Preliminary Draft

Case Study Report

to the

60th Legislature Water Policy Interim Committee

August 13, 2008

Montana Bureau of Mines and Geology

Report Outline

Section 1: General Concepts — John LaFave

Section 2: Case Studies

- Lower Beaverhead — Ginette Abdo, Gary Icopini, John Metesh
- Gallatin — Kirk Waren
- Bitterroot — John LaFave

Section 3: Evaluation of Hydrologic Assessments — Tom Michalek

WATER POLICY INTERIM COMM.
AUGUST 13, 2008
EXHIBIT 1

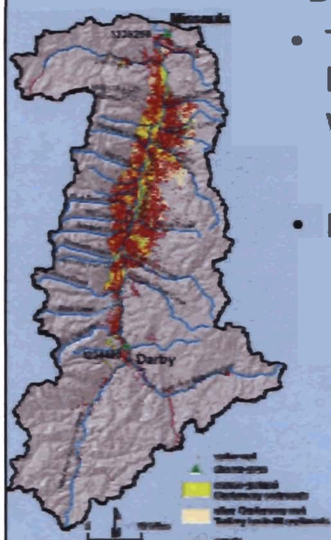
Today's Presentations

Summary of Case Studies:

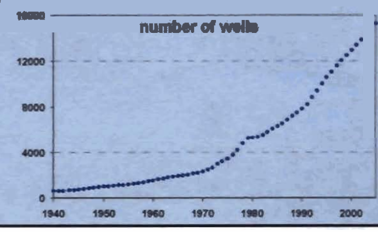
1)	Bitterroot River	John LaFave
2)	Gallatin River	Kirk Waren
3)	L. Beaverhead River	John Metesh

