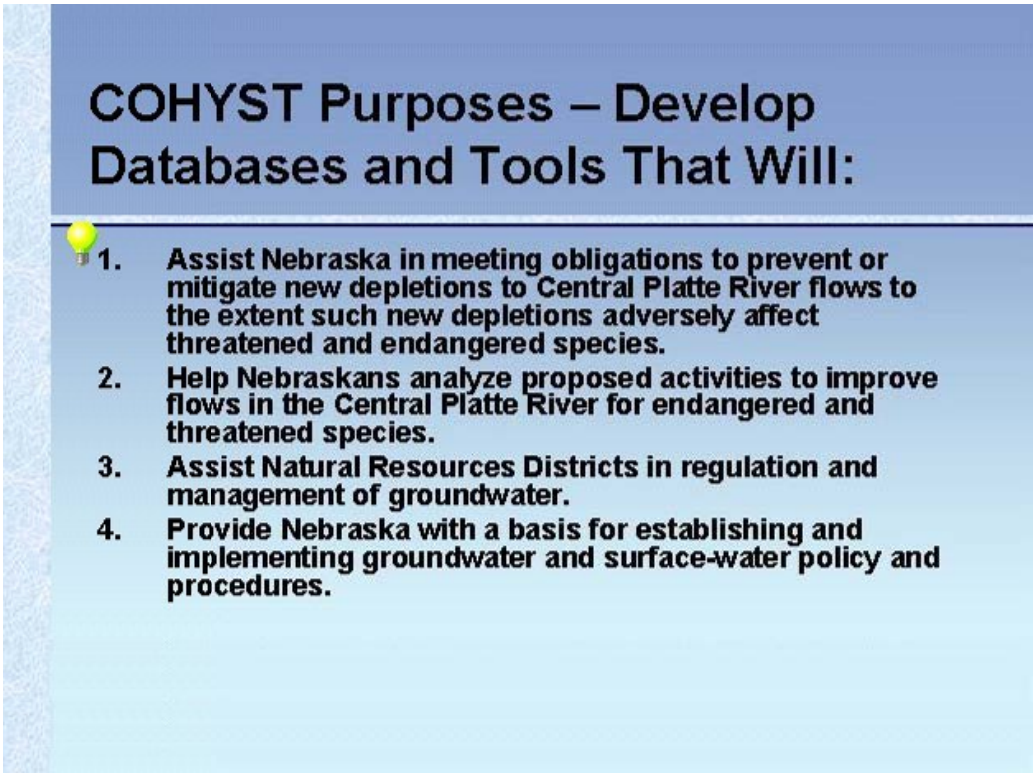
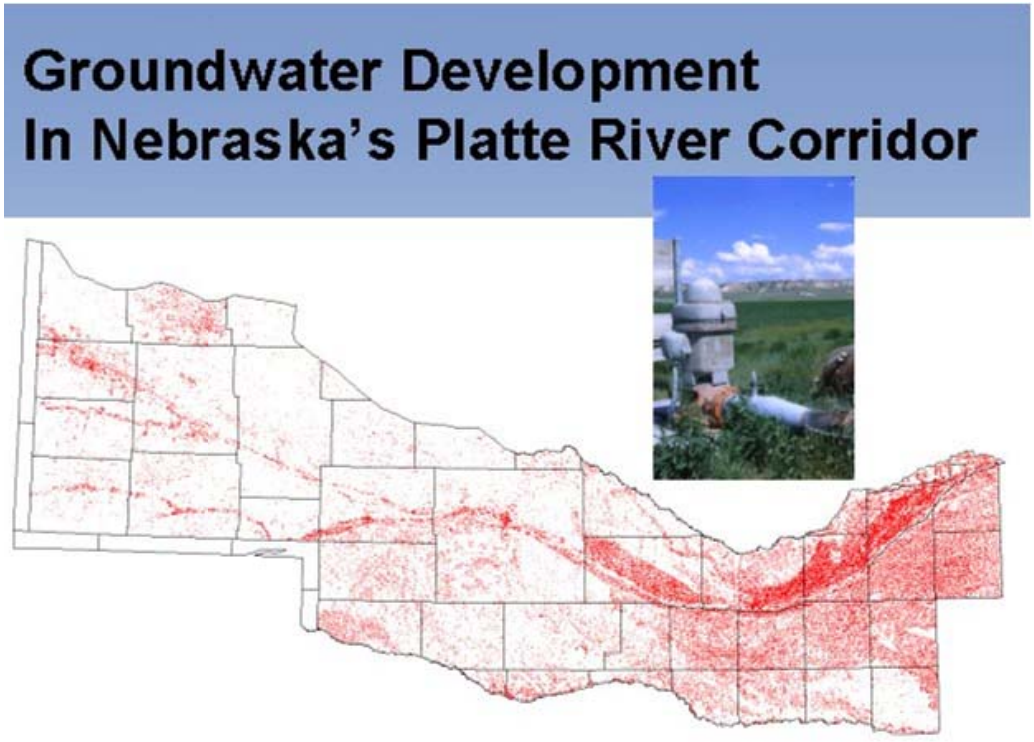
Welcome to the COHYST Website. This set of 26 slides will guide you through a discussion of the background, objectives, and status of Nebraska's Cooperative Hydrology Study (COHYST). Simply click through the slides and read the brief notes attached to each.

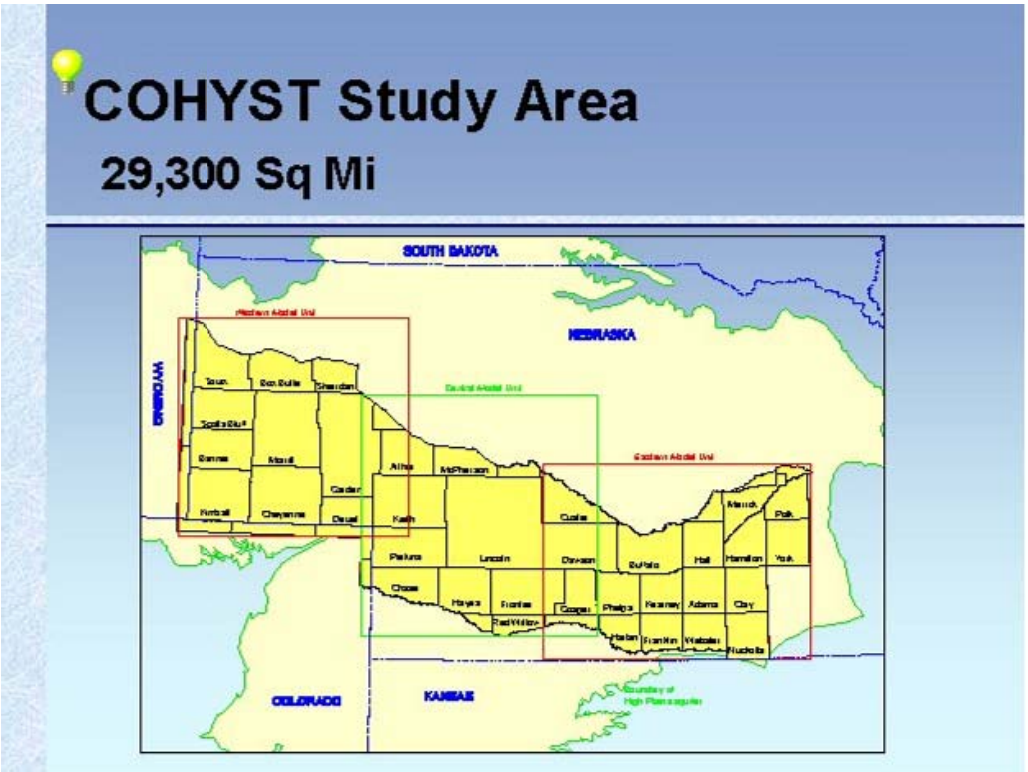


As shown here, the COHYST study has several important objectives. The first two listed above specifically relate to the habitat needs of Central Platte endangered and threatened species. For information about how those objectives are being addressed collectively by the states of Colorado, Nebraska, Wyoming, and the US Department of the Interior and how the COHYST databases and tools would be used to further those objectives, click here. The other two objectives reflect Nebraska's other reasons to better understand and be prepared to manage groundwater and surface water especially where they are hydrologically connected. All four form what is known as a "DSS," or Decision Support System, consisting of data, databases, and computer models of the surface and groundwater systems.

