

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

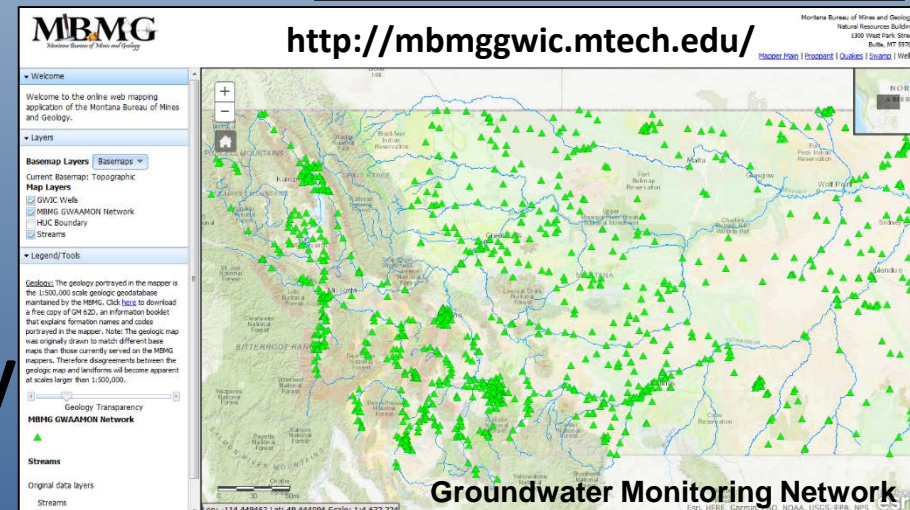
a department of Montana Tech

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

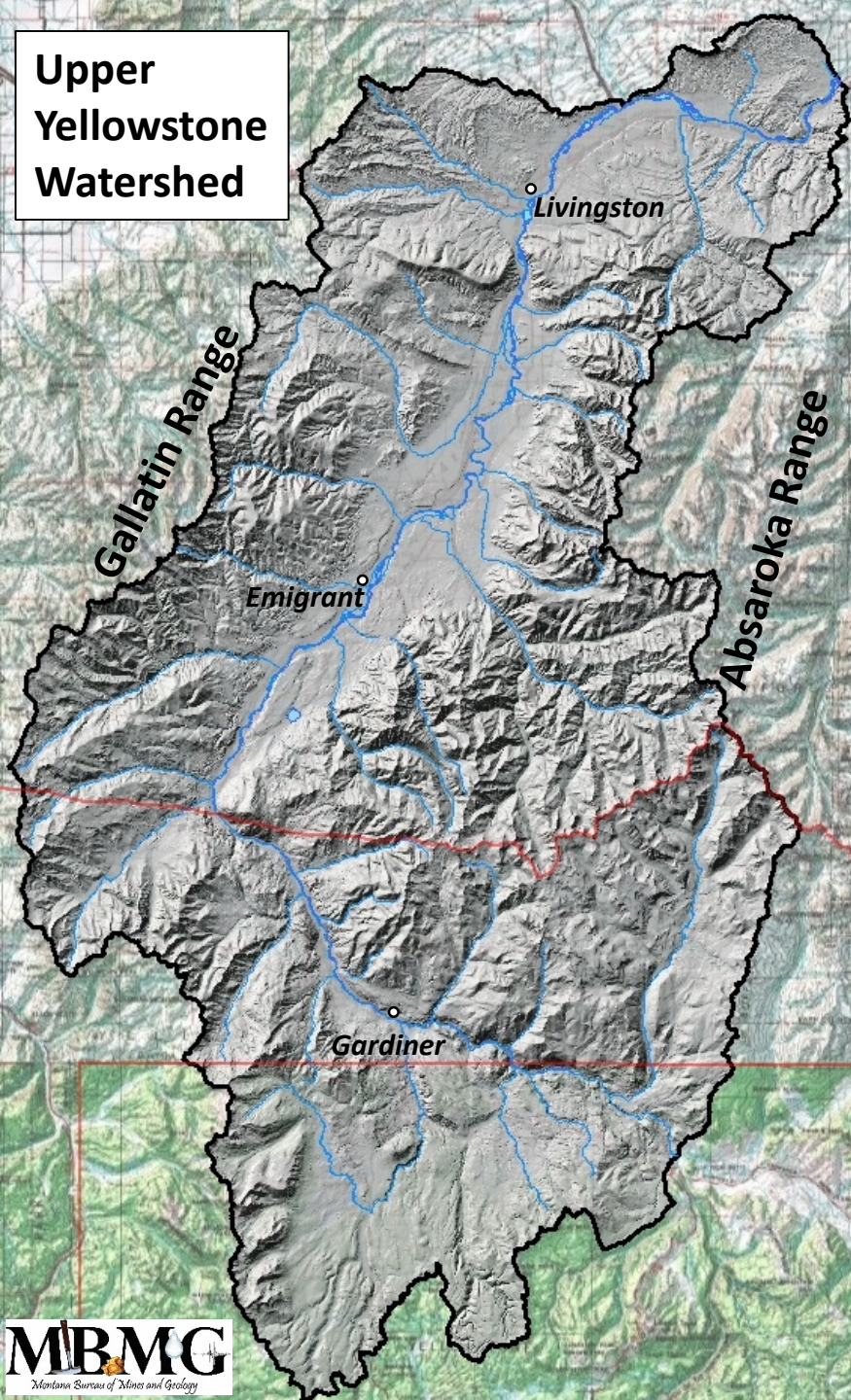
Ground Water Information Center

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

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



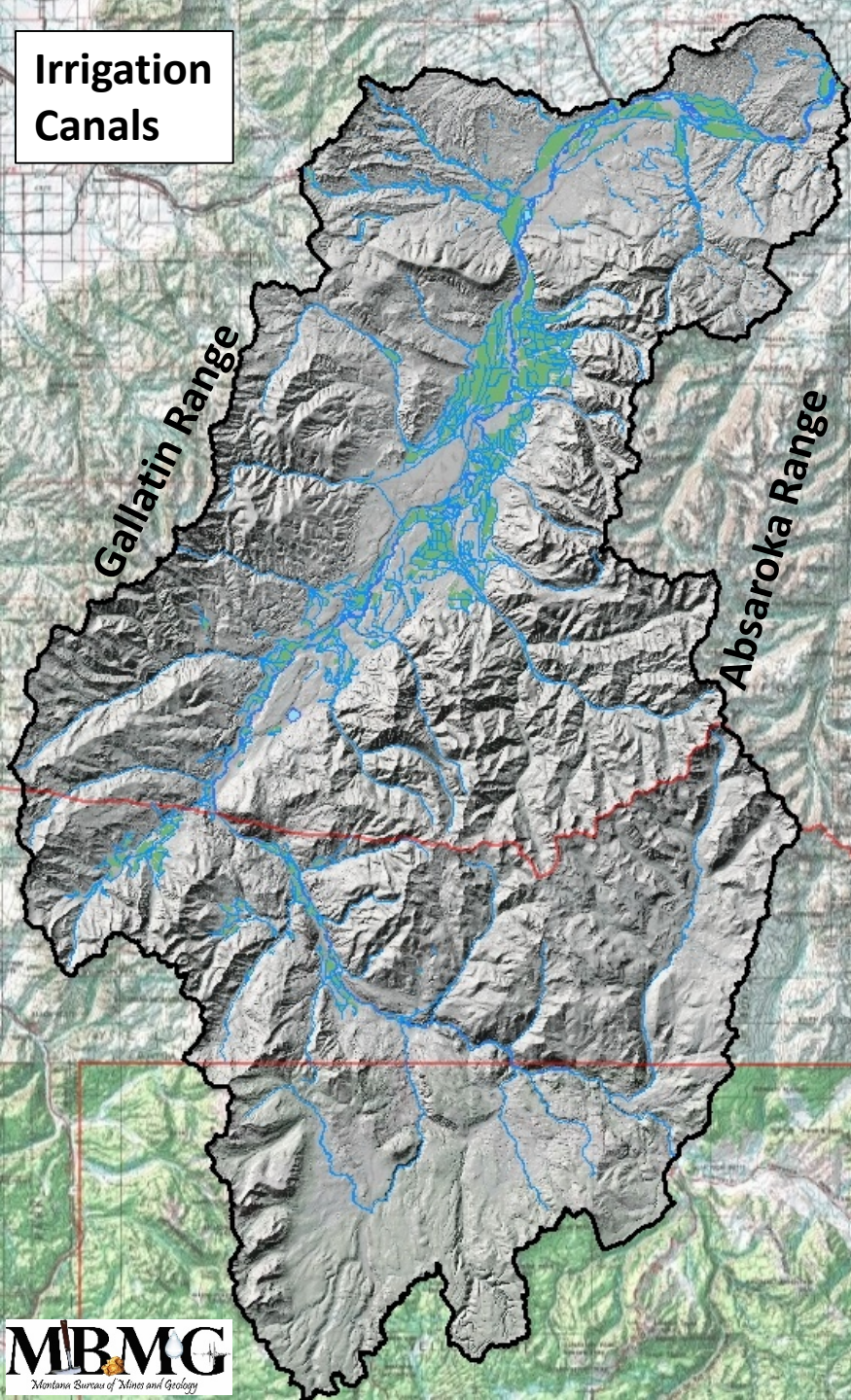
Upper Yellowstone Watershed



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



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- Irrigation and irrigation canals
 - 62K acres - 400+ mi canals

**Abandoned/
inactive
mines**

Trail Creek

Gallatin Range

Absaroka Range

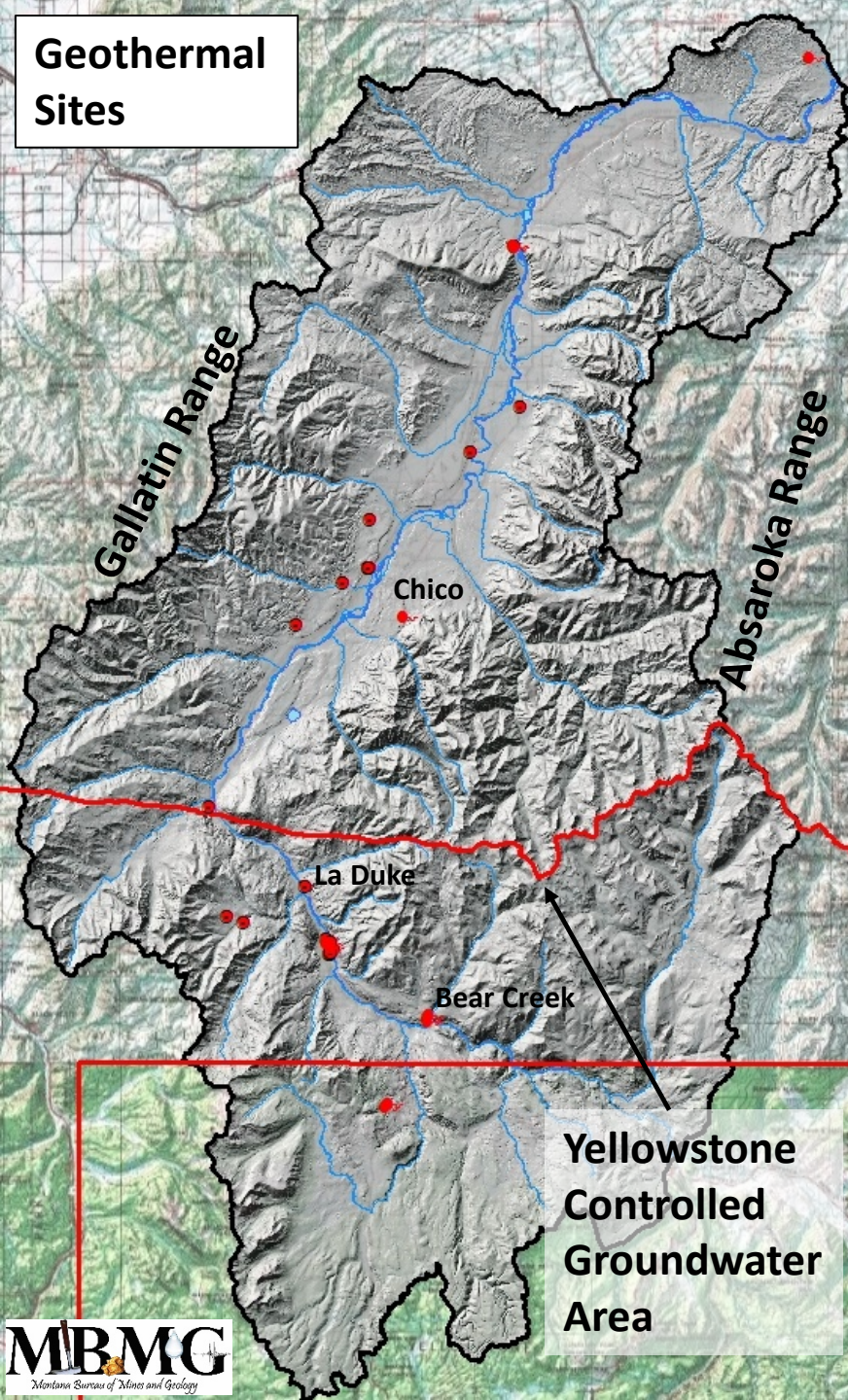
Emigrant
(Lucky)

