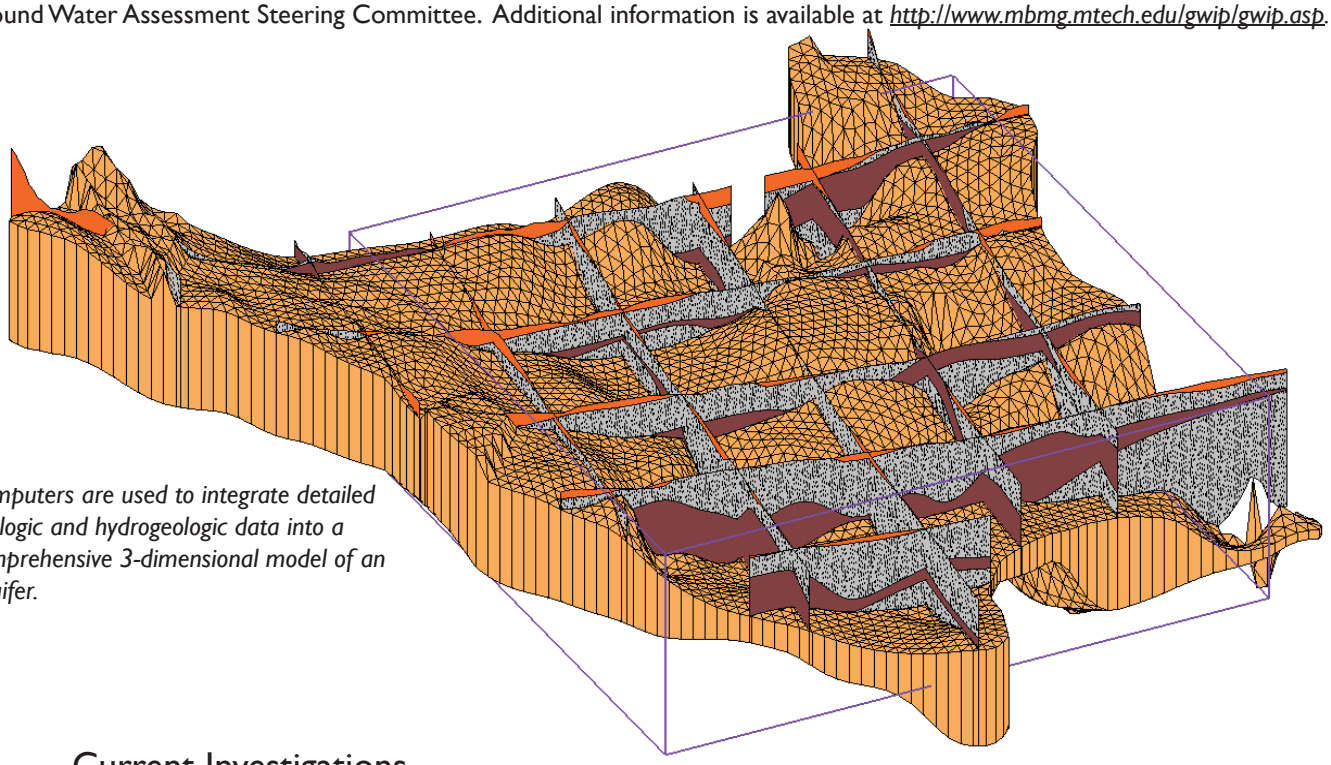
MONTANA BUREAU OF MINES AND GEOLOGY

Ground Water Investigation Program

The Montana State Legislature's 2007/2008 Water Policy Interim Committee (WPIC) recognized that competition for water resources and the lack of detailed information on groundwater/surface water interaction has challenged informed water-resource management and development in Montana. The WPIC found that "continued and expanded study of groundwater resources is vital to shaping statewide policy as well as providing the data necessary for local decisions regarding water." The Ground Water Investigation Program was funded by the 61st Montana Legislature to complete 6 to 8 projects per biennium, and operates under the oversight of the Ground Water Assessment Steering Committee. Additional information is available at *http://www.mbmg.mtech.edu/gwip/gwip.asp*.



Computers are used to integrate detailed geologic and hydrogeologic data into a comprehensive 3-dimensional model of an aquifer.

Current Investigations

1) **North Hills area, Helena**—Increasing groundwater development by subdivisions in this area has raised concerns of impacts to water-rights holders, and concerns about potential impacts from use of individual septic systems in dense housing developments. Computer modeling is being used to interpret declining water levels.

2) **Four Corners area, Bozeman**—Large-scale irrigation has altered a complex interconnection between groundwater and surface water. Changes due to population growth and changing irrigation practices that may affect water availability and senior water rights are being investigated to improve predictability and optimize water-use efficiency.

3) **Belgrade**—New water uses may cause negative impacts on water quality and quantity. A primary question being addressed by GWIP is whether mitigation can be effective in compensating for potential impacts.

