Analysis of Groundwater Level Changes, Surface Water Conditions, and Water Use in the Greater Barrington Region, 2014–2019

Barrington Area Council Of Governments

ILLINOIS
Illinois State Water Survey
PRAIRIE RESEARCH INSTITUTE

Presentation to NWPA, September 10th 2020

USGS
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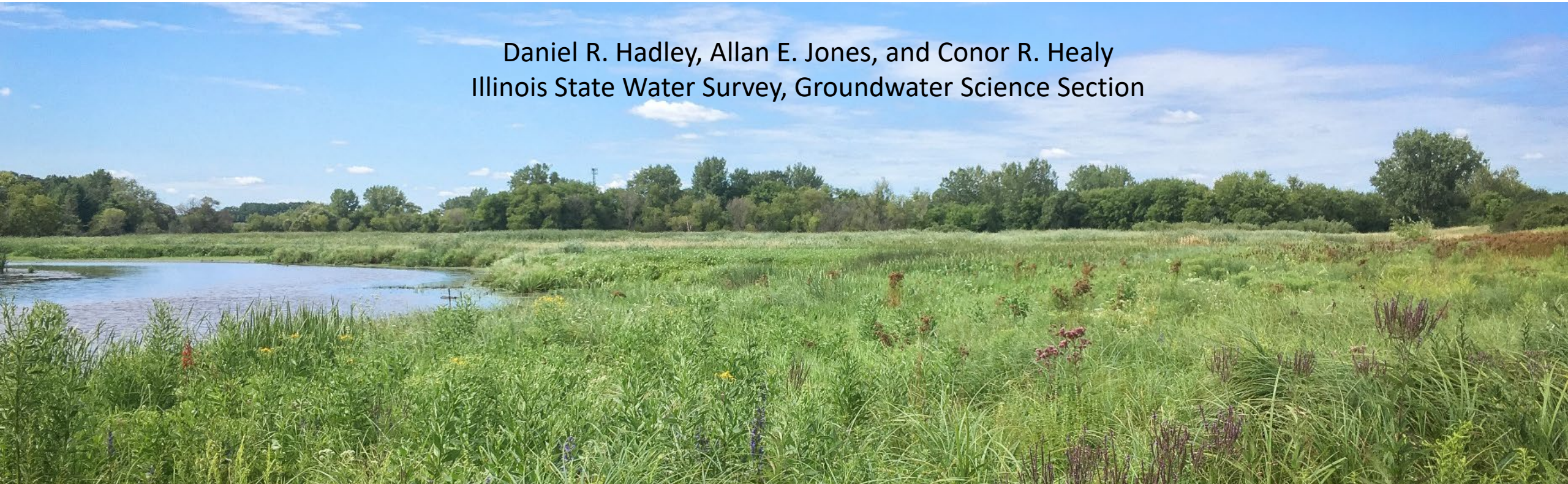


Motivation of Study

- Update the previous BACOG report developed by KOT environmental Consulting in 2015
- Evaluate changes in groundwater levels, surface water flow, and trends in municipal water use since the 2015 report
- Provide insight into the hydrogeology of the BACOG region to support decision making

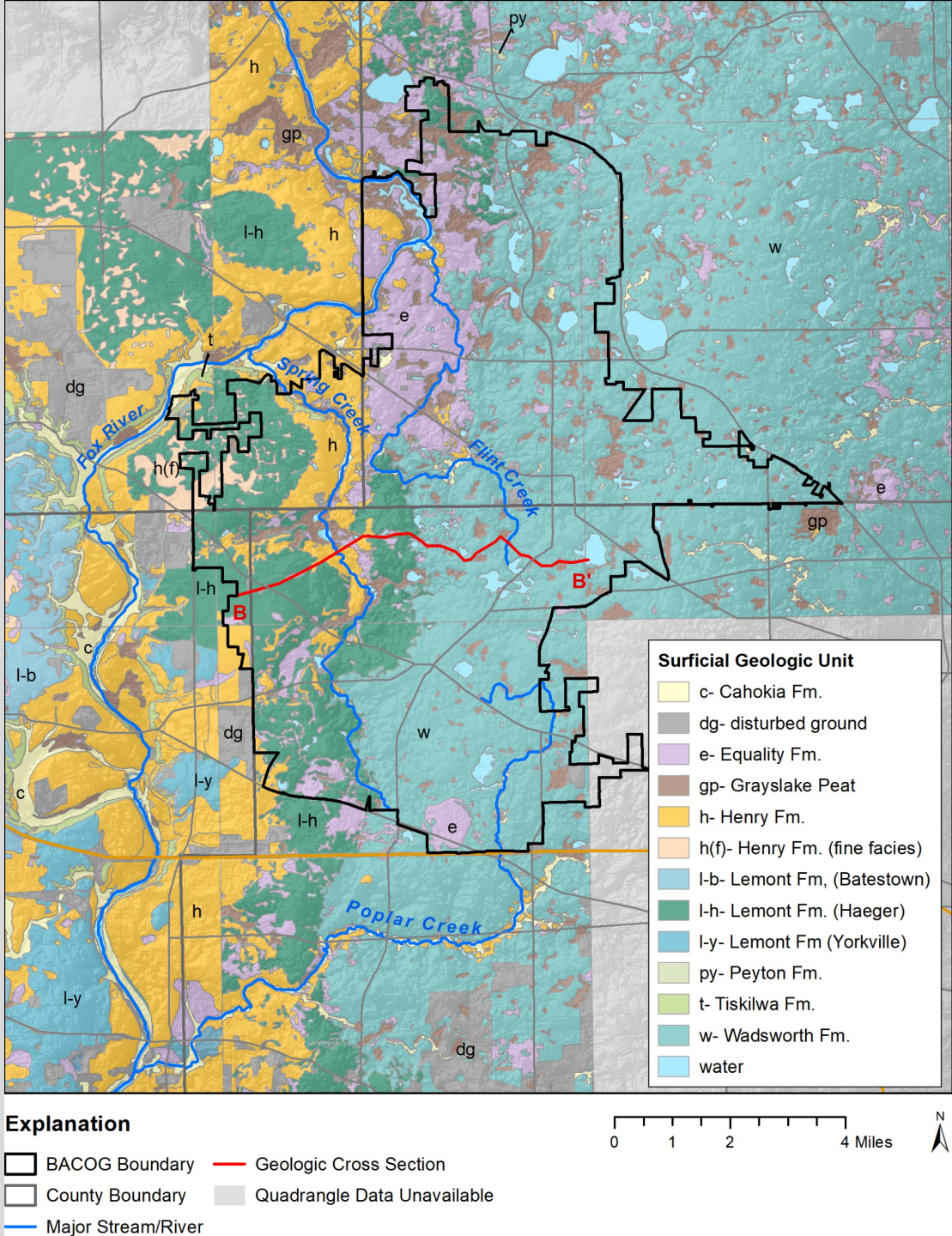
Wagner Fen. Photo: Janet Agnoletti

Geology of the BACOG Region

Surficial Geology

- Western half - sandy glacial material at land surface
- Referred to as Henry Formation
- Henry Formation is primary sand and gravel aquifer
- Sand and gravel aquifer connected to Spring Creek and Fox River (direct sources of recharge)

- Eastern half- clay and till material at land surface
- The sand and gravel aquifer is confined (covered by tills)



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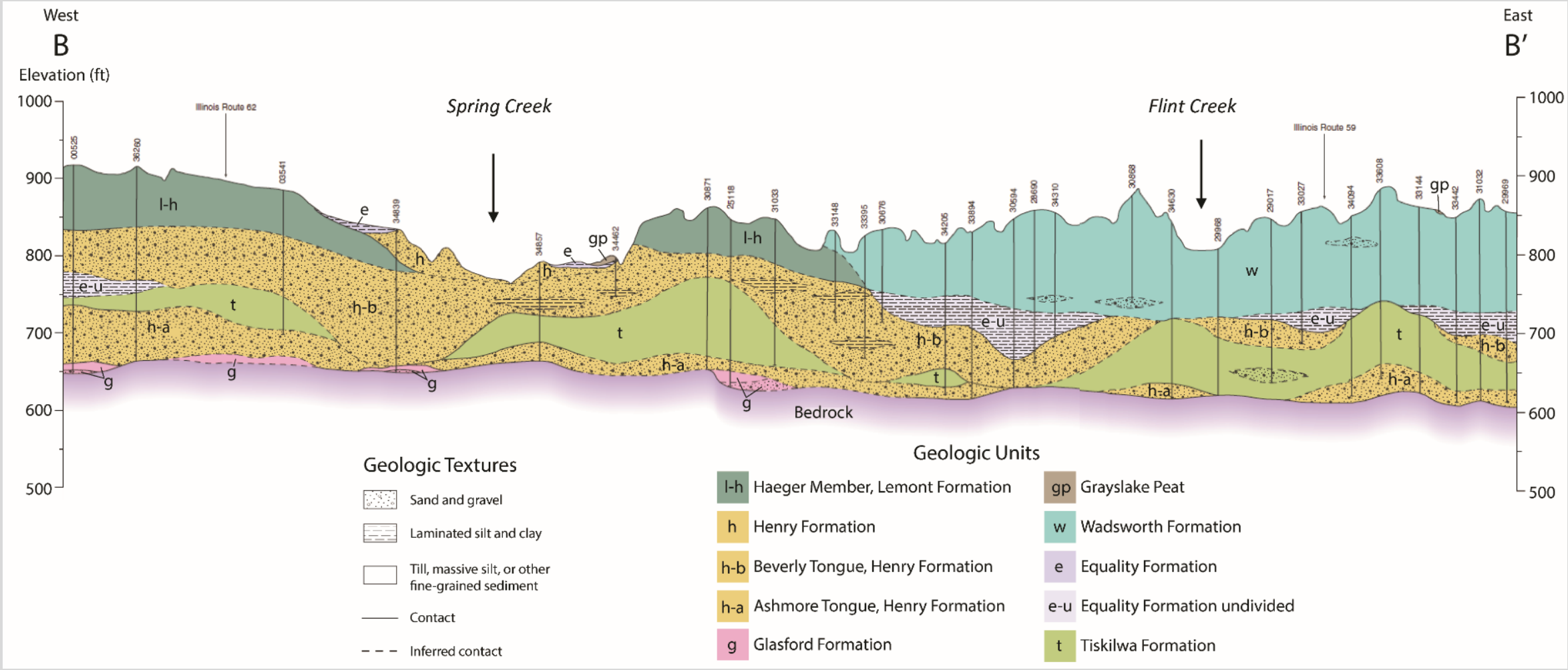
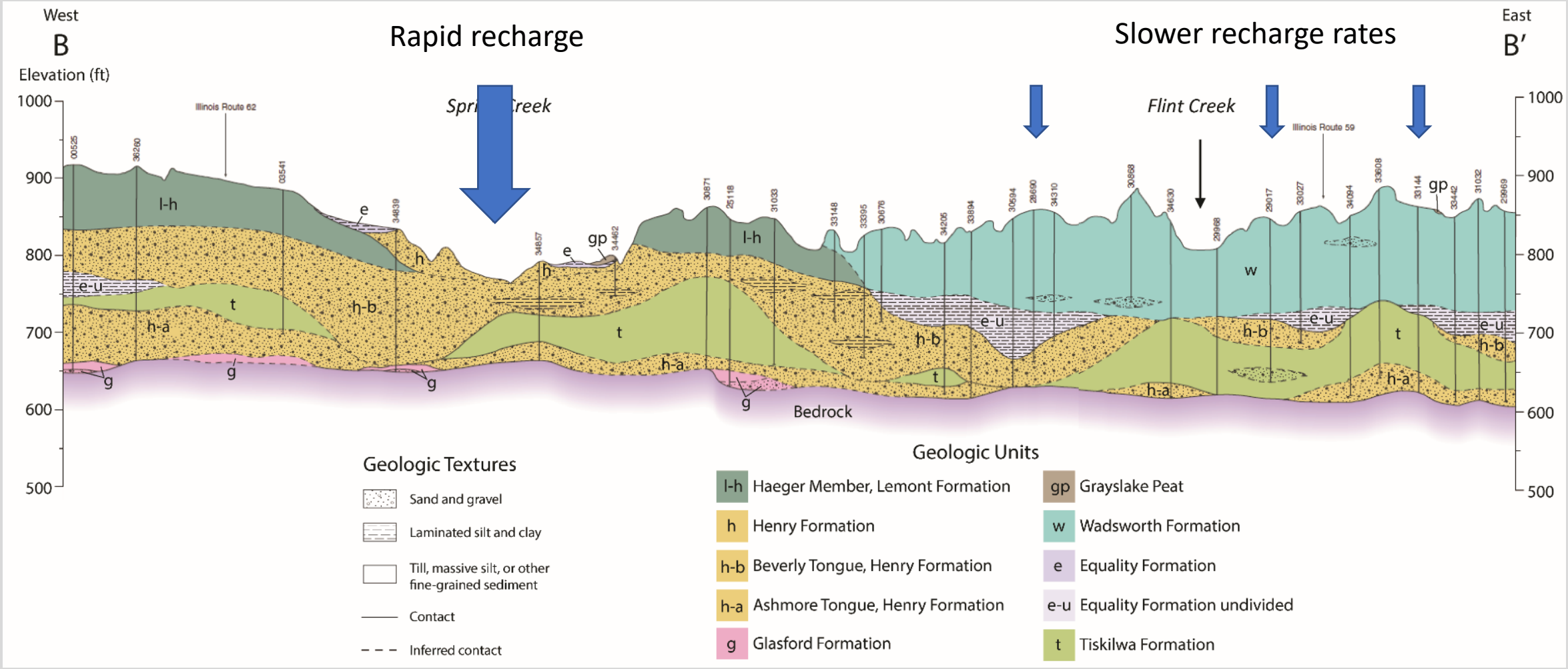


What's underneath the glacial material?

- Silurian Dolomite (mostly)
- Maquoketa Shale (minor)

Geology of the BACOG Region



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- Silurian Dolomite (mostly)
- Maquoketa Shale (minor)

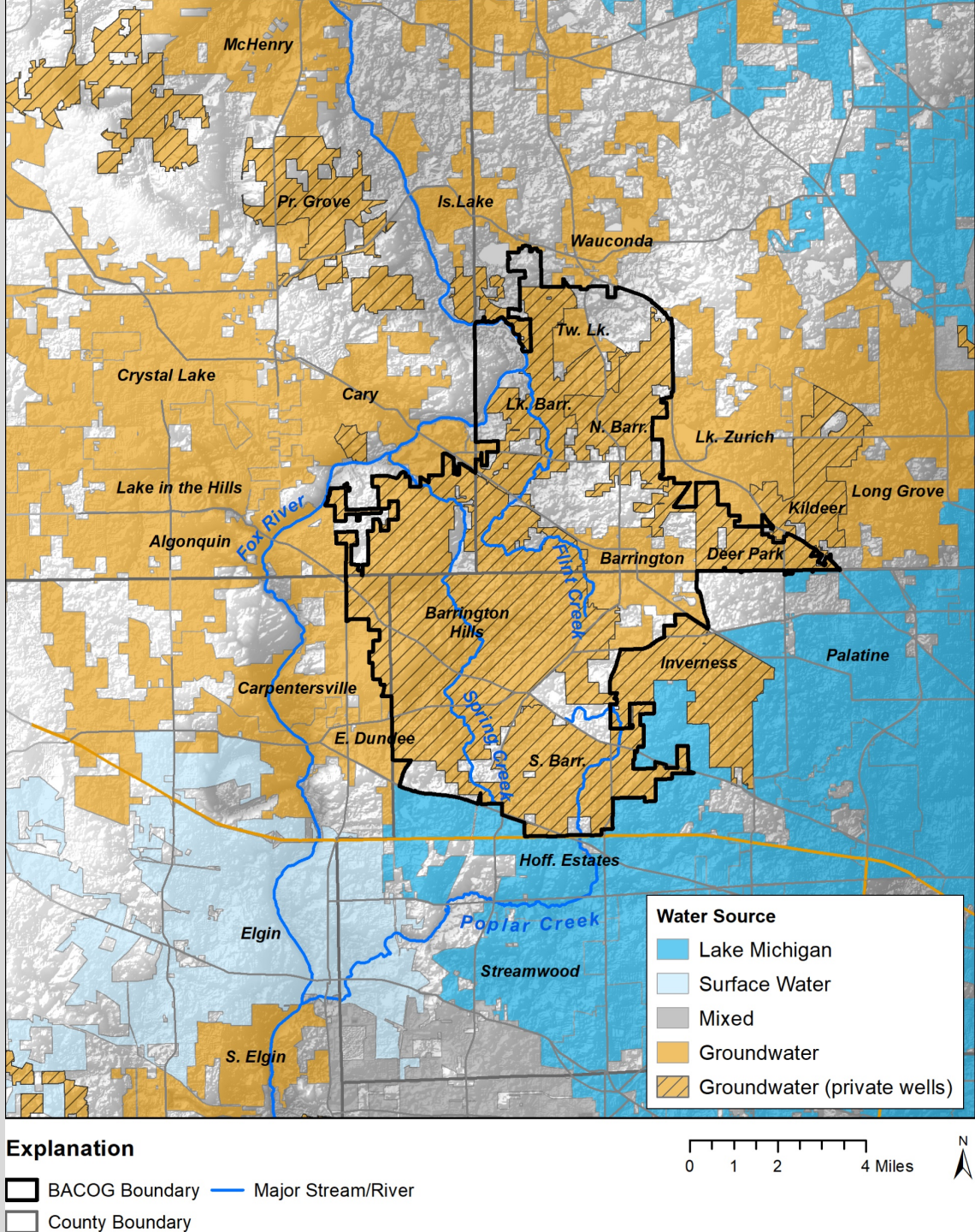
Water Use in BACOG Region

Inside the BACOG area

- Dependent on groundwater
- Mostly private wells within communities
- 70% of BACOG residents use wells
- Shallow sand and gravel + shallow bedrock wells
- Municipal systems- only Barrington and Tower Lakes
- South Barrington has deep sandstone well that serves businesses and subdivision, but overall water use is from private wells

Outside the BACOG area

- Some private well communities
- Unincorporated areas on private wells
- Primarily municipal systems
  - Lake Michigan
  - Fox River (Elgin)
  - Shallow and deep groundwater



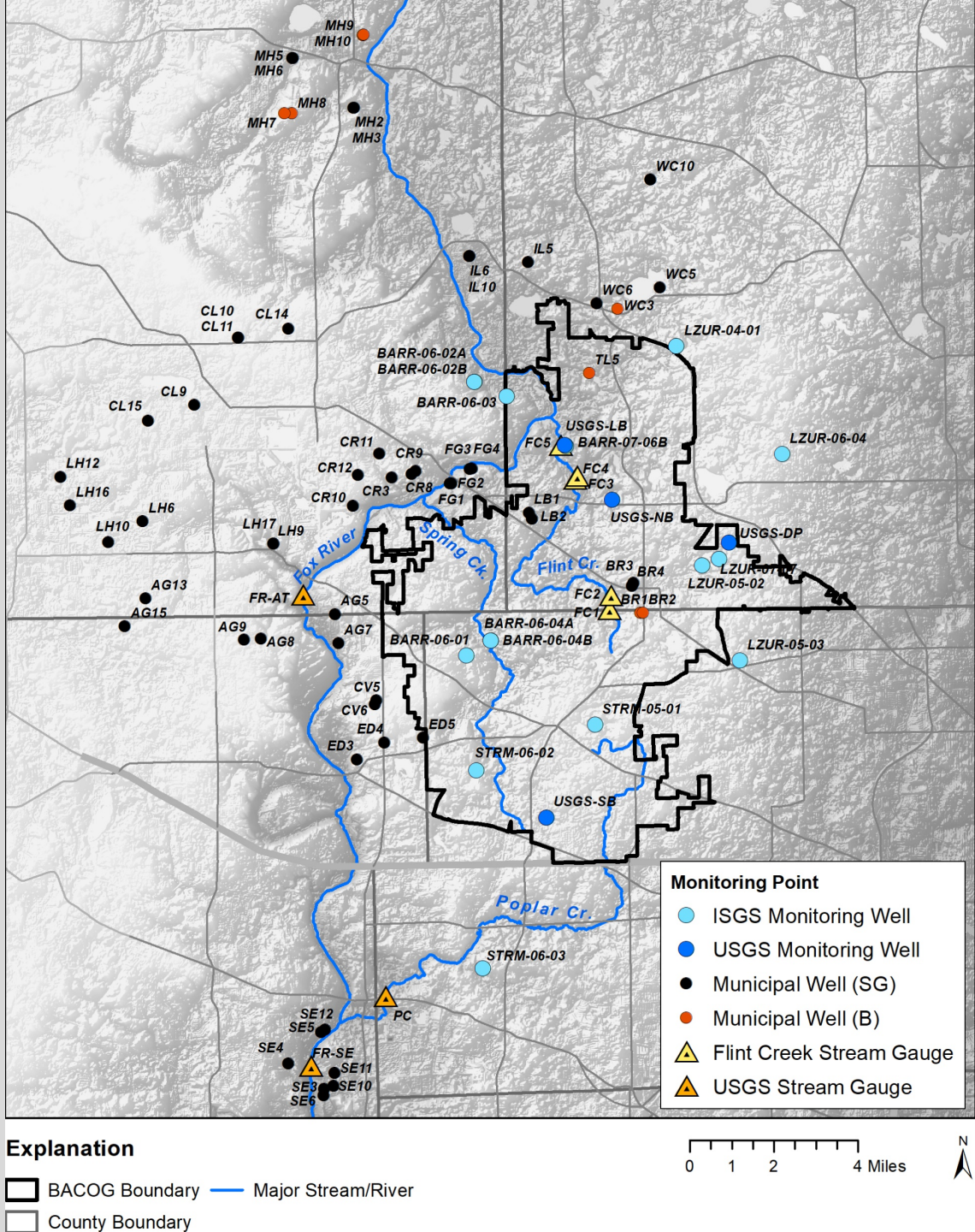
Monitoring in the BACOG Region

Surface Water

- USGS stream gauges- stage and discharge
- Flint Creek stream gauges (Flint Creek Watershed Partnership)-stage

