Fox Hills-Hell Creek Aquifer

Alex Johanson
Montana Bureau of Mines and Geology

House Bill 935

Directed the MBMG to…

“Complete a feasibility study on ground water availability from the Fox Hills-Hell Creek Aquifer”

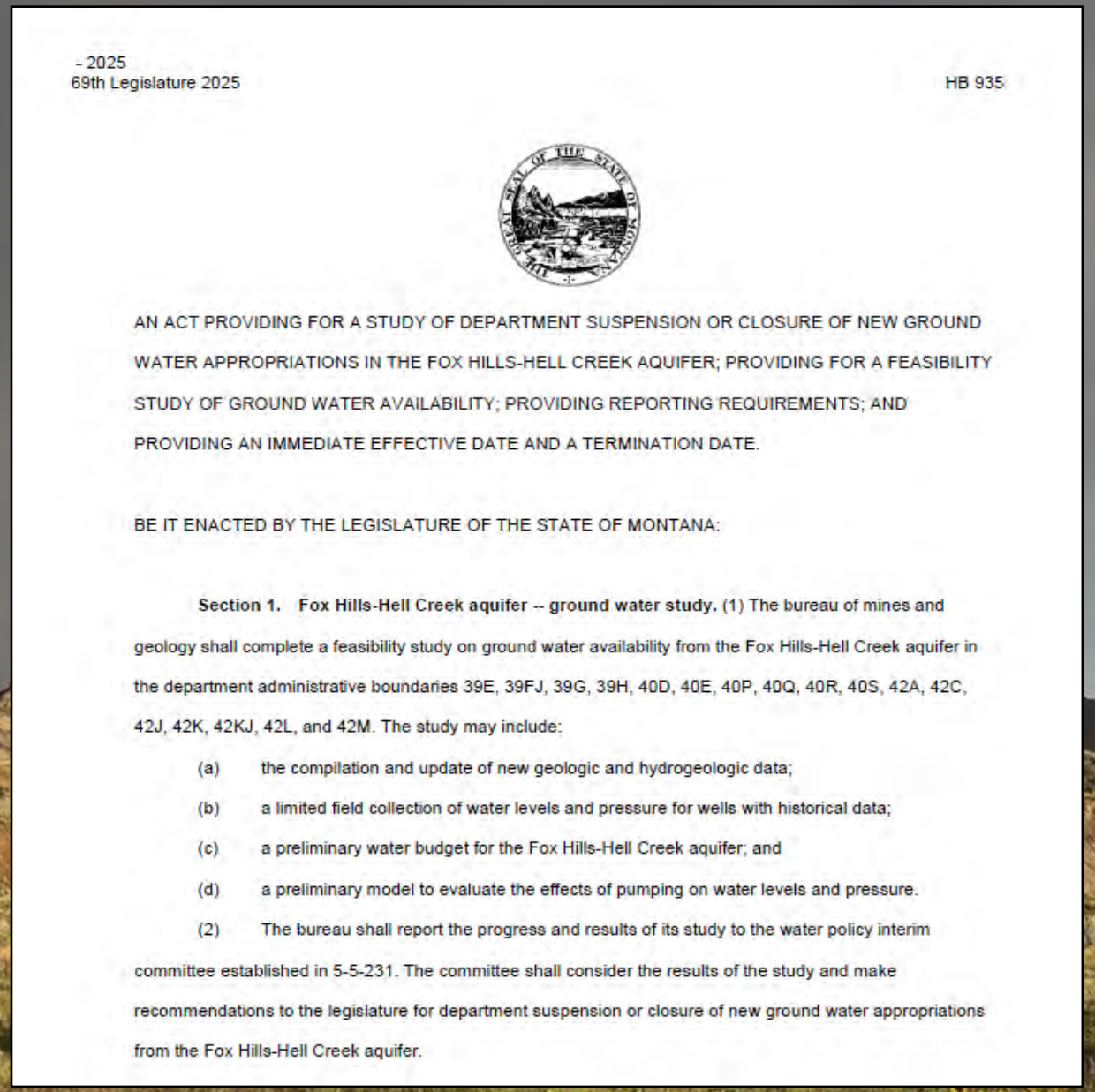
Including…

a) **The compilation and update of new geologic and hydrogeologic data**

a) **A limited field collection of water levels and pressure for wells with historical data**

a) **A preliminary water budget for the Fox Hills-Hell Creek aquifer**

a) **A preliminary model to evaluate the effects of pumping on water levels and pressure**



- 2025
69th Legislature 2025 HB 935

AN ACT PROVIDING FOR A STUDY OF DEPARTMENT SUSPENSION OR CLOSURE OF NEW GROUND WATER APPROPRIATIONS IN THE FOX HILLS-HELL CREEK AQUIFER; PROVIDING FOR A FEASIBILITY STUDY OF GROUND WATER AVAILABILITY; PROVIDING REPORTING REQUIREMENTS; AND PROVIDING AN IMMEDIATE EFFECTIVE DATE AND A TERMINATION DATE.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MONTANA:

Section 1. Fox Hills-Hell Creek aquifer -- ground water study. (1) The bureau of mines and geology shall complete a feasibility study on ground water availability from the Fox Hills-Hell Creek aquifer in the department administrative boundaries 39E, 39FJ, 39G, 39H, 40D, 40E, 40P, 40Q, 40R, 40S, 42A, 42C, 42J, 42K, 42KJ, 42L, and 42M. The study may include:

(a) the compilation and update of new geologic and hydrogeologic data;

(b) a limited field collection of water levels and pressure for wells with historical data;

(c) a preliminary water budget for the Fox Hills-Hell Creek aquifer; and

(d) a preliminary model to evaluate the effects of pumping on water levels and pressure.

(2) The bureau shall report the progress and results of its study to the water policy interim committee established in 5-5-231. The committee shall consider the results of the study and make recommendations to the legislature for department suspension or closure of new ground water appropriations from the Fox Hills-Hell Creek aquifer.

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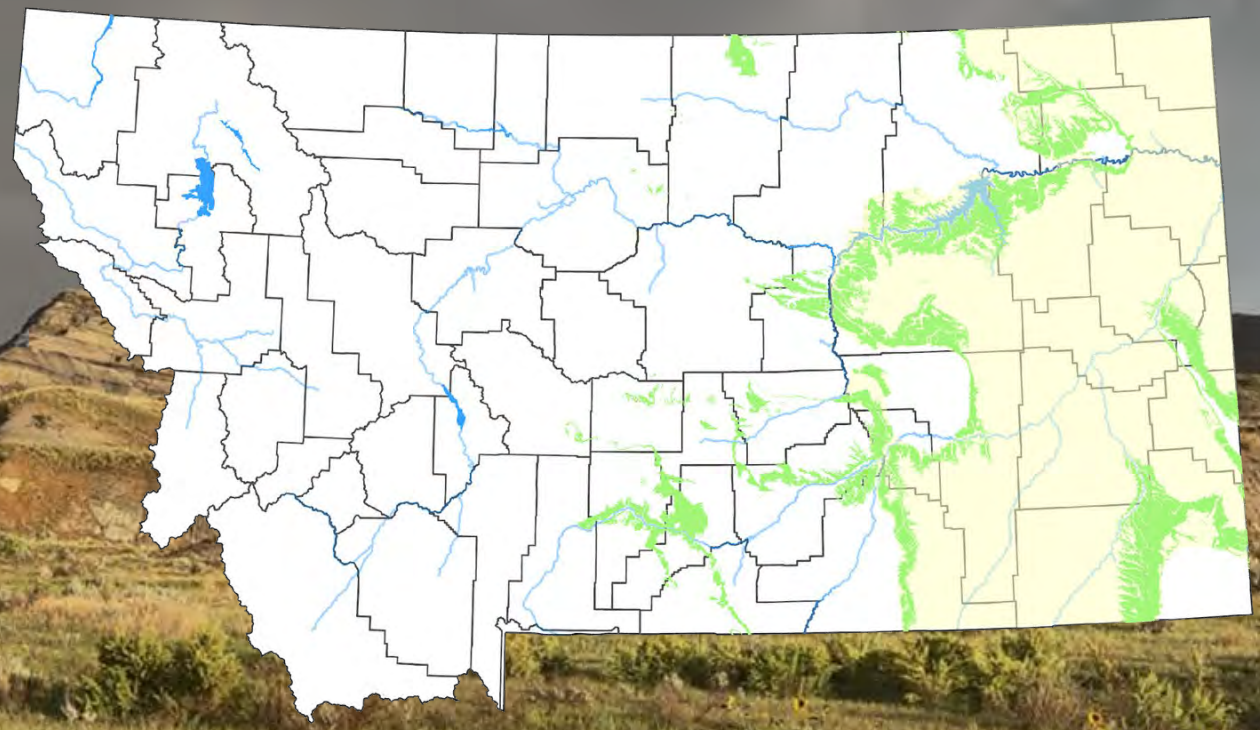
a) **A limited field collection of water levels and pressure for wells with historical data**

a) **A preliminary water budget for the Fox Hills-Hell Creek aquifer**

a) **A preliminary model to evaluate the effects of pumping on water levels and pressure**

Talk Topics

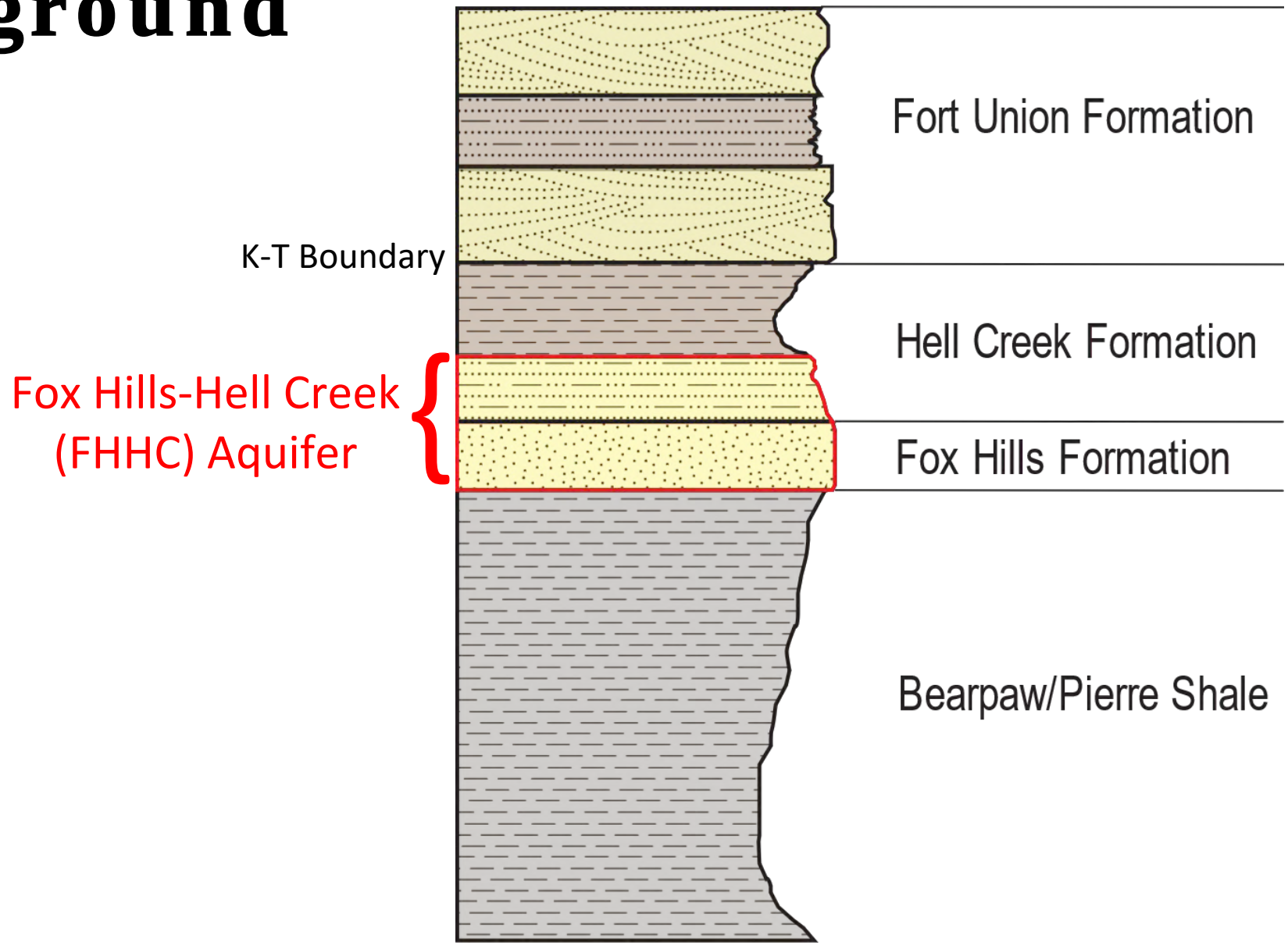
1. Geology and hydrogeology of the Fox Hills-Hell Creek Aquifer (FHHC)
2. Groundwater trends
3. MBMG Research Efforts



