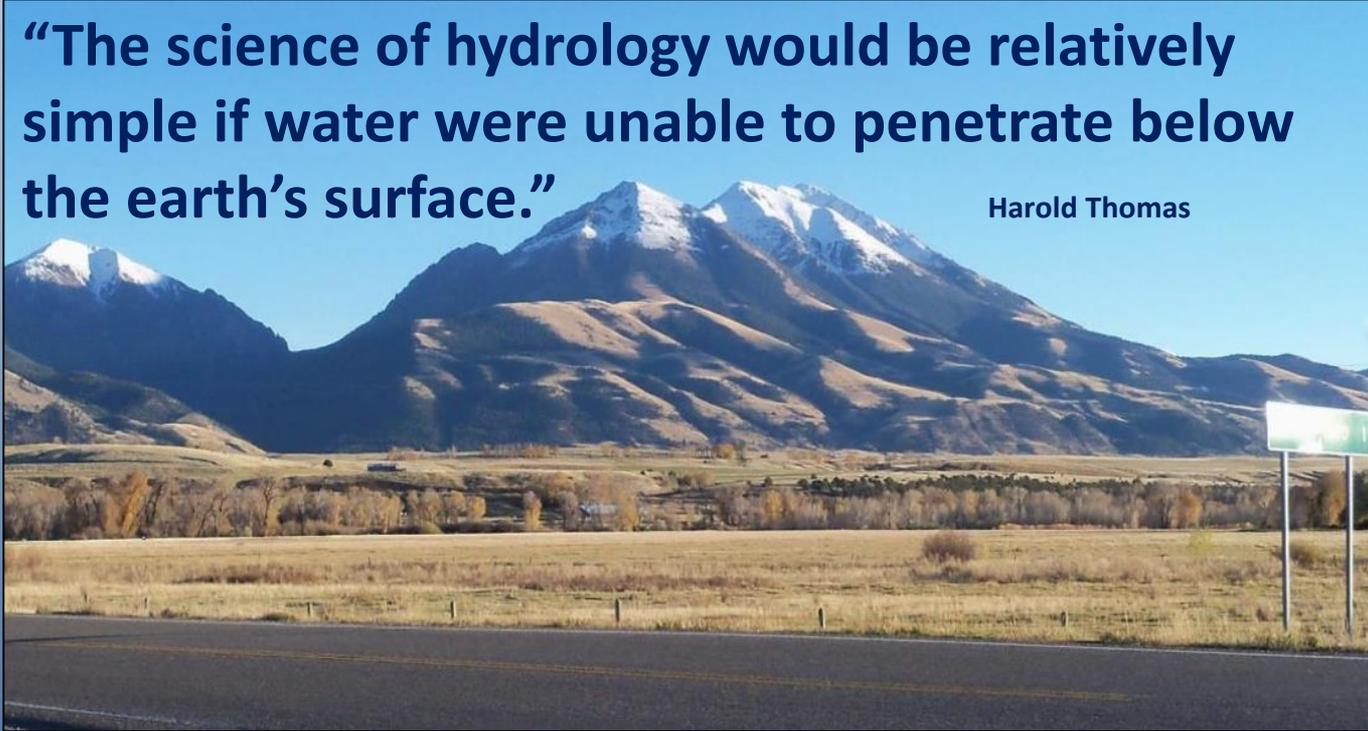


Groundwater Conditions – Upper Yellowstone Watershed

“The science of hydrology would be relatively simple if water were unable to penetrate below the earth’s surface.”

Harold Thomas



Outline

- MBMG
- Basin Setting
- Basin Geology
- GW Development
- GW Storage
- GW Quality

John LaFave
Montana Bureau of Mines and Geology
Ground Water Assessment Program

Upper Yellowstone Workshop
Sept. 5, 2018

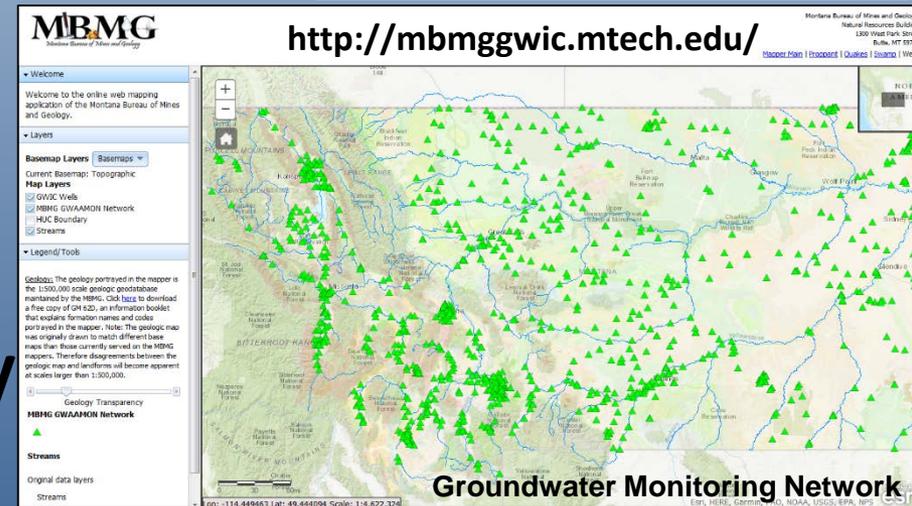
Montana Bureau of Mines and Geology

a department of Montana Tech

- Established in 1919 to provide reliable and unbiased earth science information
- Non regulatory, applied research

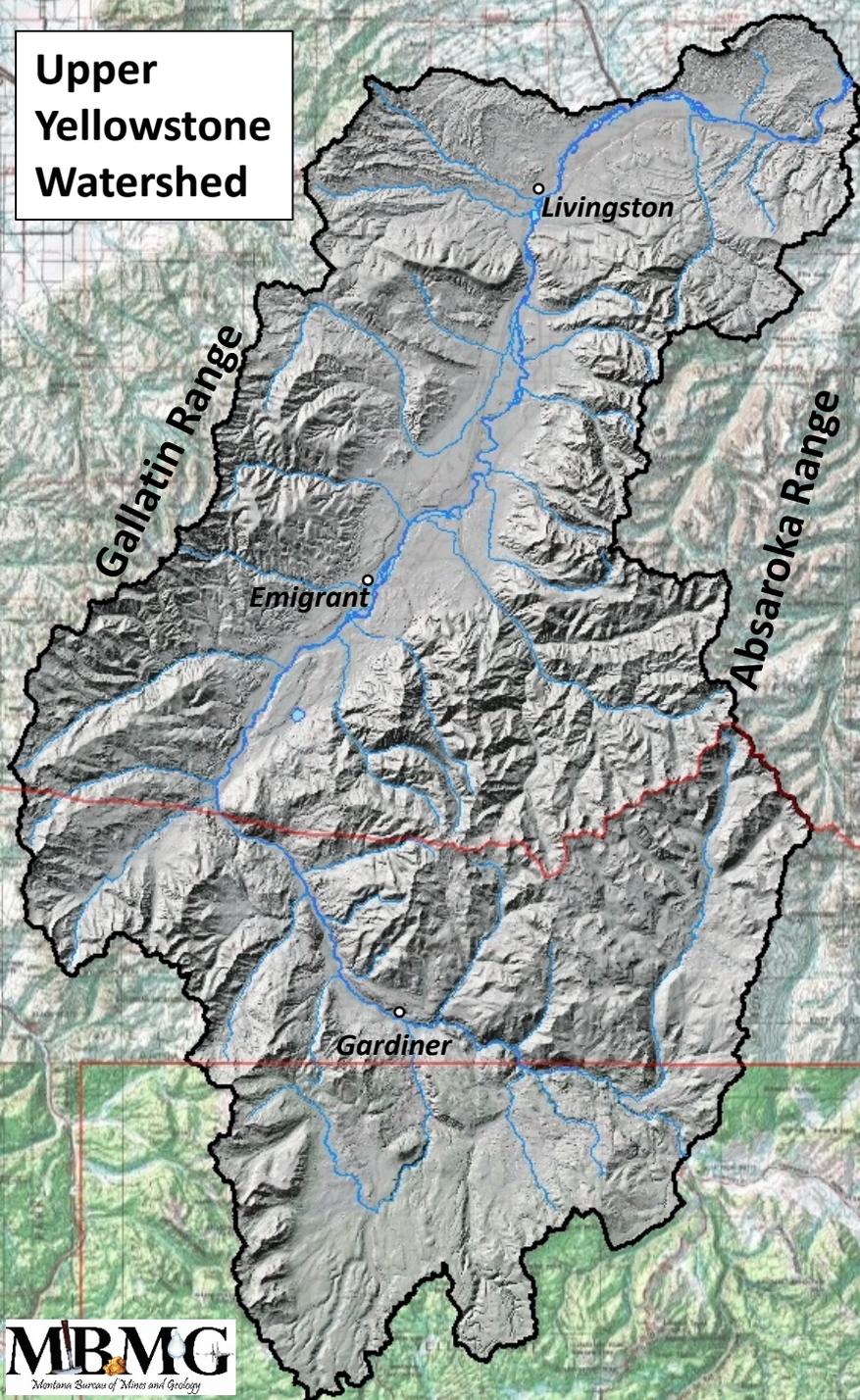
Ground Water Information Center

- Geologic Mapping
- Earthquake Studies
- Economic Geology
- Environmental Hydrology
- Groundwater



- Web: <http://www.mbmgs.mtech.edu/>

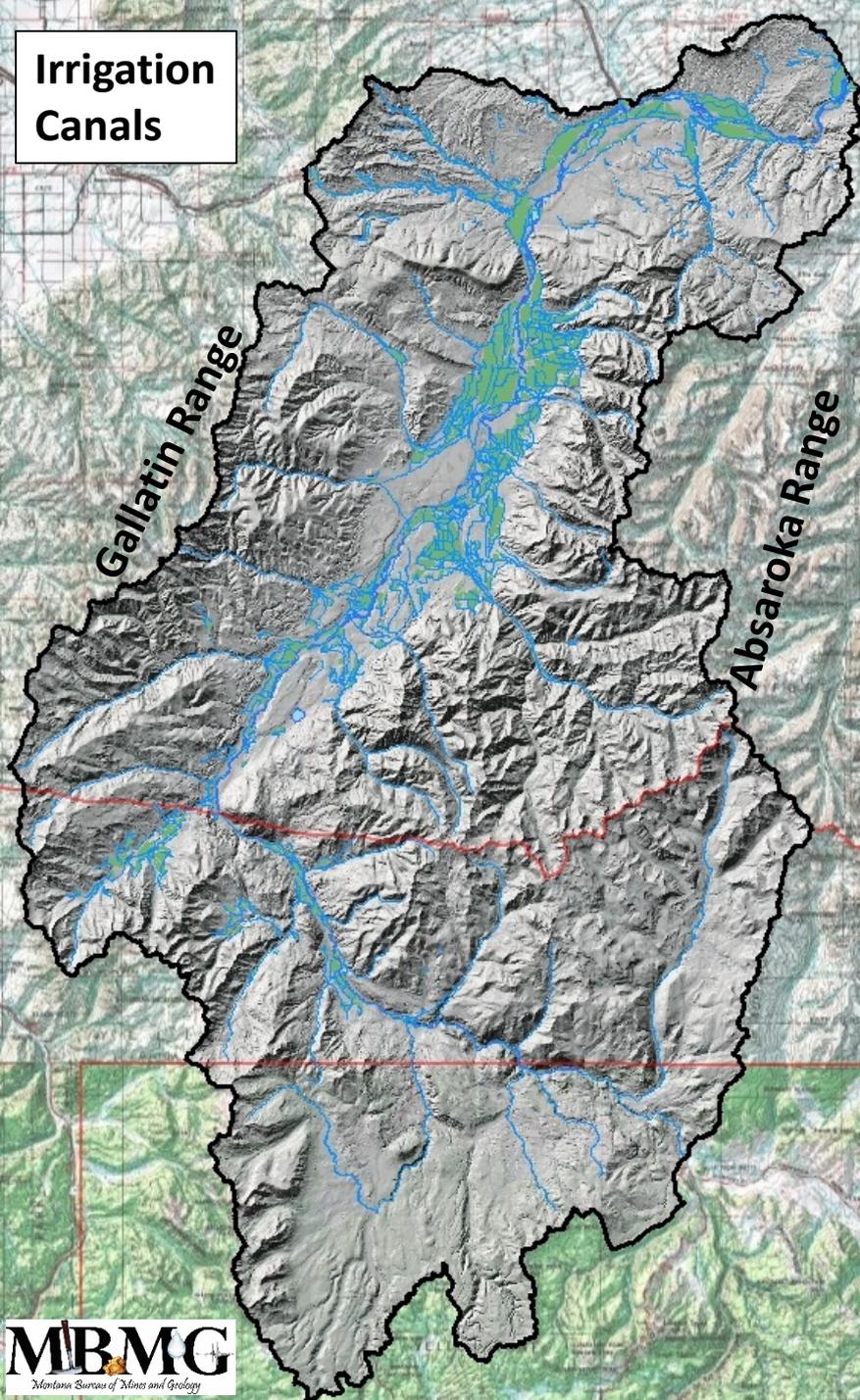
Upper
Yellowstone
Watershed



Upper Yellowstone Watershed Setting

- Intermontane Basin - ~ 1 M acres
- Topographic Relief - >10,000 to 4,200 ft
- Framed by Gallatin and Absaroka Ranges
- Drained by Yellowstone and tributaries
- Valley floor <1 to 8 miles wide