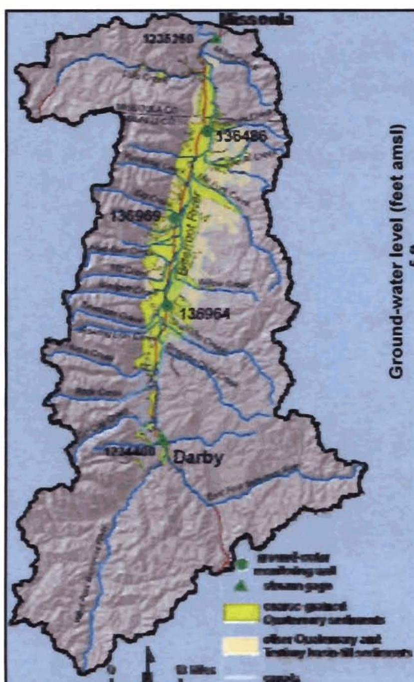
Bitterroot River John LaFave

Ground-Water Development in the Bitterroot Valley

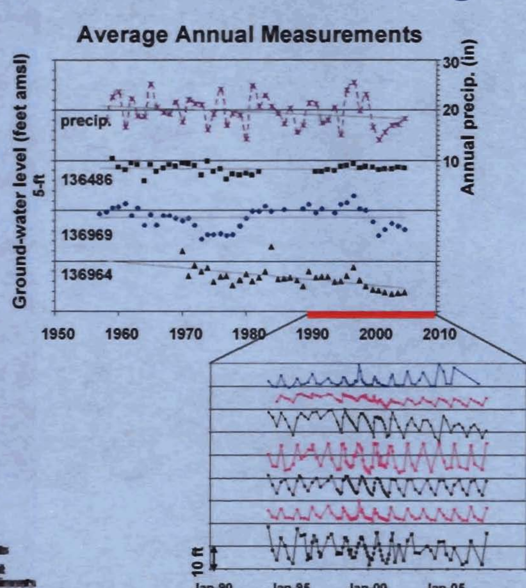


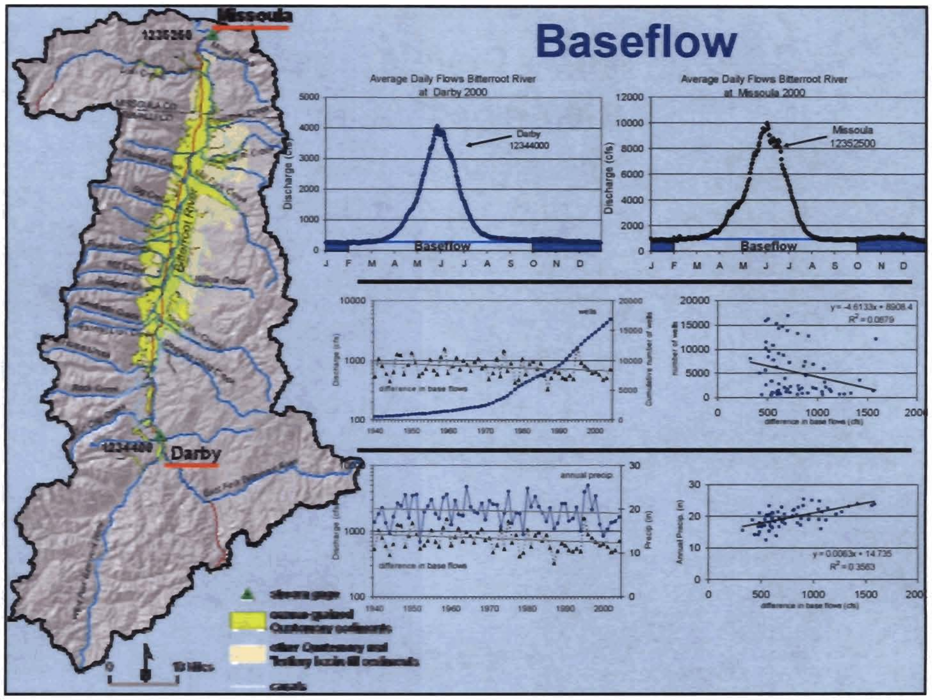
- The Bitterroot Valley has the highest concentration of exempt wells in the state
    - What's the impact?
- Expect to see:
    - 1) reduction in gw storage
    - 2) reduction in baseflow