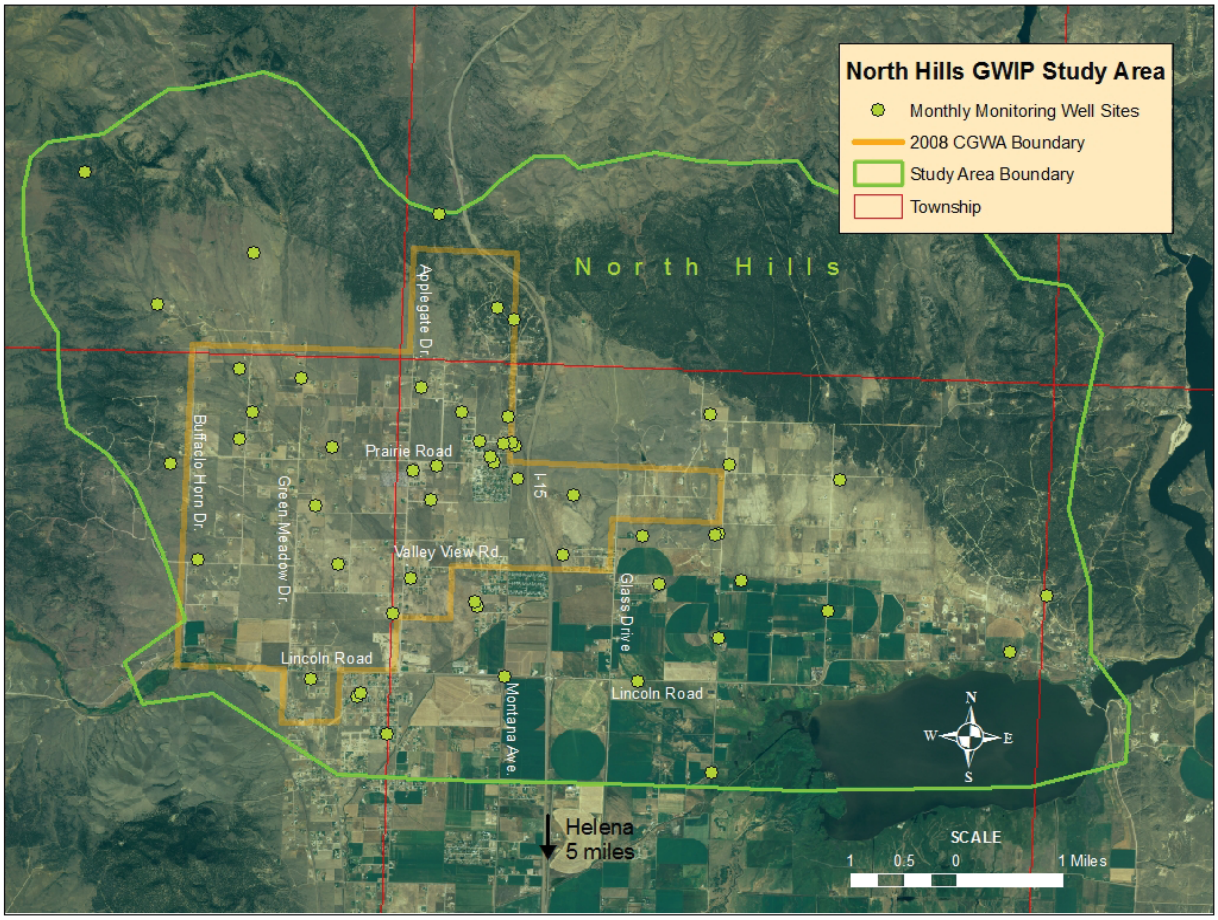
4) **Lower Beaverhead River West, Dillon**—The increased number of high-volume production wells since the mid-1990s may impact senior water-rights holders and may stress the aquifer beyond sustainability. Understanding the impact of increased groundwater withdrawals on groundwater and surface water availability is the primary focus of this project. A computer model has been used to evaluate the impact of high-capacity wells on potential depletion of water resources.

5) **Scratchgravel Hills, Helena**—Declining water levels concurrent with subdivision growth have been observed in some parts of this project area. This project is providing a better quantification of aquifer recharge and withdrawals.

6) **Florence**—Increasing population density in the Bitterroot Valley has increased the demand on the aquifer and the possibility of inducing contamination of drinking water by septic waste drainage.

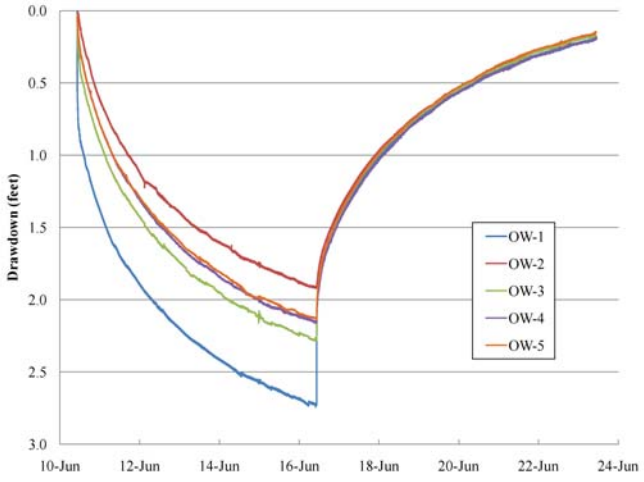
7) **Flathead Valley Deep Confined Aquifer**—The increases in high-capacity municipal and irrigation wells, domestic wells, and localized water-level declines in the deep aquifer have raised concerns about the long-term sustainability of this water supply. The result of this project will be a detailed understanding of this aquifer.

GWIP PROJECT AREA:
NORTH HILLS, HELENA, LEWIS & CLARK COUNTY



The North Hills Study Area is located at the north end of the Helena Valley, including Silver Creek. This is an unincorporated area where both subdivisions and individuals rely on groundwater. Septic systems are a common wastewater treatment approach. Increasing development and declining groundwater levels resulted in the establishment by the Montana Department of Natural Resources and Conservation (DNRC) of a temporary Controlled Ground Water Area (CGWA) in 2002. After a study of the area was completed through a cooperative effort by the Montana Bureau of Mines and Geology, the Lewis and Clark County Water Quality Protection District, and the DNRC, the temporary CGWA was terminated in 2006. The matter was re-evaluated, resulting in the establishment of a second, smaller CGWA in 2008. The justification for this controlled groundwater area is the likelihood of impacts from continued groundwater development. Also, the practice of using individual septic systems in dense housing developments is a concern.

This investigation is providing more accurate descriptions of the geologic setting, hydrologic properties of the aquifers, available water supplies, and stresses on the hydrologic systems. Work includes assembling existing data and reports, establishing new meteorological and hydrologic monitoring, drilling exploratory and test wells, conducting aquifer tests, water quality sampling, and evaluating transpiration consumption by both crops and natural vegetation. A numerical groundwater model is being constructed to simulate the observed hydrogeologic conditions. Such a model can be used to evaluate the response of the groundwater system to specific stresses, such as new wells or well fields. The final product will be a publicly available interpretive report, groundwater model and comprehensive data set.