Groundwater

- Dedicated monitoring wells
  - USGS continuous monitoring
  - Periodic measurements at ISGS wells
- Municipal Wells
  - Sand and gravel wells
  - Shallow bedrock wells
  - Mass measurement every July (2014-2020)



Methods

Municipal Water Use

- Illinois Water Inventory Data, 2005-2018
- Reviewed up to 2015, “as is” after 2015
- Separated by aquifer type

Potentiometric Surfaces 2014-2019

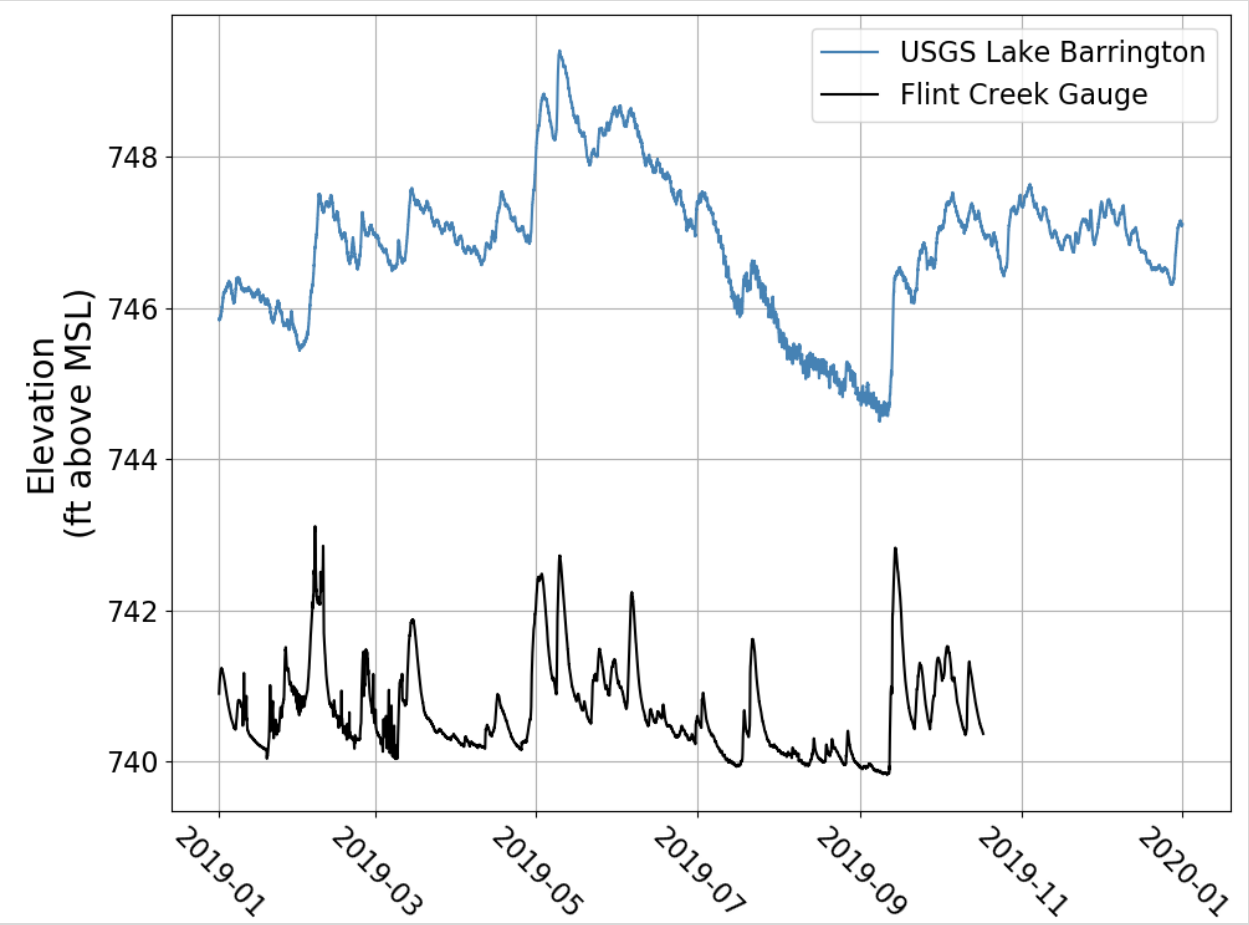
- Maps that represent groundwater elevation of sand and gravel aquifer
- Year to year change and overall change
- Used July mass measurement data with contouring tools
- Surface water elevations used where aquifer is connected
- National Hydrography Dataset

USGS Hydrographs

- Plotted with precipitation data from NOAA climate station in BACOG region

Analysis of baseflow

- USGS PART method
- Fox River and Poplar Creek
- Seasonal Mann-Kendall test to determine + or - trend



Results-Municipal Water Use

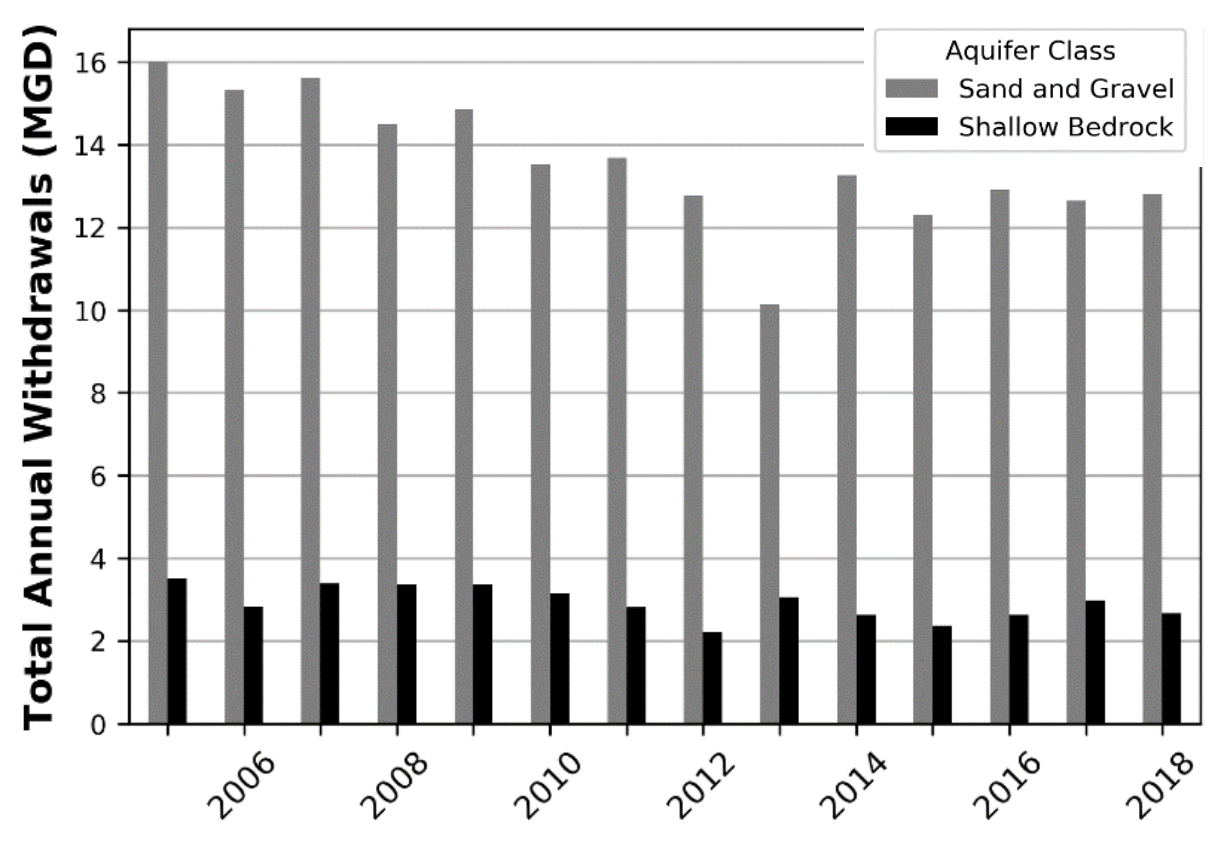
Shallow bedrock withdrawals

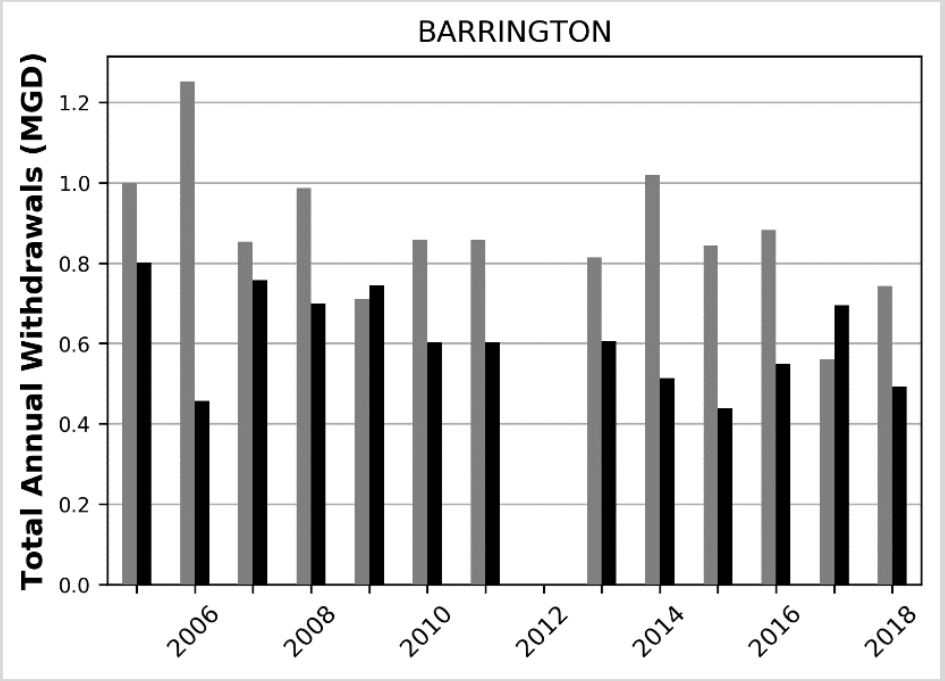
- no change

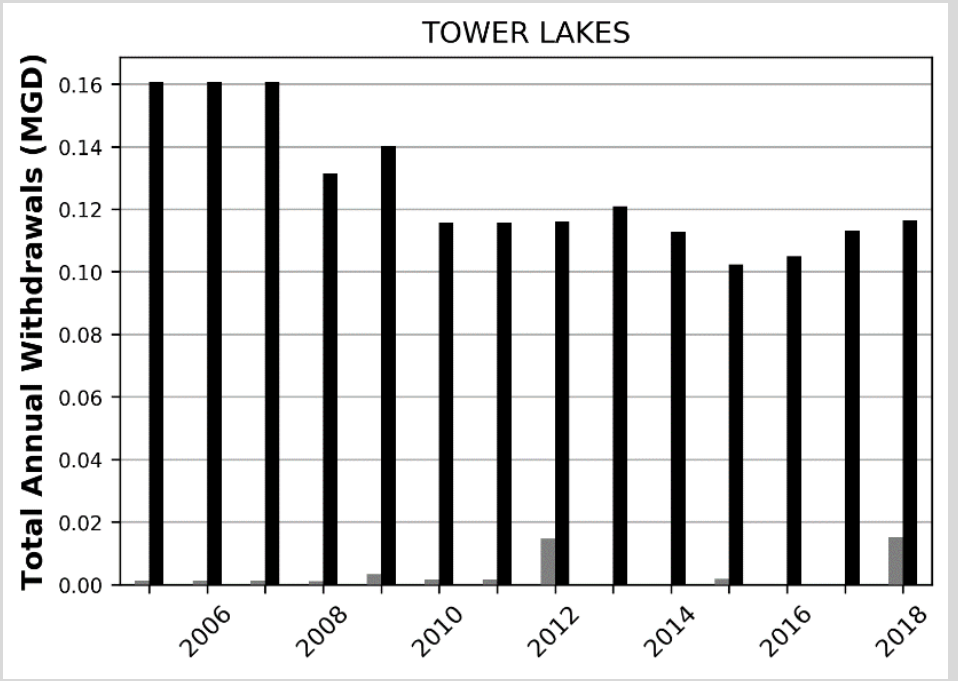
Sand and gravel withdrawals

- decrease of few MGD overall
- Steady over last 5 years

Around 75% of withdrawals are from sand and gravel aquifer most years







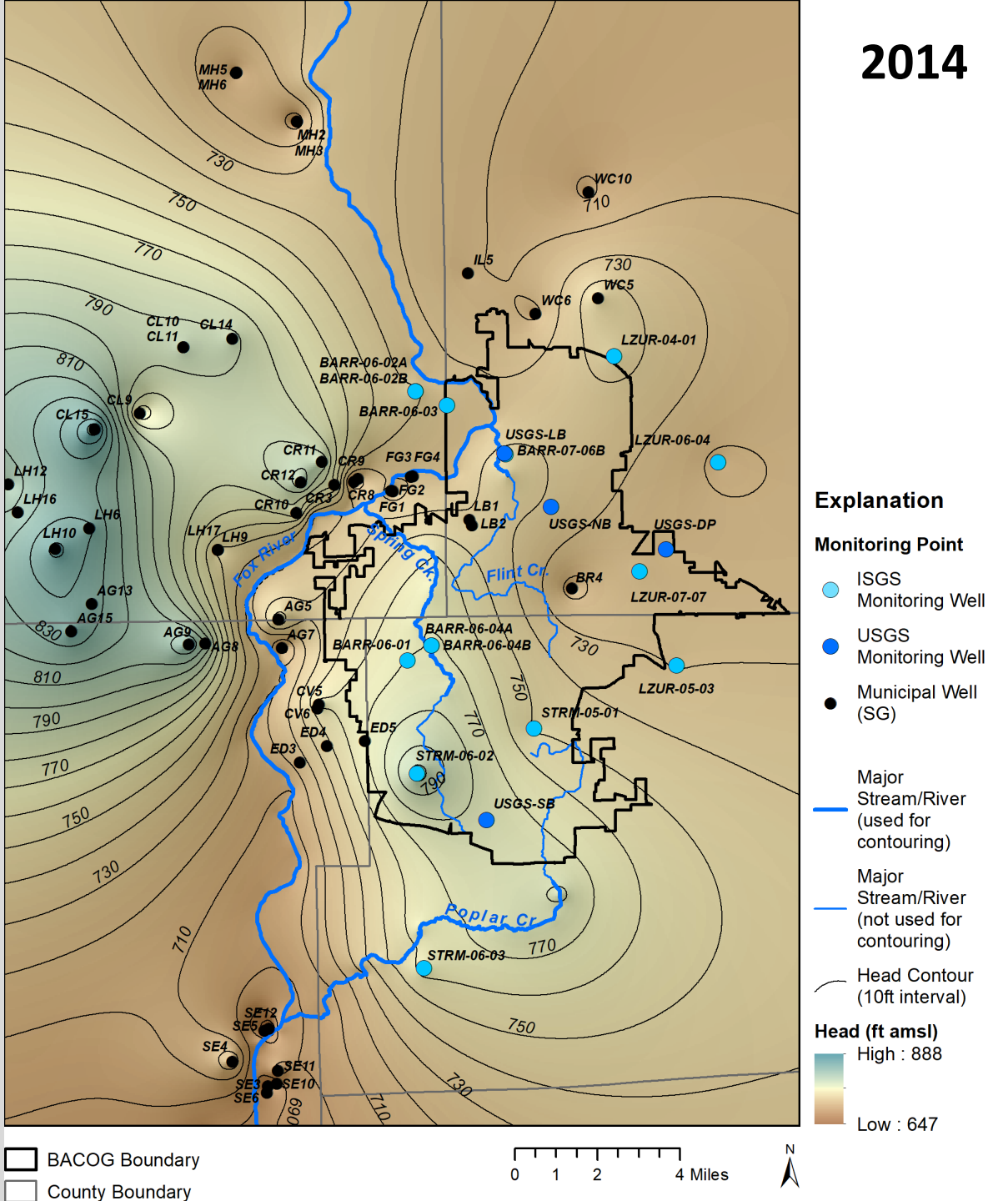
Results- Groundwater Elevation Maps

What is it and how to use?

- Sand and gravel Aquifer
- Elevation of water level in drilled well
- Read like a topographic map (peaks and valleys)
- Blue shading = High Elevation
- Brown shading = Low Elevation
- Groundwater flows from high to low

Insights

- Fox River is groundwater divide
- Groundwater high in western BACOG (area of recharge)
- Lower elevation in eastern BACOG (confined, less recharge)
- Most change west of Fox River



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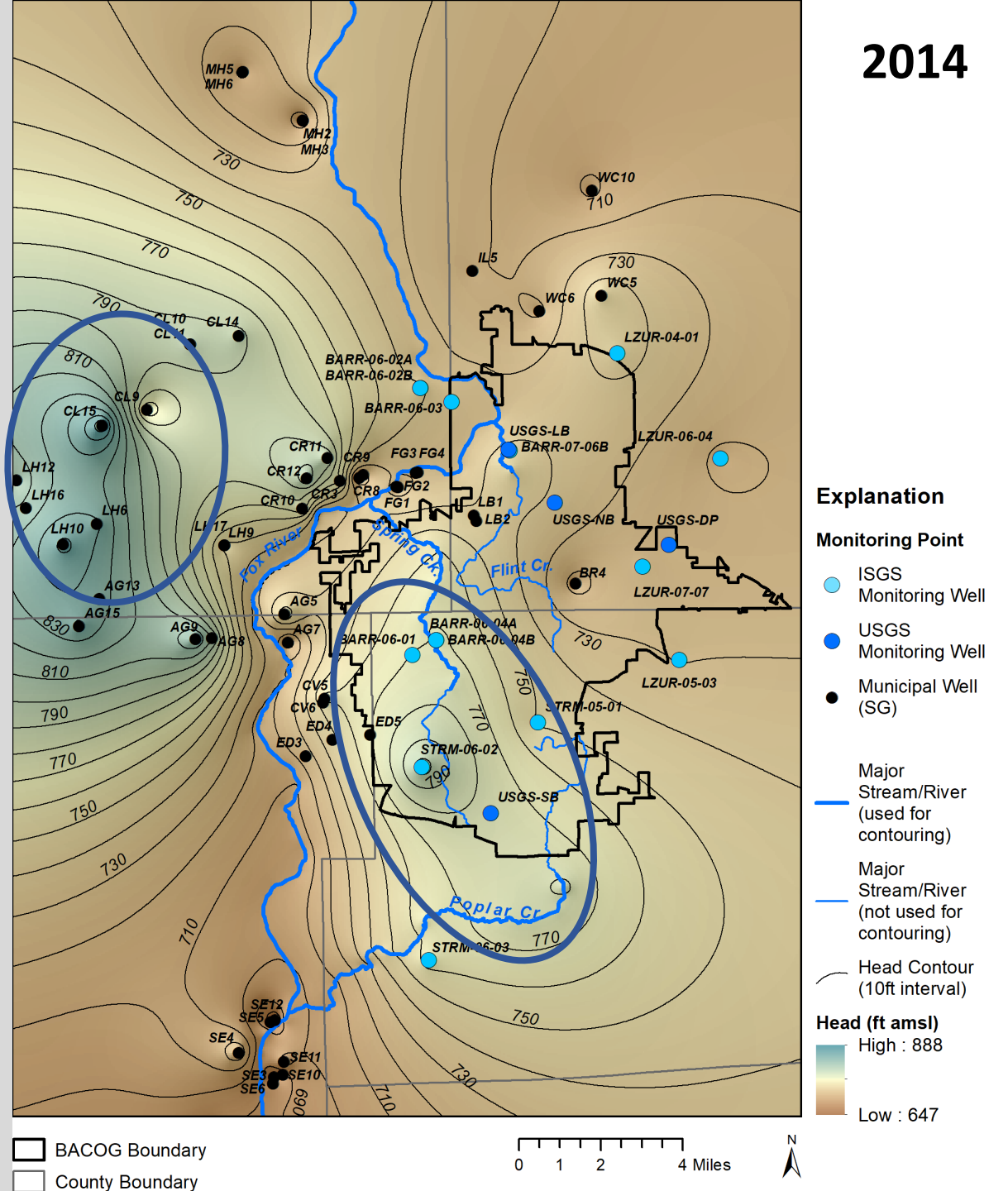