MBMG
Montana Bureau of Mines and Geology

Geologic Background

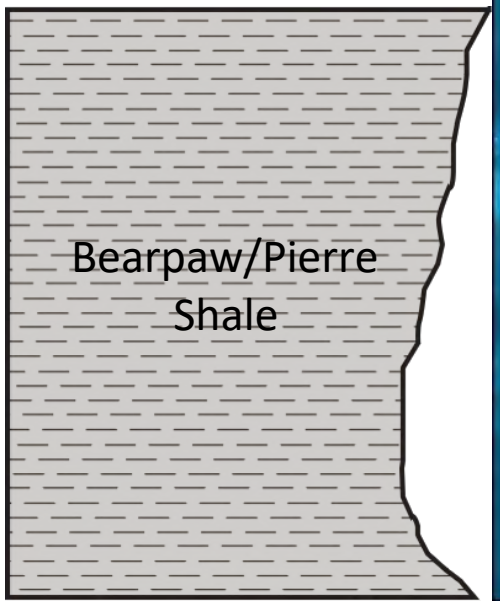
Late Cretaceous age stratigraphic sequence deposited during the final regression of the Western Interior Seaway



Geologic Background

Bearpaw/Pierre Shale

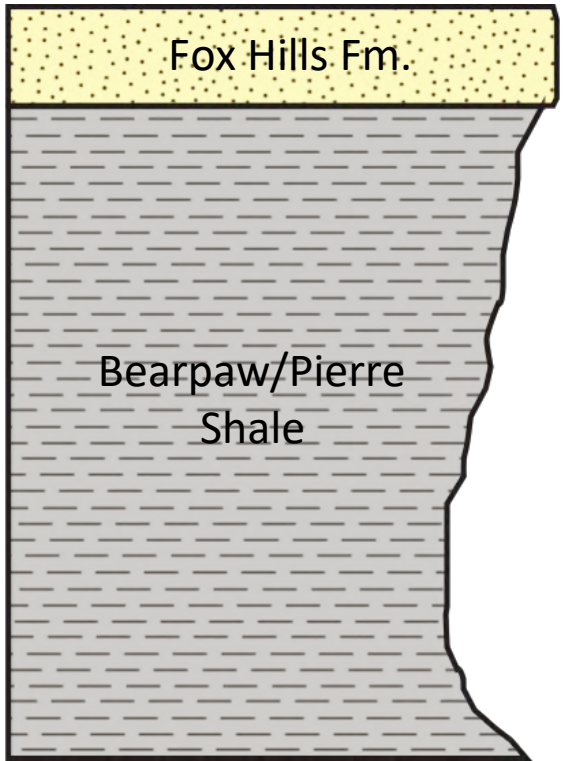
- 86-67 Million Years Ago
- Offshore shale deposits of the Bearpaw Sea
- Final transgression of the Western Interior Seaway
- Dark grey/black shale
- Forms regional aquitard in eastern Montana



Geologic Background

Fox Hills Formation

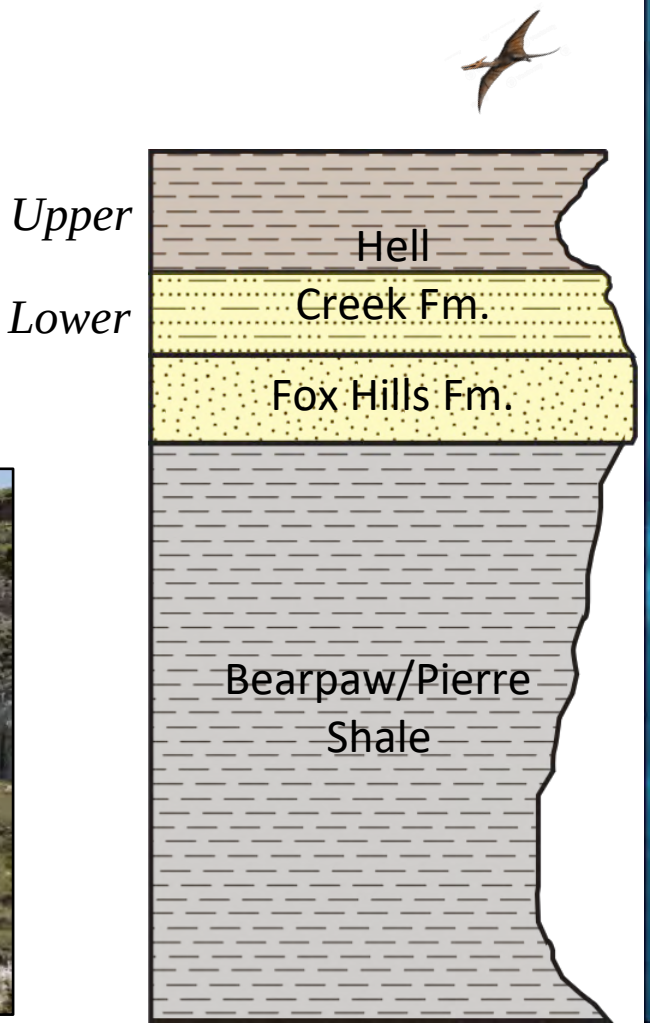
- 75-67 Million Years Ago
- Shoreface sandstone deposited during the final regression of the Western Interior Seaway
- Sheet-like geometry across nearly all of Eastern Montana
- Forms a sandstone aquifer



Geologic Background

Hell Creek Formation

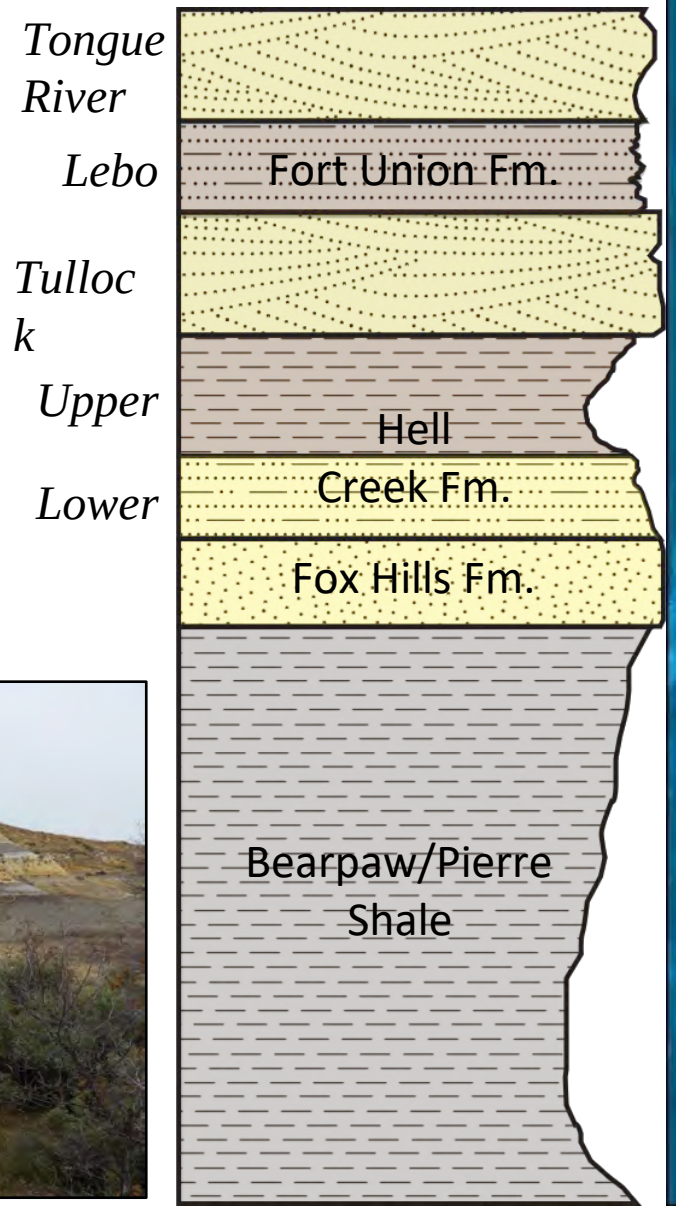
- 86-65 Million Years Ago
- Sandstones and mudstones deposited by streams in laterally migrating channel belts and floodplains.
- Bottom third is composed primarily of sandstones, upper two thirds primarily mudstones.
- Bottom third forms aquifer, upper two-thirds forms confining unit



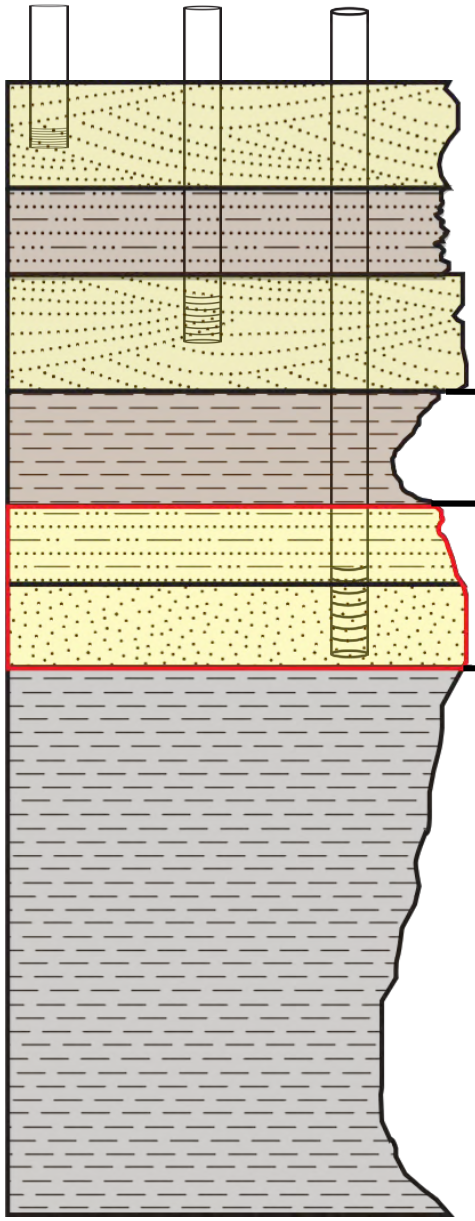
Geologic Background

Fort Union Formation

- 86-68 Million Years Ago
- Deposited by east flowing streams and swamps that drained the ancestral northern rocky mountains
- Interbedded sandstones and mudstones, cover much of the pre-glacial surface of eastern Montana.
- Sandstones form aquifers, mudstones form confining units

