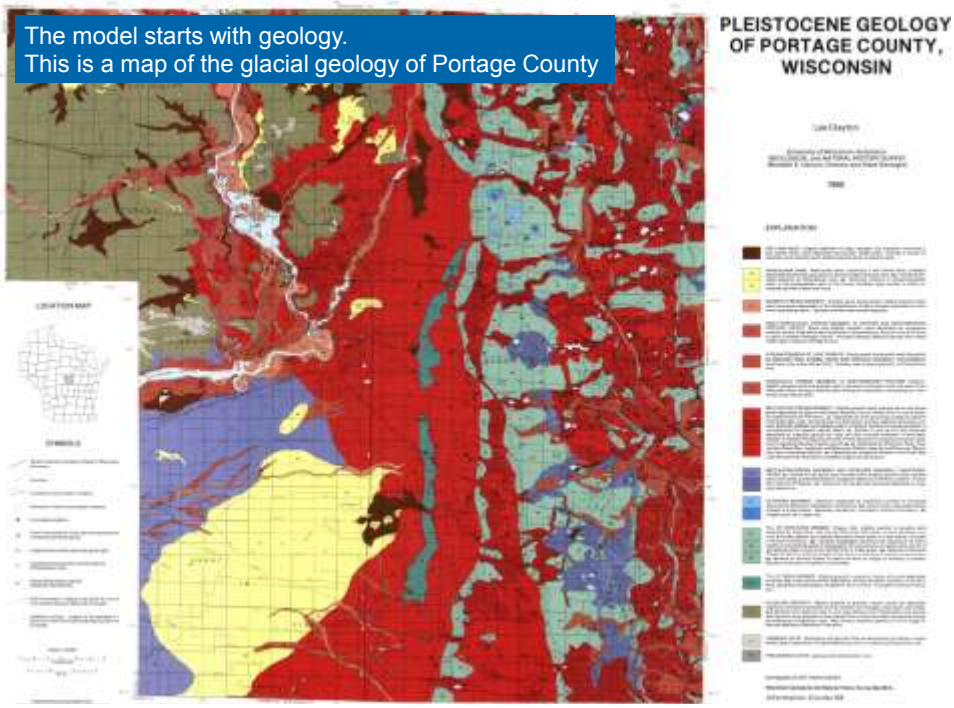
Extension
Wisconsin Geological and Natural History Survey

Objectives

- This project will develop the following:

1. A groundwater flow and optimization model that will be a science-based expert system for decision support of water management in the Little Plover River Basin as a pilot location to evaluate techniques that might later be expanded to the entire central sands region.
2. A platform to demonstrate fundamental scientific constraints inherent to the hydrologic system and context for the costs and benefits for differing scenarios.
3. An educational tool for fostering science-based discussion for both the public and the technical community.

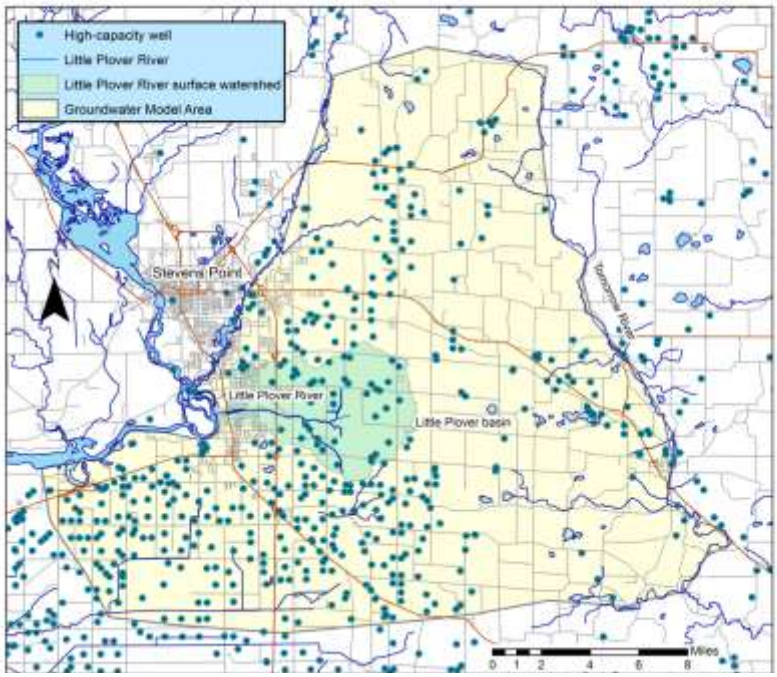
The model starts with geology.
This is a map of the glacial geology of Portage County