Ground-Water Storage



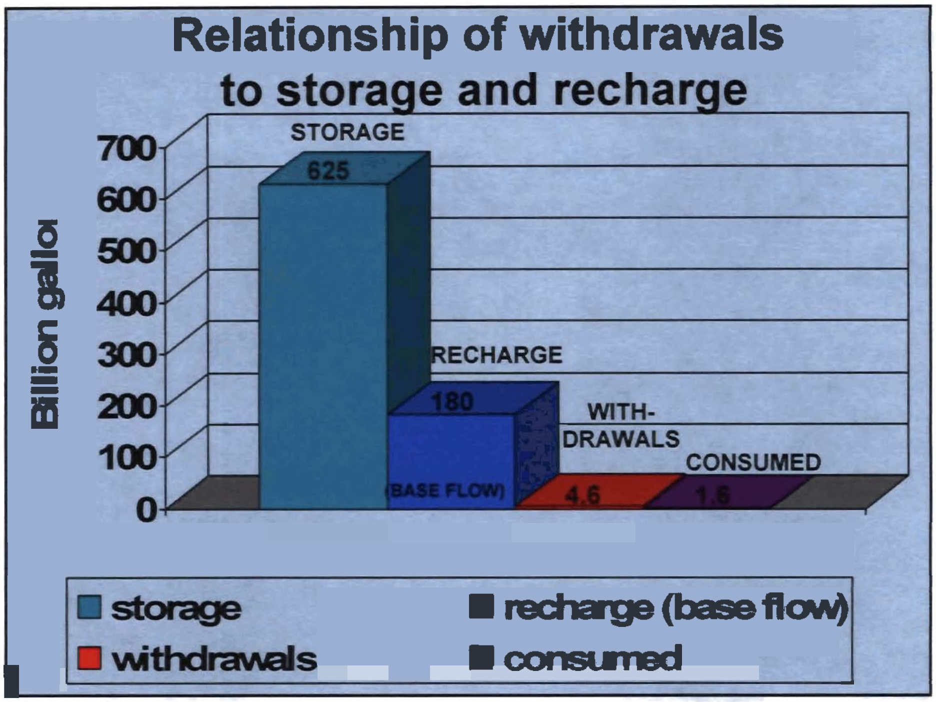


Ground-Water Recharge

Recharge to an aquifer*
results in an equal amount of discharge to a stream

Average Base Flow Gain Between Darby and Missoula
775 cfs

180 Billion Gallons/yr



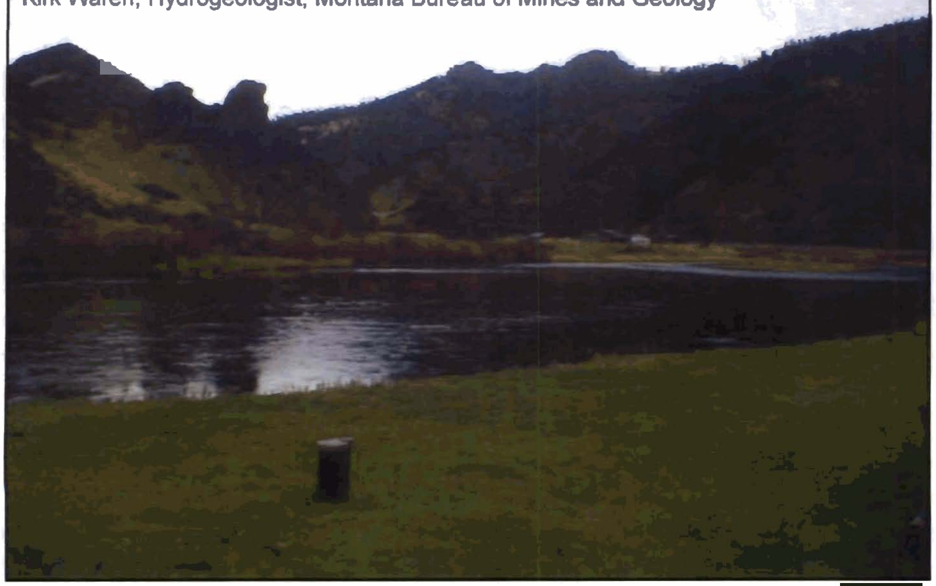
Bitterroot Summary

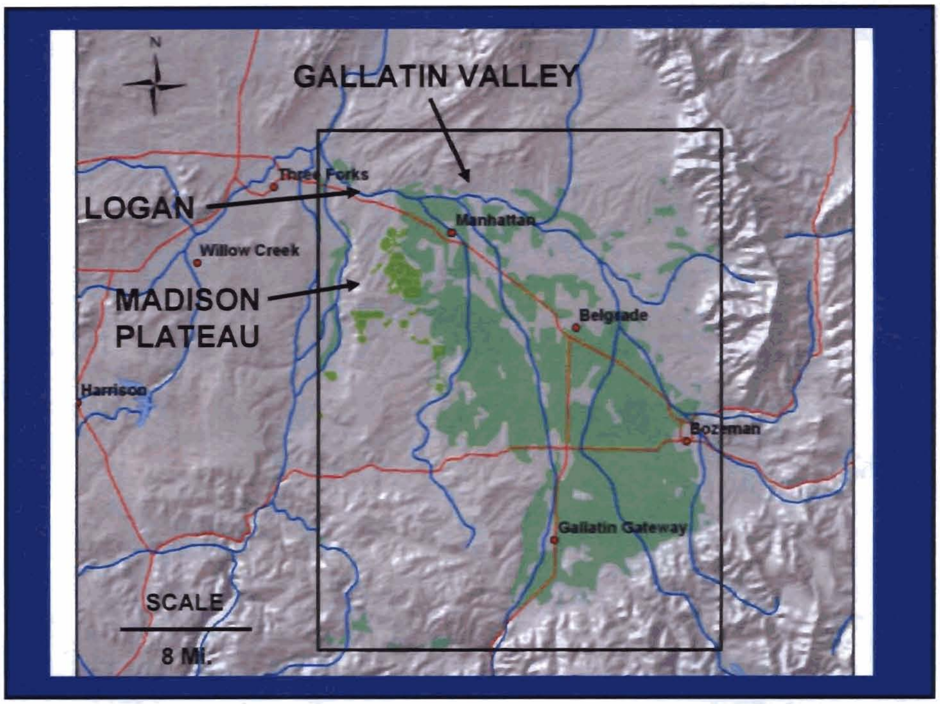
- On basin-wide scale no measurable impacts to ground-water storage or river baseflows
  - May not pick up localized impacts
- Compared to the magnitude of ground-water recharge and discharge, the consumptive use of ground water is a minor fraction (~1 percent)
  - May not pick up seasonal impacts

