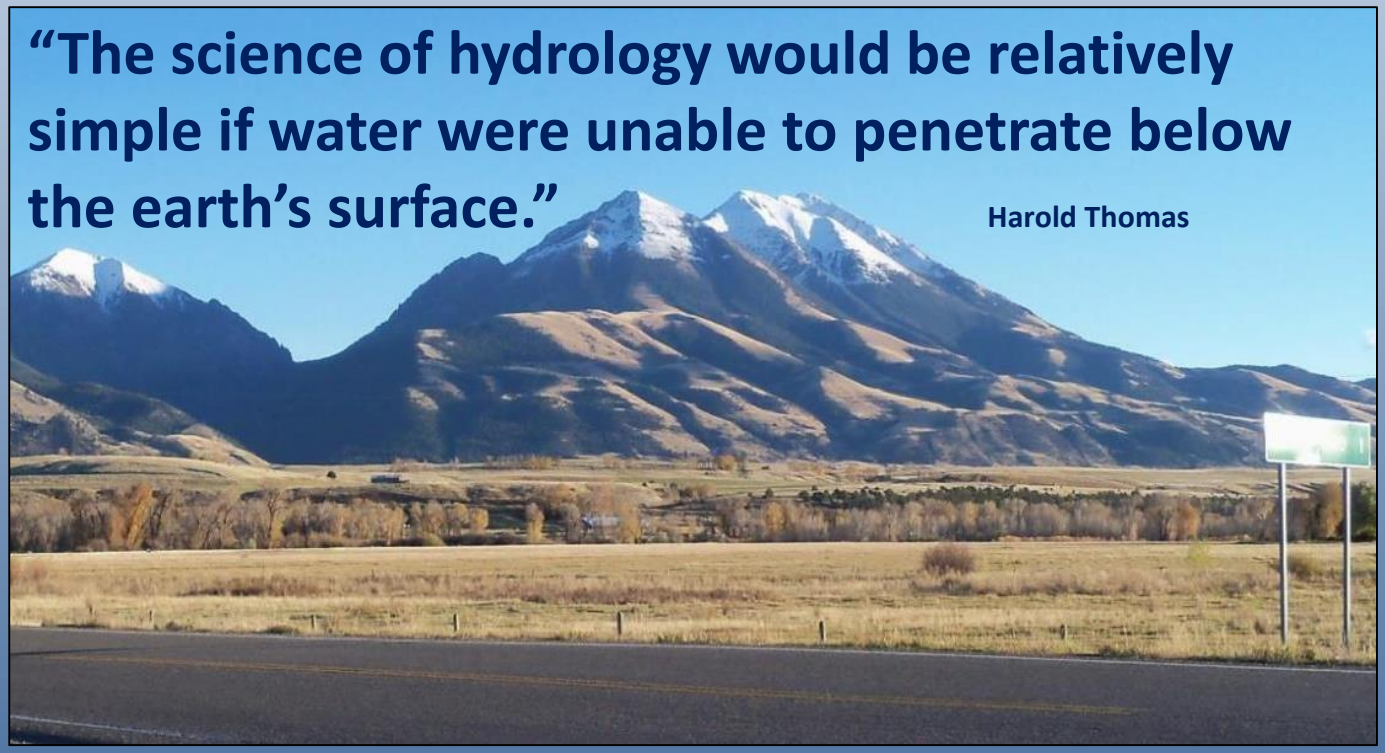
# Domestic Wells and Groundwater– Upper Yellowstone Watershed




## Outline

- Basin Setting
- Basin Geology
- GW Wells
- GW Use
- GW storage trends
- GW drought

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

**Upper Yellowstone Drought Focus Group**
**April 11, 2019**

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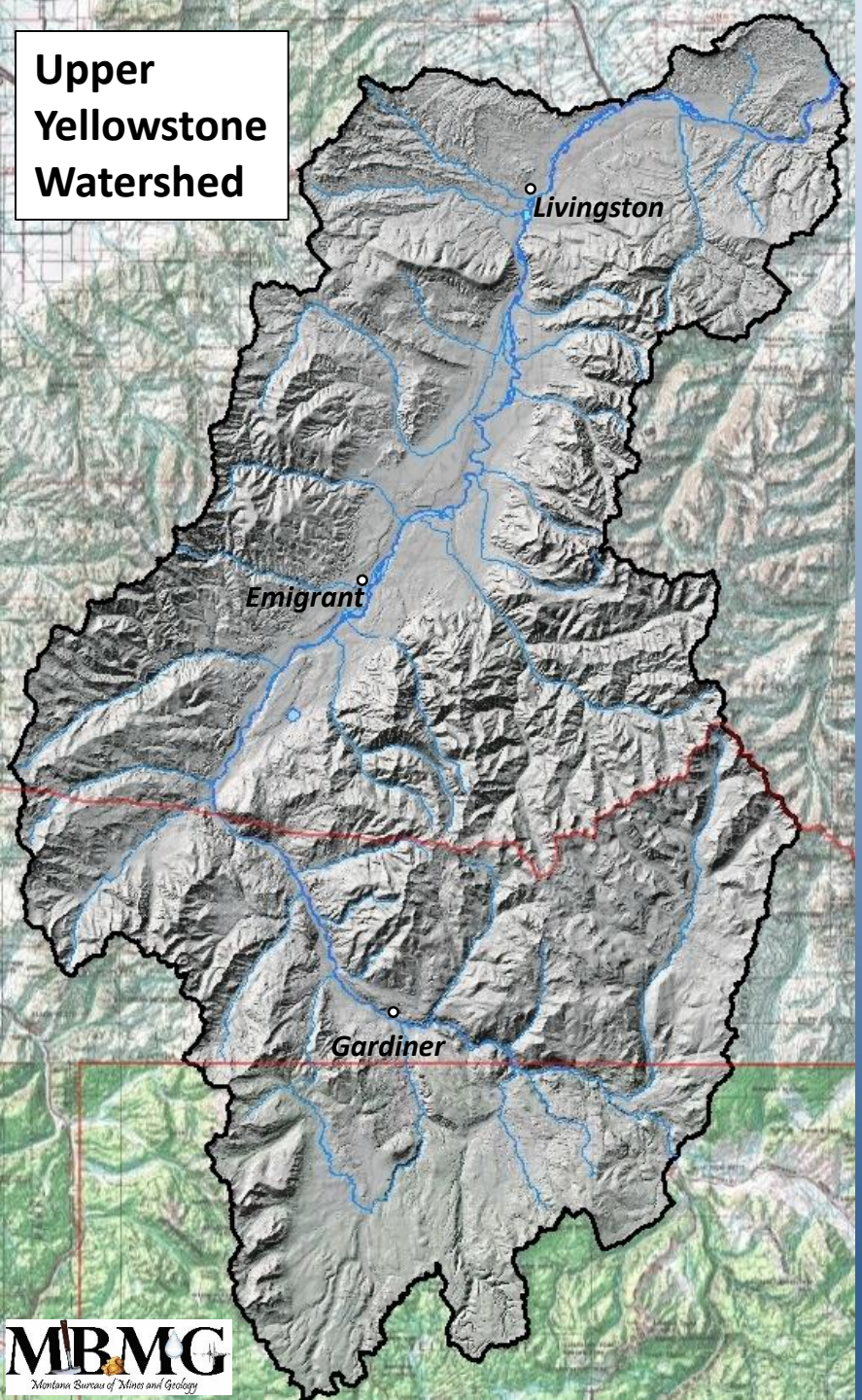
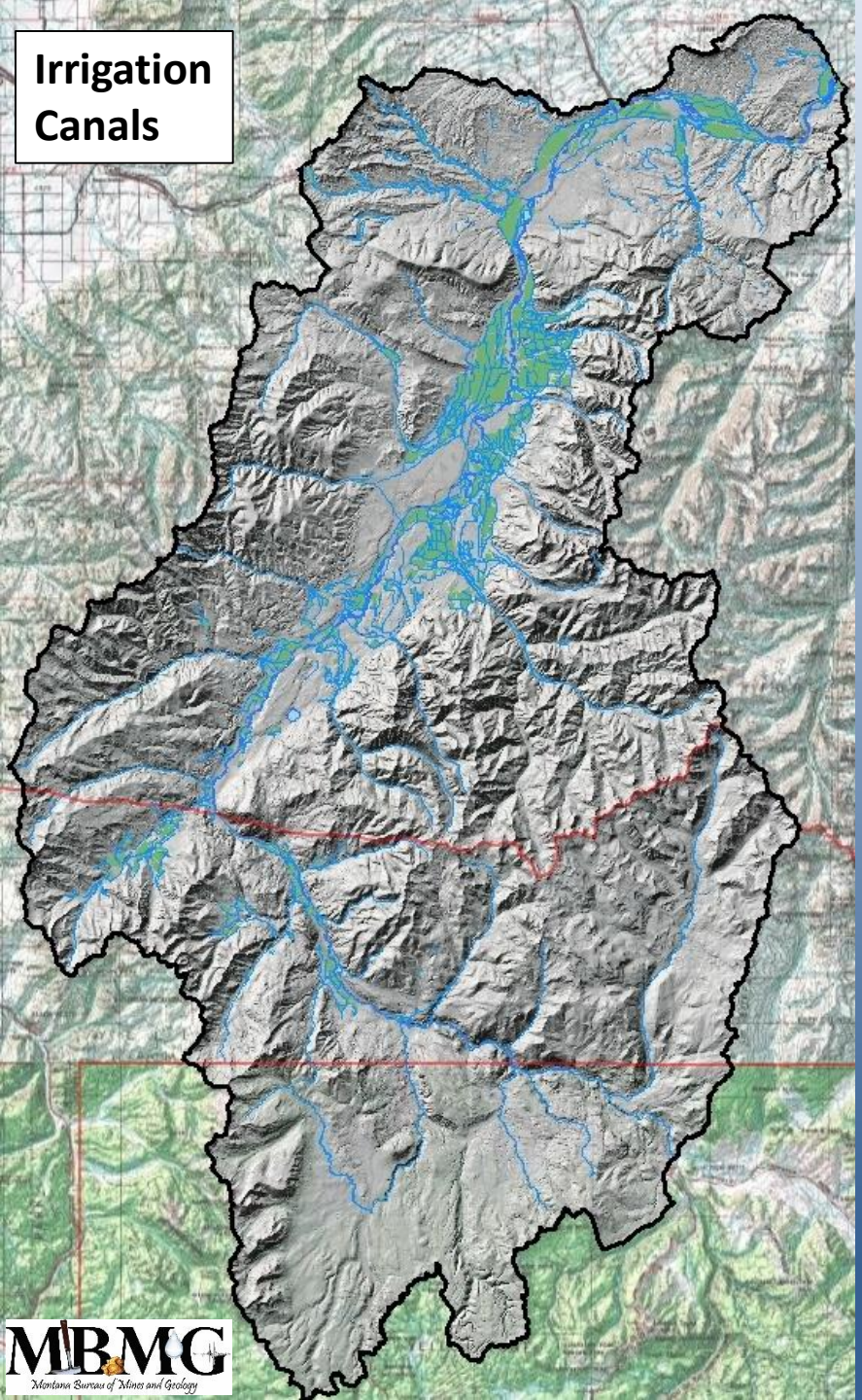