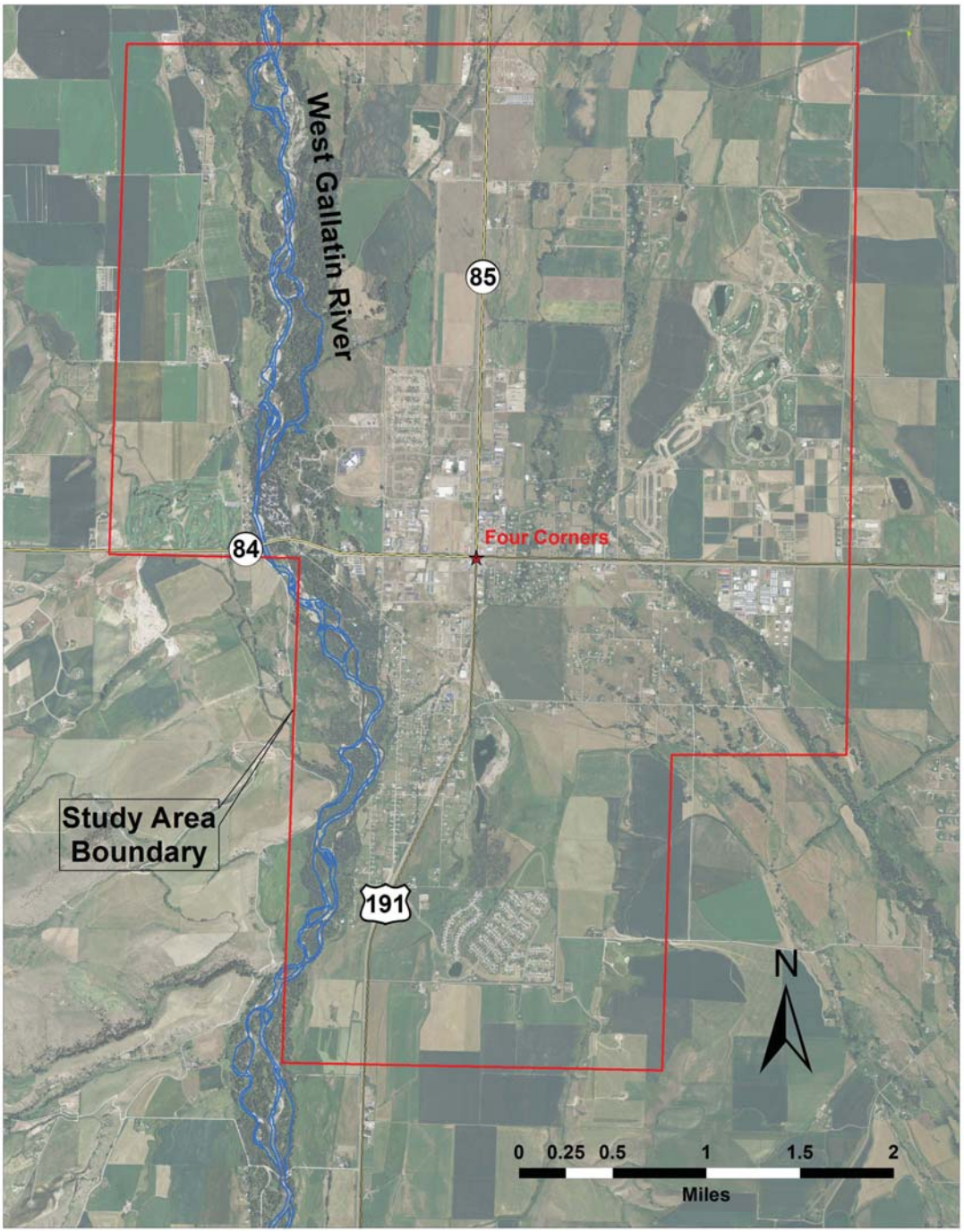
Water levels in observation wells respond to pumping and recovery during aquifer tests. Hydrographs, such as the one shown here, are used to interpret the responses and determine characteristics of the aquifers including transmissivity and storativity.

Current MBMG personnel assigned to this project:

Kirk Waren
Team Leader/Hydrogeologist
406.496.4866
kwaren@mtech.edu

Julie Ahern
Hydrogeologist
406.496.4854
jahern@mtech.edu

GWIP PROJECT AREA:
FOUR CORNERS, GALLATIN COUNTY



Subdivisions and rural residential and commercial development are transforming agricultural land in the area of this busy intersection four miles west of Bozeman. Commercial water distribution and wastewater treatment systems are replacing traditional well and septic systems. The possible hydrologic effects of land use conversion from irrigated agriculture to high-density residential have raised questions concerning both water quality and water availability.

In order to provide more accurate descriptions of the geology, hydrologic properties of the aquifers, available water supplies, and the effects of stresses on the groundwater and surface water in the Four Corners area, GWIP has been installing stream gauging stations and measuring stream flows at over 35 locations along the West Gallatin and major tributaries.

We have added over 30 new and existing monitoring wells to the groundwater network, increasing the total to over 60. We have also installed test/monitoring wells at four test sites in the Belgrade/Four Corners area. These test sites will be used to conduct long-term aquifer tests to generate detailed data for use in computer models of the study area. A numerical groundwater model is being constructed to simulate the observed hydrogeologic conditions and to evaluate the response of the groundwater system to specific stresses, such as new wells or well fields. We have and will continue to collaborate with local agencies and water users. The final product will be used by water rights holders and others to manage water better in the valley. Products will include a publicly available interpretive report, computer model, and data set.

Current MBMG personnel assigned to this project:

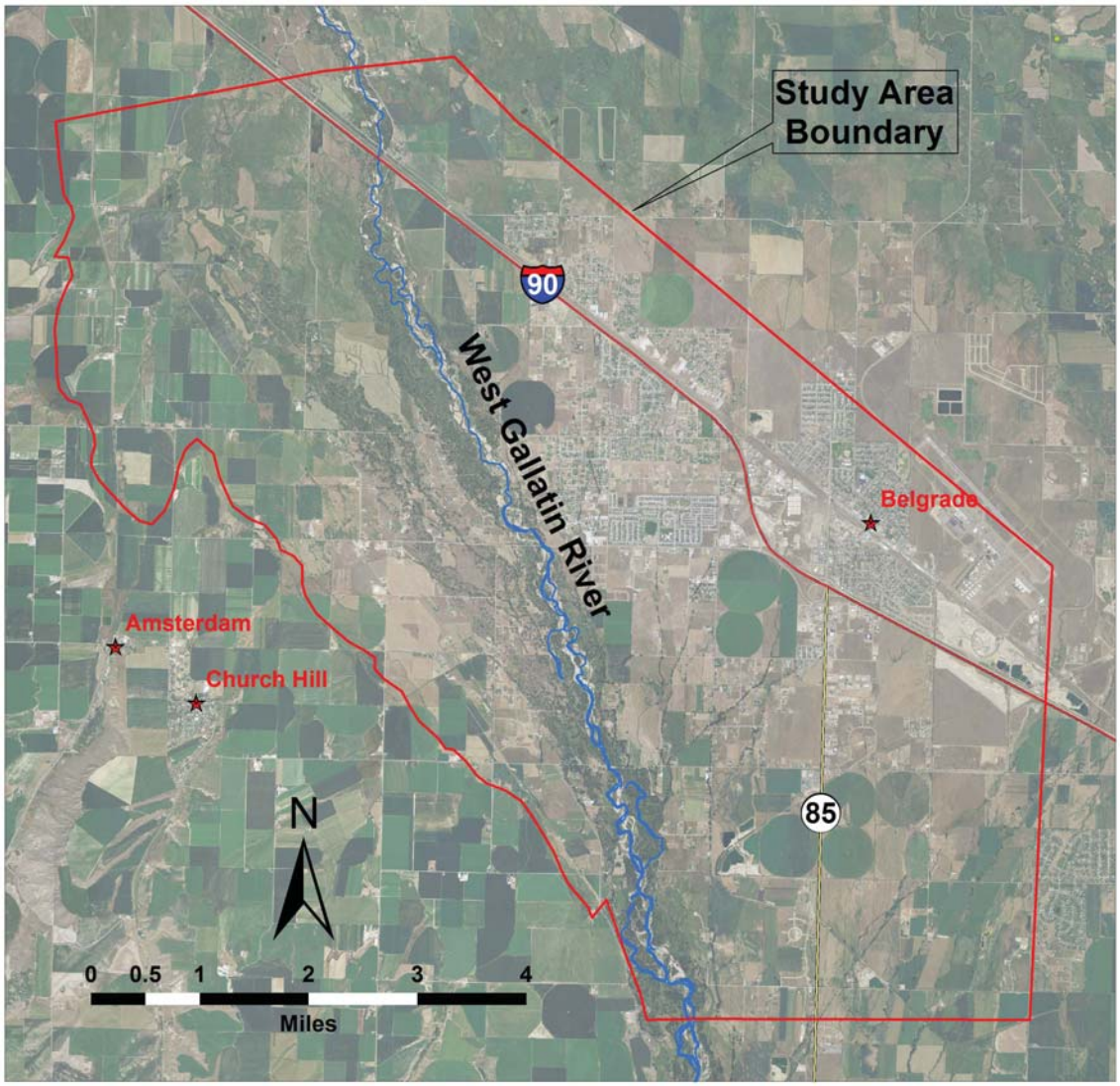
Tom Michalek
Team Leader/Hydrogeologist
406.496.4405
tmichalek@mtech.edu

Mary Sutherland
Hydrogeologist/Modeler
406.496.4410
msutherland@mtech.edu

Mark Schaffer
Hydrologist
406.580.8008
mschaffer@mtech.edu

GWIP PROJECT AREA:

BELGRADE—LOWER WEST GALLATIN RIVER, GALLATIN COUNTY



New neighborhoods, utilizing both on-site septic systems and community wastewater systems, are replacing agricultural land around the growing community of Belgrade. Shallow groundwater with elevated nitrate concentrations has been identified in the area between Belgrade and the West Gallatin River. To assist in the appropriate management of water resources in this area, it is important to identify details concerning groundwater flow directions (including both horizontal and vertical gradients) and the hydrologic relationship between the aquifer and the river.

In order to provide more accurate descriptions of the geology, hydrologic properties of the aquifers, available water supplies, and the effects of stresses on the groundwater and surface water in the Belgrade–Lower West Gallatin area, GWIP has been installing stream gauging stations and measuring stream flows at over 35 locations along the West Gallatin and major tributaries. We have added over 30 new and existing monitoring wells to the groundwater network, increasing the total to over 60. We have also installed test/monitoring wells at four test sites in the Belgrade/Four Corners area. These test sites will be used to conduct long-term aquifer tests to generate detailed data for use in computer models of the study area. A numerical groundwater model is being constructed to simulate the observed hydrogeologic conditions and to evaluate the response of the groundwater system to specific stresses, such as new wells or well fields. We have and will continue to collaborate with local agencies and water users. The final product will be used by water rights holders and others to manage water better in the valley. Products will include a publicly available interpretive report, computer model, and data set.

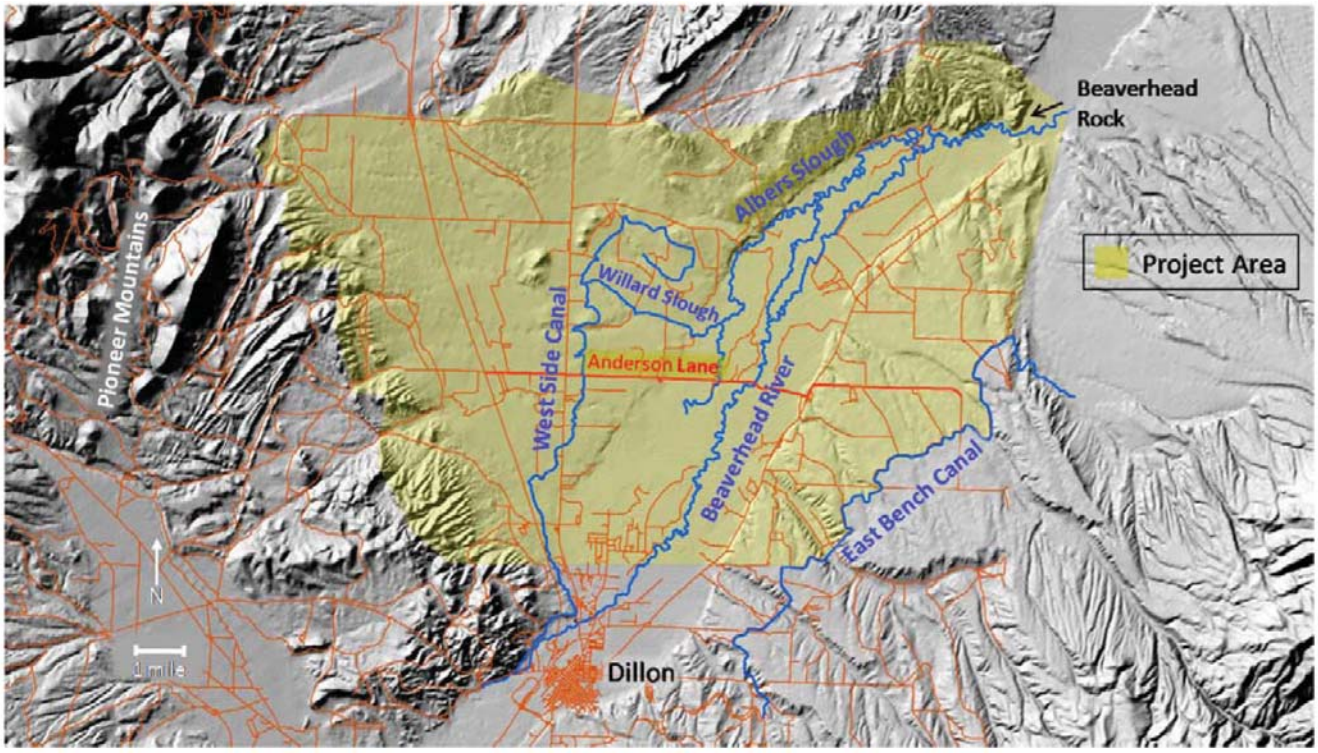
Current MBMG personnel assigned to this project:

Tom Michalek
Team Leader/
Hydrogeologist
406.496.4405
tmichalek@mtech.edu

Mary Sutherland
Hydrogeologist/Modeler
406.496.4410
msutherland@mtech.edu

Mark Schaffer
Hydrologist
406.580.8008
mschaffer@mtech.edu

GWIP PROJECT AREA:
LOWER BEAVERHEAD RIVER WEST, BEAVERHEAD & MADISON COUNTIES



The Lower Beaverhead River-West project area, north of Dillon, is shown on the map. The mainstay of the economy in this area is agriculture, which is supported by groundwater and surface-water irrigation. The Beaverhead River basin has been closed to new surface-water appropriations since 1993. Groundwater permit applications must include a hydrogeologic assessment that evaluates whether the proposed appropriation will result in a net depletion of surface water. If so, the application must be accompanied by aquifer recharge or mitigation plans.

Irrigation needs are primarily met by the Clark Canyon Reservoir and the Beaverhead River, which supply the East Bench Canal, West Side Canal, and ditches throughout the valley. As a result of drought and increasing irrigation demands, there has been an increase in high-volume production wells since the mid-1990s. Applications for well permits have resulted in conflicts between senior and junior groundwater and surface-water rights holders. A primary concern is that groundwater withdrawals will result in stream depletion by inducing flow away from the stream or by capturing stream recharge. Several hydrogeologic studies were previously conducted in the Beaverhead River valley, but none provided adequate information for the west side of the Beaverhead River valley north of Dillon.

This investigation is providing more detailed hydrogeologic information in order to better understand the effects of pumping high-capacity wells on groundwater and surface water. Data collection includes well drilling, aquifer testing, water-chemistry sampling, and monitoring groundwater and surface water. A numerical groundwater model is being used to predict impacts of groundwater development on the Beaverhead River and its tributaries. The final products will be a publicly available report and several web-based project maps, and the groundwater model. GWIP results will provide land owners and regulatory personnel with scientific information to help make informed water management decisions that provide a balance between further development and protection of water resources.

Current MBMG personnel assigned to this project:

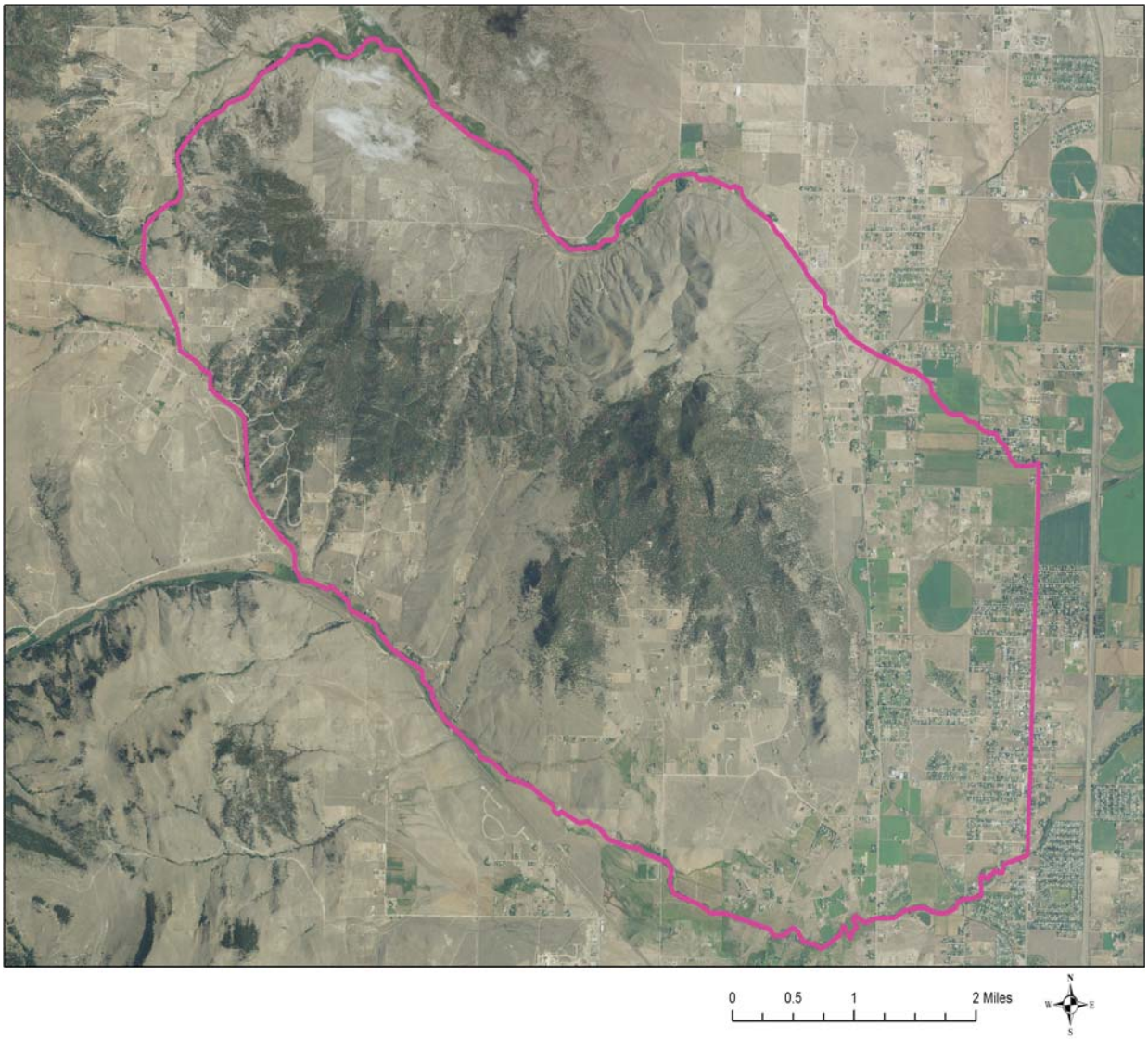
Ginette Abdo
Team Leader/Hydrogeologist
406.496.4152
gabdo@mtech.edu

