# Regional Groundwater Modeling Results for Water Supply Planning in Northeast Illinois

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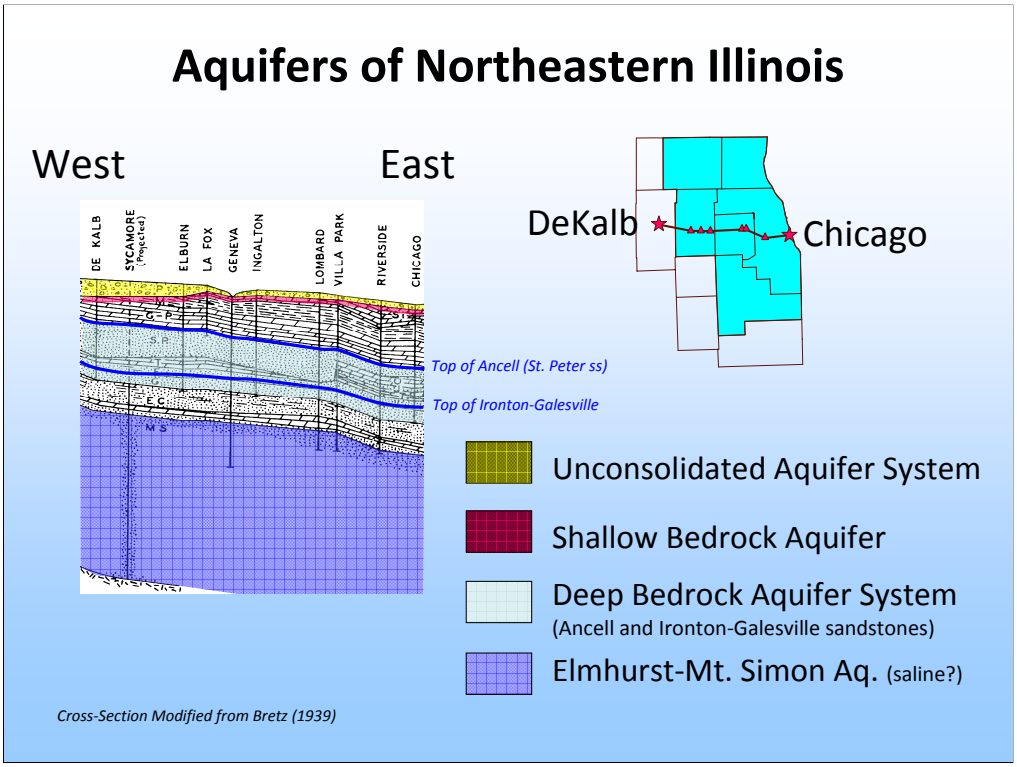
*NE Illinois Regional Water Supply Planning Group*
*December 16, 2008*

# Acknowledgments

Yu-Feng Lin, Ph.D., Center for Groundwater Science, ISWS

Jason Thomason, Ph.D., Geologic Mapping and Hydrogeology Center, ISGS




Elevation and Depth[1]

Top of Elmhurst-Mt. Simon Aquifer: Elev -1100 to -600 ft MSL, Depth 1400 to 1800 ft . Top of Ironton-Galesville Aquifer: Elev -600 to -100 ft MSL, Depth 900 to 1400 ft. Top of Ancell Aquifer: Elev 0 to 300 ft MSL, Depth 500 to 1300 ft. Top of Shallow Bedrock Aquifer: Elev 500 to 800 ft MSL, Depth 0 to 350 ft (100 to 250 ft in most of county)

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Elmhurst-Mt. Simon Aquifer: 2000-2600 ft. Deep Bedrock Aquifer System: 450-800 ft [Ironton-Galesville Aquifer150-200 ft, “Middle Confining Unit” 100-450 ft, Ancell Aquifer 200-450 ft]. Maquoketa Confining Unit: 300-560 ft [Galena-Platteville Groups 300-350 ft, Maquoketa Group 0-210 ft (top eroded in much of county … sometimes unit entirely removed by erosion)]. Shallow Bedrock Aquifer: 50 to 100 ft. Glacial Drift: 0 to 350 ft [individual aquifers up to about 100 ft thick]

[1]Depth estimates assume land surface elevations of 610 to 1065 ft MSL [based on USGS topographic maps]. Aquifer top elevations from Visocky et al (1985), except for shallow bedrock aquifer [Graese et al (1988)]

[2]Unit thicknesses from Visocky et al (1985)

## CAUTION! REMINDER!

Analysis of impacts, not assessment of availability

Using prescribed demand scenarios to evaluate impacts primarily in the form of drawdowns & critical water levels – streamflows have not been assessed yet

Model runs used pumping rates from the various aquifers based on the proportional split of the 2005 pumping rates – sources were not shifted if a source ran out or levels went below a certain level

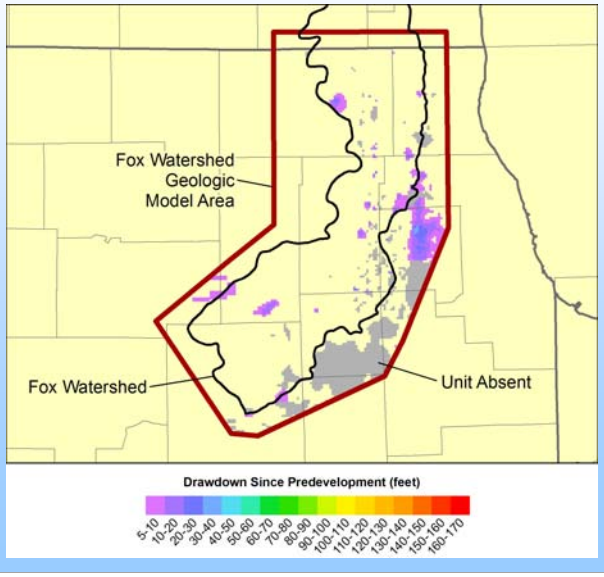
Results from pumping shallow s/g wells outside the FRB are highly uncertain and not shown – uncertainties also exist within the FRB

We have not assessed the shallow bedrock yet or all wells that went "dry"

Several items worth noting concerning the regional model and the results the model provides: (1) the model provides output as layer "heads" (water level elevations) from which potentiometric surfaces or drawdowns can be shown (results today will be shown as drawdowns). (2) Prescribed demands were used in the model as input to simulate impacts. Drawdowns are one form of an impact. Drawdowns that are too great will reach critical levels, such as dewatering aquifers or reducing base flows in streams. We have run only the 3 basic scenarios not drought or climate change. Nor have the results so far been examined to evaluate baseflows. Remember that an evaluation of the impacts of demand scenarios is NOT the same as a very different and much more difficult question to answer – how much water is available? (3) Certain assumptions had to be made in the model. One of those assumptions concerned the water source used to meet the demand scenarios. We assumed that future withdrawals will be sourced in the same proportion as in 2005, so for example, a 70%/30% split between deep & shallow aquifer withdrawals for a community in 2005 stayed that way all the way out to 2050. (4) Finally, the shallow aquifer part of the model contains the most geologic detail inside the Fox River Basin (FRB). Model results for shallow sand and gravel aquifer areas outside the FRB are highly uncertain and not reliable.

## Drawdown in Quaternary Coarse-Grained Unit 2

*End of Summer Irrigation Season, 1985*

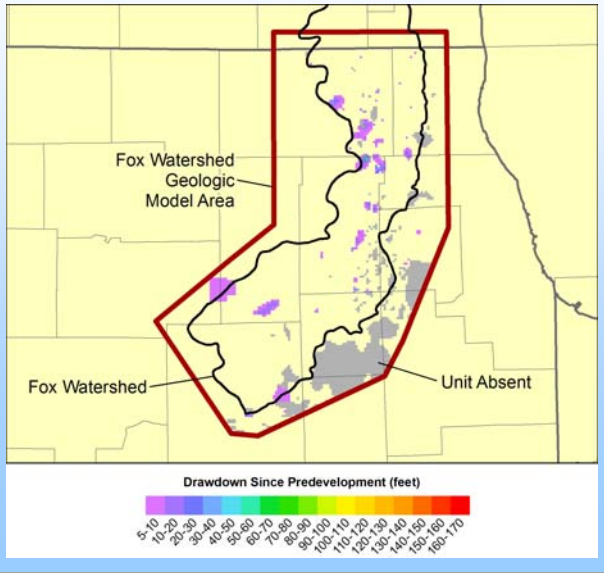



Red boundary denotes area of detailed 5-layer geologic modeling of the shallow unconsolidated deposits above bedrock. The regional model outside the red boundary also contains a 5-layer depiction of these shallow deposits, but unlike inside the red boundary, is not a true representation of layer variability (thickness, presence/absence, interconnectedness). “Quaternary Coarse-Grained Unit 2” means the basal sand aquifer lying on the bedrock surface and is the most-used sand/gravel unit for community supply. This slide shows conditions at the end of the summer irrigation season in 1985. Greatest drawdowns can be seen in DuPage County, Woodstock area in McHenry County, and Montgomery, Kane County. This represents a time before Lake Michigan allocations had been extended to DuPage County. Drawdowns in DuPage County are a reflection of pumping from shallow bedrock?

Model results for areas outside the red boundary in this and following slides are “clipped” (not shown).

## Drawdown in Quaternary Coarse-Grained Unit 2

*End of Summer Irrigation Season, 2005*

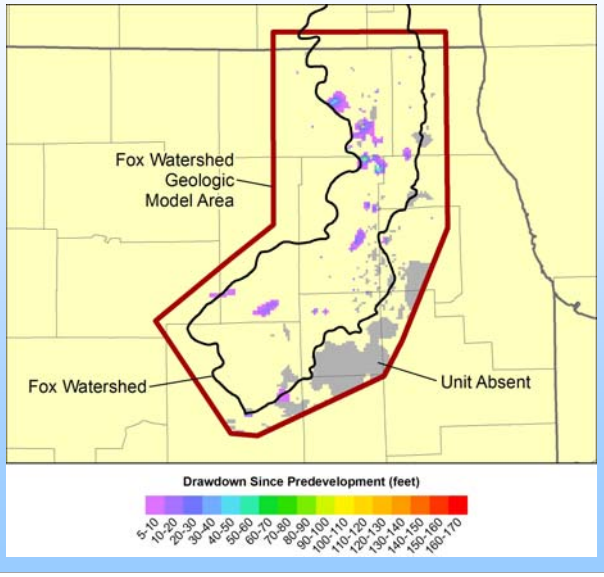



Shallow aquifer results for 2005. Note the disappearance of the cone of depression in DuPage County as a result of Lake Michigan allocations into the County. Proceeding north to south through the Fox River basin, we see developing cones of depression in Woodstock, Crystal Lake, Algonquin, Carpentersville, Elgin/South Elgin, Batavia/St.Charles, and Montgomery.

## Drawdown in Quaternary Coarse-Grained Unit 2

*End of Summer Irrigation Season, 2025*

***Baseline Scenario***

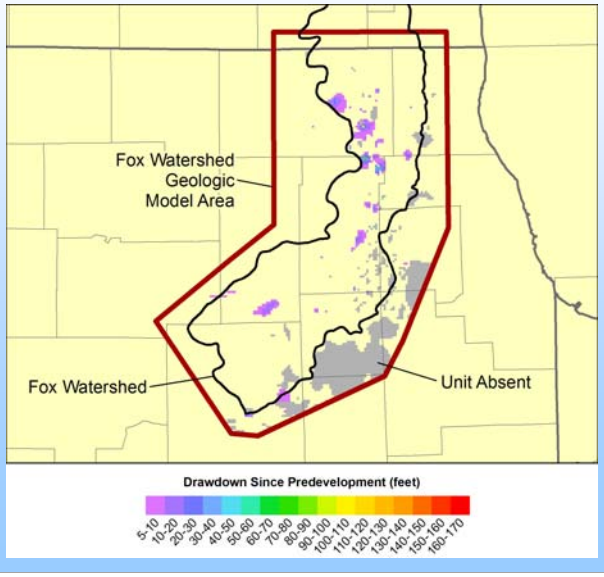



2025 Baseline Scenario results for the basal sand and gravel aquifer. This and the next two slides will step us through the 2025 drawdowns for the baseline, less resource intensive, and more resource intensive scenarios. We see deepening cones of depression especially at Woodstock, Crystal Lake, Algonquin, and Carpentersville.