# Upper Yellowstone Watershed Setting

- 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

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

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# 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)


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# 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)

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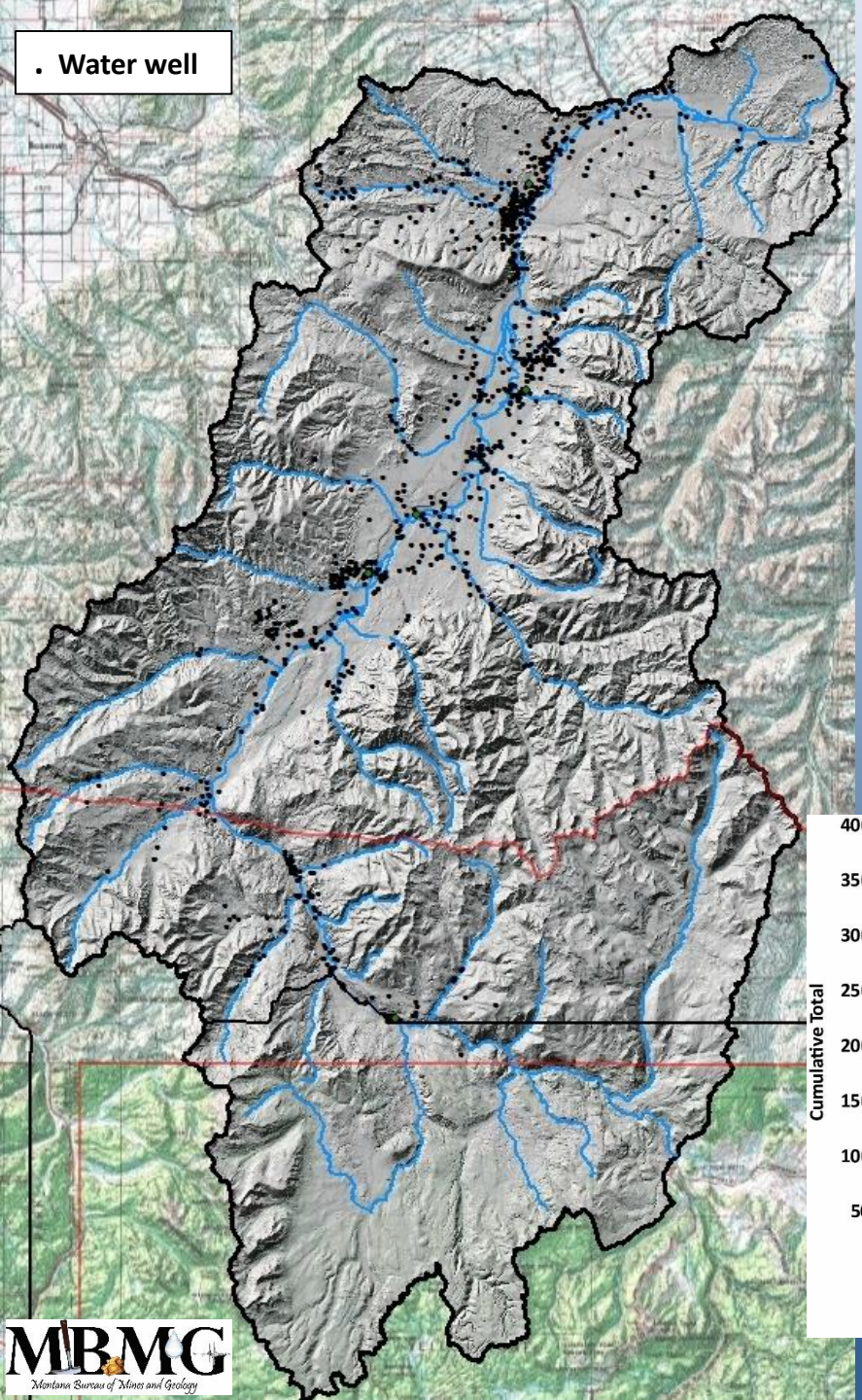
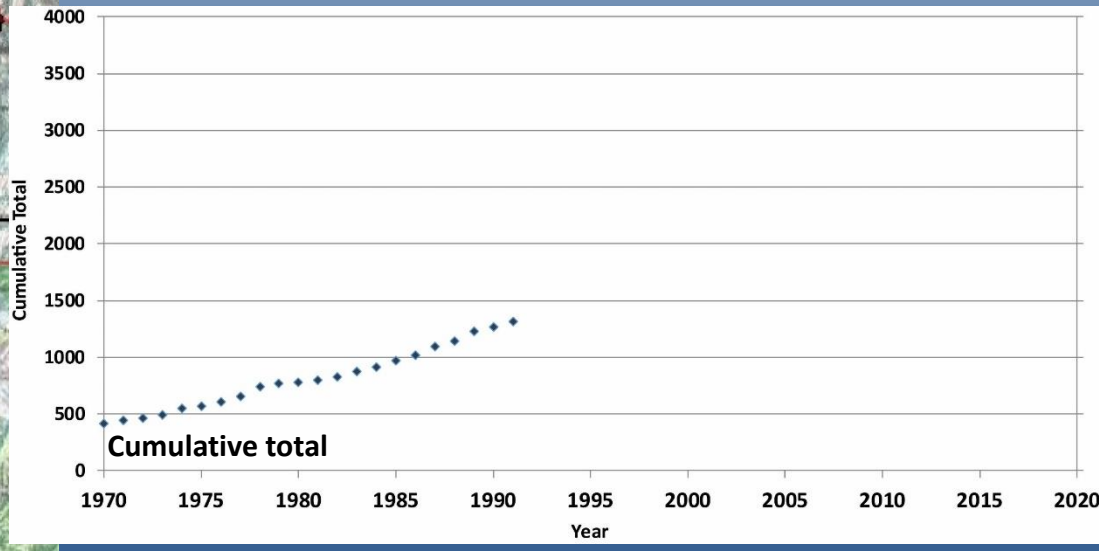
# Upper Yellowstone Watershed Groundwater Development