Jardine
(Crevice)

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- Irrigation and irrigation canals
- Mining -
 - Emigrant: Au, Ag, Cu, Mo, Pb
 - Jardine: Au, W, Ag, Cu, Pb
 - Trail Creek: coal

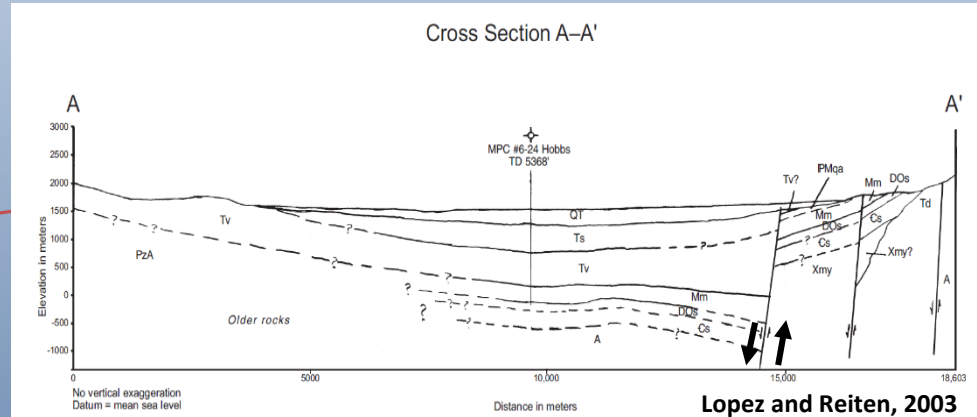
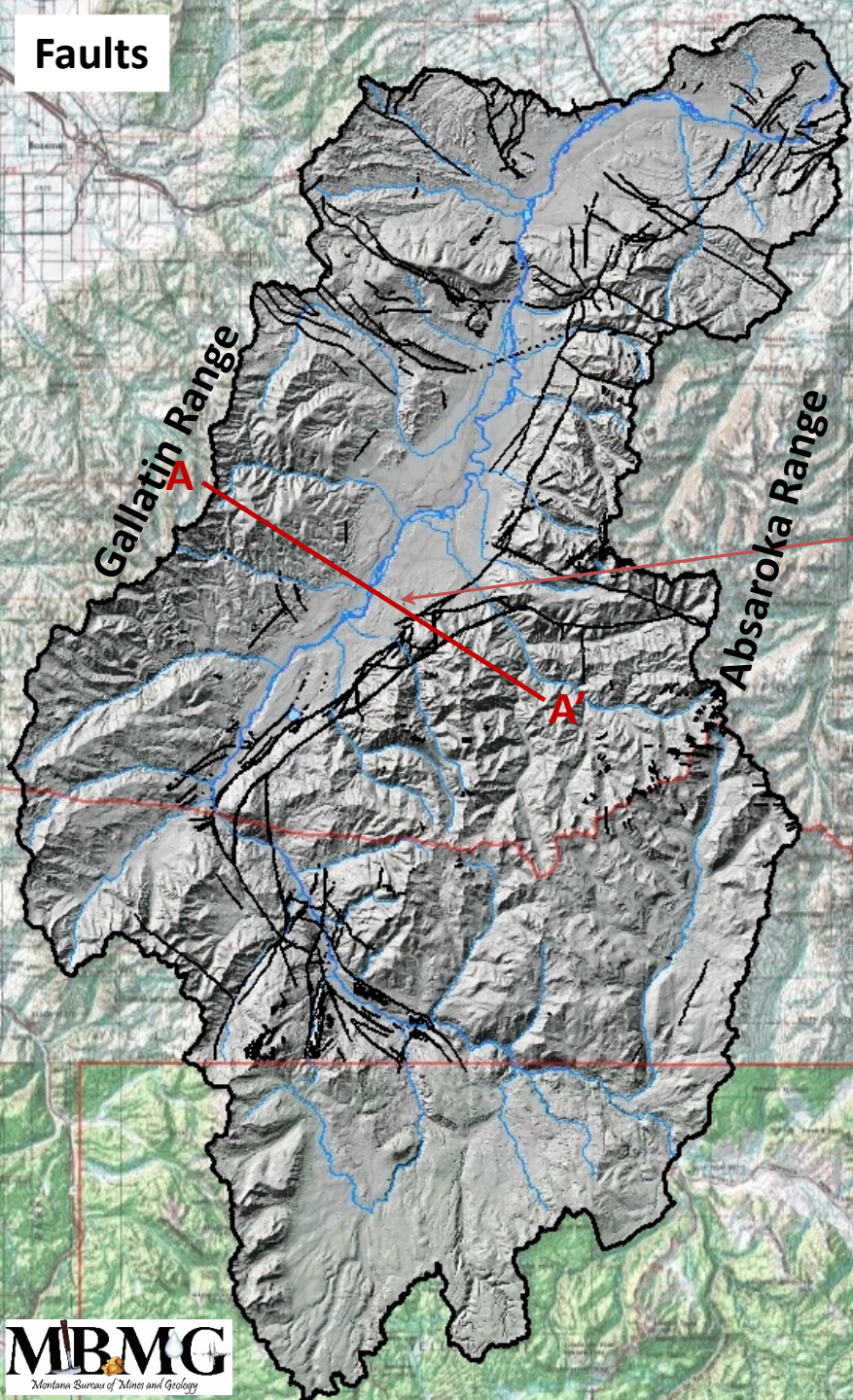
Geothermal Sites



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- Geothermal features
 - Controlled GW Area

Upper Yellowstone Watershed Structural Basin







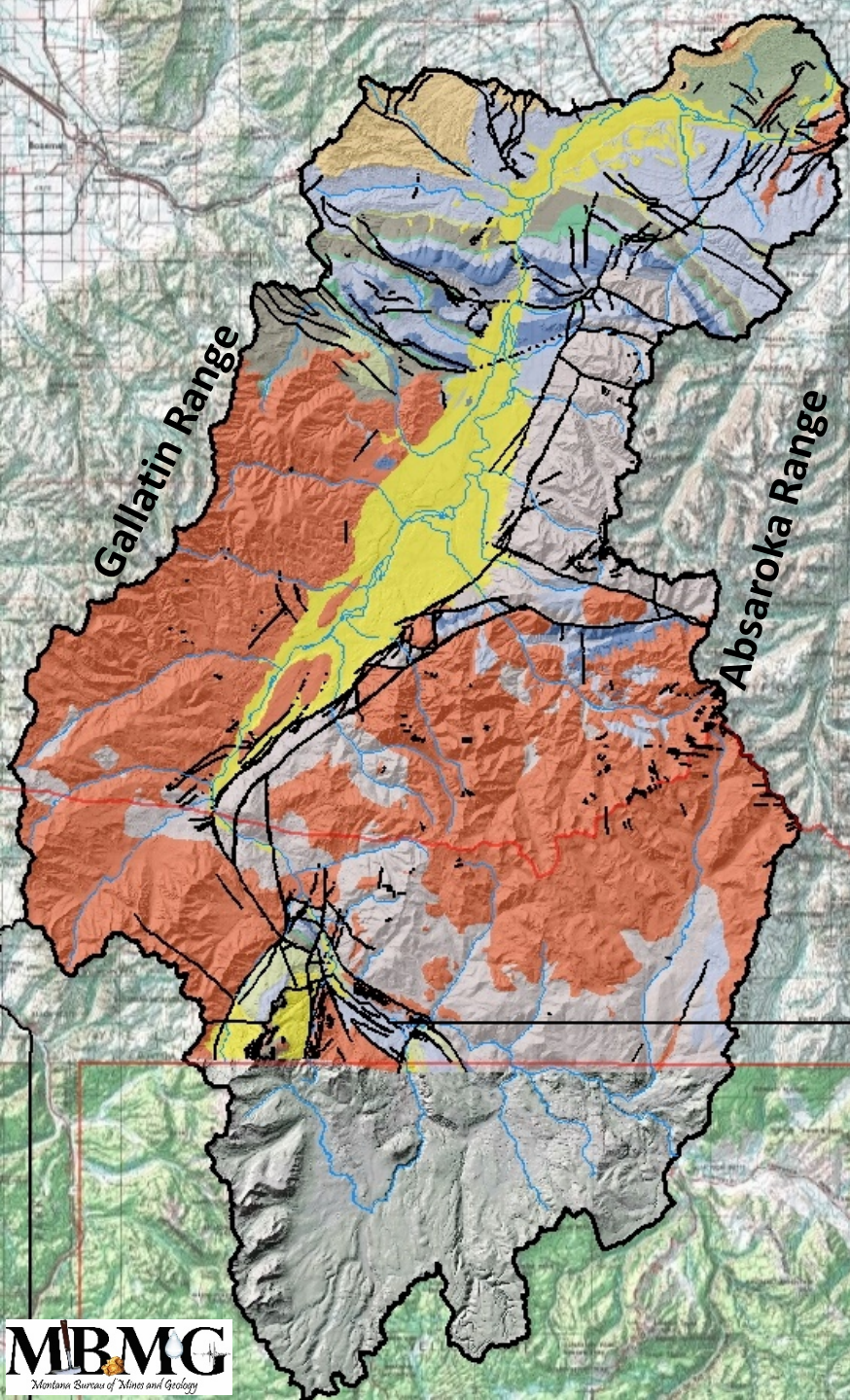
- Series of 'range-front' faults
 - Down dropped valley bottom
 - Accumulation of 'basin-fill' sediments
 - Uplifted Mtn ranges (Absaroka Range)

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

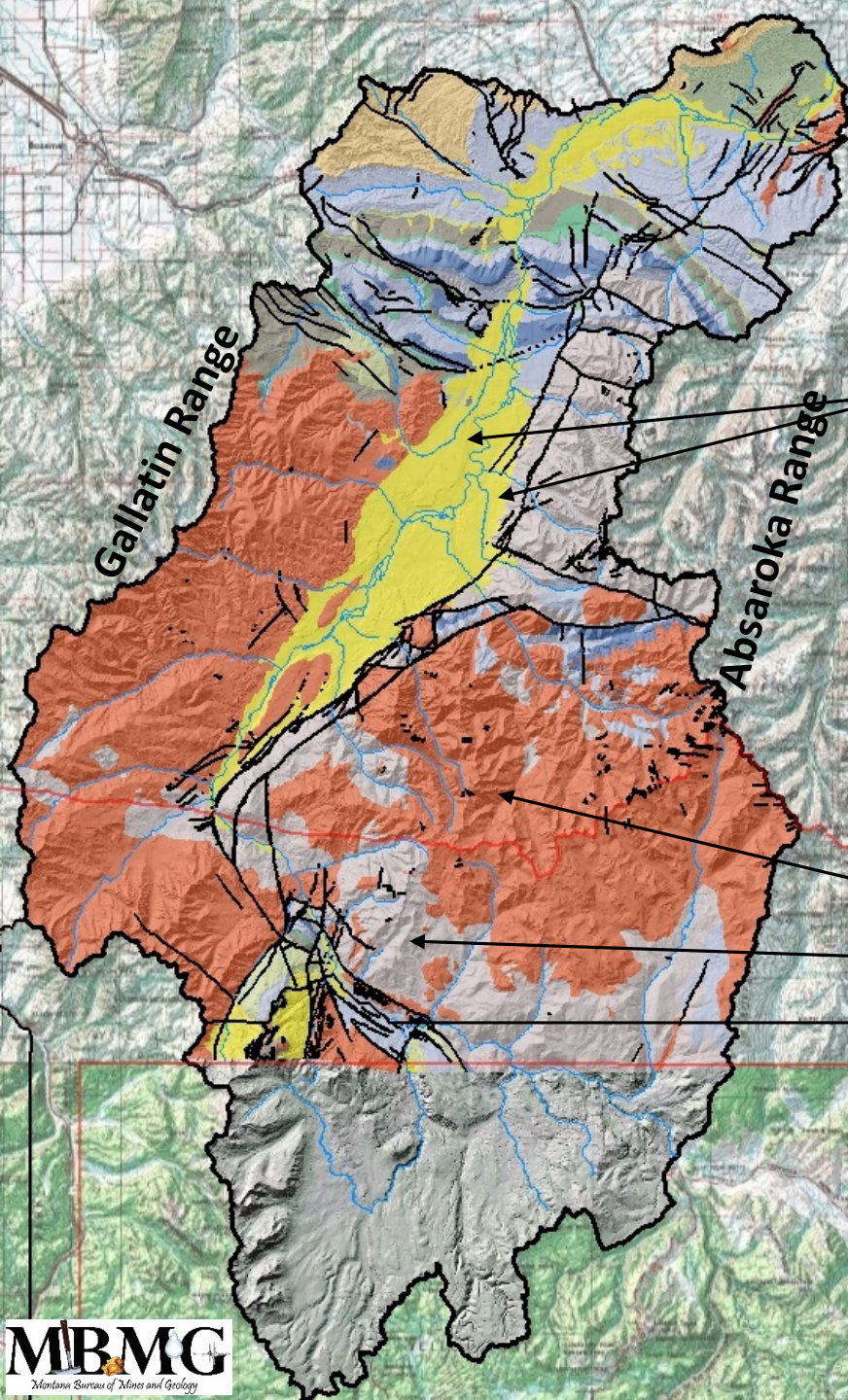
 Basin Fill and Alluvium (Valley bottom)