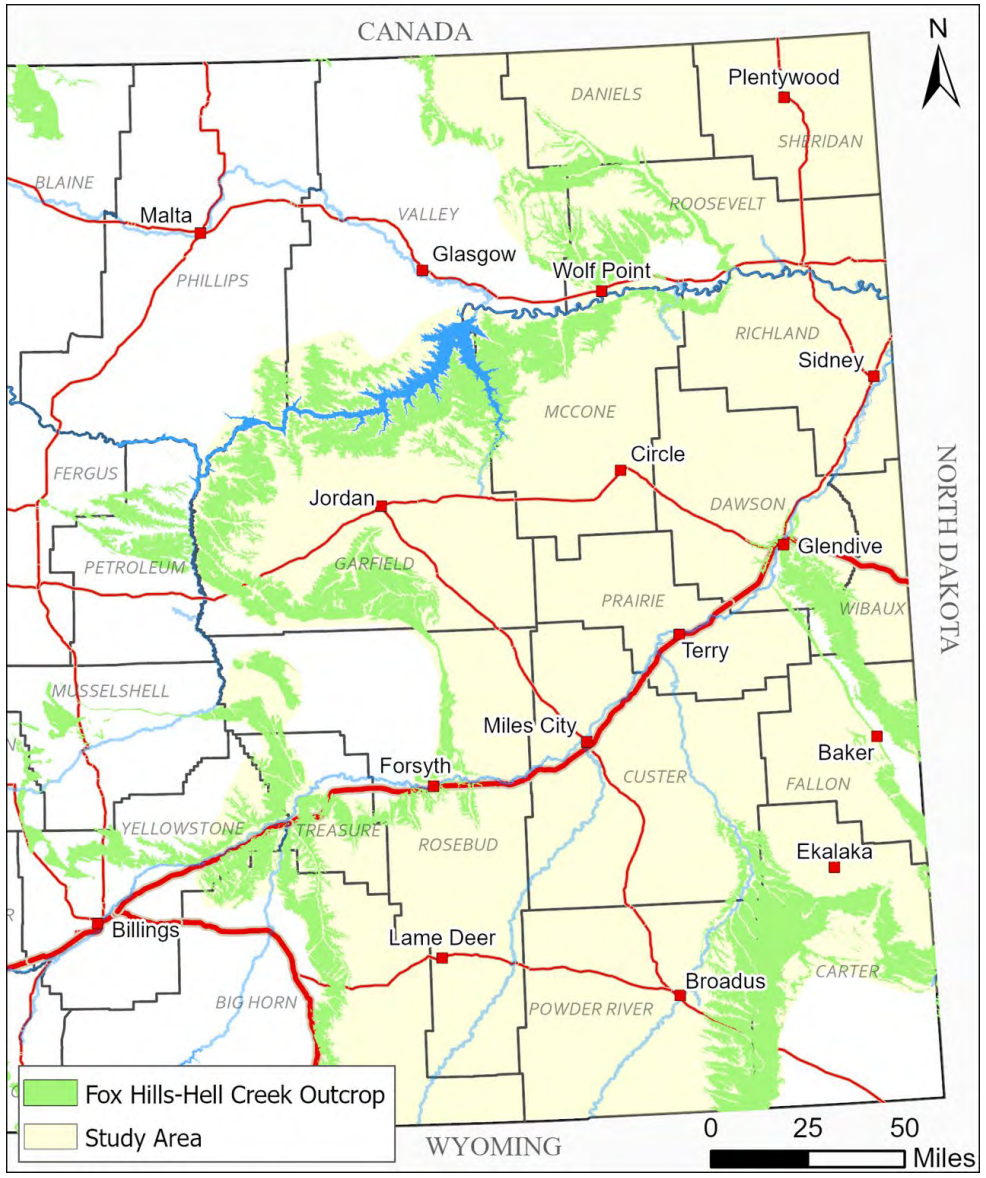


Where can you find groundwater in Eastern Montana?

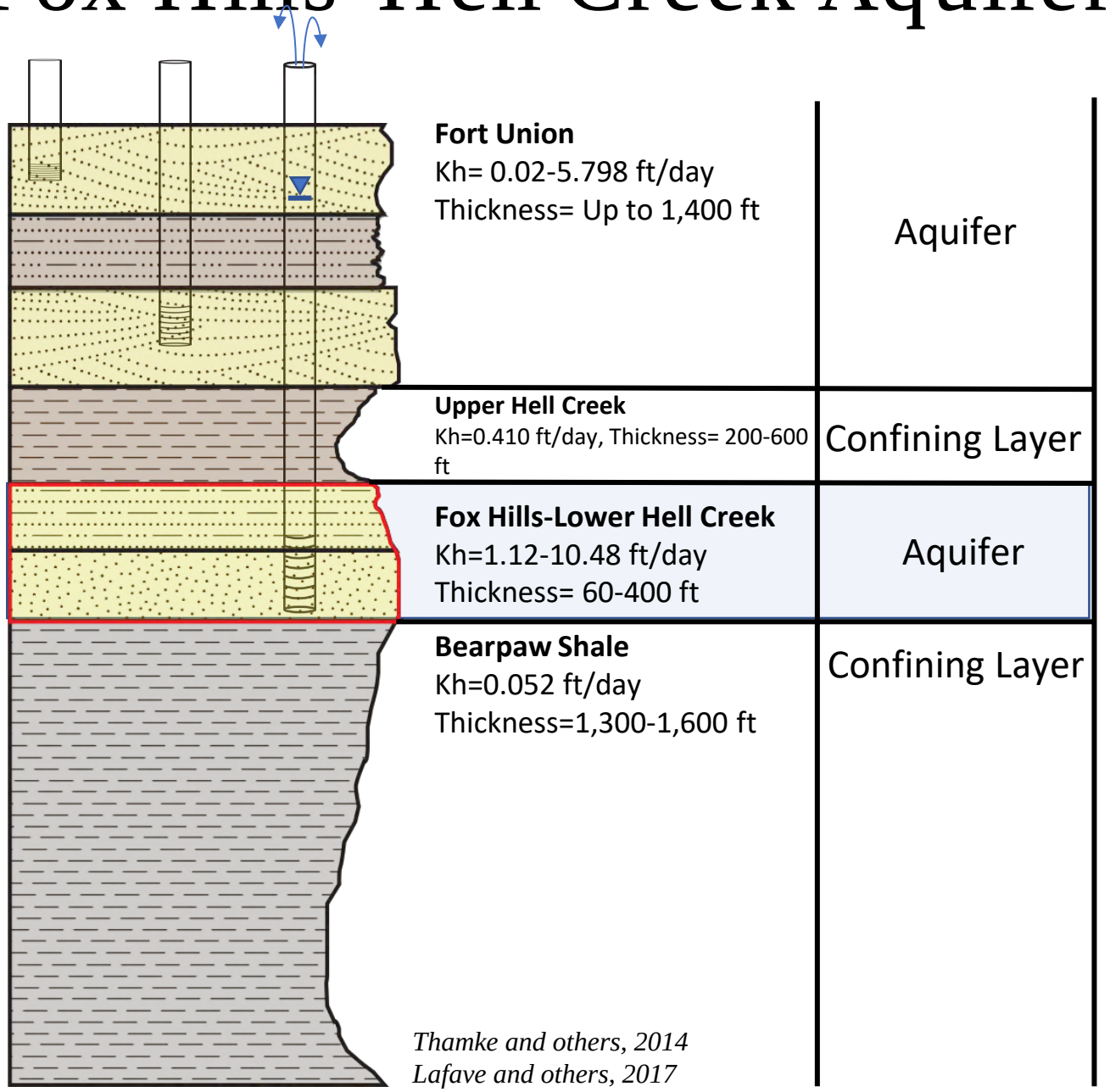


Fort Union Kh= 0.02-5.798 ft/day Thickness= Up to 1,400 ft	Aquifer
Upper Hell Creek Kh=0.410 ft/day, Thickness= 200-600 ft	Confining Layer
Fox Hills-Lower Hell Creek Kh=1.12-10.48 ft/day Thickness= 60-400 ft	Aquifer
Bearpaw Shale Kh=0.052 ft/day Thickness=1,300-1,600 ft	Confining Layer

Thamke and others, 2014
Lafave and others, 2017



Fox Hills-Hell Creek Aquifer



Thamke and others, 2014
Lafave and others, 2017

Pressurized Aquifer

1. The FHHC is **stratigraphically confined** by two hydraulically restrictive layers. This confinement restricts head pressure from releasing to overlying formations

1. The overlying formations are thick. The FHHC is buried under 1,000+ ft of **overburden pressur**e from Hell Creek and Fort Union sediments.

1. The FHHC is also **structurally deformed.** This elevates recharge zone elevations, creating a hydraulic gradient across the aquifer.