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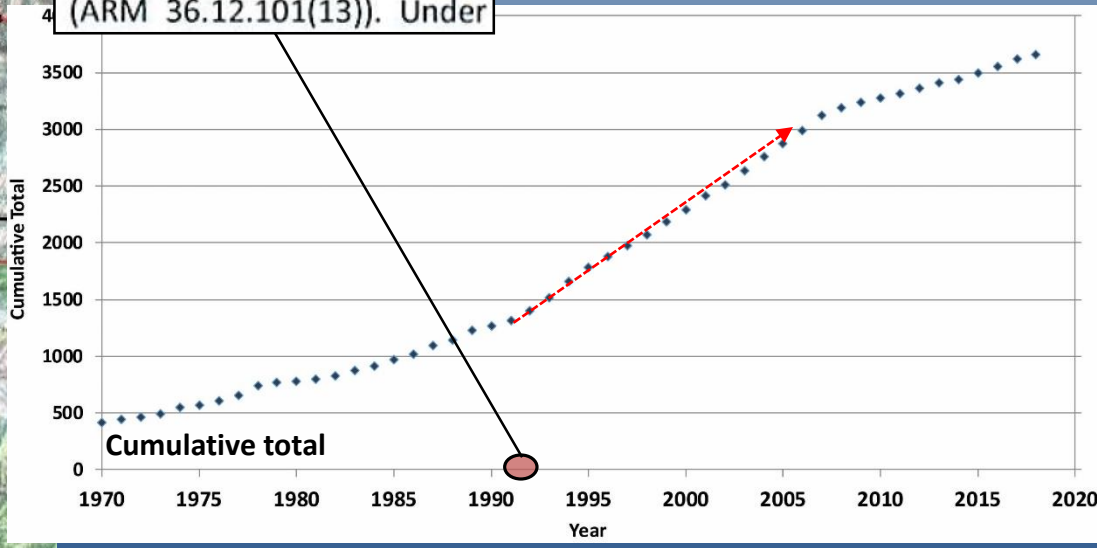
# Upper Yellowstone Watershed Groundwater Development

. Water well

*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

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# Upper Yellowstone Watershed Groundwater Development

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TUESDAY, SEPTEMBER 16, 2008 - VOL. CCLII NO. 65

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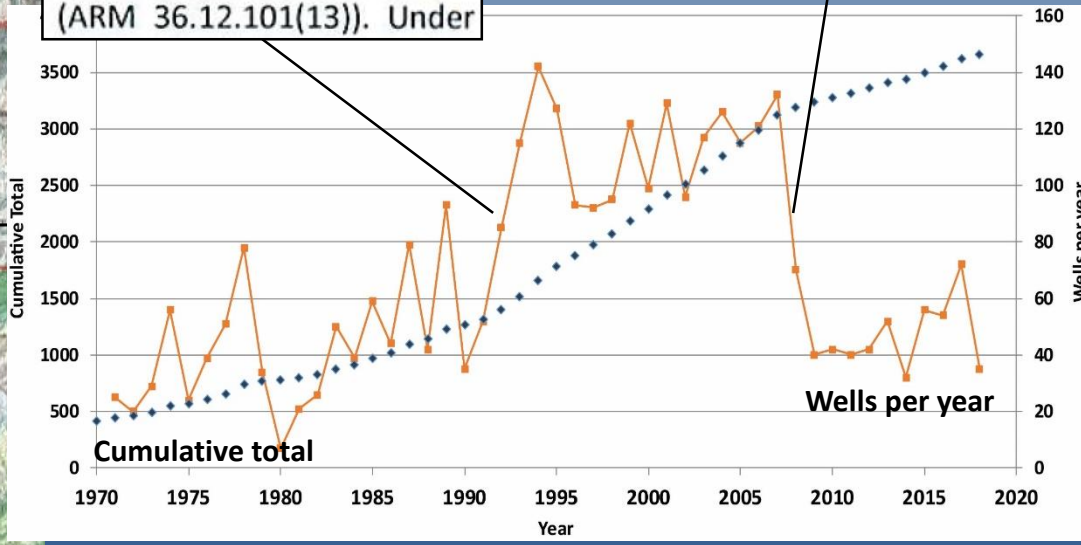
*Focus Moves to Fate of Giant Insurer After U.S. Allows Investment Bank to Fail; Barclays in Talks to Buy Core Lehman Unit*

AIG Faces Cash Crisis As Stock Dives 61%

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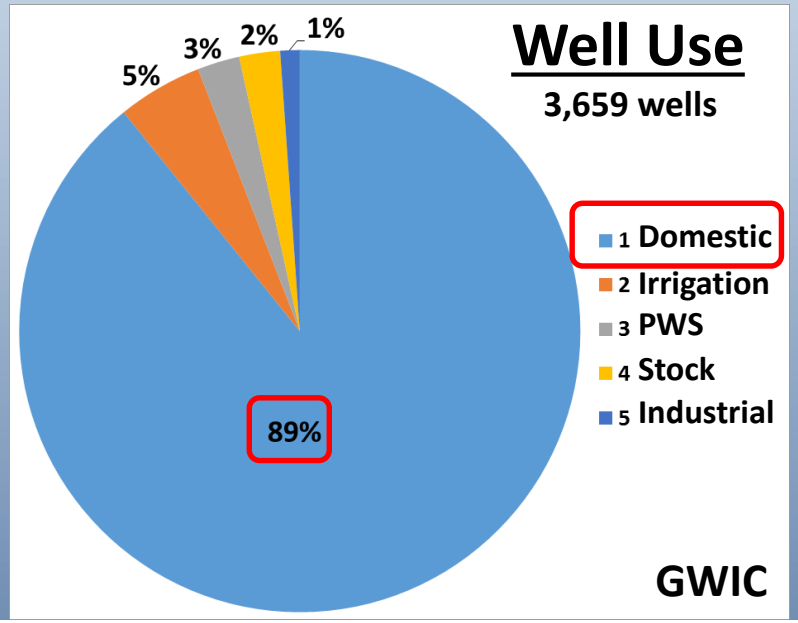
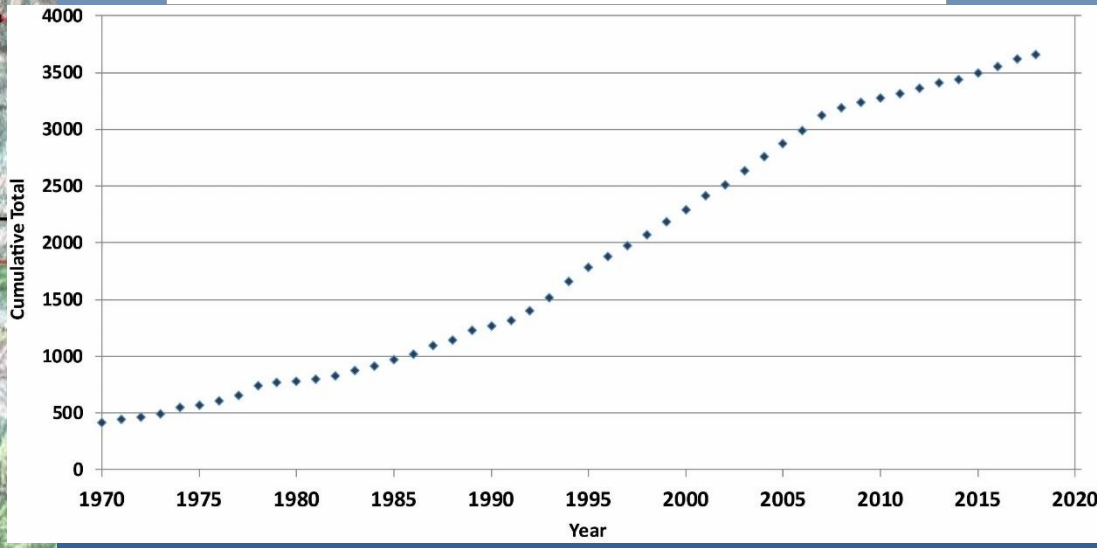
# Upper Yellowstone Watershed Groundwater Use