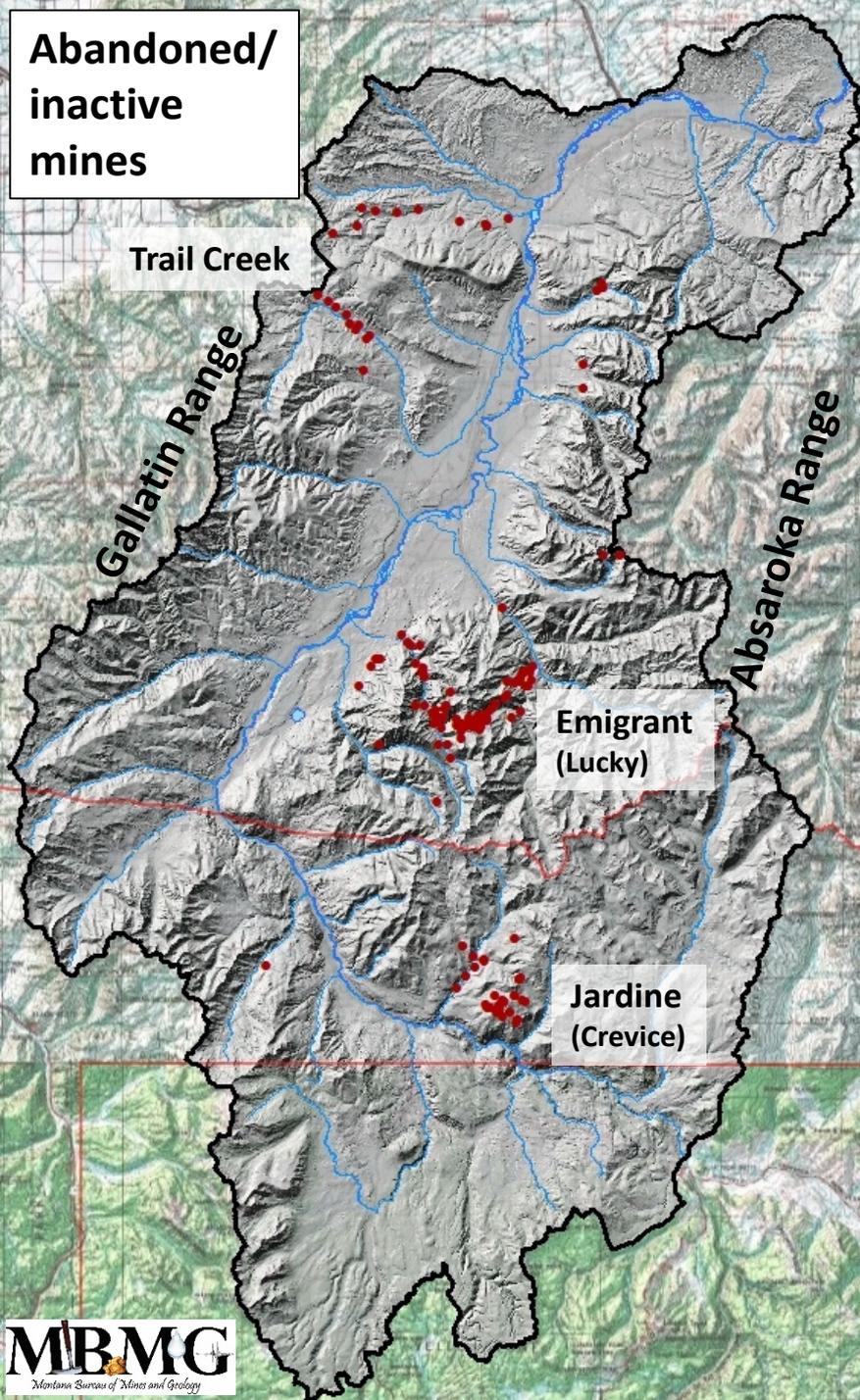
Irrigation
Canals



Upper Yellowstone Watershed Setting

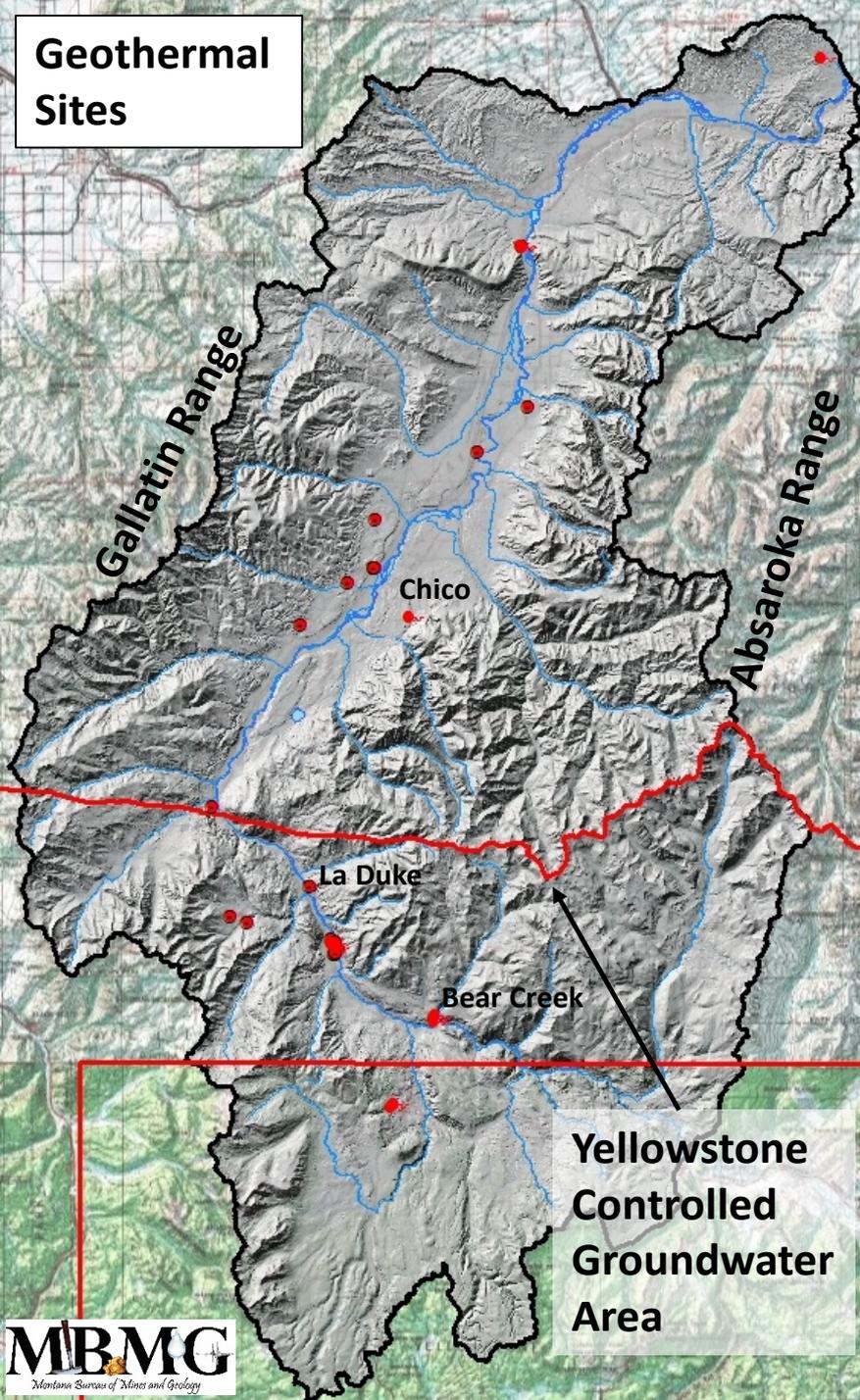
- Intermontane Basin - ~ 1 M acres
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- Drained by Yellowstone and tributaries
- Valley floor <1 to 8 miles wide
- Irrigation and irrigation canals
 - 62K acres - 400+ mi canals

Upper Yellowstone Watershed Setting



- Intermontane Basin - ~ 1 M acres
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- Drained by Yellowstone and tributaries
- Valley floor <1 to 8 miles wide
- Irrigation and irrigation canals
- Mining -
 - Emigrant: Au, Ag, Cu, Mo, Pb
 - Jardine: Au, W, Ag, Cu, Pb
 - Trail Creek: coal

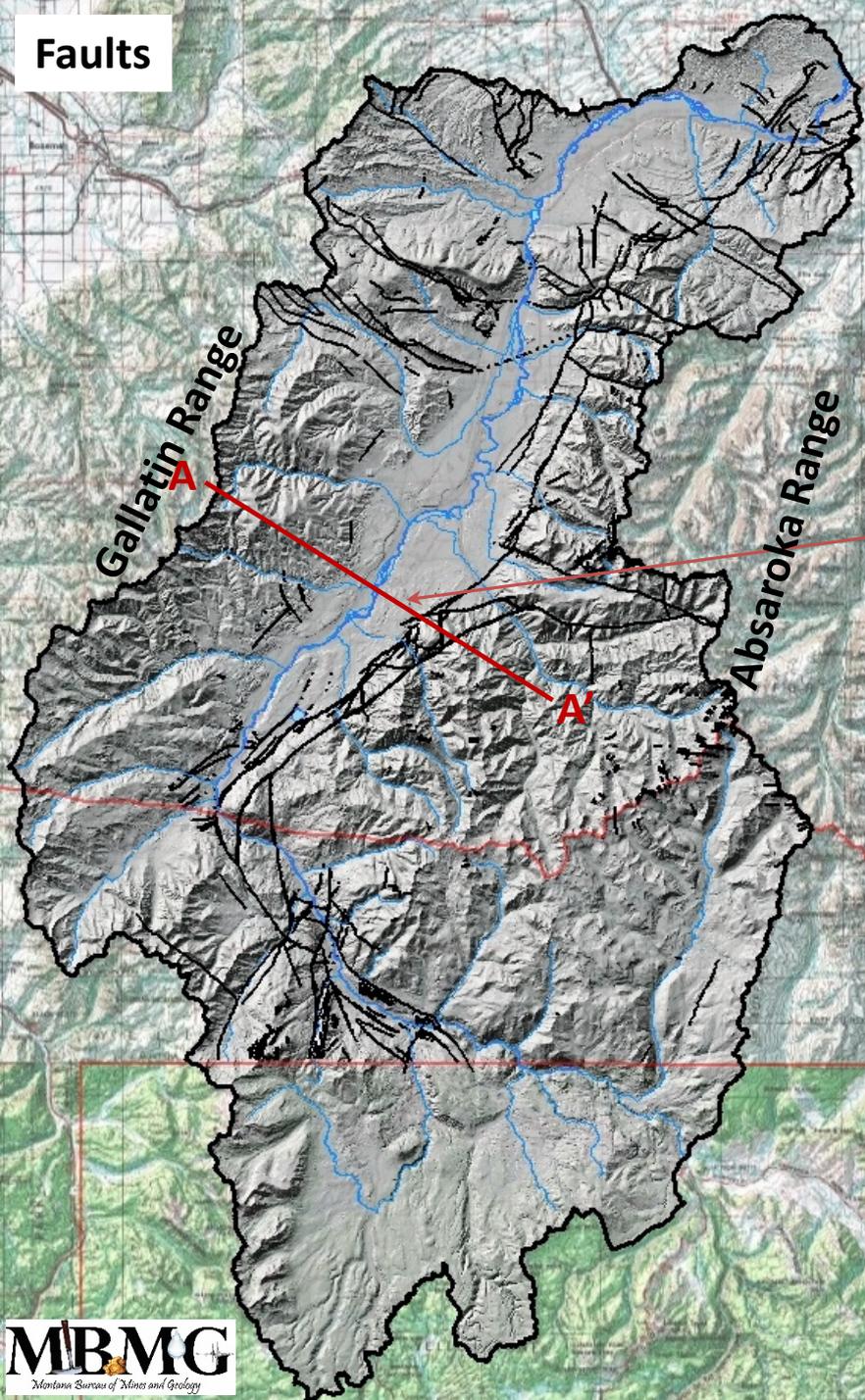
Geothermal
Sites



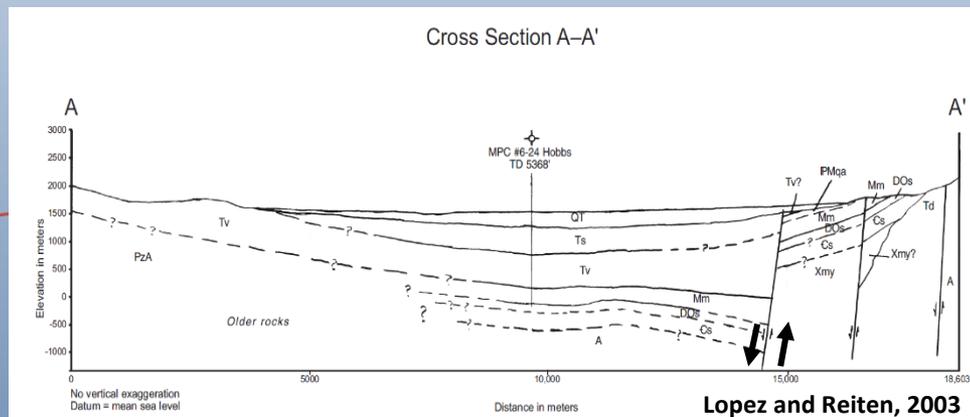
Upper Yellowstone Watershed Setting

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 - Trail Creek: coal
- Geothermal features
 - Controlled GW Area

Faults

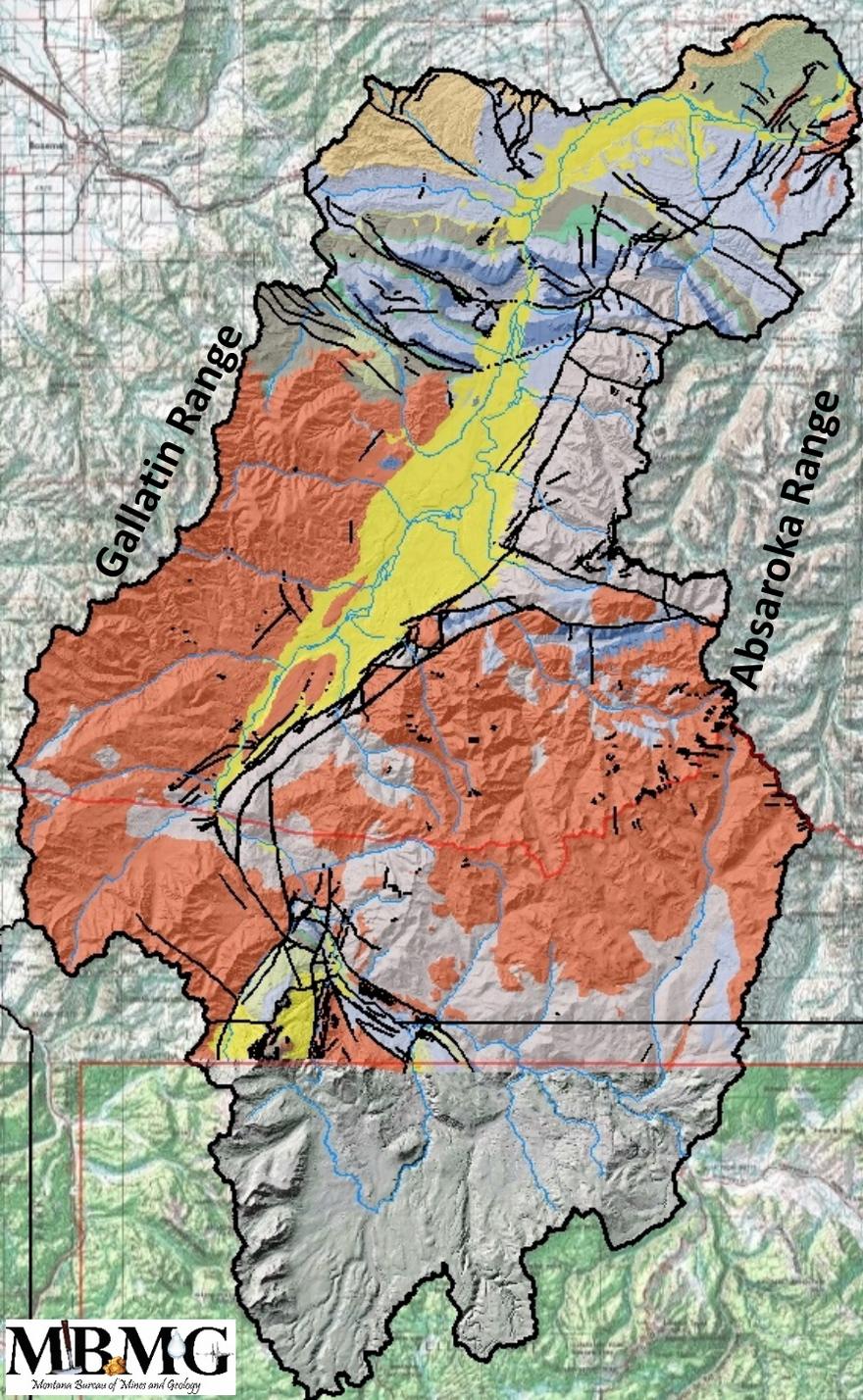


Upper Yellowstone Watershed Structural Basin



- Series of 'range-front' faults
 - Down dropped valley bottom
 - Accumulation of 'basin-fill' sediments
 - Uplifted Mtn ranges (Absaroka Range)

Upper Yellowstone Watershed Surficial Geology Generalized Units



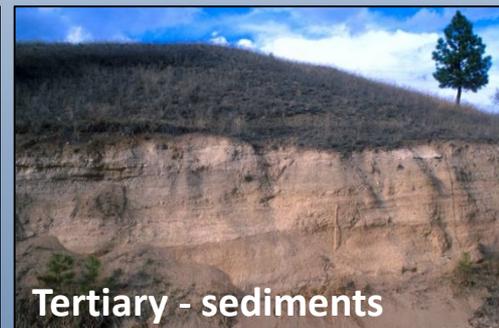
-  Basin Fill and Alluvium (Valley bottom)
-  Tertiary Absaroka Volcanic Rocks (Mountains)
-  Madison Limestone (Allenspur – N end of Valley)
-  PreC Meta-sedimentary Belt Rocks (Mountains – east)



Upper Yellowstone Watershed Surficial Geology Generalized Aquifers

1) Basin-fill

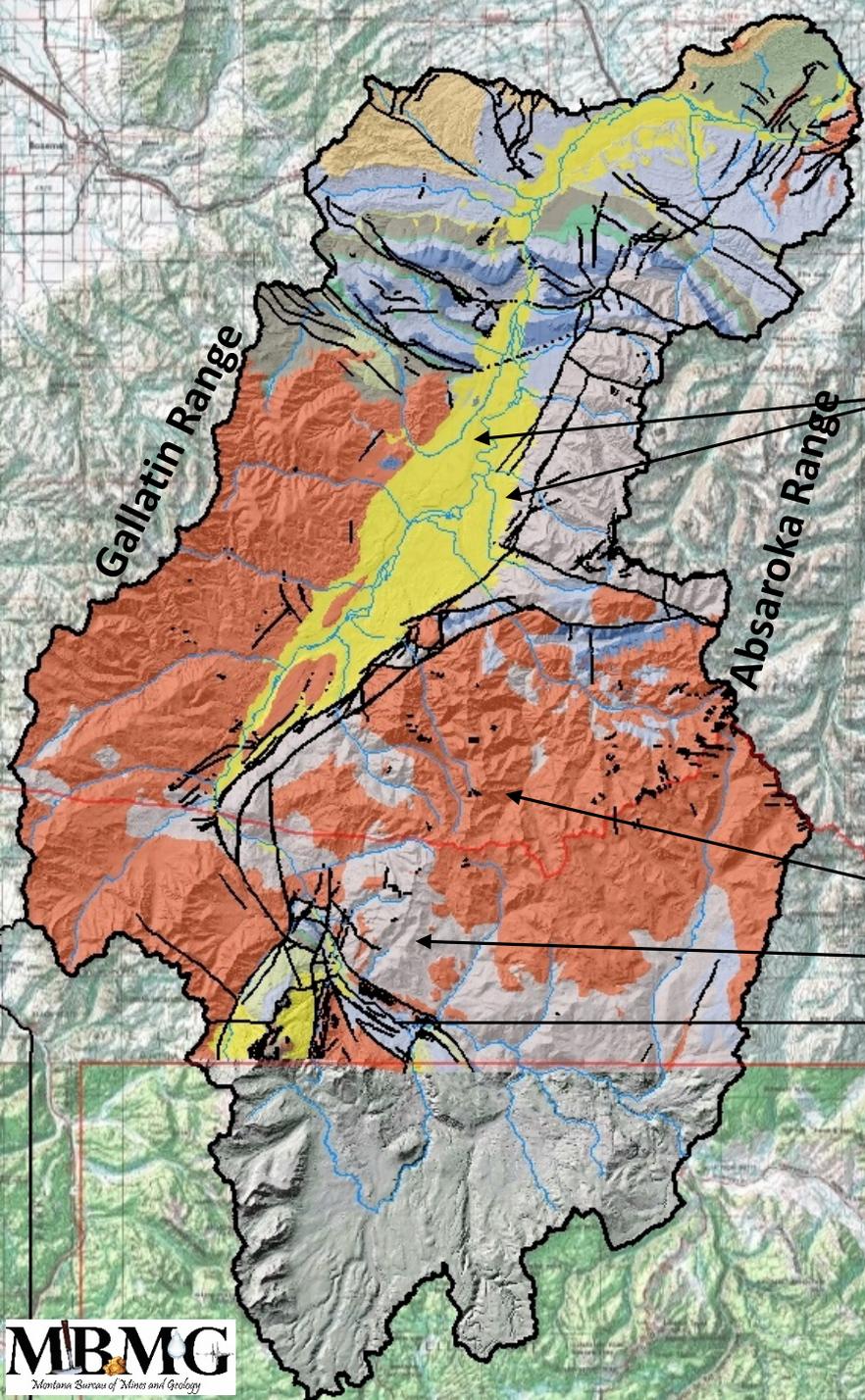
 Basin Fill and Alluvium (Valley bottom)



