

AN OVERVIEW OF THE ENNIS GROUNDWATER INVESTIGATION

Montana Bureau of Mines and Geology (MBMG)
Ground Water Investigations Program (GWIP)

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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

- Geologic Mapping
- Earthquake Studies
- Environmental Assessment
- Economic Geology

Groundwater

Assessment
Program
(GWAP)

Investigation
Program
(GWIP)

Web: <http://www.mbmng.mtech.edu/>



Ground Water Investigation Program (GWIP)

Addresses specific groundwater questions across Montana

- ✓ Competition for water resources;
 - Answer locally identified questions, crucial for water management;
- ✓ Focused, intensive studies in a structured, widely accepted program



*Understanding impacts and **lack** of impacts, both are equally important*

Provide information so aquifers can be managed, Not just used

GWIP Project Areas

GWIP adds to Montana's capability to deal with complex water resource issues

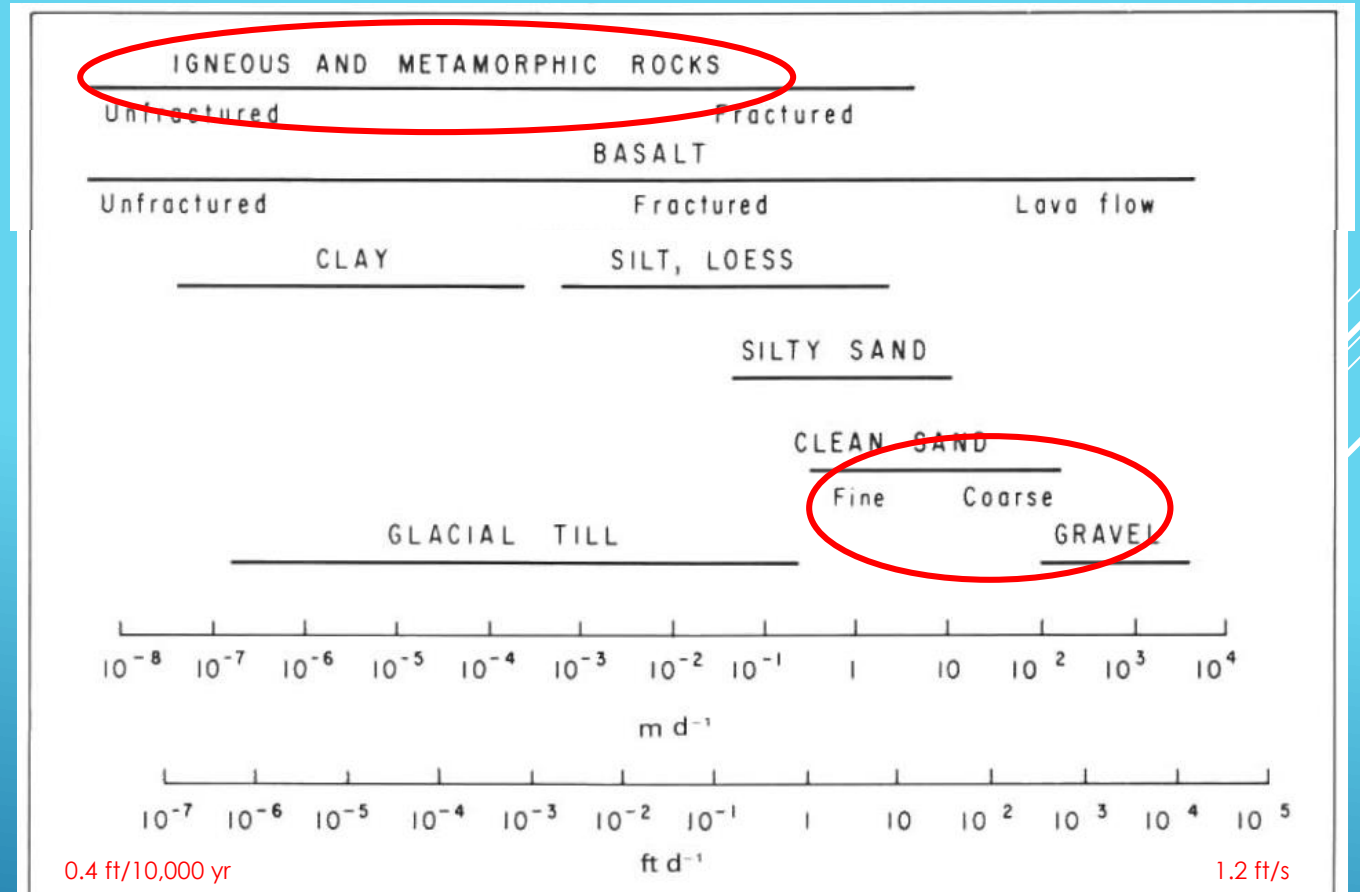


Types of issues:

- stream depletion from pumping wells
- groundwater drawdown from pumping wells
- effects of changing land use on water resources
- the impacts of irrigation practices on groundwater/ surface-water interactions
- evaluating mitigation success and offset plans in closed basins.

PURPOSE

Assess the likely effects from different intensities of water development from the bedrock aquifer on the west bench.