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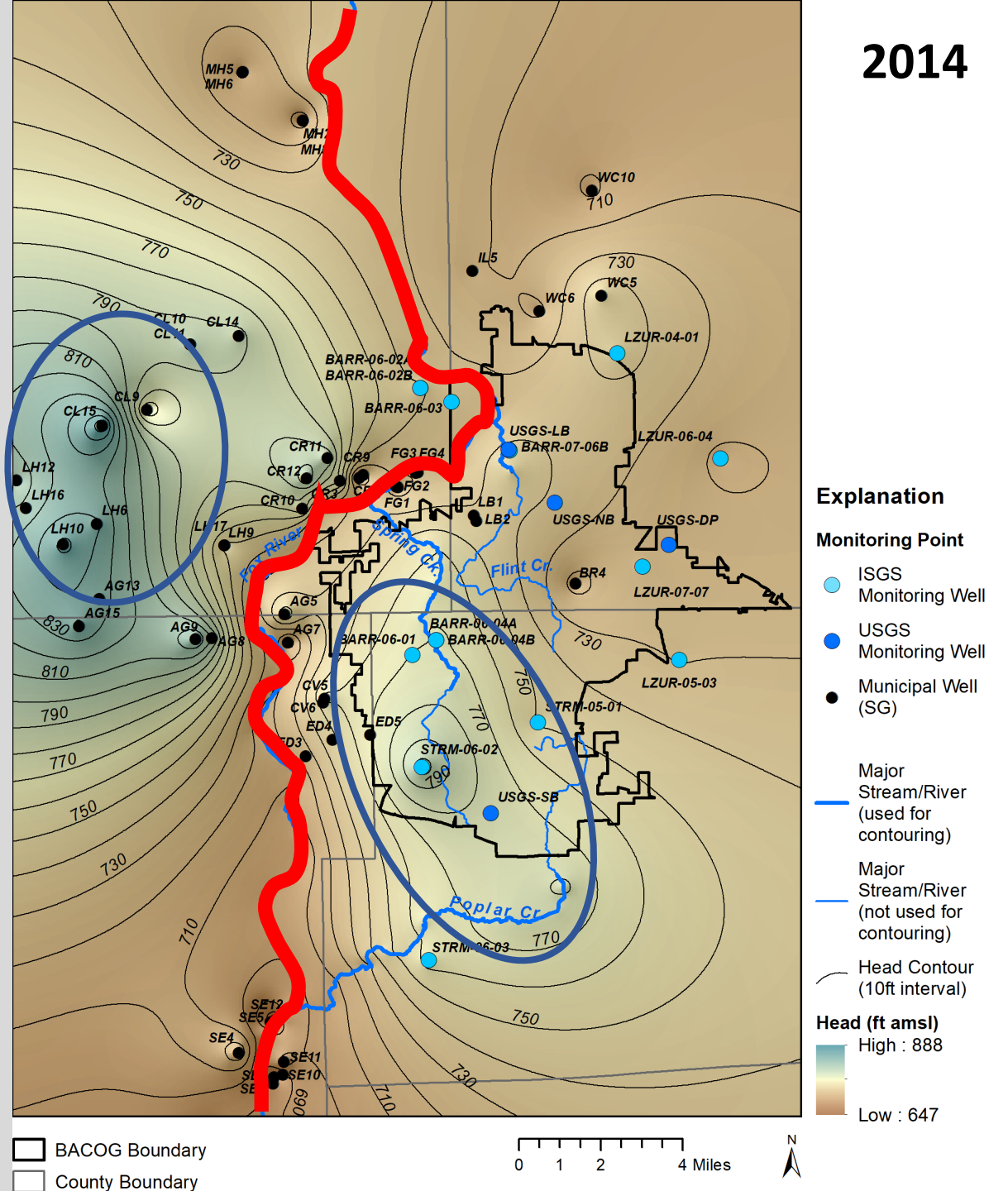

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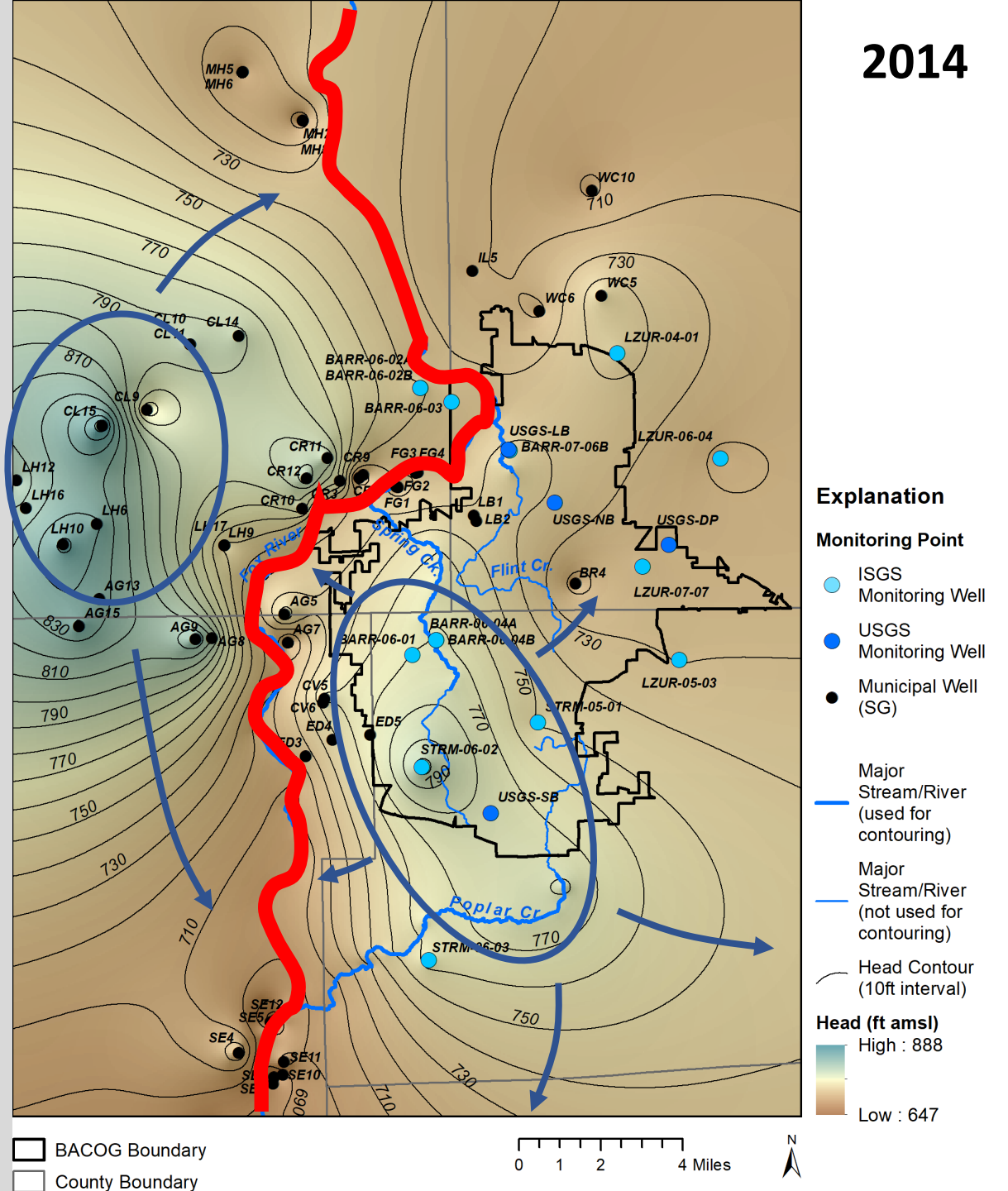

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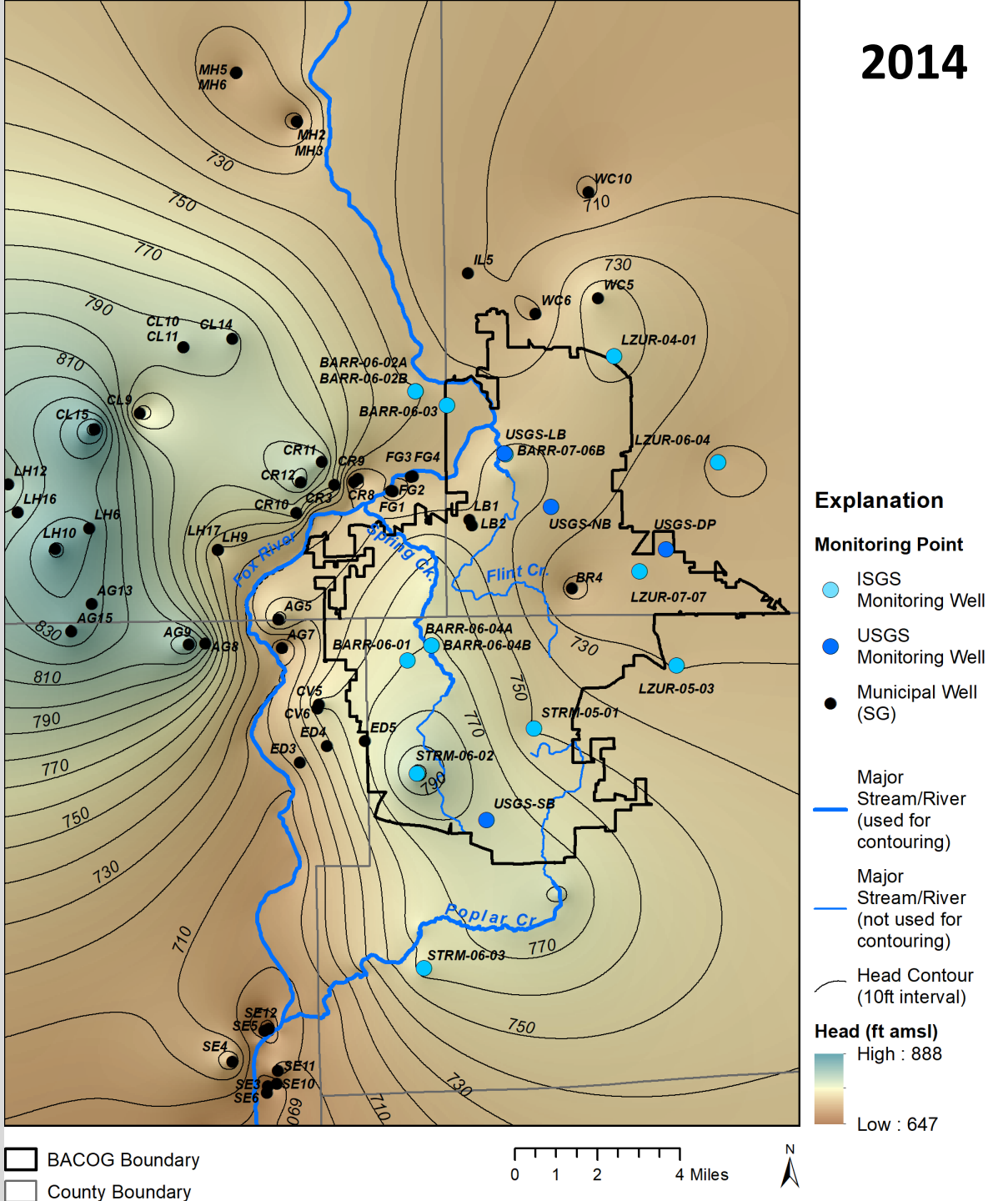

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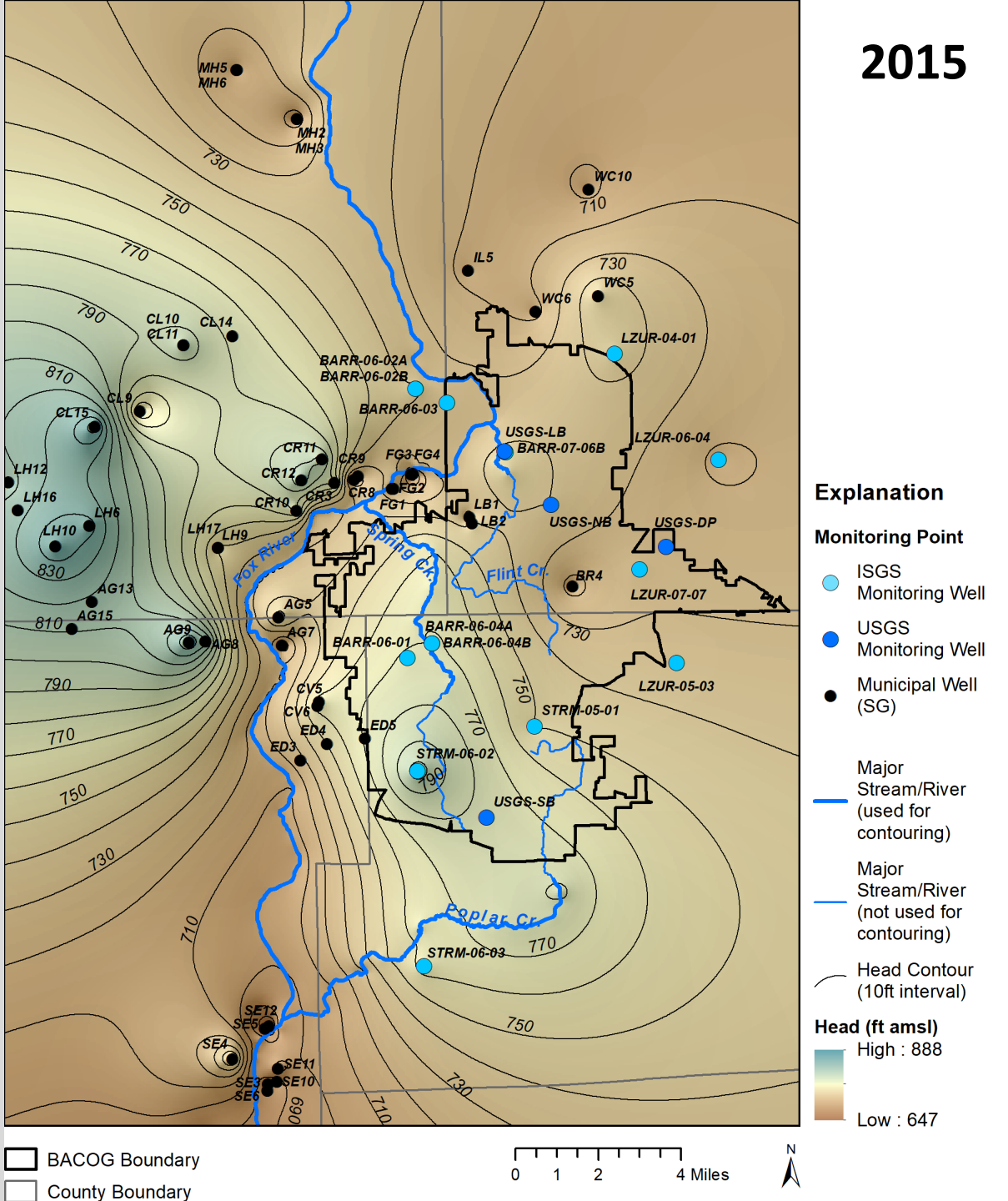

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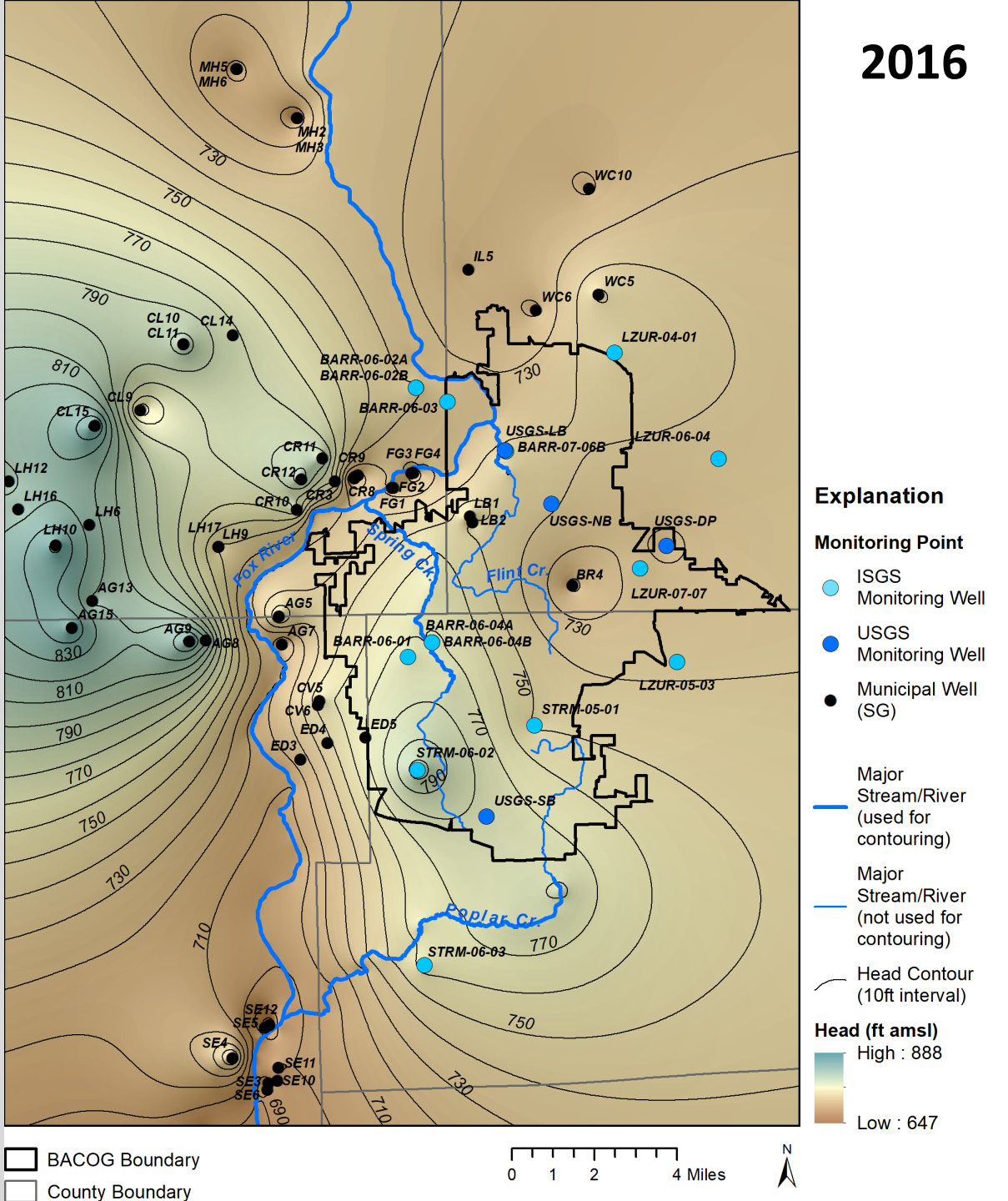

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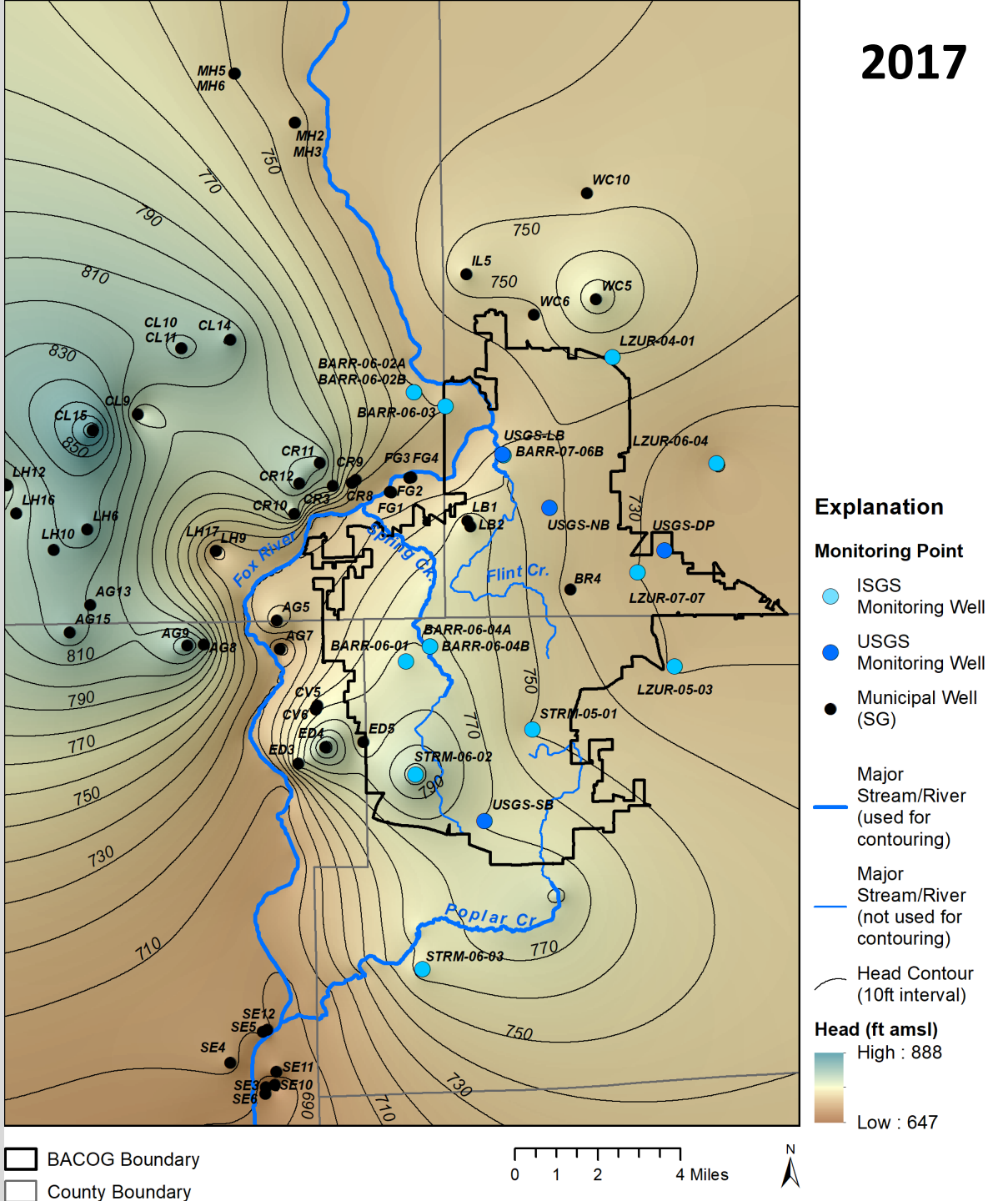

