MBMG
Groundwater Investigations Program
Helena Area Projects

Stakeholders Meeting
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Helena Area Projects

North Hills

Scratchgravel Hills
OUTLINE

For both the **North Hills** and **Scratchgravel Hills** Study Areas:

• Key Questions
• Investigative Methods
• Work to date
• Upcoming work
• Summary
North Hills Area

**Key Questions**

- **Can the North Hills aquifer system sustain current and projected groundwater withdrawals?**
  - Water budget (ET, surface water runoff)
  - Aquifer types & extents

- **Is the North Hills aquifer system vulnerable to nitrate contamination?**
  - Water quality (historic & current)
North Hills Area

Finding Answers Via...

- Review of Existing Data
- Geophysical Surveys & Exploratory Drilling
- Aquifer Tests
- Monitoring Network
- Groundwater Flow Modeling
North Hills Area

Finding Answers Via...

• Review of Existing Data

• Geophysical Surveys & Exploratory Drilling

• Aquifer Tests

• Monitoring Network

• Groundwater Flow Modeling
Aquifer Delineation in blue (Madison, 2006)
Aquifer Delineation in blue (Madison, 2006)

Reynolds Surficial Geologic Map 2008, unpublished
North Hills Area

*Finding Answers Via...*

- Review of Existing Data
- **Geophysical Surveys & Exploratory Drilling**
- Aquifer Tests
- Monitoring Network
- Groundwater Flow Modeling
Objectives of Geophysical Testing

To create a geologic model to aid in determining the nature of the North Hills aquifer system

- Determine depth to bedrock and/or water table
- Interpret results in conjunction with existing drilling logs & geologic maps
North Hills Area

*Geophysical Surveying by MTech Students*

- Resistivity sounding conducted on shallow bedrock/possible fault zone – **October 2009**
- Resistivity, TDEM, and seismic surveys north of previous area - **February 2010**
- MTech field camp used gravity and resistivity methods – **May-June 2010**
- Combination of gravity and magnetic methods proposed – **Summer 2010**
Geophysical Site: February 2010 Project

February 2010 Student Work:
• Loop-loop resistivity survey E & W of I-15
• Seismic refraction survey W of I-15
• Time domain EM survey E & W of I-15

Previous (November 2009) Student Work in Same Area:
• Schlumberger DC (resistivity) survey E & W of I-15
• Time domain EM survey E & W of I-15

(Kunstek and Woodward, 2010)
Interpretation of 2009 Geophysical Results

Silt, sand & gravel
Sand/gravel lense
Clayey silt, sand & gravel
Weathered bedrock
Bedrock

Station 1 100 m Station 2 300 m Station 3 TDEM
Interpretation of February 2010 Geophysical Results
DRILLING SITES
Completed & Planned

DRILLING PURPOSES

Borings:
1. Explore thickness & depths of hydrogeologic units
2. Support/refute geophysical test findings
3. Make sense of ambiguous drillers logs

Wells:
1. Monitor areas of declining water levels
2. ID & measure degree of vertical gradient
3. Aquifer testing
North Hills Area
Finding Answers Via...

- Review of Existing Data
- Geophysical Surveys & Exploratory Drilling
- **Aquifer Tests**
- Monitoring Network
- Groundwater Flow Modeling
Aquifer Test Objectives

ESTIMATE AQUIFER PROPERTIES

• Transmissivity – How easily is water transmitted?
• Storativity – How much water can the aquifer store?
• Anisotropy – Does its ability to transmit or store water change with direction?
Drawdown in PM-66

Observed Drawdown
PM-66

$y = 0.0348\ln(x) - 0.1388$
$R^2 = 0.9042$

Recovery in PM-66

Observed Recovery
PM-66

$y = -0.046\ln(x) + 0.3906$
$R^2 = 0.9289$
HELENA VALLEY FAULT AQUIFER TEST

Estimated location of Helena Valley Fault

Well 2 (4-day test, 3rd, 105 gpm)

Well 1 (8-hr test, 2nd, 23 gpm) - Flowing Well

Well 3 (8-hr test, 1st, 100 gpm)
**GOAL:** Estimate aquifer properties of the Spokane Formation (bedrock)
- Fractured Precambrian Argillite
- Primary aquifer, underlies most of the study area
North Hills Area

Finding Answers Via...