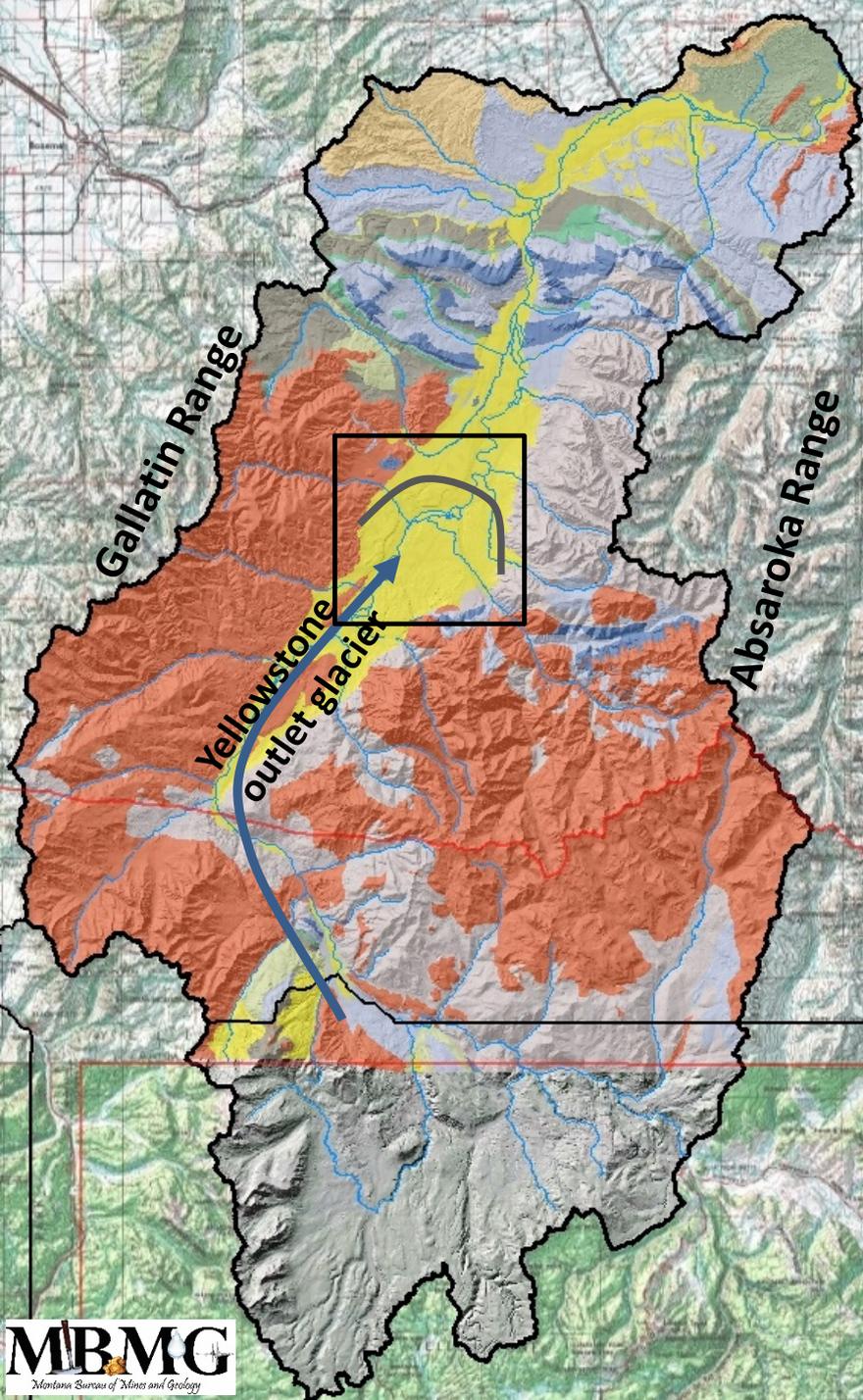
2) Fractured Rock

 Tertiary Volcanic Rocks (Mountains)

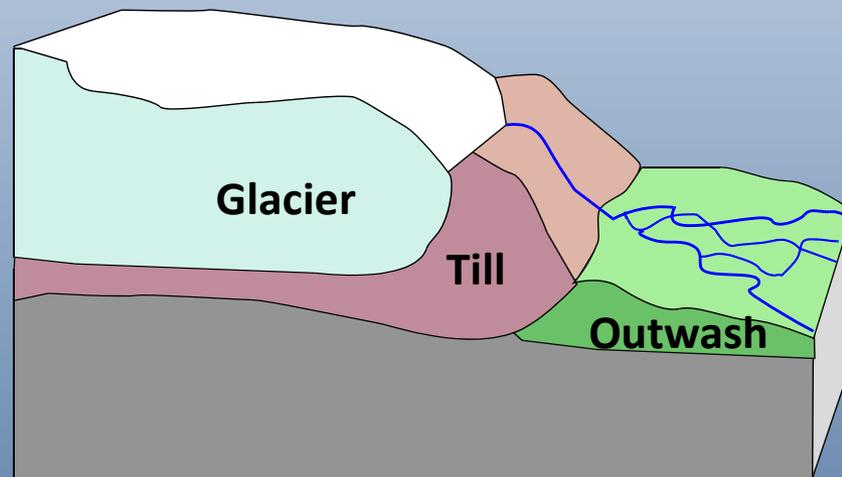
 PreC Meta-sedimentary Rocks (Mountains – east)



Upper Yellowstone Watershed Glacial Geology



Quaternary Basin Fill and Alluvium



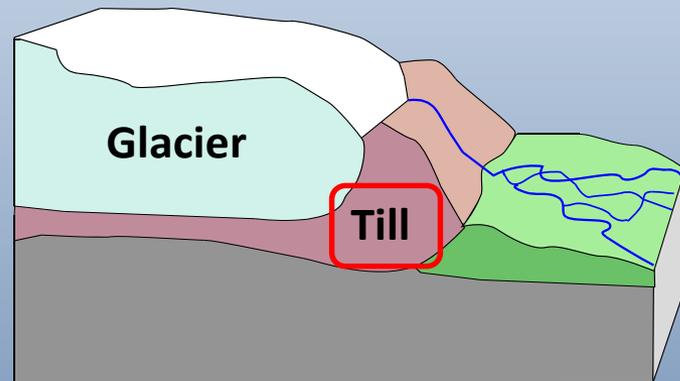
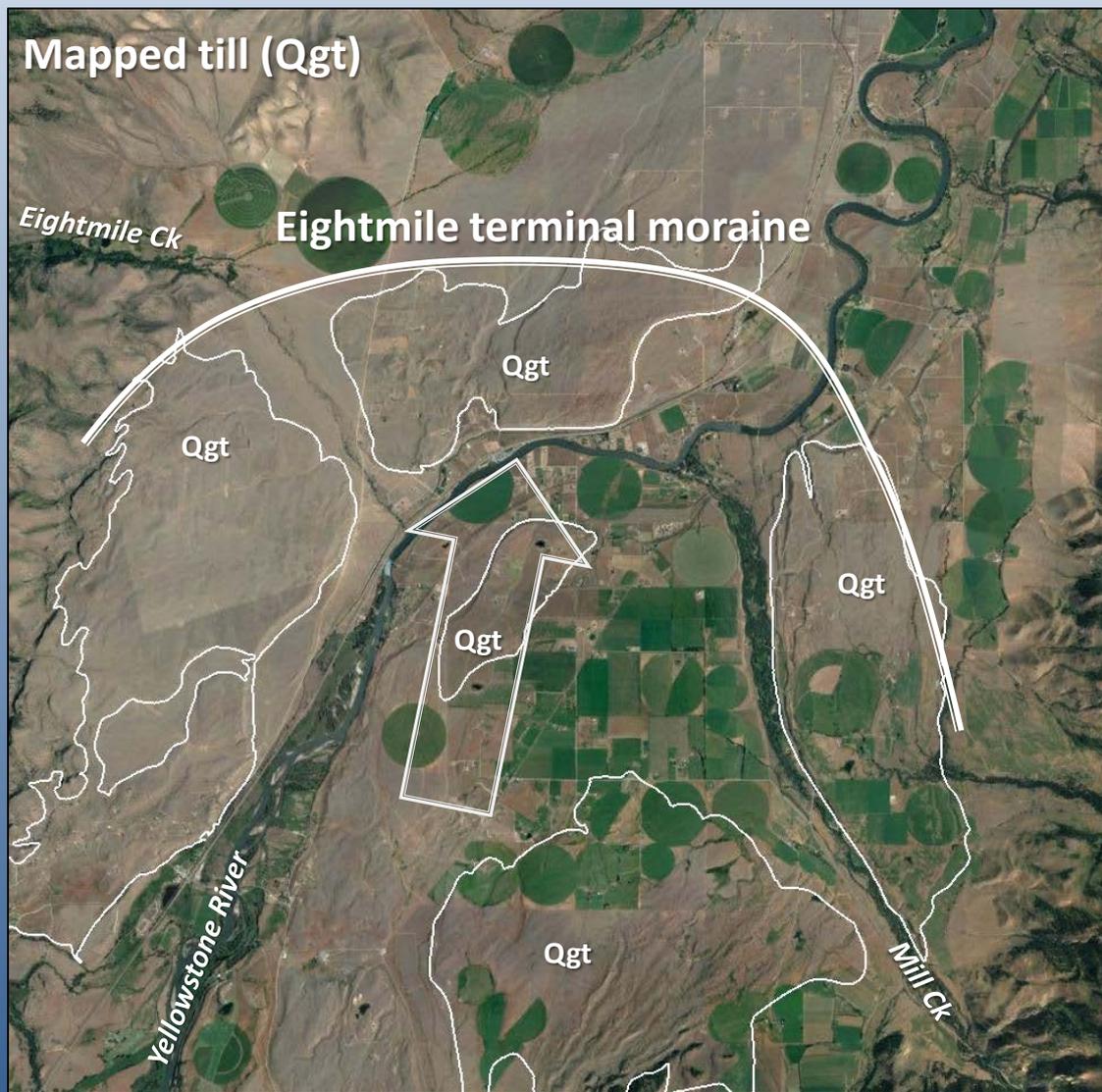
Upper Yellowstone Watershed Glacial Geology

Eightmile moraine and outwash fan



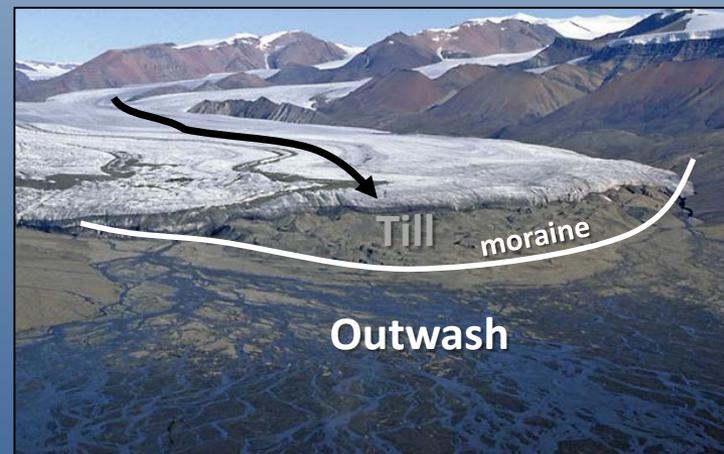
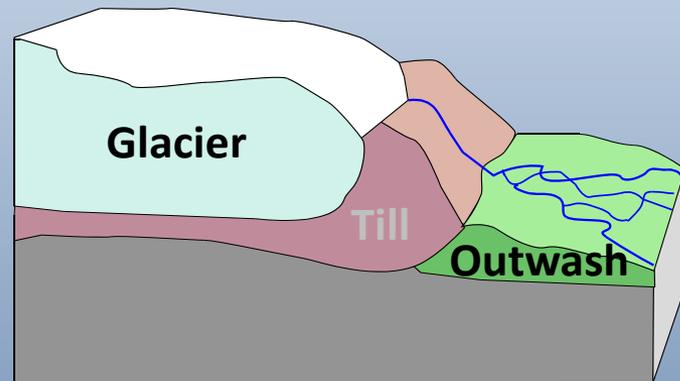
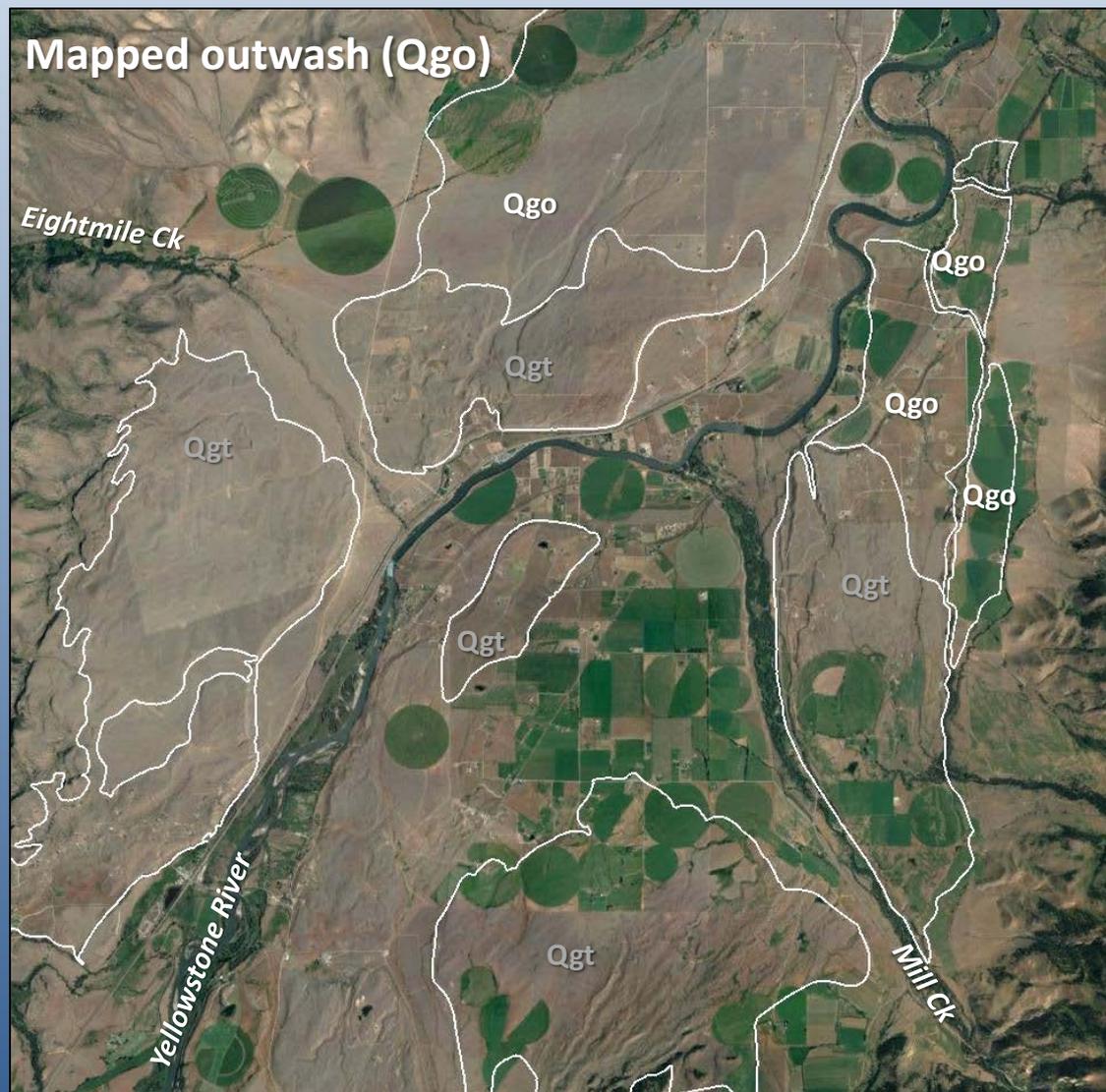
Upper Yellowstone Watershed Glacial Geology

Eightmile moraine and outwash fan



Upper Yellowstone Watershed Glacial Geology

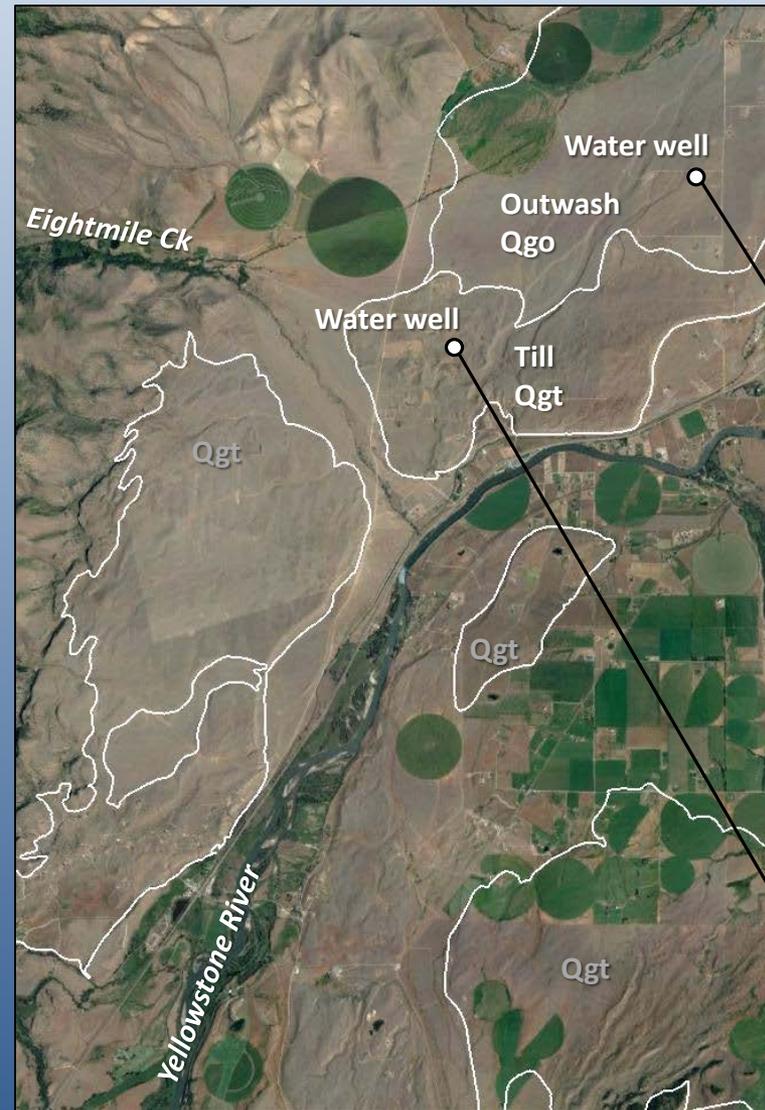
Eightmile moraine and outwash fan



(Lopez and Reiten, 2003)

Upper Yellowstone Watershed Glacial Geology

Eightmile moraine and outwash fan



MONTANA WELL LOG REPORT Other Options

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

[Return to menu](#)
[Plot this site in State Library Digital Atlas](#)
[Plot this site in Google Maps](#)
[View scanned well log \(11/22/2005 9:23:00 AM\)](#)

Site Name: STROHSZHEIN, SHAWN
GWIC Id: 222133

Section 1: Well Owner(s)
1) STROHSZHEIN, SHAWN (MAIL)
PO BOX 830
WRIGHT WY 82732 [00/19/2005]

Section 2: Location

Township	Range	Section	Quarter Sections	Geocode
04N	09E	31	SW¼ NW¼ NW¼	
County				

PARK

Latitude	Longitude	Geomethod	Datum
45.44933	-110.66966	NAV-GPS	NAD27

Ground Surface Altitude **Ground Surface Method** **Datum** **Date**

Addition **Block** **Lot**

Section 3: Proposed Use of Water
DOMESTIC (1)

Section 4: Type of Work
Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: Friday, August 19, 2005

Section 7: Well Test Data

Total Depth: 240
Static Water Level: 197
Water Temperature:

Air Test *

.50 gpm with drill stem set at 238 feet for 1 hours.
Time of recovery 0.5 hours.
Recovery water level 197 feet.
Pumping water level _ feet.