What's being simulated:

- The topographic basin of the Little Plover
- The surrounding region extending to natural regional hydrogeologic boundaries (Wisconsin River, Tomorrow River, regional flow divides)
- The sand-and gravel aquifer and underlying sandstone aquifer

Model area

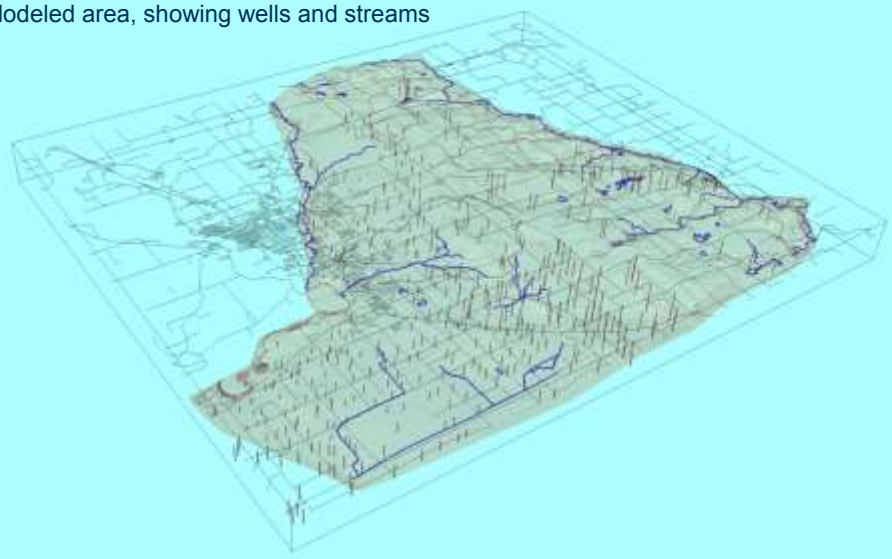


Close-up of the Little Plover basin

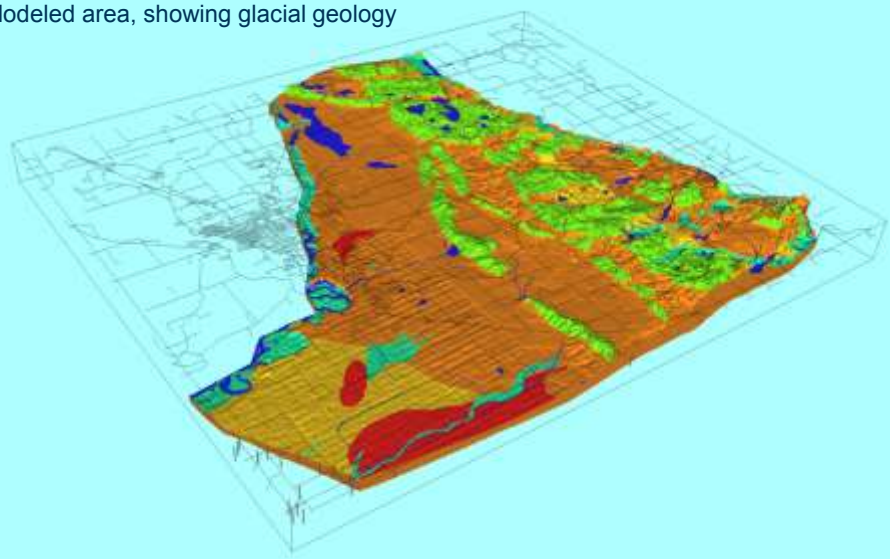
Preliminary simulated water-table contours