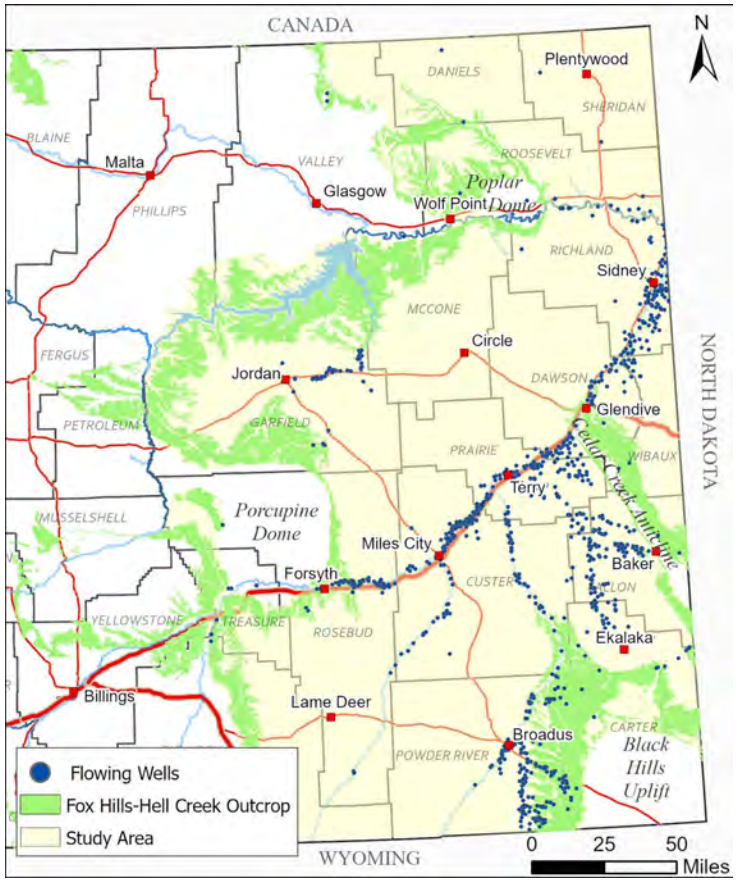
Fox Hills-Hell Creek Aquifer

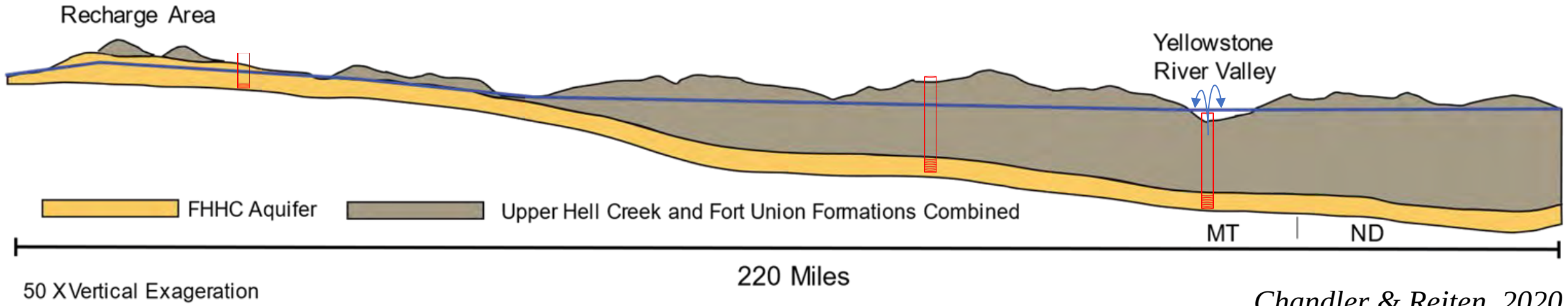
Groundwater Setting

1. Wells completed near recharge zones are unconfined.

1. Wells completed in terraces are artesian, but not flowing.

1. Wells completed in river valleys are artesian, and have potential to be free flowing

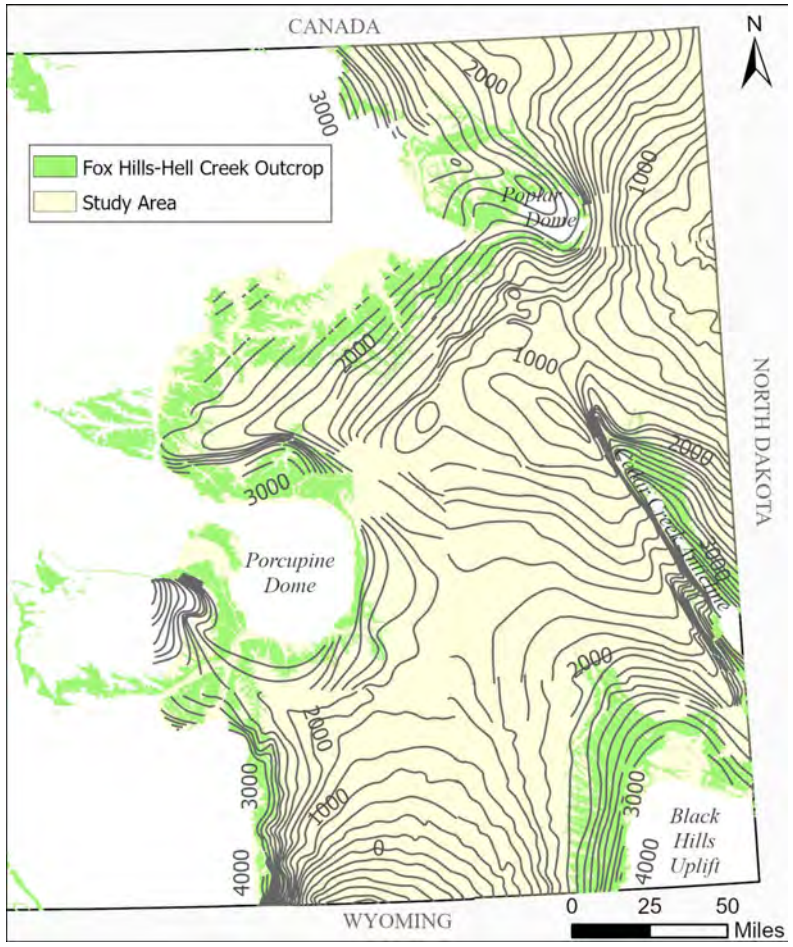




Chandler & Reiten, 2020

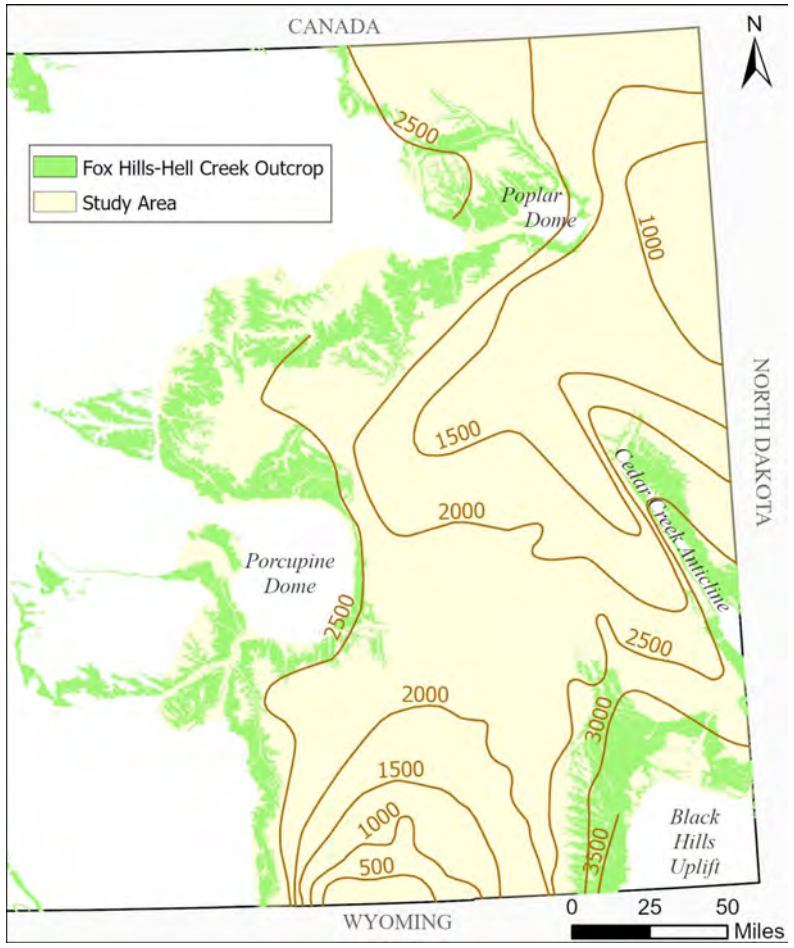
Groundwater Flow

Top of Bearpaw Elevation Contours



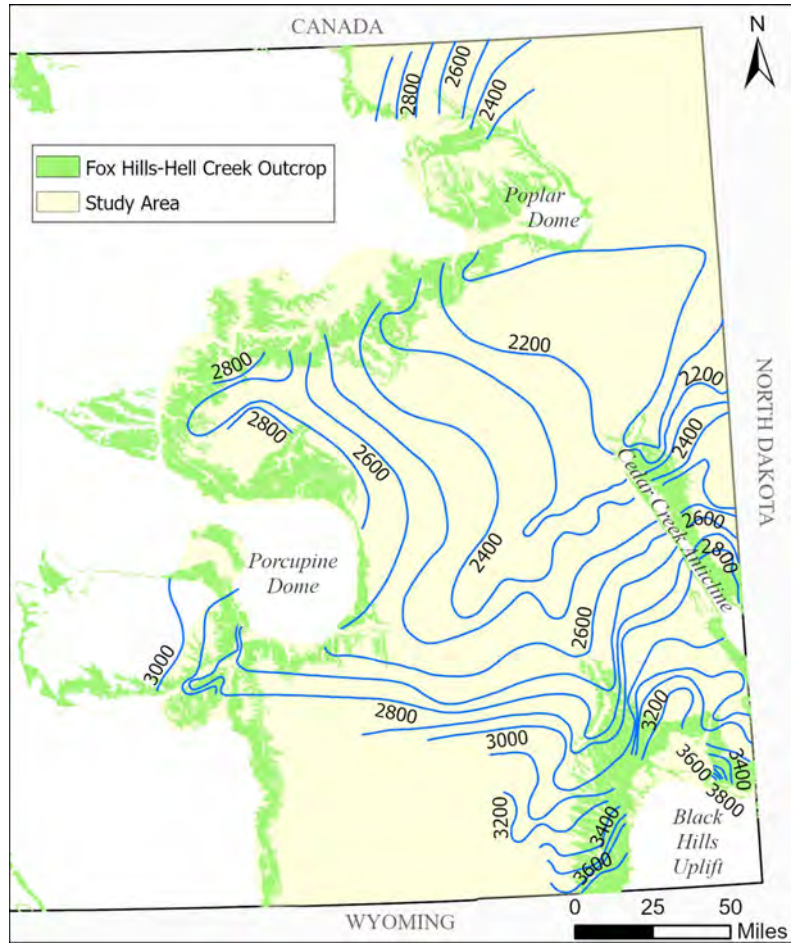
Bergantino, 1982

Top of FHHC Elevation Contours