Section 8: Remarks

Section 9: Well Log Geologic Source

Unassigned

From	To	Description
0	240	SAND, GRAVEL, & BOULDER



MONTANA WELL LOG REPORT Other Options

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[Return to menu](#)
[Plot this site in State Library Digital Atlas](#)
[Plot this site in Google Maps](#)
[View scanned well log \(2/11/2010 2:21:03 PM\)](#)

Site Name: GUARDIANI JOE
GWIC Id: 124065
DNRC Water Right: C077818-00

Section 1: Well Owner(s)
1) GUARDIANI, JOE (MAIL)
6 BIG DIPPER DR
SEYMORE CT 06483 [03/15/1991]

Section 2: Location

Township	Range	Section	Quarter Sections	Geocode
05S	08E	2	NE¼ NE¼	
County				

PARK

Latitude	Longitude	Geomethod	Datum
45.436447	-110.694819	TRS-SEC	NAD83

Ground Surface Altitude **Ground Surface Method** **Datum** **Date**

Addition **Block** **Lot**

PARADISE RANCH II 33-18

Section 3: Proposed Use of Water
DOMESTIC (1)

Section 4: Type of Work
Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: Friday, March 15, 1991

Section 7: Well Test Data

Total Depth: 299
Static Water Level: 240
Water Temperature:

Air Test *

.55 gpm with drill stem set at _ feet for 0.01 hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level 299 feet.

Section 8: Remarks

Section 9: Well Log Geologic Source

Unassigned

From	To	Description
0	30	SMALL GRAVEL
30	80	GRAVEL
90	126	CLAY
126	260	CLAY & GRAVEL
260	300	GRAVEL & BOULDERS

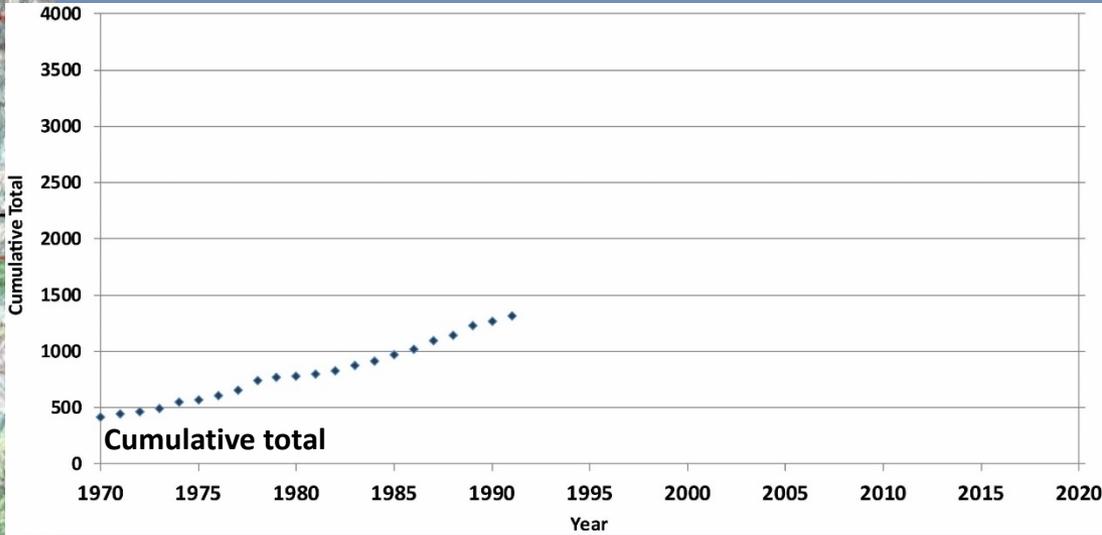
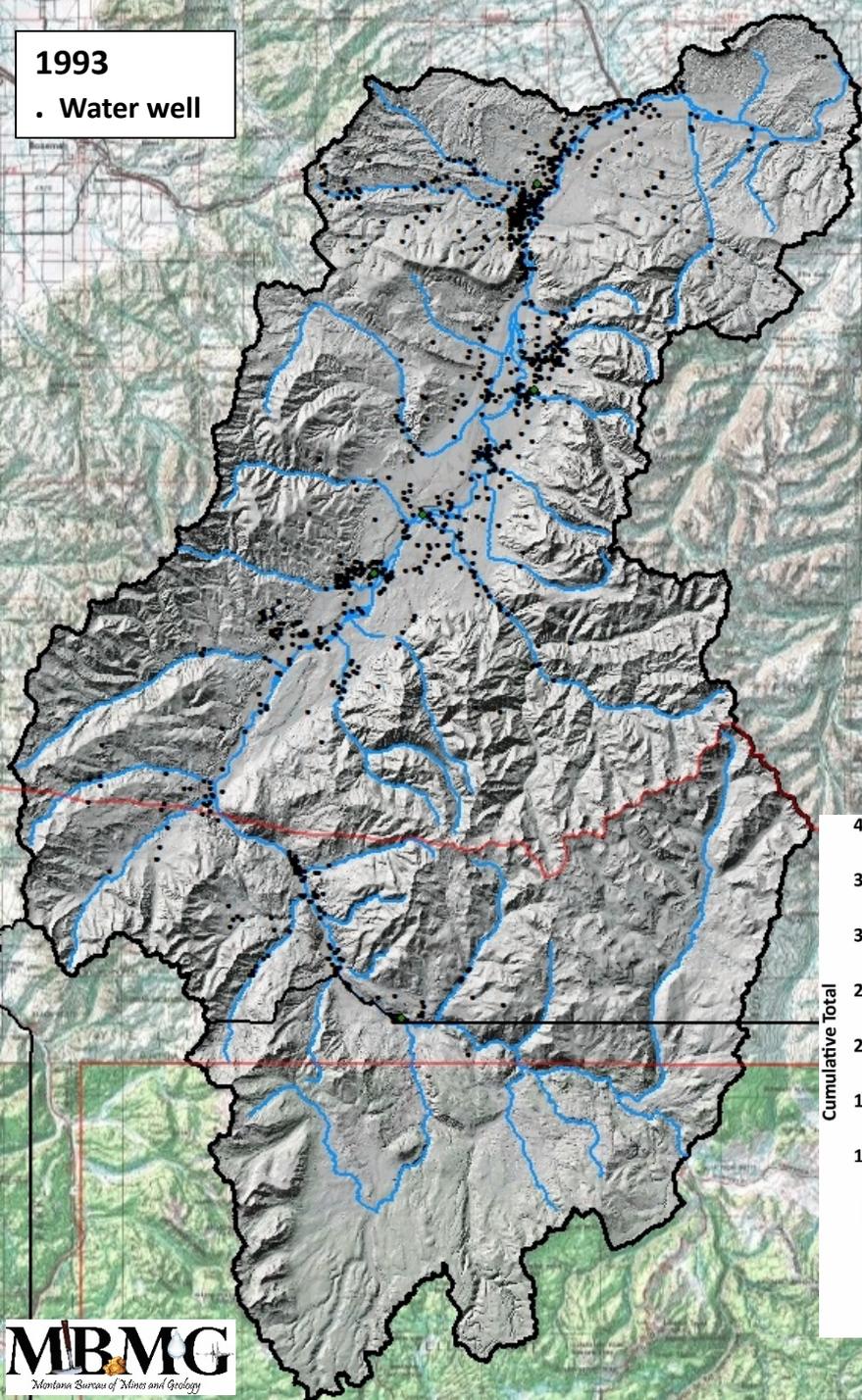


(Lopez and Reiten, 2003)

1993

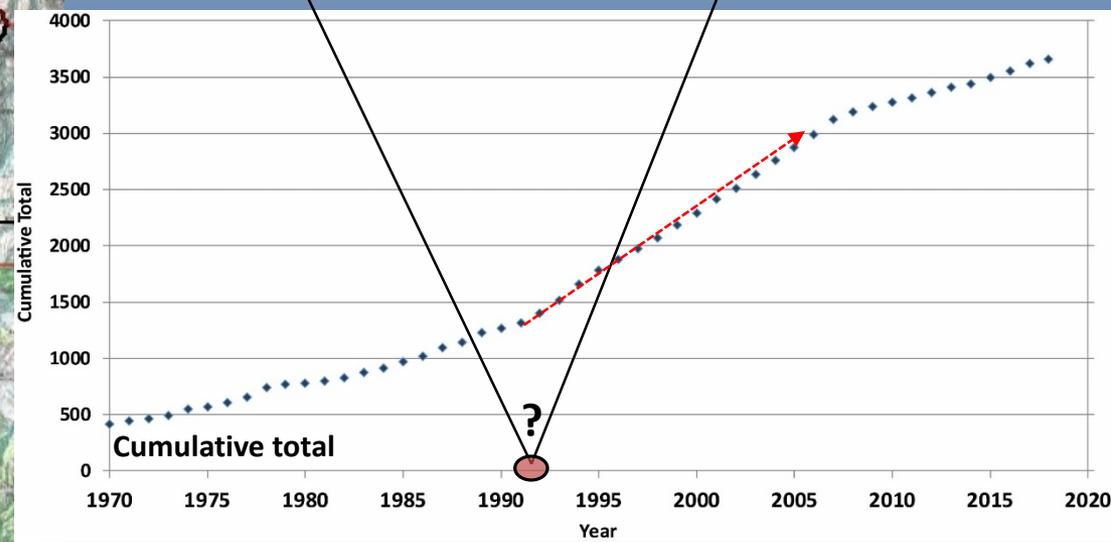
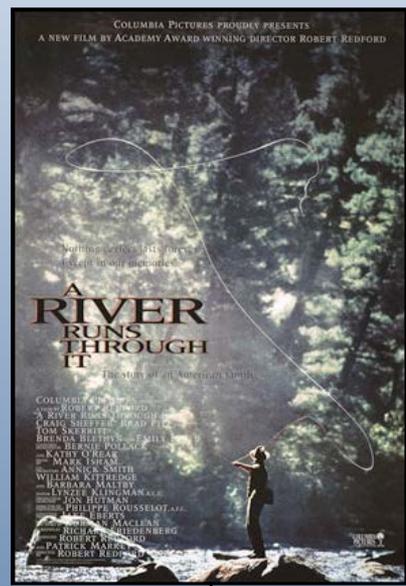
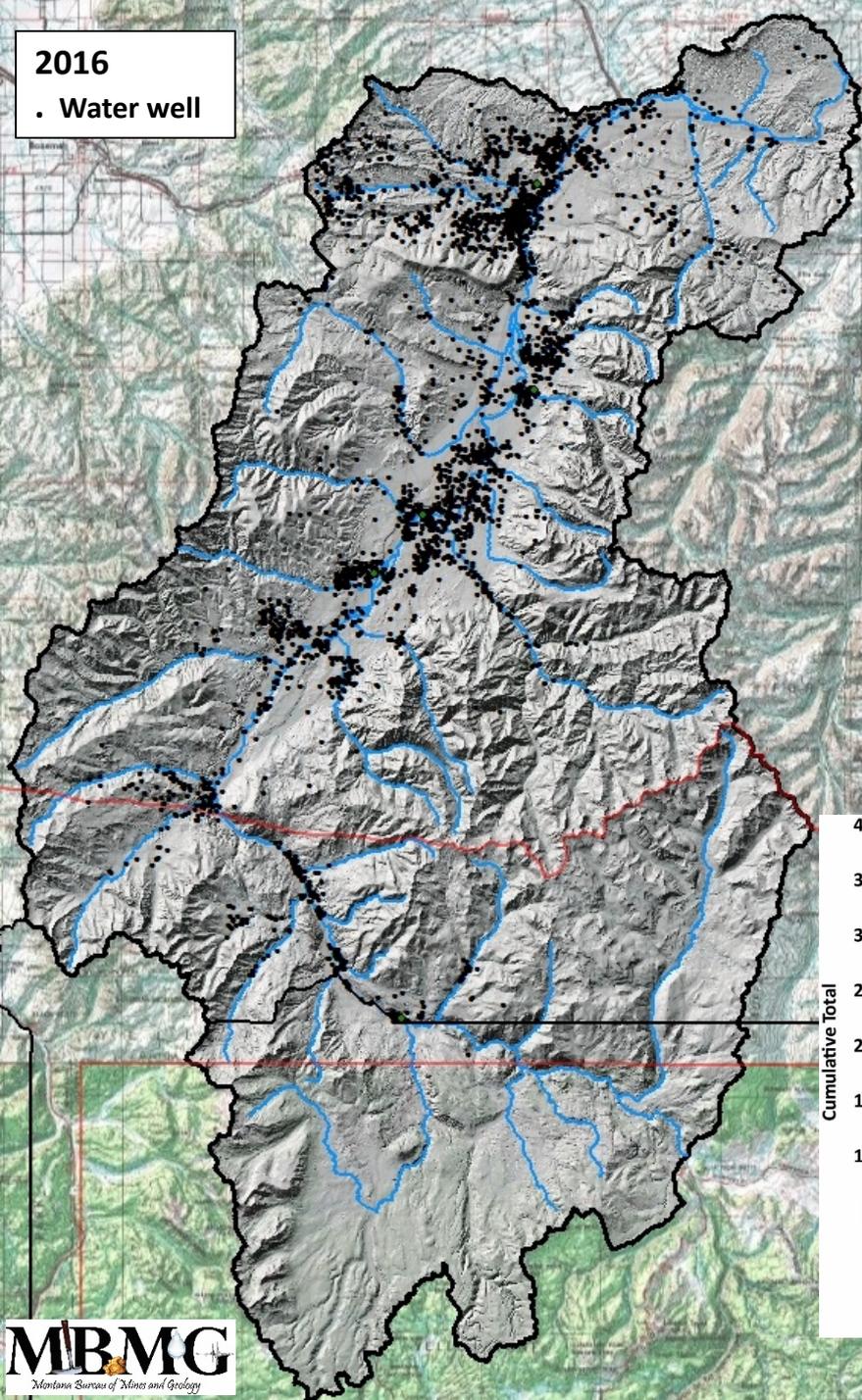
• Water well