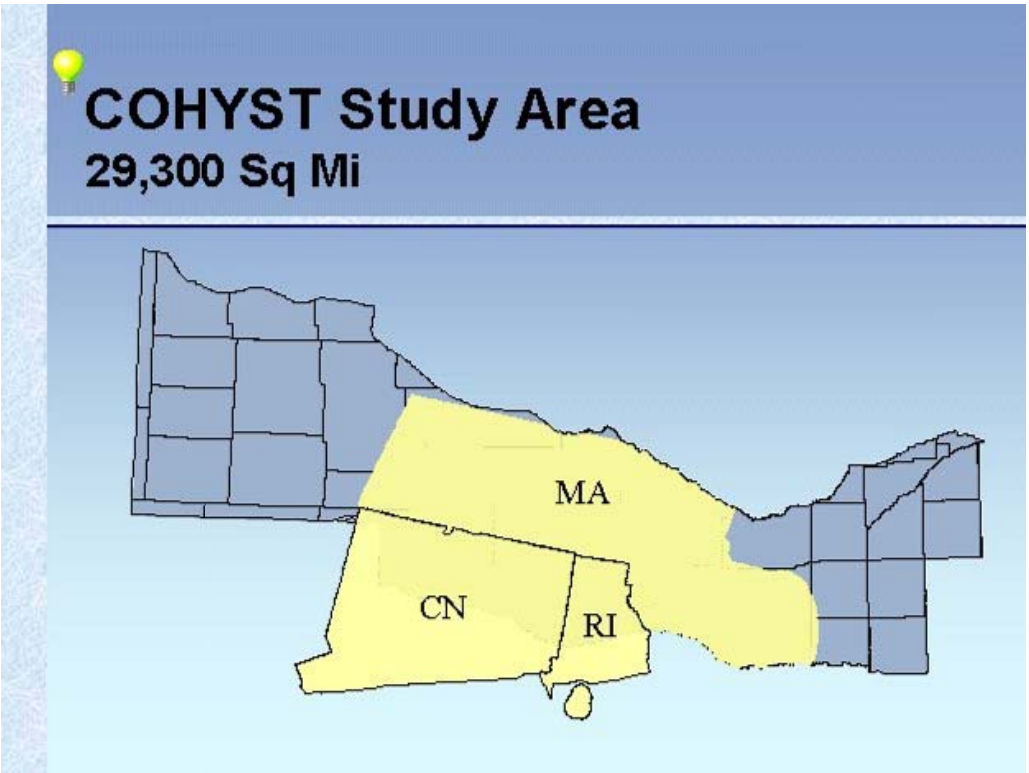


Using more technical terms, the COHYST project was initiated to improve understanding of the hydrological and geological conditions in the basin, to better understand the interconnection of surface and ground water, and to provide the data and tools needed to assess the impact of wells on river flows in all parts of the river upstream of Columbus.

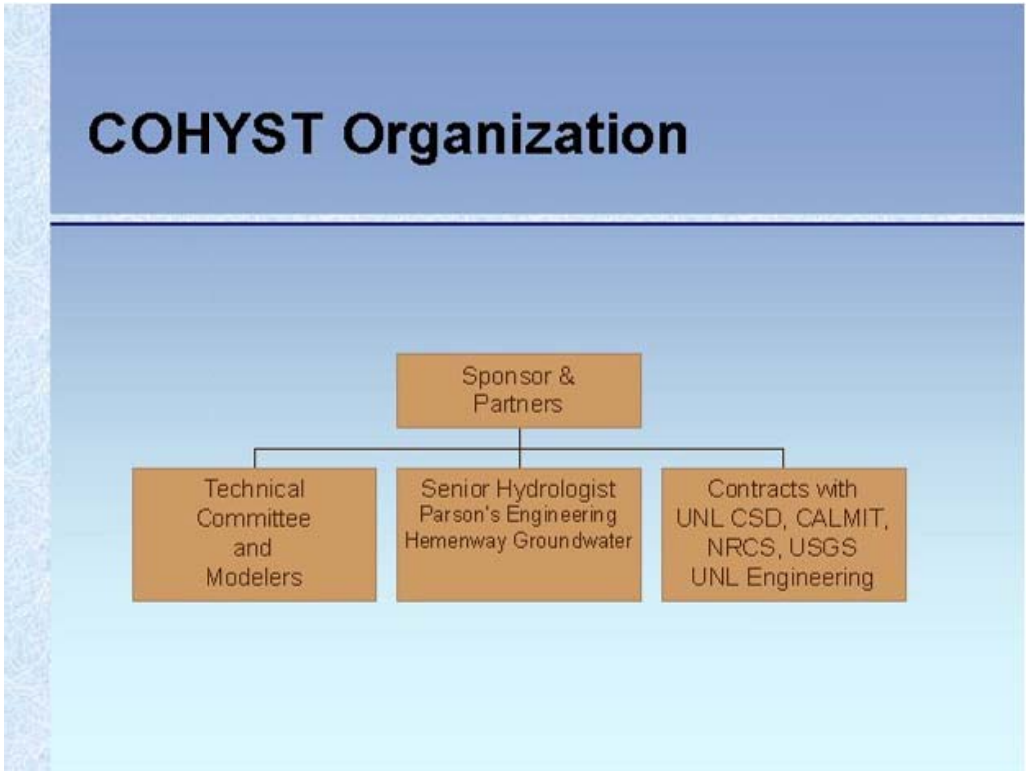
This 1996 map shows that there were about 67,000 wells in the COHYST area of interest. Most of these wells are for irrigation and were installed since the 1950's, with over half installed in the 1970's when crop prices soared. Irrigation wells have the potential of impacting flows in the river.



The area selected for study in COHYST includes 29,300 sq mi of land surface in the Platte, Republican, and Loup River basins. The hydrologic boundaries for the study extends westward from Columbus, Nebraska to six miles into Wyoming and Colorado on the North and South Platte Rivers, respectively. The northern boundary is the South Loup and Loup River in the eastern end, and the known groundwater “ridge” or divide in the west. The southern boundary is the Republican River in the east and Frenchman Creek in the west. The red and green lines in this figure show the boundaries of three overlapping river and groundwater flow models being developed by technical staff. The portions of the study in Wyoming and Nebraska are included only to provide a “buffer” zone for modeling. No mapping of hydrologically connected ground water (HCGW) for those zones is planned in COHYST.