PROJECT AREA

West Bench

Underlain by bedrock

Generally low productivity

Effects of new development

Effects on existing wells

Effects on other new wells

Effects on surface waters

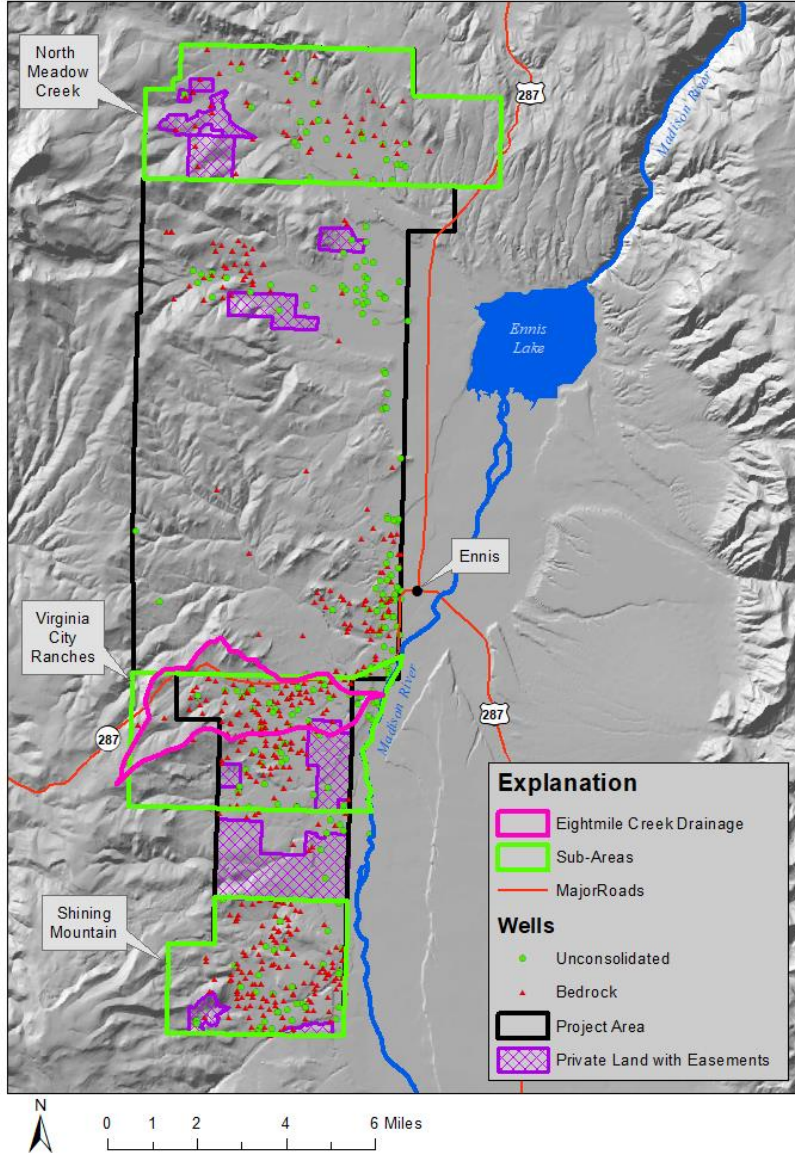
Sub-Areas

North Meadow Creek

Virginia City Ranches/Pronghorn Meadows

Shining Mountain

Focus Area on Eightmile Creek



SURFICIAL GEOLOGY

Major Units (>5%)

Bedrock (59%)

48% - Archean Gneiss (Amt)