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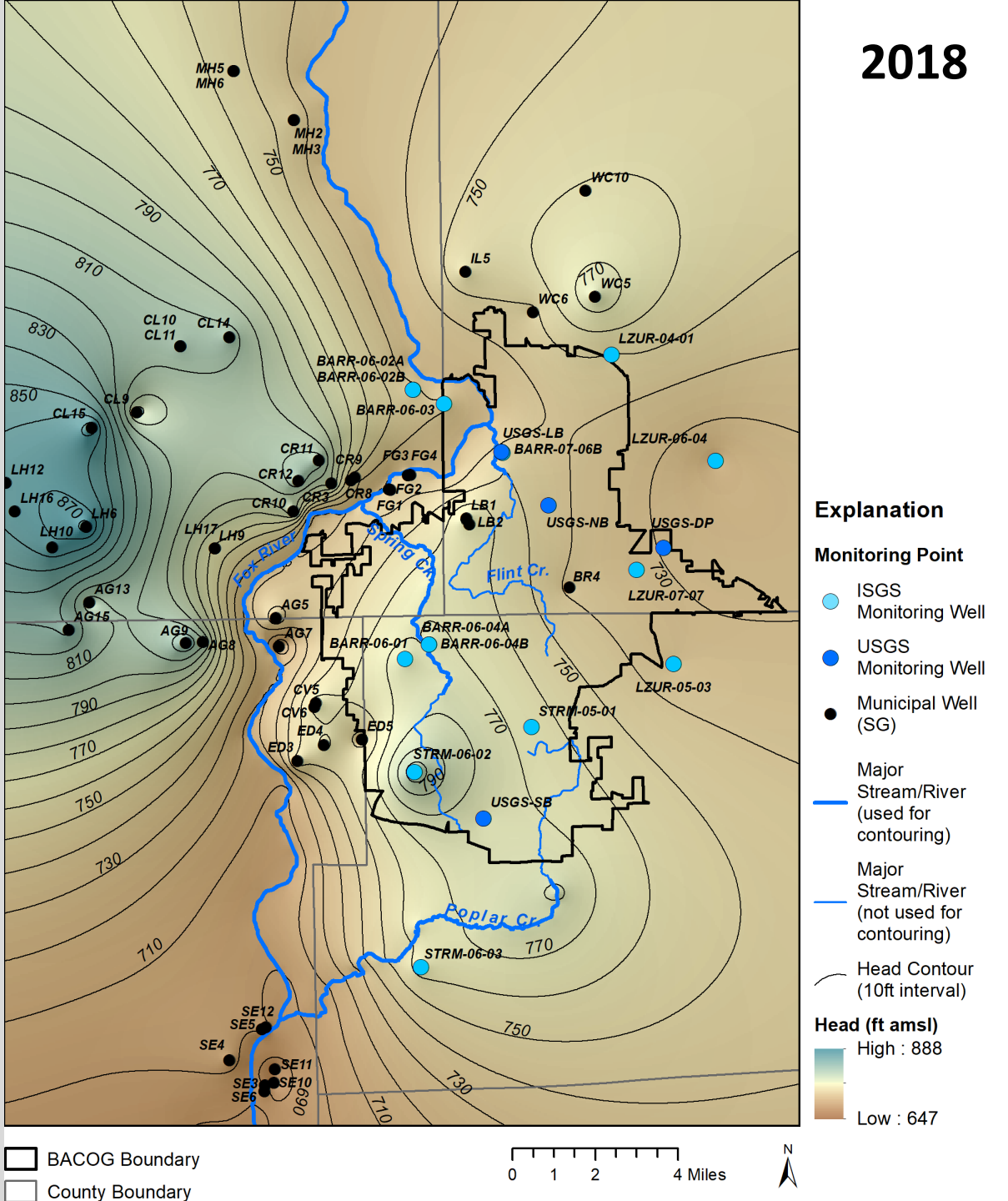

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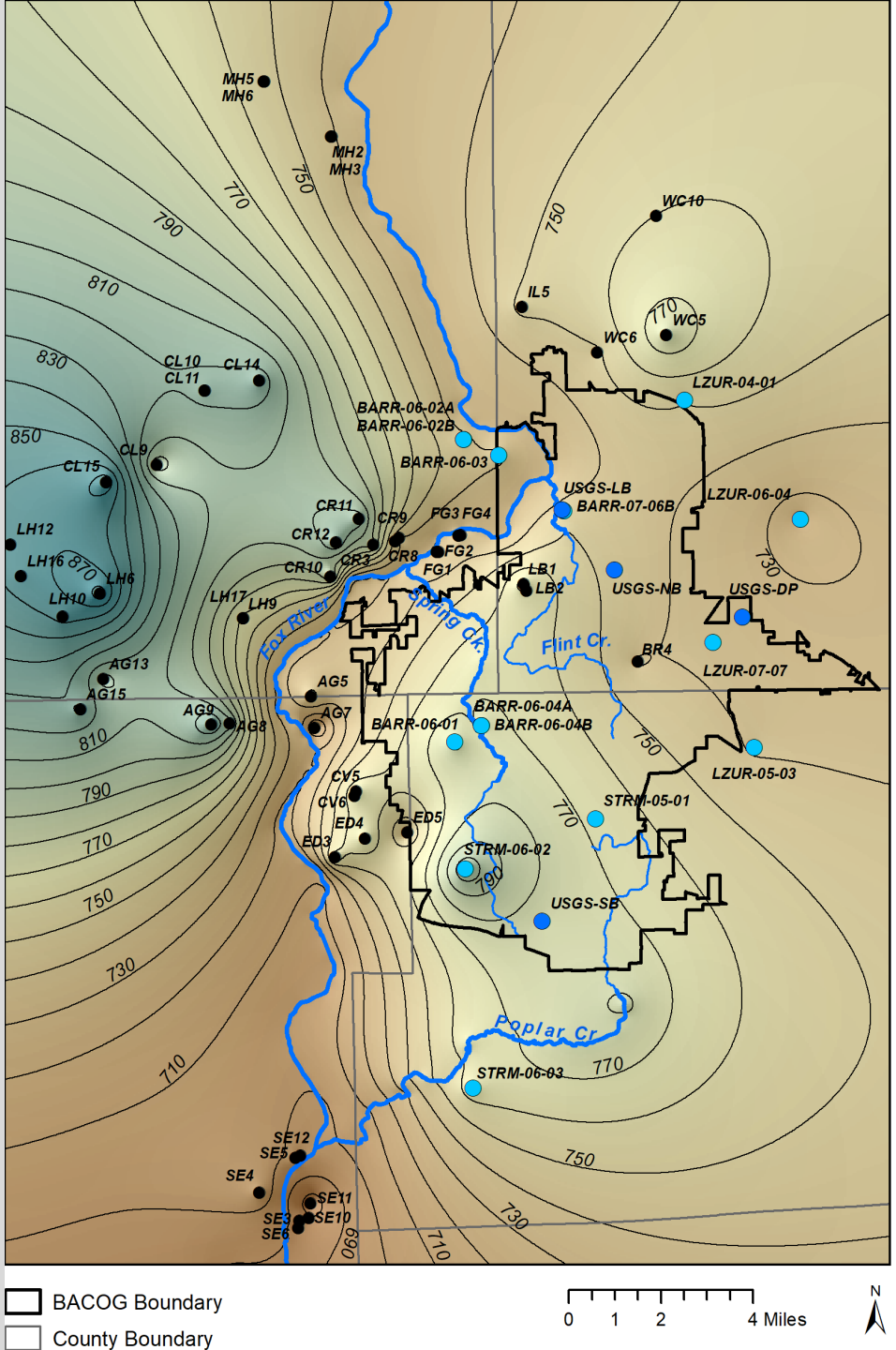
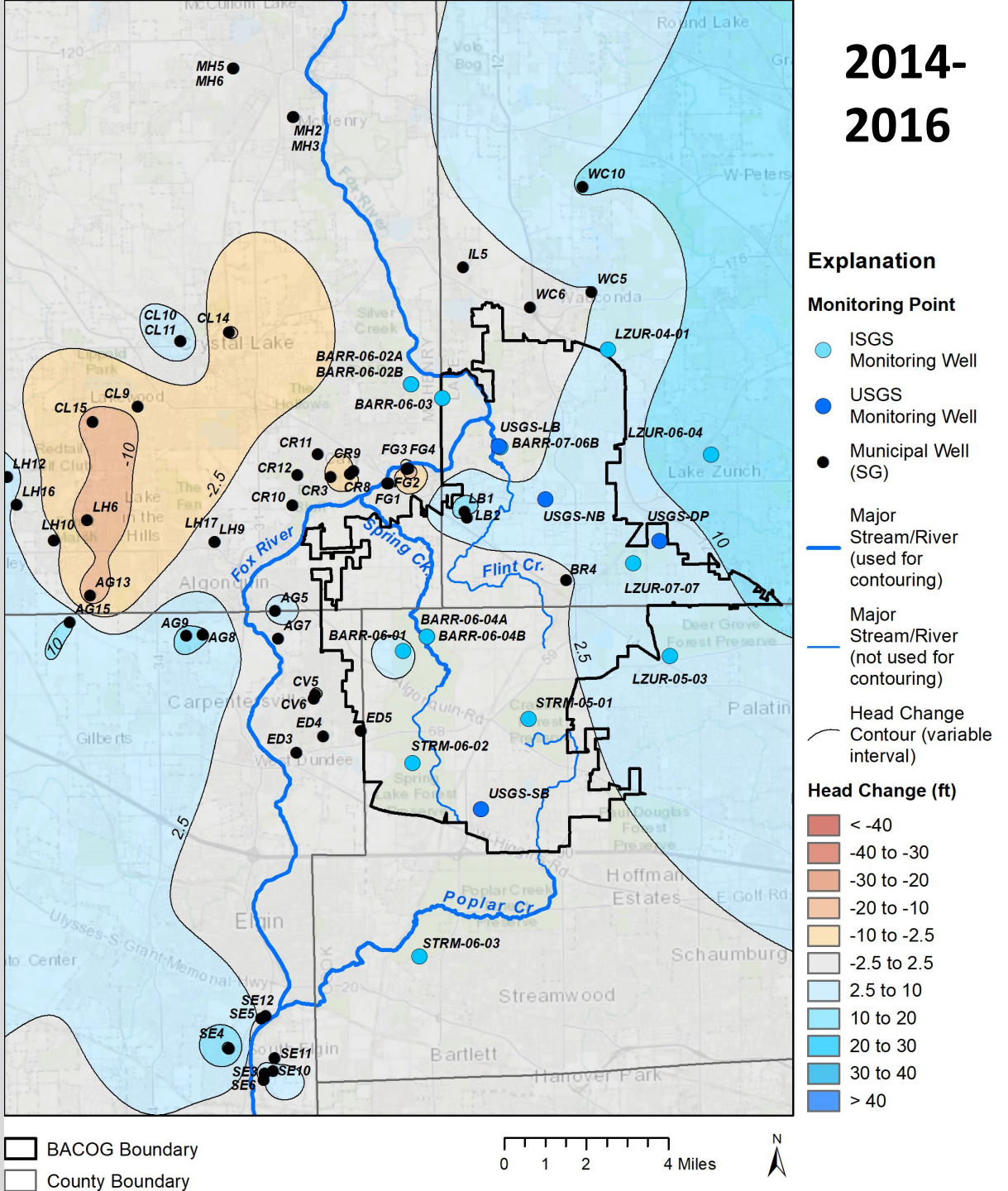


Results- Groundwater Level Change

- Blue shading = Levels are increasing
- Red shading = Levels are decreasing
- Gray= no change

Insights

- Slight decline at Crystal Lake/Lake in the Hills
- Western BACOG- no change
- Eastern BACOG- increase up to 10 feet



Results- Groundwater Level Change

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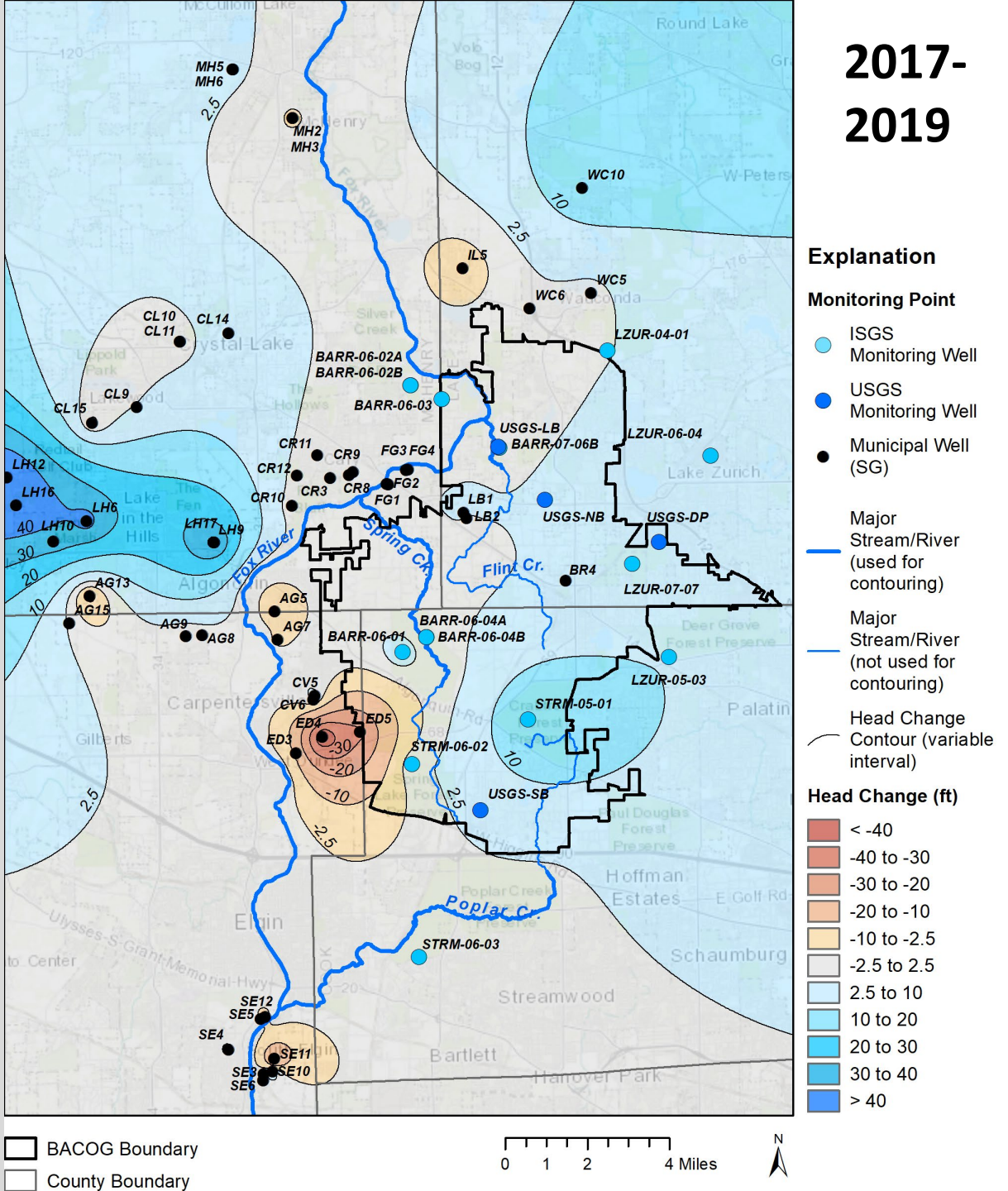
Insights

- Increase at Crystal Lake/Lake in the Hills
- Western BACOG- no change, but decline at East Dundee
- Eastern BACOG- increase up to 20 feet



Results- Groundwater Level Change

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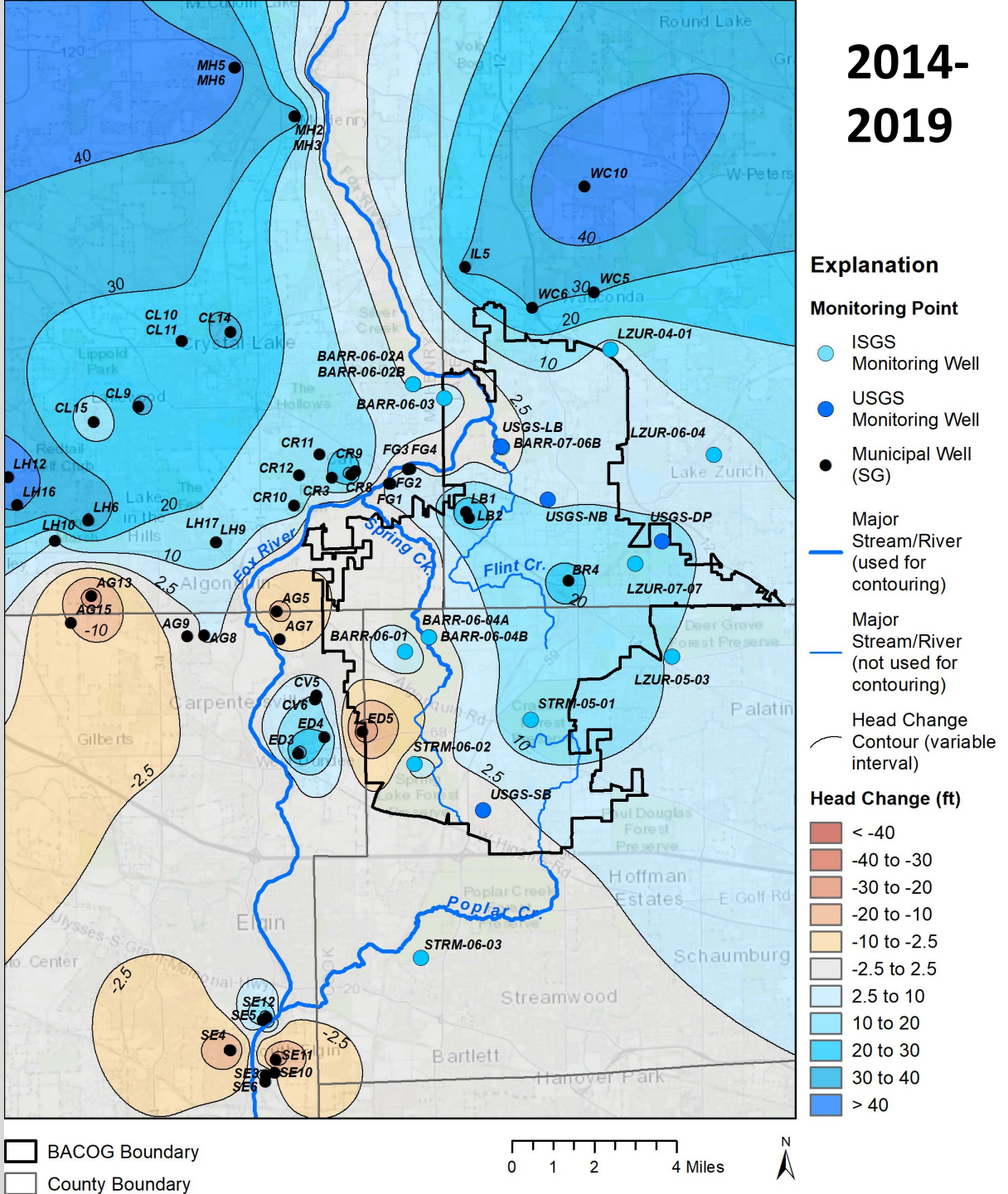
- Gray= no change