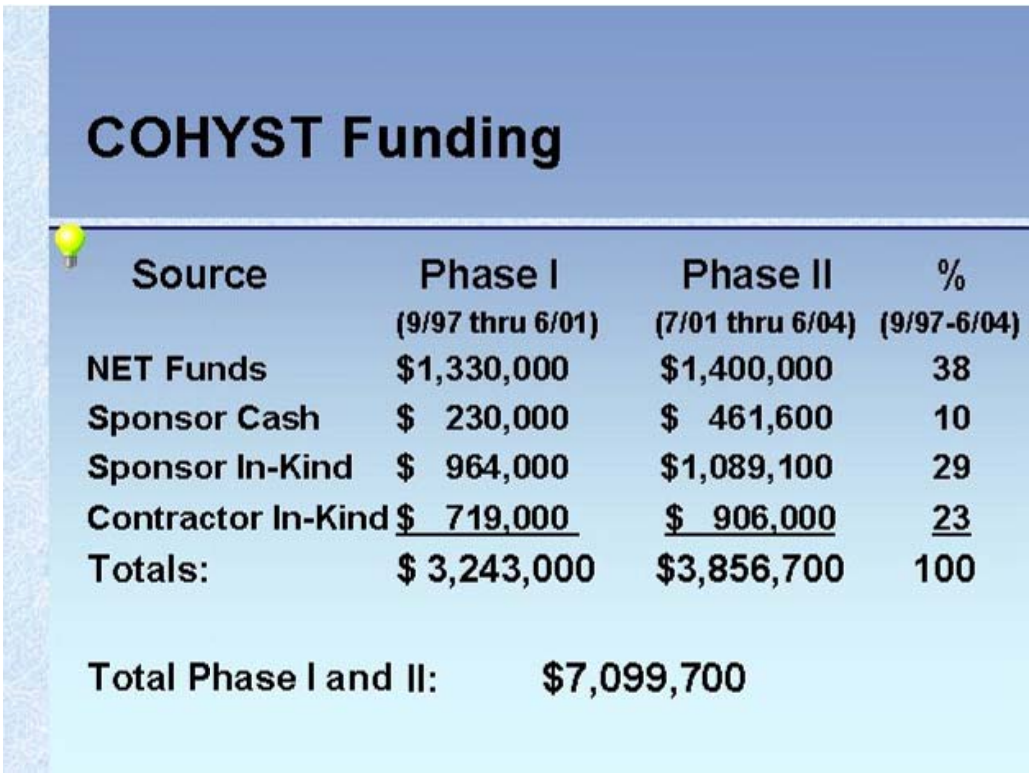
To give you an idea of the study area size, the COHYST area is contrasted here as equal the size of Connecticut, Rhode Island, and a large portion of Massachusetts.



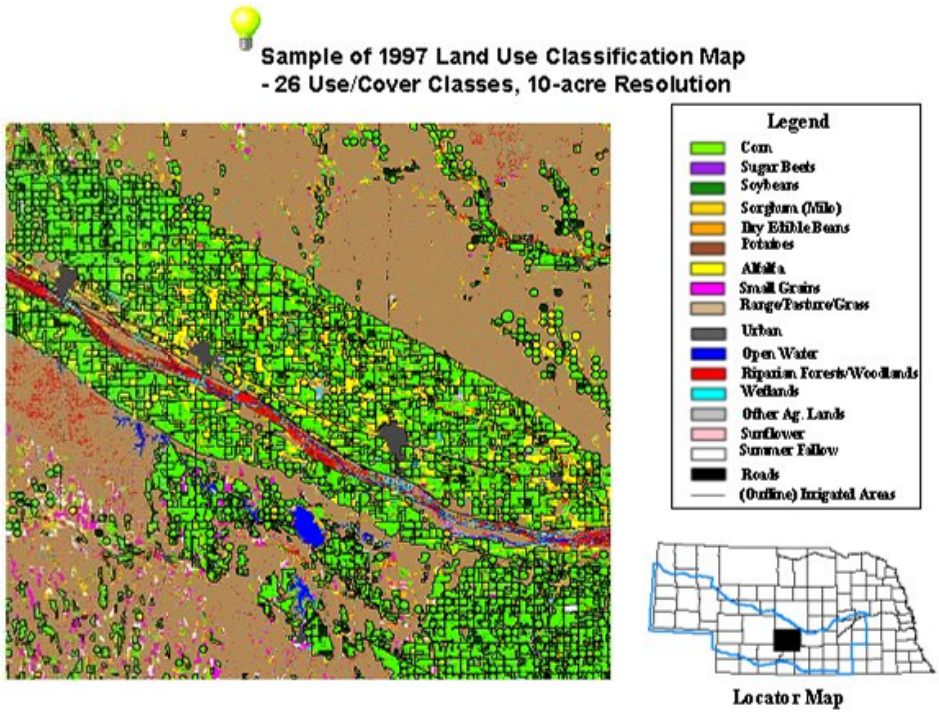
The sponsor and partner agencies do not have sufficient staff who are free to divert from their responsibilities to work full-time on this study. Three full-time modelers were hired and located at sponsor offices in the three model regions. These geologists and engineers are part of a technical committee made up of employees of the Sponsor agencies, university researchers, the USGS, the NRCS, and outside consultants who provide the working staff for the study. Two senior engineers from Parsons, Inc. and Hemenway Groundwater, Inc. were retained to provide technical direction for the study.

The 11 Sponsors of COHYST are either local resource management agencies within the study region, power and irrigation water suppliers in the region, or state agencies having jurisdiction for resource management in the region. As shown later, the Sponsors and contractors contribute about 70 percent of the total resources (personnel and monetary) needed to conduct the study.

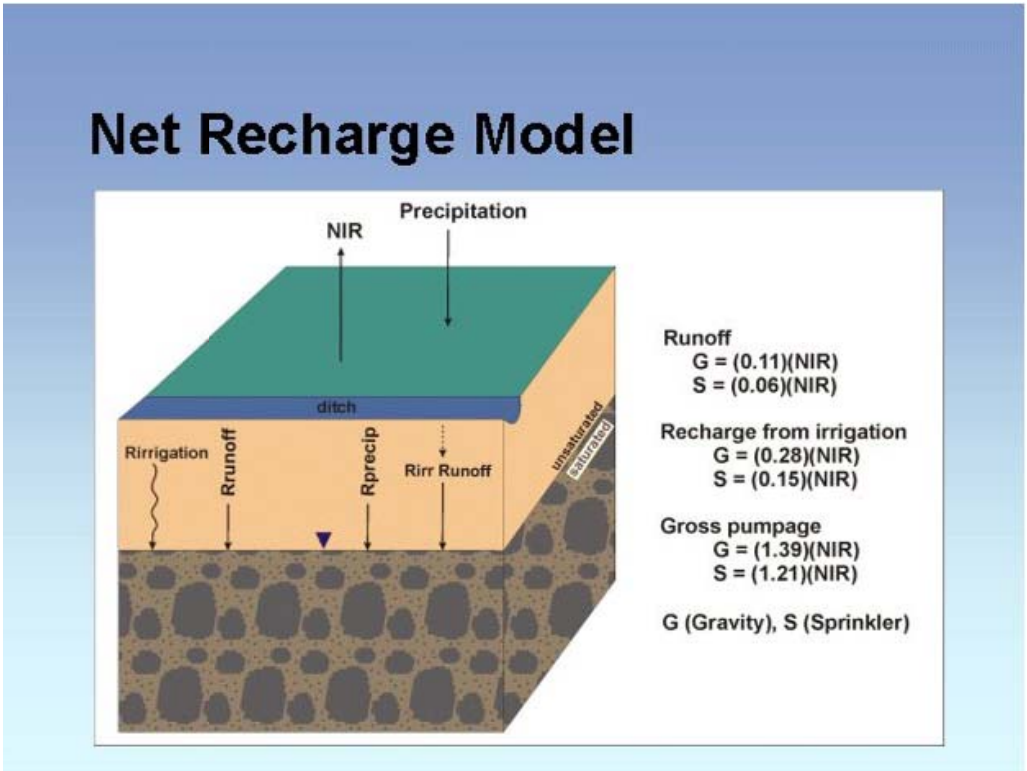
Partners of COHYST are all stakeholders and frequently attend the Sponsors meetings and participate in the technical committee activities. The primary differences between sponsors and partners is that the partners are not required to provide in-kind matching support in the form of staff time or cash contributions.