. Water well

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# Upper Yellowstone Watershed Groundwater Use

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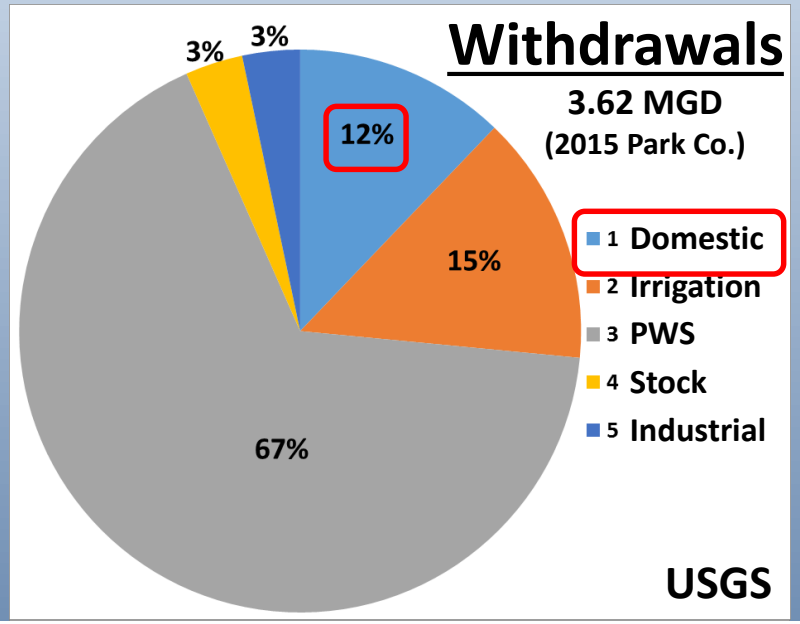