Feltis, 1984

FHHC Potentiometric Surface



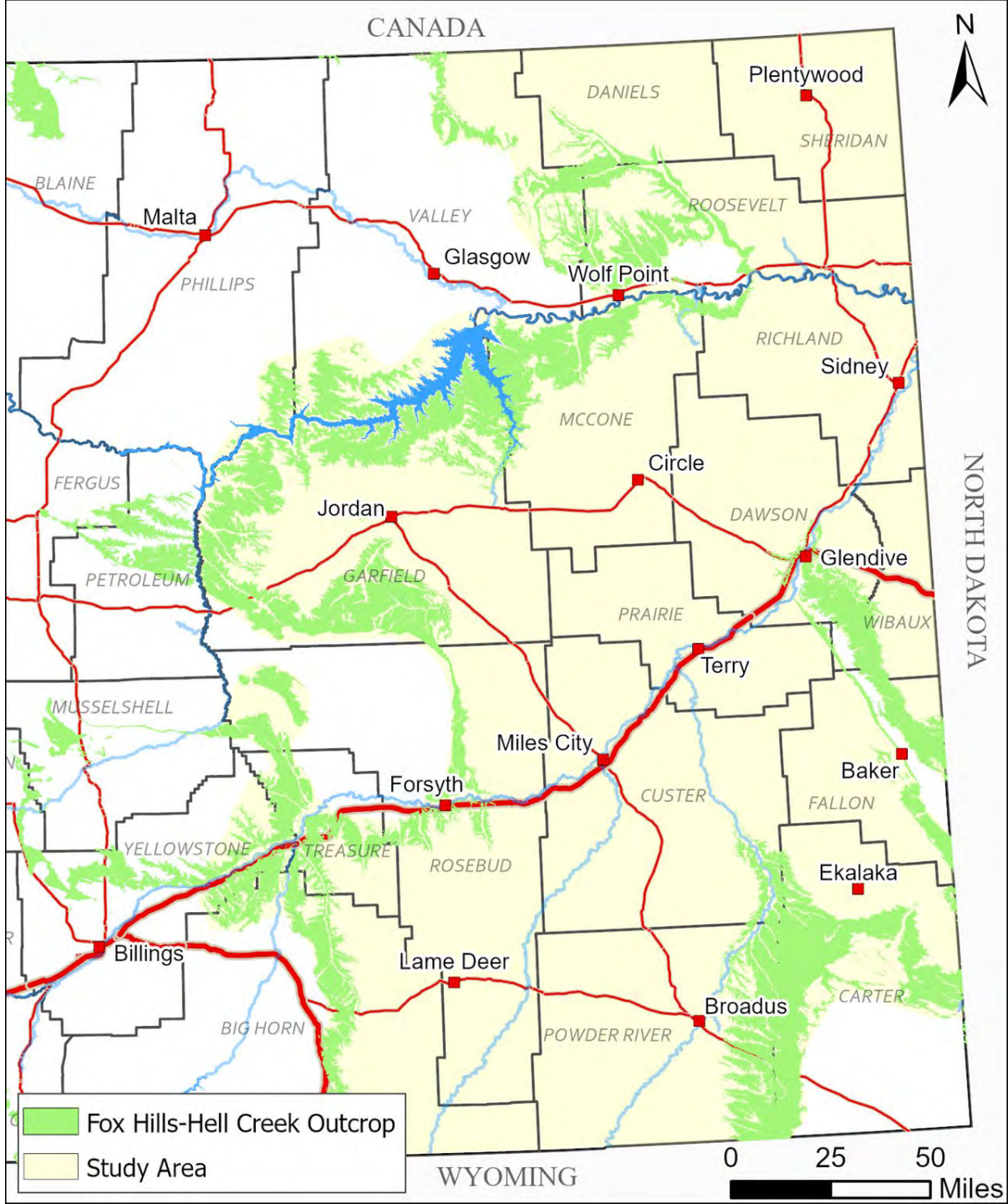
Levings, 1982

Fox Hills-Hell Creek Aquifer

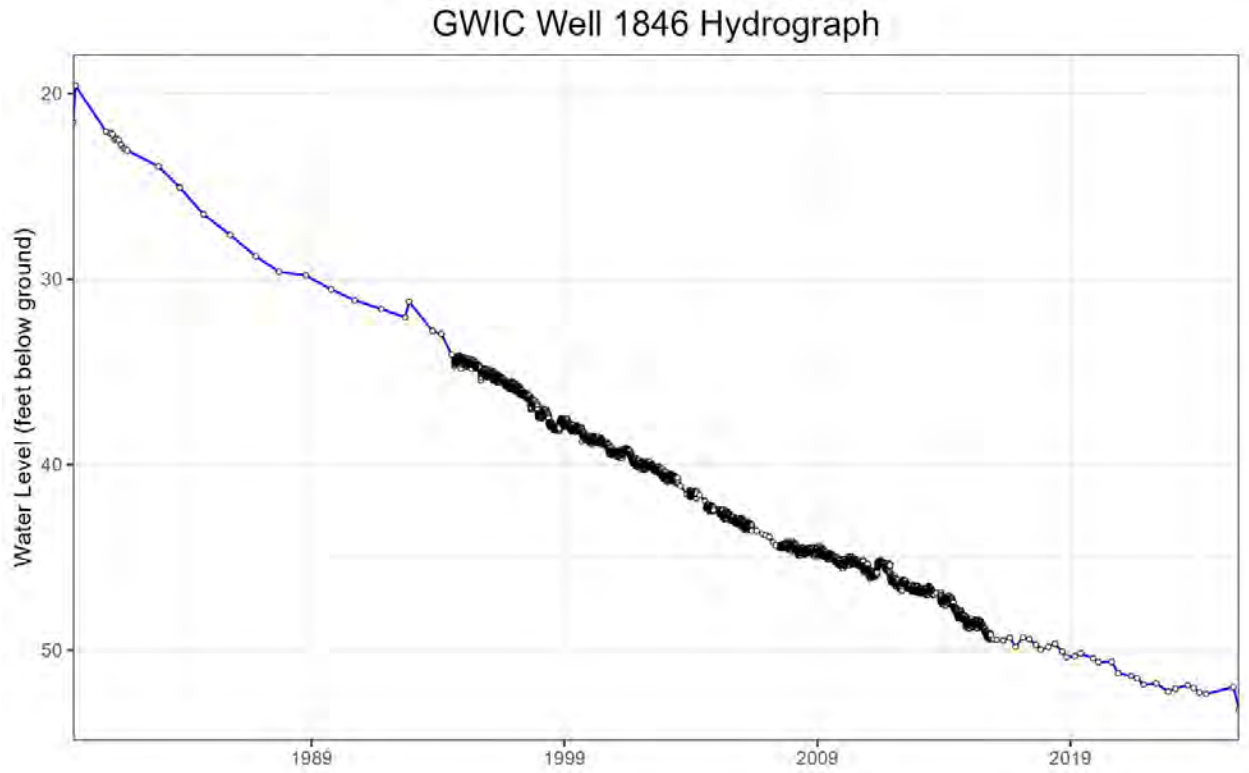
What have we learned about the Fox Hills-Hell Creek Aquifer?

1. Cretaceous aged, laterally widespread sandstone aquifer stratigraphically underlain by the Bearpaw Shale
2. Pressurized aquifer confined by the Upper Hell Creek Formation which may produce flowing wells
3. Critical groundwater resource in Eastern Montana

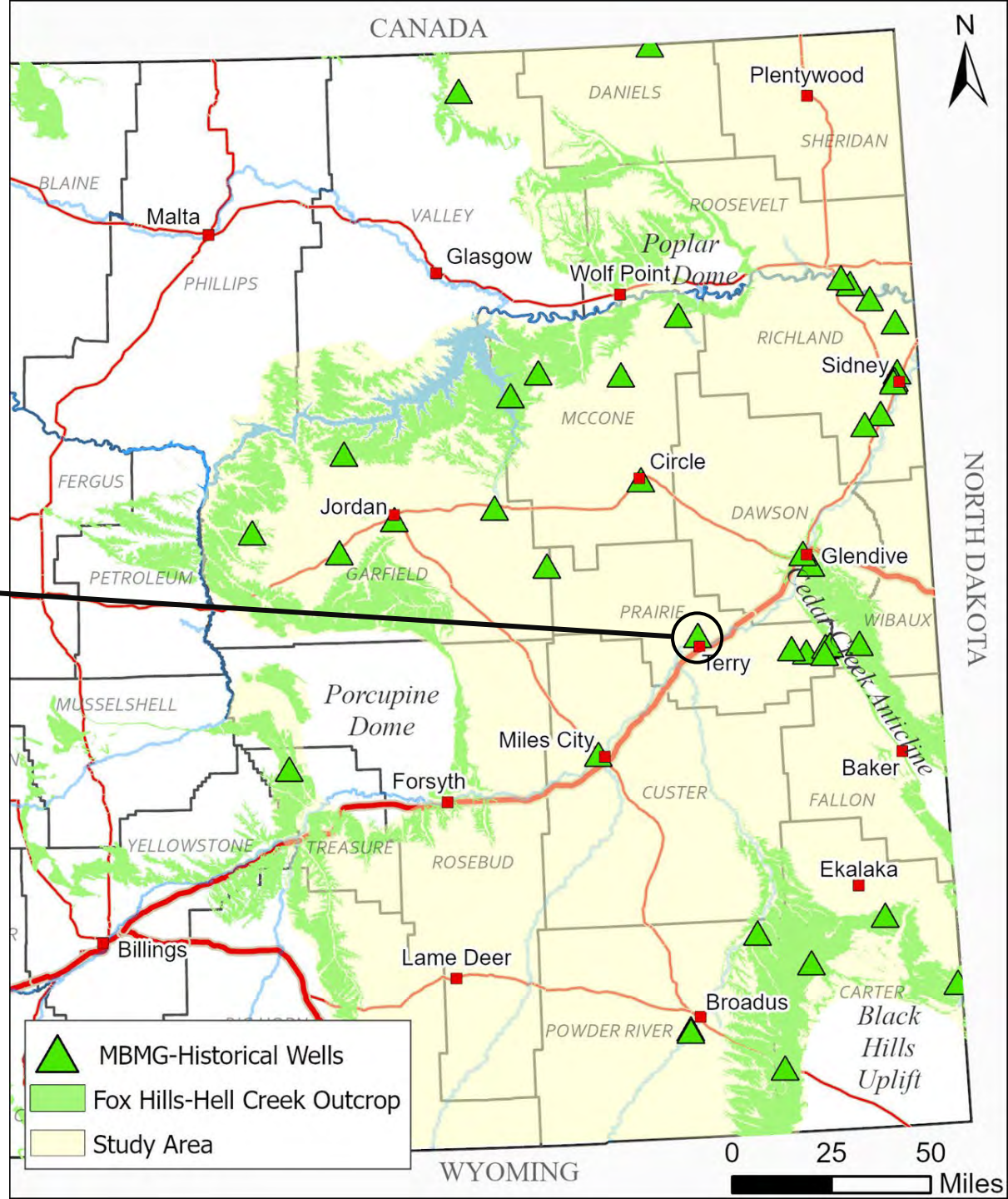
Why is the Legislature Interested?