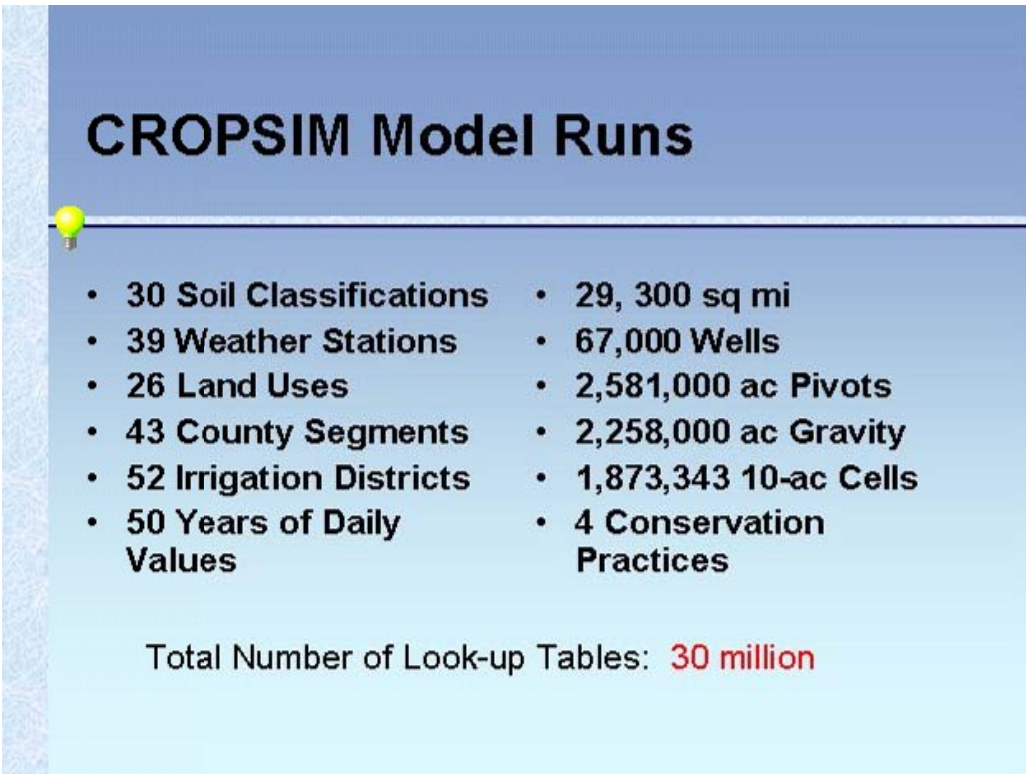
Nebraska's lottery funds administrated by the Nebraska Environmental Trust (NET), were instrumental in making the study possible, but as shown here, 62 percent of the total funding for the two phases comes from sponsors and cooperators. This demonstrates the grassroots and statewide support for this technology.



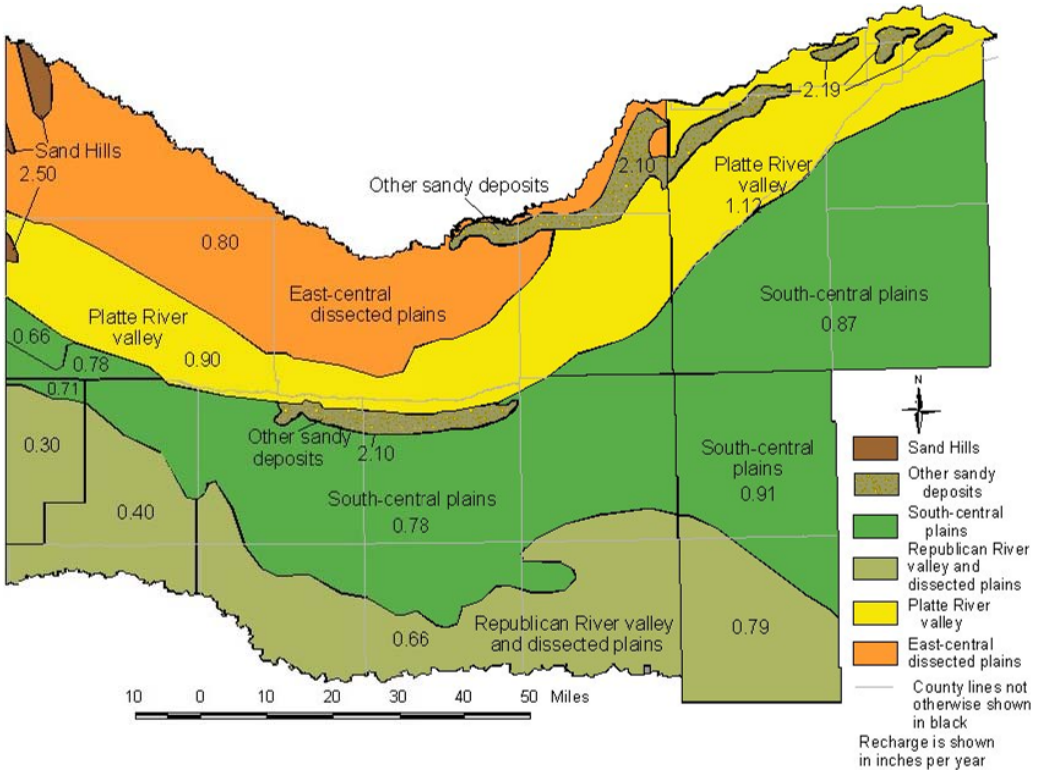
The rest of the slides in this presentation describe some of the technical activities and products of COHYST. Regional models of a surface and groundwater system of this size require a large amount of data collection and data processing. Nebraska is known as the Cornhusker state, and corn requires water. In 1997, three of the 20 million acres classified were in irrigated corn. Consumptive use of water by vegetation for both irrigated and dryland areas is needed to solve for the amount of precipitation that recharges the aquifer. Land uses were mapped in 1982, and satellite imagery was used to classify all 1997 land uses, with a 10-acre resolution, throughout the study area as shown in this sample. Another map for 2001 will be constructed as part of Phase II, which will allow the modelers to asses changes in irrigation over time. Land use coverages for earlier years are being developed by starting with the 1997 detailed map, and using county crop statistics gathered every 4 to 5 years to trace land uses backward throughout the period of development.



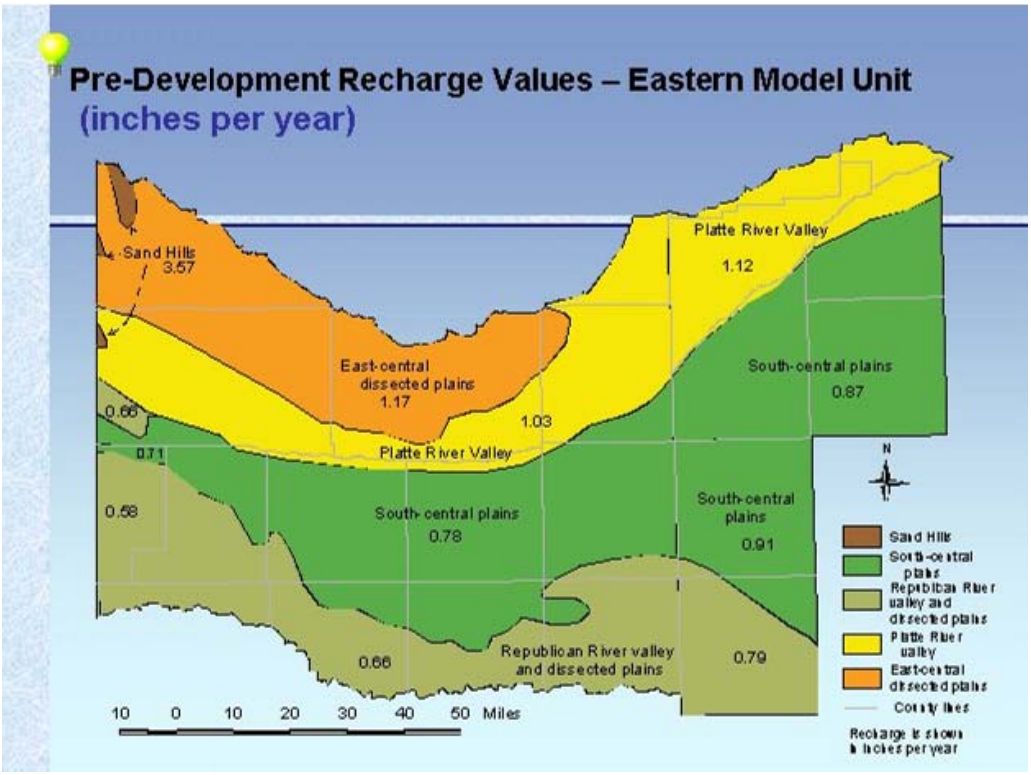
Vertical movement of water from the land surface to the water table is modeled in three-dimensional cubes, each 10 acres in size. NIR is the net irrigation requirement of the crops or pasture. If accurate estimates of land use and crop water use not supplied by precipitation are available, the amount of precipitation and irrigation water that percolates to the water table can be determined using a crop growth/ net recharge model, CROPSIM, developed at the University of Nebraska. Crop water demands are based on soil type, land use/land cover, crop practices, and climatic station data for each cube. Gravity (G) and Sprinkler (S) irrigation systems are modeled separately because they have different runoff, recharge, and pumpage characteristics.