2) Fractured Rock

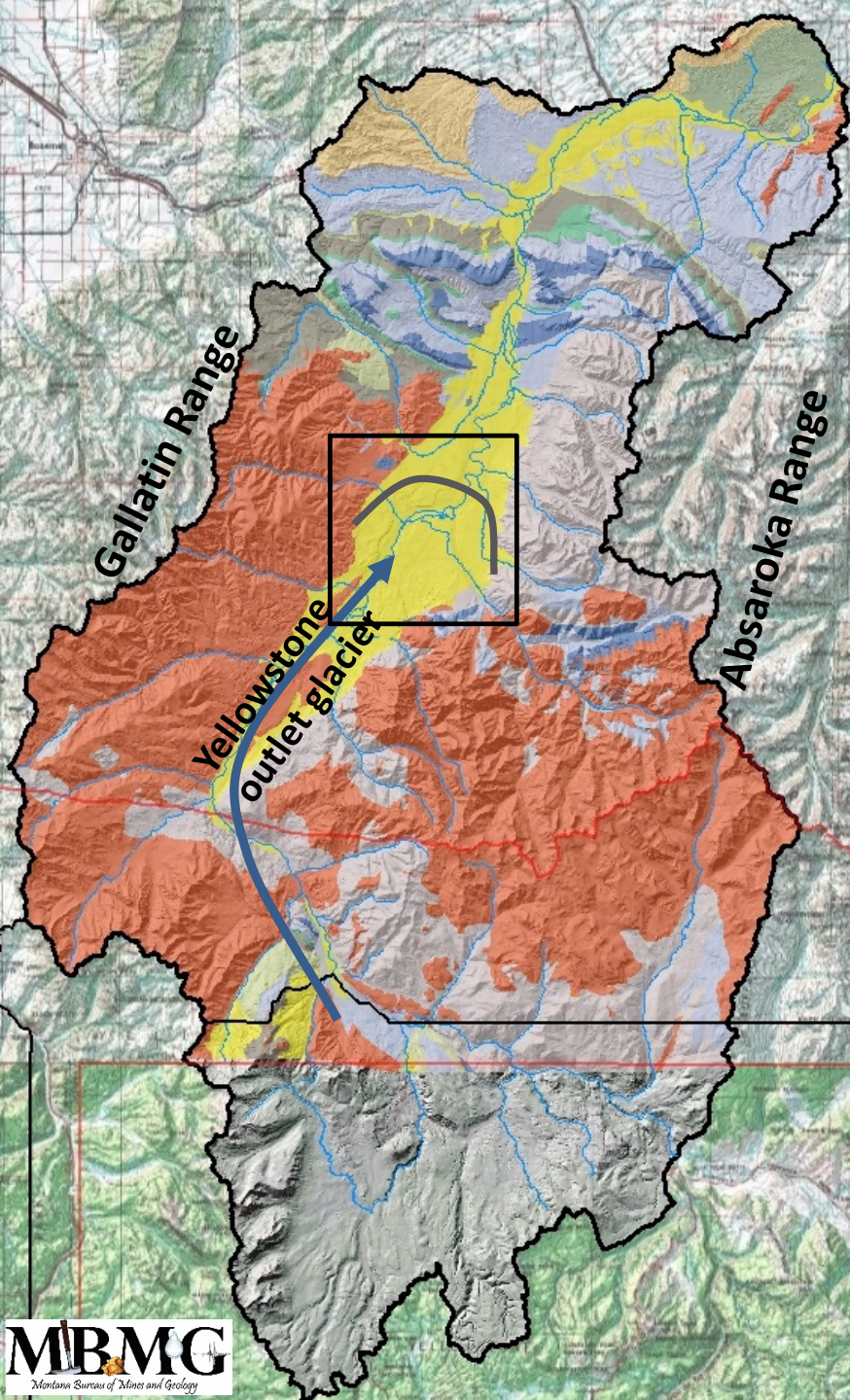
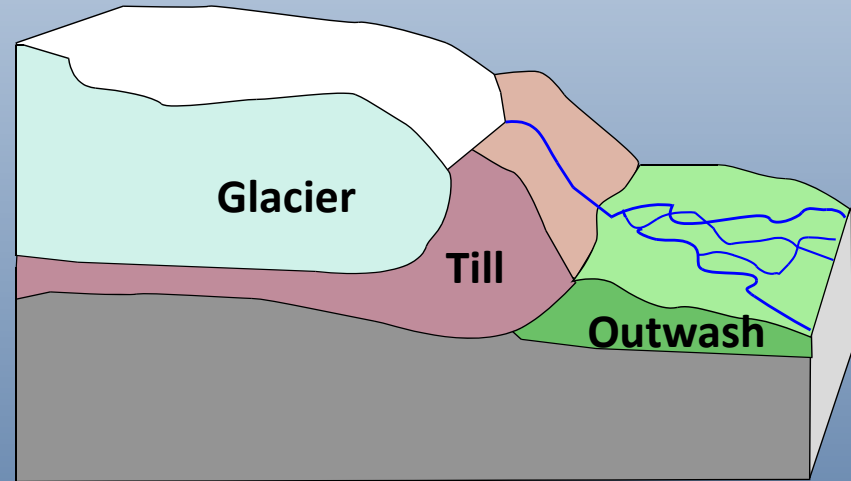
 Tertiary Volcanic Rocks (Mountains)

 PreC Meta-sedimentary Rocks (Mountains – east)



Upper Yellowstone Watershed Glacial Geology

 Quaternary Basin Fill and Alluvium



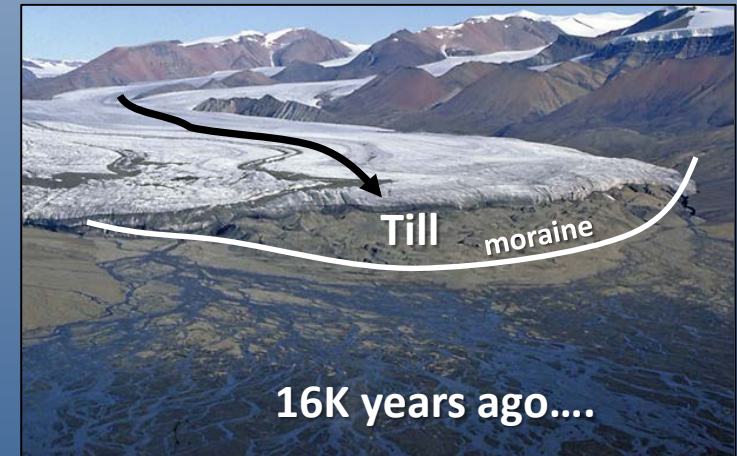
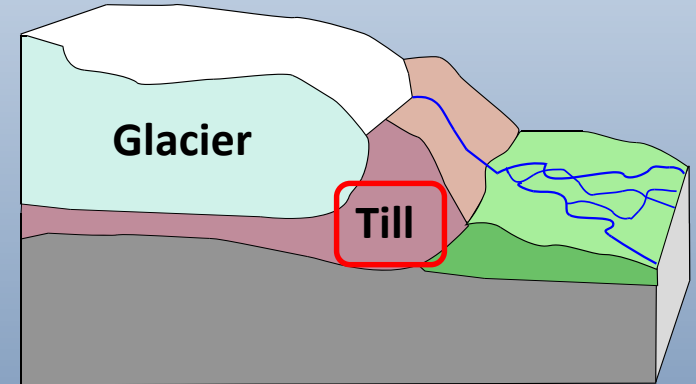
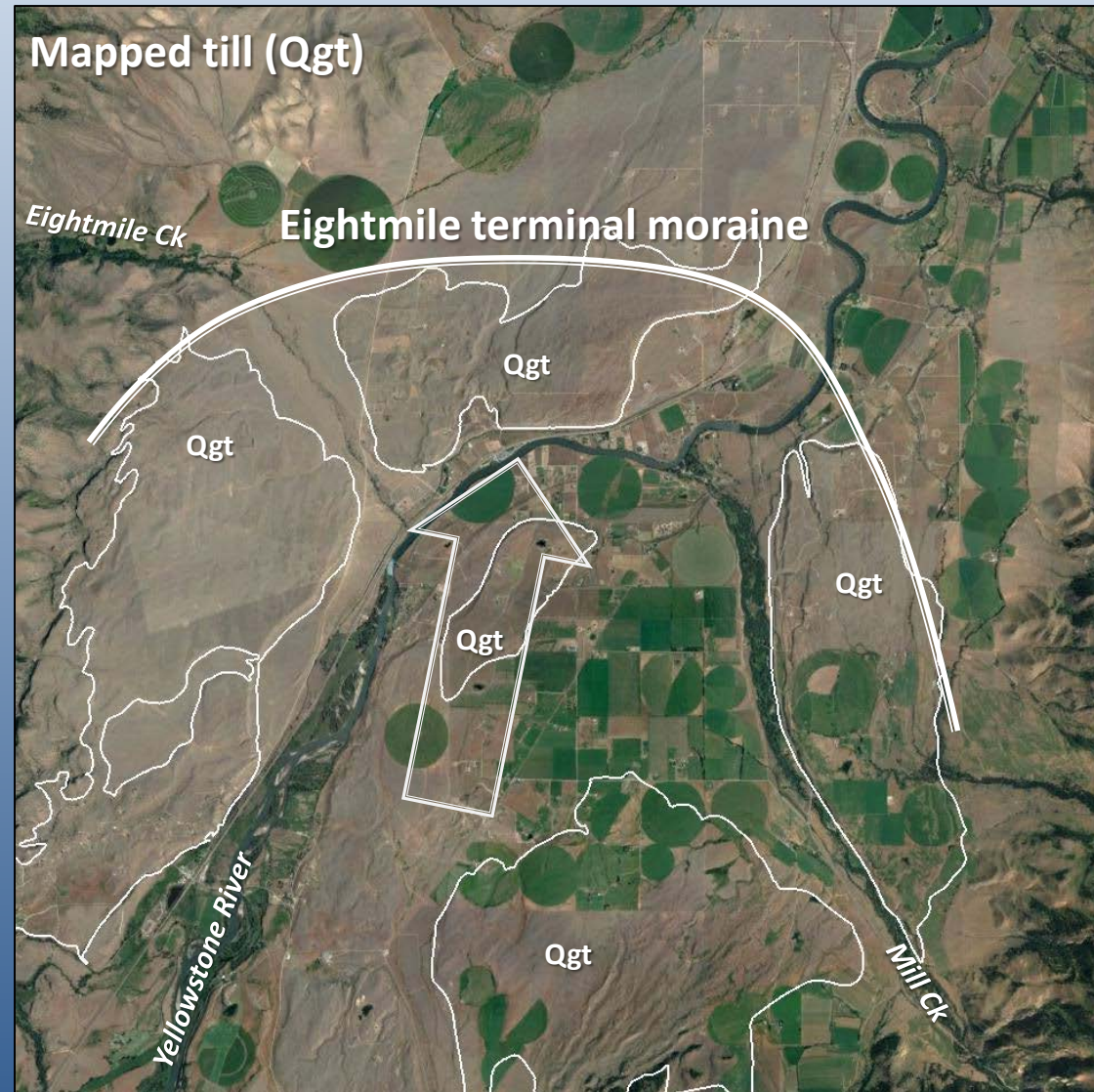
Upper Yellowstone Watershed Glacial Geology