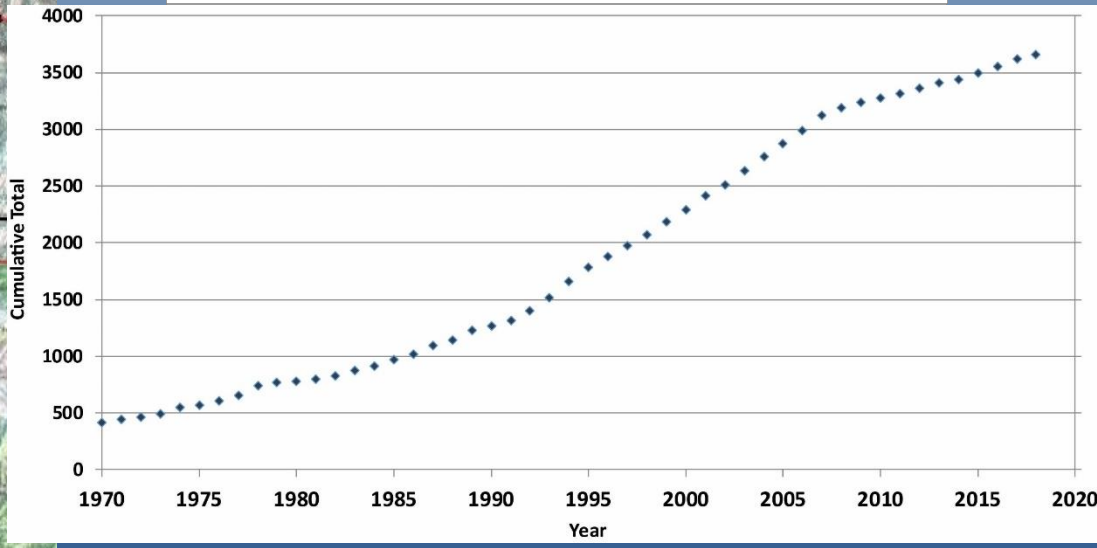


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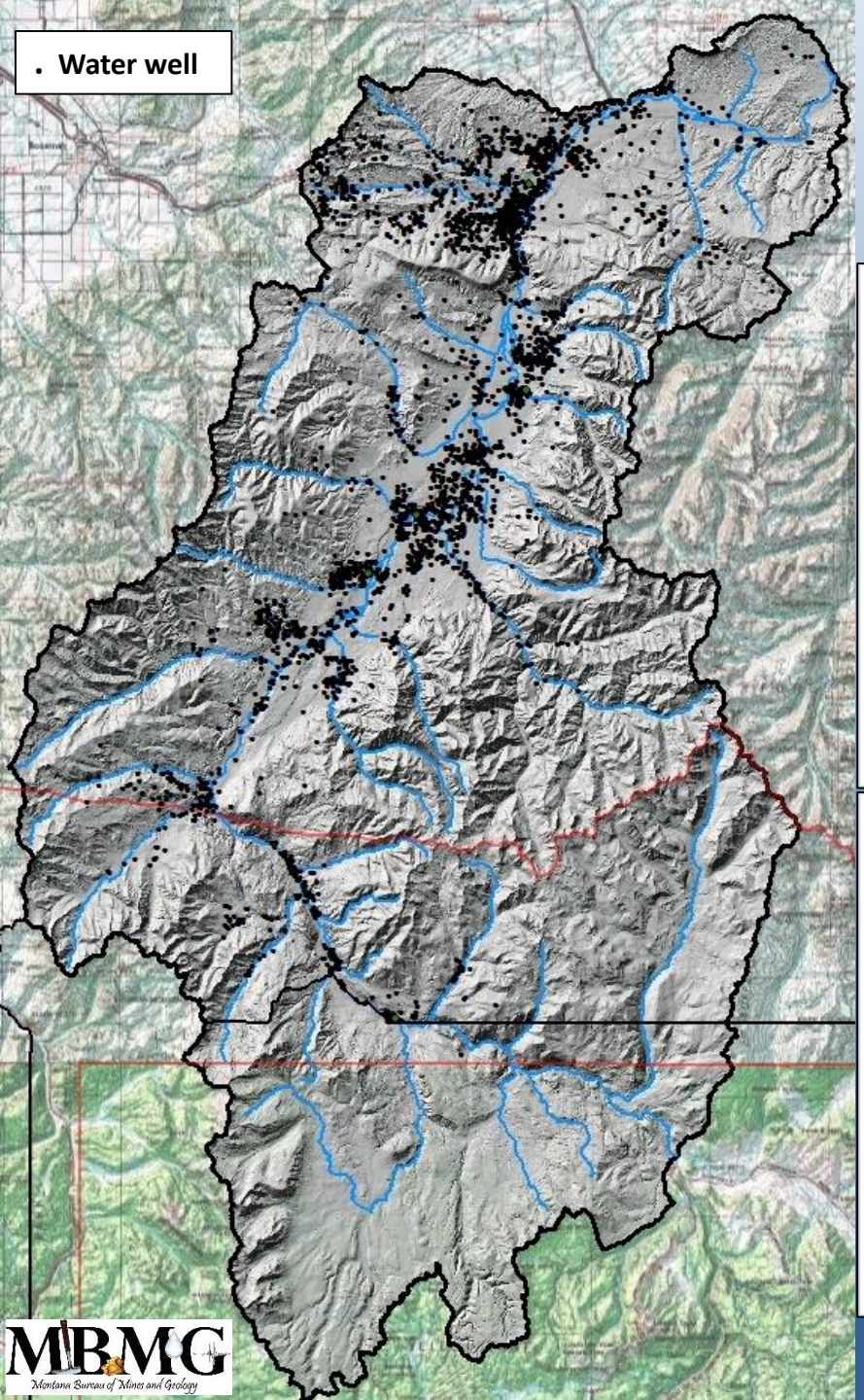
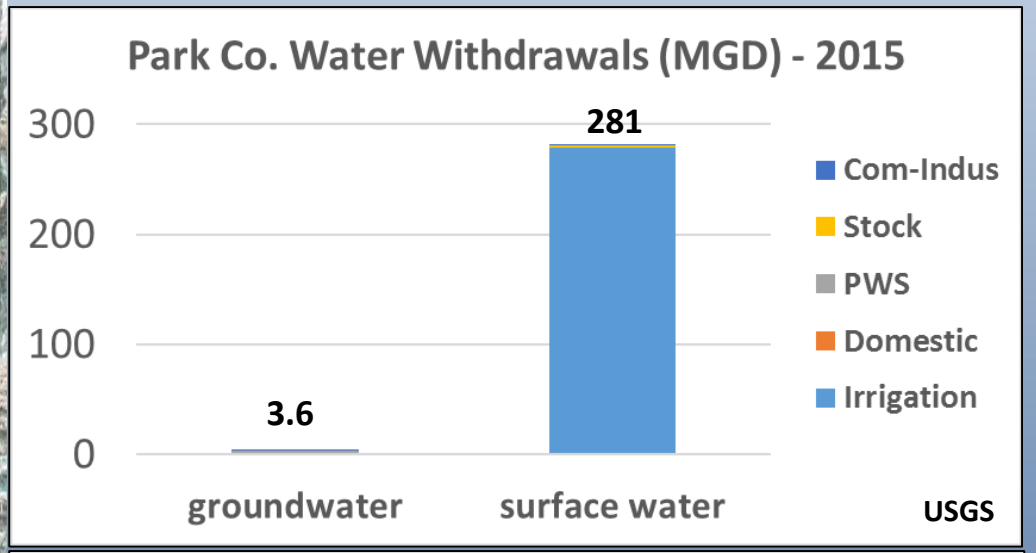
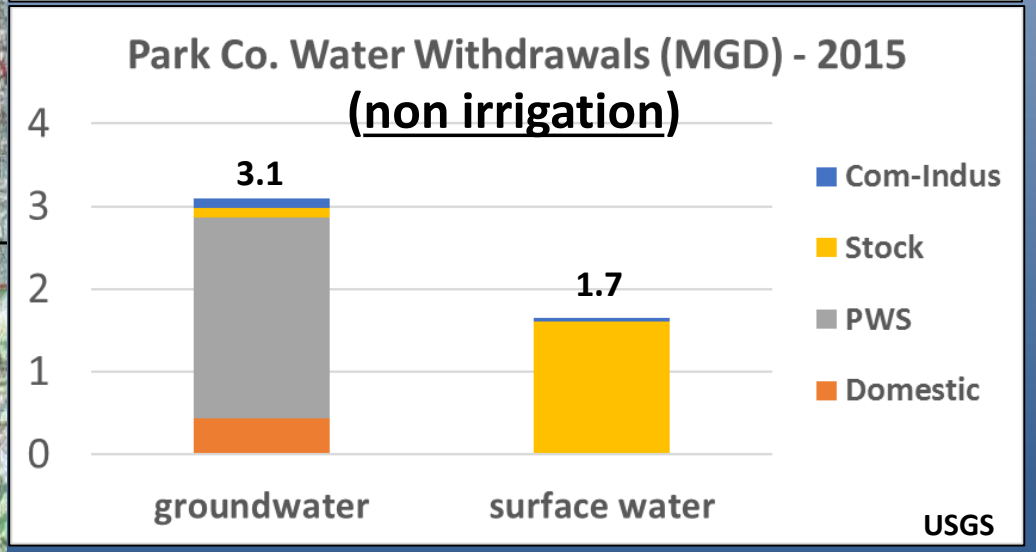



# Upper Yellowstone Watershed

## Groundwater – Surface Water Use

### Volumetrically - minor

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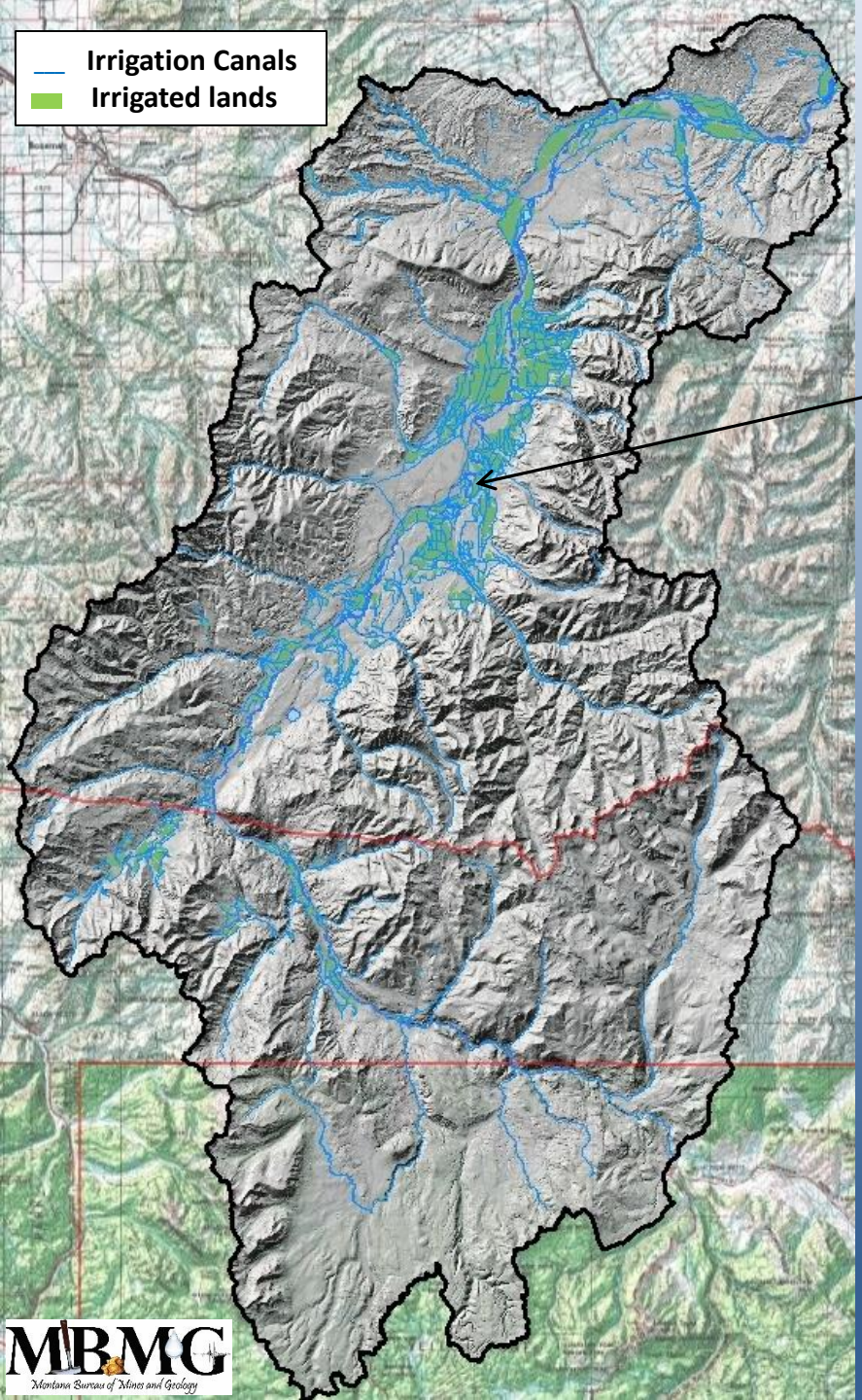