When all the possible combinations of soil type, land uses, conservation practices, irrigation methods and other factors are considered over the 29,300 square mile area, about 30 million different simulations of CROPSIM are needed to define the net recharge for all the 10-acre parcels in the model area.



This map shows the pre-settlement recharge in inches per year for the Eastern Model unit, prior to development of groundwater irrigation. Values were developed by evaluating how much recharge must have occurred in order to match the known water table levels and stream flows around 1945. Maps of recharge for every season since 1945 are developed in COHYST by inputting meteorological data and year-by-year land uses in the CROPSIM model.



The University of Nebraska Conservation and Survey Division (CSD) and other cooperators have retained an extensive database of cuttings and logs from test holes drilled throughout the state. Senior former and current staff from C&SD were hired to examine the samples and prepare detailed reports of the vertical classification of the formations encountered in each hole by county. The COHYST area covers all or parts of 43 counties. During Phase I, the geologists updated and published test-hole log books for about 1,600 logs in 30 counties. During Phase II they reviewed an additional 300 logs collected by the North Platte NRD in four counties and updated the log books for those counties. CSD has also updated 11 county test-hole log books for other projects that were used in the COHYST geology work.

Updated Test Hole Logs

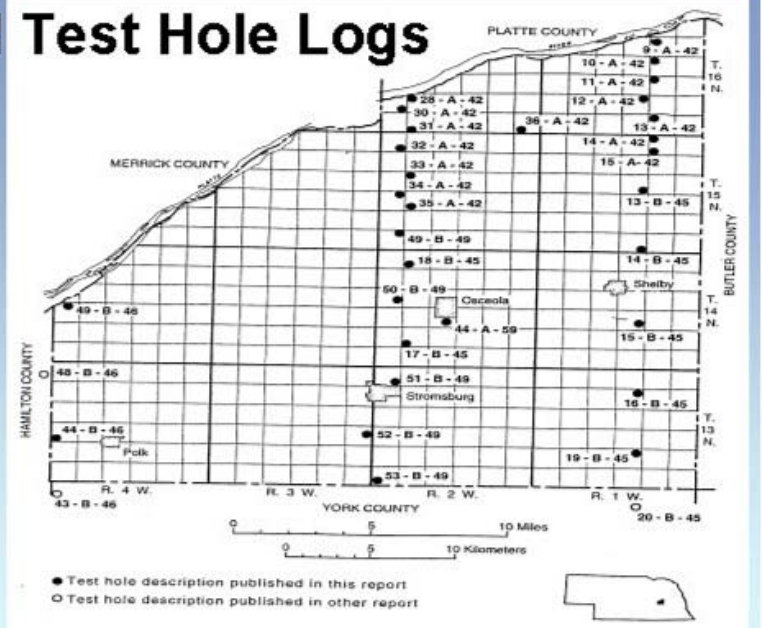
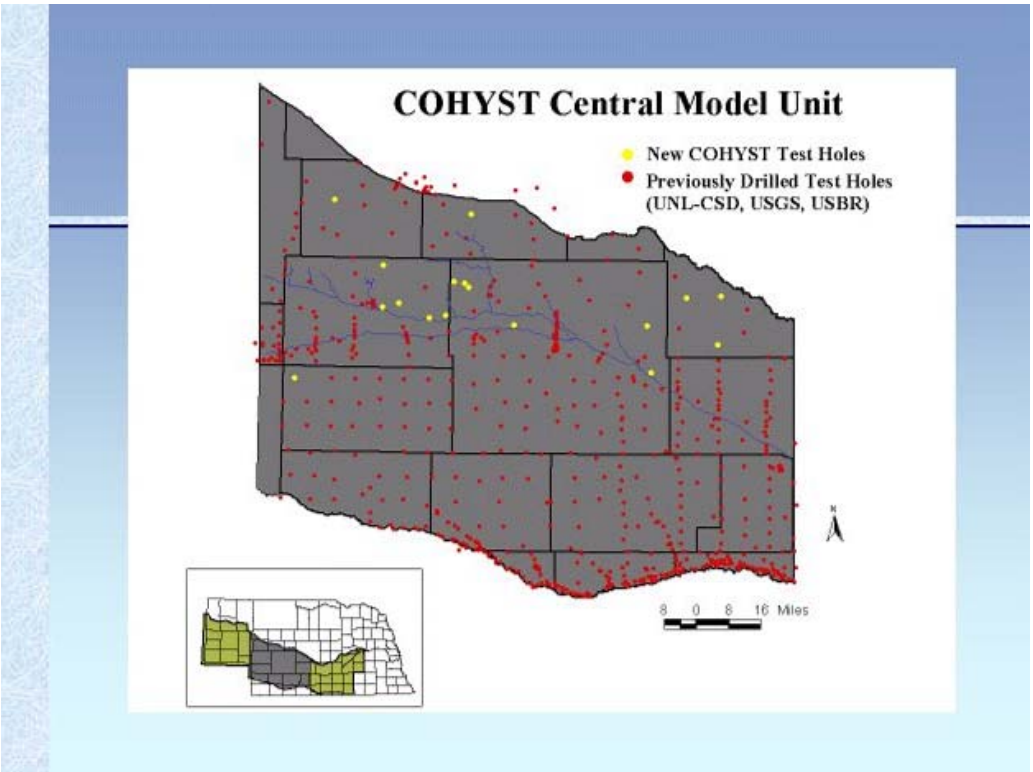
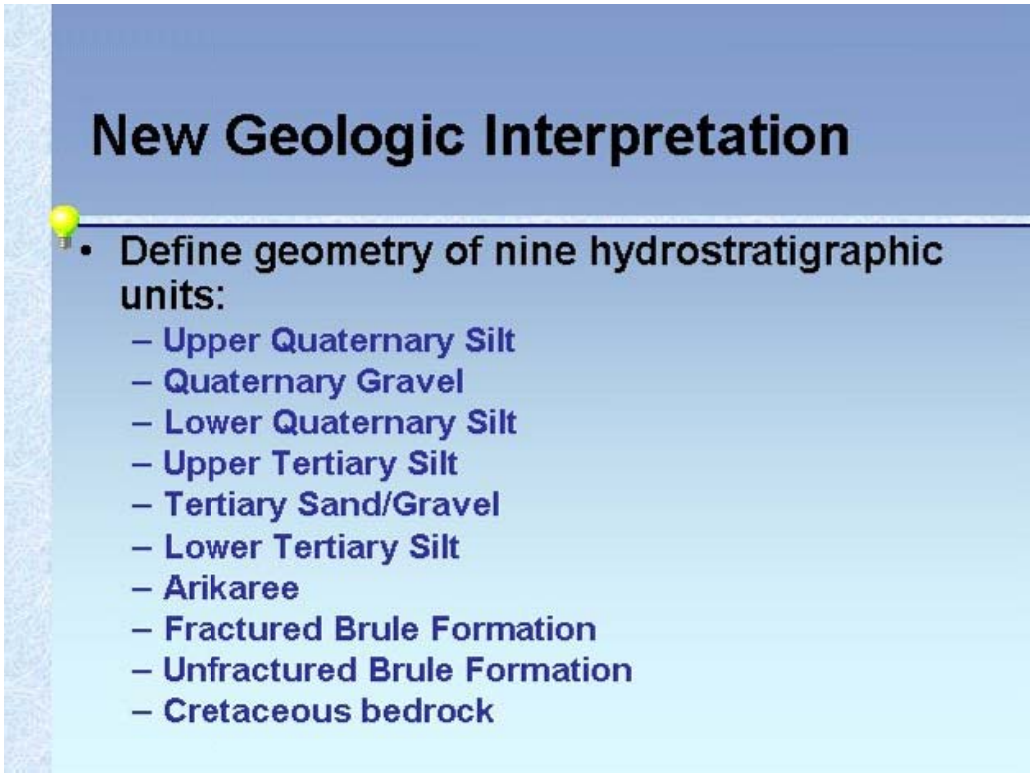