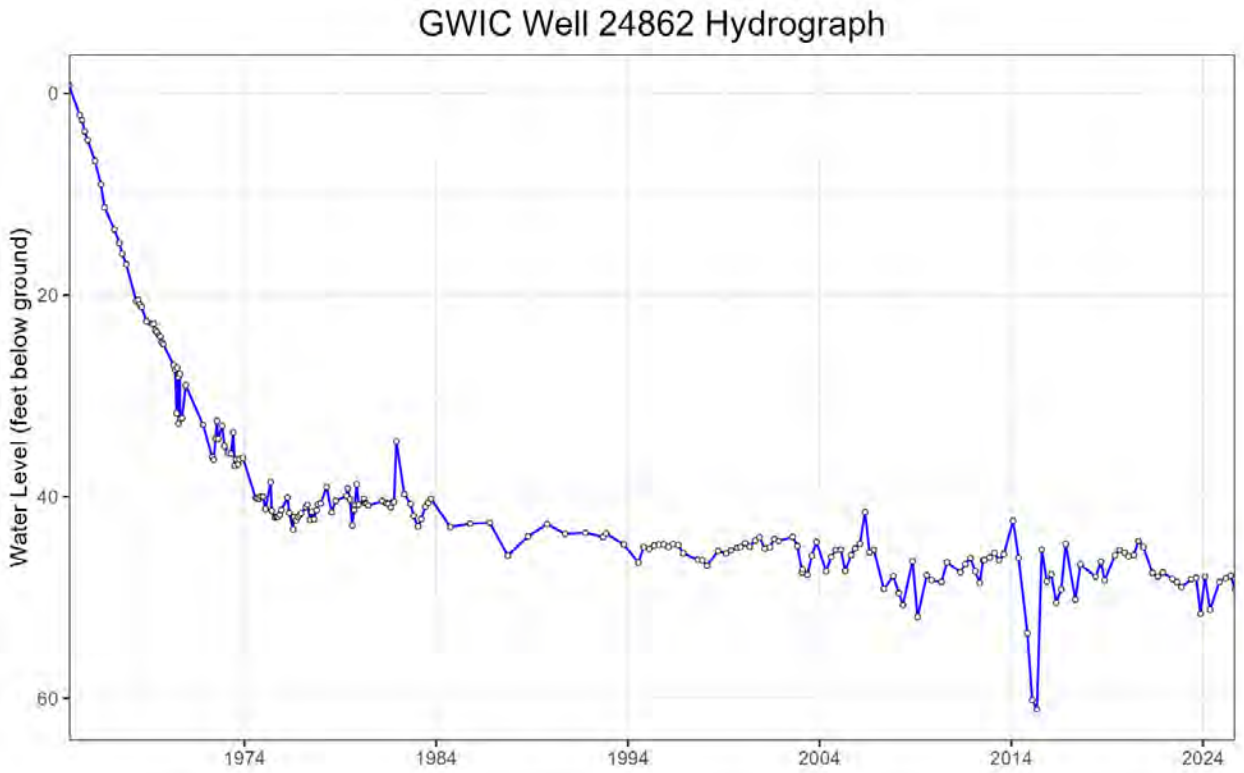
FHHC Groundwater Declines



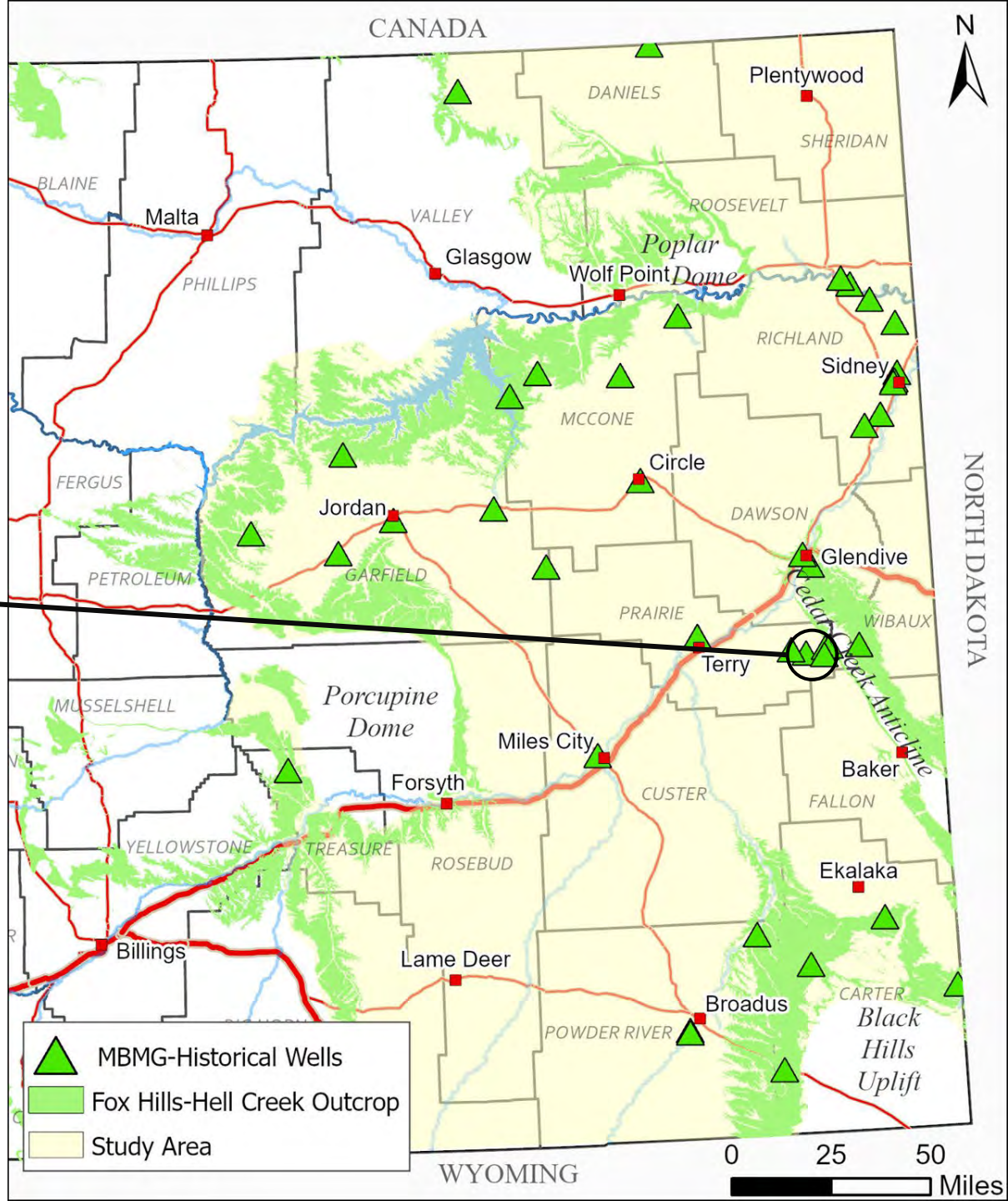
Period of Record: 1979-2025
13 ft loss in head
0.28 ft loss per year



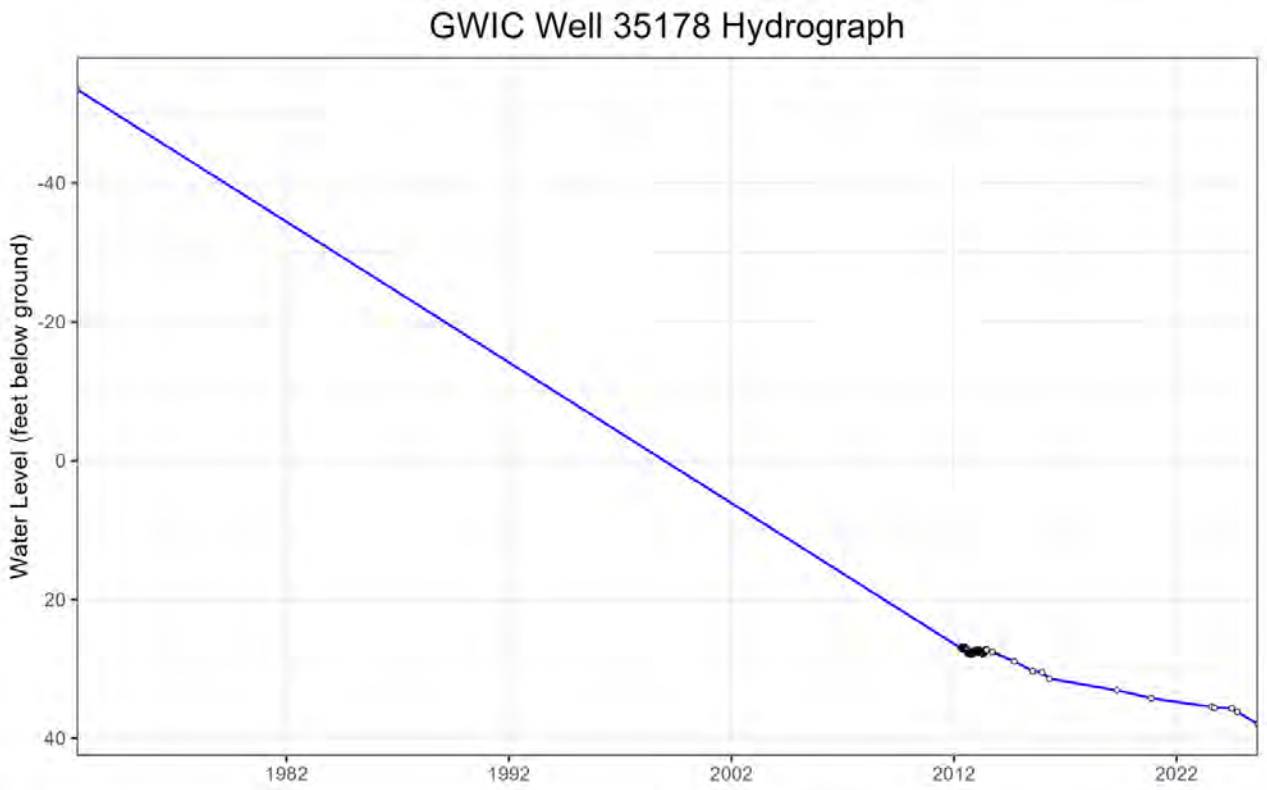
FHHC Groundwater Declines



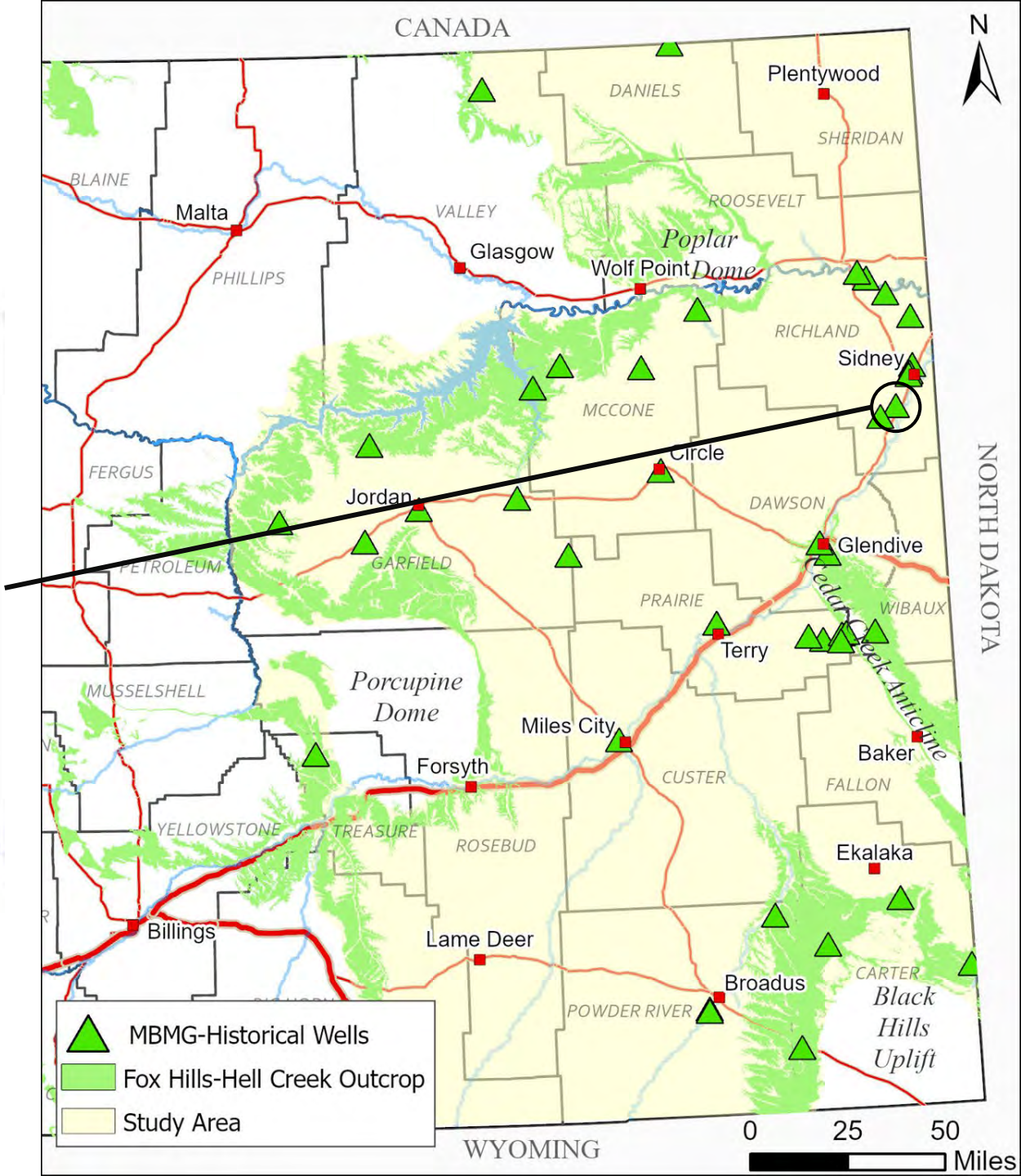
Period of Record: 1964-2025
50 ft total loss in head
0.8 ft loss per year