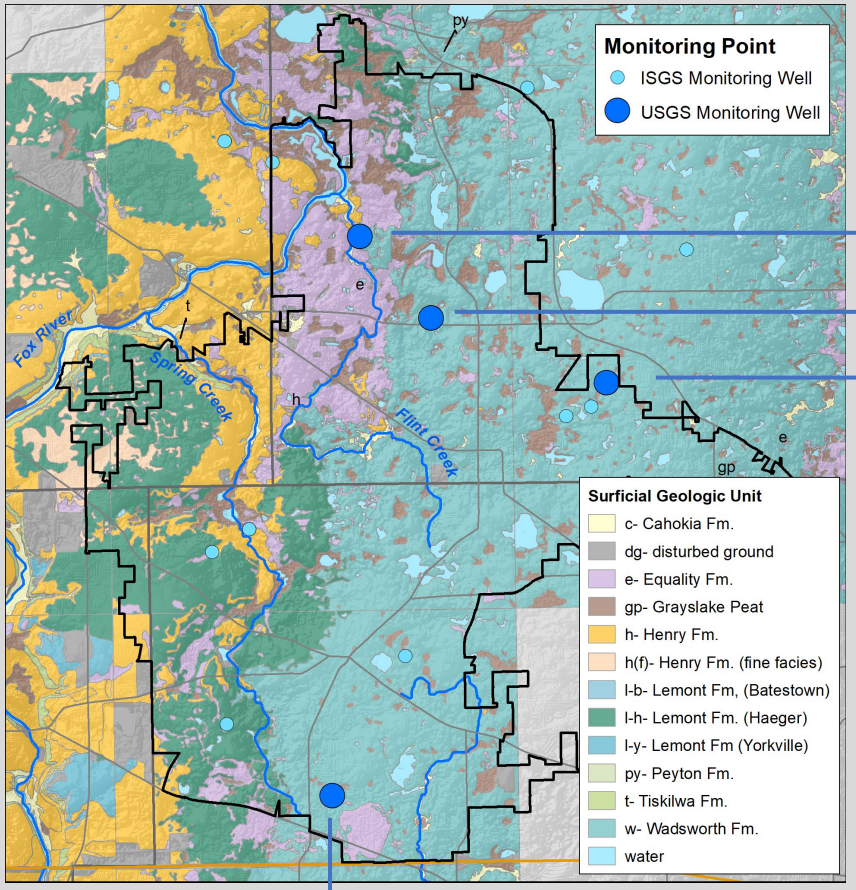
Insights

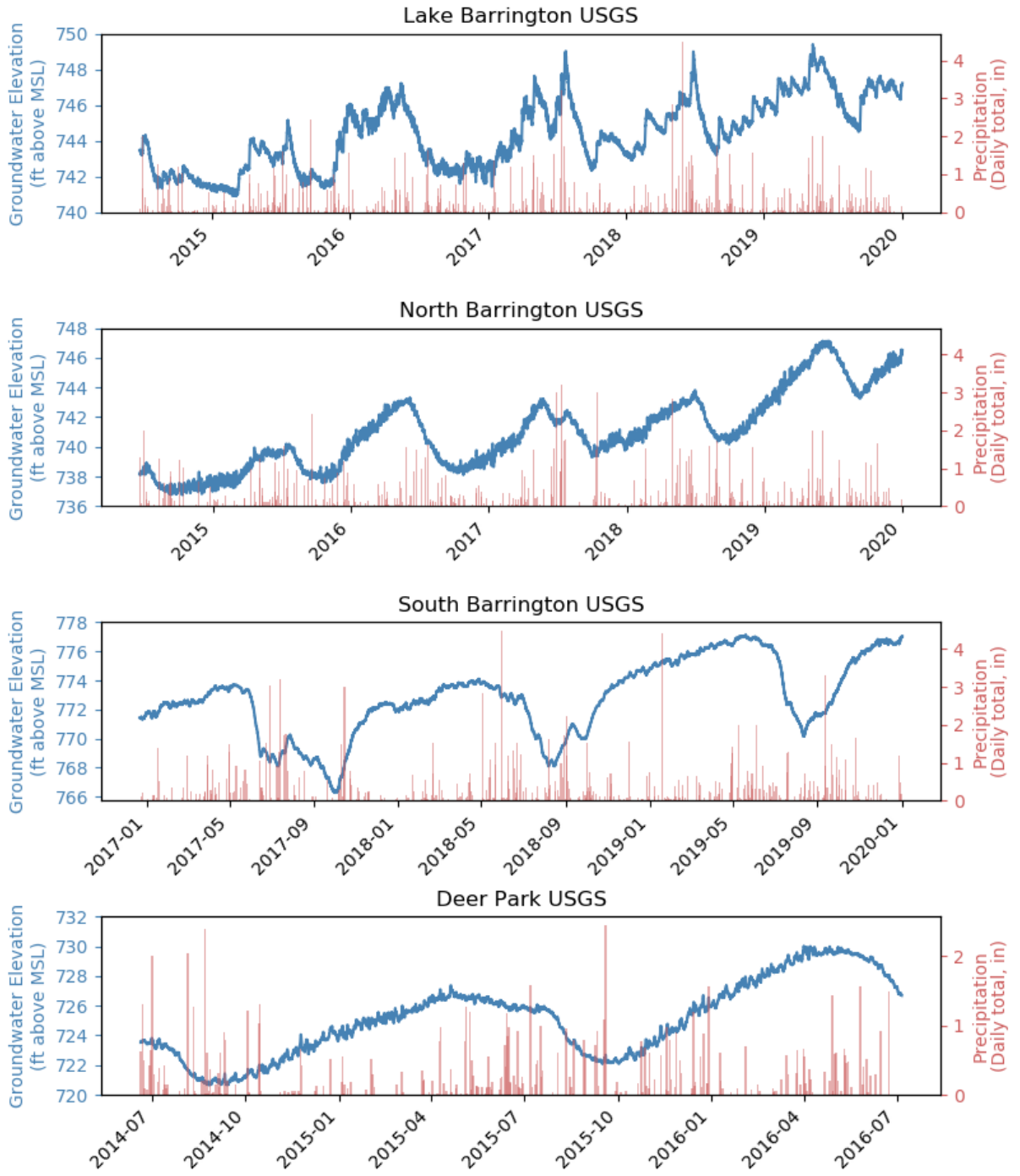
- Increase at Crystal Lake/Lake in the Hills
- Western BACOG- no change, but decline at East Dundee/Algonquin
- Eastern BACOG- increase in general from 2.5-20 feet

NOTE: Increases shown west of Fox River and at municipal wells in BACOG area also include the increase in water levels from pumping to static conditions!!!



Results-USGS Hydrographs





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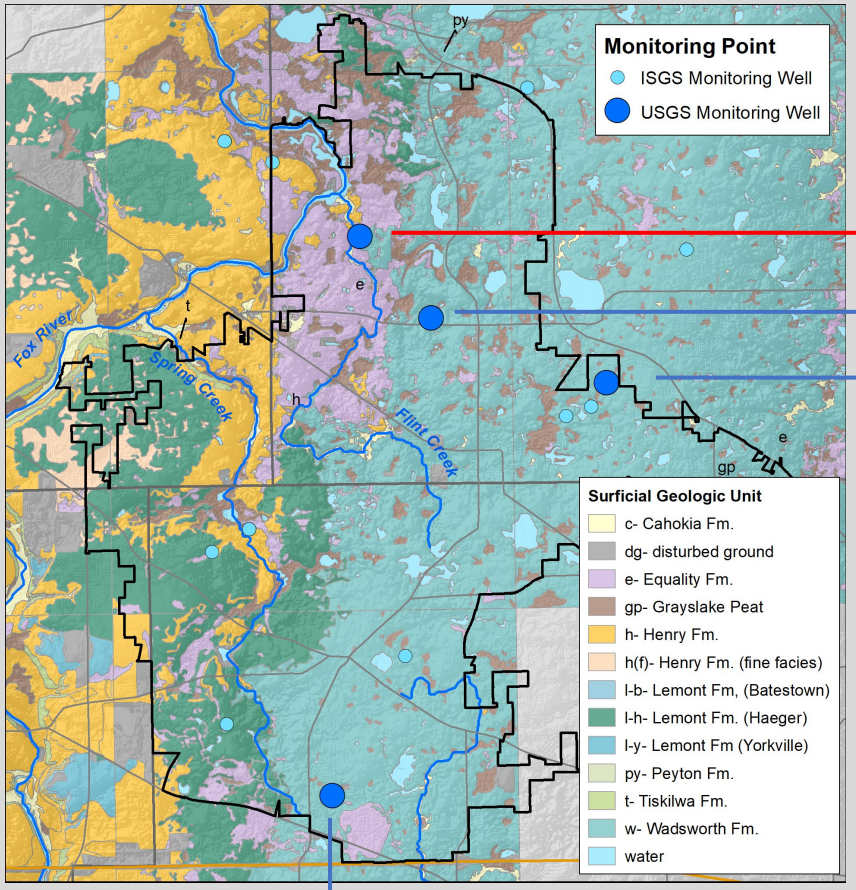
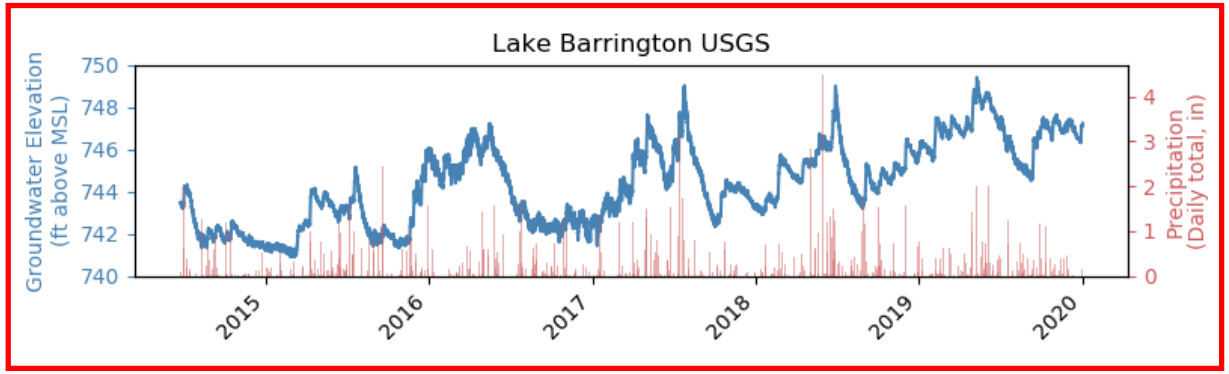
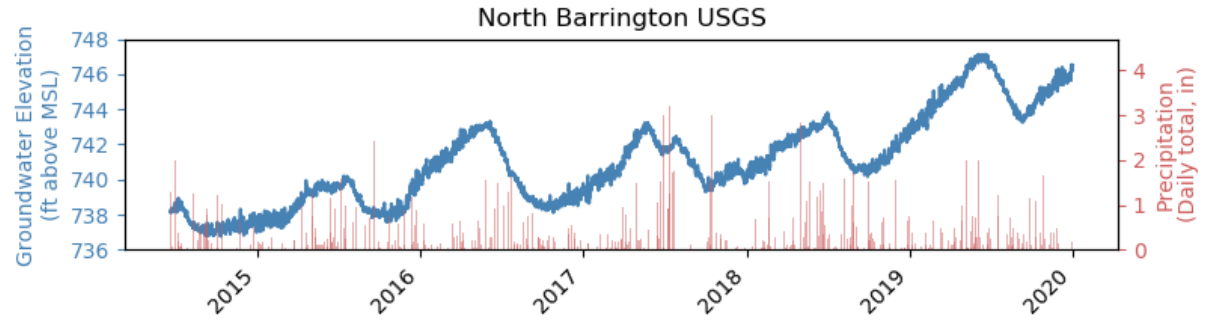
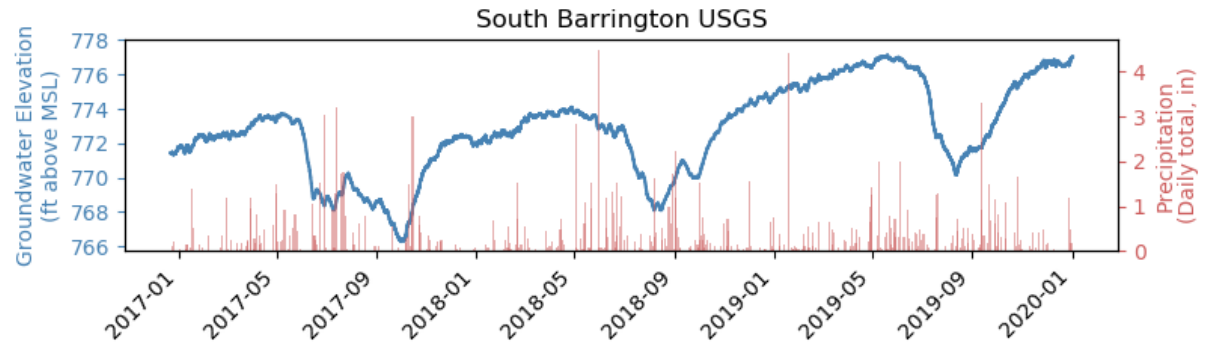
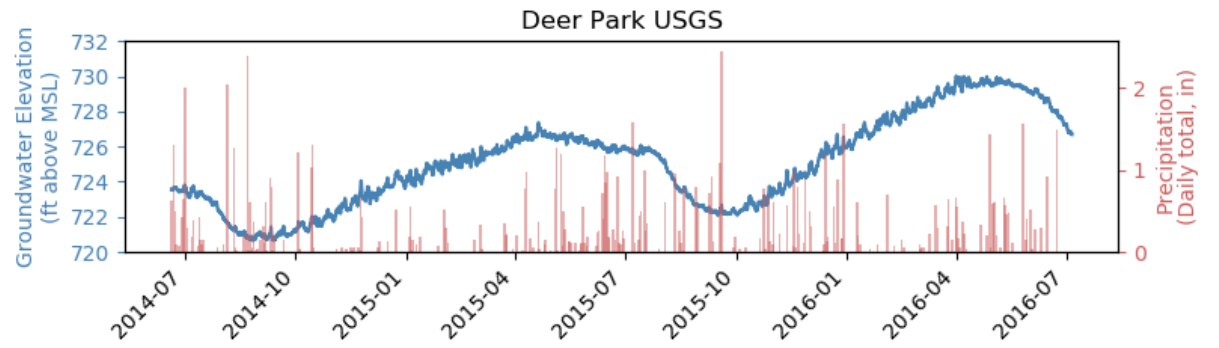


- Unconfined
- Responds rapidly to rainfall
- Increase of ~ 5 feet









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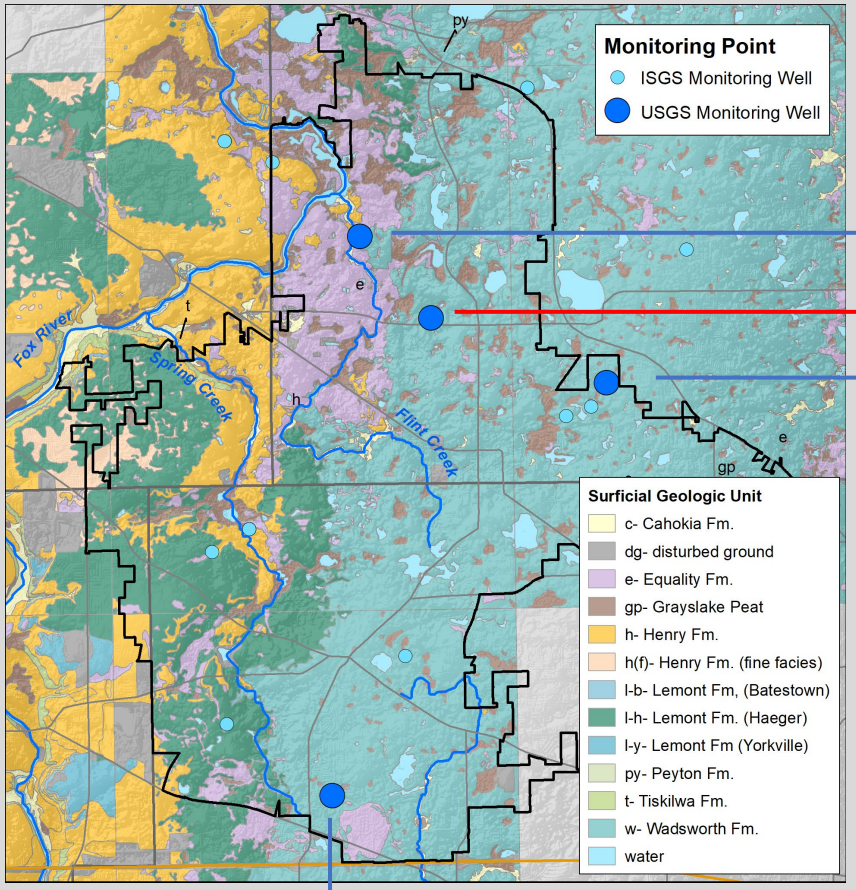
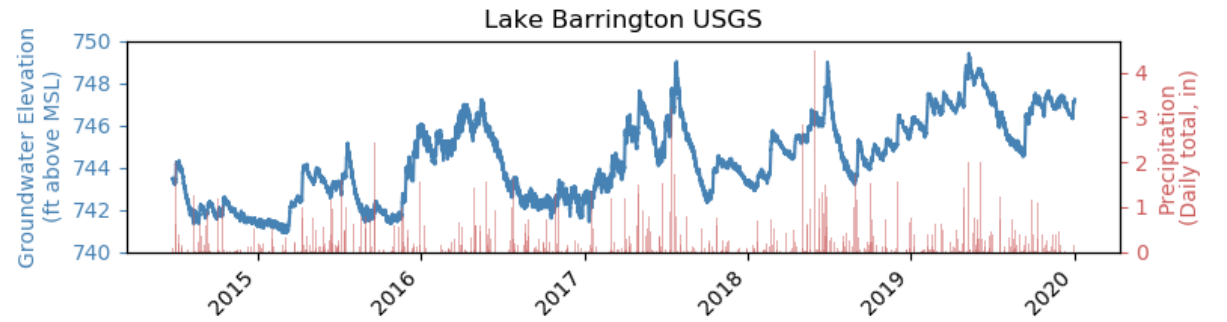
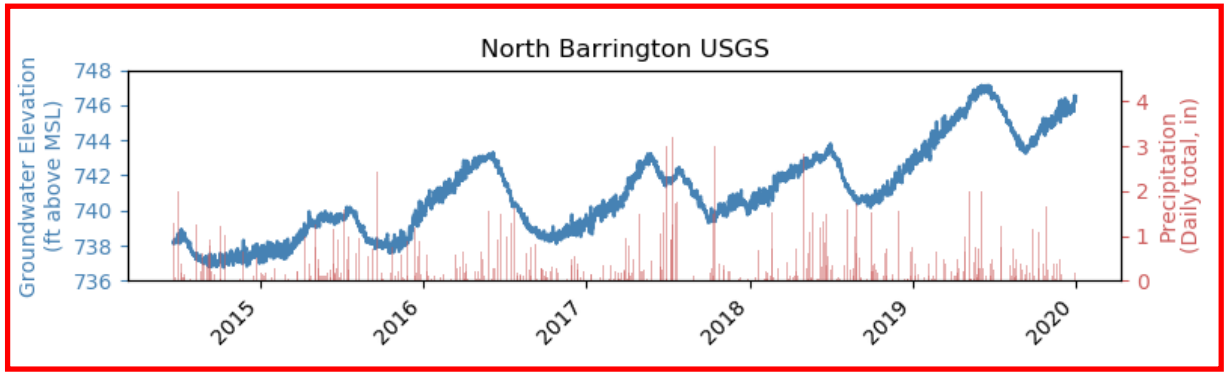
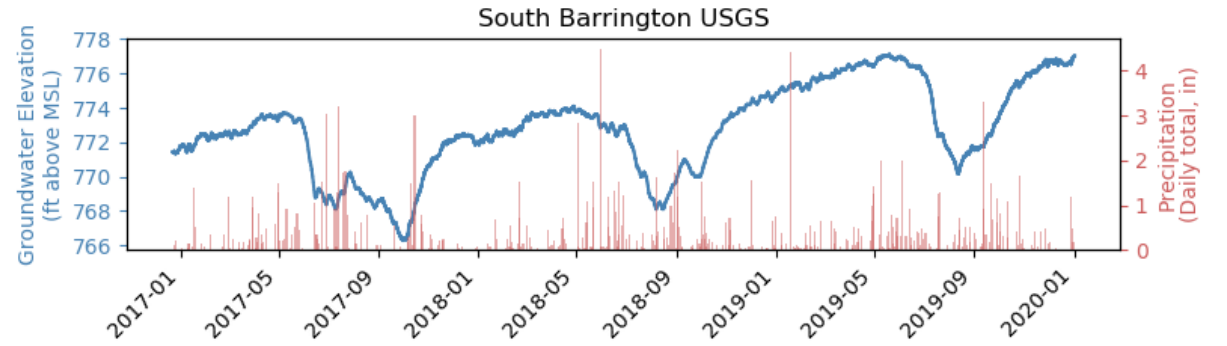
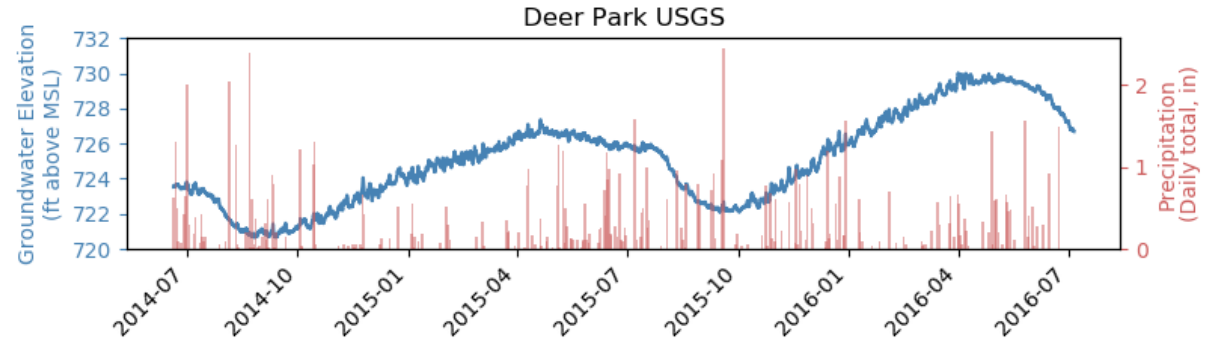