Julie Ahern
Hydrogeologist
406.496.4854
jahern@mtech.edu

Todd Myse
Hydrogeologist
406.496.4838
tmyse@mtech.edu

Dean Snyder
Hydrogeologist
406.496.4882
dsnyder@mtech.edu

GWIP PROJECT AREA:
SCRATCHGRAVEL HILLS, LEWIS & CLARK COUNTY



The Scratchgravel Hills project area is northwest of Helena. Within this area, the Green Meadow temporary controlled groundwater area was designated by the DNRC in April 2008. Increased subdivisions and declining water levels have been observed in some areas; however, a lack of data prevents an evaluation of cause and effect. The shallow geology of the Scratchgravel Hills consists of alluvial deposits on top of faulted and fractured granitic bedrock and fractured older bedrock. This investigation is providing more detailed hydrogeologic information in order to better understand the geologic setting of this area, to determine aquifer properties, and to better quantify aquifer recharge and withdrawals. Drilling and coring have been conducted in order to establish lithology, particularly with respect to depth to bedrock. Aquifer tests and water chemistry are helping us to define aquifer properties and to determine the degree to which aquifers are connected. This information is being used to develop a model of the groundwater system. This model then is being used to evaluate the effects of pumping wells on groundwater and surface-water availability.

Final products will include a publicly available report, several web-based project maps, and the groundwater model. GWIP results will provide landowners and regulatory personnel with scientific information to help make informed water management decisions that provide a balance between future development and protection of water resources. Also see the GWIC website for data as they become available.

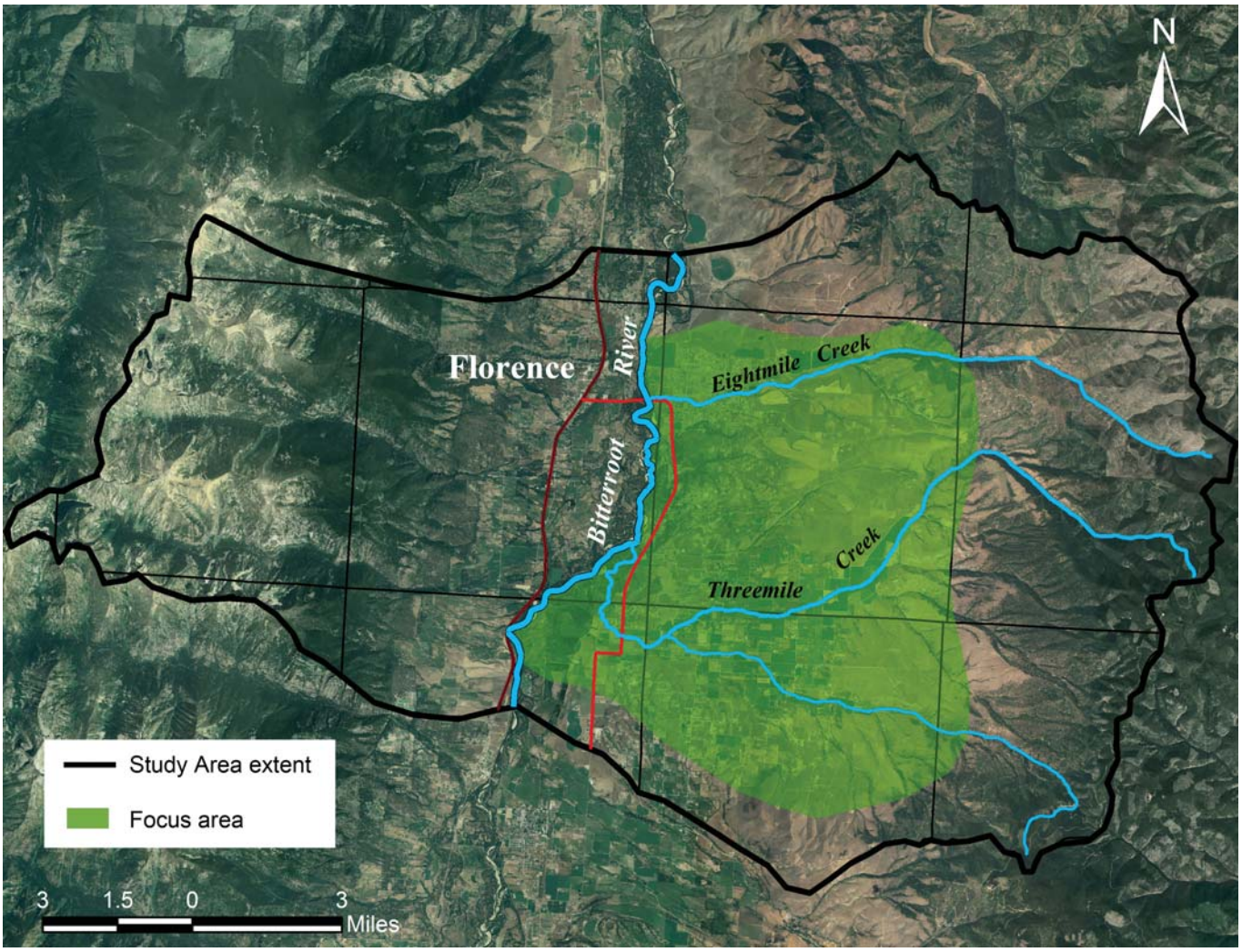
Current MBMG personnel assigned to this project:

Kirk Waren
Team Leader/Hydrogeologist
406.496.4866
kwaren@mtech.edu

Julie Ahern
Hydrogeologist
406.496.4854
jahern@mtech.edu

Andrew Bobst
Hydrogeologist
406.496.4409
abobst@mtech.edu

GWIP PROJECT AREA:
FLORENCE AREA, RAVALLI COUNTY



Increased population density in the Bitterroot Valley has raised concerns by Ravalli County about water availability and effects on water quality. Population growth has resulted in conversion of irrigated land to residential, resulting in a higher density of wells that has increased the demand for groundwater resources. As the demand on the aquifer increases, questions on groundwater availability are coupled with the county's concerns of inducing degradation of drinking water by septic waste drainage.