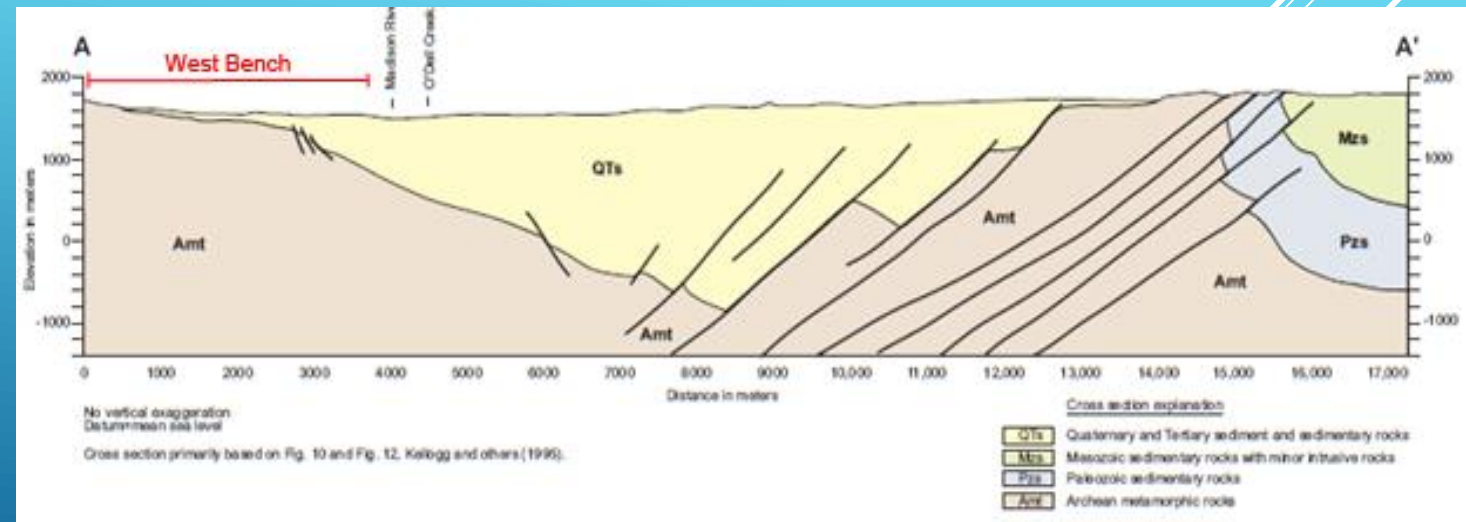
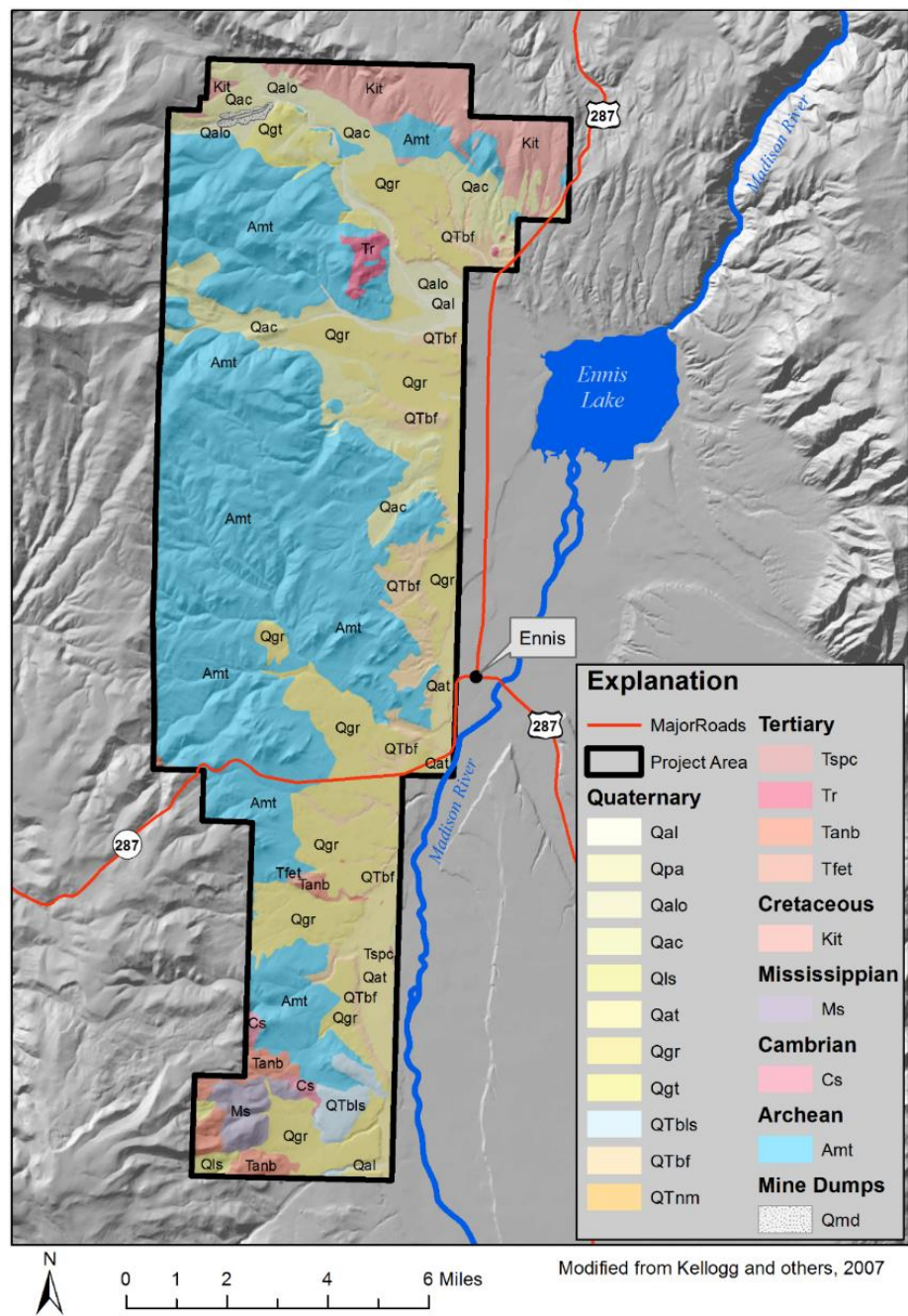
5.5% - Cretaceous Granite (Kit)

Unconsolidated (41%)

18% - Quaternary Gravel (Qgr)