- Confined
- Responds seasonally to rainfall
- Increase of ~ 5 feet









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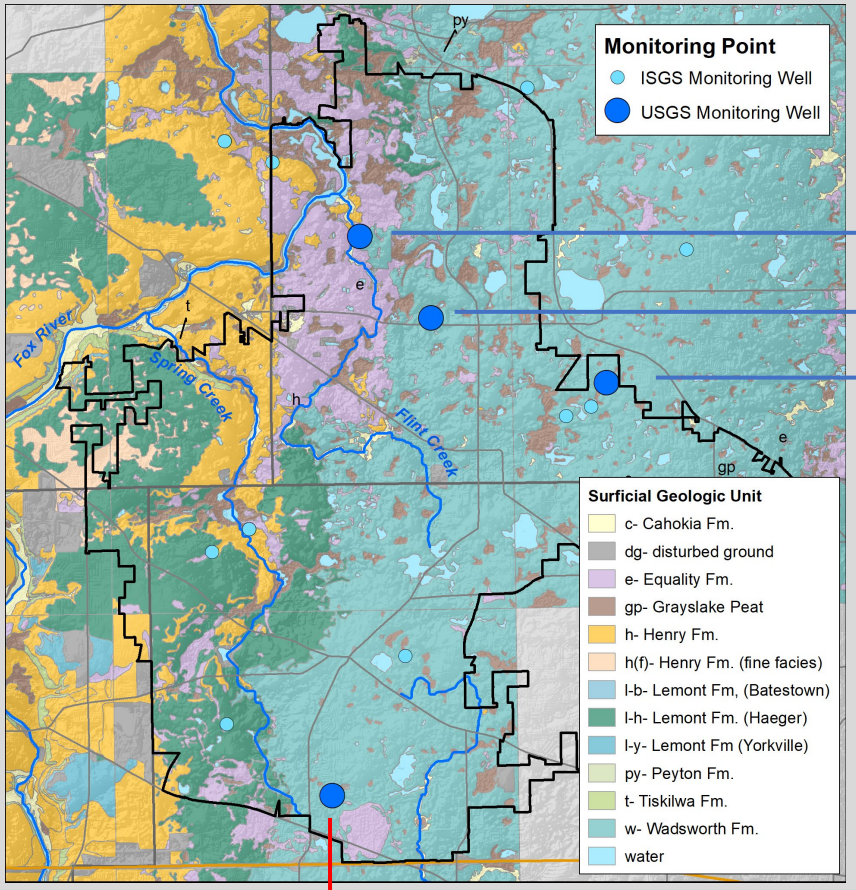
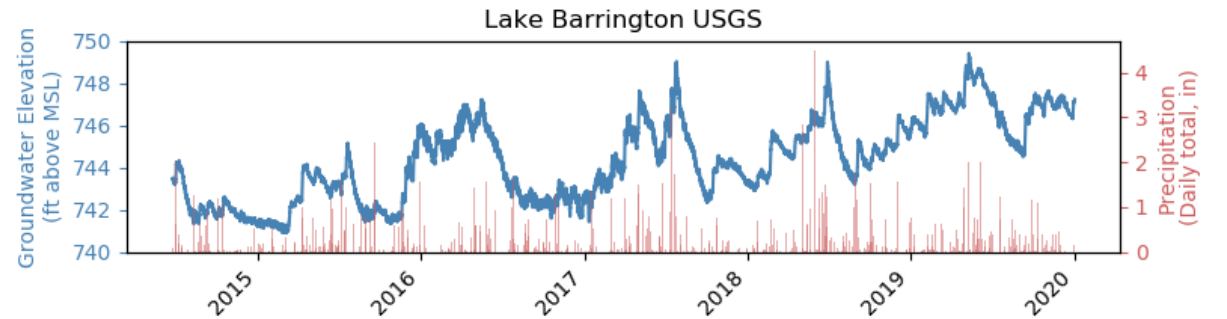
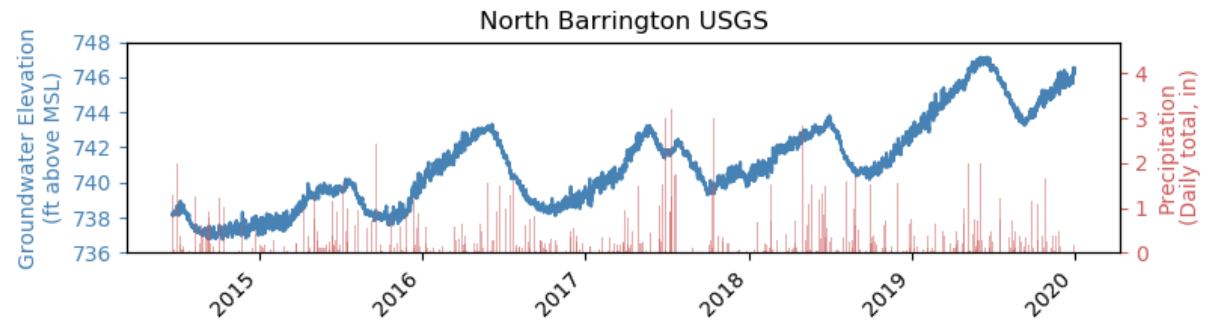
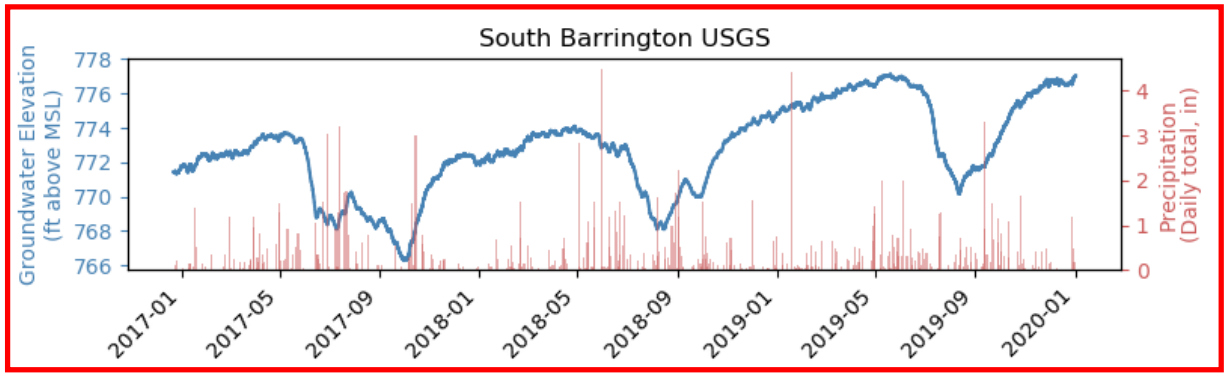
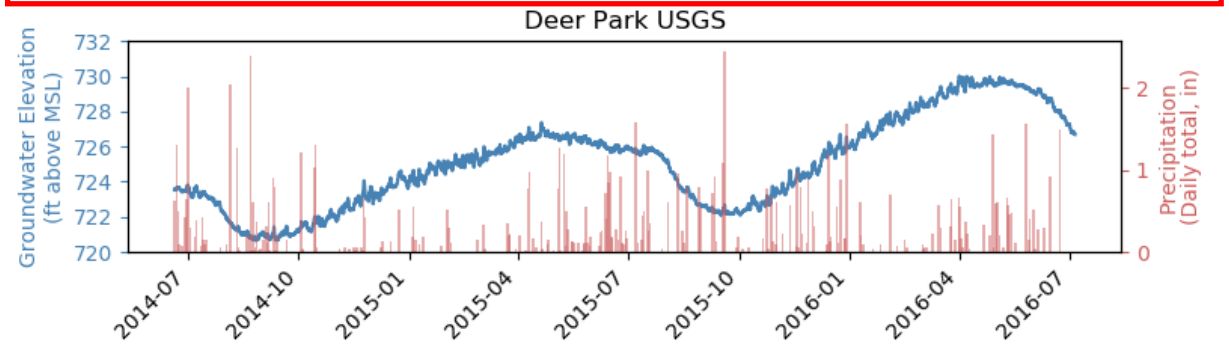


- Confined
- Responds seasonally to rainfall
- Influenced by nearby pumping
- Increase by ~3 feet









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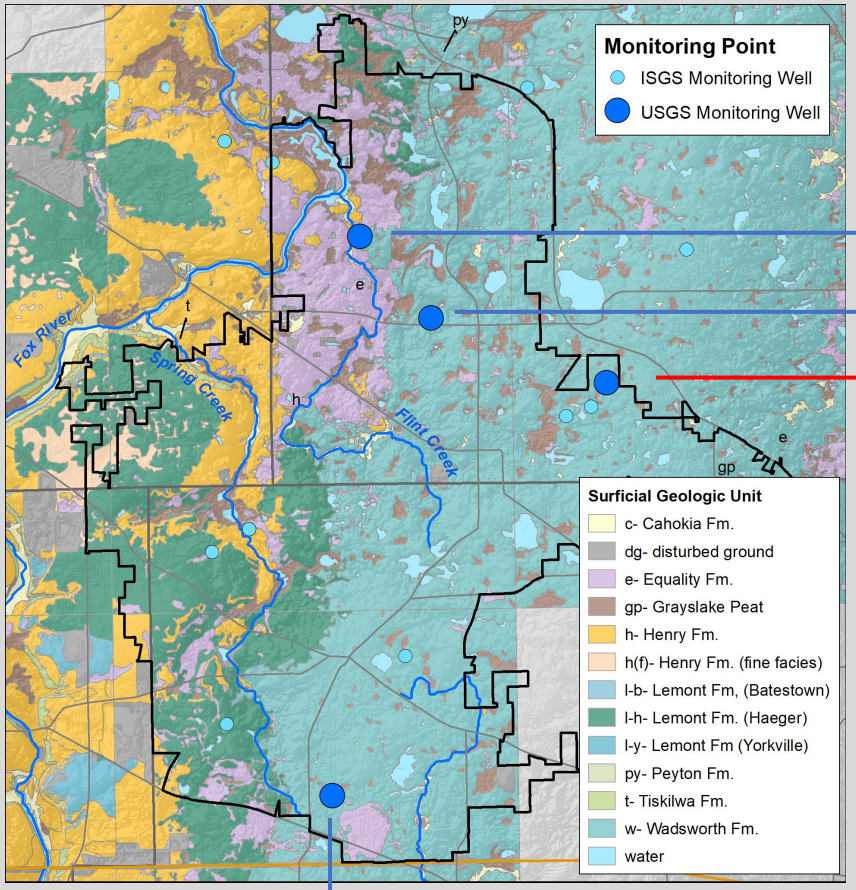
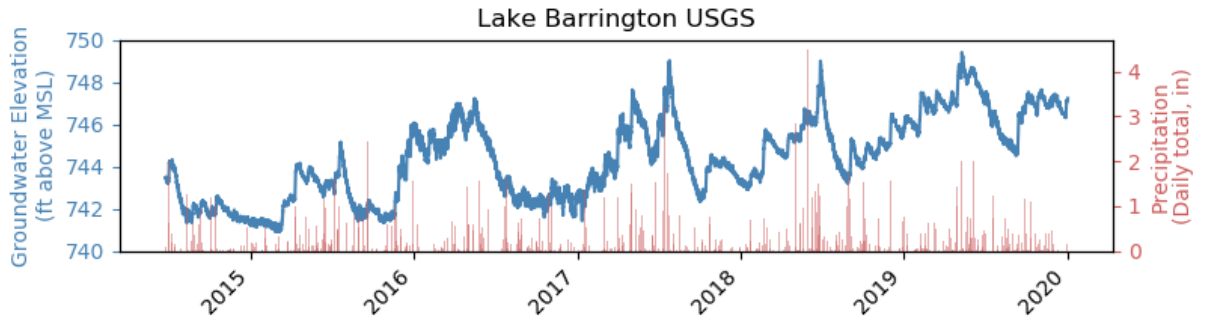
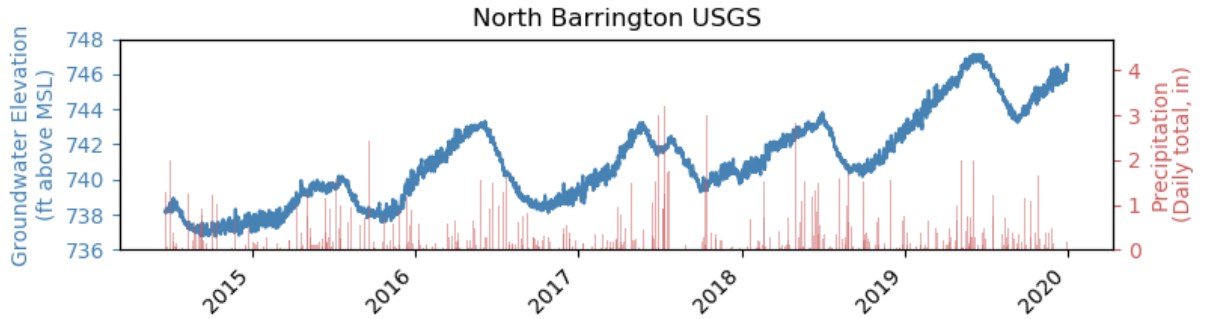
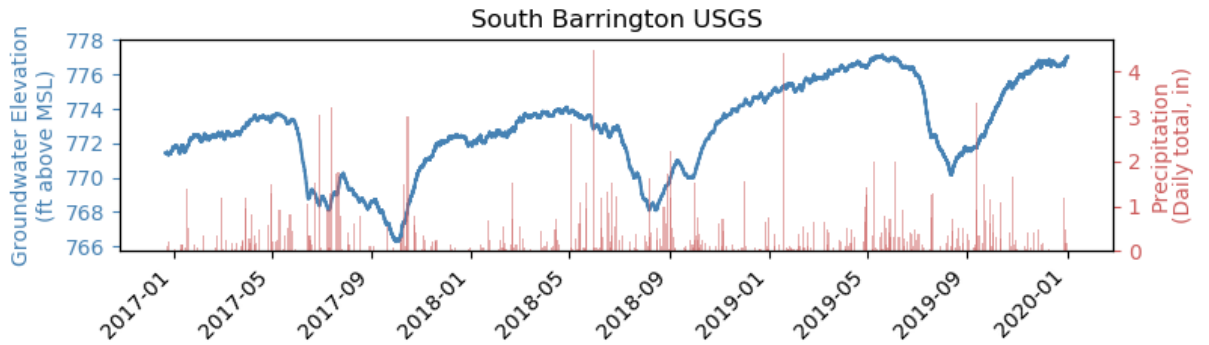
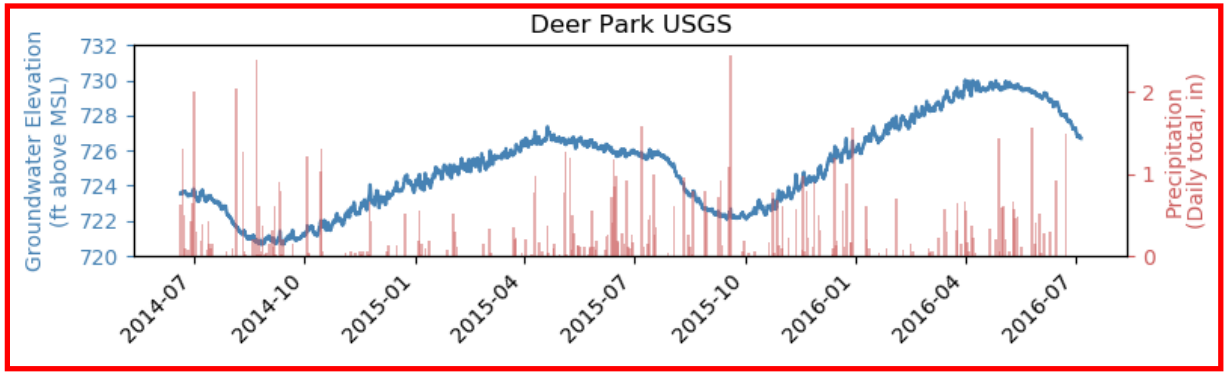


- Most confined response
- Responds seasonally to rainfall
- Increase by ~2 feet









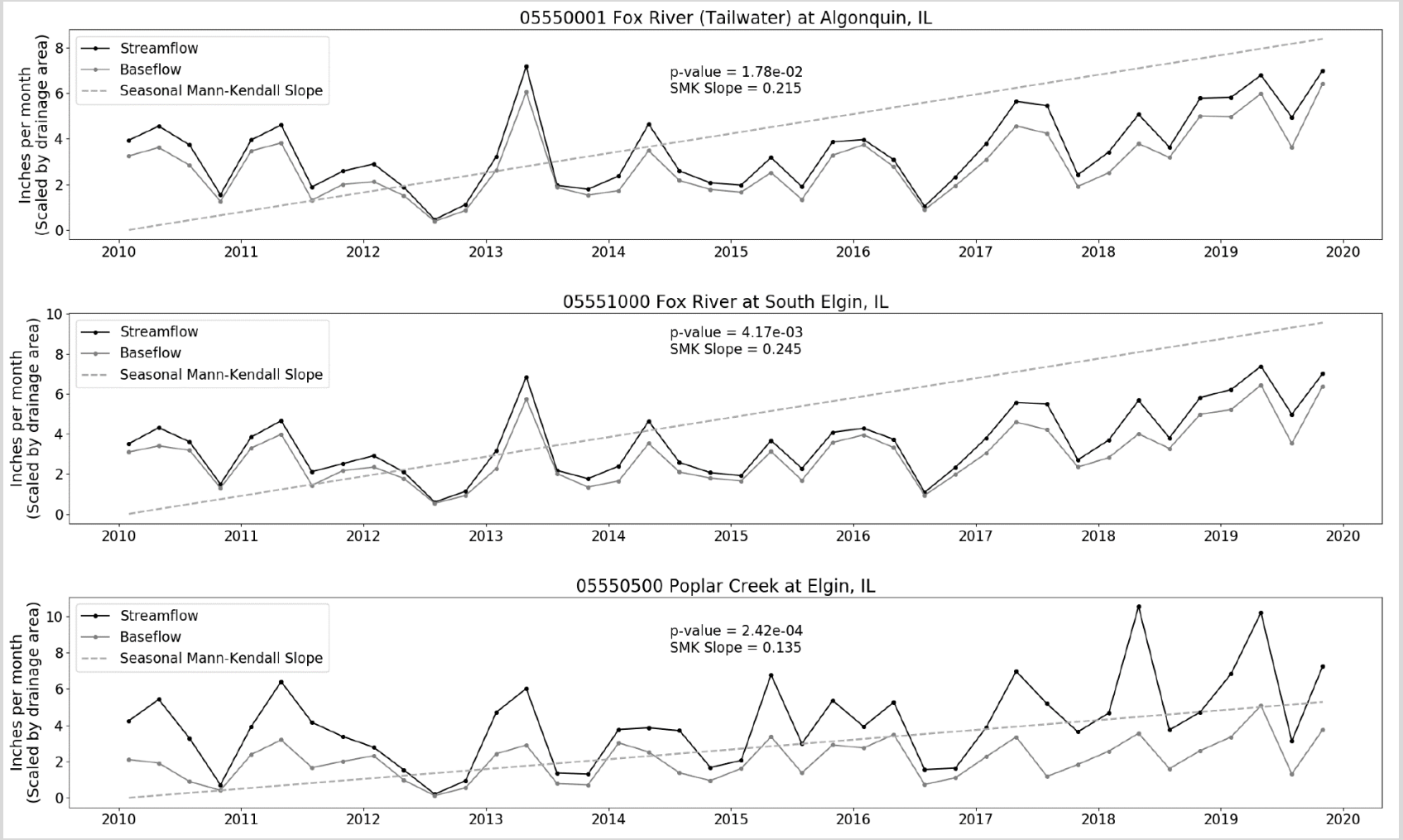
Results- Baseflow Analysis

Limitations

- Stream gauge needs to be low in the watershed
- Not meant to determine baseflow at modified streams/rivers

Insights

- Unrealistic results at Fox River
  - Baseflow is modified
  - Wastewater effluent
- Good results at Poplar Creek
  - Trend analysis shows increasing baseflow over 5 years



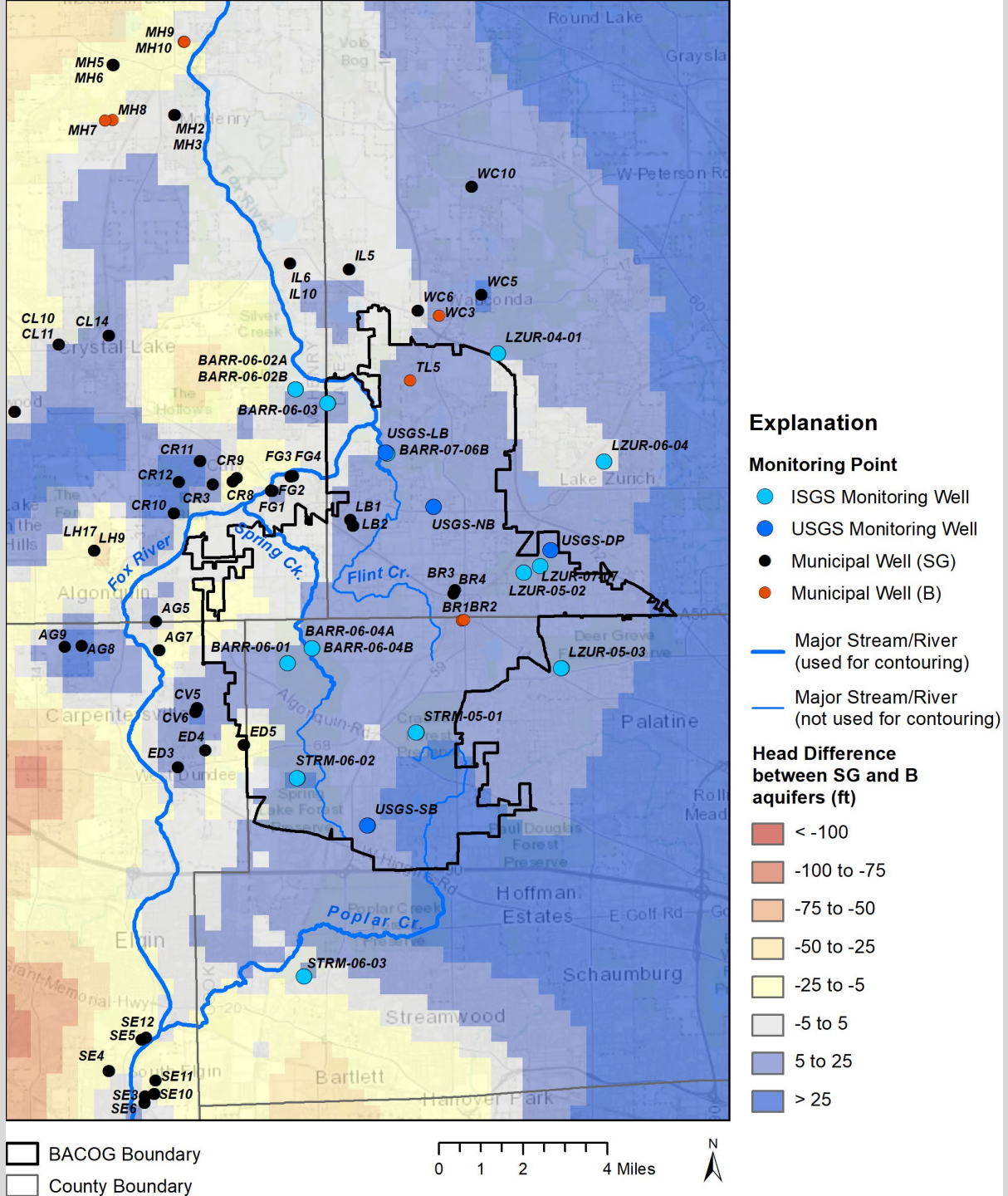
Results-Shallow Bedrock Water Levels

How do water levels differ in shallow bedrock aquifer?