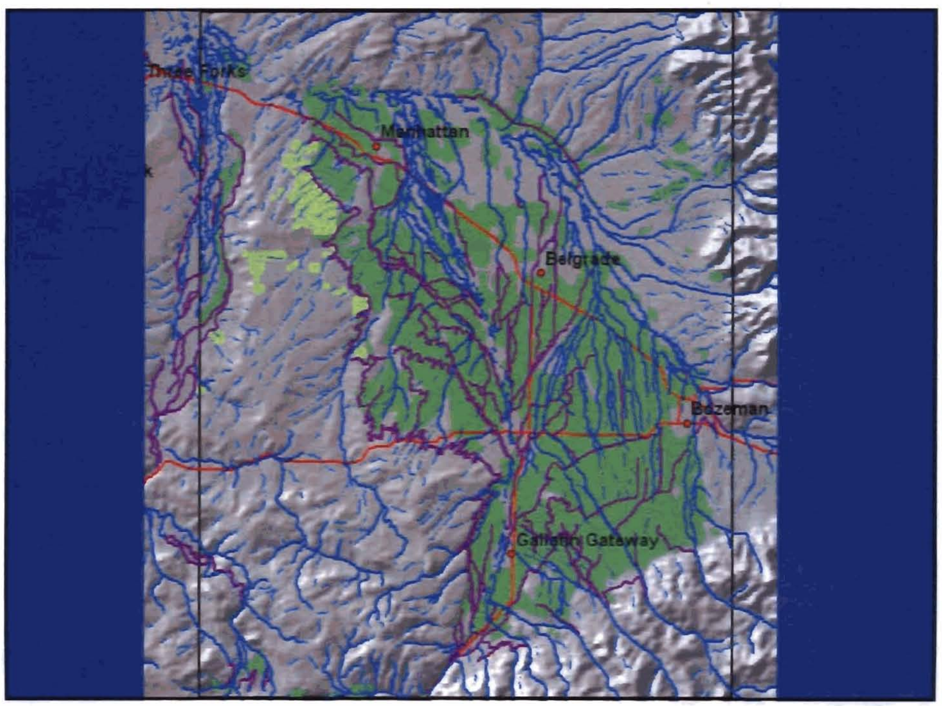
Gallatin River Kirk Waren

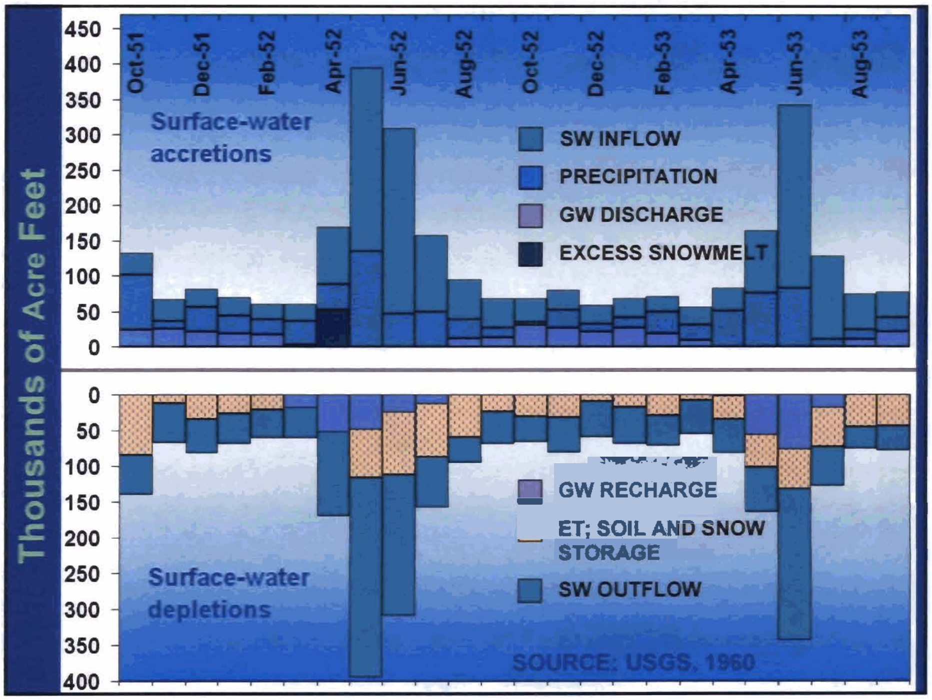
Gallatin Valley Case Study – A Basin-Scale Ground-Water Model to Evaluate Ground-Water and Surface-Water Interaction