Eightmile moraine and outwash fan



Upper Yellowstone Watershed Glacial Geology

Eightmile moraine and outwash fan

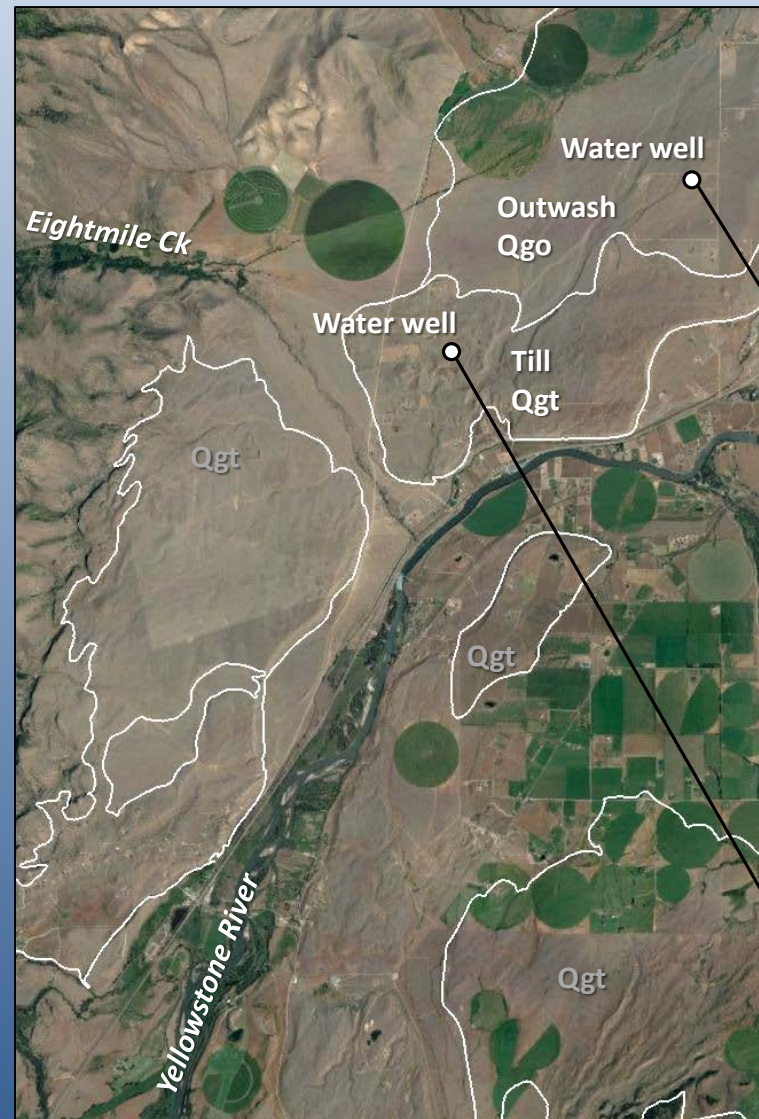


(Lopez and Reiten, 2003)

Upper Yellowstone Watershed

Glacial Geology

Eightmile moraine and outwash fan



MONTANA WELL LOG REPORT

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

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.

Site Name: STROHSZHEIN, SHAWN
GWIC id: 222133

Section 1: Well Owner(s)
1) STROHSZHEIN, SHAWN (MAIL)
PO BOX 830
WRIGHT WY 82732 [08/19/2005]

Section 2: Location
Township: 04N, Range: 09E, Section: 31, Quarter Sections: SW¼ NW¼ NW¼, County: Park, Geocode: 45.44933, -110.66966, Geomethod: NAV-GPS, Datum: 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
* During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.

Section 9: Well Log Geologic Source
Unassigned

From	To	Description
0	240	SAND, GRAVEL, & BOULDER



MONTANA WELL LOG REPORT

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

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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: 05S, Range: 08E, Section: 2, Quarter Sections: NE¼ NE¼, County: Park, Geocode: 45.436447, -110.694819, Geomethod: TRS-SEC, Datum: NAD83, Ground Surface Altitude: , Ground Surface Method: , Datum Date: , Addition: PARADISE RANCH II, Block: 33-18, 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, March 15, 1991

Section 6: Well Construction Details

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
* During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.

Section 9: Well Log Geologic Source
Unassigned

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

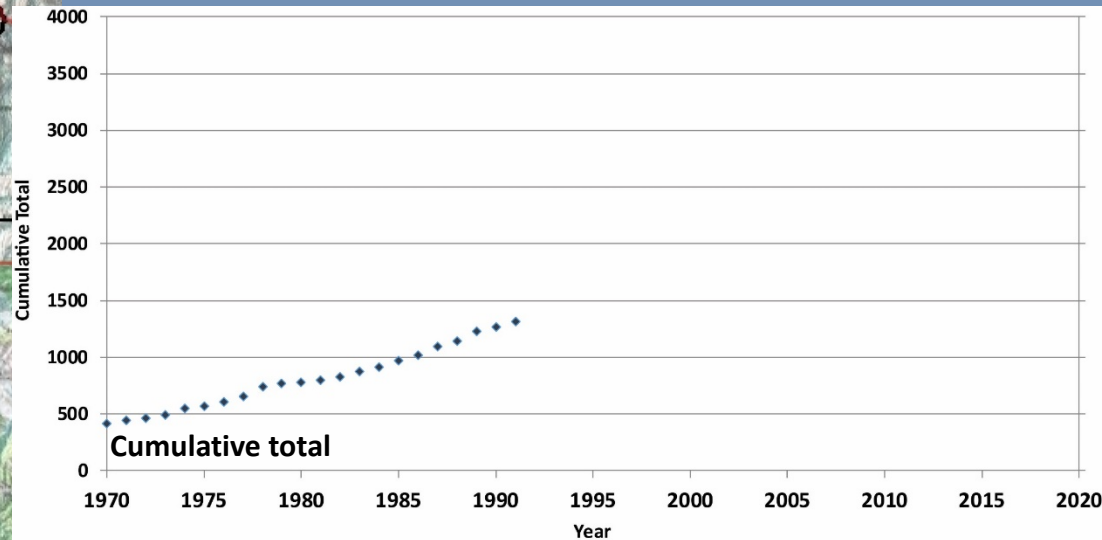
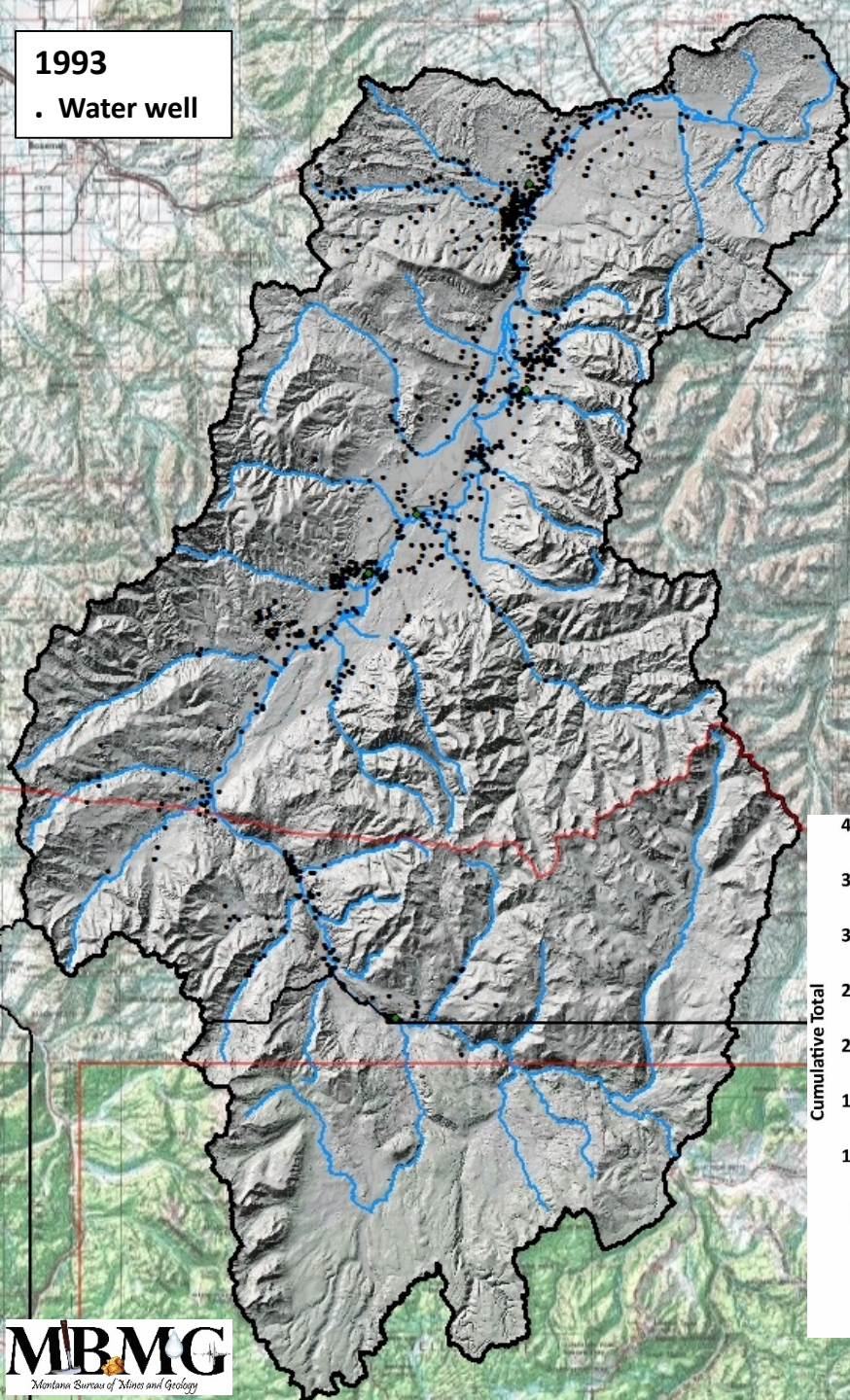


(Lopez and Reiten, 2003)