- Shallow bedrock potentiometric surface - sand and gravel potentiometric surface (2019)
- Shallow bedrock surface from composite of measurements (1990-2006)
- Blue= higher water levels in sand and gravel aquifer compared to shallow bedrock aquifer
- Red= higher water levels in shallow bedrock aquifer than in sand and gravel aquifer

Insights

- BACOG region- higher water levels in sand and gravel aquifer compared to shallow bedrock aquifer
- Outside BACOG region- variable, but low confidence due to sparse data



Conclusions

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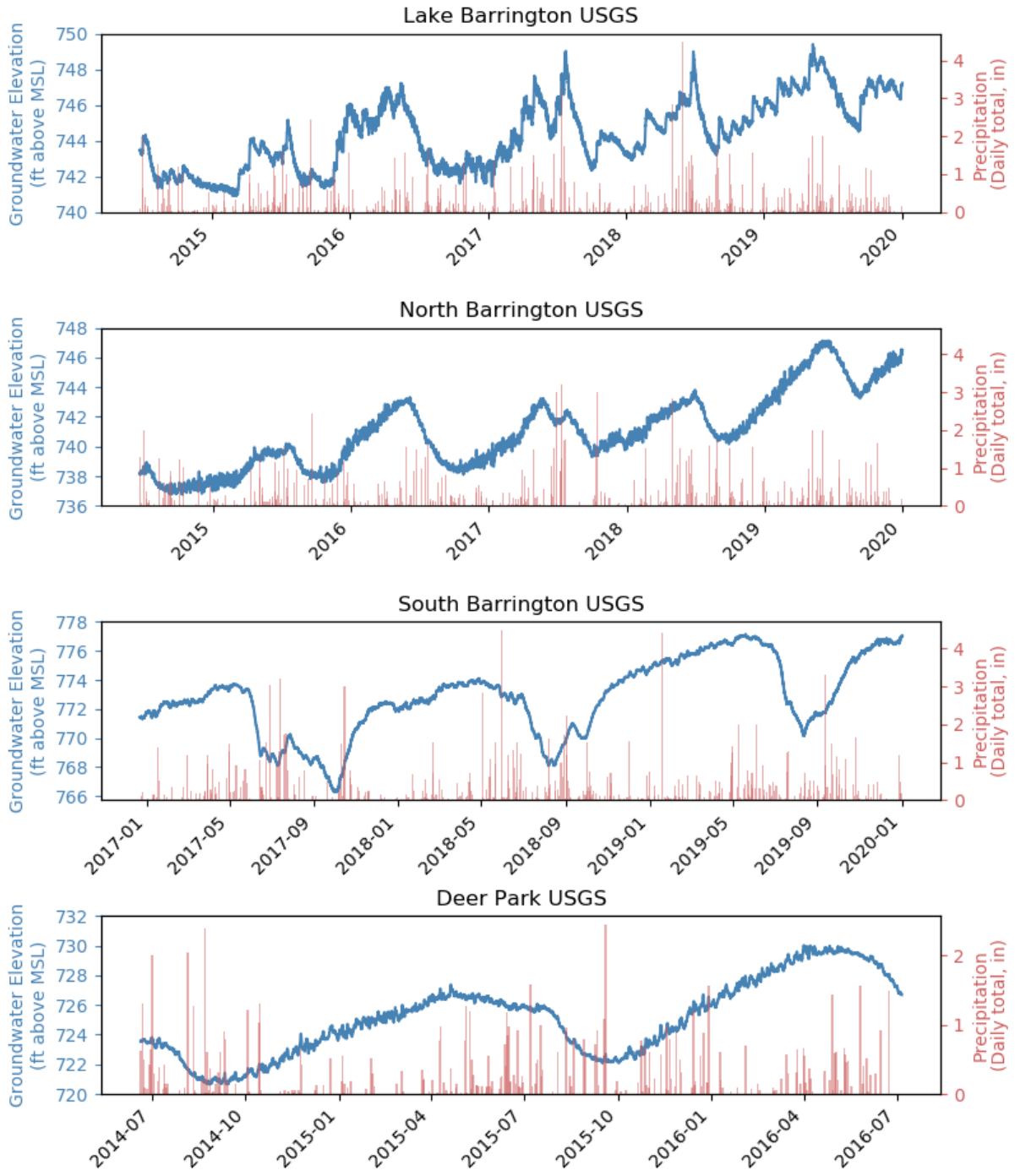

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Owner	Monitoring Well Name	Water Level Elevation (ft AMSL)		Change 2014-2019
		2014	2019	
ISGS	BARR-06-01	770.79	783.47	12.68
ISGS	BARR-06-02A	735.54	736.58	1.04
ISGS	BARR-06-02B	750.85	752.64	1.79
ISGS	BARR-06-03	-	743.27	-
ISGS	BARR-06-04A	774.03	779.20	5.17
ISGS	BARR-06-04B	-	771.79	-
ISGS	BARR-07-06B	743.67	745.57	1.90
ISGS	LZUR-04-01	746.17	750.52	4.35
ISGS	LZUR-05-02	788.67	763.98	-
ISGS	LZUR-05-03	729.33	738.56	9.23
ISGS	LZUR-06-04	717.05	723.37	6.32
ISGS	LZUR-07-07	727.23	737.51	10.28
ISGS	STRM-05-01	748.33	-	-
ISGS	STRM-06-02	808.45	814.44	5.99
ISGS	STRM-06-03	765.86	768.53	2.67
	Average water level change			5.58

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	2014-2016	2017-2019	2014-2019
Average water level change in SG wells (ft)	2.2	3.2	17.9

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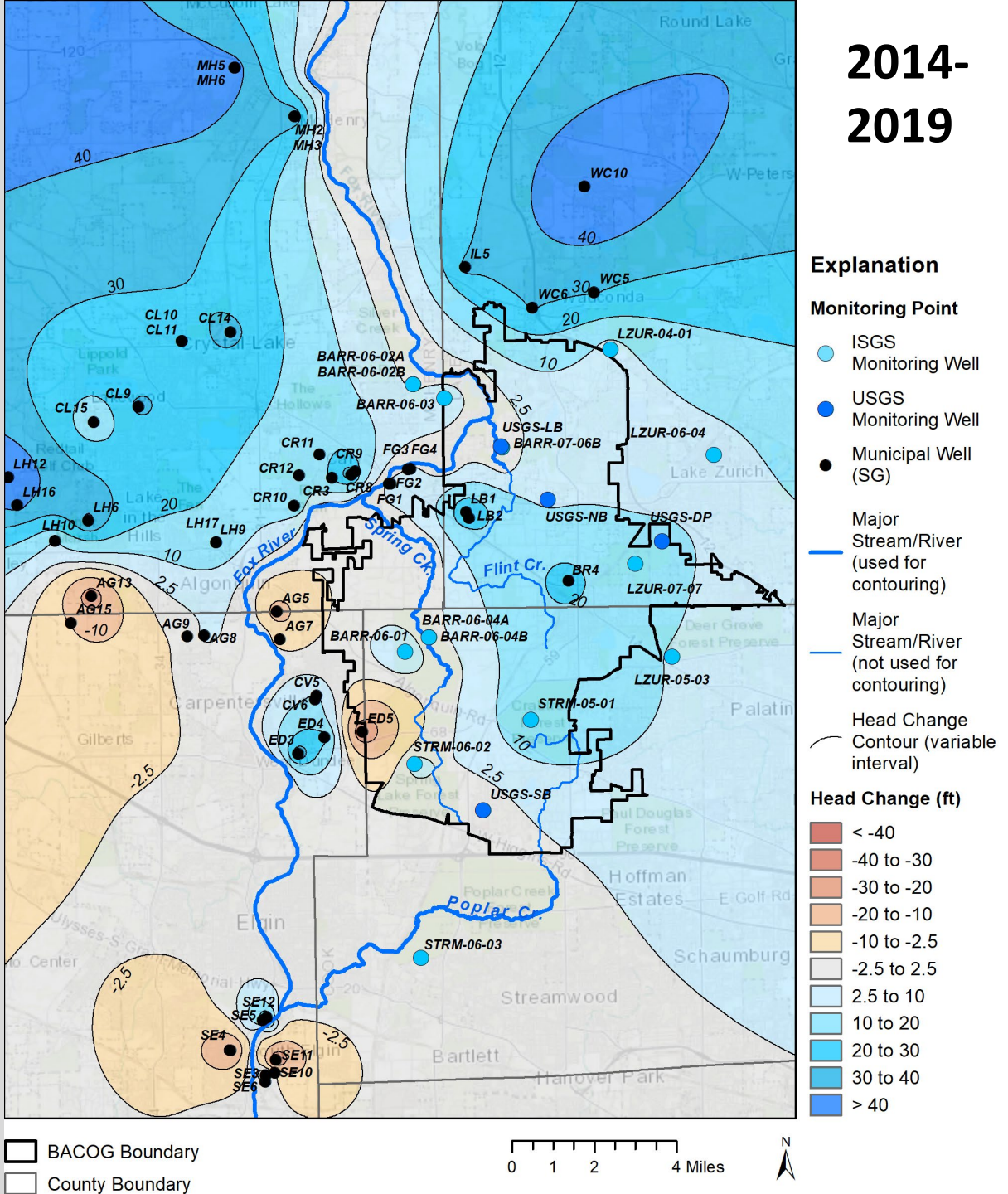
The water elevation maps reflect these increasing water levels



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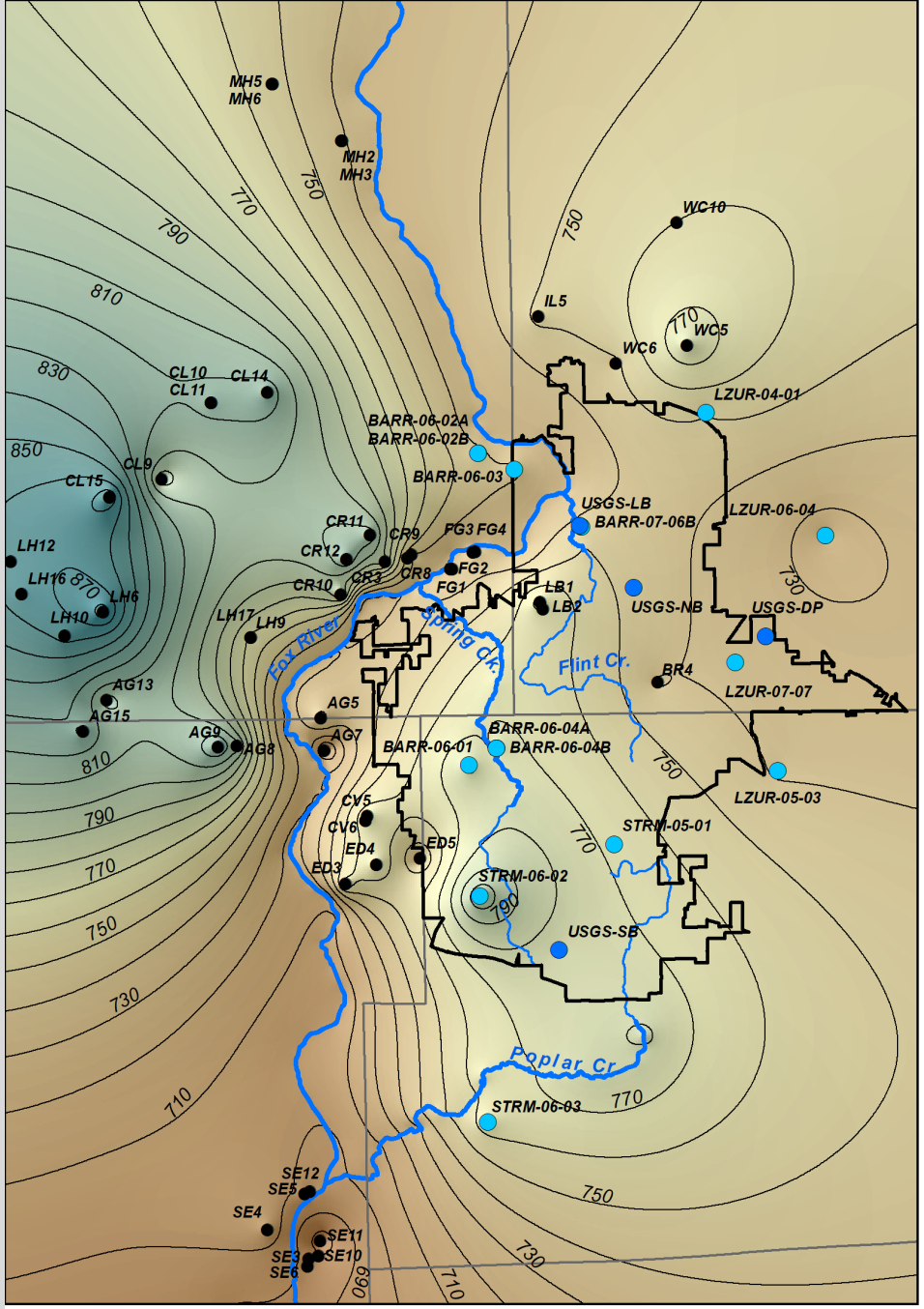

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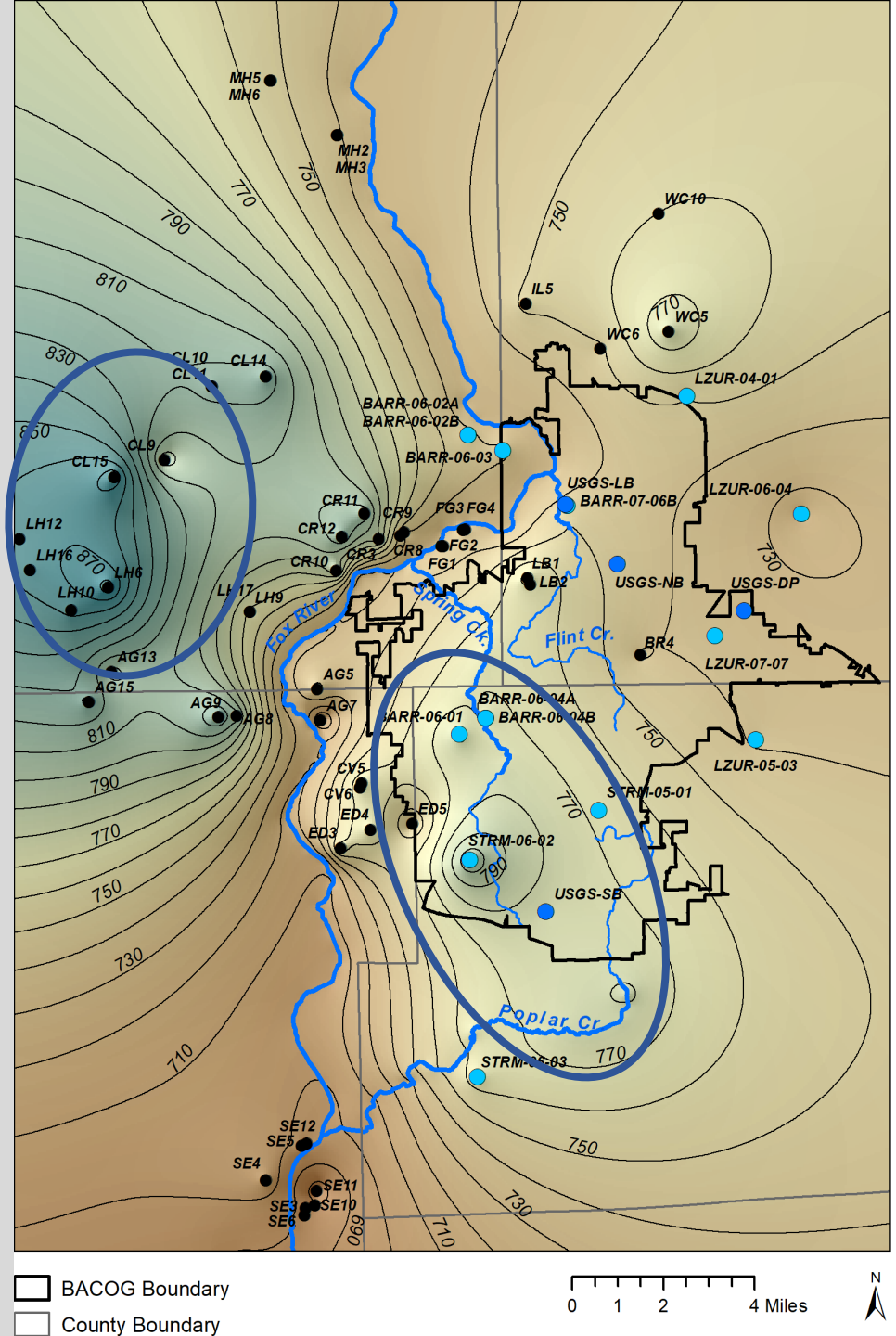

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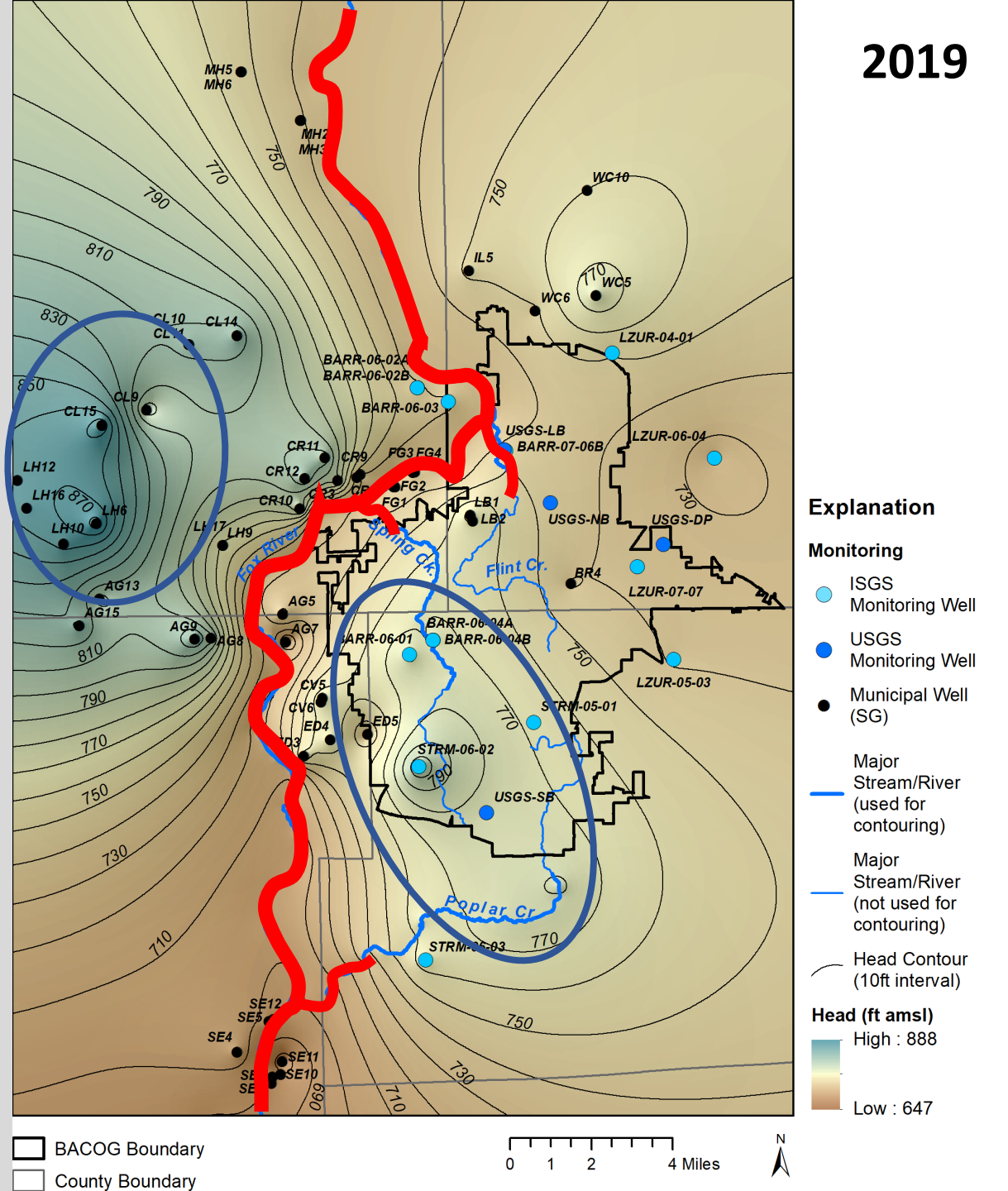