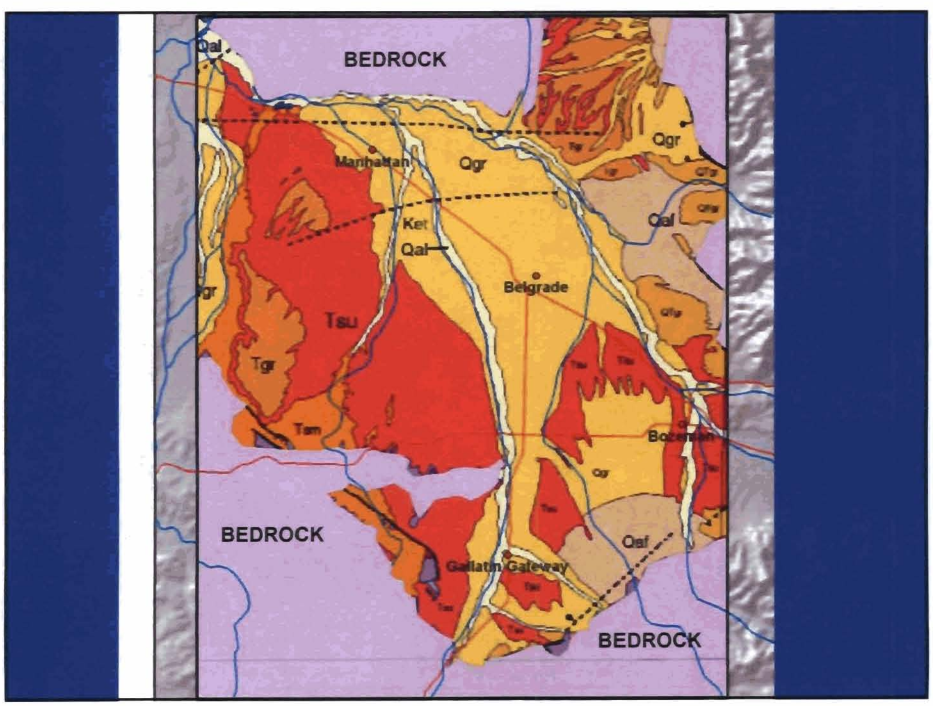
Kirk Waren, Hydrogeologist, Montana Bureau of Mines and Geology




N
GALLATIN VALLEY
Three Forks
LOGAN
Manhattan
Willow Creek
MADISON
PLATEAU
Belgrade
Harrison
Bozeman
Gallatin Gateway
SCALE
8 Mi.


Three Forks
Manhattan
Belgrade
Bozeman
Gallatin Gateway


Thousands of Acre Feet
450
400
350
300
250
200
150
100
50
0
Oct-51
Dec-51
Feb-52
Apr-52
Jun-52
Aug-52
Oct-52
Dec-52
Feb-53
Apr-53
Jun-53
Aug-53
Surface-water accretions
SW INFLOW
PRECIPITATION
GW DISCHARGE
EXCESS SNOWMELT
0
50
100
150
200
250
300
350
400
GW RECHARGE
ET; SOIL AND SNOW STORAGE
SW OUTFLOW
Surface-water depletions
SOURCE: USGS, 1960