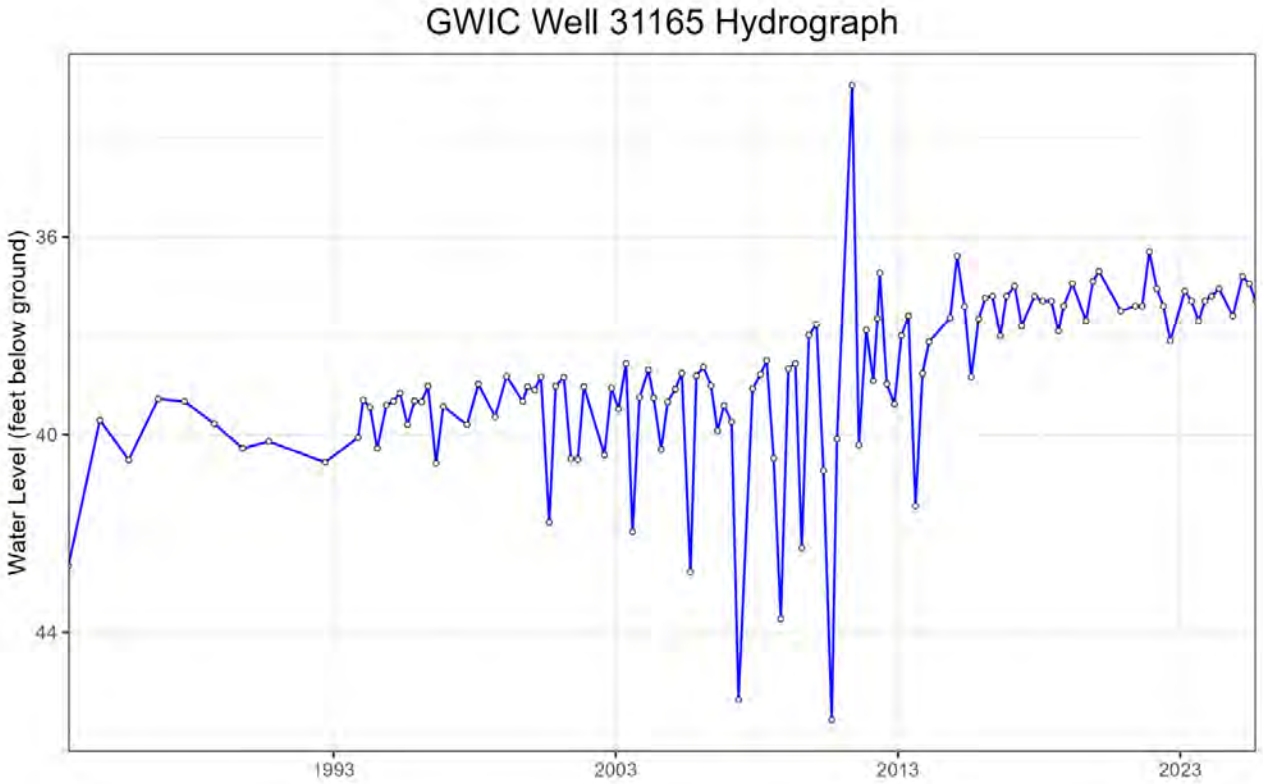
FHHC Groundwater Declines



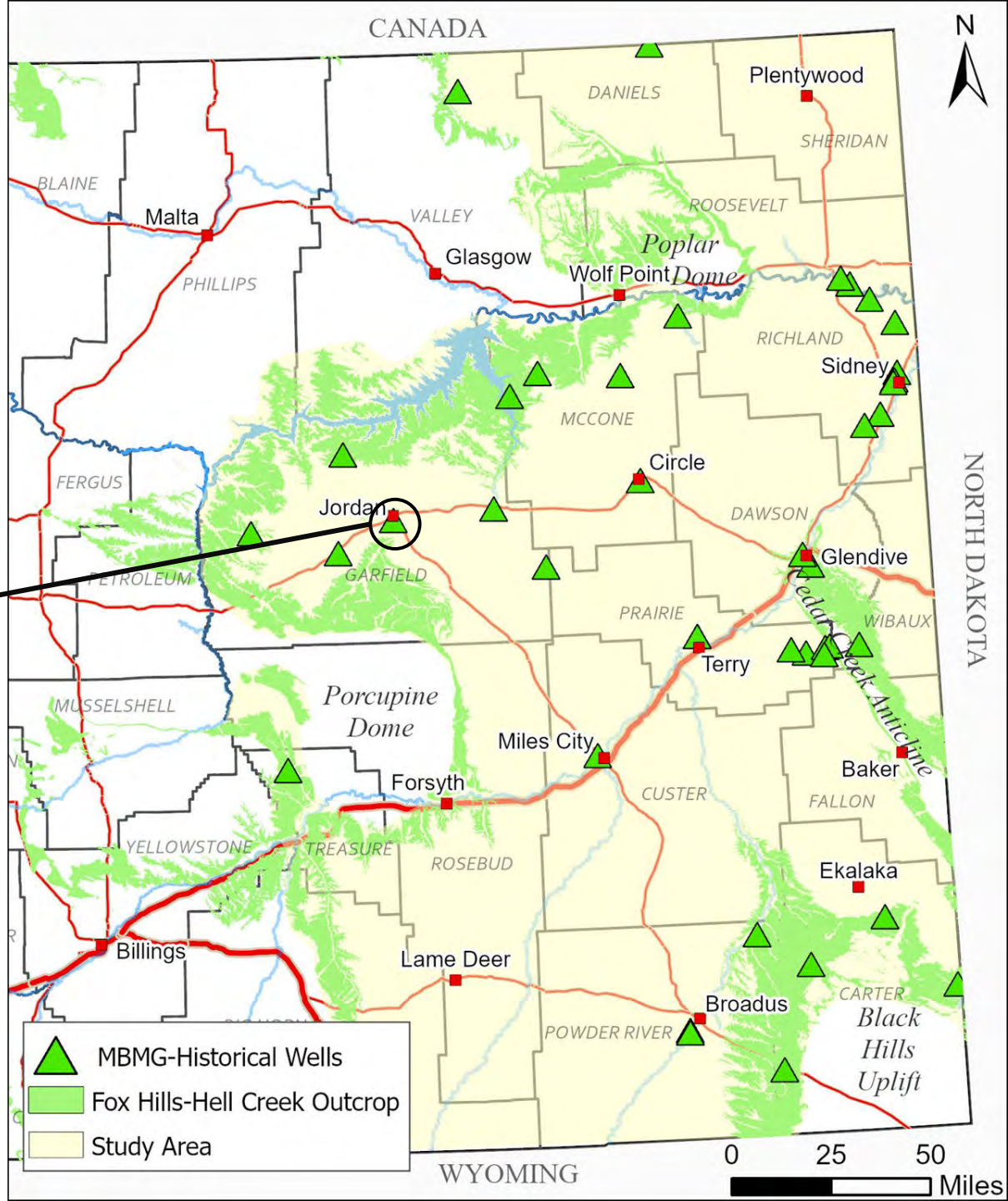
Period of Record: 1972-2025
90 ft loss in head
1.7 ft loss per year



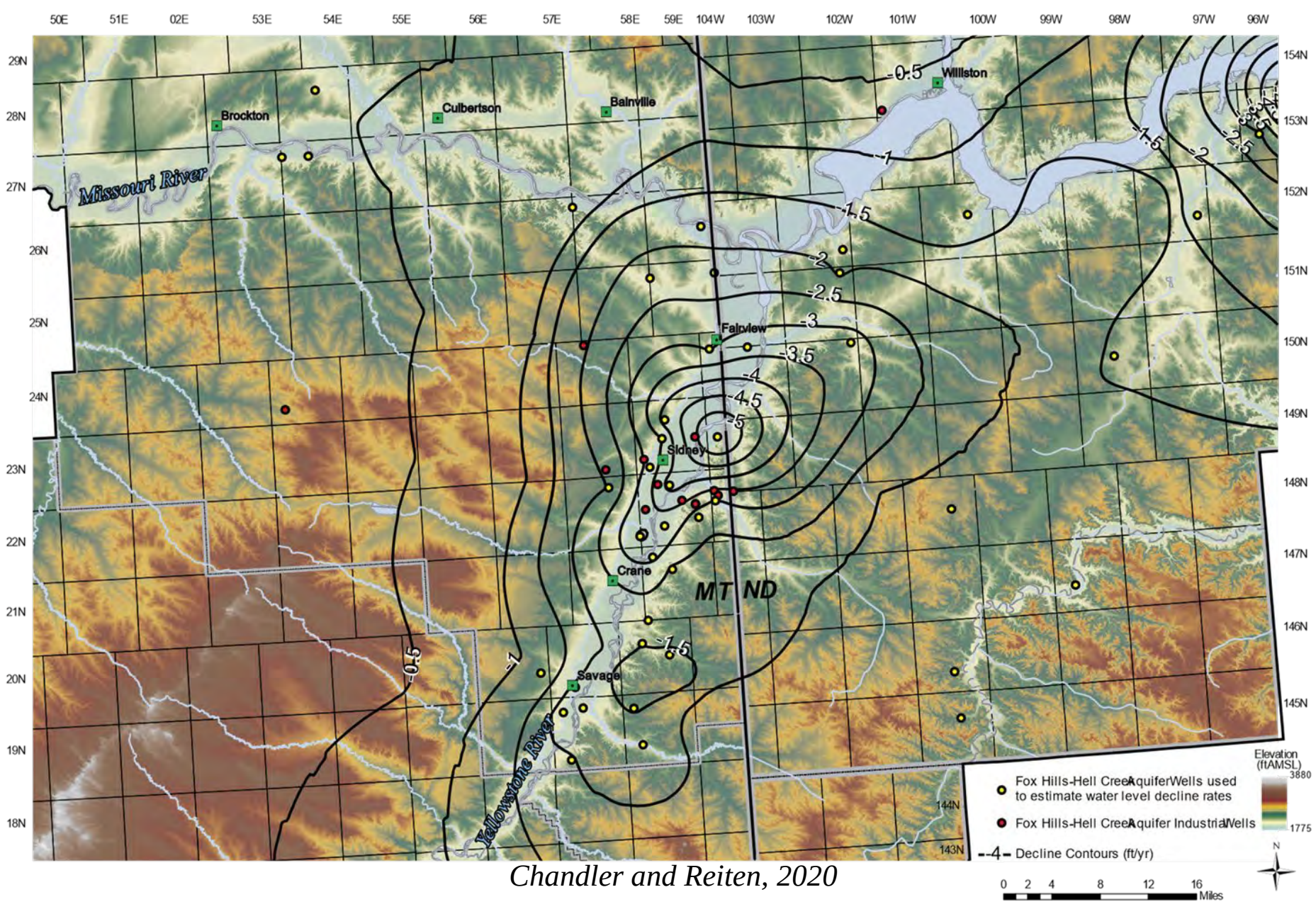
FHHC Groundwater Declines



Period of Record: 1983-2025
5 ft gain in head
.11 ft gain per year



The rate of static water-level decline in feet/year in the FHHC aquifer.