# Upper Yellowstone Watershed Groundwater recharge

- **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**

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# Upper Yellowstone Watershed Groundwater recharge

- Precipitation*
- <u>Mountain front stream loss</u>
- Canal seepage – “Incidental Recharge”


2.5 mi


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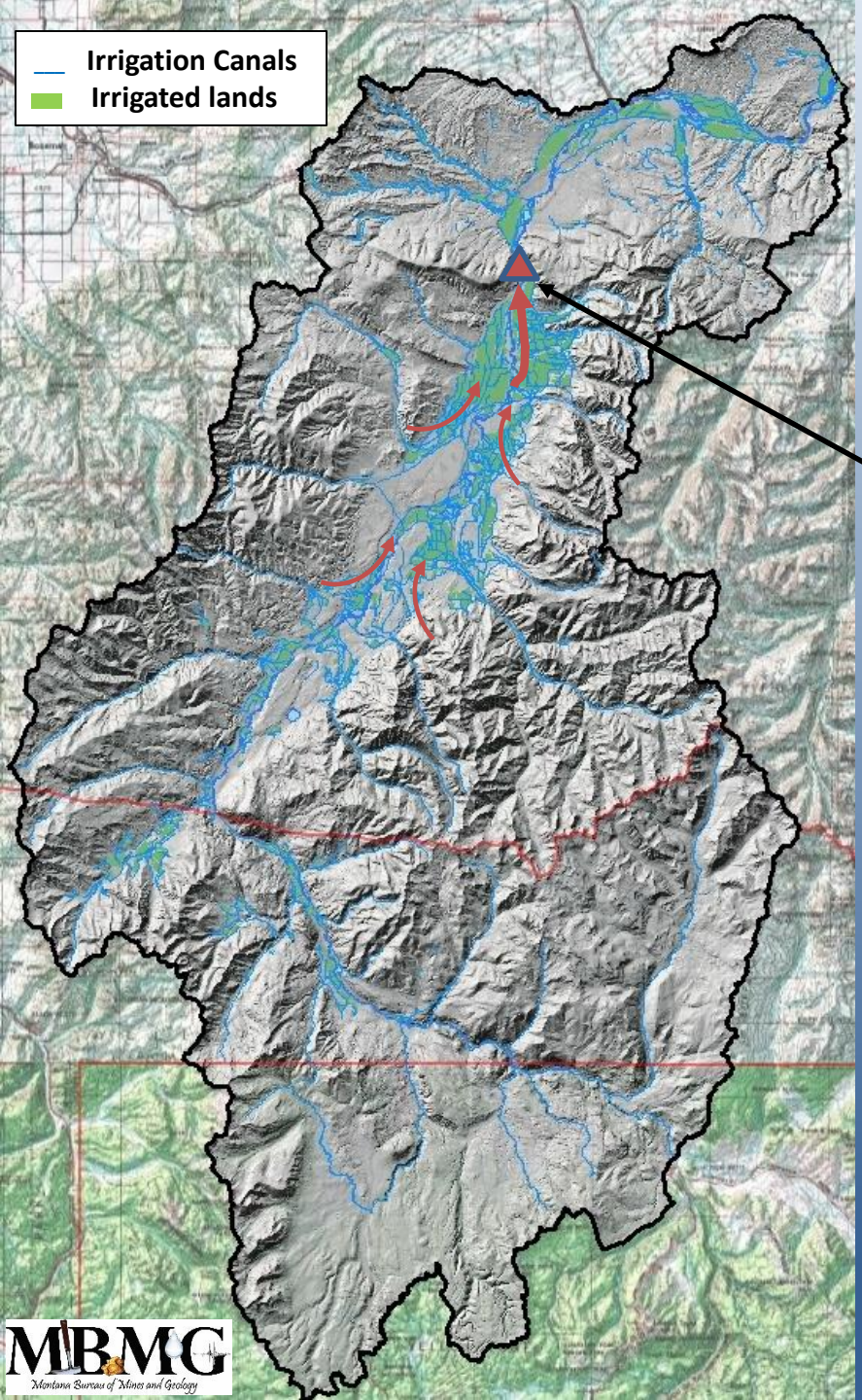
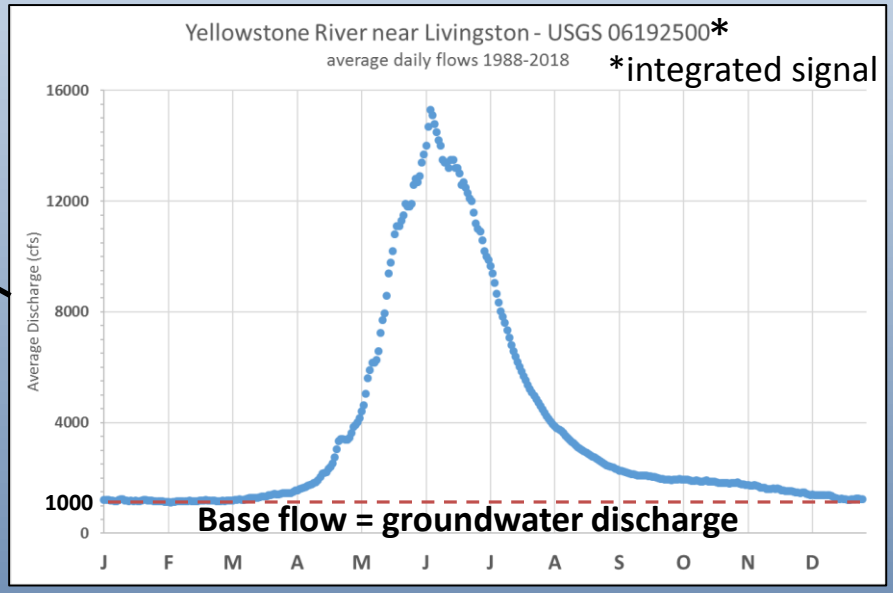
# Upper Yellowstone Watershed Groundwater Discharge




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

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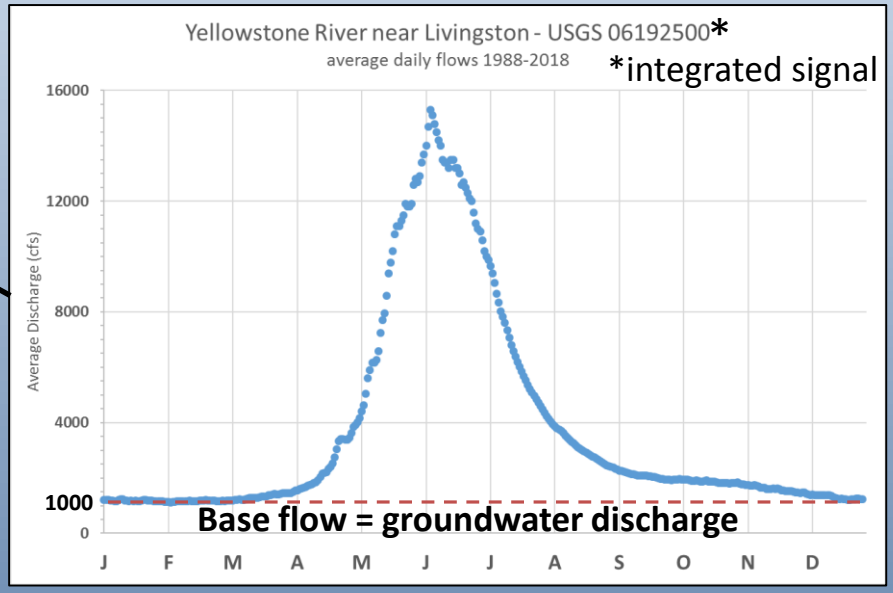
. Water well