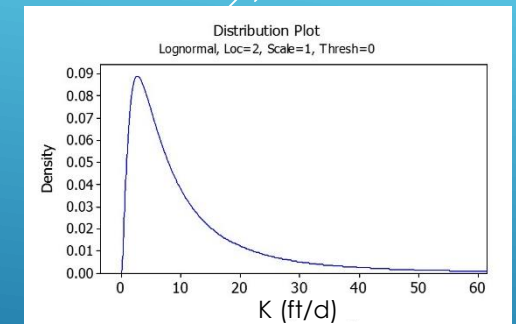
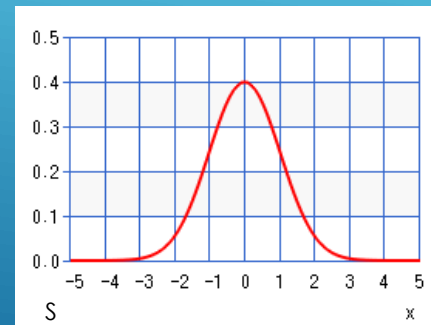
8.5% - Quaternary Alluvium/Colluvium (Qac)

5.3% - Basin Fill (QTbf)



OBJECTIVES

1. Evaluate groundwater levels
 - a) Variations - Sources of recharge
 - b) Elevations – Potentiometric Surface
 - i. Groundwater flow directions
 - ii. Groundwater budget
2. Define areas where bedrock is the only aquifer
3. Estimate bedrock aquifer properties
 - a) Probability distributions




OBJECTIVES (CONT.)

4. Develop numerical model of Eightmile Creek
 - a) Test scenarios to understand the types of effects to expect from development in the area

5. Understand uncertainty in predictions
 - a) Use probability distributions to understand probabilistic effects
 - i. Explicitly address uncertainty
 - ii. ~25th to 75th percentiles
 - b) Numerical model (4) or analytical model
 - i. Numerical model is complex, so a simple analytical model may provide a clearer understanding.
 - c) “It is likely that Scenario B would result in 1.2 to 2.5 ft of drawdown at 1 mile from the new development.”

TASKS

1. Groundwater-Level Monitoring
 - a) Monthly water levels at ~80 wells
 - b) ~20 in each sub-area
 - c) Ending December 2019
 - d) Survey measuring points

 2. Define Bedrock Aquifer Area
 - a. Well Logs
 - b. Geologic Maps
 - c. Soils Maps
 - d. Remote Sensing Data
 - i. Natural Color Air Photographs
 - ii. Near Infrared Air Photographs
 - iii. Montana Wetlands Riparian Framework
 - iv. LANDFIRE vegetation data
 - v. LANDSAT imagery
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TASKS (CONT)

3. Install Wells

- a) Observation wells near existing wells
- b) Pumping wells if needed
- c) ~ 8 sites

4. 8-hr single well aquifer tests (K only)

- a) Pre-existing wells
- b) ~12 sites

5. 72-hr aquifer tests (K and S)

- a) At sites with multiple wells

TASKS (CONT)

6. Surface-Water Monitoring on Eightmile Creek

- a) Exchange of water between stream and aquifer
- b) July-November 2018
- c) April-November 2019

7. Eightmile Creek elevations

- a) Survey
- b) Elevation model?

8. Model Hydrogeologic Units

- a) Combine geologic units with similar aquifer properties
- b) Determine 3D distribution

TASKS (CONT)

9. Groundwater Budget for Eightmile drainage

- a) Areal recharge
- b) Stream infiltration
- c) Stream gains
- d) Evapotranspiration (ET)
- e) Well withdrawals
- f) Groundwater outflow

10. Develop and Calibrate Eightmile Transient Numerical Model

- a) Groundwater Elevations
- b) Water Budget
- c) Distribution of Hydrogeologic Units

TASKS (CONT)