BEDROCK
Qal
Manhattan
Qgr
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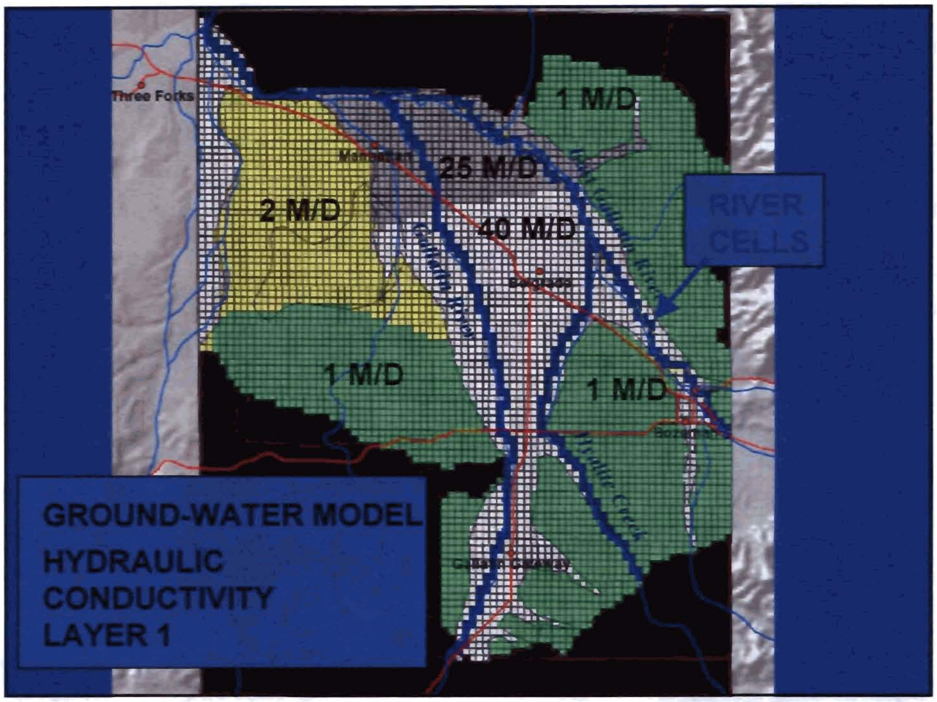
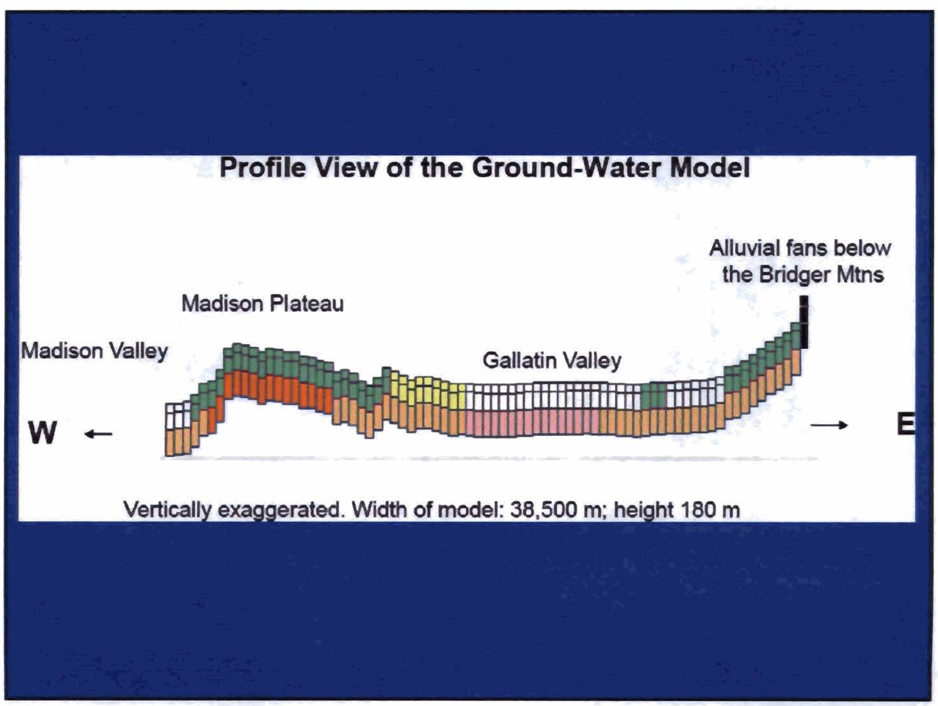
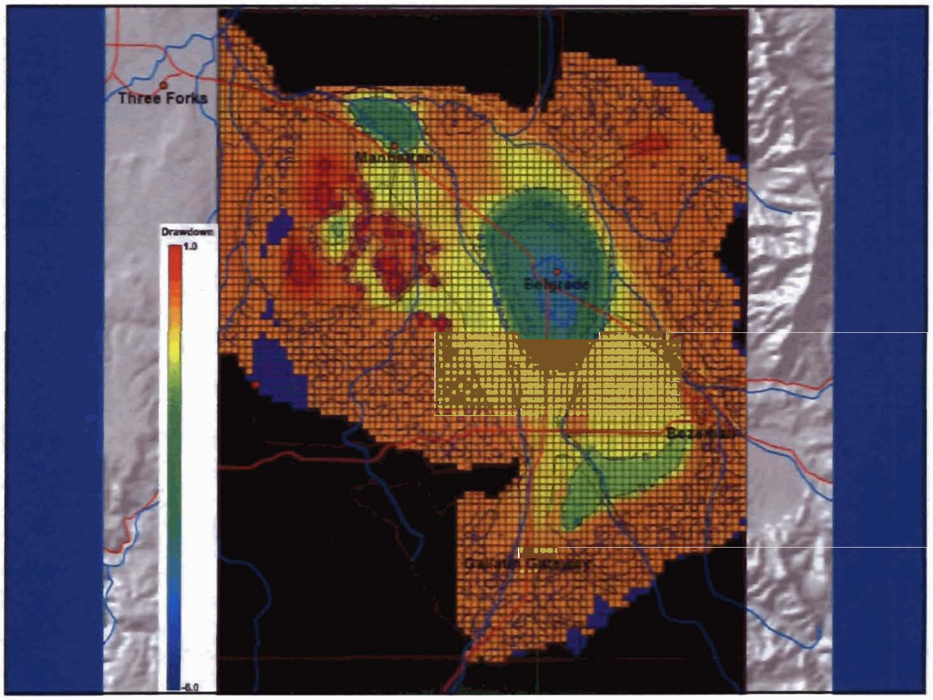
Belgrade
Tsu
Tgr
Bozeman
BEDROCK
Qaf
Gallatin Gateway
BEDROCK