1993

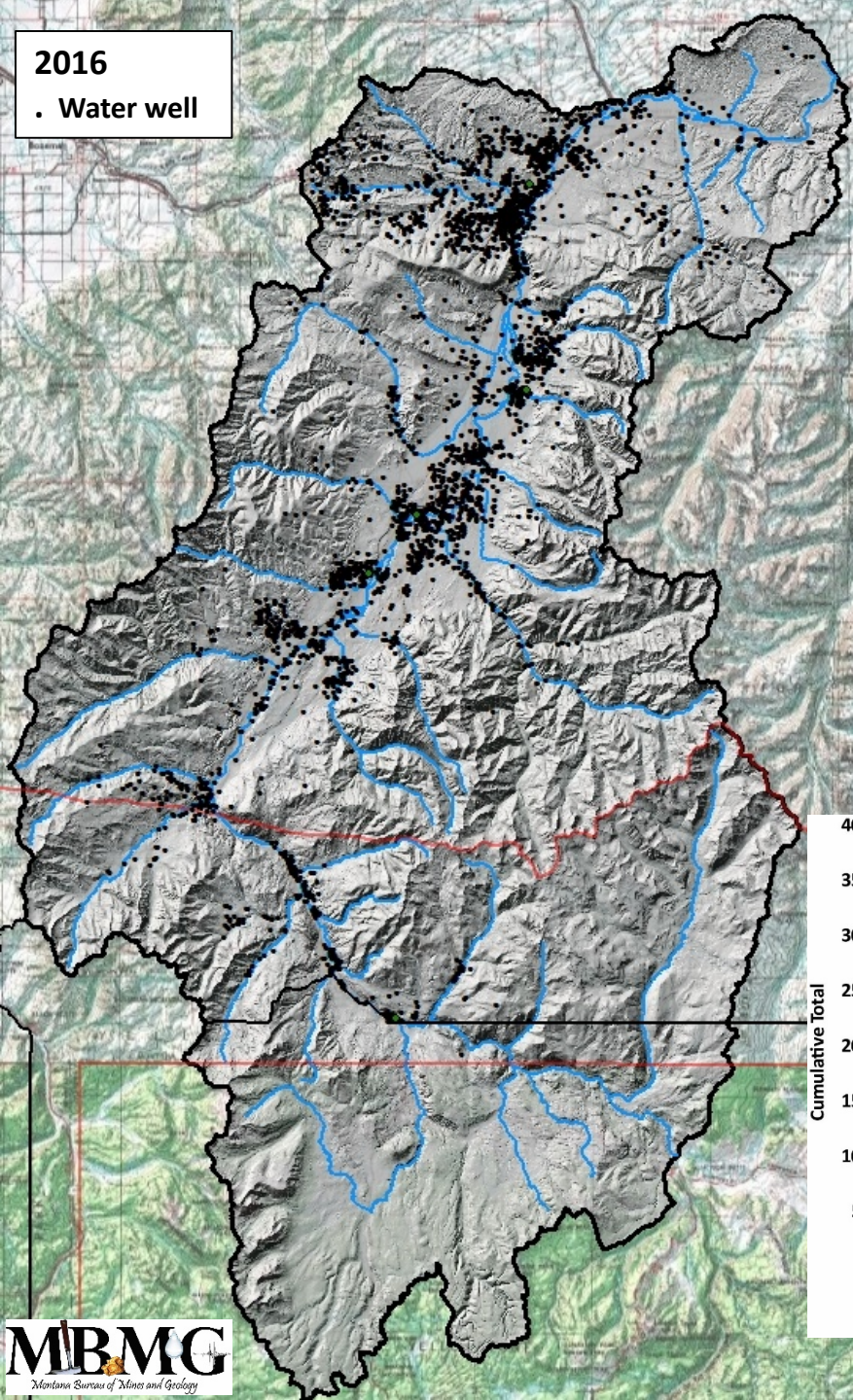
• Water well

Upper Yellowstone Watershed Groundwater Development

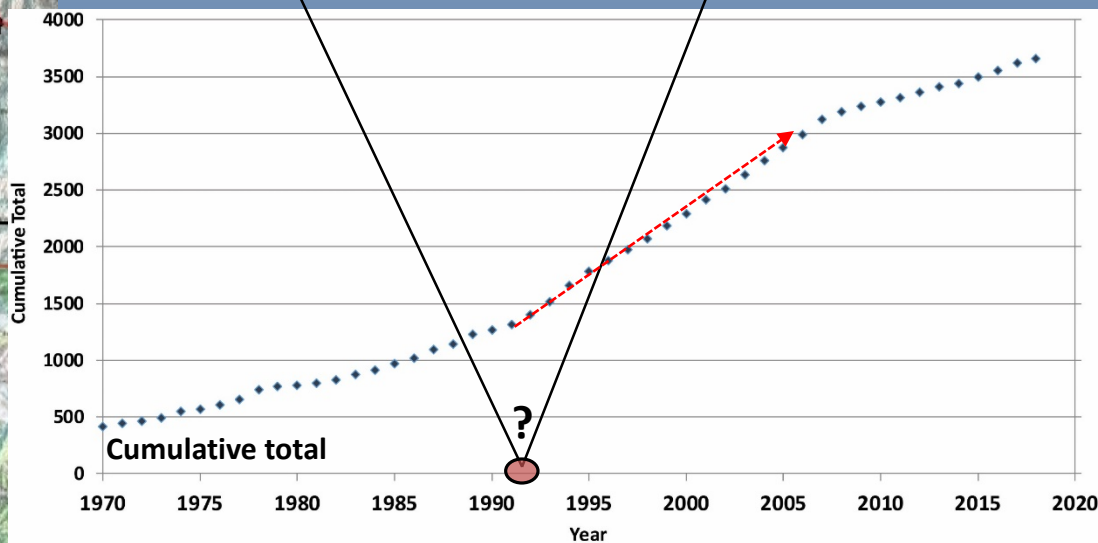
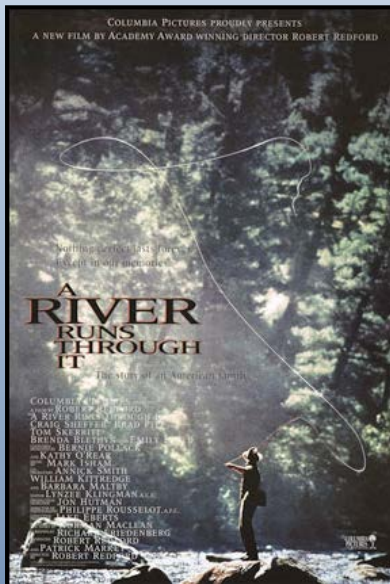


2016

• Water well



Upper Yellowstone Watershed Groundwater Development



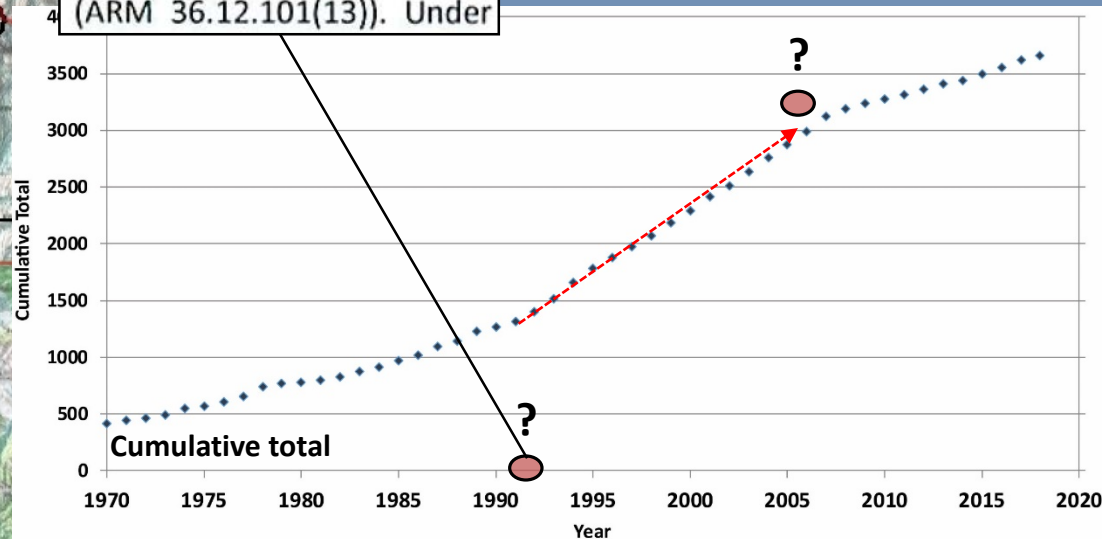
2016

• 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



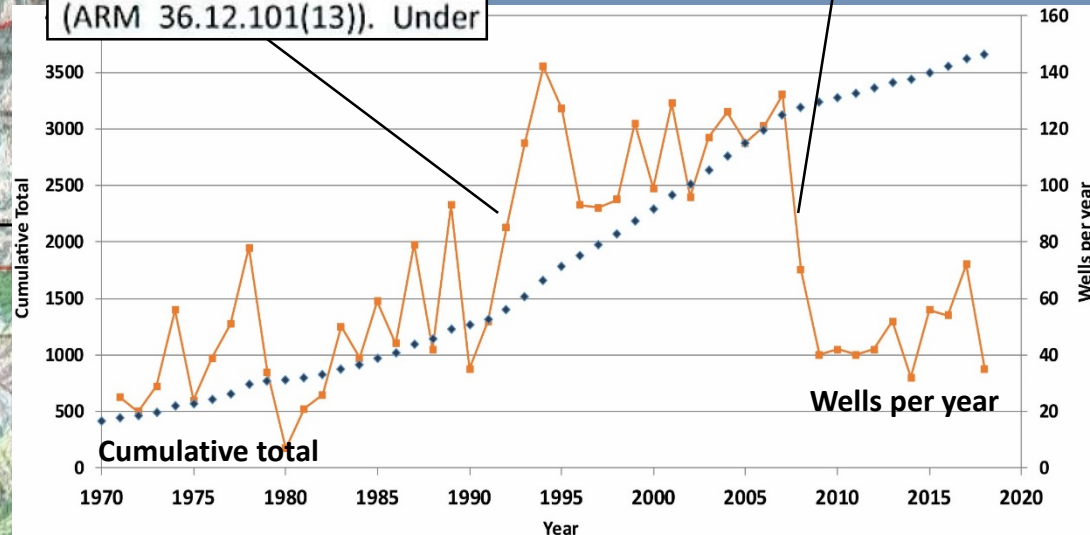
2016

• Water well

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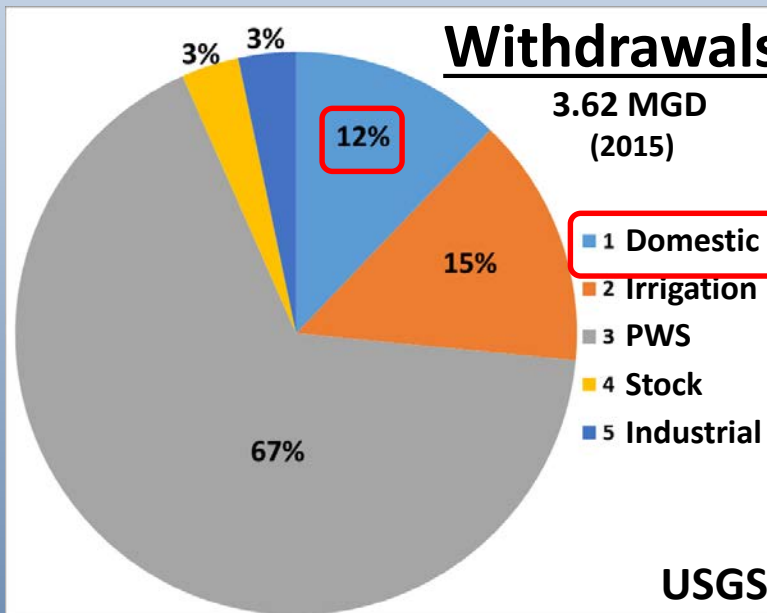


• Water well

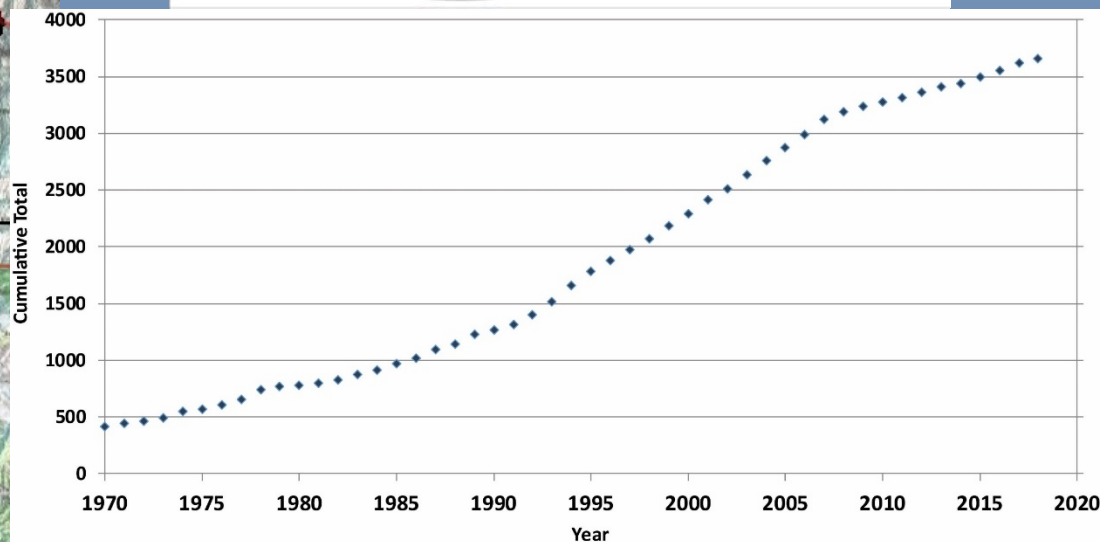
Upper Yellowstone Watershed Groundwater Use

Withdrawals

3.62 MGD
(2015)



USGS

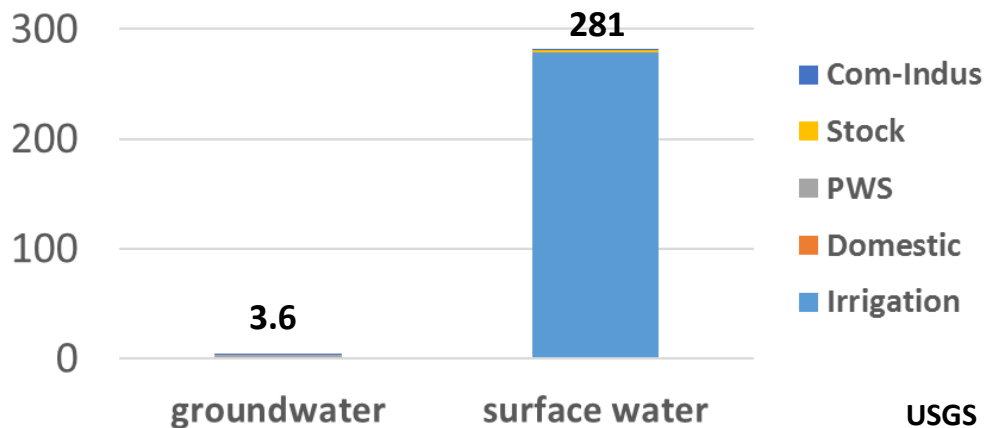


• Water well

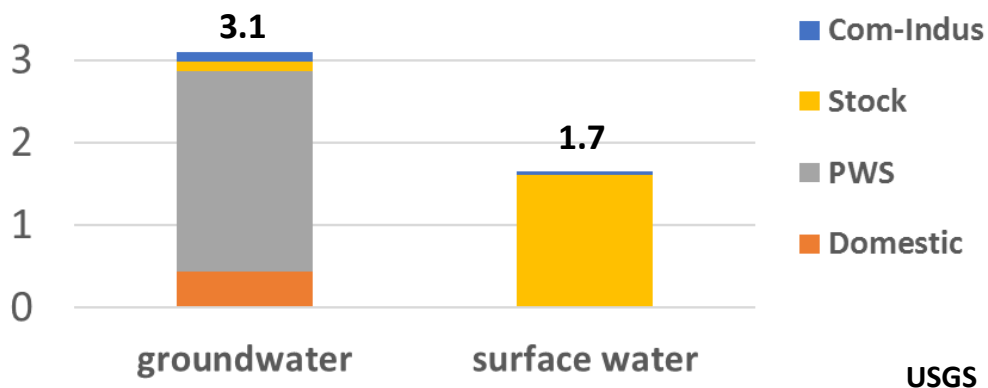
Upper Yellowstone Watershed Groundwater – Surface Water Use