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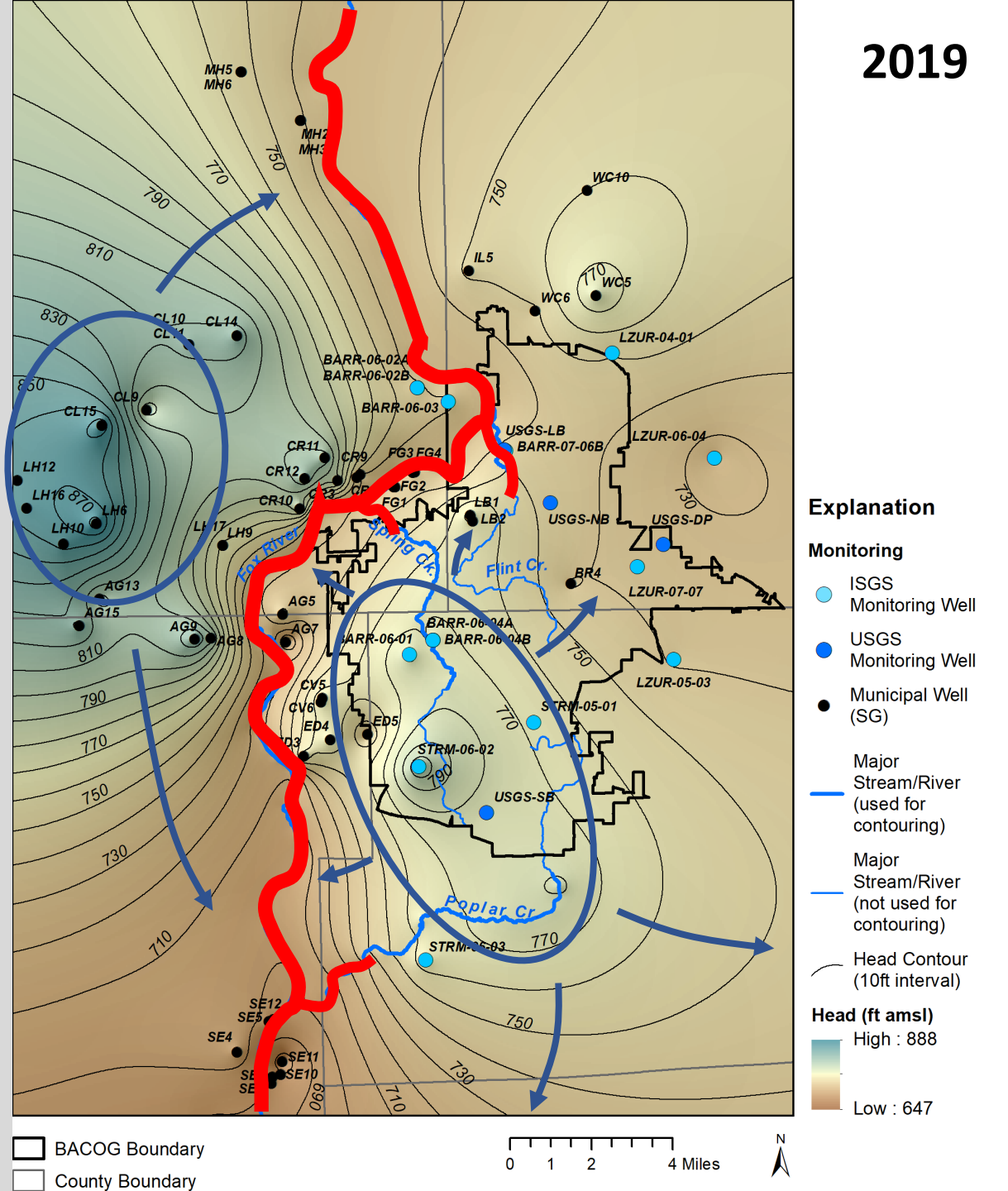

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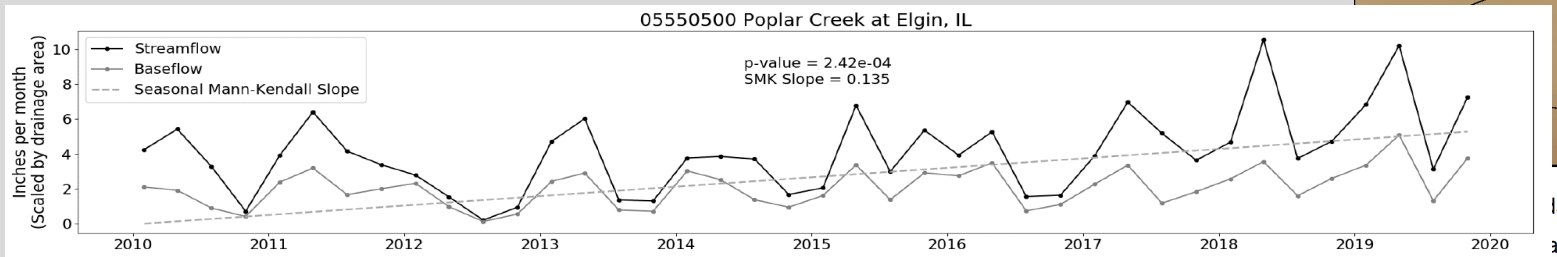
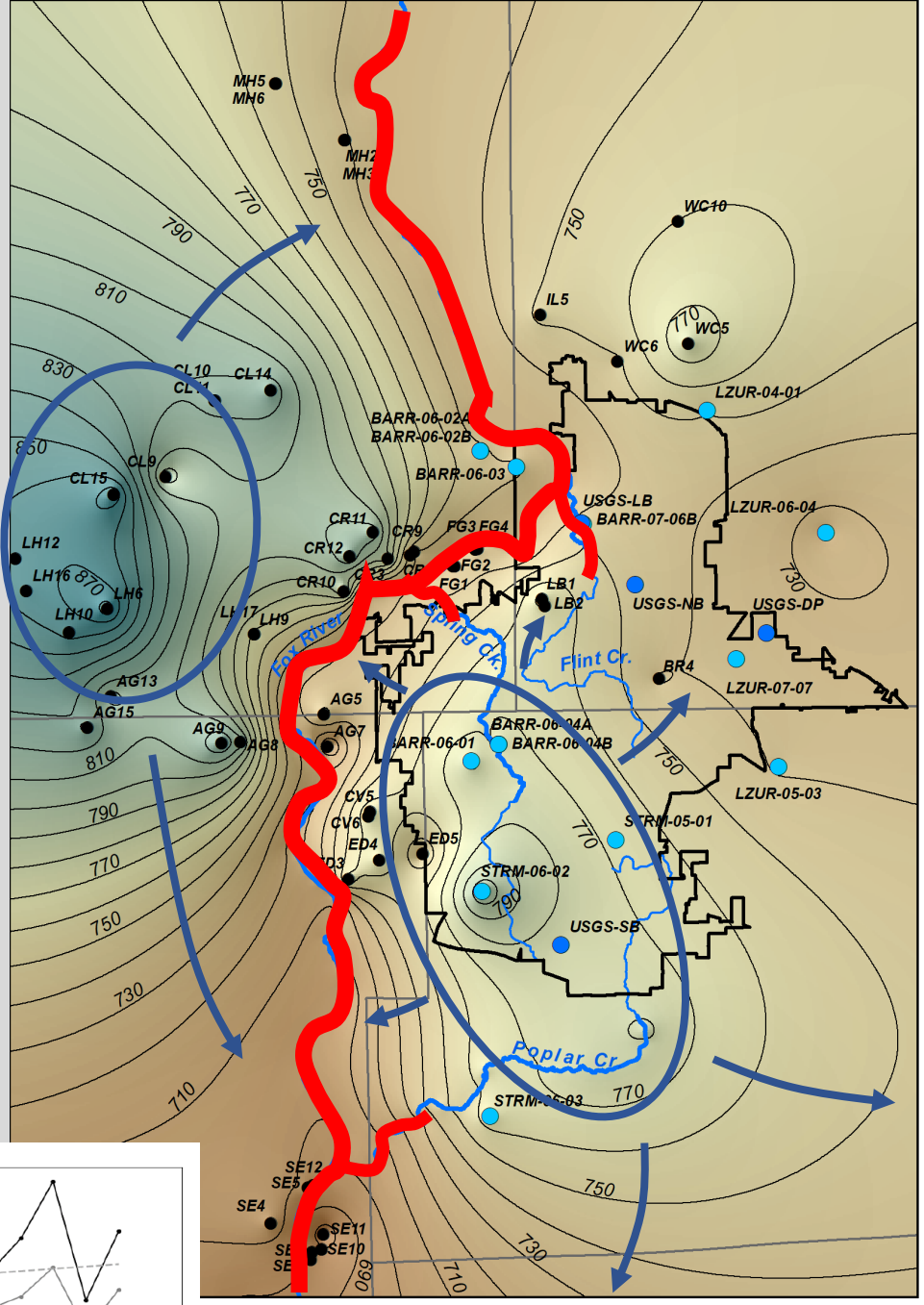
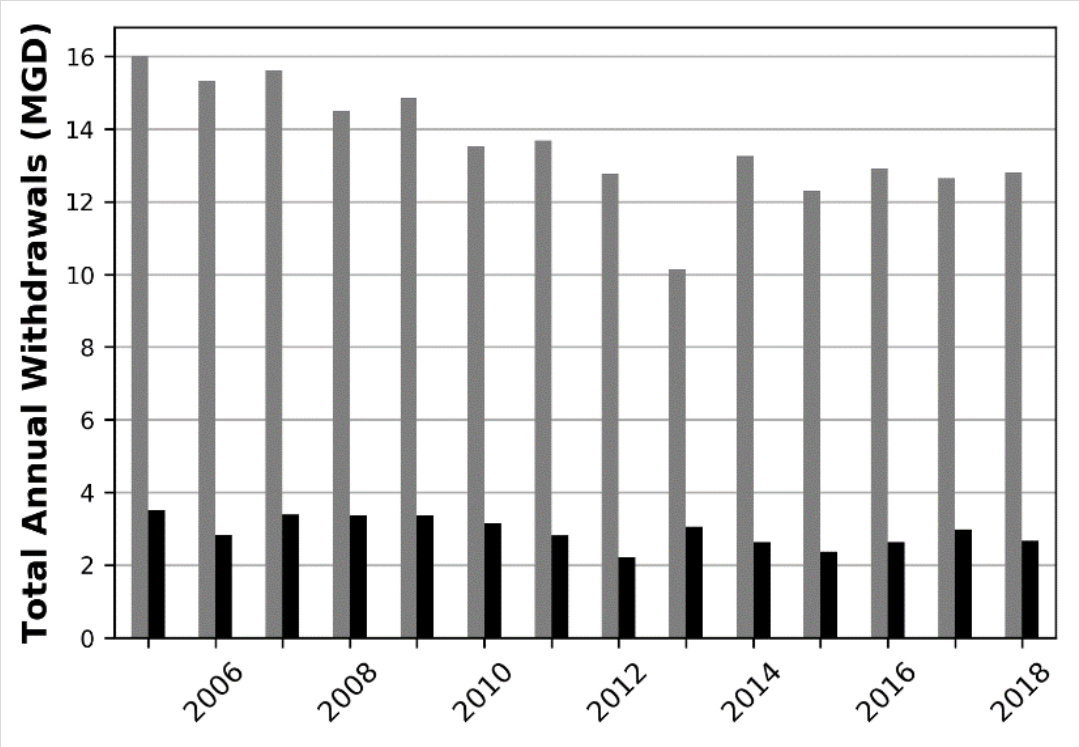
- Poplar Creek baseflow in increasing





Why are aquifer levels going up?

- ***Increased precipitation?***
- ***No significant droughts during study period***
- ***Less municipal water use***
- ***16 MGD to 13 MGD***
- ***Better household water efficiency?***
  - More efficient appliances
  - Less lawn watering
  - Water use from private wells is unknown



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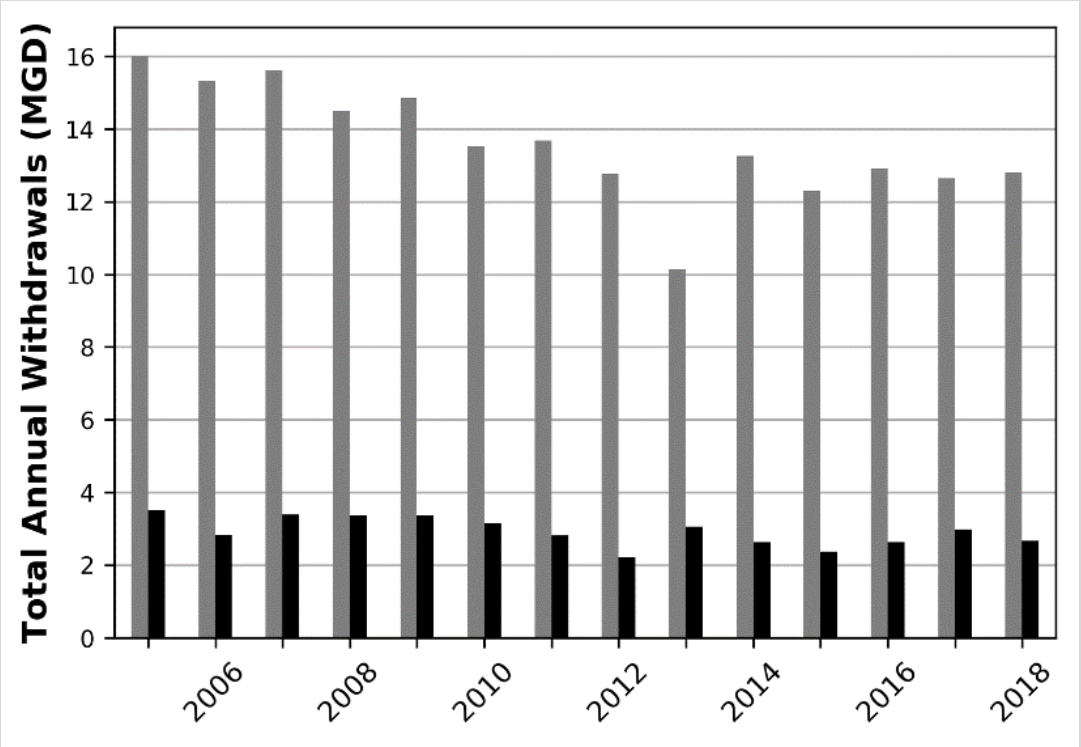

What does this all mean?

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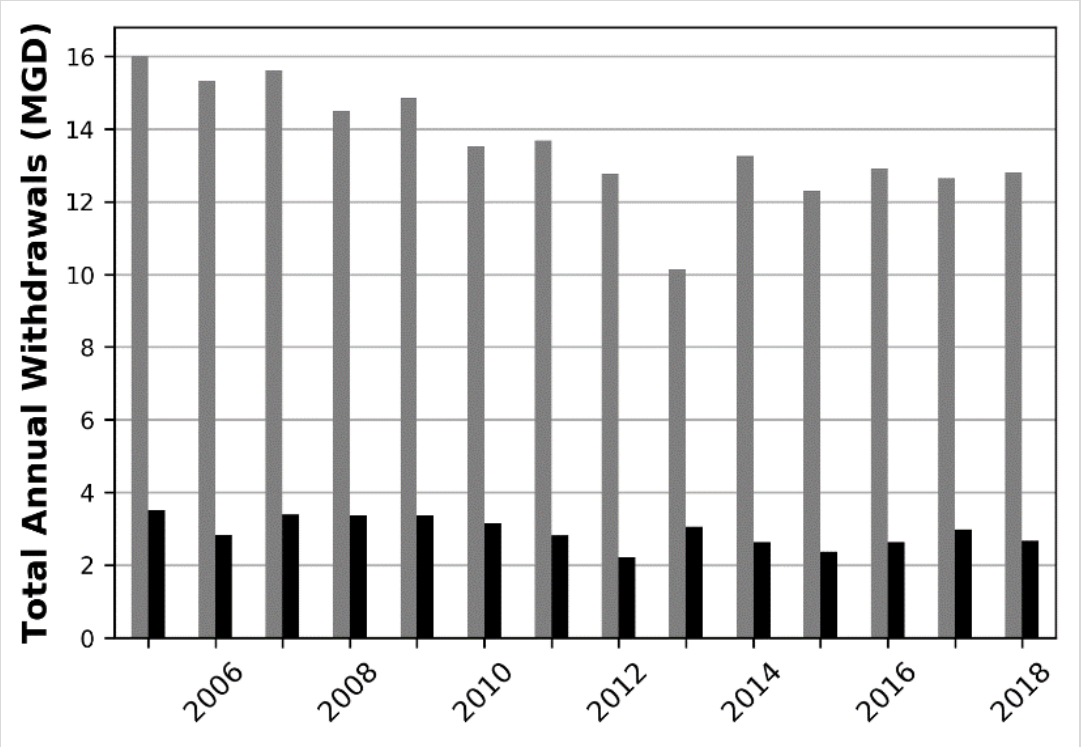


What does this all mean?

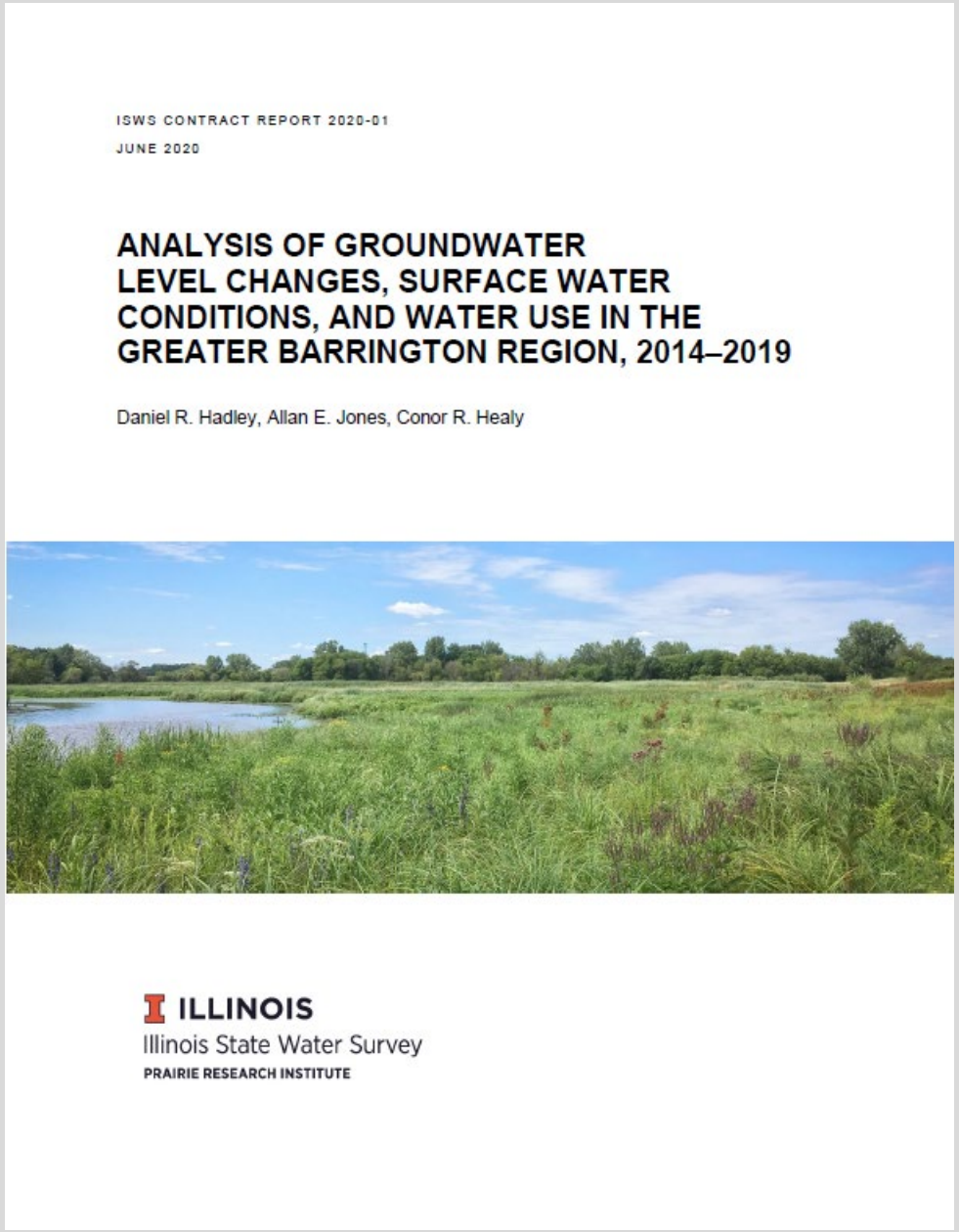
- ***Water supply is more than sufficient for now***
- ***Quantity of water is less a concern than quality***
- ***Unconfined sand and gravel deposits susceptible to contamination***
  - Chloride from road salt
  - Fertilizers/Pesticides from lawn care
- ***Long-term monitoring essential tool for planning and decision making***
  - Storm intensity projected to increase
  - Flood and drought events predicted to become more extreme and more common
  - Shifts is climate patterns may lead to changes in timing of aquifer recharge

Acknowledgements

- Janet Agnoletti
- Tomasz Szczuka (GIS)
- BACOG Board Members
- USGS
- ISGS
- ISWS
- Kurt Thomsen (KOT Env.)
- Water Operators

Questions?

- Daniel Hadley
- drhadley@Illinois.edu
- 217-300-0402



https://www.ideals.illinois.edu/handle/2142/107287