The model grid is uniform with 100-ft spacing

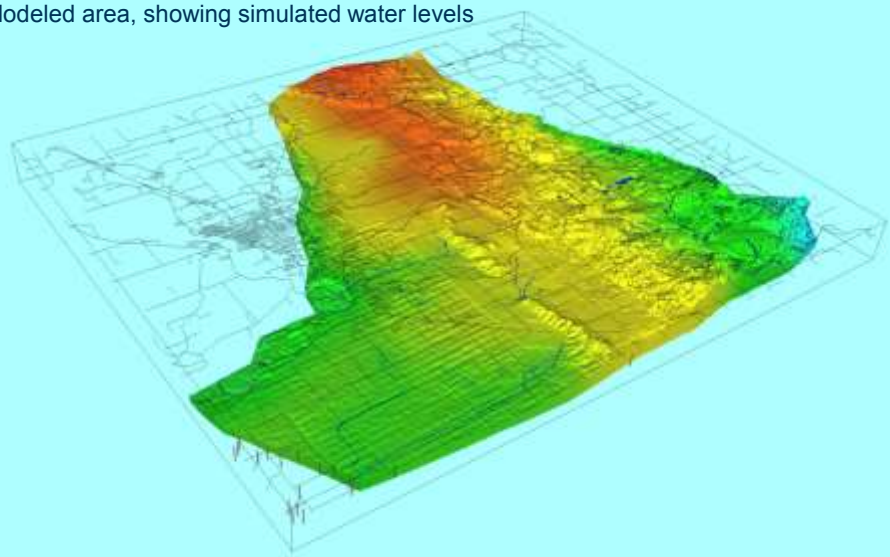
Modeled area, showing wells and streams



Modeled area, showing glacial geology



Modeled area, showing simulated water levels



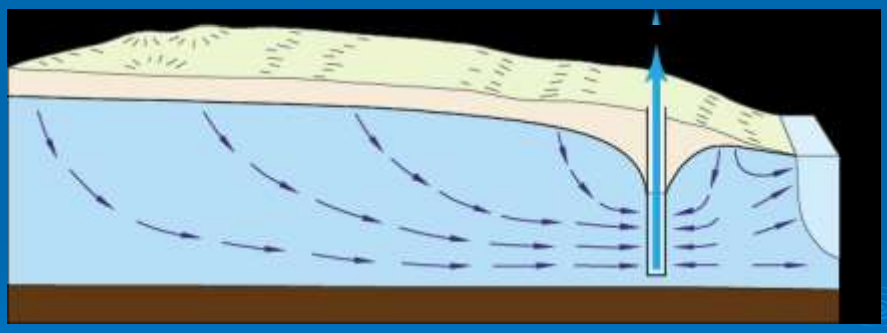
Model features:

- Uses the industry standard modeling code MODFLOW;
- Transient, with simulation time scales ranging from years to weeks;
- 3-dimensional, allows for vertical flow
- All permitted high-capacity wells in basin simulated individually;
- All significant streams, ditches, lakes, and wetlands in the basin will be simulated;
- Areally and temporally variable recharge and evapotranspiration
- Geology represented by multilayer hydrostratigraphy;
- Includes streamflow routing, and will include the ability to simulate the manipulation of drainage ditches

Model features:

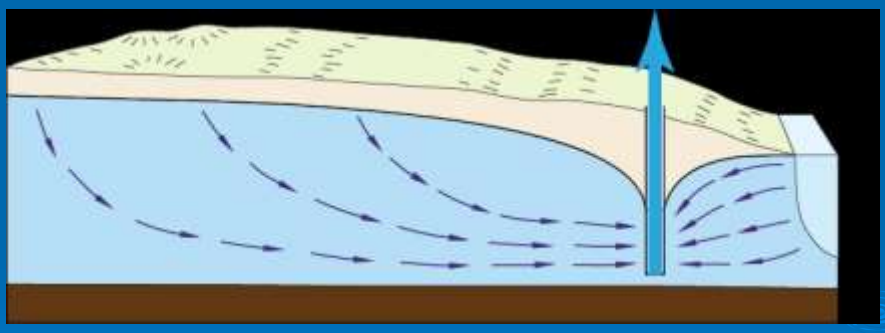
- The model will be calibrated to measured water levels and streamflow using state-of-the-science calibration and uncertainty methodology;
- Three-dimensional, graphical visualization of the groundwater system;
- Management optimization will enable the evaluation of costs and benefits of various management scenarios such as:
  - Evaluations of locations and pumping rates of wells can be constrained by management criteria such as maintaining specific flow rates in streams or water levels near lakes
  - Evaluations of land use change (such as crop type) with associated costs can be assessed to balance resource constraints with costs and profits to farmers and other land users.

Management Optimization with Constraints



Water flows through the aquifer to supply water to a stream
Pumping water can reduce water entering the stream
Pumping more water can even pull water from the stream

Management Optimization with Constraints



Constrained optimization allows adjusting one part of the system to balance with a required condition on another part.
For example, adjusting pumping rates to balance with streamflow or water levels.

Schedule…

- November, 2013; funding received, project started
- February, 2014; recharge estimation complete
- June, 2014; geology, conceptual model, boundary conditions
- August, 2014; steady-state calibration
- October, 2014; transient calibration
- November, 2014; scenario testing and management optimization modeling based on discussions with user groups
- March, 2015; Final Report, presentation of results

http://fyi.uwex.edu/littleplovermodel/