Upper Yellowstone Watershed Groundwater Development



2016
• Water well

Upper Yellowstone Watershed Groundwater Development

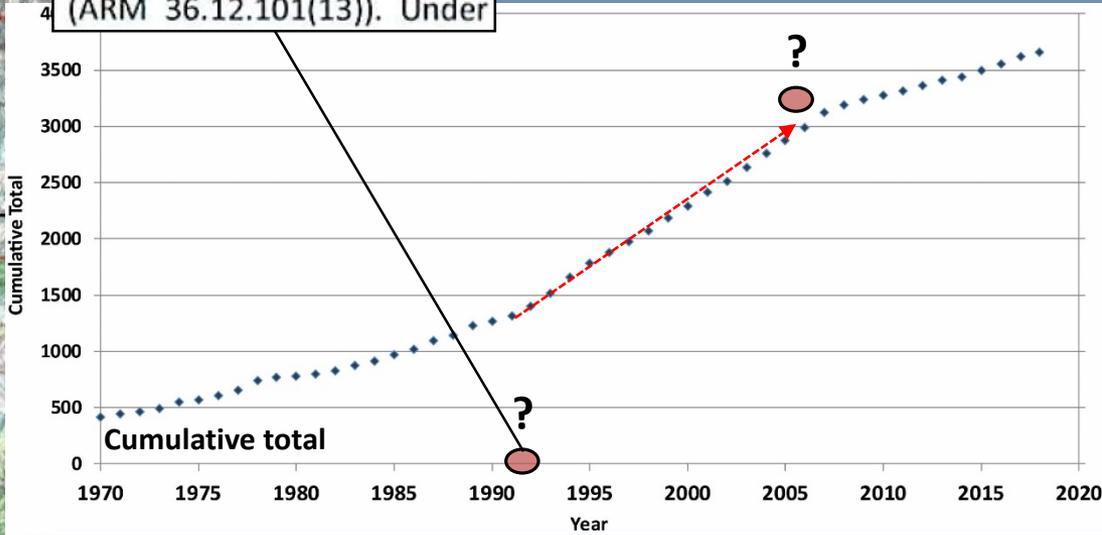
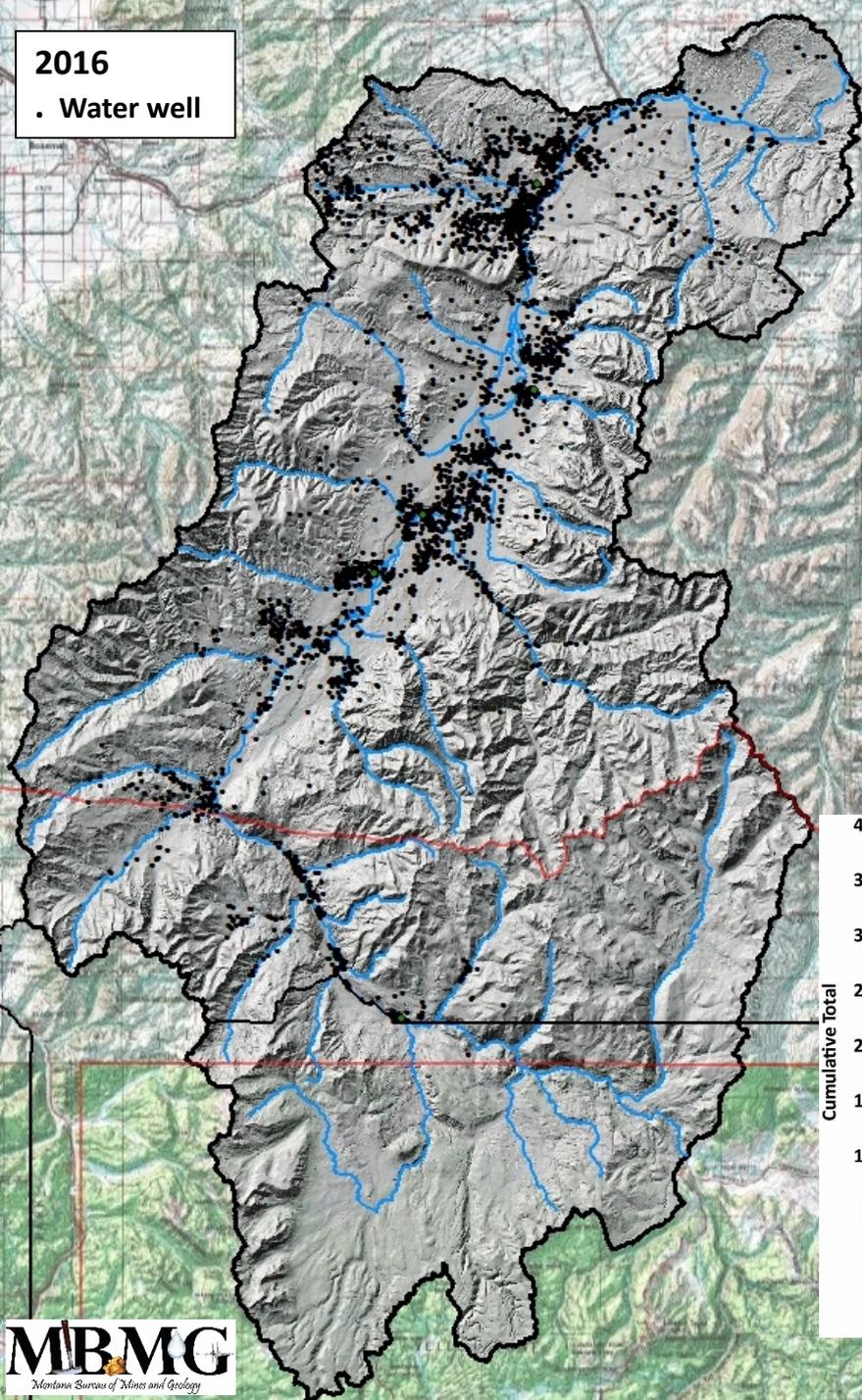


2016
• Water well

Upper Yellowstone Watershed Groundwater Development

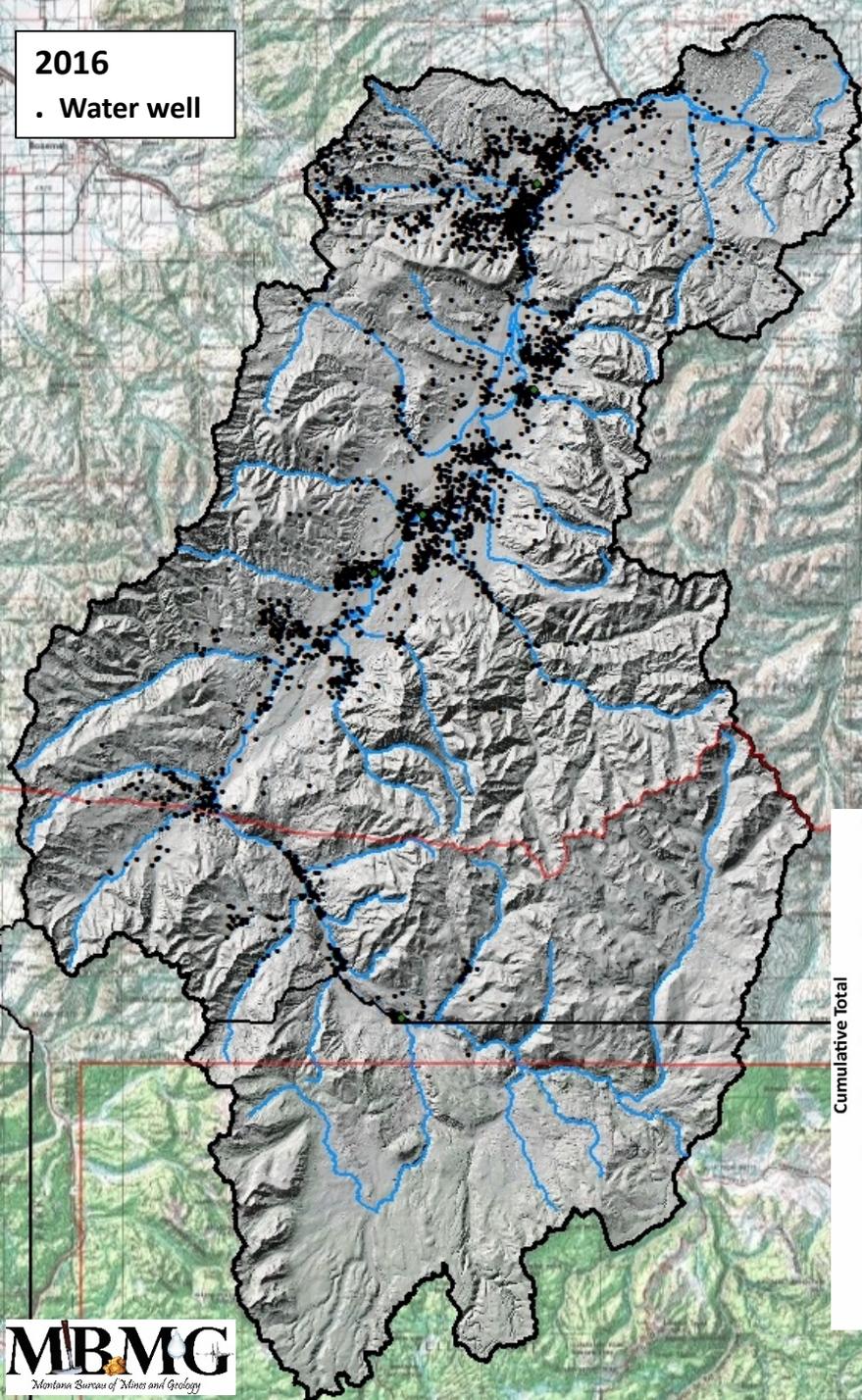
Overview

In 1993 the Montana Department of Natural Resources and Conservation (DNRC) put in place an Administrative Rule defining “combined appropriation of exempt wells” as an appropriation of water from the same source aquifer by two or more groundwater developments, that are physically manifolded into the same system (ARM 36.12.101(13)). Under



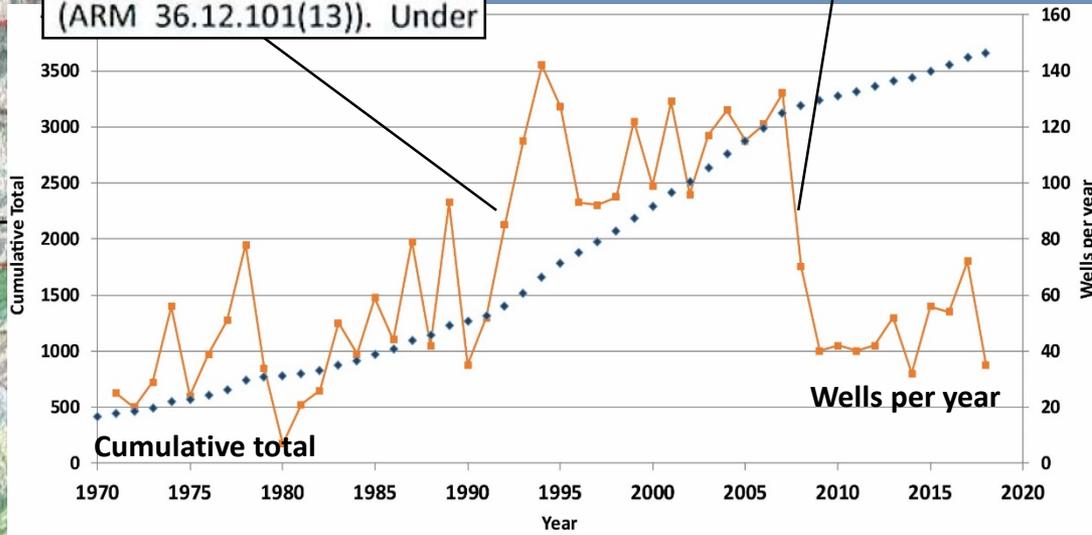
2016
• Water well

Upper Yellowstone Watershed Groundwater Development



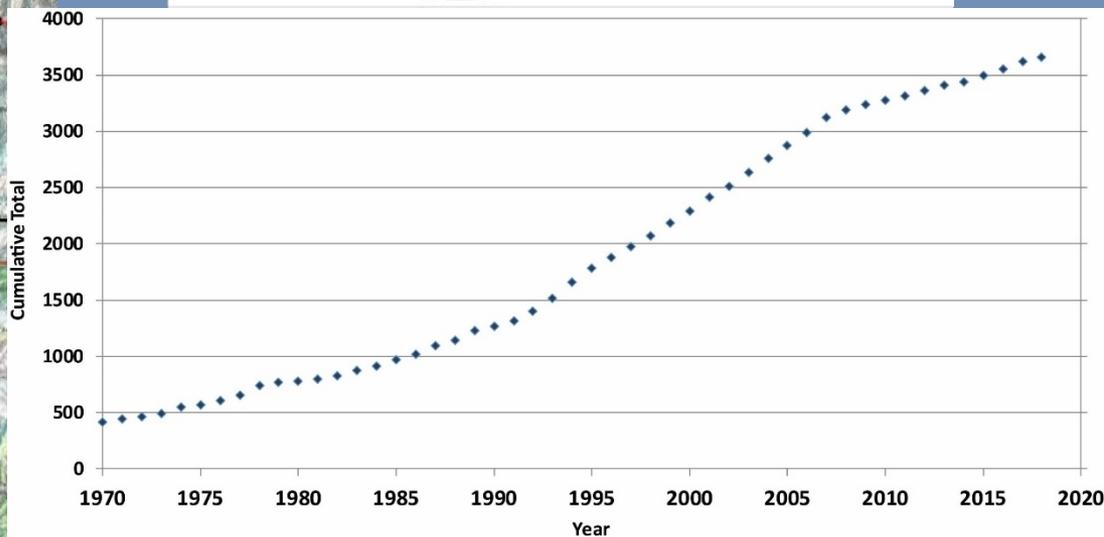
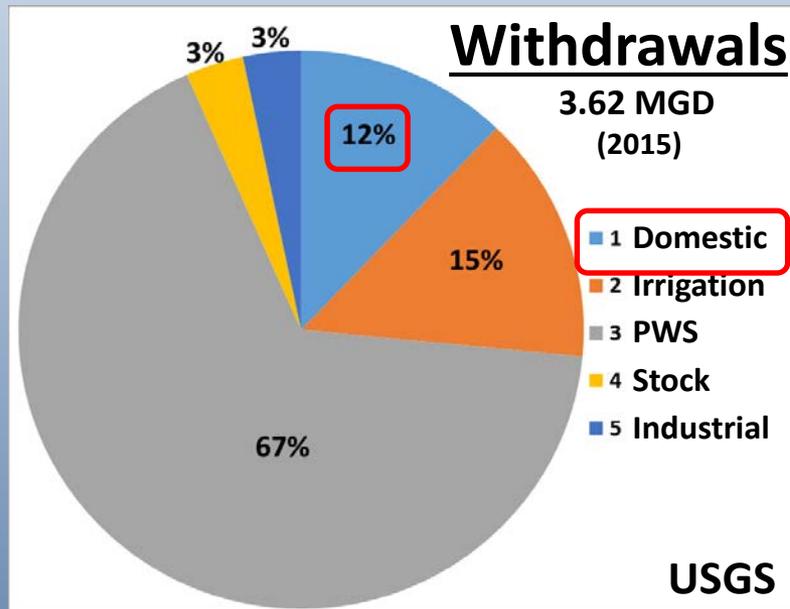
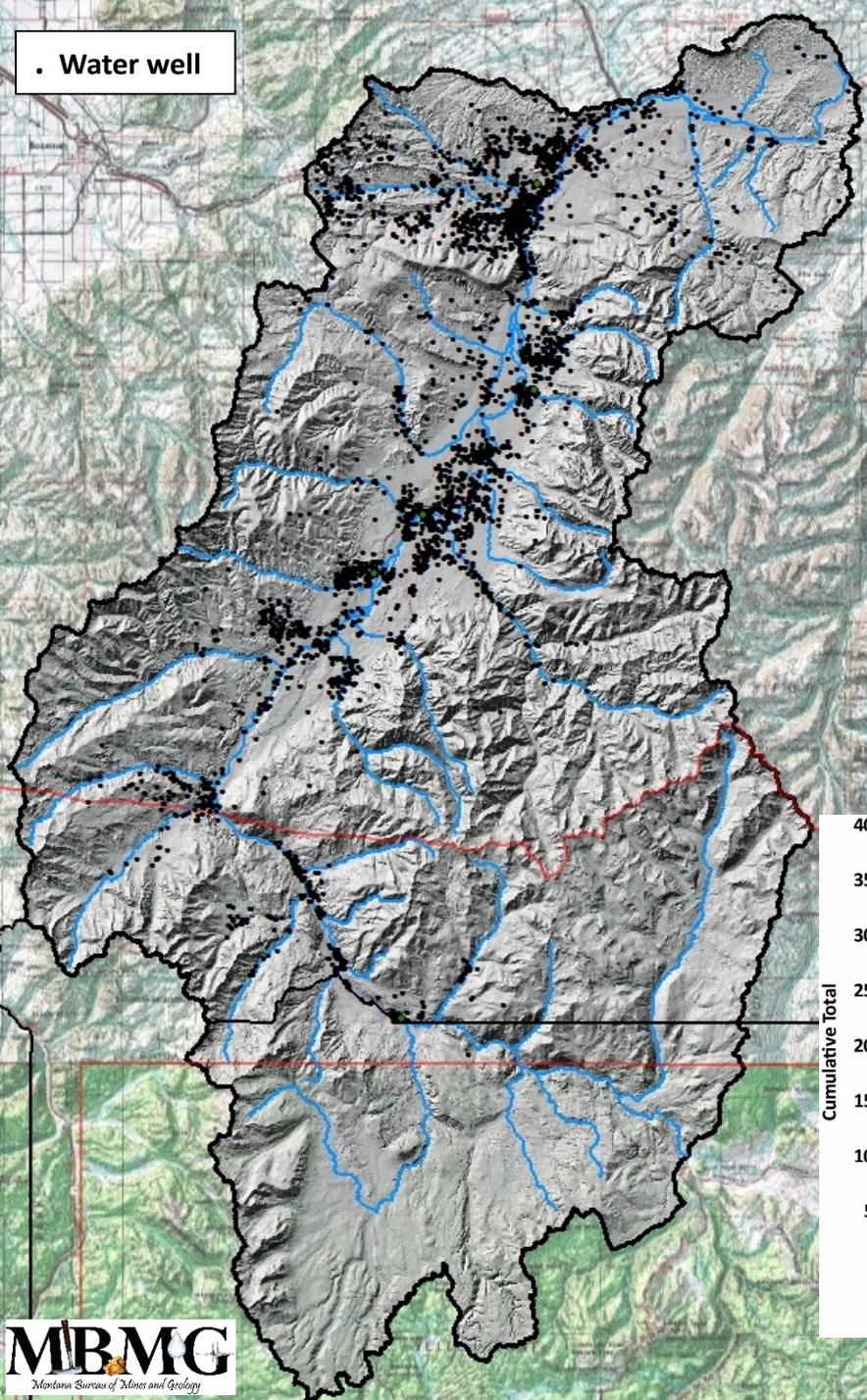
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• Water well