Three Forks
1 M/D
25 M/D
2 M/D
40 M/D
RIVER CELLS
Gallatin River
1 M/D
1 M/D
GROUND-WATER MODEL
HYDRAULIC CONDUCTIVITY
LAYER 1



Profile View of the Ground-Water Model
Alluvial fans below the Bridger Mtns
Madison Plateau
Madison Valley
Gallatin Valley
W ←
→ E
Vertically exaggerated. Width of model: 38,500 m; height 180 m



Gallatin Valley Case Study

- A relatively simple ground-water model was developed for the Gallatin Valley as a demonstration project

The ground-water model shows that stream depletions from an existing well field pumping an estimated 87 cfs each irrigation season are likely highly buffered by distance and depth.

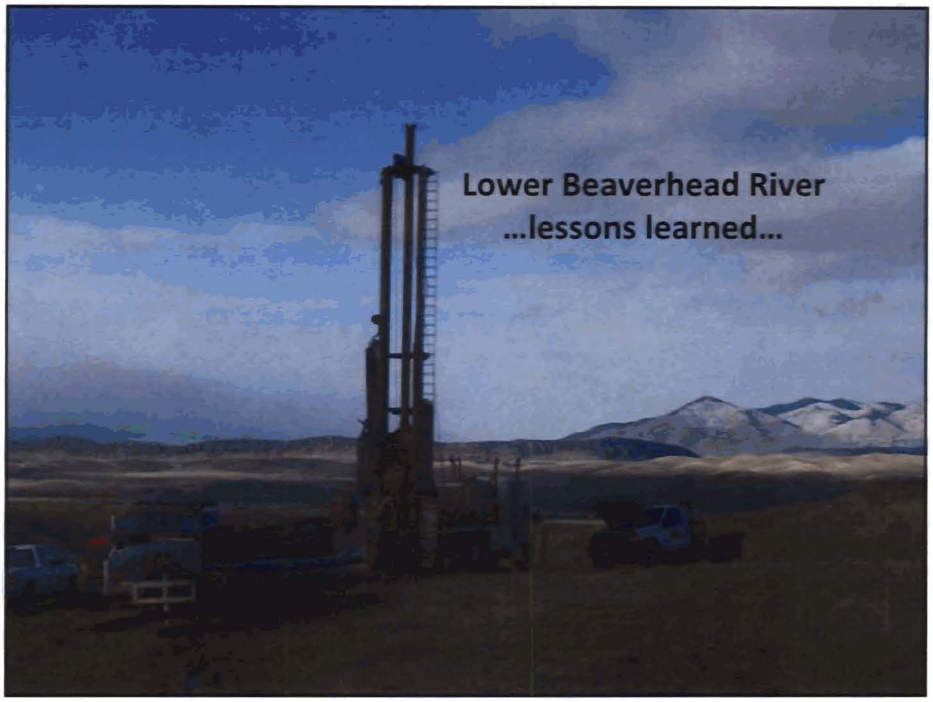
Gallatin Valley Case Study

- If this model were operated for many years, the calculated cumulative stream flow depletions would eventually average out to about 36 cfs occurring year-round.
- Due to the dynamic annual water budget, such long-term calculated depletions become questionable, because the system can be replenished during times of abundant water.

Gallatin Valley Case Study

- The specific times and places of water shortages must be determined.

A more advanced modeling effort can used to evaluate the response of the system to periods of abundant water and test water management alternatives to address identified problems.

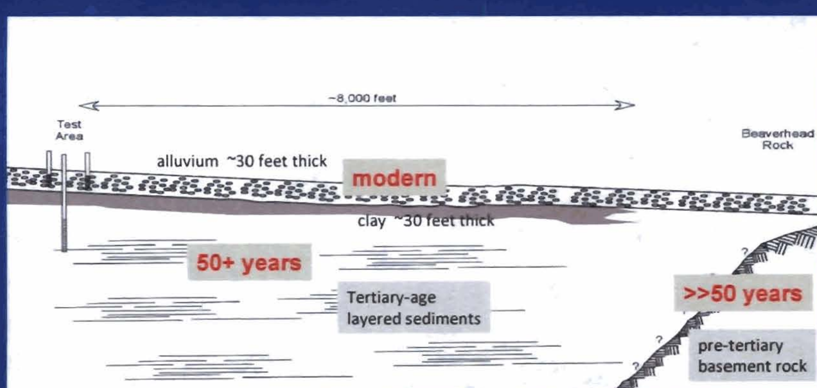


Basin hydrogeology

NEW!