11. Test Scenarios

- a) Housing Density
- b) Water Management

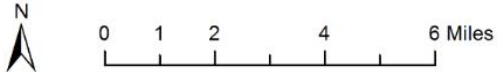
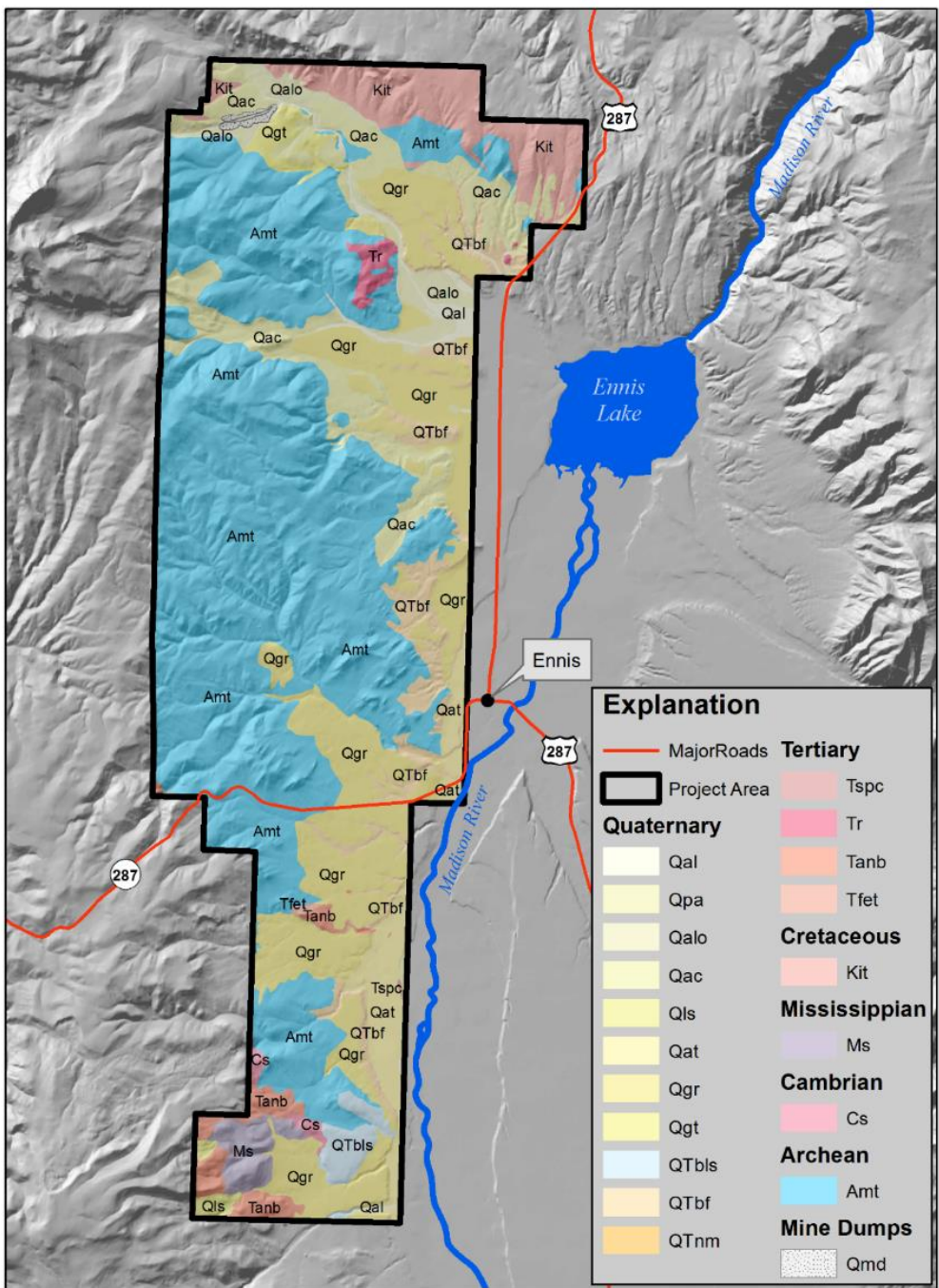
12. Modeling Results

- a) Effects to stream gains and losses
- b) Effects to flow in the Madison River
- c) Maximum groundwater drawdown in the developed area

13. Evaluate Uncertainty

- a) Ranges of likely effects

QUESTIONS?



Modified from Kellogg and others, 2007

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