This investigation focuses on the Eightmile Creek and Threemile Creek drainages as examples of increased pumping density on groundwater supply and surface-water resources in the Bitterroot Valley. The study also examines the sources and extent of nutrients in groundwater and surface water as a result of residential development/septic systems, animal, and agricultural sources. Water chemistry sampling/analyses of the shallow, intermediate, and deep aquifers and surface water are helping to develop the hydrogeologic framework and aquifer vulnerability to over-taxation and degradation. The controls on groundwater availability are being evaluated by examining geology and monitoring the groundwater system.

A numerical model is being used to evaluate the effects of future residential development on groundwater and surface-water quantity. Project results can be used as a management tool for landowners, county and State agencies, and other interested parties as a guide for responsible development, thereby minimizing impacts to groundwater and surface water quantity and quality.

Current MBMG personnel assigned to this project:

Ginette Abdo
Team Leader/Hydrogeologist
406.496.4152
gabdo@mtech.edu

Dean Snyder
Hydrogeologist
406.496.4882
dsnyder@mtech.edu

Jane Madison
Hydrogeologist
406.496.4865
jmadison@mtech.edu

Todd Myse
Hydrogeologist
406.496.4838
tmyse@mtech.edu

GWIP PROJECT AREA:
FLATHEAD VALLEY DEEP AQUIFER, FLATHEAD COUNTY

Population in the Flathead Valley has increased by more than 25 percent in the past decade and is currently about 70,000. All of these residents, with the exception of Whitefish, rely on groundwater. The deep confined aquifer in the Flathead Valley is a thick deposit of sand and gravel that occurs below depths ranging from 75 to 300 feet below the land surface; it is the most utilized aquifer in the valley, supplying high-capacity municipal and irrigation wells in addition to thousands of domestic wells. Continued growth and localized water-level declines in the deep aquifer have raised concerns about the long-term sustainability of the water supply.

This investigation includes monitoring selected existing wells and installing a series of wells at strategic locations across the valley to characterize the geologic framework and the hydrologic relationship among surface water, shallow aquifers, and the deep confined aquifer. The wells are being used to perform tests to define the aquifer's transmissivity properties and assess the changes in aquifer storage. Aquifer vulnerability is being evaluated through targeted water chemistry sampling, groundwater-age dating, barometric efficiency analysis, and isotope and noble gas data. The new project data, along with groundwater/surface-water elevation data, will be used to better understand the groundwater flow systems. The result will be tools that water managers can use to help balance protection and expanding development. All data and interpretations will be published and publicly available to water users, managers, regulators, and scientists.

Current MBMG personnel assigned to this project:

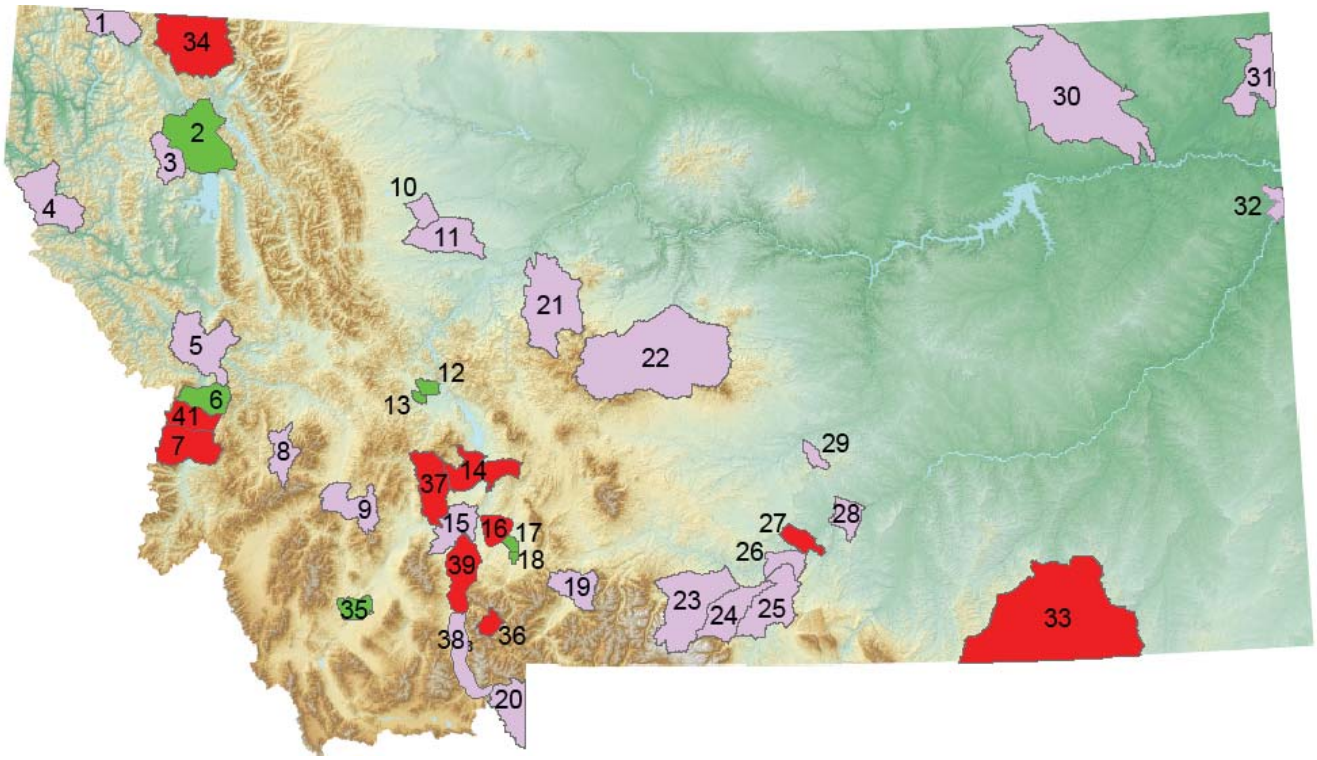
John Wheaton
Hydrogeologist/Project Manager
406.496.4848
jwheaton@mtech.edu

James Rose
Hydrogeologist
406.496.4829
jrose@mtech.edu

STATUS AND FUTURE DIRECTIONS:

MAP OF PROJECT AREAS:

Green, projects for 2009–2011
Red, planned projects for 2011–2013;
Pink, proposed future GWIP projects.