Volumetrically - minor

Park Co. Water Withdrawals (MGD) - 2015



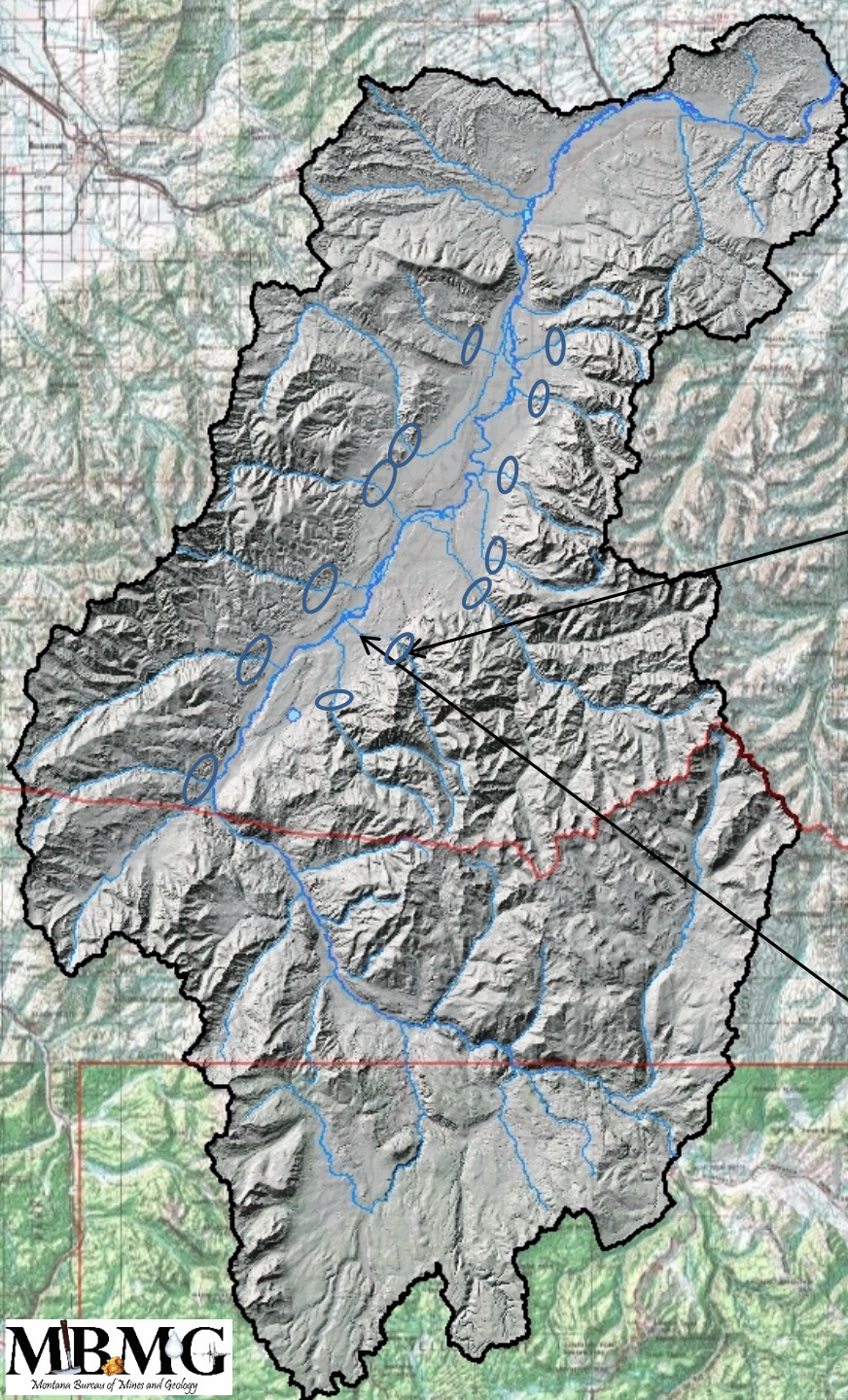
Park Co. Water Withdrawals (MGD) - 2015
(non irrigation)



Upper Yellowstone Watershed

Groundwater recharge

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



2.5 mi



Upper Yellowstone Watershed

Groundwater recharge

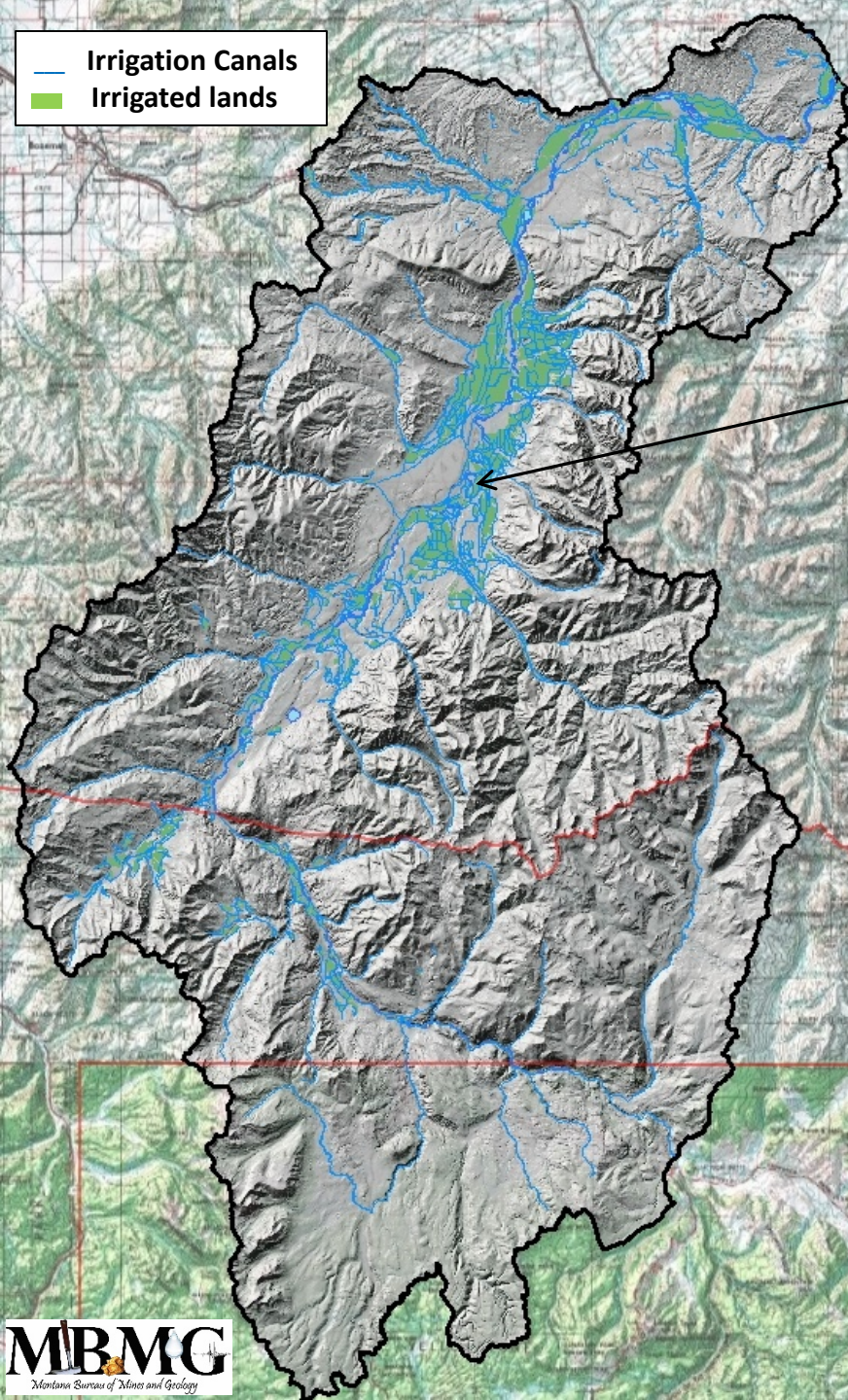
- Precipitation*
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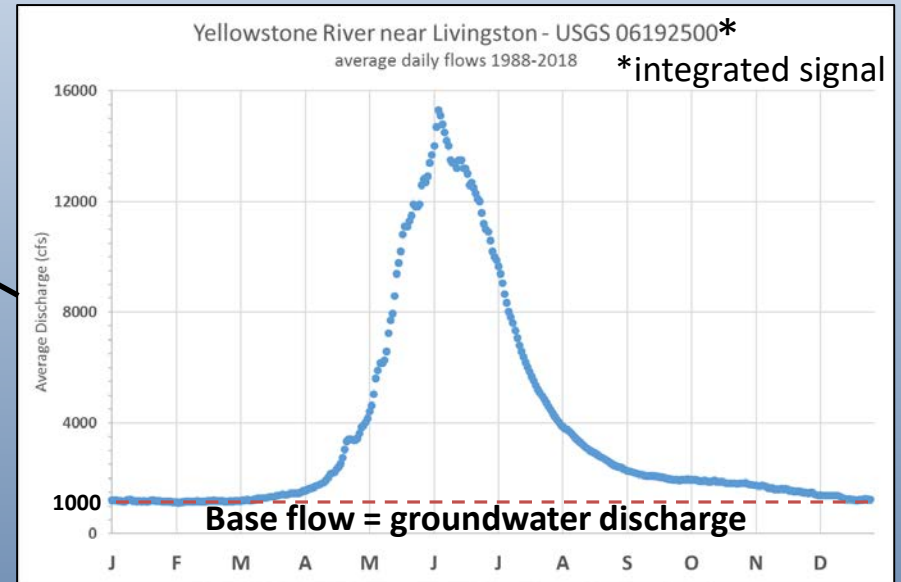
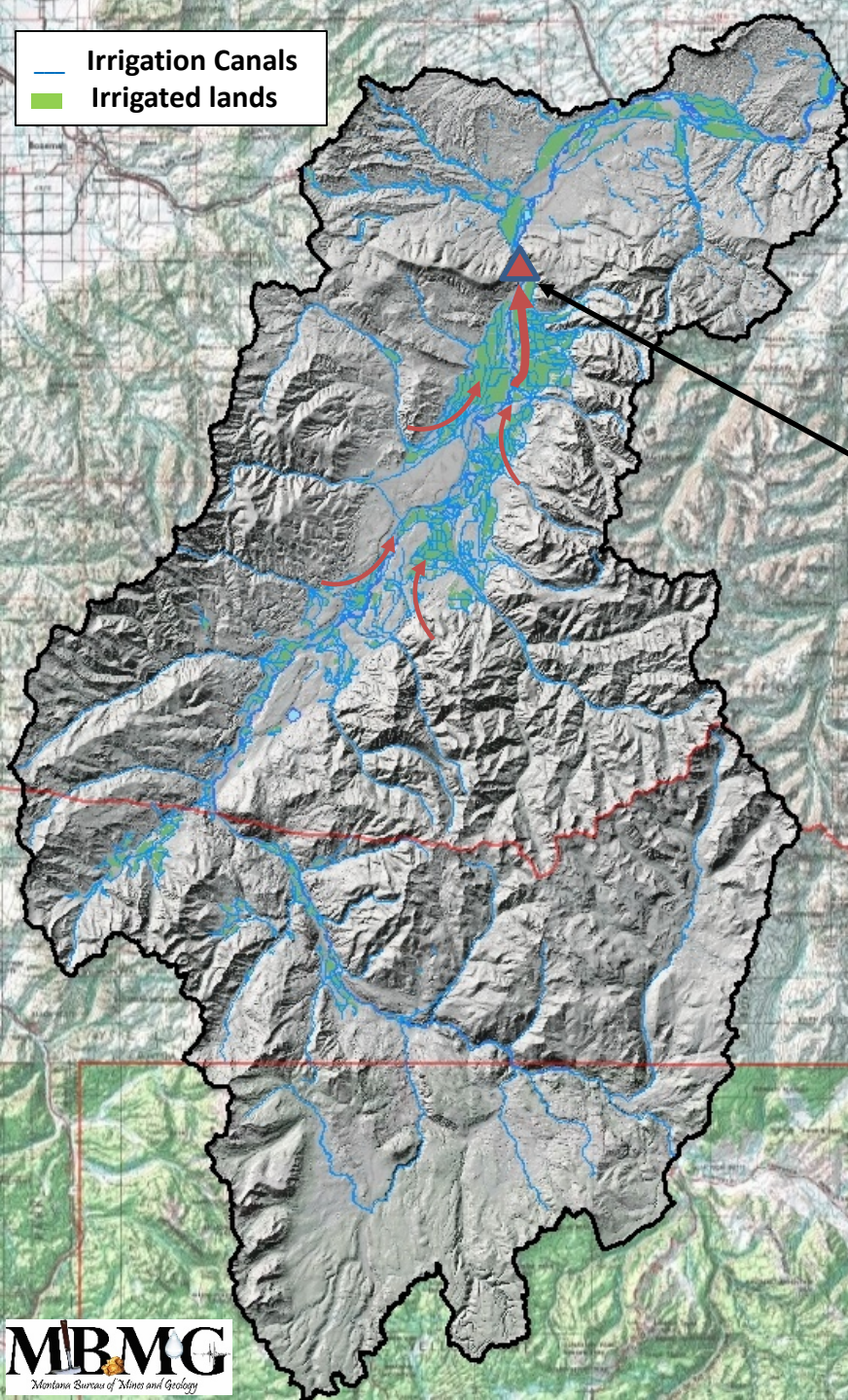
Park Co. (USGS 2015)