## Drawdown in Quaternary Coarse-Grained Unit 2

*End of Summer Irrigation Season, 2025*

***Less Resource-Intensive Scenario***

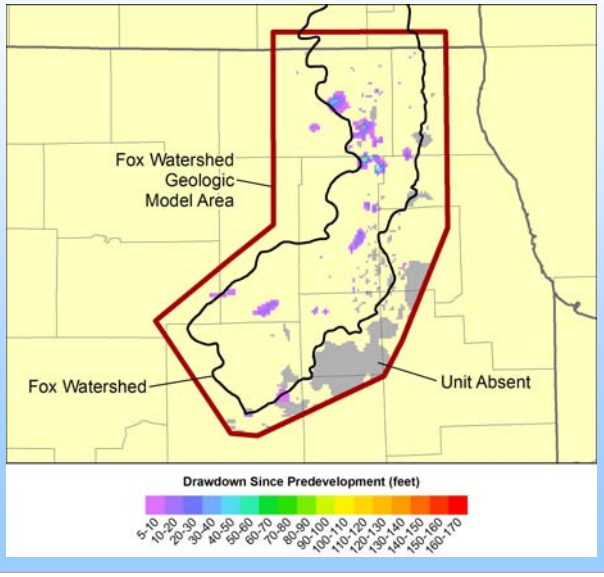



2025 LRI Scenario results for the basal sand and gravel aquifer.

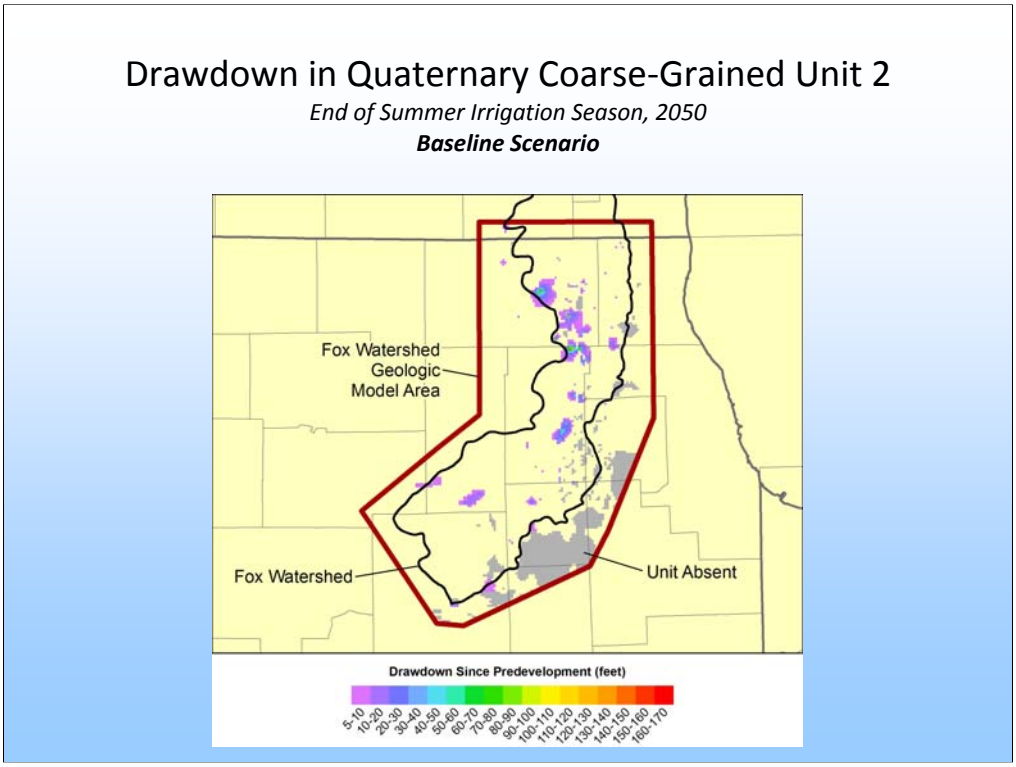
## Drawdown in Quaternary Coarse-Grained Unit 2

*End of Summer Irrigation Season, 2025*

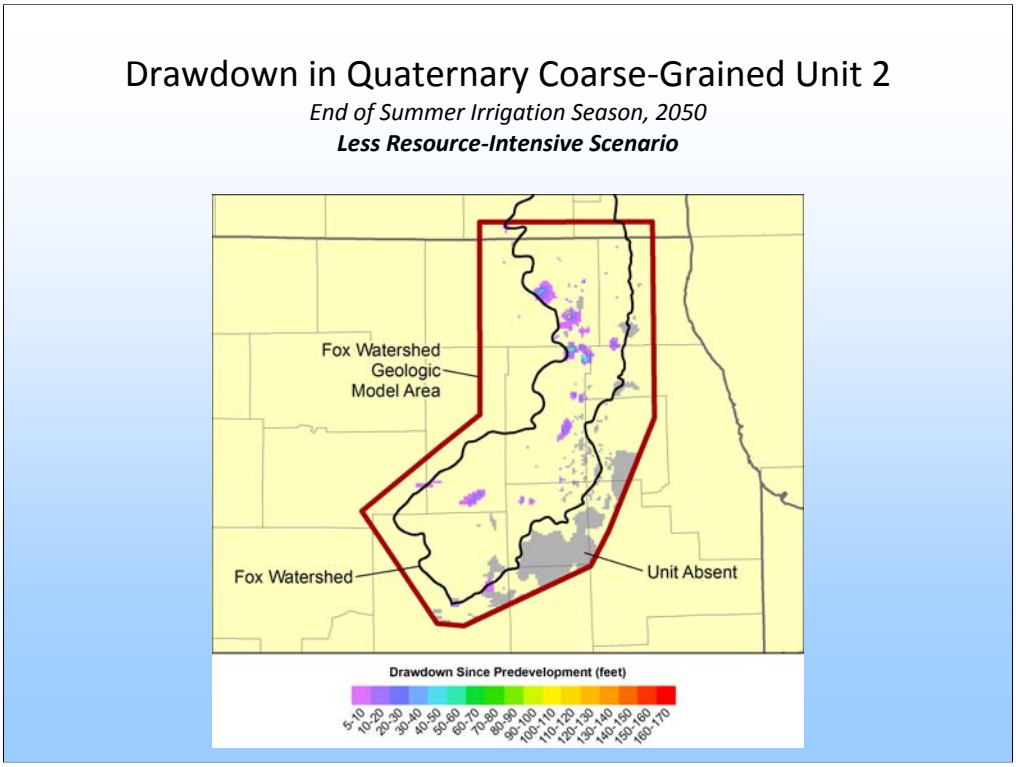
***More Resource-Intensive Scenario***




2025 MRI Scenario results for the basal sand and gravel aquifer.




2050 Baseline Scenario results for the basal sand and gravel aquifer.

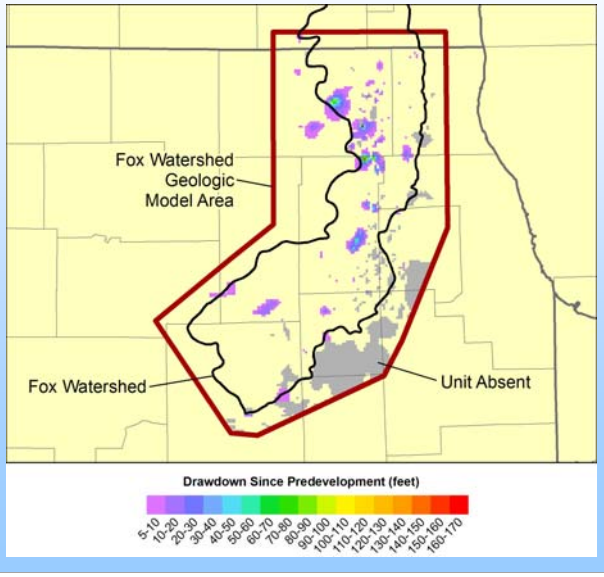



2050 LRI Scenario results for the basal sand and gravel aquifer.

## Drawdown in Quaternary Coarse-Grained Unit 2

*End of Summer Irrigation Season, 2050*

***More Resource-Intensive Scenario***



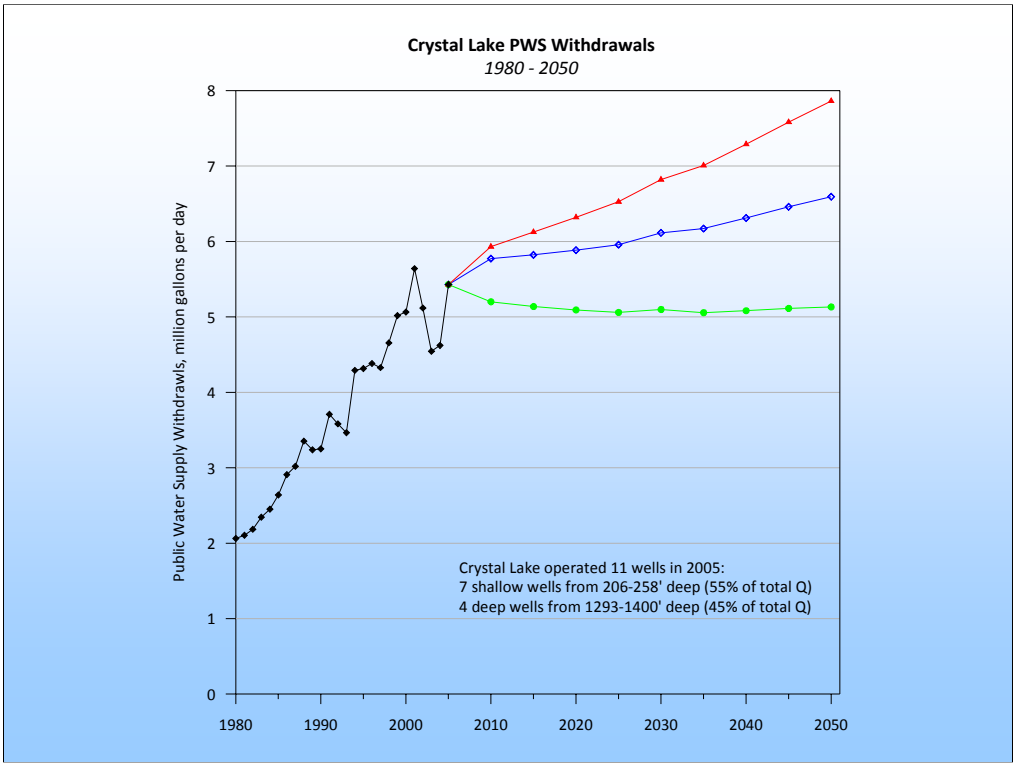

2025 MRI Scenario results for the basal sand and gravel aquifer. Very deep cones evident in Crystal Lake and Algonquin.

## Simulated Hydrograph Locations

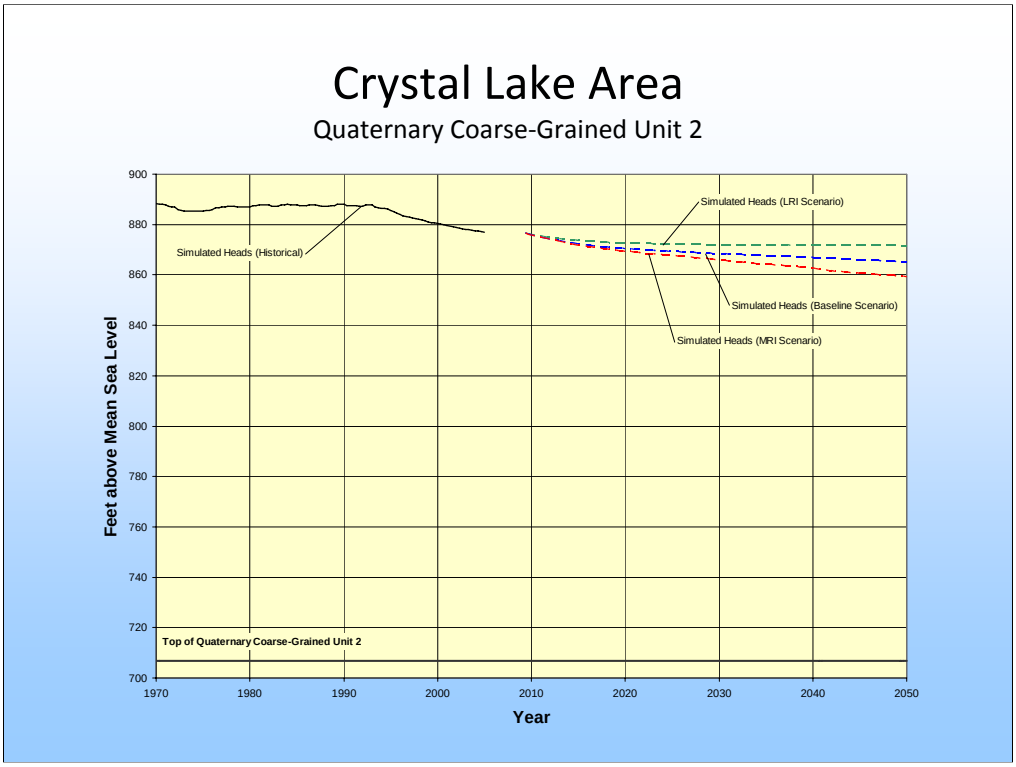
- Coarse-Grained Unit 2 (Model Layer 5)
- "Deep" Bedrock Ancell & Ironton-Galesville Units (Model Layers 14 & 17)


Locations we chose for presentation of hydrographs due to proximity to the cones of depression just displayed. In this case, we selected model cells in Unit 5, but we still need to look at other model layers, such as Coarse-Grained Unit 1.