# Upper Yellowstone Watershed Groundwater Discharge




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

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

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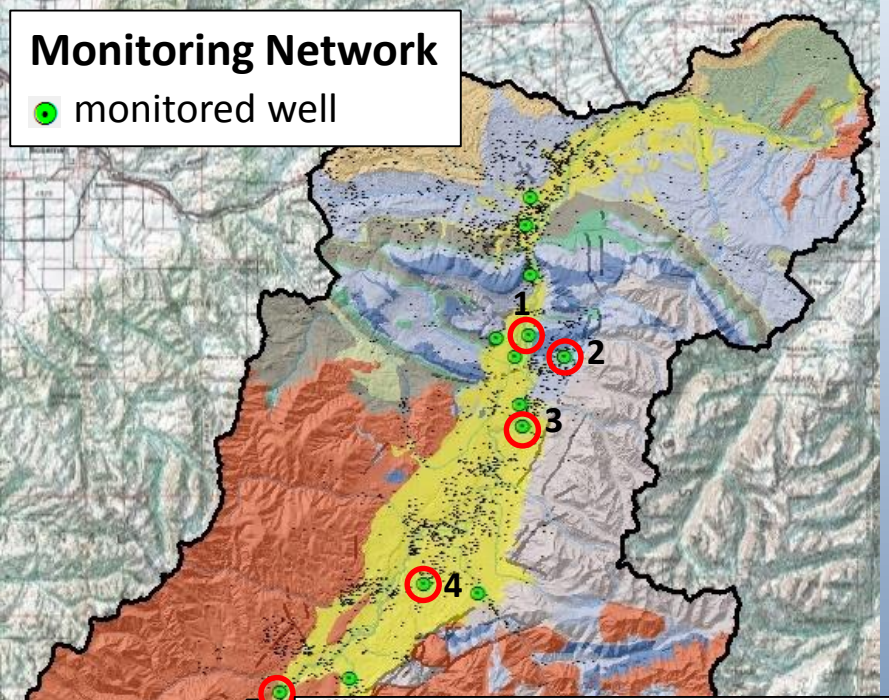
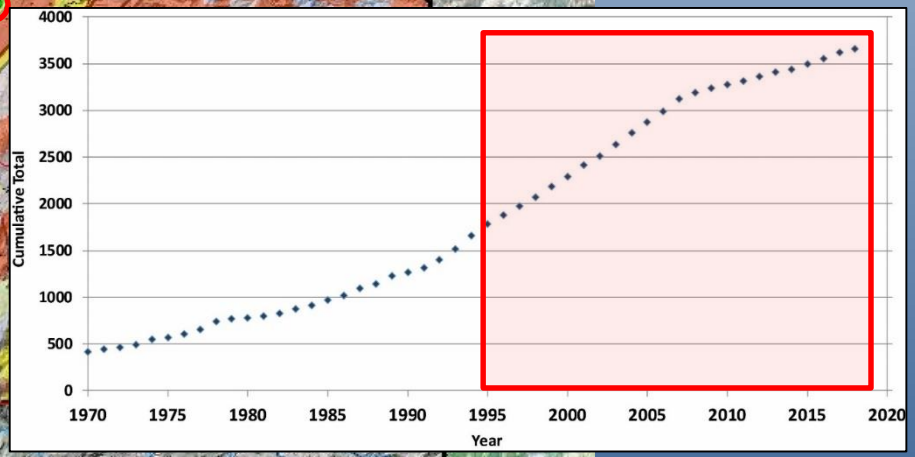
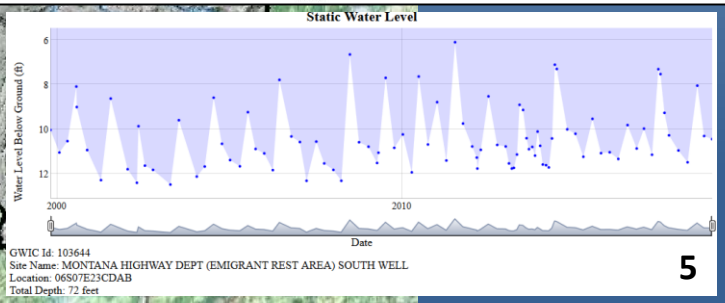
# Upper Yellowstone Watershed Groundwater level trends

**Monitoring Network**

monitored well

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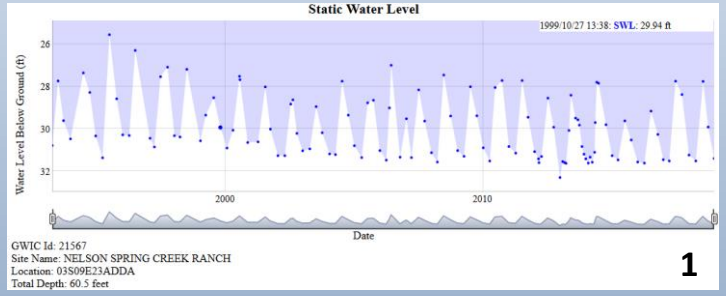


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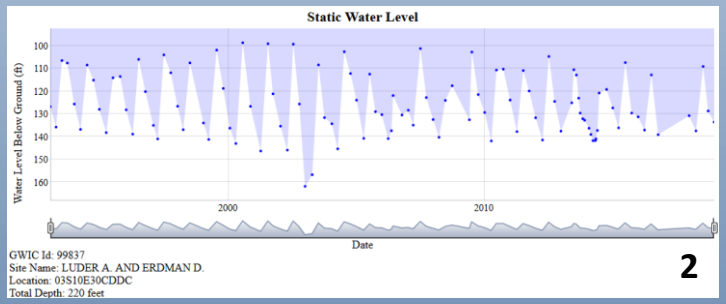


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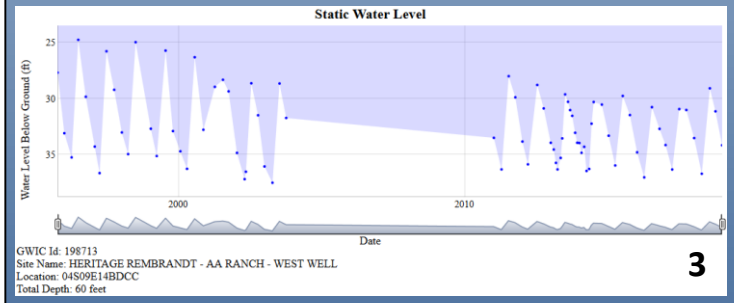


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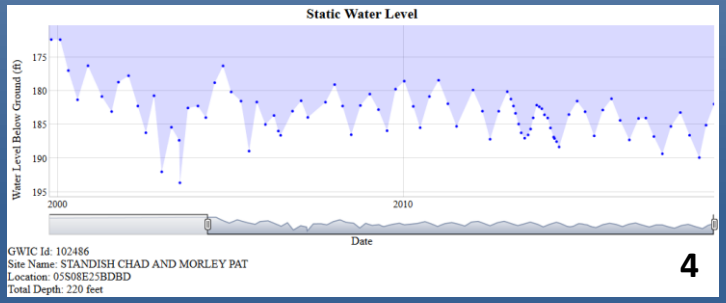


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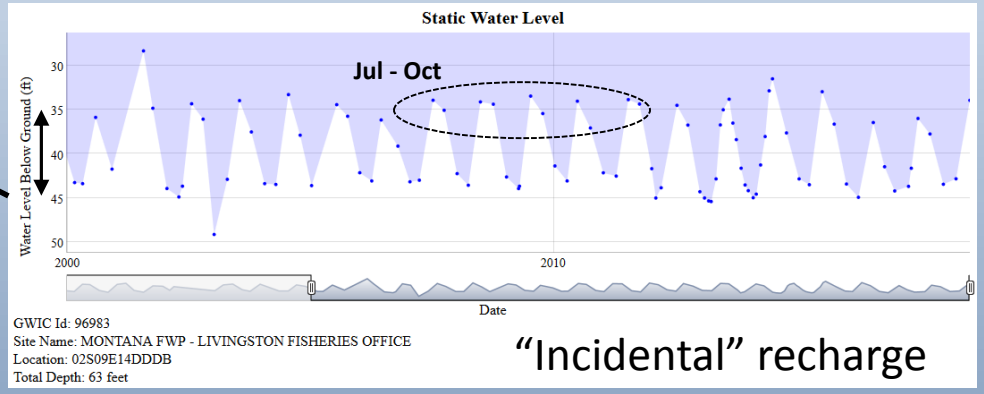
# Upper Yellowstone Watershed Groundwater level trends