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

~ 5 ft of water per acre



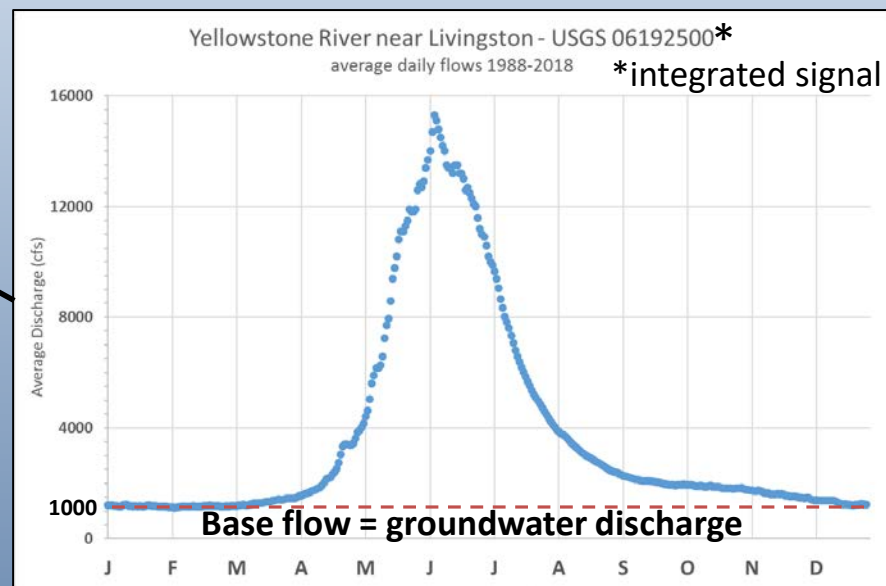
Upper Yellowstone Watershed Groundwater Discharge



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

• Water well

Upper Yellowstone Watershed Groundwater Discharge



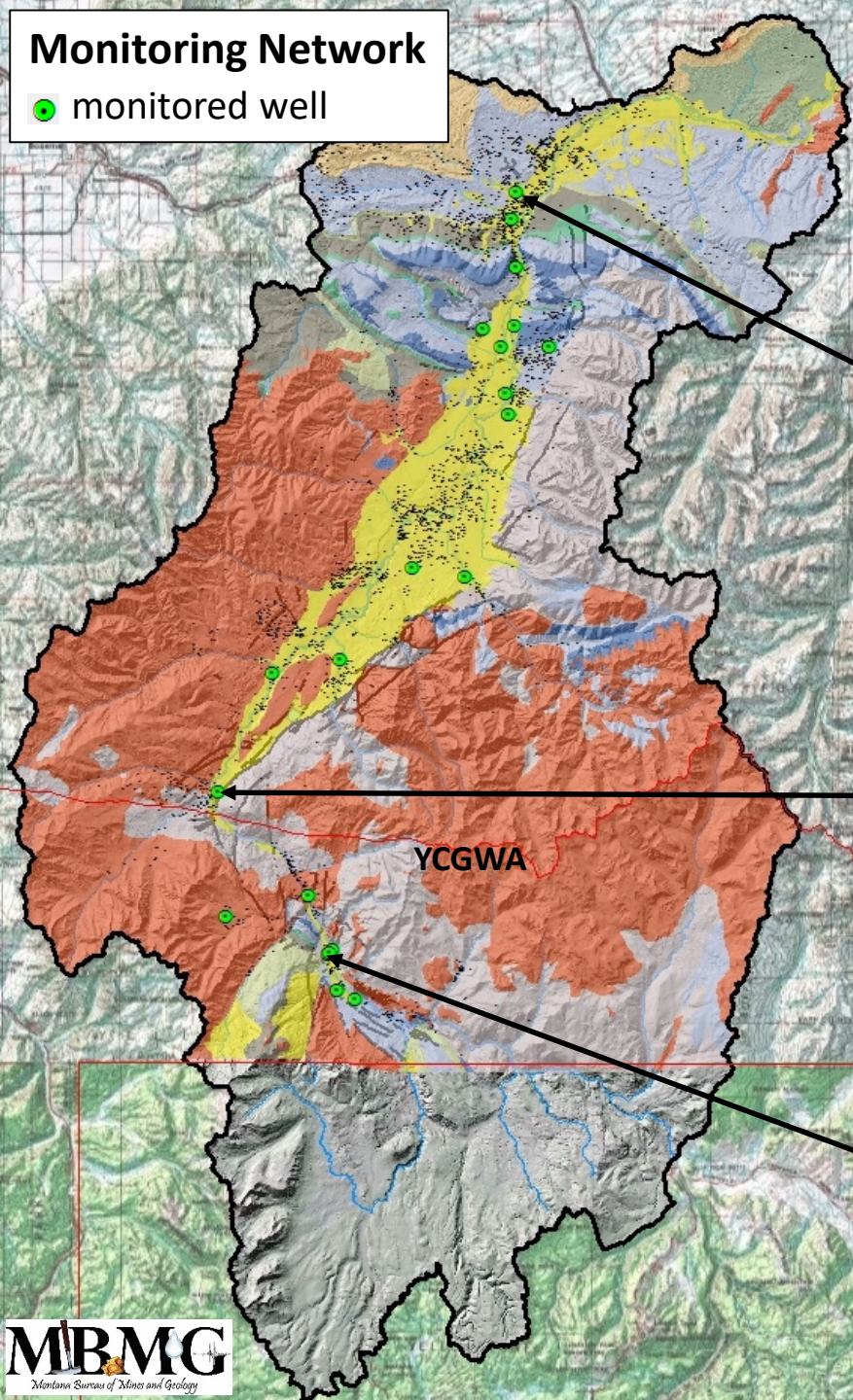
1) 1000 cfs = 1983 ac-ft/day = **724,000 ac-ft/yr**



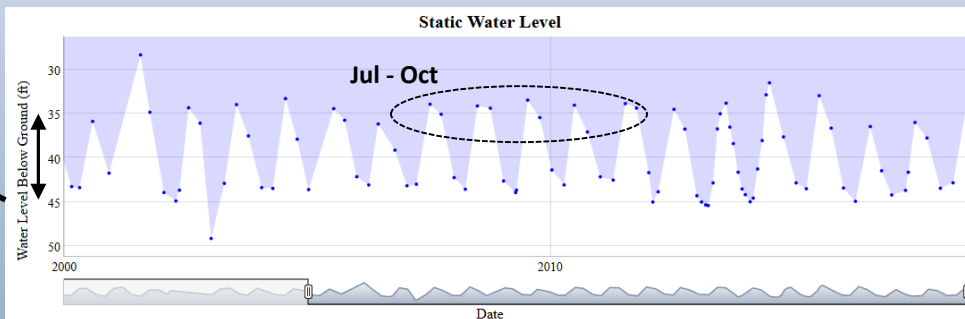
2) GW Withdrawals
3.8 MGD = 11 ac-ft/day
= **4,000 ac-ft/yr**

Monitoring Network

● monitored well

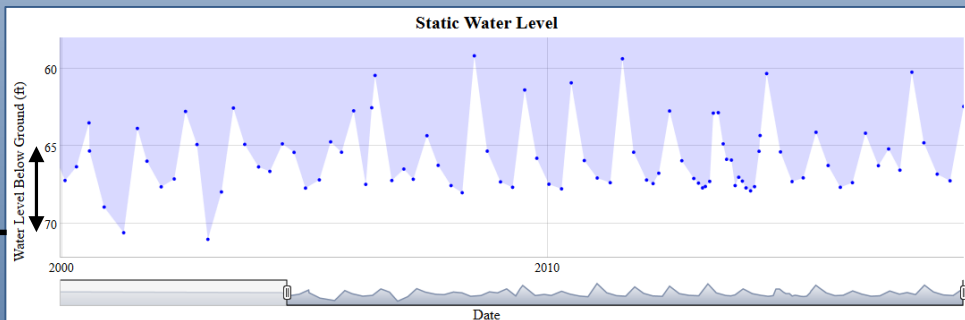


Upper Yellowstone Watershed Groundwater level trends



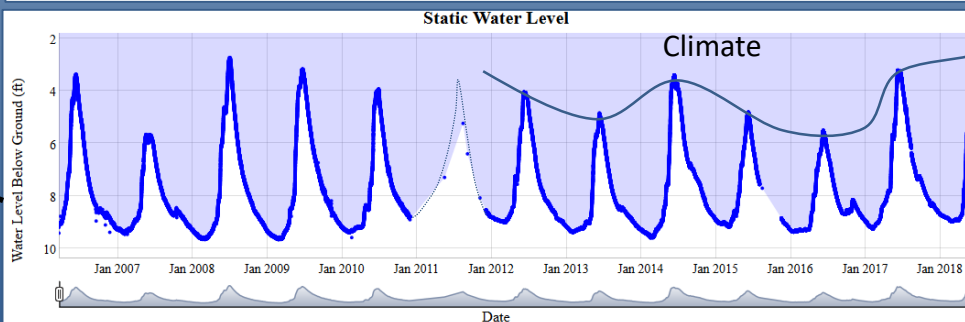
GWIC Id: 96983
Site Name: MONTANA FWP - LIVINGSTON FISHERIES OFFICE
Location: 02S09E14DDDB
Total Depth: 63 feet

“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

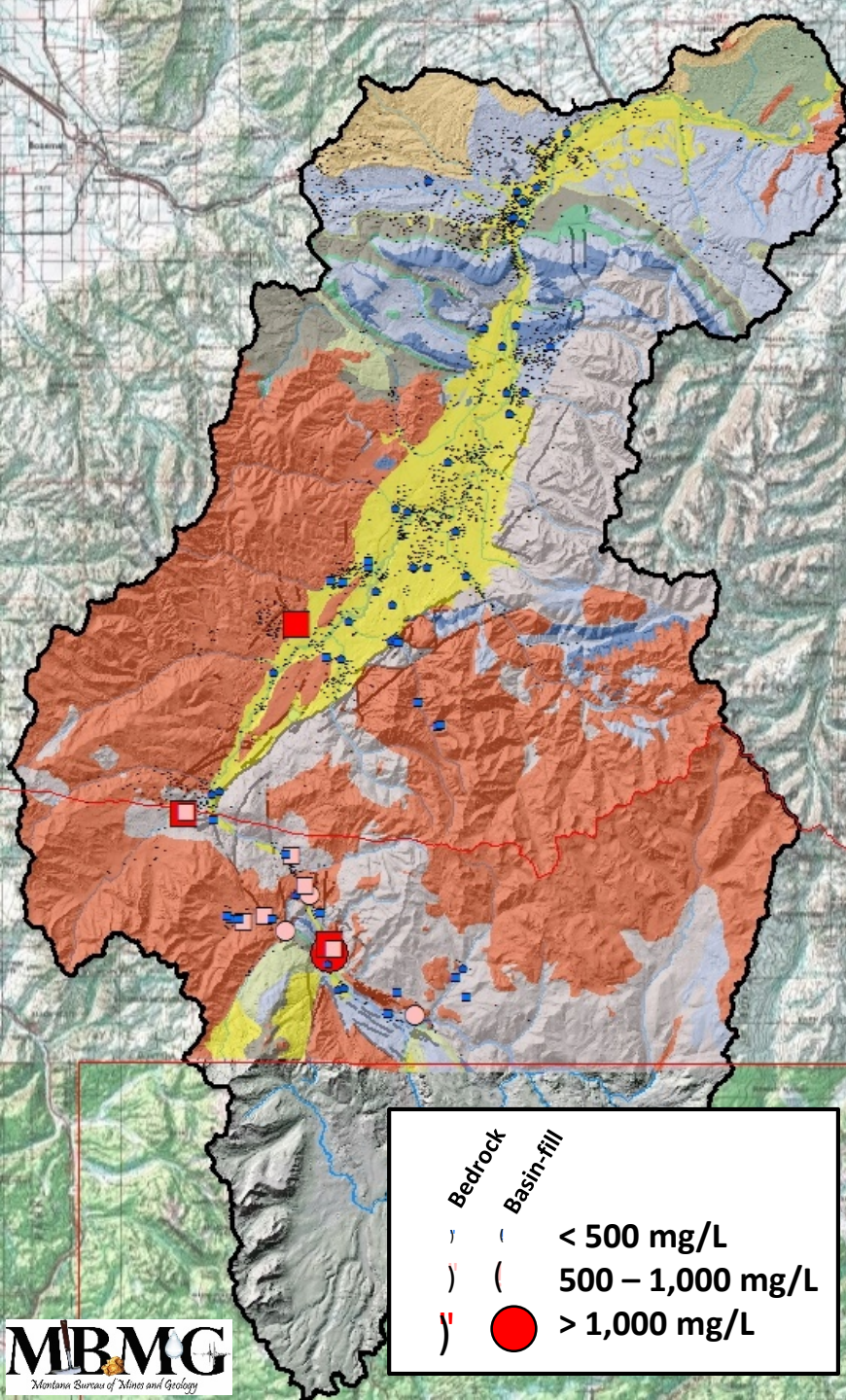
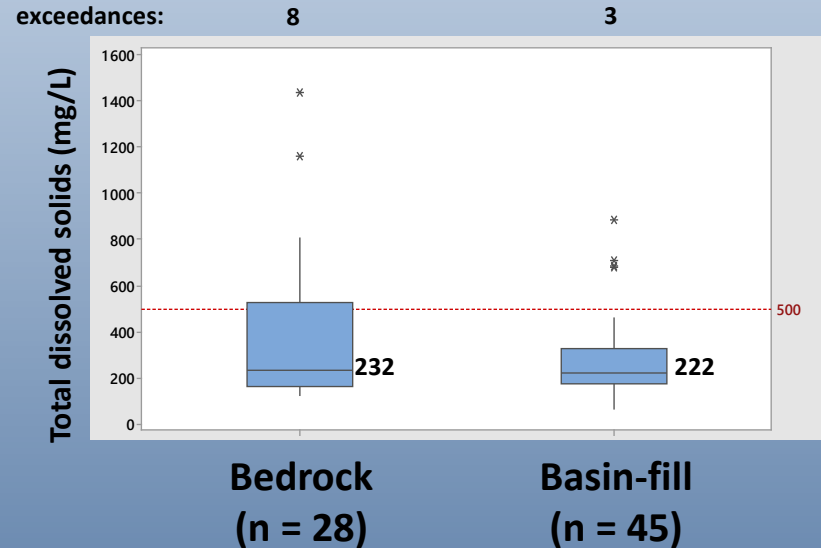