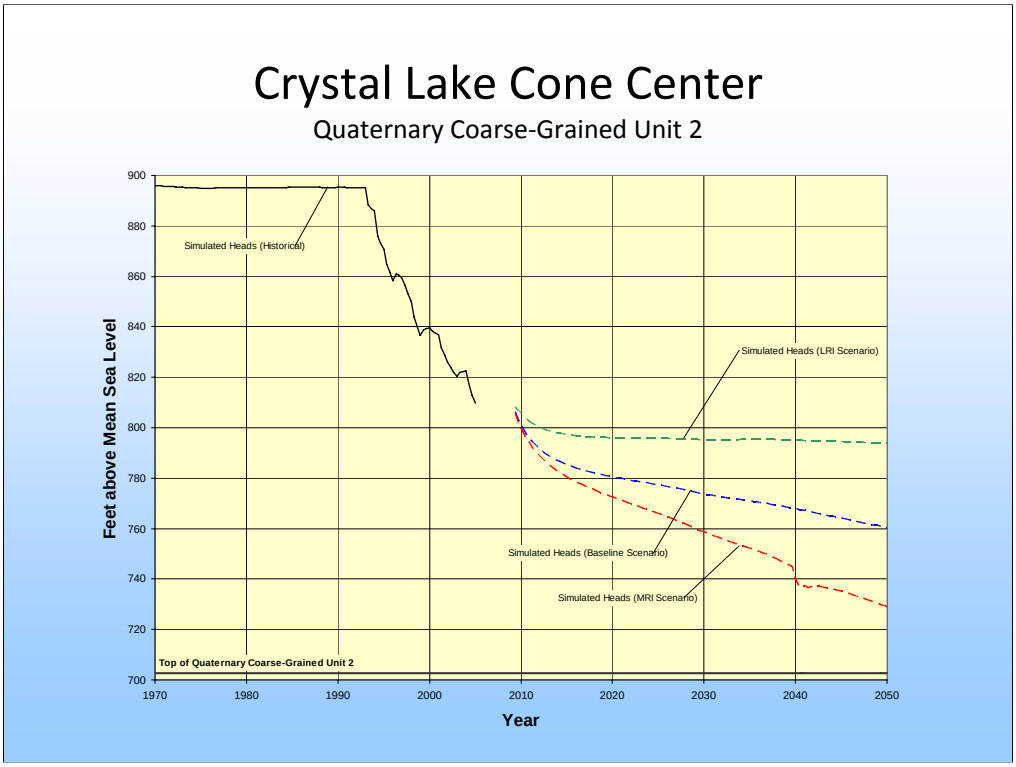
Also will be displaying hydrographs of deep bedrock model cells later in the presentation.



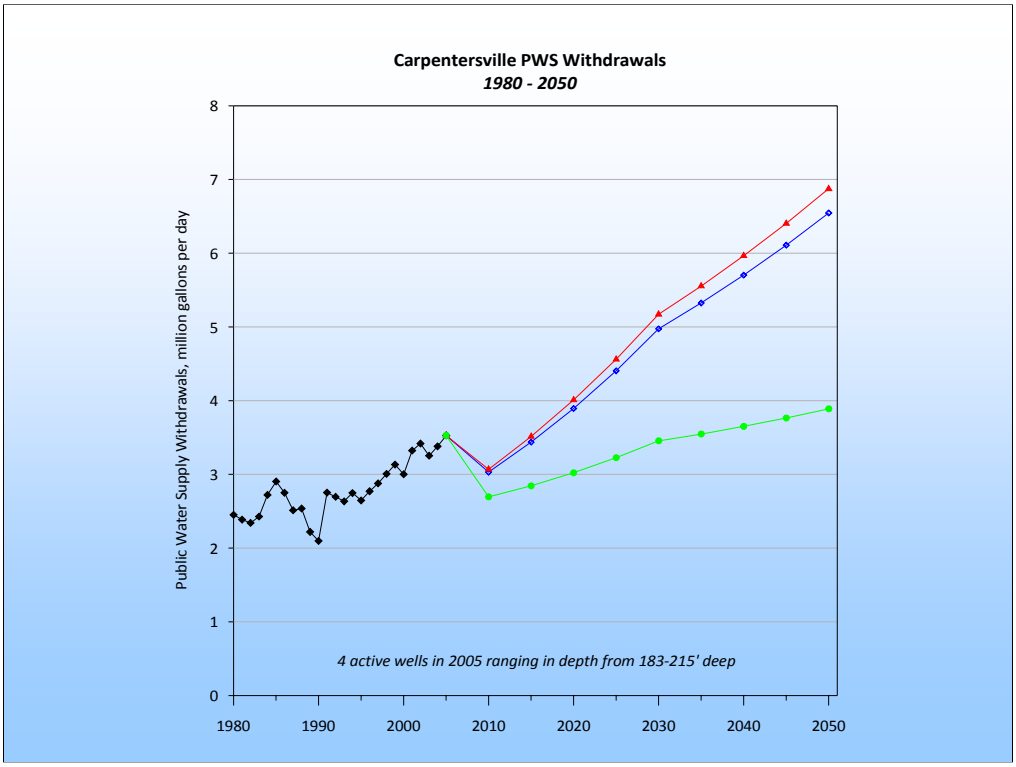

Crystal Lake withdrawals. The three future scenarios for Crystal Lake are relatively well separated.



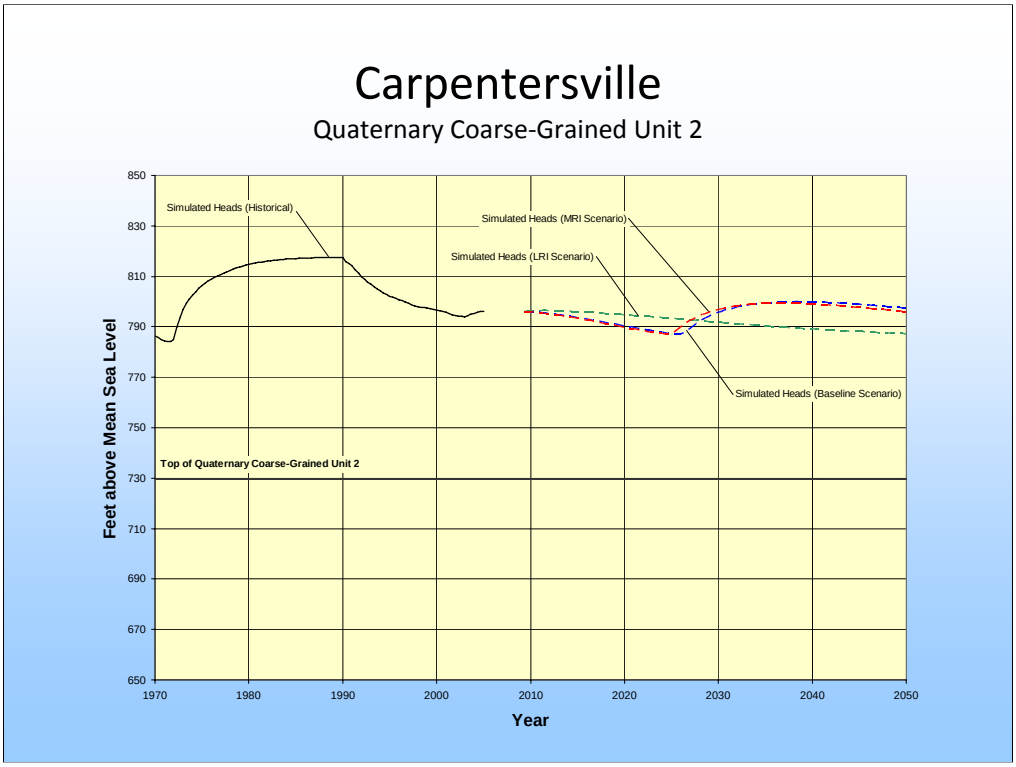

Hydrograph of water levels near Crystal Lake.



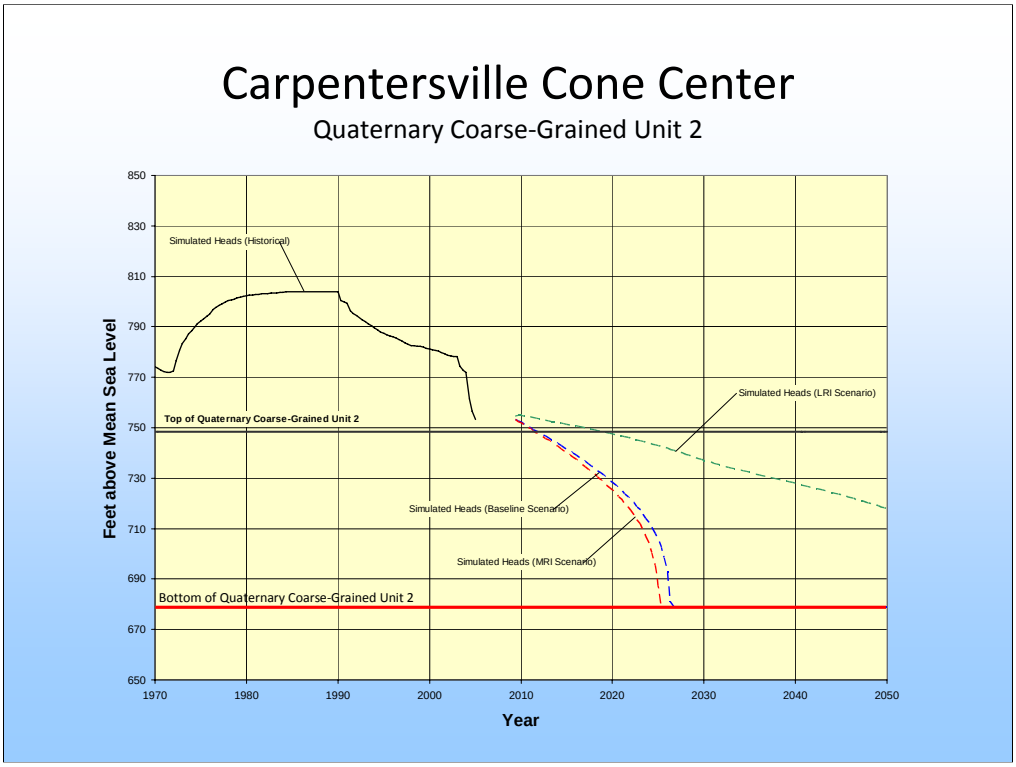

Hydrograph of water levels in a model cell near the center of the Crystal Lake pumping center. This graphic suggests pumping in this area can be achieved safely, if the only impact consideration is not pulling water levels down into the aquifer. (A check on water levels in shallower units and impacts on nearby streamflows is still needed.)



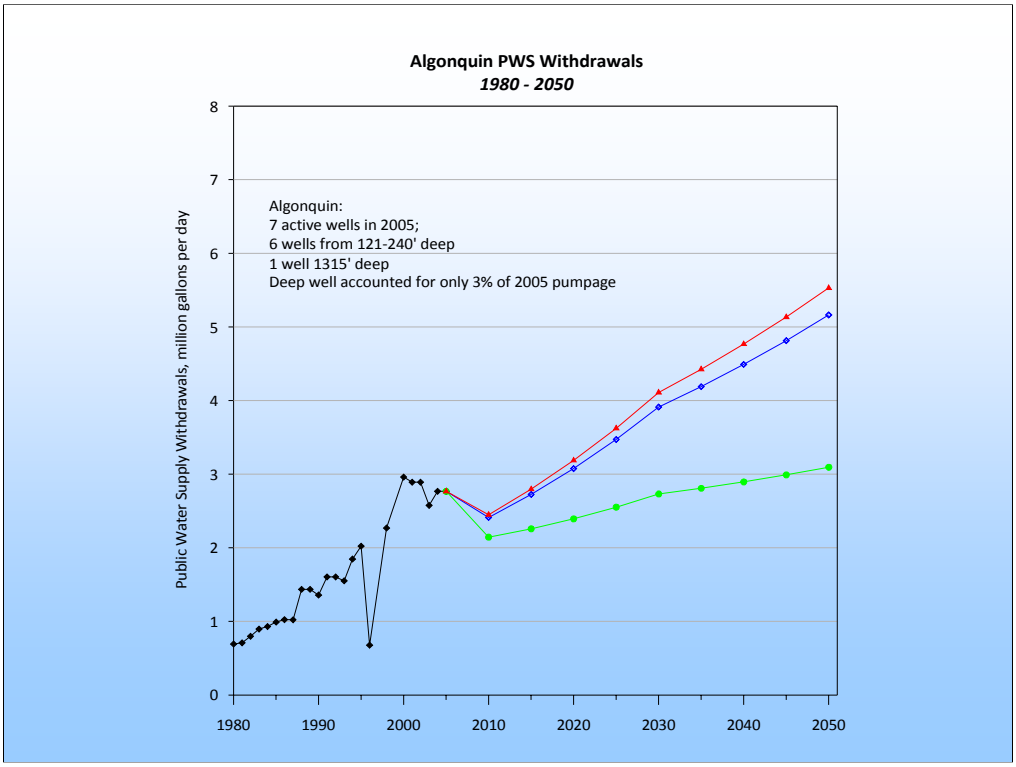

Actual historical and model simulated demand scenarios for Carpentersville. Unlike the Crystal Lake withdrawals displayed earlier, the BL and MRI scenarios are relatively similar with the LRI scenario being much lower. Note, too, that all of Carpentersville's wells are sand & gravel wells completed in Quaternary coarse-grained unit 2.