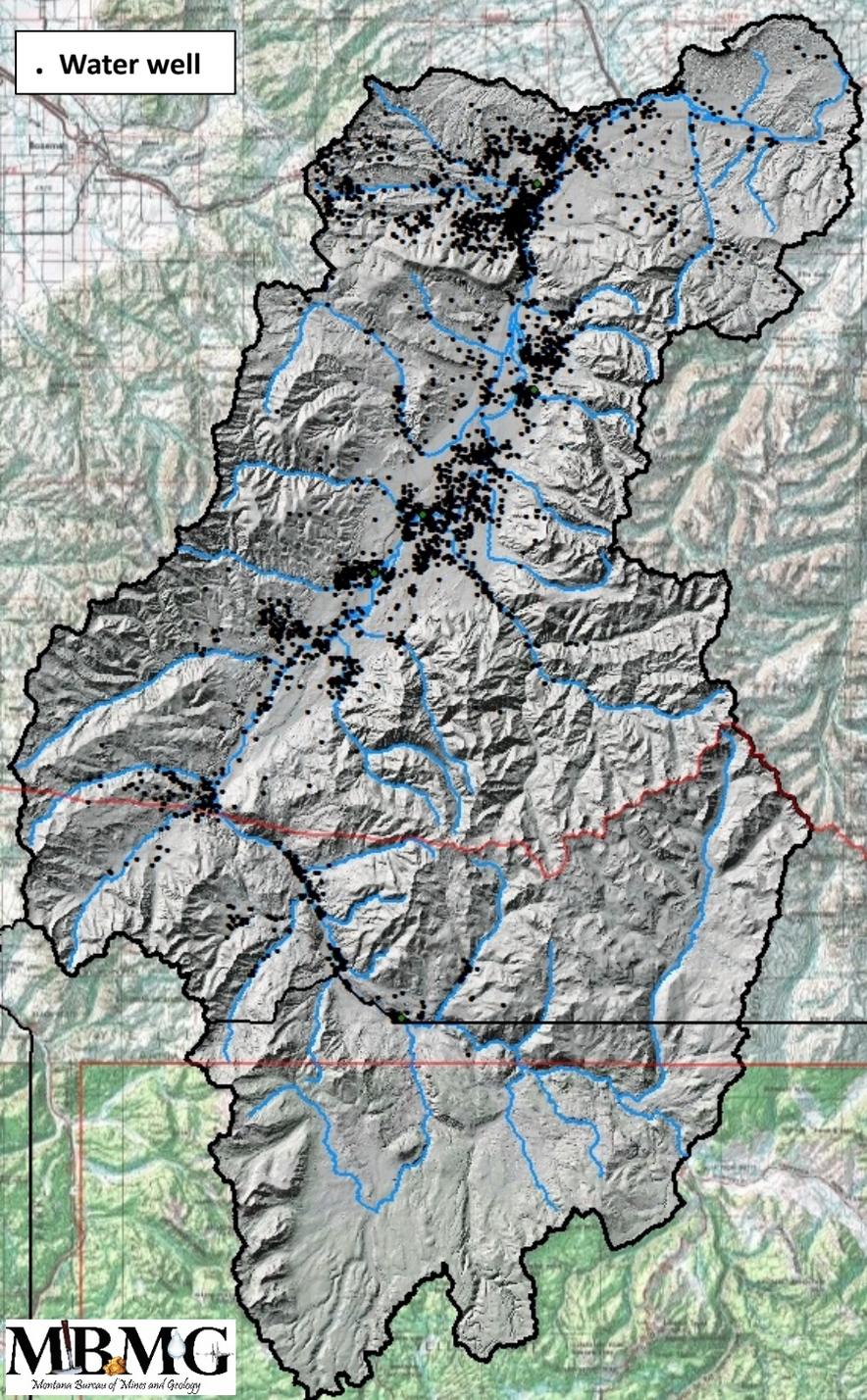
Upper Yellowstone Watershed Groundwater Use



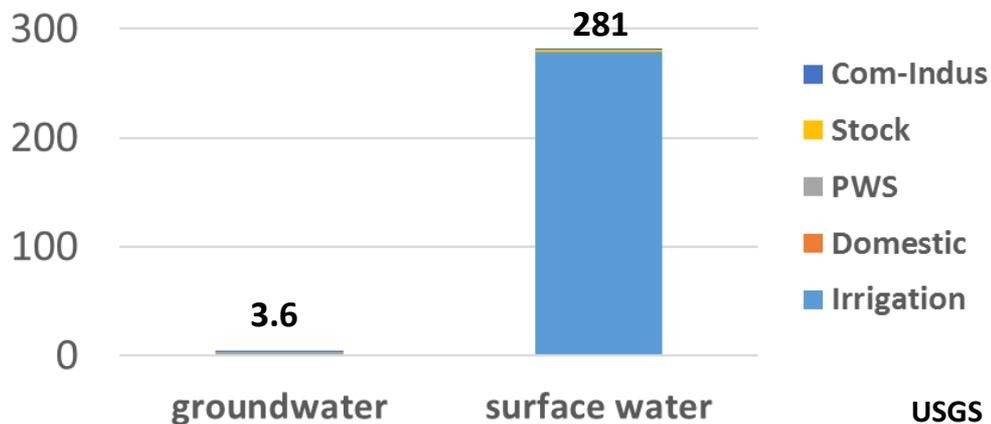
• Water well

Upper Yellowstone Watershed Groundwater – Surface Water Use

Volumetrically - minor

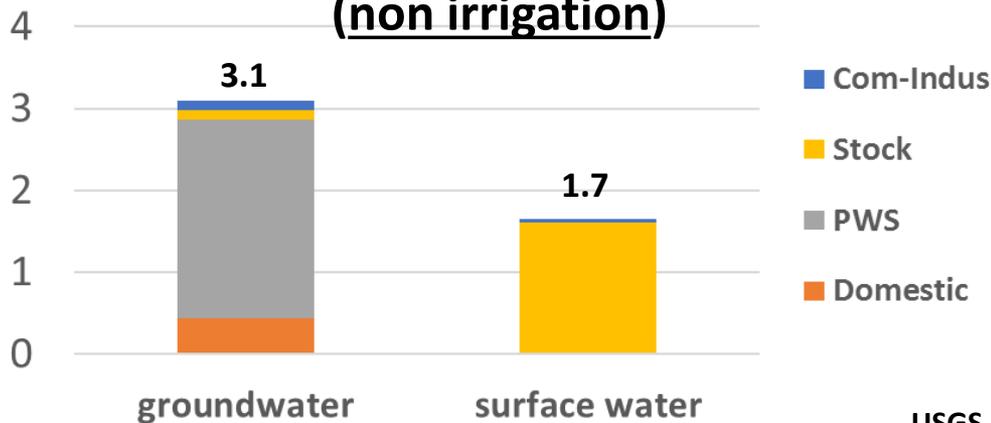


Park Co. Water Withdrawals (MGD) - 2015



USGS

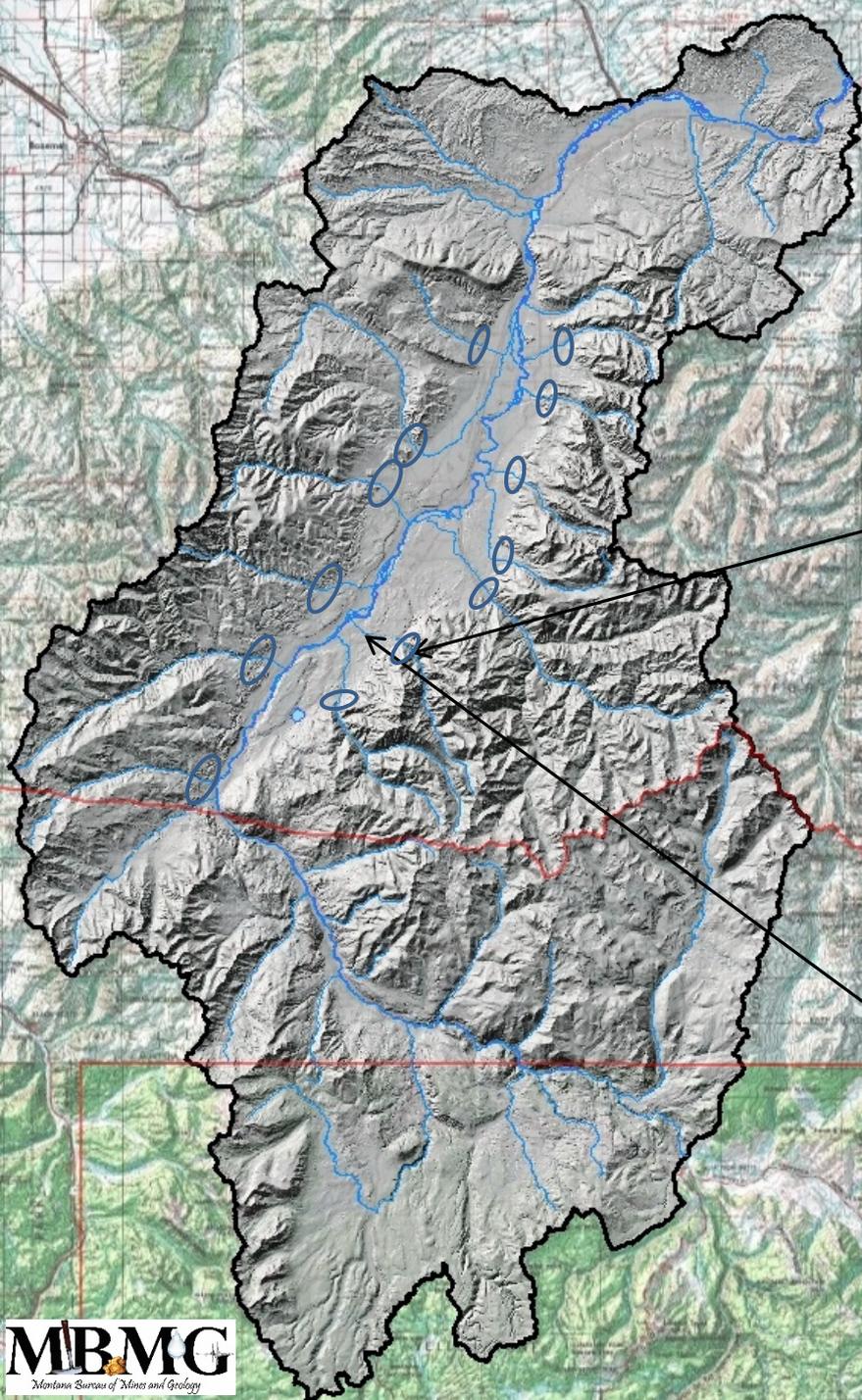
Park Co. Water Withdrawals (MGD) - 2015 (non irrigation)



USGS

Upper Yellowstone Watershed Groundwater recharge

- Precipitation*
- Mountain front stream loss
- Canal seepage – “Incidental Recharge”



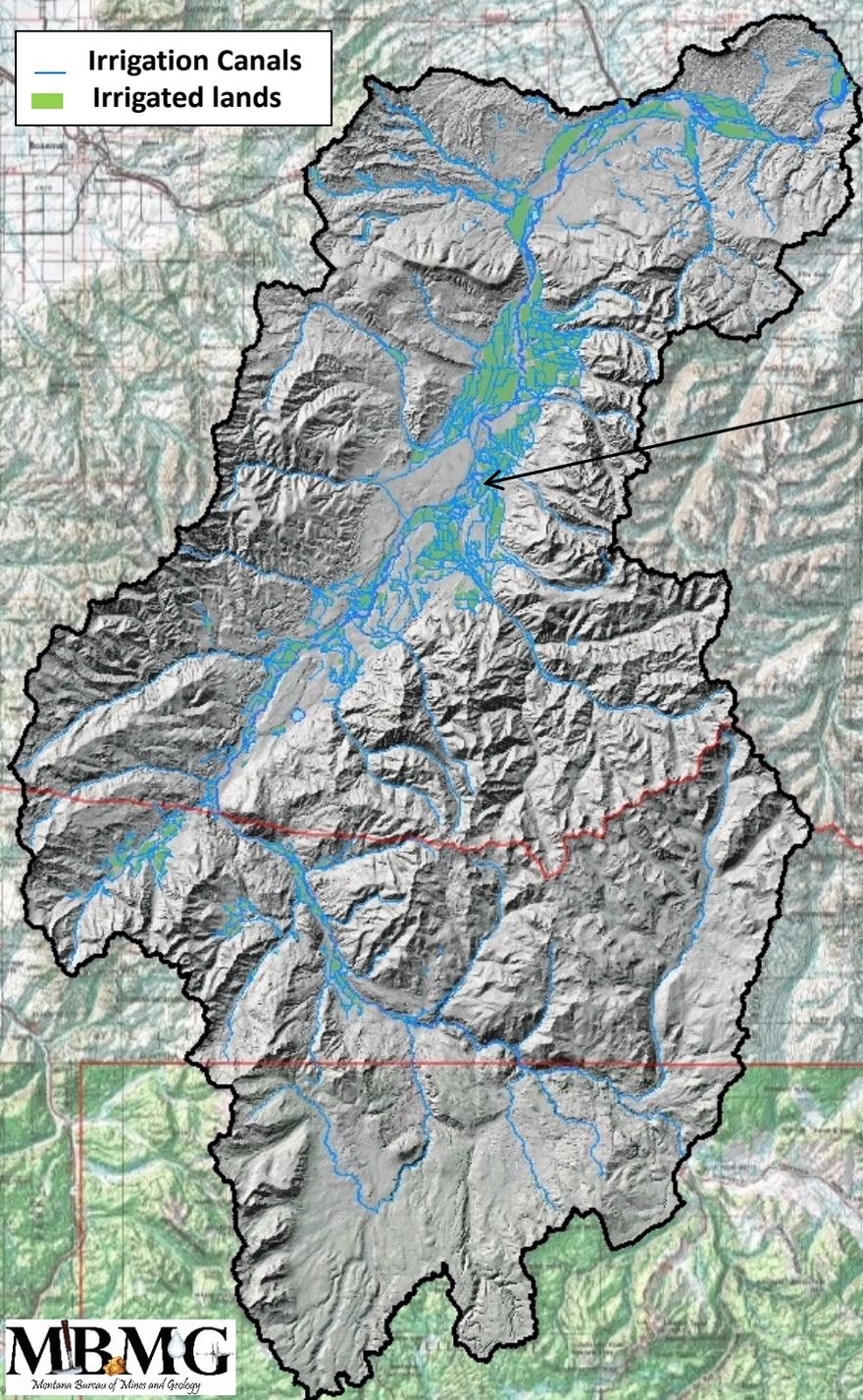
2.5 mi



Upper Yellowstone Watershed

Groundwater recharge

- Precipitation*
- Mountain front stream loss
- Canal seepage – “Incidental Recharge”

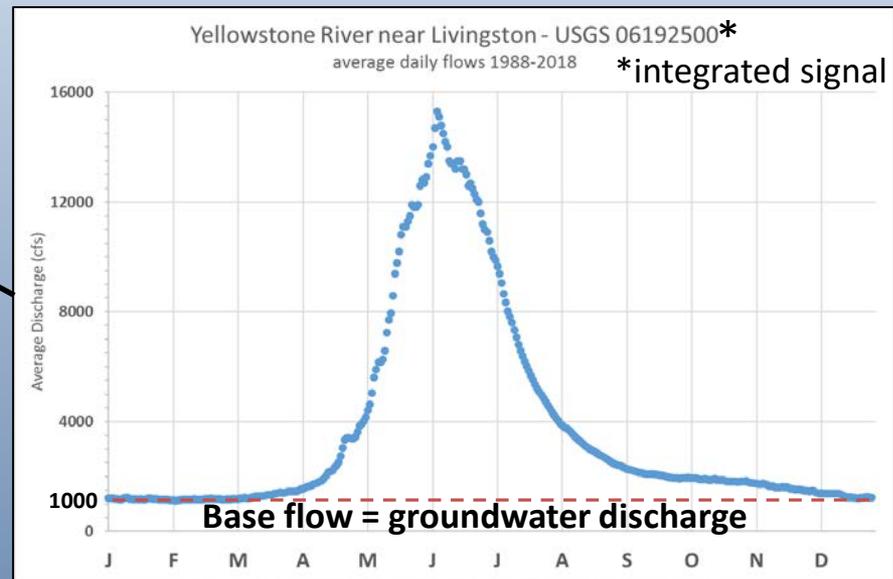
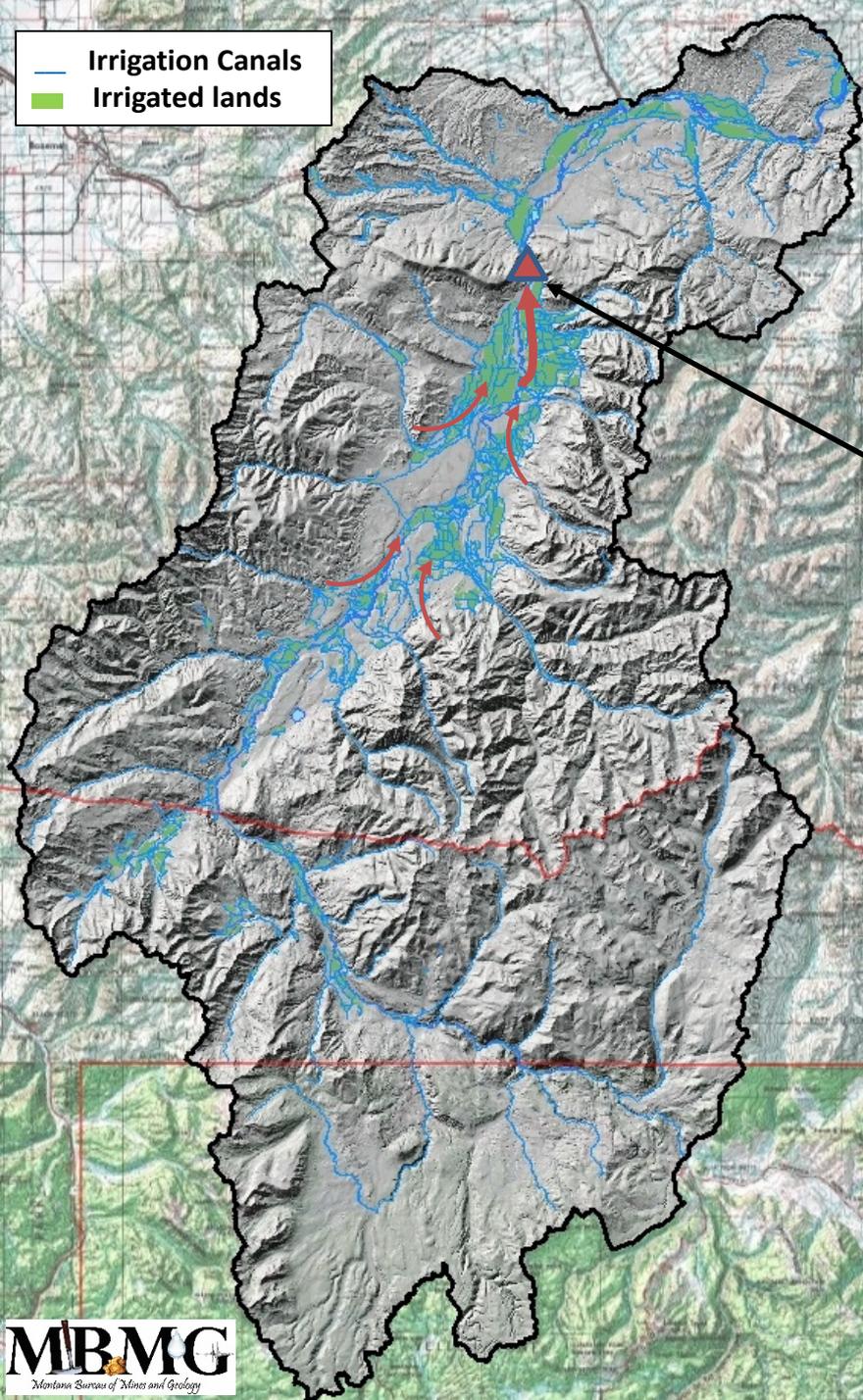