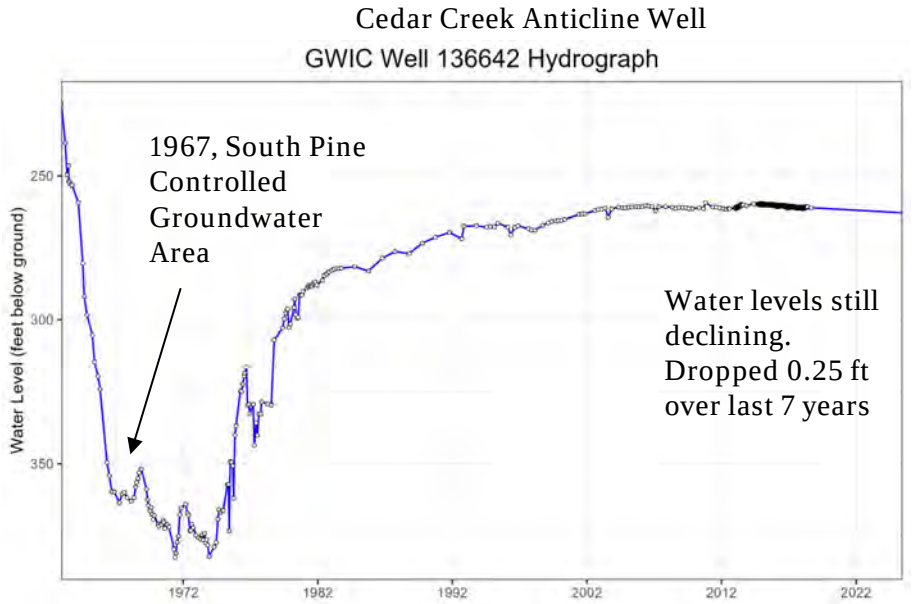


Chandler and Reiten, 2020

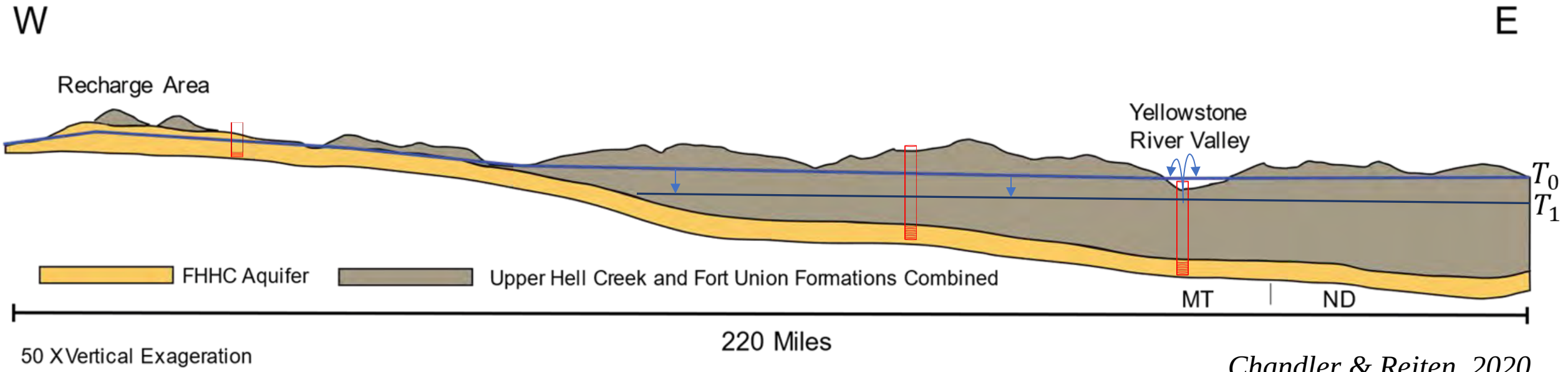
FHHC Groundwater Declines

Groundwater declines occur when…

Water Removed From Aquifer **>** **Water Recharged to Aquifer**

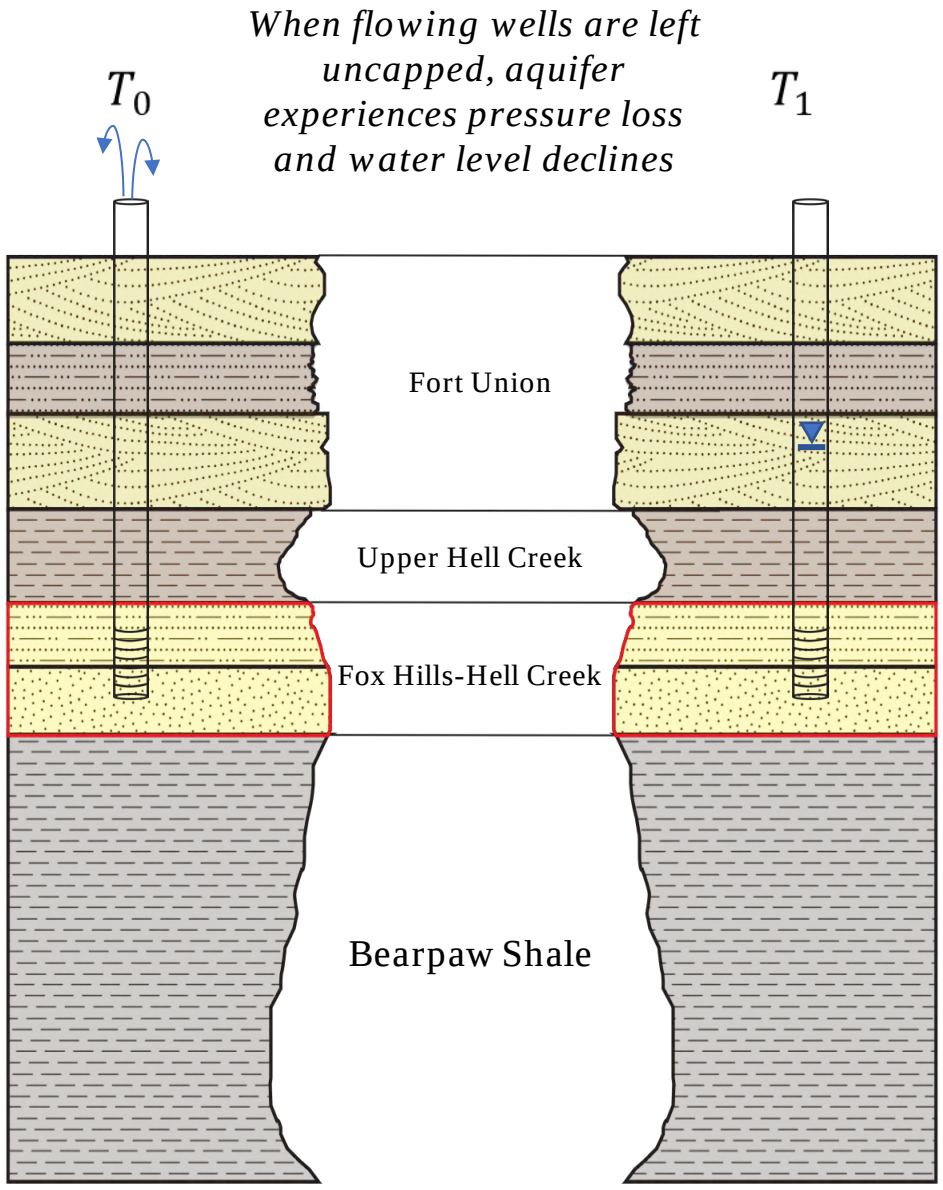


GWCP-01 study found C-14 ages 10,000+ for FHHC Groundwater



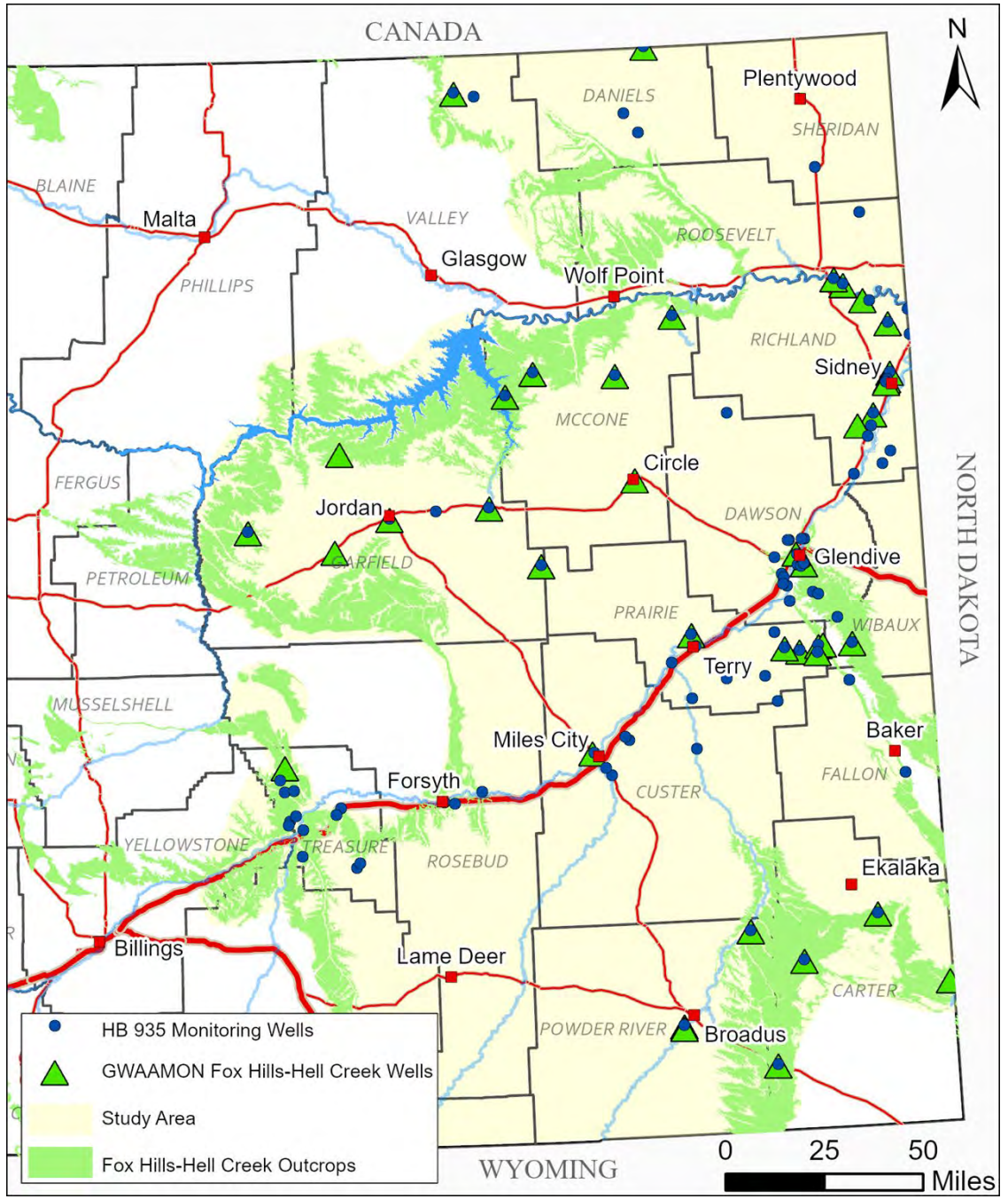
Chandler & Reiten, 2020

FHHC Groundwater Declines



MBMG Research Efforts

- MBMG staff have collected water levels or pressure readings from 99 wells completed in the Fox Hills-Hell Creek
- Compare water levels to historic measurements
- Water levels will also inform potentiometric surface and groundwater model, water budget



What happens with the results of this study?

- MBMG presents the study to the Water Policy Interim Committee
- The Committee will make recommendations to the legislature about any suspension or closure of new groundwater appropriations from the FHHC aquifer
- The bill terminates June 30, 2027 – MBMG is hoping to finish our field efforts this fall to allow time for data processing and reporting

Questions?

Alex Johanson
Hydrogeologist
Montana Bureau of Mines and Geology

Special Thanks: John LaFave, Mike Richter, Alan English, Cam Carstarphen, Sara Edinberg, James Madison, Jon Reiten, Don Mason, Jackson Quarles, Gary Icopini, Josie Grigsby