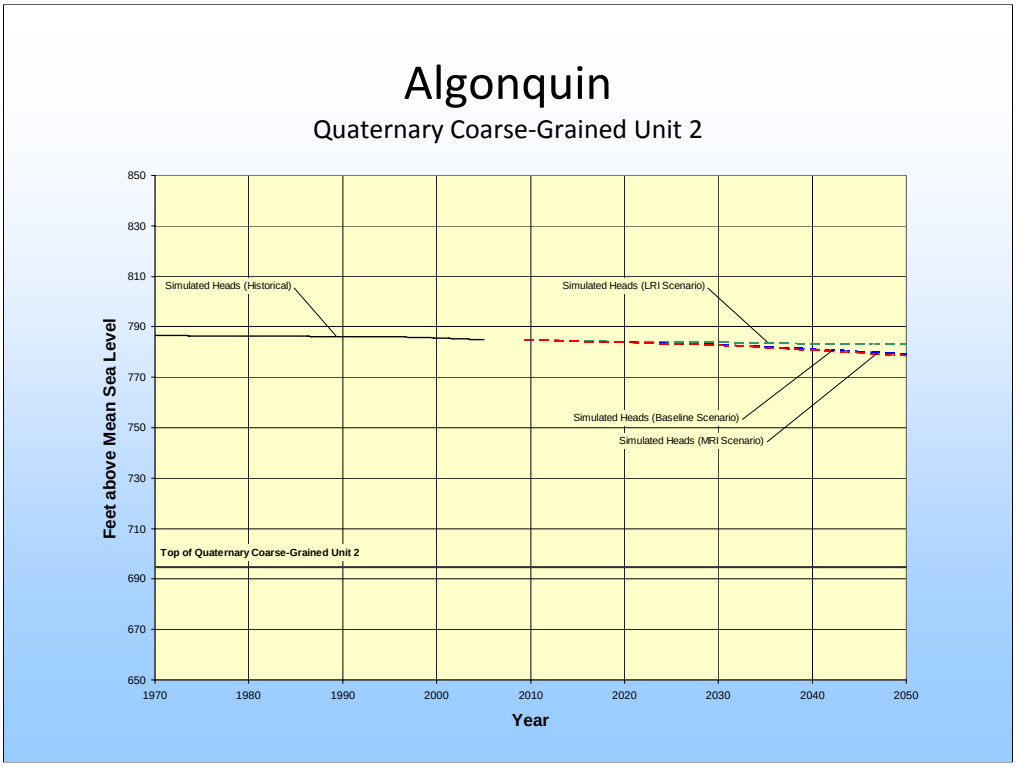

Hydrograph for a model cell near C'ville. Note the water level "rise" in the BL and MRI scenarios around 2025. This is due to wells going off nearby.



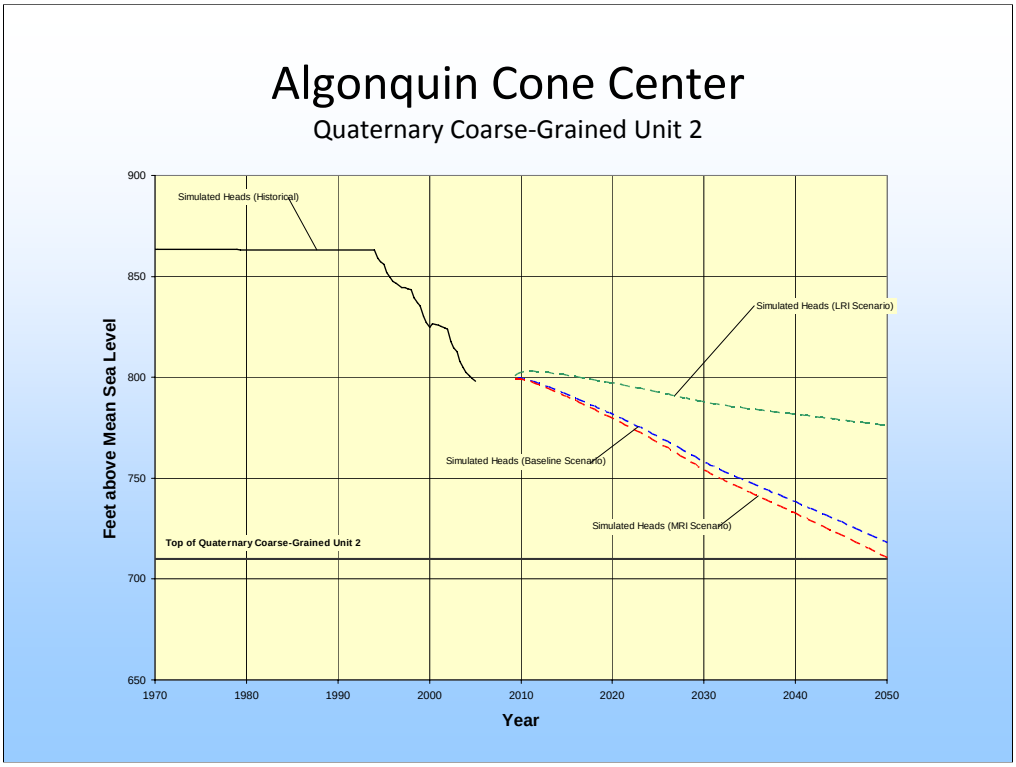

This hydrograph of water levels was selected for a model cell near the center of the Carpentersville cone of depression. The hydrographs for the Baseline and MRI scenarios shows the aquifer cannot meet those demands some time around 2025. We are looking closely at this because we did not see this in our more highly resolved model for Kane County, but I must also caution that the demand projections we used in the Kane model were not as high as the BL and MRI scenarios.



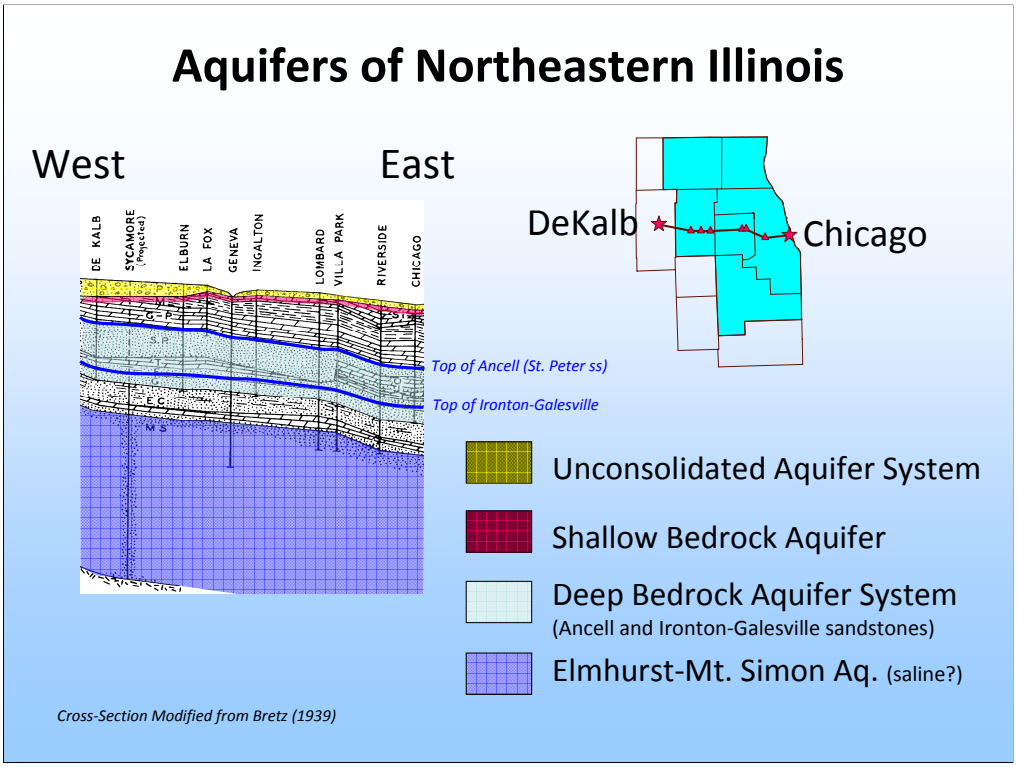

Algonquin withdrawals.Again, see how similar the BL and MRI scenarios are. Algonquin operates 7 wells, of which only one is not a sand & gravel well. The deep bedrock wells pumped only 3% of their water.




Hydrograph of model cell near Algonquin.




Hydrograph of model cell in Algonquin pumping center. The BL and MRI scenarios show water levels reaching top of the aquifer by 2050.

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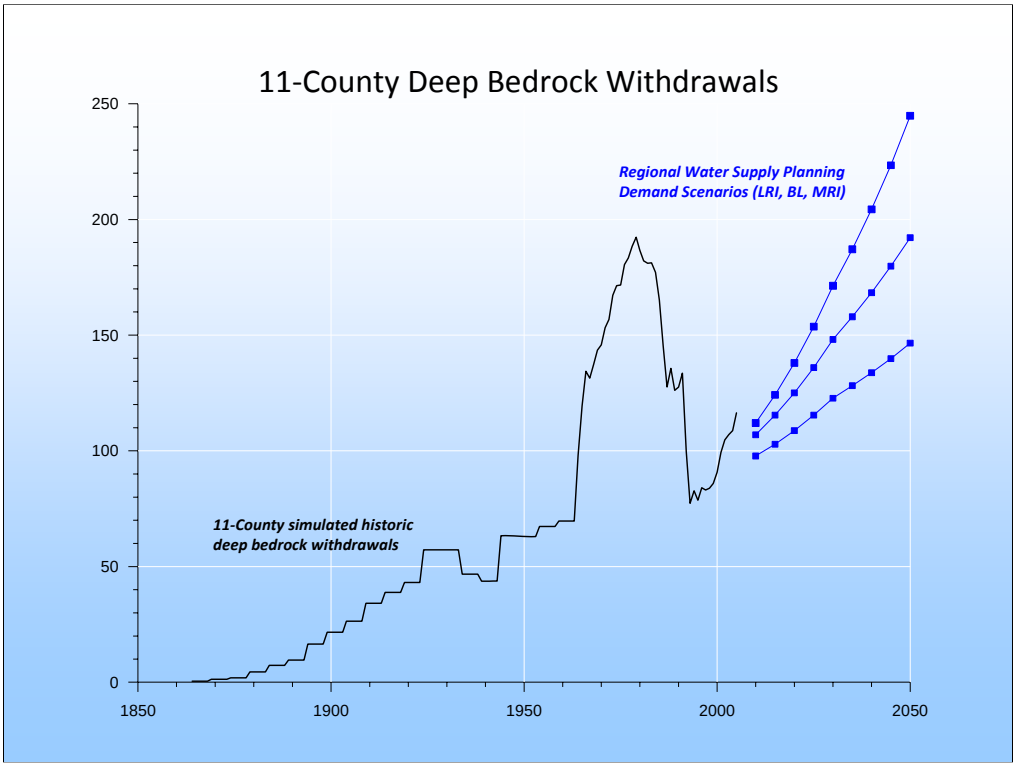
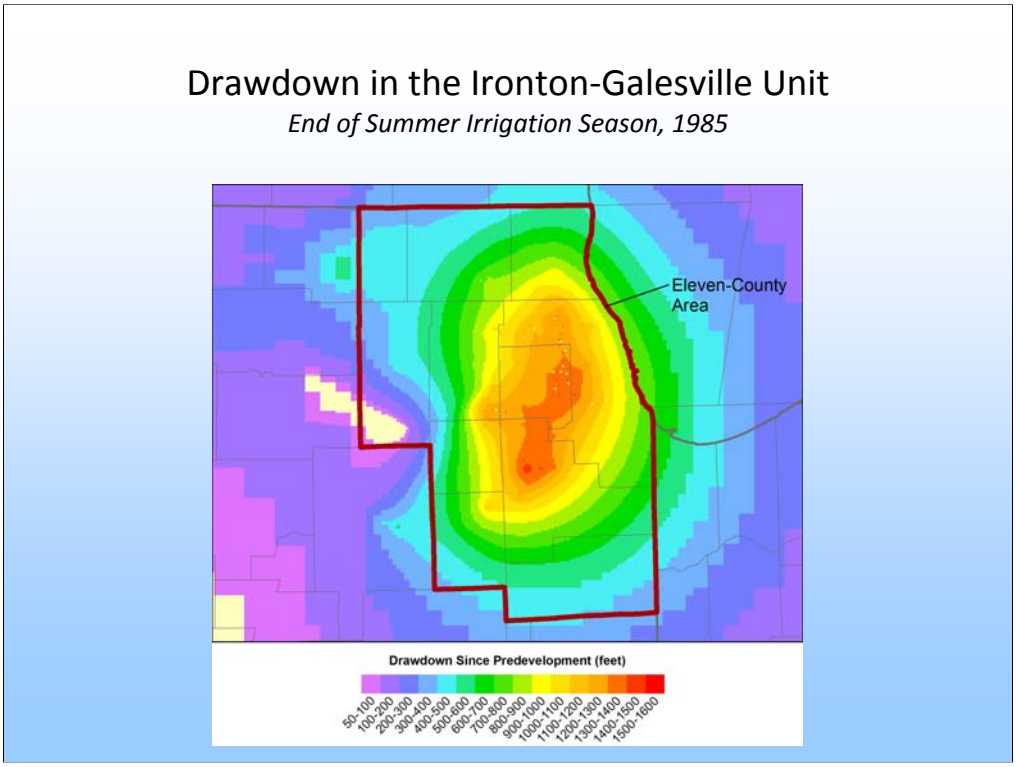


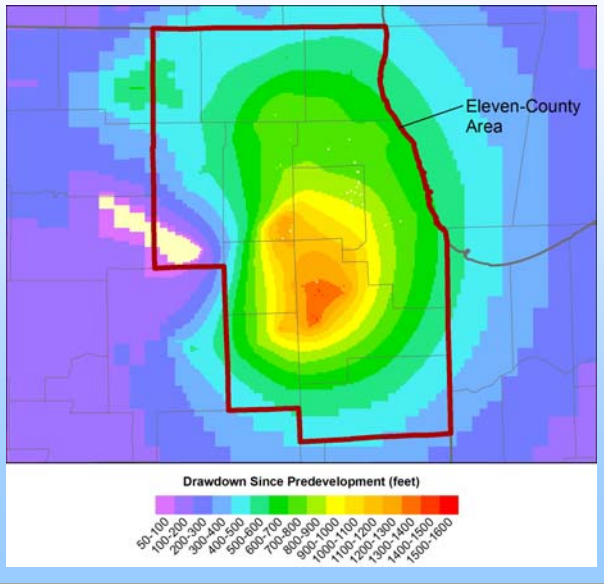

Deep bedrock withdrawals within the 11-county planning region. Deep bedrock withdrawals outside the 11-county region but within the model domain were simulated to grow along one straight-line path as projected by Dziegielewski (2000?) for the Midwest.