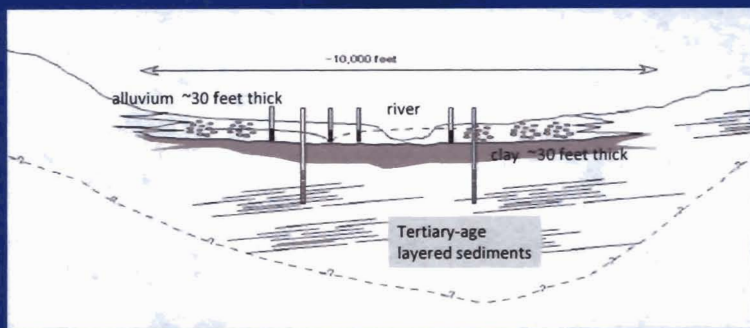
•aquifers (drill hole data, aquifer tests, isotope age-dates)

3 distinct aquifers…for now…



Basin hydrogeology

- clay layer: not if, but where and when SD will occur
  - current and future applications
    - mitigation/offset methods/location(s)
      - develop deep distal, recharge shallow near subdivisions?
      - 30 foot aquifer



Methods for Stream Depletion Analysis

Analytical

Glover and Balmer (1954)

Grigoriev (1957)

Bochever (1966)

Jenkins (1968, 1970)

Schroeder (1987)
"Colorado model"

Wilson (1993)

Sophocleous et al (1995)

Hunt (1999)

Integrated Decision Support Group (2004)*

Butler et al (2001)

Hunt (2003, 2007)*

Di Matteo and Dragoni (2005)

Miller et al (2007)

Numerical

MODFLOW (McDonald and Harbaugh (1988)

STRMDEPL (Zarriello, 2001)

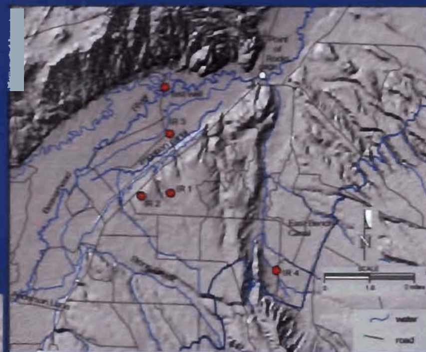
BRANCH (Schafranek, 1987)

HSPF (Bucknell et al, 1997)

Stream Depletion models:

rates, location, timing

specific to LBH



AND (more importantly?)

Mitigation/offset analyses:

one size does not fit all

Public Comments

Received (as of 8.11.08):

- DNRC
- Nicklin Earth & Water, Inc.

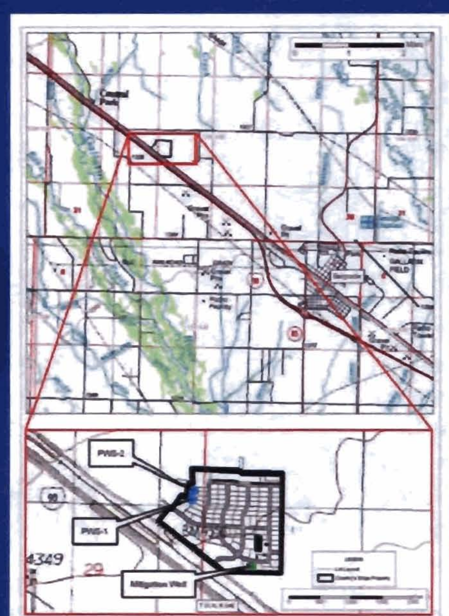
Response

attachment to final report ?

Evaluation of Hydrologic Assessments

Tom Michalek

Example of a site map from
a Hydrogeologic Assessment



Hydrogeologic Assessments are required to accompany applications for new ground-water use in closed basins.

The assessments are necessary to determine net depletion of surface water and/or adverse effect on senior appropriators due to the proposed new use.

If adverse effect is predicted, a mitigation plan is required.

This section of the report summarizes the application process, the Hydrogeologic Assessment reporting and analytical requirements, and the utility of the information provided in the assessments.

- Hydrogeologic Assessments include aquifer testing and a general evaluation of geologic and hydrologic conditions in the area of proposed use.
- Analytical methods used contain the same inherent simplifications and limitations as other ground water techniques.
- The information produced by these assessments is generally useful to future applicants and investigators.
- Because each new application can affect water availability, cumulative impacts are addressed to the extent that lack of adverse effect is harder to prove in subsequent applications in the same area.
- DNRC and MBMG have developed a process to prepare Hydrogeologic Assessments and data for inclusion in the Ground-Water Information database to provide public access.