Fig. 2. Test-hole location map of Polk County.

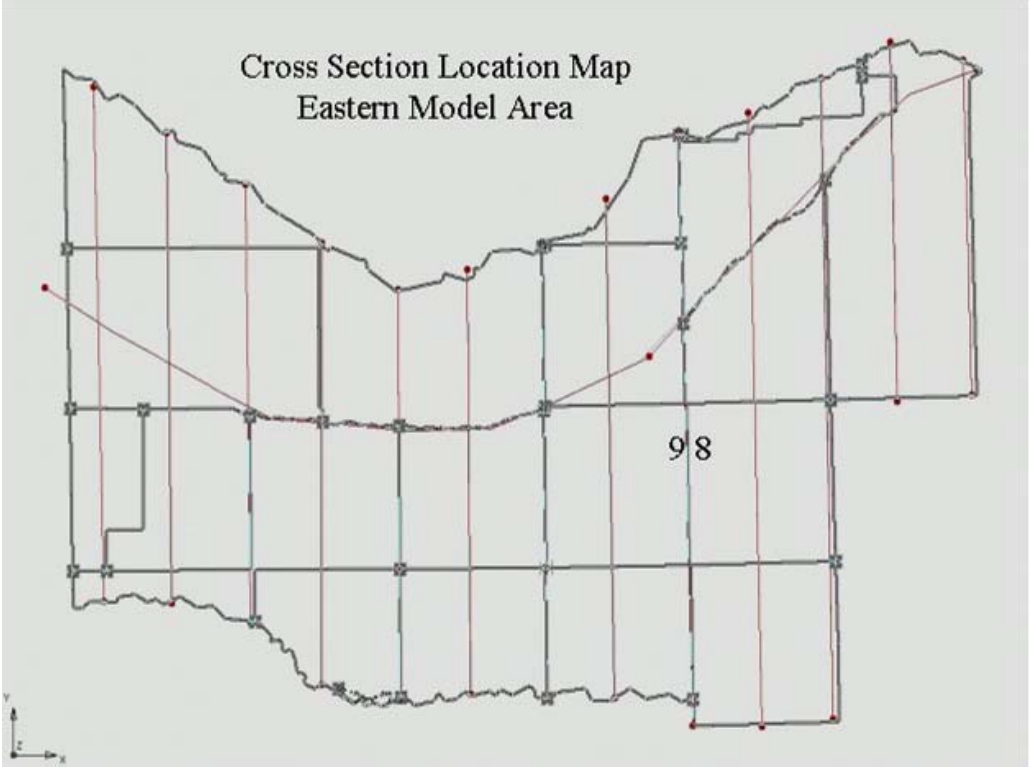
About 300 new test holes and logs are being drilled during Phase II in areas where gaps existed in the pre-COHYST database. This slide shows the locations of the new test holes drilled in the central model unit. These were located in areas where little or no previous data existed.



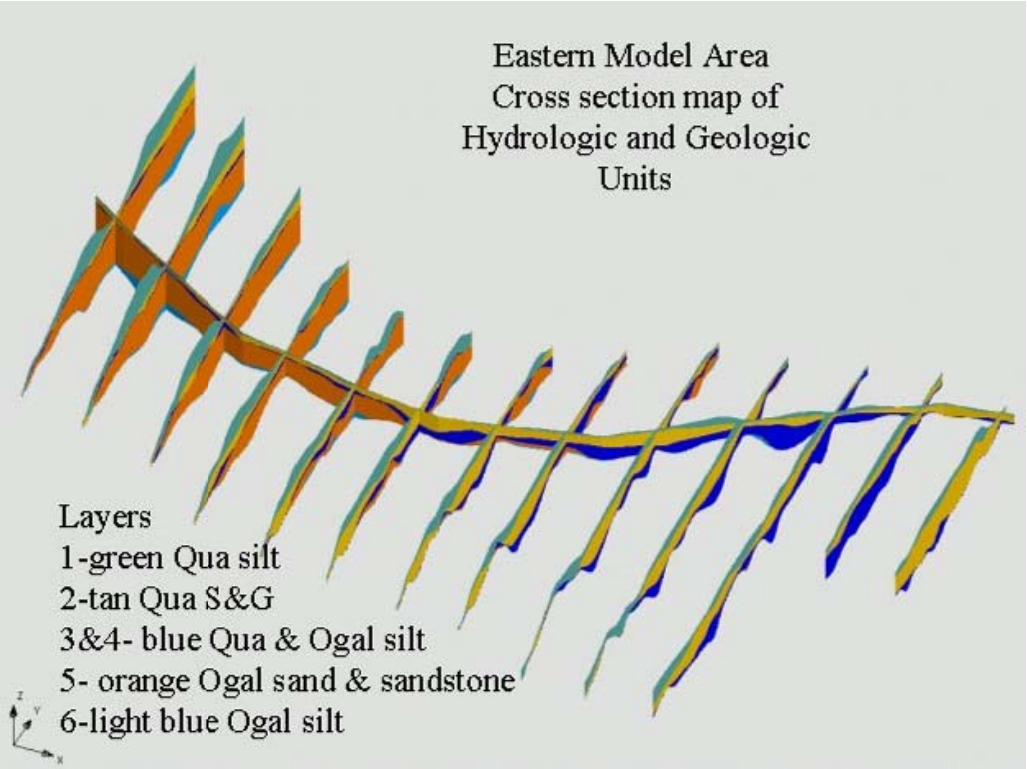
The groundwater models being used for COHYST allow the geology to be described in layers. The technical committee determined that there could be up to eight different hydrologically-significant formations and two types of bedrock units at any location. Staff geologists have screened the test-hole data and identified which layers exist and at what elevations for each test hole. Over 3,800 irrigation well logs were used to supplement this database, allowing geologists to map the surface contours of each formation. These maps are input to the groundwater flow models.
All ten geologic layers were found to exist, but never all at one location. Some areas have only one layer.



In addition to defining the layers, the new interpretation of test hole logs is giving geologists a better understanding of Nebraska's geologic and geomorphic history. Some researchers have hypothesized that the Platte River, shown here as the curved line through the Eastern Model Unit, may have originally followed a straight south-easterly route through Kansas to the Missouri River instead of curving back to the north. For reference, the vertical lines are locations of cross-sections shown on the next slide.