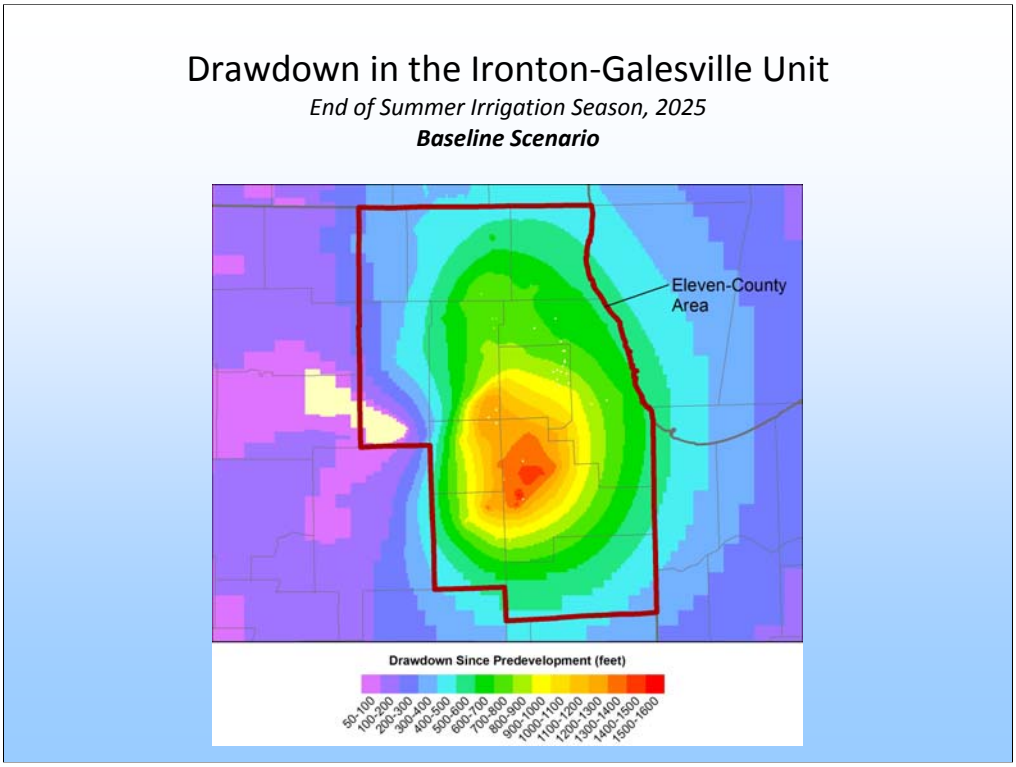

Drawdown in the I-G, model layer 17, in 1985. Deep cone has developed in eastern DuPage and northwestern Will Counties. Where the colors are closer together, the cone of depression is steeper than where the color bands are wider.

## Drawdown in the Ironton-Galesville Unit

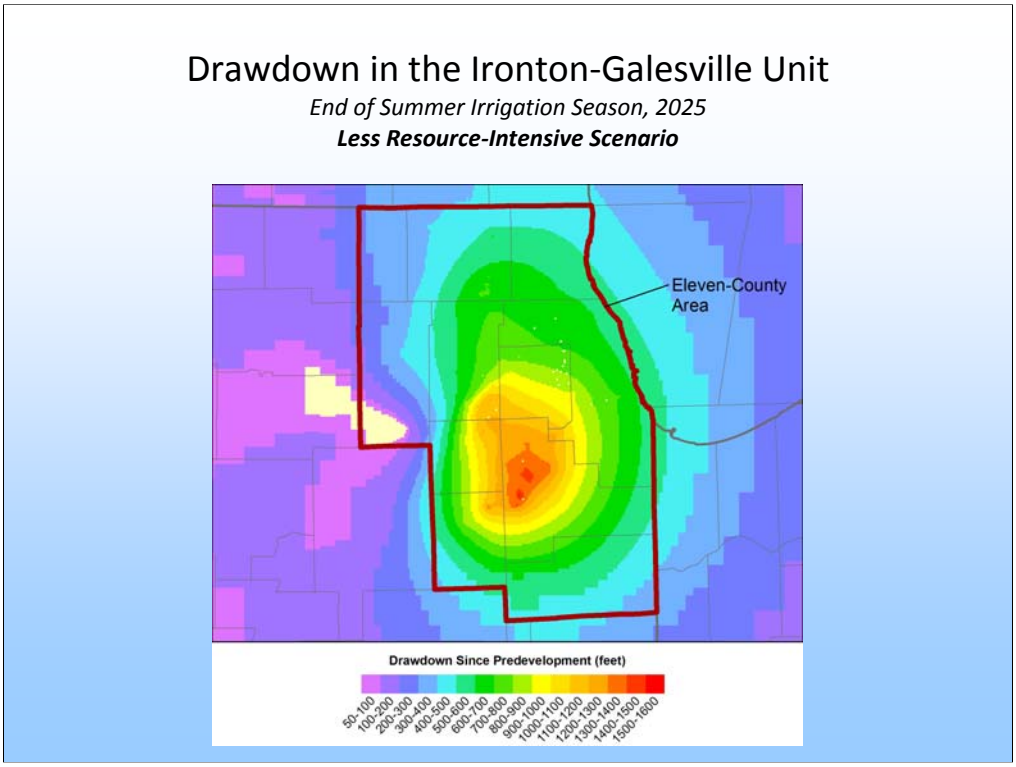
*End of Summer Irrigation Season, 2005*



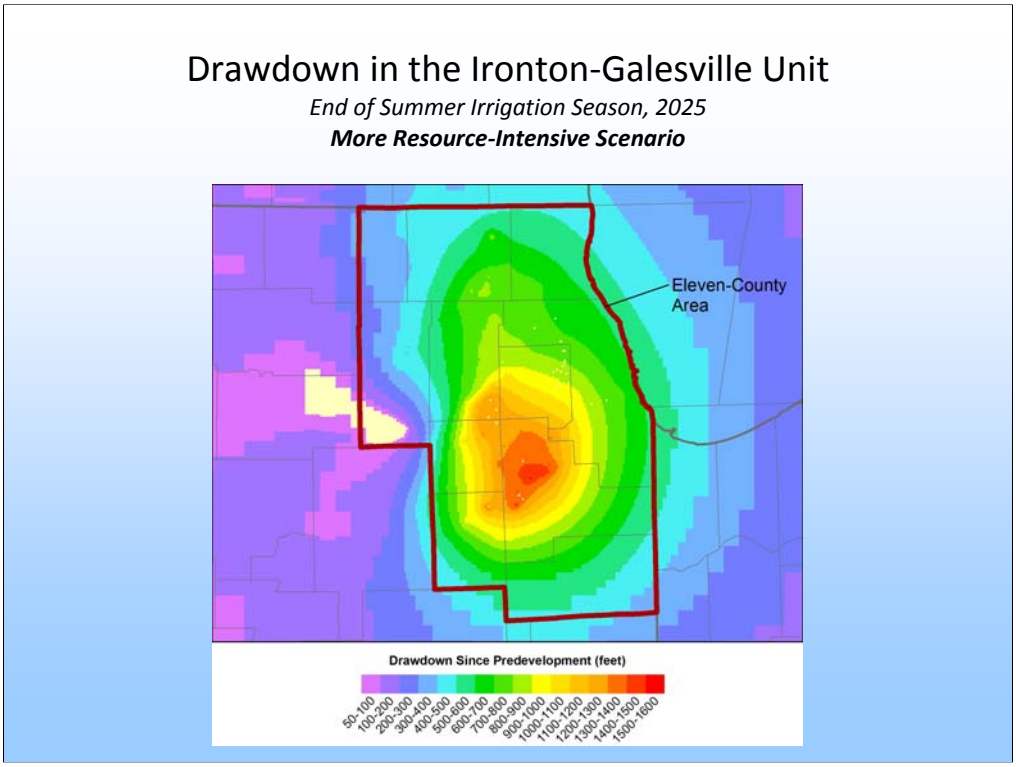

Drawdown in 2005. Deepest part in Will County. Deeper area in DuPage County has experienced some recovery – still some 600-800' below predevelopment levels.




Model results for the I-G in 2025, baseline scenario.




Model results for the I-G in 2025, LRI scenario.

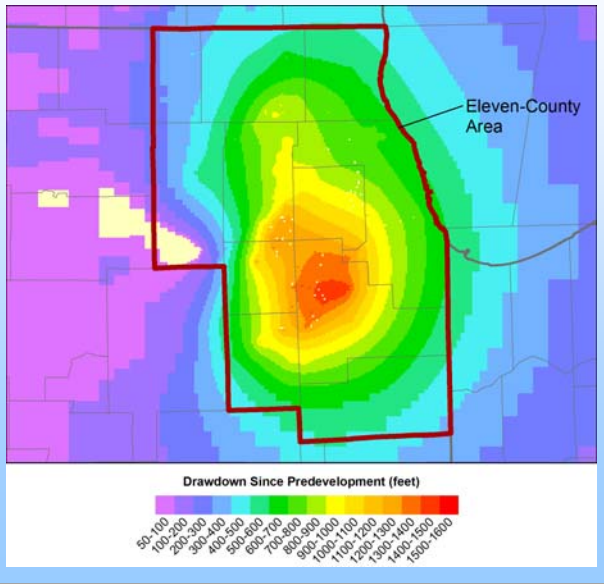



Model results for the I-G in 2025, MRI scenario.

## Drawdown in the Ironton-Galesville Unit

*End of Summer Irrigation Season, 2050*

***Baseline Scenario***

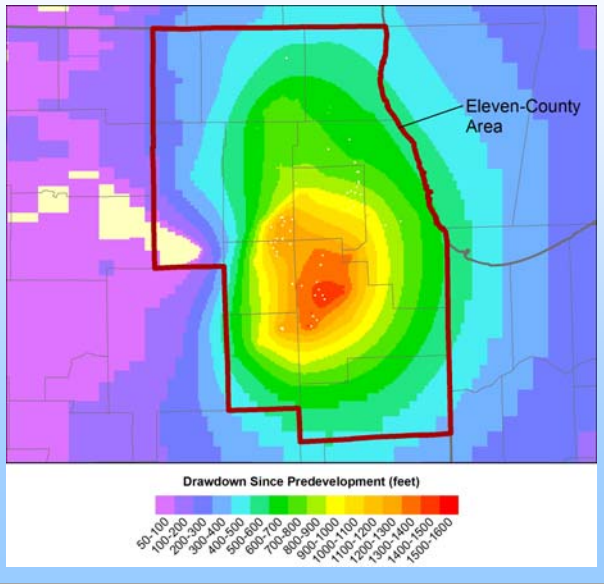



Model results for the I-G in 2050, baseline scenario. Can see migration of the cone northward along Fox River up eastern Kane County.

## Drawdown in the Ironton-Galesville Unit

*End of Summer Irrigation Season, 2050*

***Less Resource-Intensive Scenario***

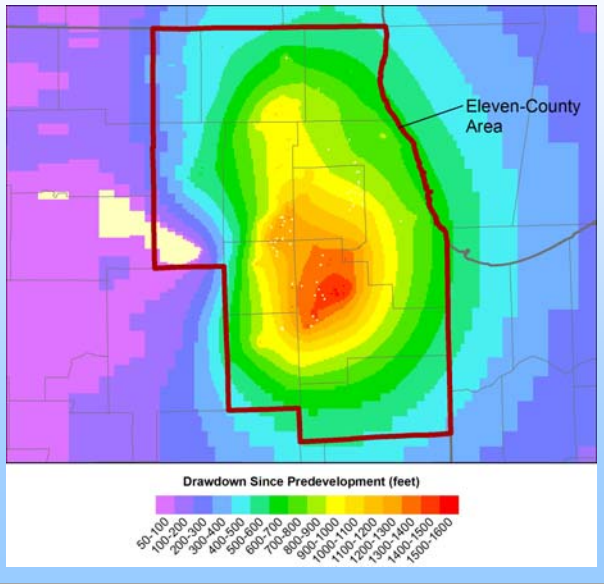



Model results for the I-G in 2050, LRI scenario.