GWIC Id: 152216
Site Name: MILLER RICHARD
Location: 09S08E5BCAA
Total Depth: 184 feet

Seasonal fluctuations

Upper Yellowstone Watershed Groundwater Quality - TDS

Secondary drinking water standard = 500 mg/L



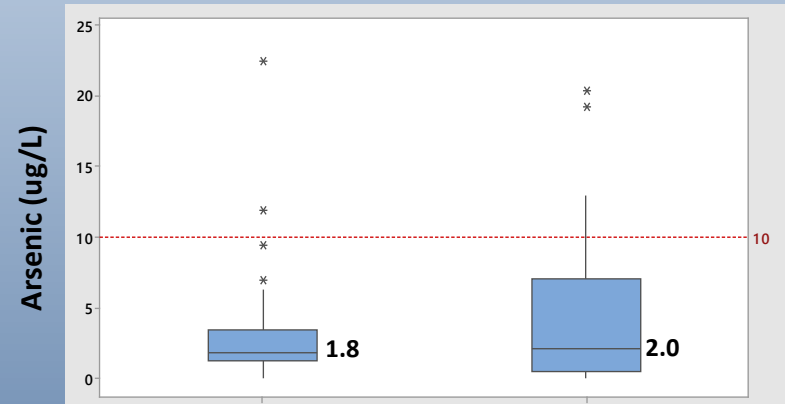
Upper Yellowstone Watershed Groundwater Quality - As

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

exceedances:

2

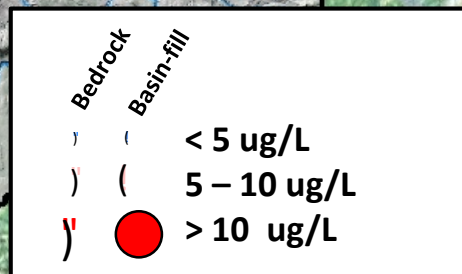
8



Bedrock
(n = 28)

Basin-fill
(n = 45)

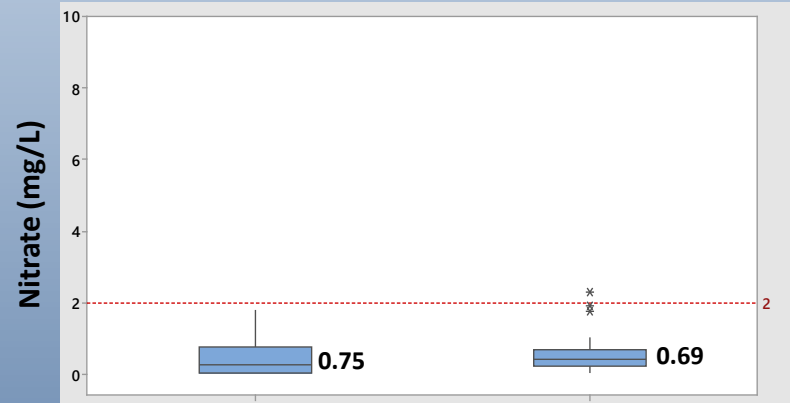
La Duke
Hot springs



Upper Yellowstone Watershed Groundwater Quality – NO3

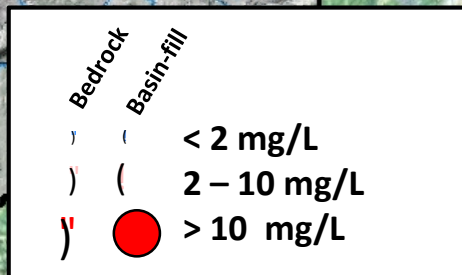
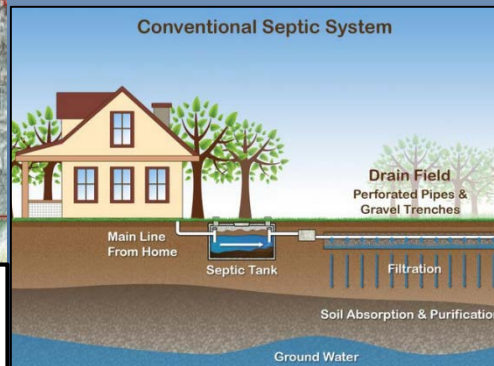
Primary drinking water standard = 10 mg/L

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/>

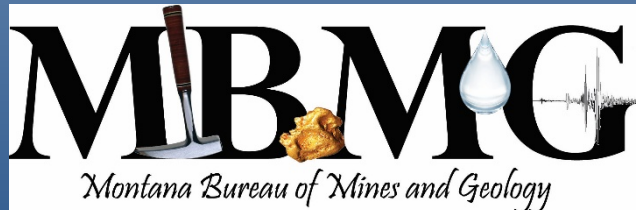
Montana Bureau of Mines and Geology:

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

John LaFave

496-4306

jlafave@mtech.edu

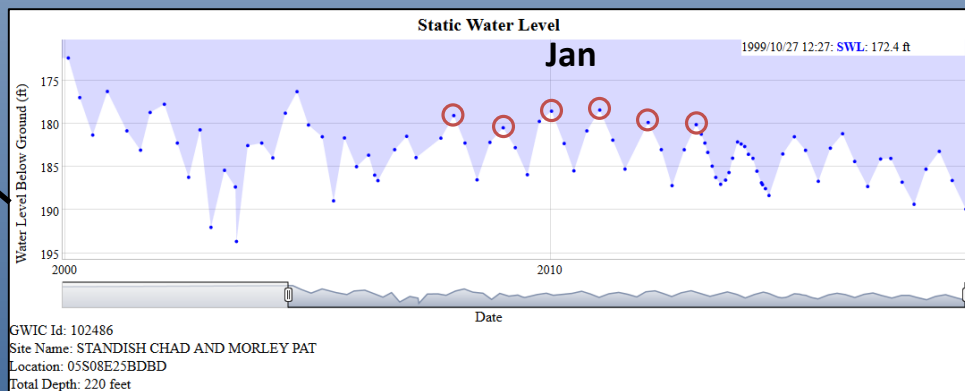
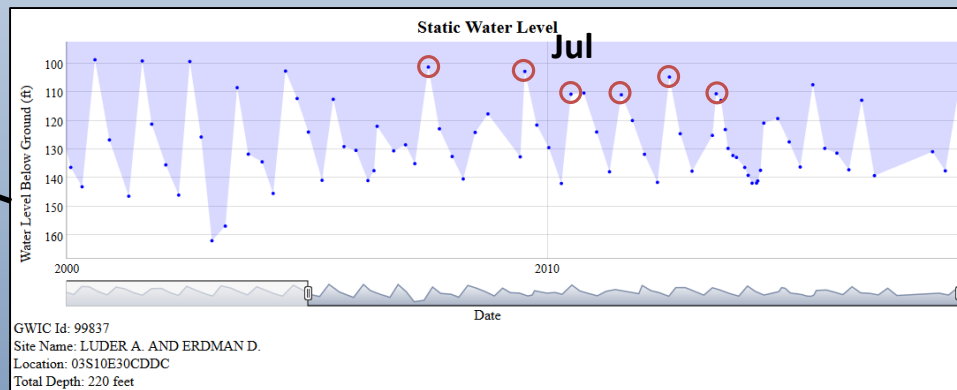


Monitoring Network

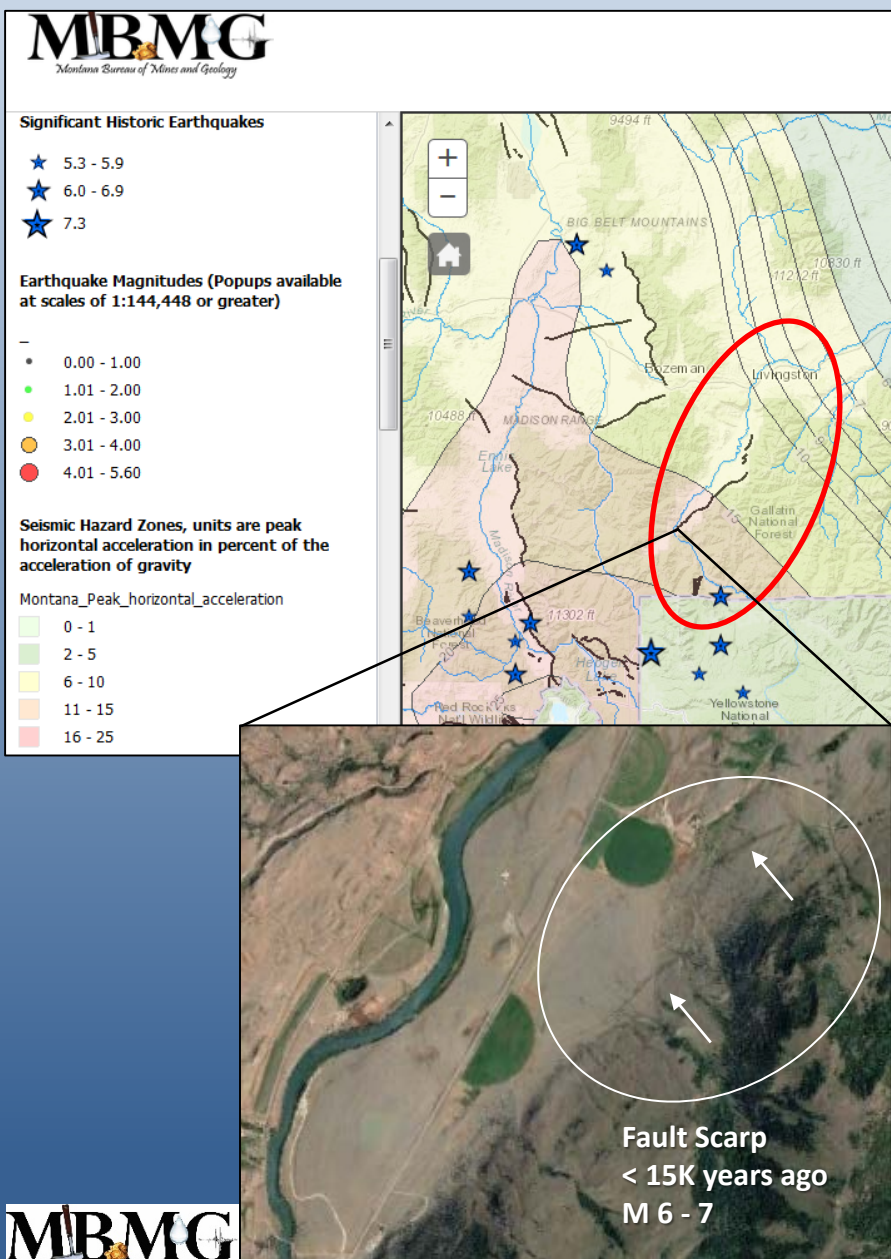
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Upper Yellowstone Watershed Groundwater level trends

Seasonal lag



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