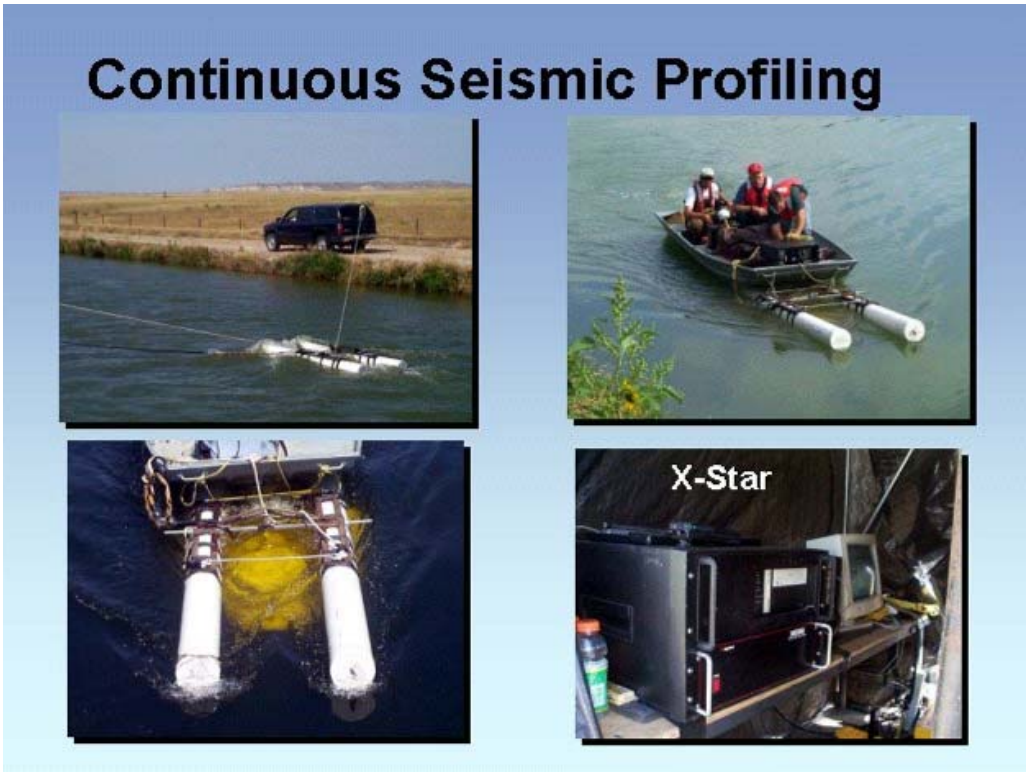


This 3-D map shows the color-coded layers along the longitudinal and transverse sections shown on the previous slide. Only six of the nine layers exist in the Eastern Model Unit. The dark blue, bottom formations in the lower right may reveal a buried, former Platte River channel heading off toward Kansas.



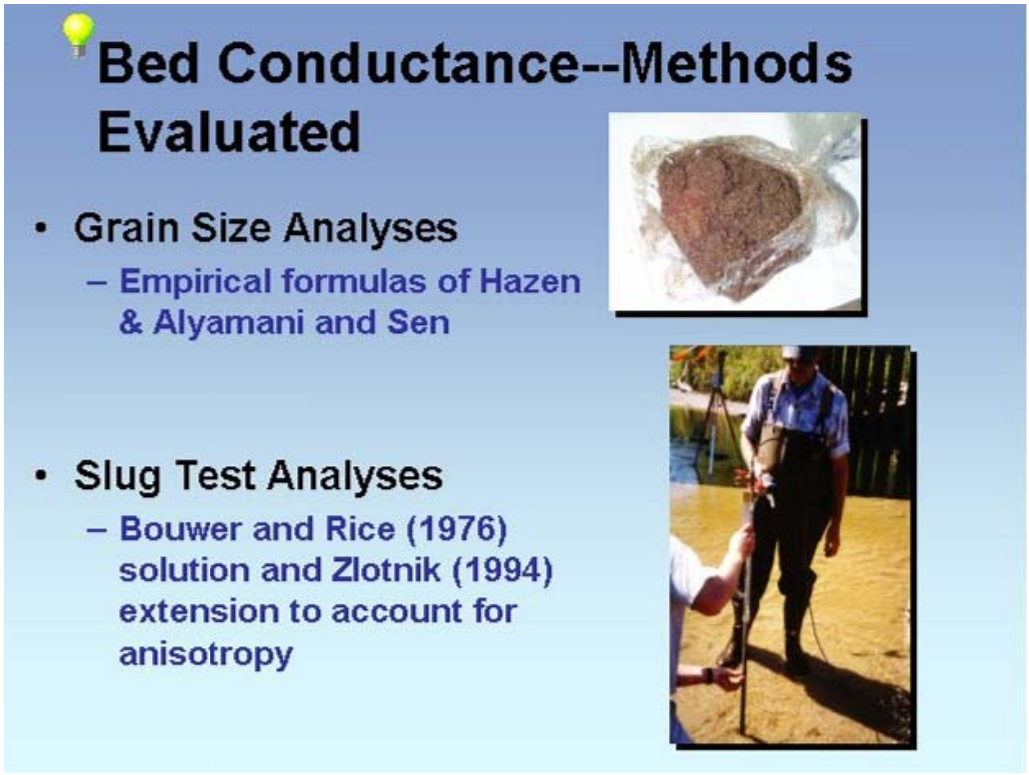
Though almost 2,000 test hole logs are available, the depth to bedrock in much of the study area is still uncertain. In addition to publication of test hole log books and implementing more test drilling, a new technology involving “seismic profiling” was used. This “fish” is towed just below the water surface at 3 to 5 ft/sec across any water body. It requires about 3 ft of water depth, so it was primarily used in irrigation canals. On-board instruments give a continuous log of bedrock levels and other layer surfaces up to 300 ft deep.

After setting the Towfish in the canal with a crane, it can be towed by two vehicles or pushed with a dinghy. Data from the Towfish is downloaded in the field to a PC and printer so that the data can be immediately verified and the instruments moved to the next study site. The effort successfully provided additional data used by COHYST's geologists for mapping the subsurface layers shown earlier.

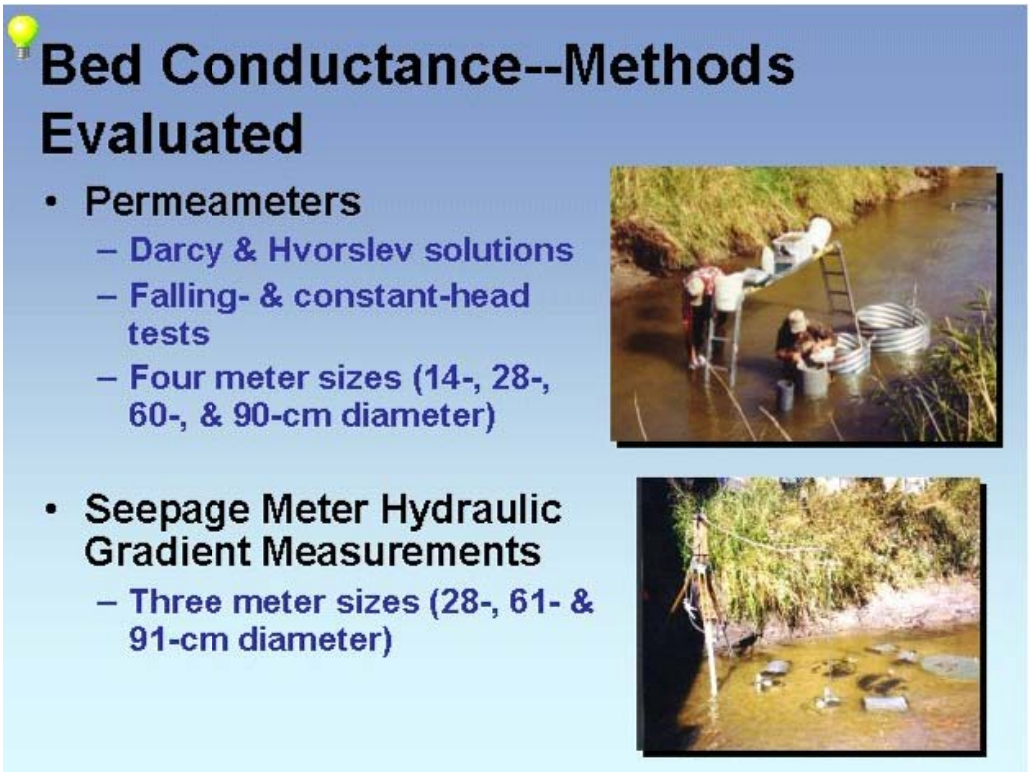


Previous surface-groundwater interconnection model studies in the Platte River basin reveal that the conductivity of the stream bed material significantly affects the model results. This K-parameter is usually back-calculated as the value that makes the modeled water levels and streamflows match the recorded water levels and streamflows during some calibration period of time. The technical committee agreed that physically measuring the conductance would reduce the uncertainty in model results, especially for this study because of the importance of HCGW. USGS hydrologists from Lincoln assisted project staff in testing several methods and analyzing the field data.