## Drawdown in the Ironton-Galesville Unit

*End of Summer Irrigation Season, 2050*

***More Resource-Intensive Scenario***

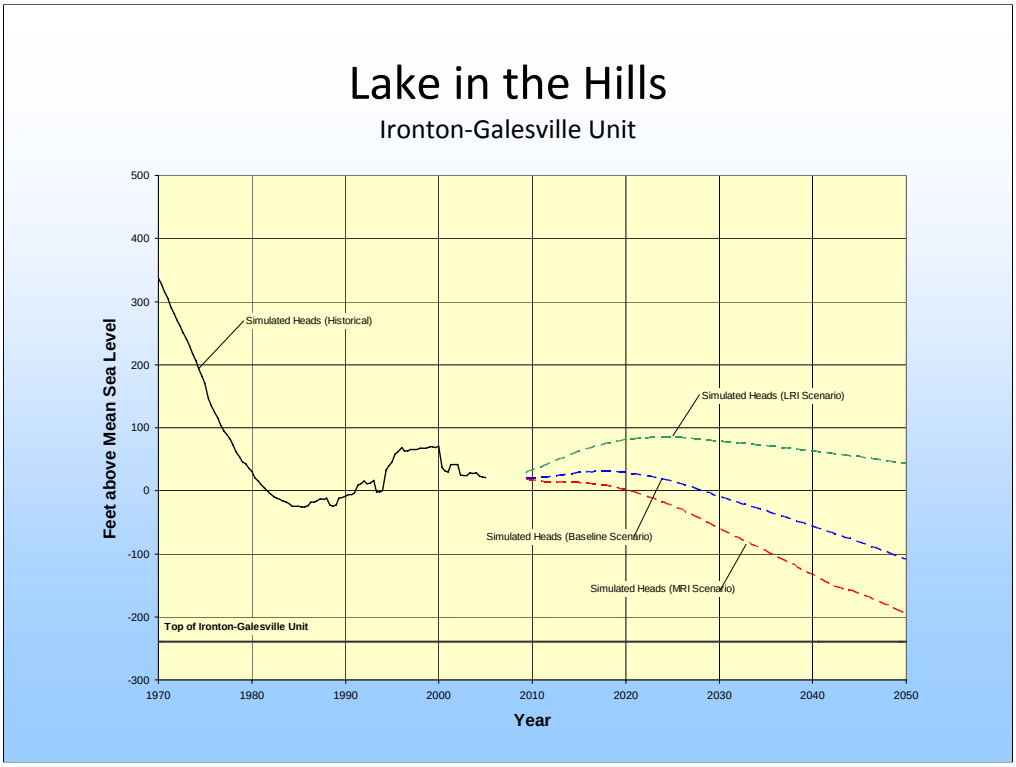



Model results for the I-G in 2050, MRI scenario. Cone progressing well up into McHenry County.

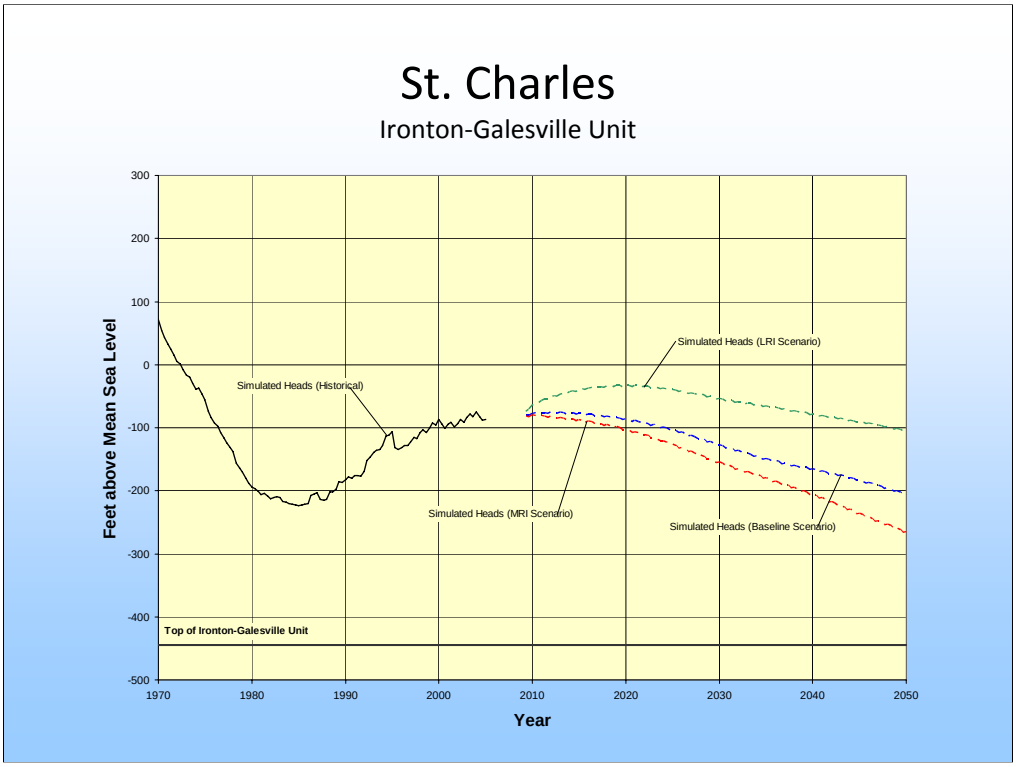
# Simulated Hydrograph Locations

- Coarse-Grained Unit 2 (Model Layer 5)
- "Deep" Bedrock Ironton-Galesville Unit (Model Layer 17)

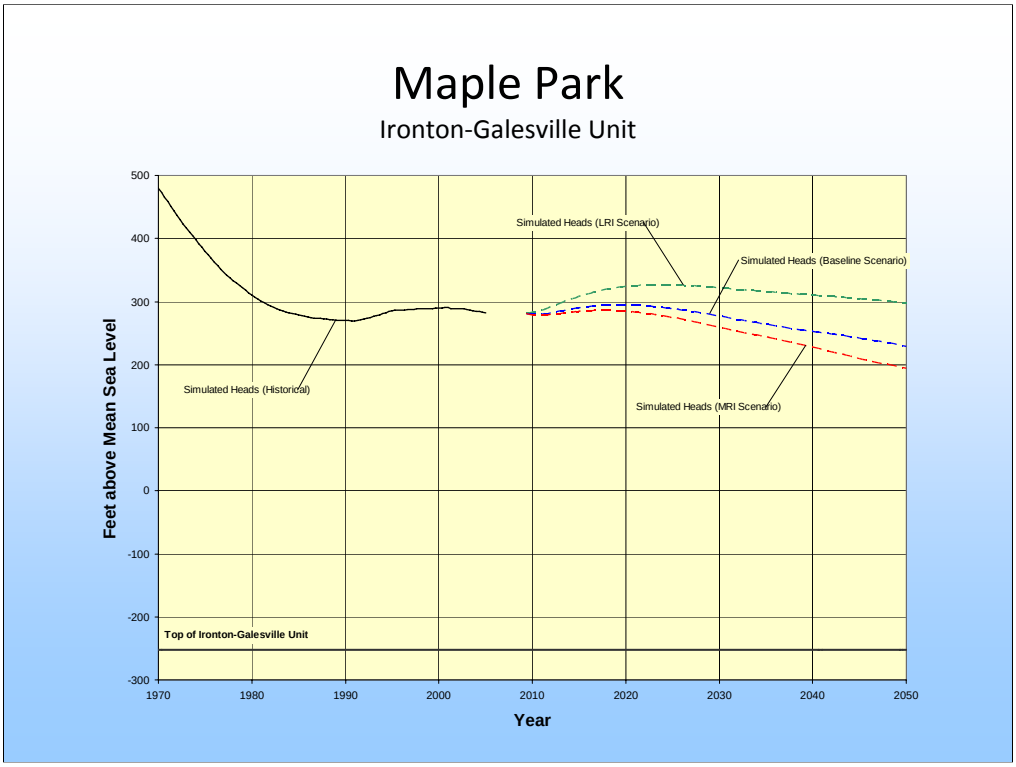

Selected hydrograph locations near-to and away-from deep bedrock cones of depression.



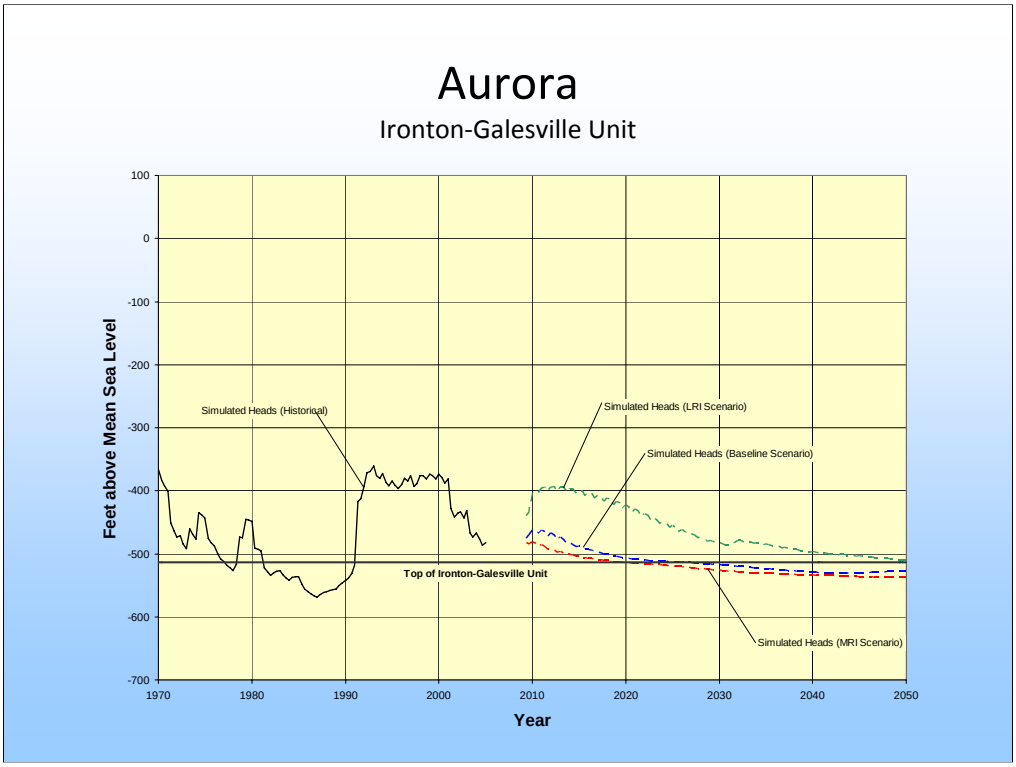

Scenario hydrographs for model cell near L-I-T-H. Heads within 100’ of top of aquifer with MRI scenario in 2040.



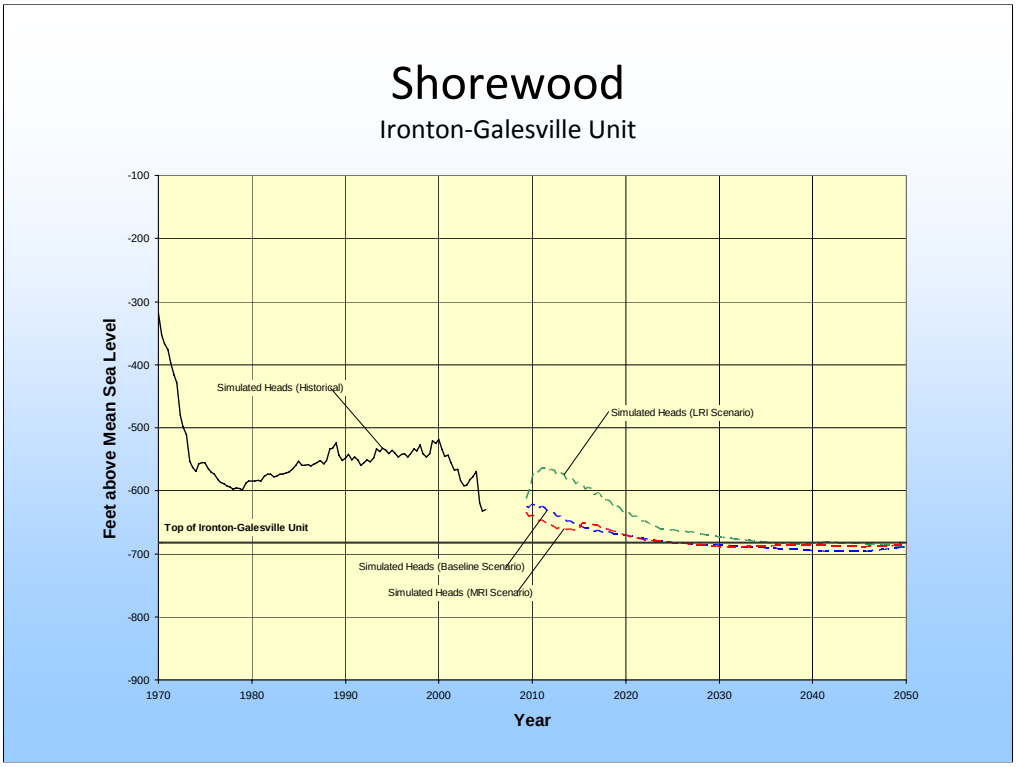

Scenario hydrographs for model cell near St. Charles. Over 100’ of head over top of aquifer in all scenarios.