• Review of Existing Data

• Geophysical Surveys & Exploratory Drilling

• Aquifer Tests

• Monitoring Network

• Groundwater Flow Modeling
• Expanded L&C Network to ~ 53 wells
• Installed crest gages in drainages
• Installed staff gages in Spring Creek
Objectives of Monitoring Network

• Monitor changes over time & space
  water levels
  water quality
  surface-water flow

• Determine factors driving such changes
  climatic
  human-induced
  combination

• Generate analytical tools
  potentiometric surface maps
  stiff diagrams
  hydrographs
  rating curves
PRELIMINARY POTENTIOMETRIC SURFACE MAP
Using Data from Previous MBMG Study (Madison, 2006)
Monitoring Network Data Examples

Groundwater:

Surface Water:
No spring runoff observed, nor measured at crest gages
Snowmelt evaporated and infiltrated
SAMPLING EVENT – APRIL 2010
A Quick Glance at Nitrate Results

North Hills GWIP Study Area
- Monthly Monitoring Well Sites
- 2007 CGWA Boundary
- Study Area Boundary
- Township
- Sample Location

Sample Location 10.21 mg/L ~ 1 mg/L
Sample Location 1.49 mg/L
Sample Location 1.75 mg/L
Sample Location ~ 1 mg/L

Helena 5 miles
North Hills Area
Finding Answers Via...

• Review of Existing Data
• Geophysical Surveys & Exploratory Drilling
• Aquifer Tests
• Monitoring Network
• Groundwater Flow Modeling
Groundwater Modeling
Objectives & Work to Date

Objectives:
• Simulate past system conditions – Calibrate model to field data
• Predict future system conditions – Perform prediction-focused calibration and sensitivity analysis

Work to Date:
• Groundwater model framework underway
• Evaluating existing data to develop *conceptual* model
  - Aquifer tests, geophysical tests, drilling logs, water-level monitoring, etc
    - hydrogeologic units >> model layers
    - aquifer property estimates >> parameter values
Stage 1: Building the Model Framework

• Define area with maps
• Assign model grid and active cell areas
• Assign elevations using Digital Elevation Models (DEM’s)
• Preliminary groundwater surface generated from areal recharge and known water elevations

Arrows show groundwater flow direction
North Hills Area

*Other Upcoming Work*

- Groundwater Sampling – Aug & Oct 2010
- Borehole & Well Drilling – Summer 2010
- ET Results (METRIC) – November 2010
- Field Data Analysis – Summer & Fall 2010
Examples and Photos

The following slides provide some examples photographs of work conducted in the North Hills groundwater investigation.
Stilling well
Scratchgravel Hills Area

**Key Questions**

- **Green Meadow Controlled Groundwater Area:** Will withdrawals exceed recharge?
  - What level of development can be sustained?

- **Upper Missouri Closed Basin:** Will groundwater pumping affect surface-water flows?

- Are wells in the Scratchgravel Hills vulnerable to nitrate contamination?
Scratchgravel Hills Area

Finding Answers Via...

• Review of Existing Data
• Monitoring Network
• Water Quality Sampling
• Aquifer Tests
• Groundwater Flow Modeling
Scratchgravel Hills Area Update

June 2010

• Drilling and aquifer test contracts finalized
• Monitoring well network up and running (60 total sites)
• Contracted services with Lewis and Clark Co. Water Protection District – 38 Wells Monitored
• Stream monitoring sites with seasonal stage recorders and peizometers
  – Three along Silver Creek
  – Two along Sevenmile Creek
  – One on Sunny Vista Ditch
  – One on Threemile Creek
  – May install one on Tenmile Creek
• Investigation of faults planned
NRCS Soils Map – Septic Tank Adsorption Fields
Red = Very Limited; Yellow = Somewhat Limited
Awaiting Results from April Sampling Event for Nitrate
Scratchgravel Hills Area Update

June 2010

• Spring monitoring has been implemented (7 springs)
• Crest Gages have been installed at three sites
• Continuous recorders have been installed in dedicated monitoring wells, and in some domestic wells
• Flow in the Helena Valley Irrigation District Canal is measured where the canal enters and exits the study area
Early formulation and testing of the Scratchgravel groundwater model is underway.
SUMMARY

Work To Date

• Data Review & Evaluation
• 3 Geophysical Student Projects
• Exploratory Drilling (10 wells)
• 3 Aquifer Tests
• Expansion of Monitoring Networks
• 1st Site-Wide Sampling Event
• Staff gage & Crest Gage Installation & Monitoring
• Development of Groundwater Model Framework
SUMMARY

Upcoming Work

- Monitoring – Ongoing into 2011
- 2 to 4 Aquifer Tests – Summer 2010
- Exploratory Drilling – Summer 2010
- Water Sampling Events – Summer & Fall 2010
- Geophysical Surveying Final Report – Summer 2010
- Groundwater Modeling – Ongoing
Agency and Group Coordination

FEDERAL:
• USGS
• EPA

STATE:
• DNRC Water Resources Division
• DEQ
• Montana Watershed Coordination Council
• University of Montana

LOCAL:
• Lewis & Clark County Water Quality Protection District
• Helena Valley Irrigation District
• Lewis & Clark County Conservation District
• Lake Helena Watershed Monitoring Committee
• Helena-area consultants, developers, and residents
Questions?

http://www.mbbmg.mtech.edu/gwip/gwip.asp