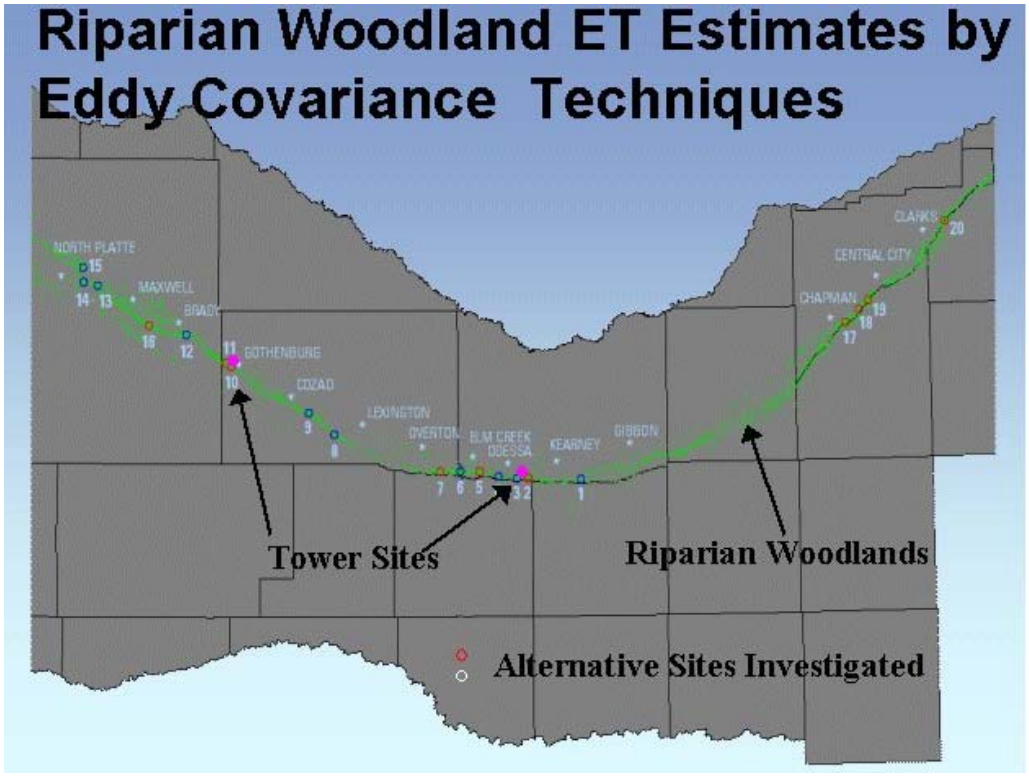
Four different methods of measuring the streambed conductance were tested. Sites were selected in the main stem Platte River channels and in some of its tributaries. Two methods are illustrated here, and two others are shown on the next slide.



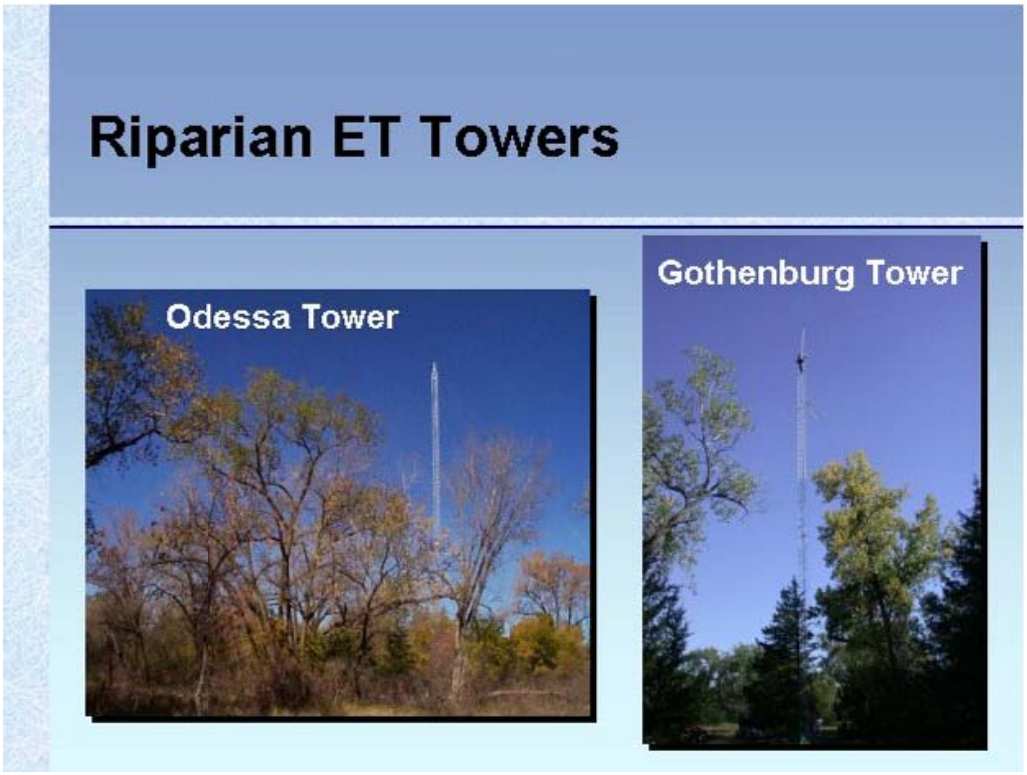
Analysis of the data led to the conclusion that when the stream has a bed of material other than the underlying aquifer, the 24-inch diameter falling-head permeameter test, analyzed with the Hvorslev solution, is the preferred method. However, variability in K across the wide Platte channel was found to exceed the variability in the methods, so this parameter will require careful analysis. COHYST has the advantage of several actual measurements to guide the modelers' choices of possible values.



Though extensive data exists regarding consumptive water use by crops and pastures in Nebraska, little is known about the evapotranspiration (ET) that occurs from the dense willow and cottonwood stands across the Platte channel. Perhaps the trees themselves are causing a considerable depletion of flow in the river. The technical committee solicited proposals and awarded a contract to the USGS to actually measure the ET from these lands. Ten possible locations were examined in detail resulting in the selection of two that had the correct density, fetch, prevailing wind direction and accessibility.



In order to measure ET from any vegetation, instruments must be placed above the canopy. The instrument packages have recently been placed on 90-ft tall towers and data collection has begun. Measurements include air temperature, precipitation, relative humidity, horizontal and vertical wind velocity, water vapor density, net radiation, solar radiation, through-fall (precipitation that reaches the ground), soil temperature, soil heat flux, soil moisture content, groundwater level, stream stages, and tree trunk temperature. Parameters derived from the field data will be used to calculate ET from wooded riparian areas.



In addition to this overview of COHYST, a large amount of other information about the project is posted on our Internet page. These data are frequently updated and supplemented, so any interested party is encouraged to revisit the site periodically. The ultimate goal will be to post virtually all the data and databases, allowing any casual or technical visitor to take full advantage of the study products.

For more information on COHYST, visit cohyst.nebraska.gov