Park Co. (USGS 2015)

- Irrigates ~ 62,000 acres
- Diverts ~ 312,000 ac-ft/yr
- 100's of miles of canals

~ 5 ft of water per acre

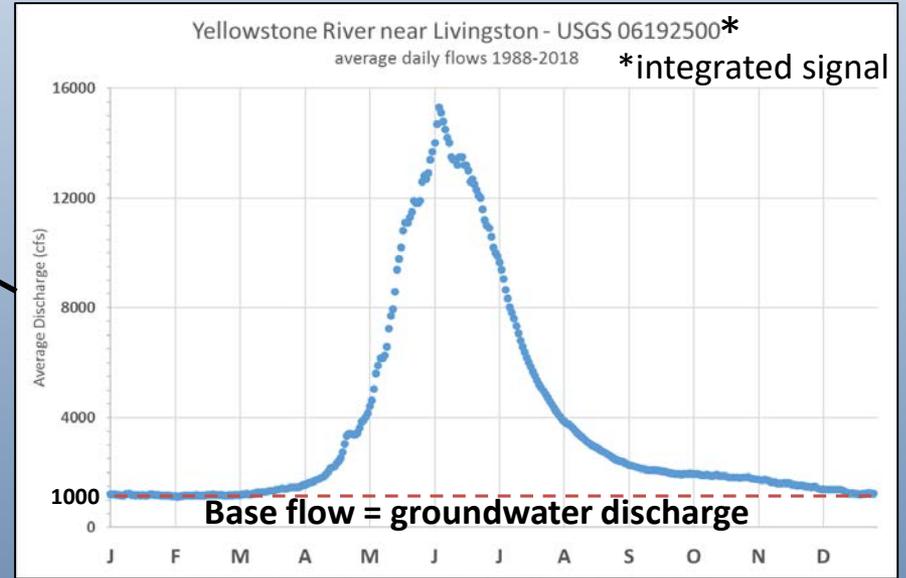
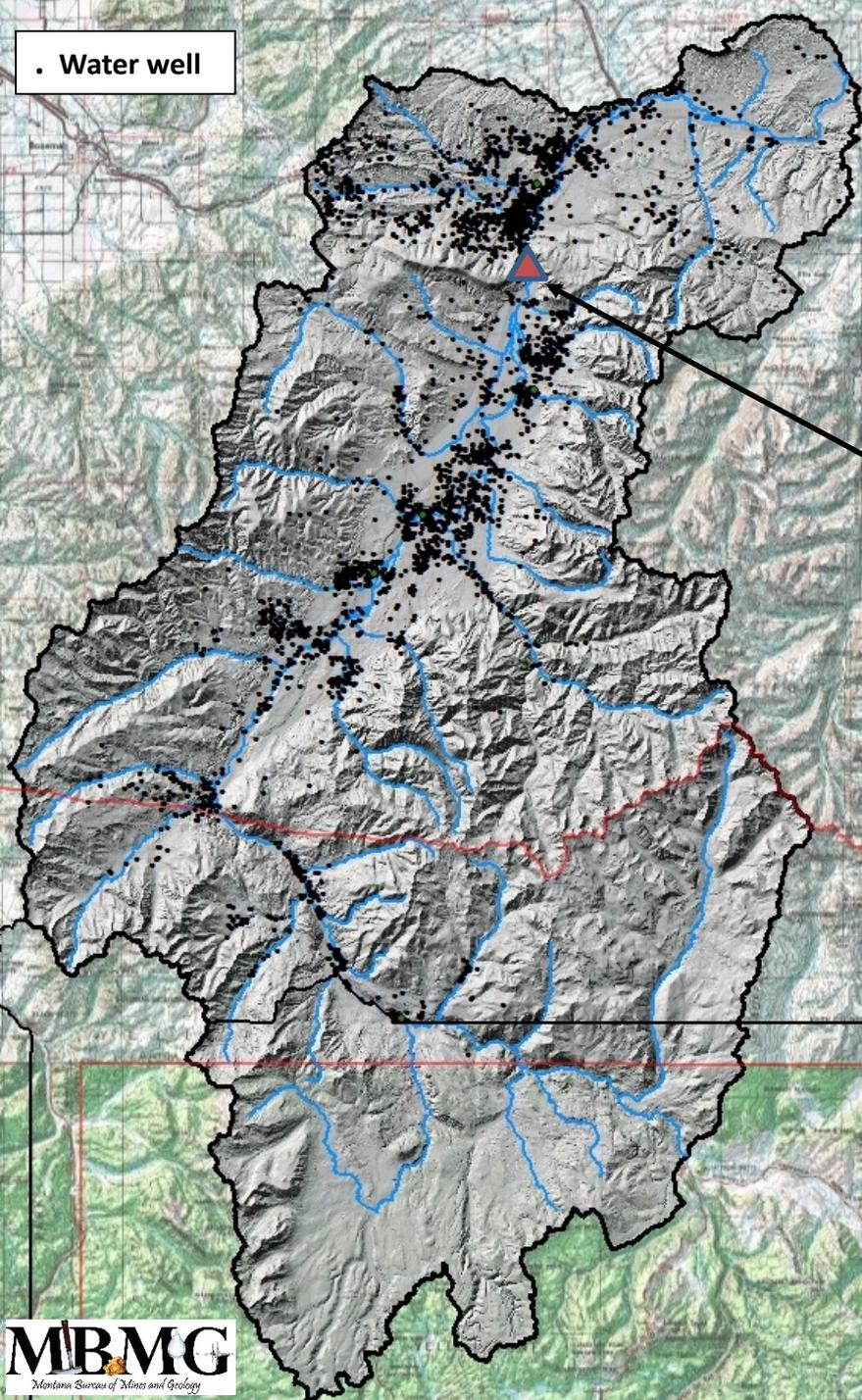
Upper Yellowstone Watershed Groundwater Discharge



1000 cfs = 1983 ac-ft/day = 724,000 ac-ft/yr

• Water well

Upper Yellowstone Watershed Groundwater Discharge



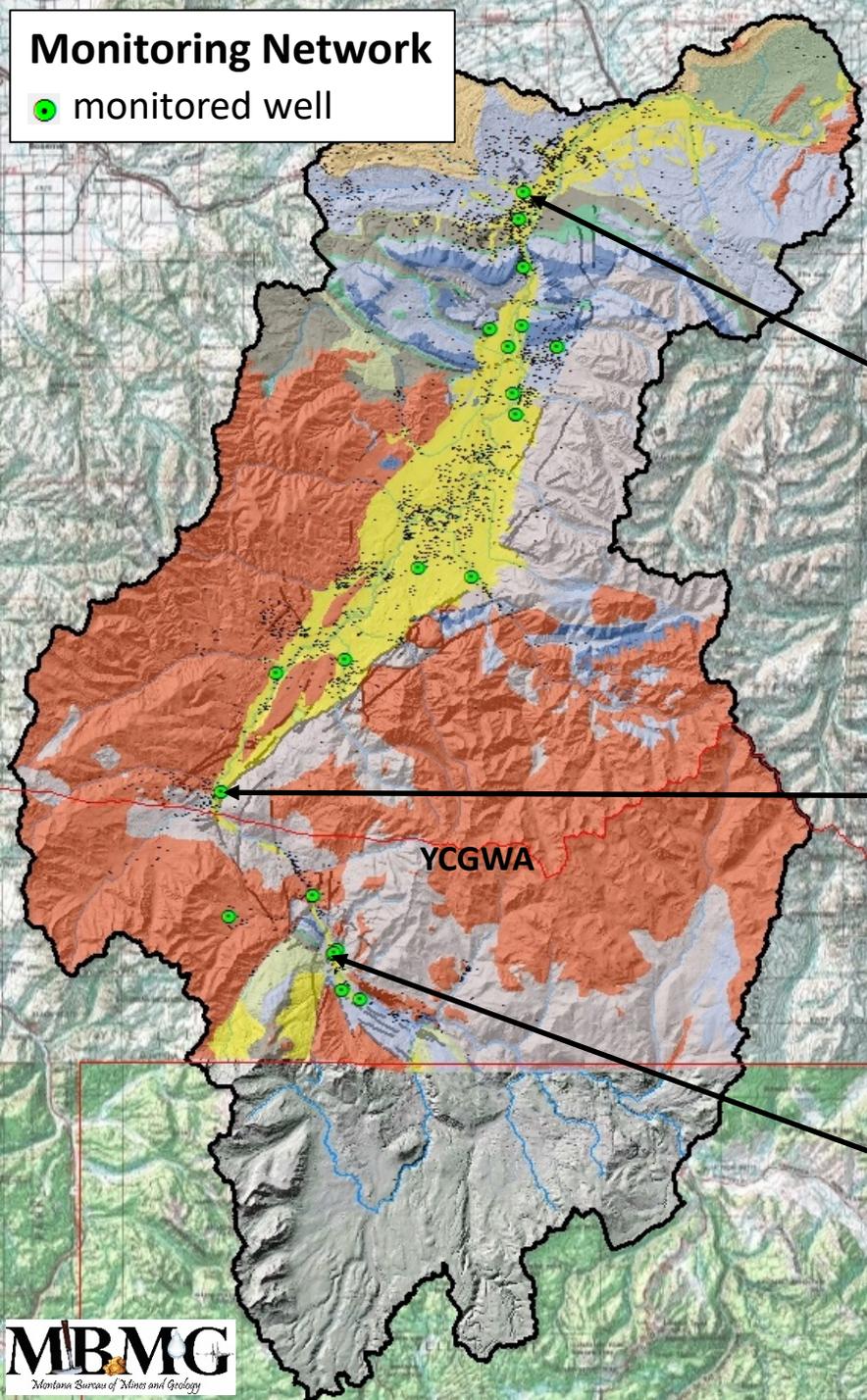
1) 1000 cfs = 1983 ac-ft/day = **724,000 ac-ft/yr**



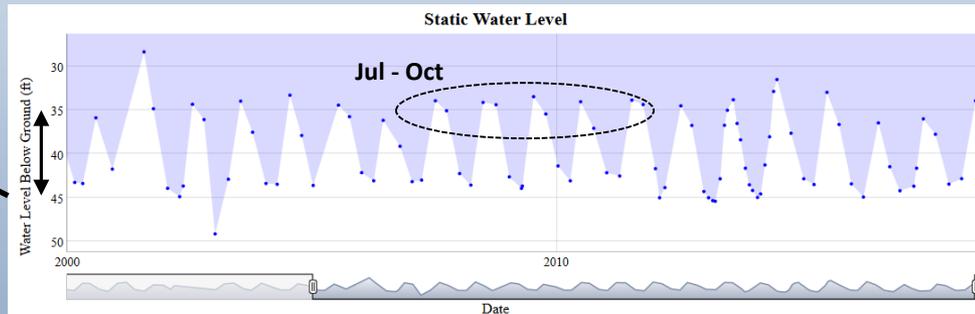
2) GW Withdrawals
3.8 MGD = 11 ac-ft/day
= **4,000 ac-ft/yr**

Monitoring Network

● monitored well

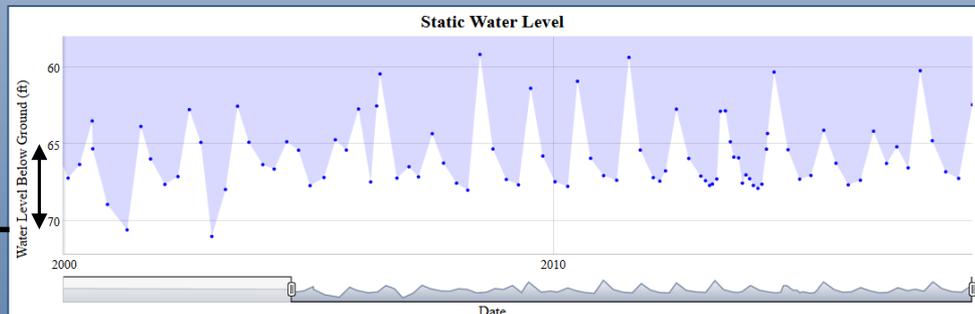


Upper Yellowstone Watershed Groundwater level trends



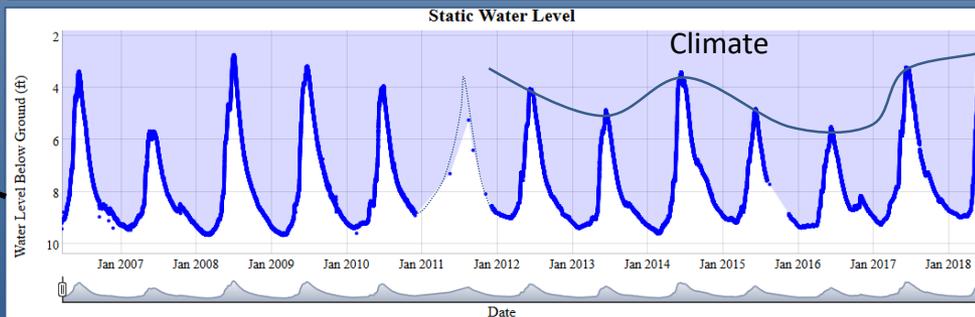
GWIC Id: 96983
 Site Name: MONTANA FWP - LIVINGSTON FISHERIES OFFICE
 Location: 02S09E14DDDB
 Total Depth: 63 feet

“Incidental” recharge



GWIC Id: 104586
 Site Name: STATE HIGHWAY DEPARTMENT - MINER SECTION HOUSE
 Location: 07S07E20CDDA
 Total Depth: 101.4 feet
 Number of Measurements: 92

Seasonal fluctuations

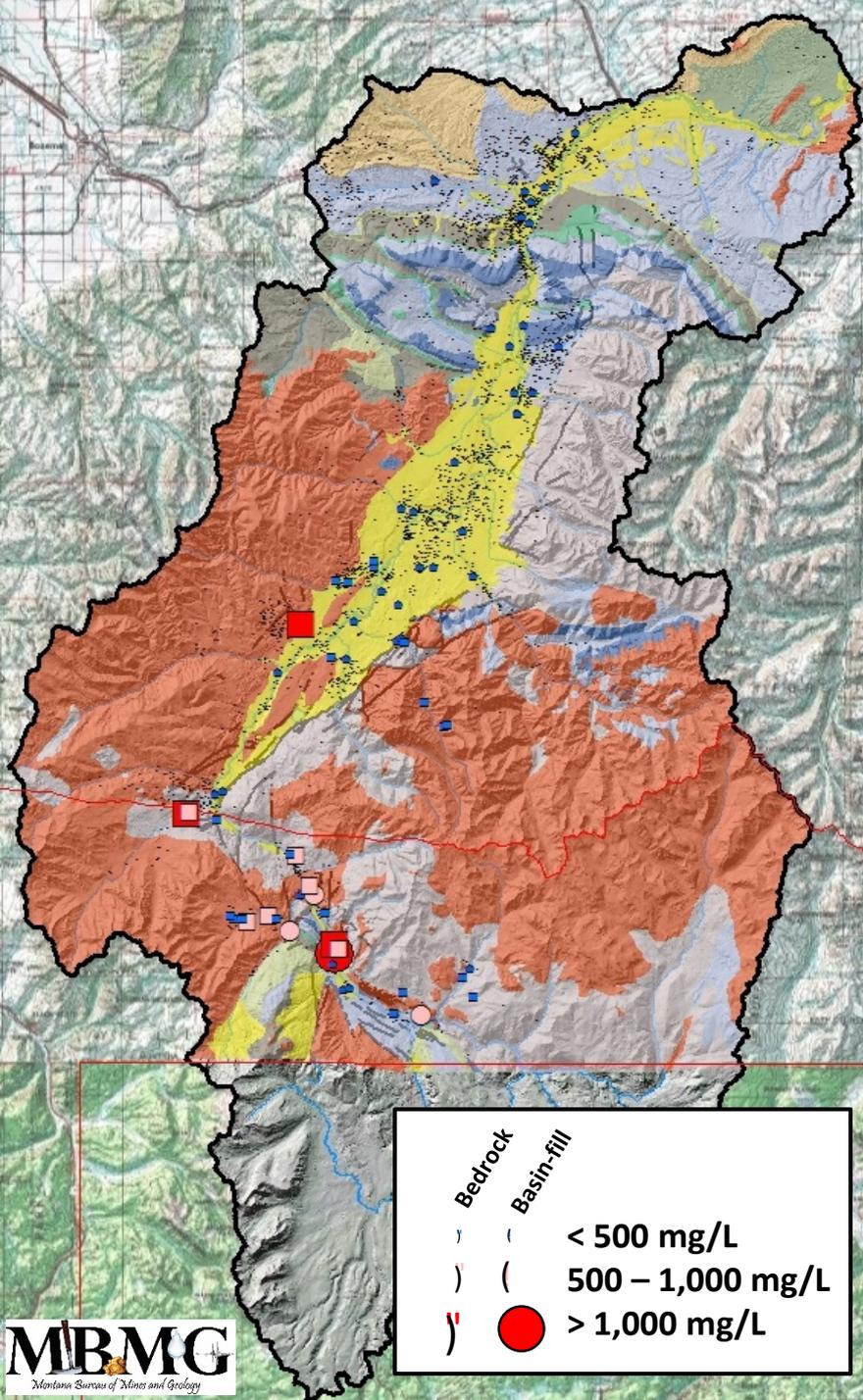


GWIC Id: 152216
 Site Name: MILLER RICHARD
 Location: 09S08E5BCAA
 Total Depth: 184 feet