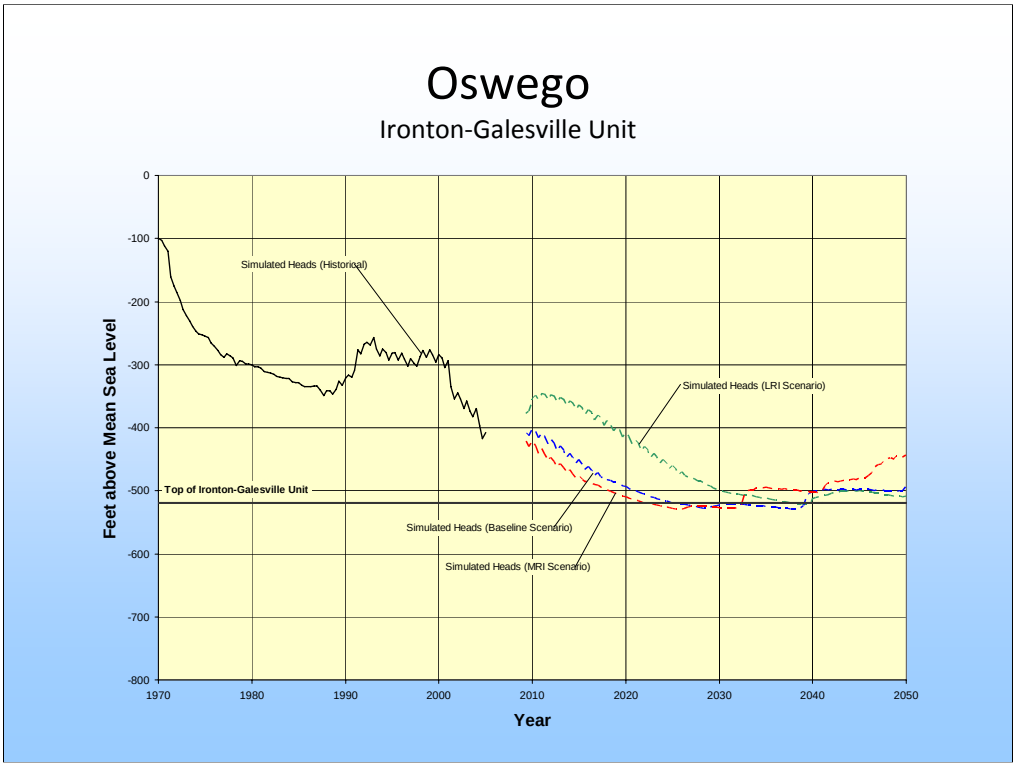

Scenario hydrographs for model cell near St. Charles. Over 400’ of head over top of aquifer in all scenarios. Maple Park is very far western Kane County  far away from pumping centers.




Scenario hydrographs for model cell near Aurora. Less than 100’ of head over top of aquifer in all scenarios including now. Heads were in the aquifer back in the 1980s.




Scenario hydrographs for model cell near Shorewood. Less than 100’ of head over top of aquifer in all scenarios including now.

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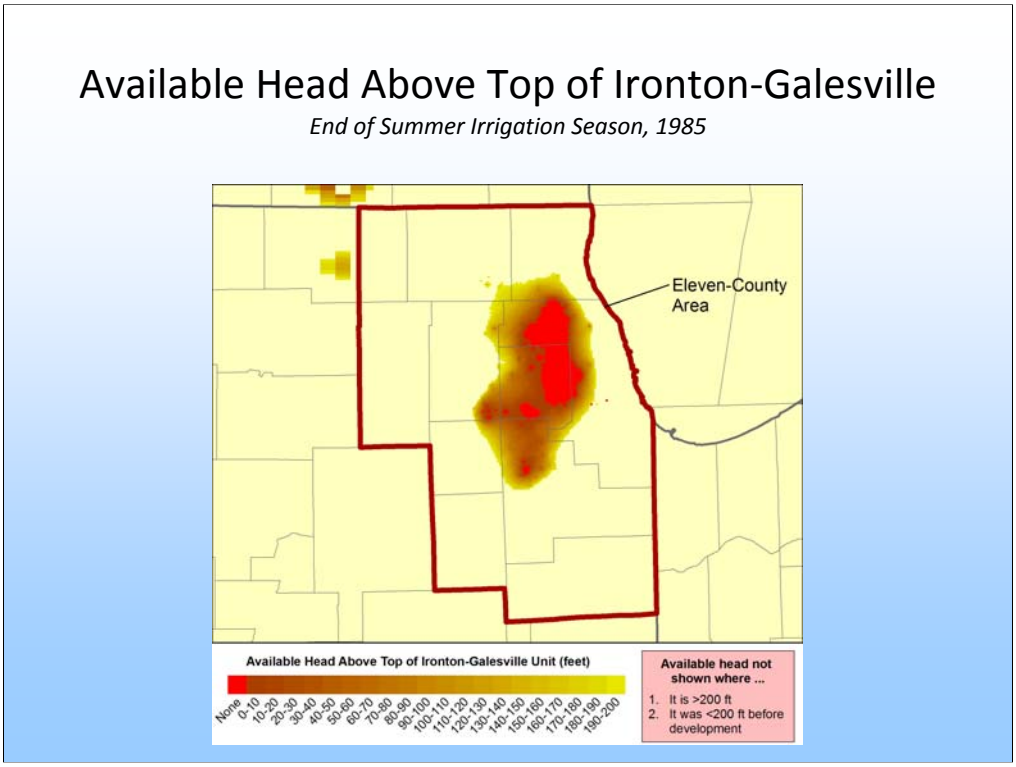
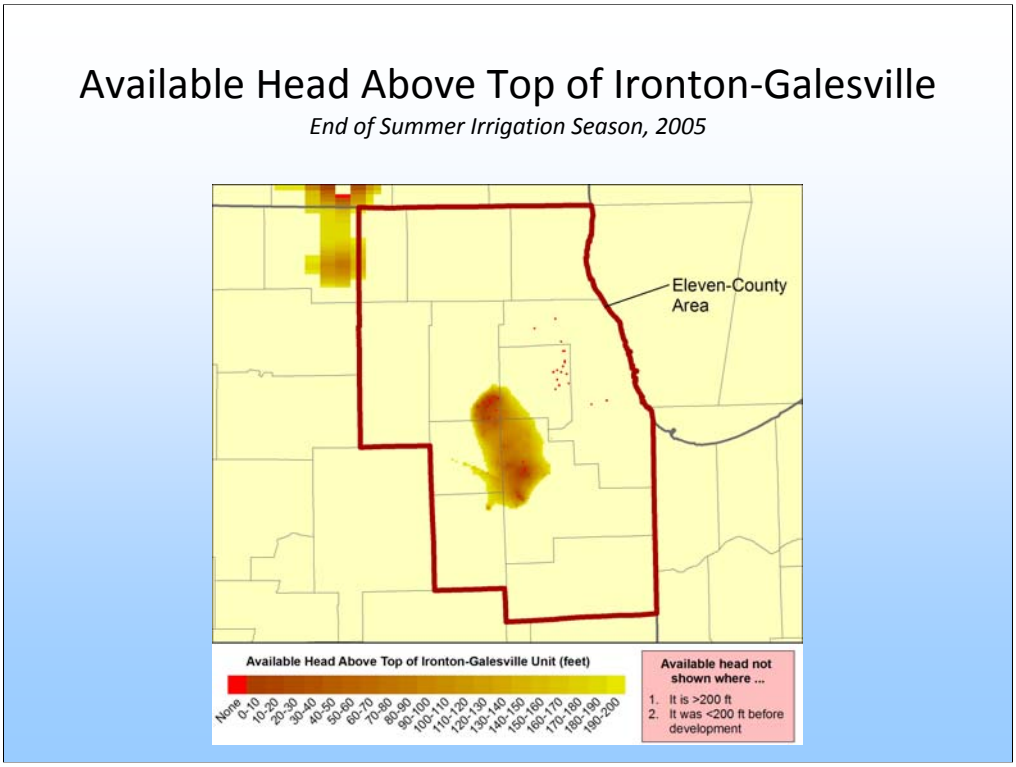
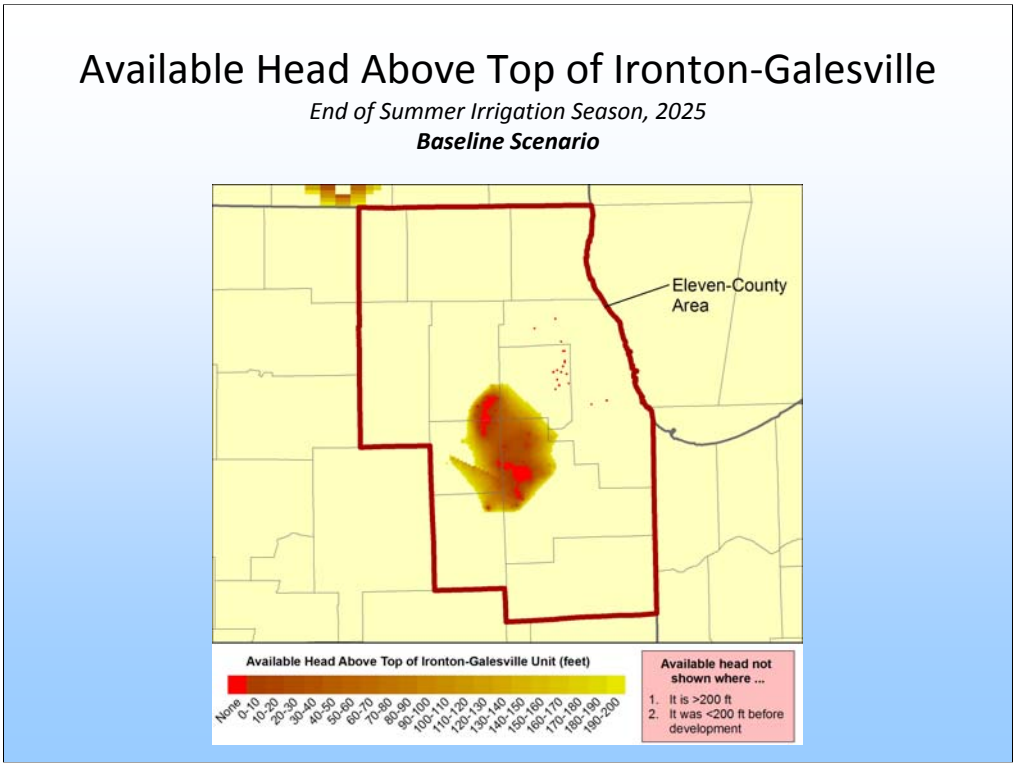


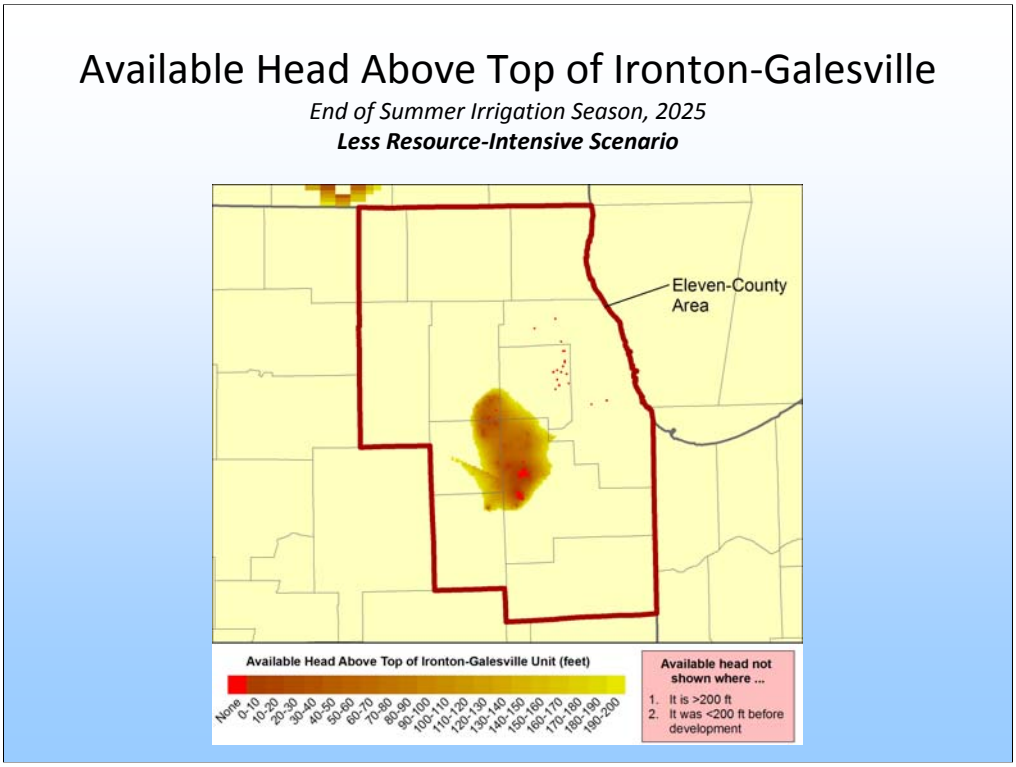

Map of available heads over the I-G. This map and the following similar maps were prepared to show where available head is/was less than 200', provided it was more than 200' originally (pre-development). We also do NOT show areas if it was less than 200' originally – mostly to the west.