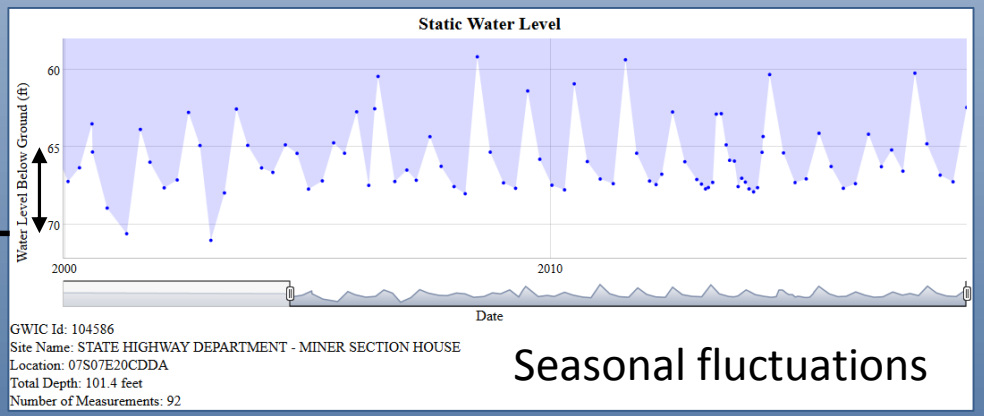
**Monitoring Network**
monitored well

YCGWA



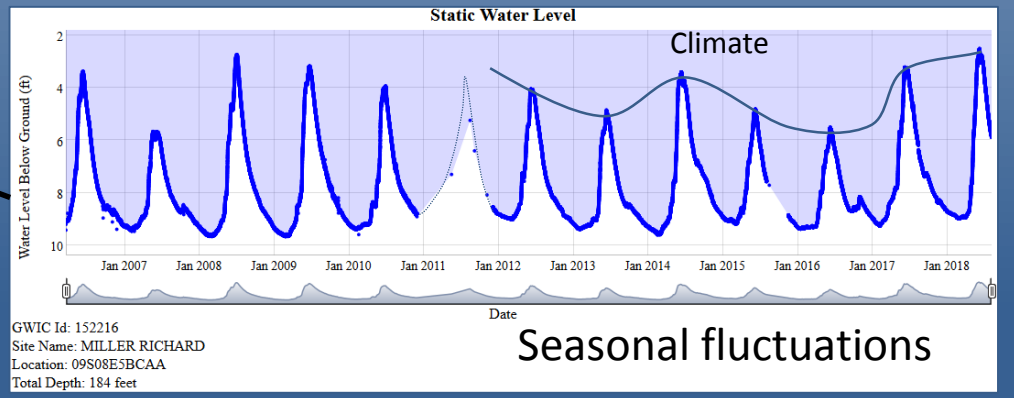

GWIC Id: 96983
Site Name: MONTANA FWP - LIVINGSTON FISHERIES OFFICE
Location: 02S09E14DDDB
Total Depth: 63 feet

"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

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# State-Wide Groundwater Monitoring Network

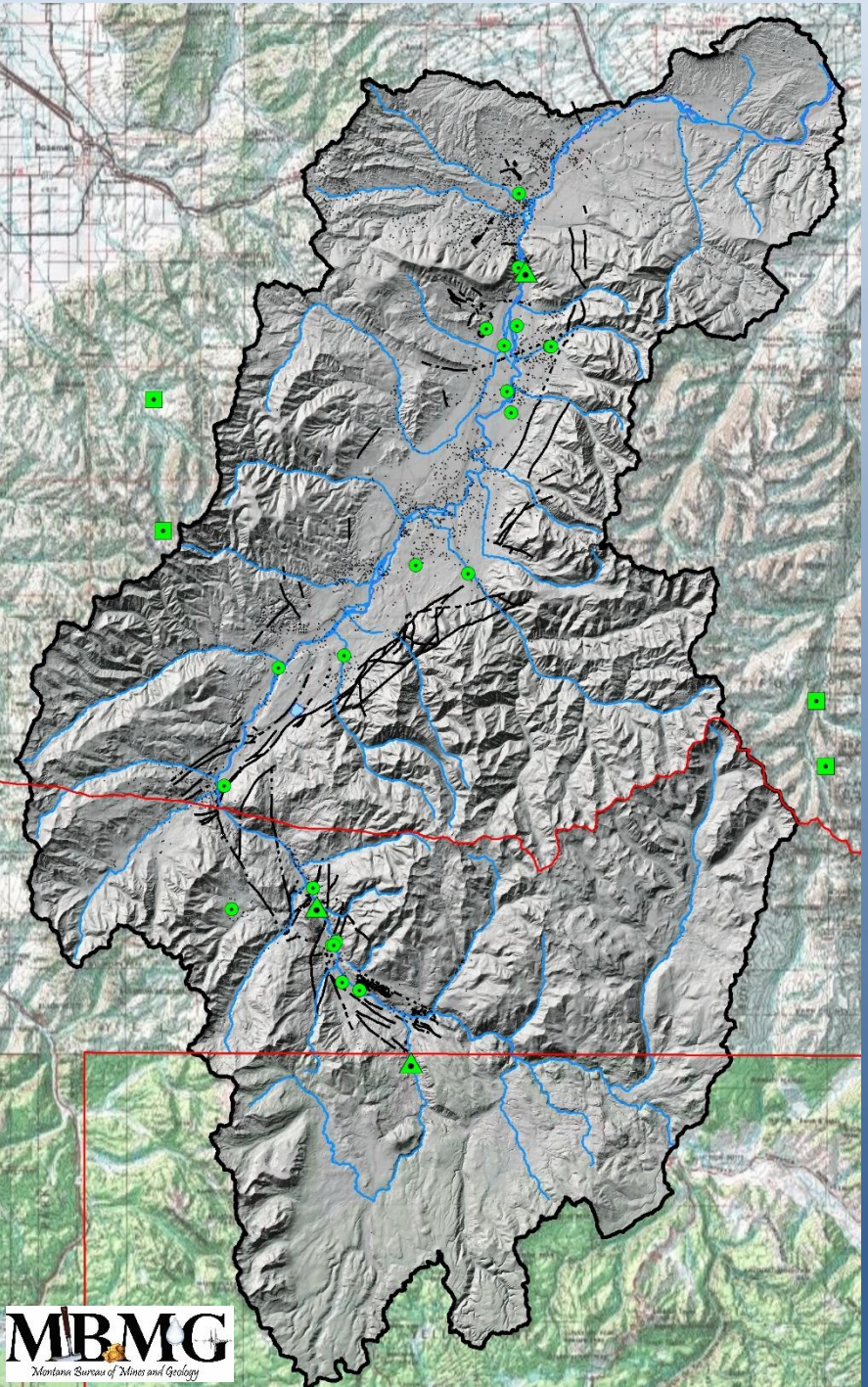
## Drought Impacts

## Period of below normal moisture –

**that can propagate through natural (and engineered) systems**

- **Meteorological Drought**
  - **decreased precipitation (increased temp)**
- **Hydrologic Drought**
  - **decreased stream flow and surface storage**
- **Terrestrial Drought**
  - **decreased soil moisture (agricultural/ecological impacts)**
- **Groundwater Drought**
  - **reduced storage (⇩ recharge ⇧ withdrawals)**
  - **reduced fluxes to other systems ( streams and springs)**

## Groundwater: lagging & buffer



# Upper Yellowstone Watershed Monitoring Infrastructure

**Surface water**
- USGS

**Snow Pack**
- NRCS SNOTEL (not in basin)

**Groundwater**
- MBMG

**Precip – Soil Moisture**?
-MCO/DOA – Mesonet ?

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# *"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.mbmg.mtech.edu/**


**John LaFave**

**496-4306**

**jlafave@mtech.edu**