Seasonal fluctuations

Upper Yellowstone Watershed Groundwater Quality - TDS

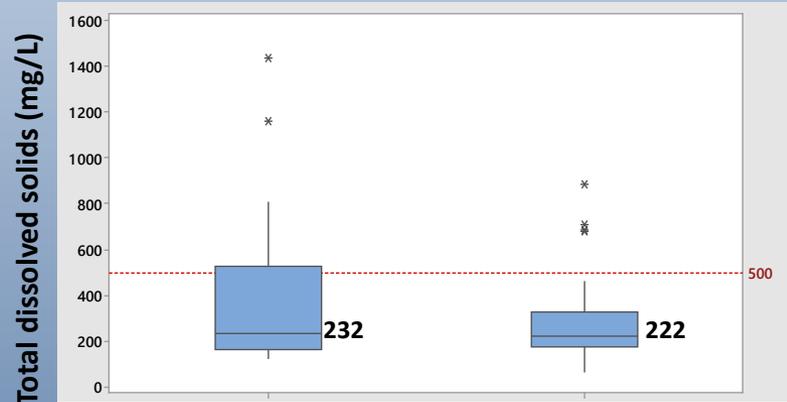
Secondary drinking water standard = 500 mg/L



exceedances:

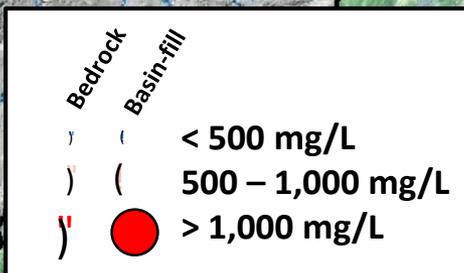
8

3



Bedrock
(n = 28)

Basin-fill
(n = 45)



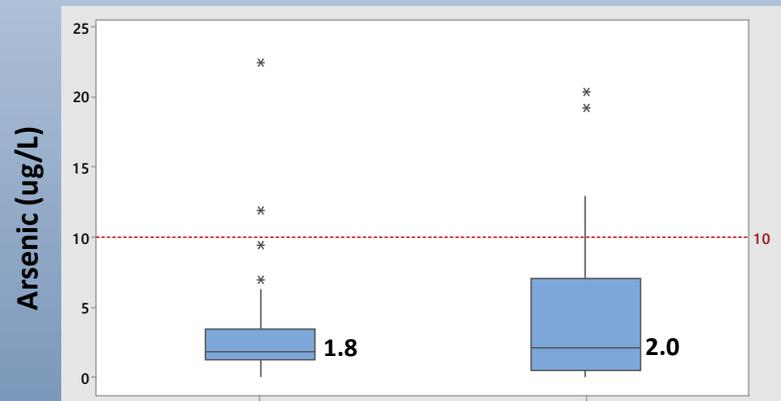
Upper Yellowstone Watershed Groundwater Quality - As

Primary drinking water standard = 10 ug/L
(parts per billion)

exceedances:

2

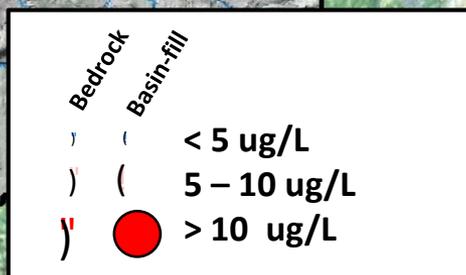
8



Bedrock
(n = 28)

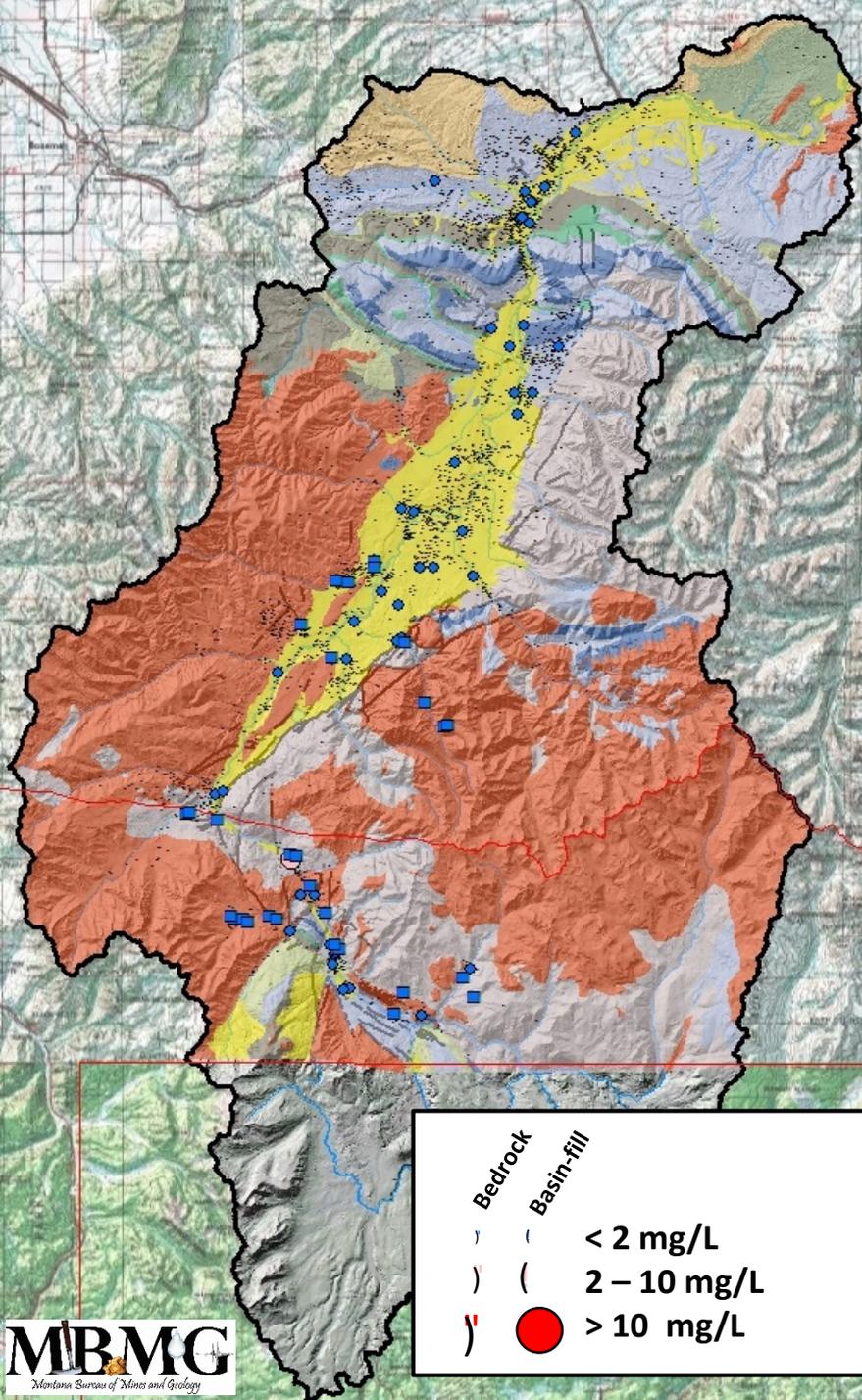
Basin-fill
(n = 45)

La Duke
Hot springs

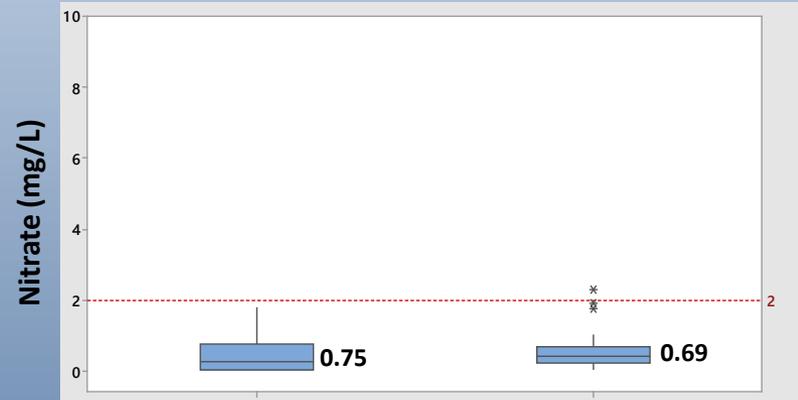


Upper Yellowstone Watershed Groundwater Quality – NO3

Primary drinking water standard = 10 mg/L

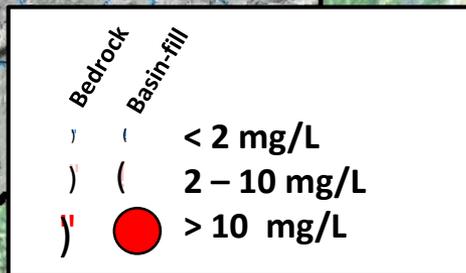
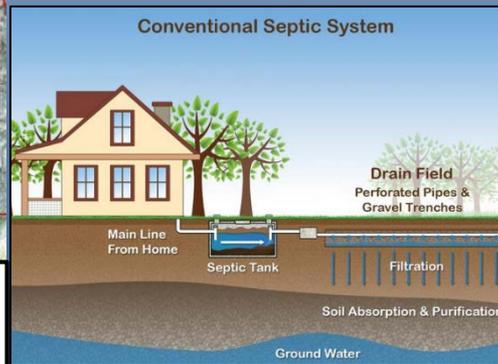


No exceedances



Bedrock
(n = 28)

Basin-fill
(n = 45)



“The imperative need in groundwater development is to know what we are doing”

Harold Thomas, 1951

- Groundwater is stored and transmitted through:
 - 1) Basin-Fill and 2) Fractured Rock Aquifers
- Groundwater supplies all drinking water in the basin
- Groundwater withdrawals small relative to ‘incidental’ recharge
 - Implications for land-use and climate changes
 - No depletion trends
- Water quality generally good (outside of geothermal areas)

Questions?

Ground-Water Information Center:

<http://mbmggwic.mtech.edu/>

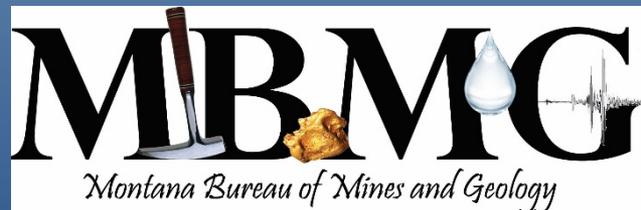
Montana Bureau of Mines and Geology:

<http://www.mbmgs.mtech.edu/>

John LaFave

496-4306

jlafave@mtech.edu

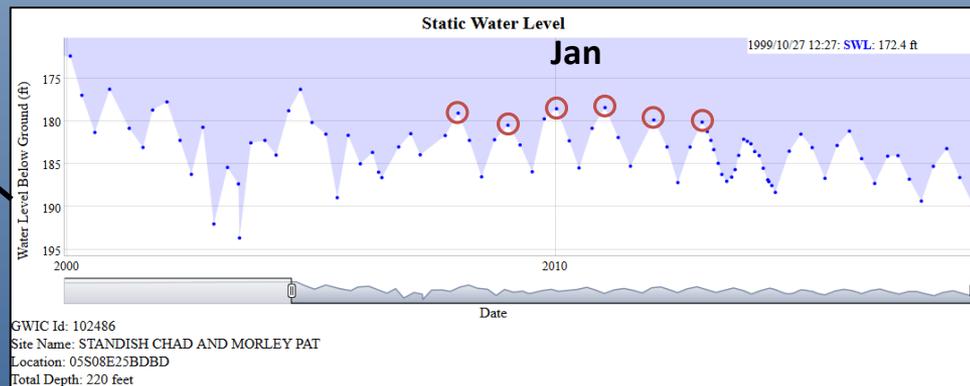
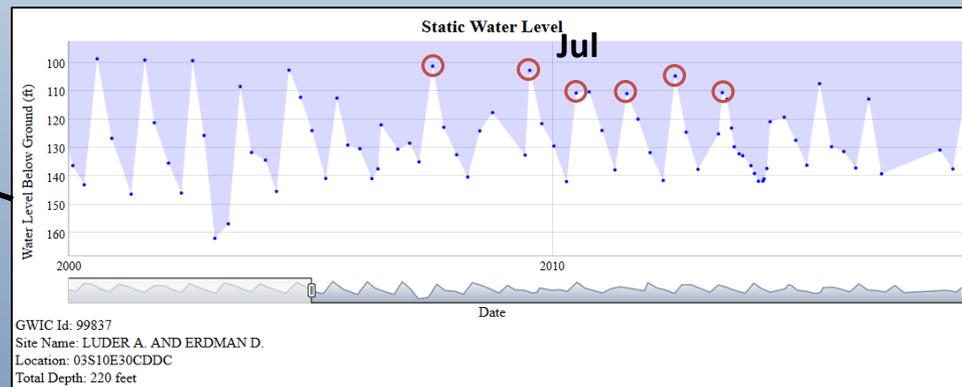


Monitoring Network

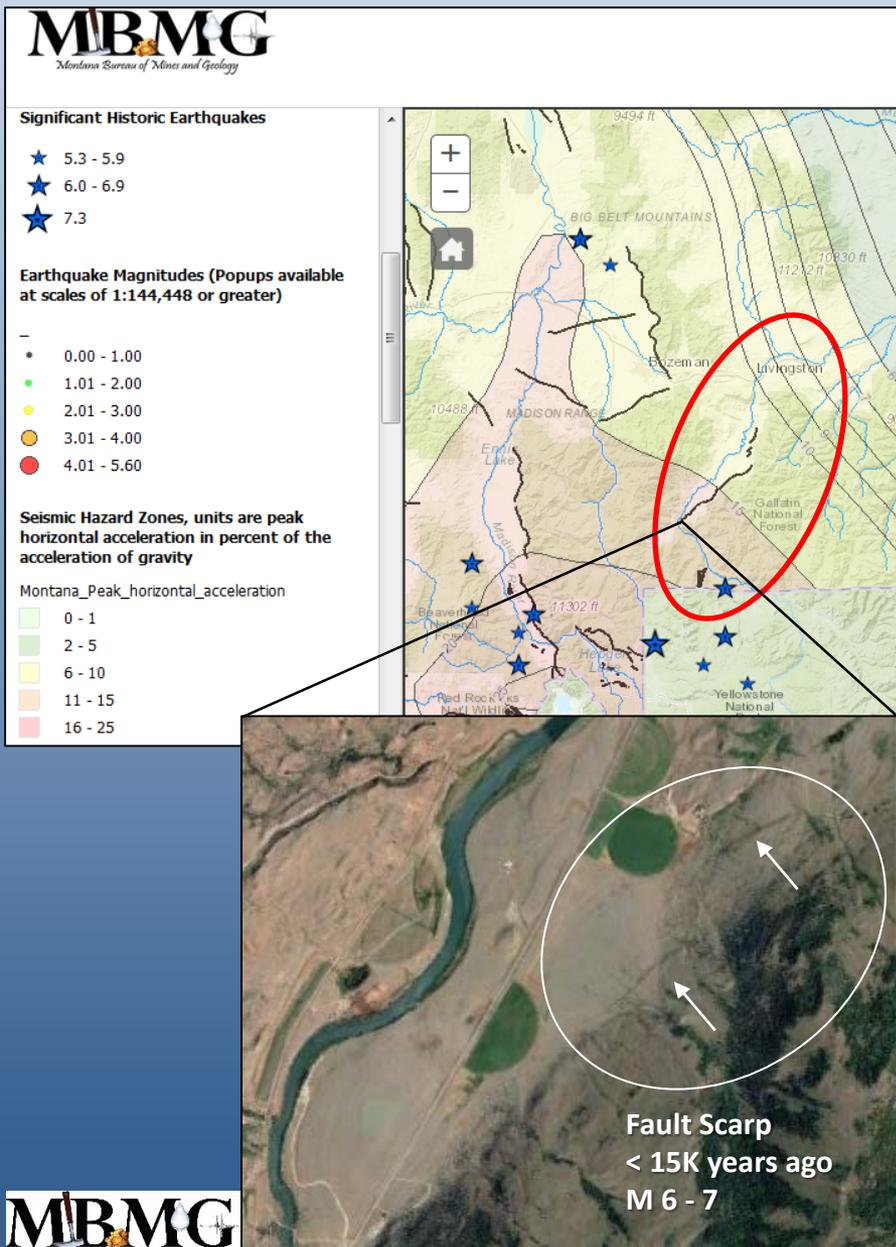
● monitored well

Upper Yellowstone Watershed Groundwater level trends

Seasonal lag



Upper Yellowstone Watershed Setting



- Intermontane Basin - ~ 1 M acres
- Topographic Relief - >10,000 to 4,200 ft
- Framed by Gallatin and Absaroka Ranges
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- Valley floor <1 to 8 miles wide
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 - Controlled GW Area
- Seismic Features