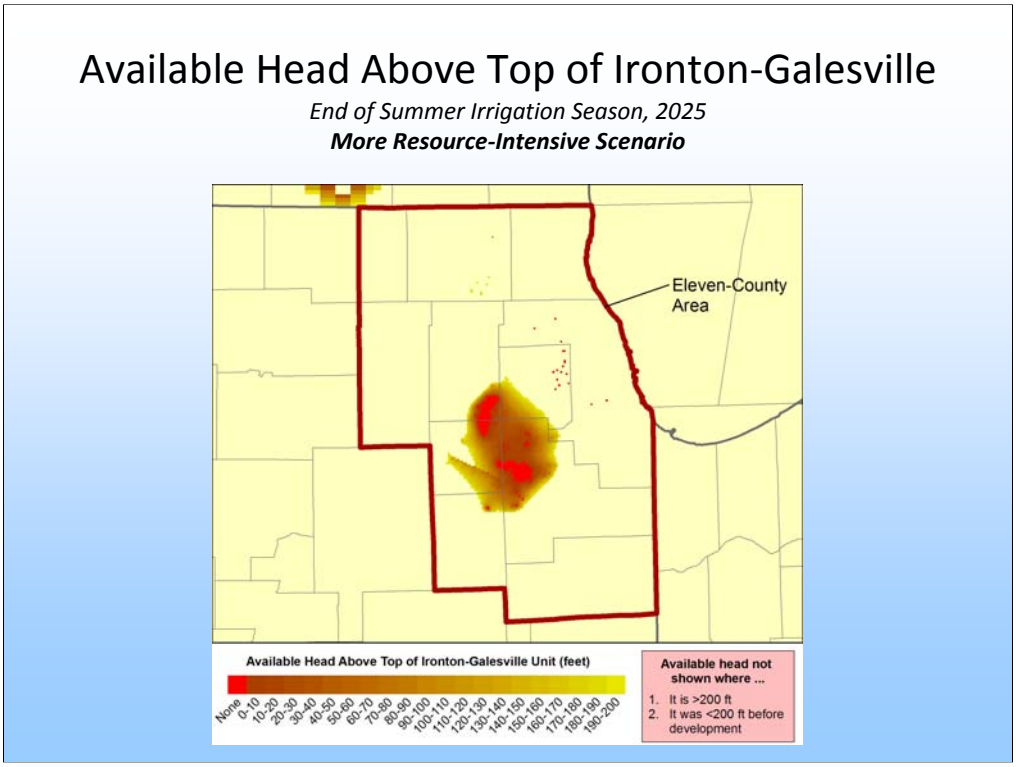

Situation that simulates conditions similar to today. The red dots are model cells and are model artifacts resultig from the previous deeper conditions. They go away eventually. You can also see the Sandwich Fault as the line emerging across Kendall County.



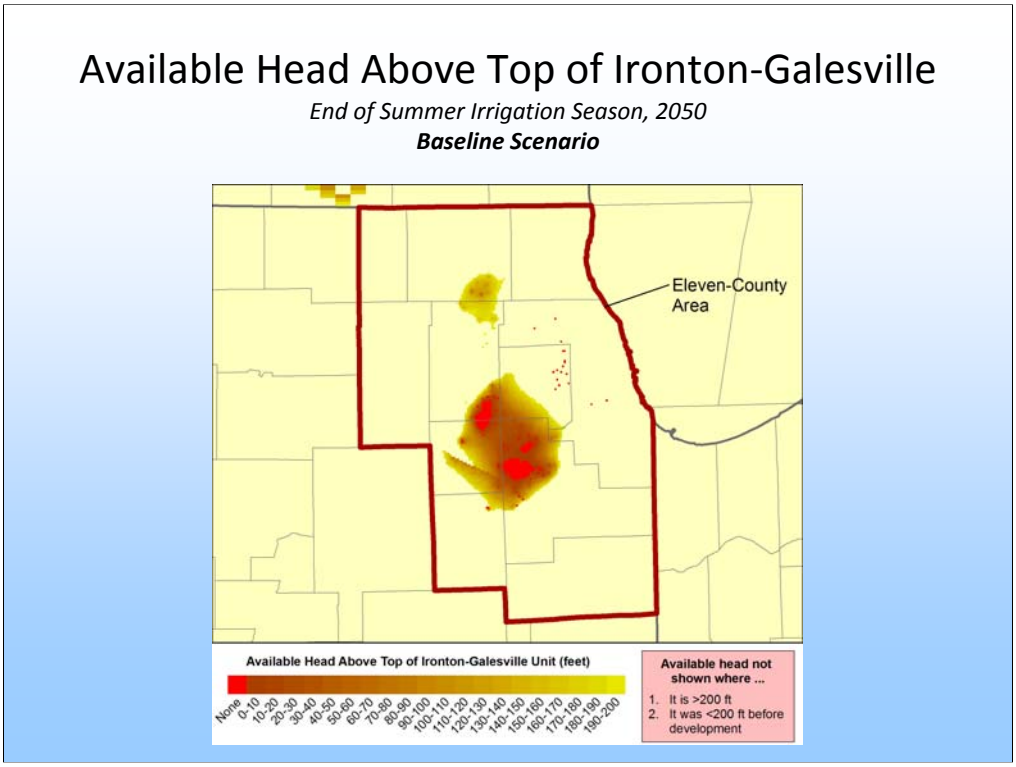

Available head in 2025, baseline scenario.



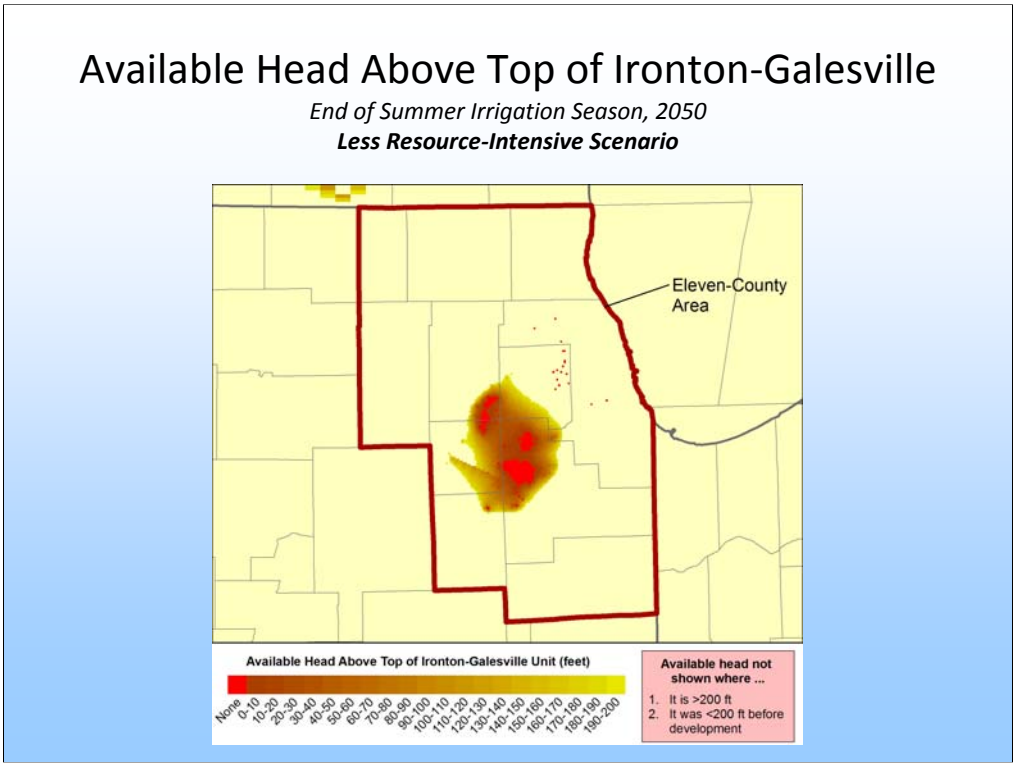

Available head in 2025, LRI scenario.



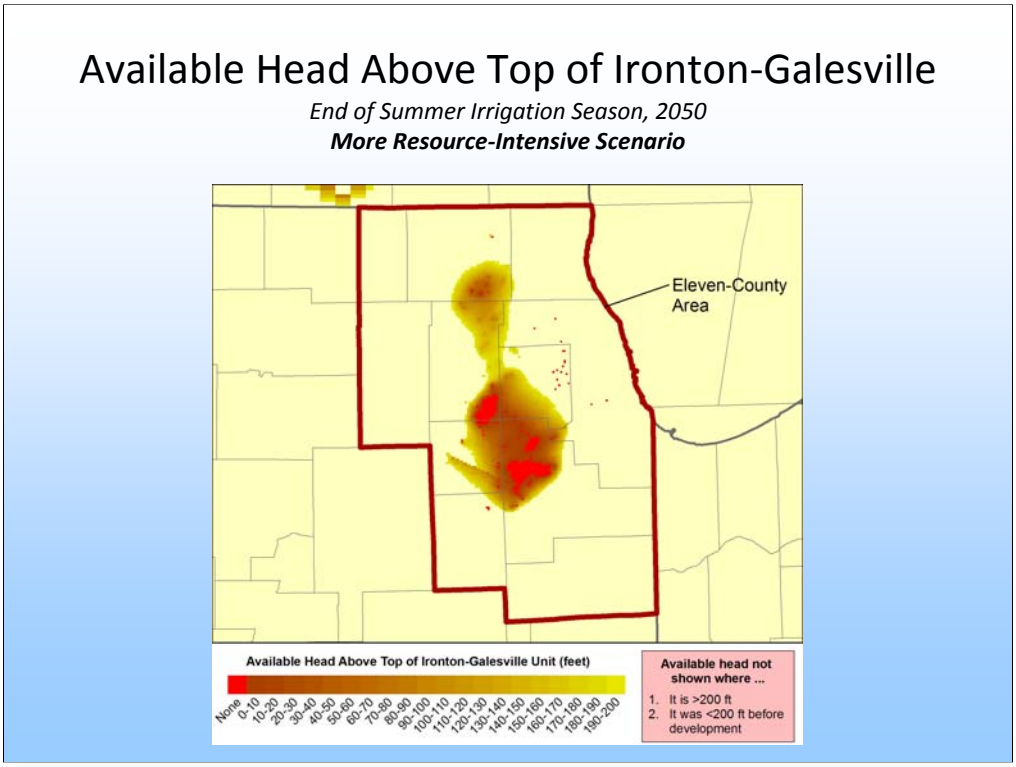

Available head in 2025, MRI scenario.




Available head in 2050, baseline scenario.




Available head in 2050, LRI scenario.




Available head in 2050, MRI scenario.

## Conclusions

- Regional groundwater flow model results have been produced for the 3 basic demand scenarios
- Results for shallow sand/gravel aquifers within the Fox River Basin were presented - cones of depression are evident in major pumping centers – some Carpentersville wells apparently went dry in the Baseline and MRI scenarios
- Stream flow impacts have not been examined yet – stream flow may be contributing significantly to sand/gravel wells
- Results for Ironton-Galesville were presented and some future demand scenarios show significant impacts, esp. in areas near Aurora and Joliet
- Model results suggest future demands can largely be met only ***if*** the impacts are deemed acceptable
- There is time to make model improvements and plan alternatives, but not time to waste

Analysis of impacts on stream flow is essential. The reason the sand and gravel cones of depression are not larger/deeper is likely a result of contribution to wells from streams. What were perennial streams may, as a result, become ephemeral. Ephemeral streams may be dry more often or for longer periods. And, the Fox River flows continue to increase as a result of effluent discharges. The hydrology of northeastern Illinois is being changed.

## To-Do List for 2009

- Evaluate model results to see if more wells went dry than just Carpentersville
- Model impacts of drought and climate change
- Assess impacts of all scenarios on streamflow
- Assess impacts on shallow bedrock aquifers

Impacts on streamflow have not been examined yet. It is likely that shallow aquifers are meeting the demand scenarios by removing large amounts of surface water flows. This may mean that local streams become more ephemeral, while Fox River flows continue to increase. Also, this presentation concentrated on two major aquifer model layers; Layer 5, the Quaternary coarse-grained unit 2 and Layer 17, the Ironton-Galesville sandstone. Model results for Layer 14, the Ancell (or St. Peter sandstone), are available but look similar to Layer 17 and in the interest of time I chose not to show them. We need to look at model layers 6-14 where the shallow bedrock is utilized. Drought and climate change will affect recharge and demand, so those are additional scenarios that address the issue of risk.

Happy Holidays!

See you next year…