2 Flathead Valley
6 Florence
12 North Hills
13 Scratchgravel Hills
17 Belgrade
18 Four Corners
35 Lower Beaverhead W.
7 Hamilton
14 Townsend, Toston
16 Manhattan
27 West Billings

33 Coalbed methane
34 NF Flathead
36 Big Sky
37 Boulder River
39 Madison Valley Ennis to Three Forks
41 Stevensville Bitterroot
1 Eureka
3 Smith Valley
4 Noxon
5 Missoula Valley

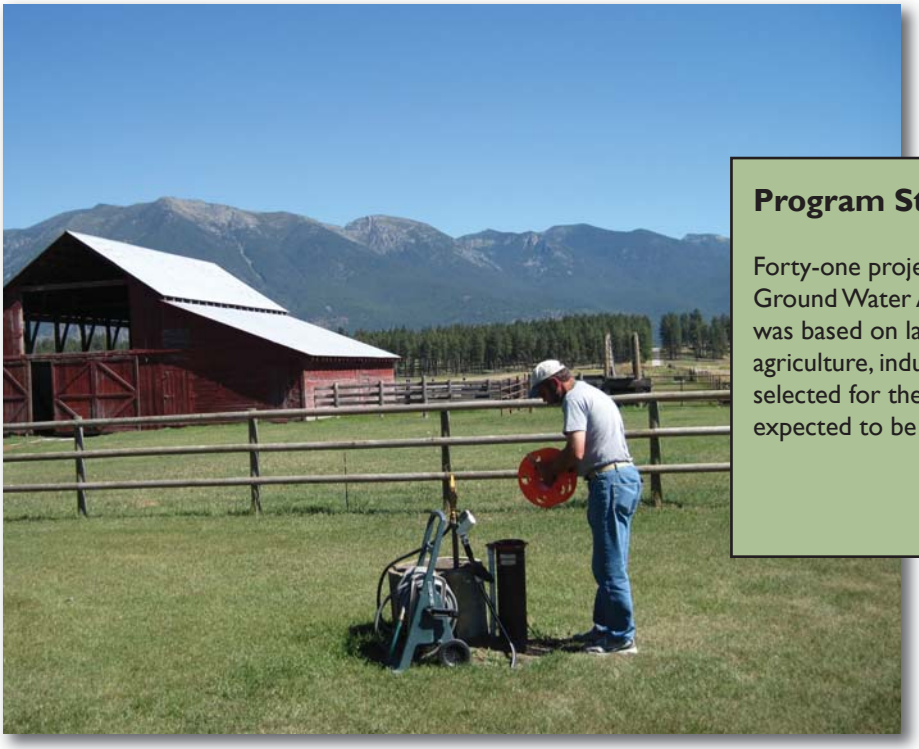
8 Georgetown Lake, Philipsburg
9 Summit Valley
10 Priest Butte Lk
11 Greenfield Bench
15 Three Forks
19 Pine Creek
20 W. Yellowstone
21 Belt, Monarch
22 Little Belt Mts
23 Stillwater Valley

24 Rock Creek
25 Pryor Mts
26 Park City
28 East Billings
29 Roundup
30 Flaxville Gravels
31 Clear Lake
32 Sidney
38 Madison Valley Quake Lake to Ennis
40 Jefferson Valley

Ground Water Investigaiton Program project prioritization matrix - Ranking by the Ground Water Assessment Steering Committee, September 9, 2010

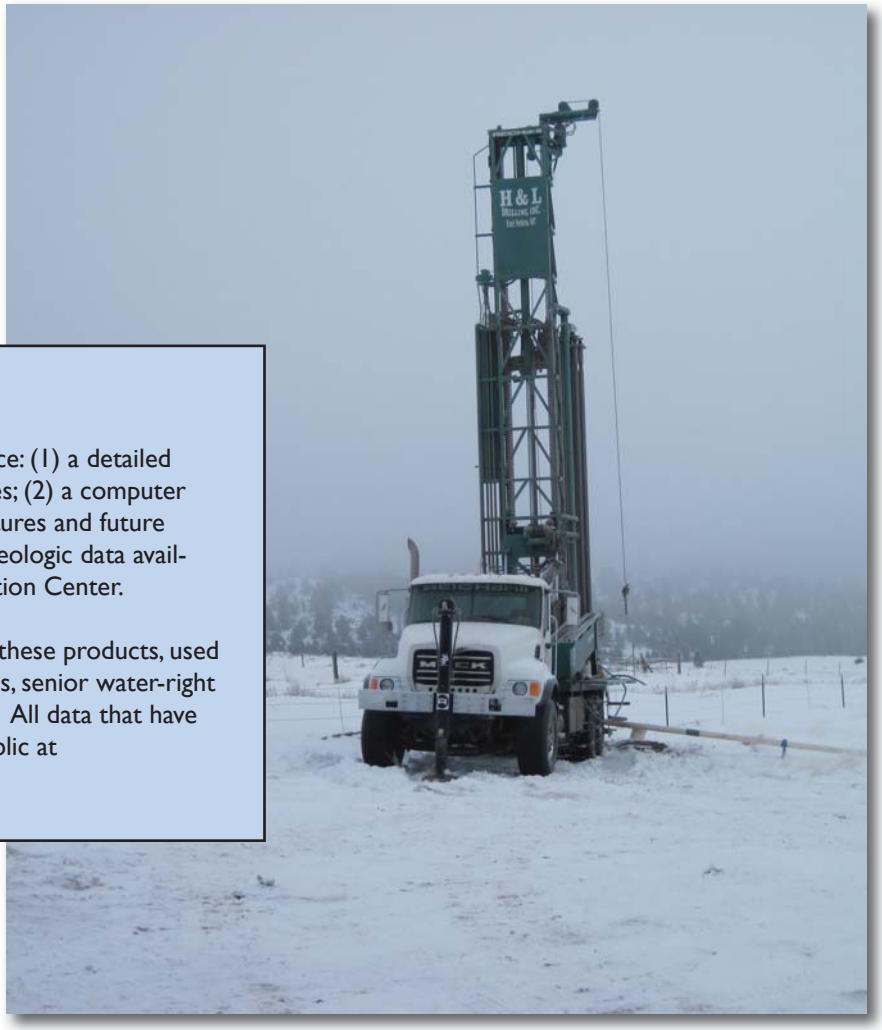
Map Location Number	Name	County	RANKING		Subdivision 2010	New wells 2010	Closed Basin 2010	Water quality 2010	Industrial 2010	Agricultural 2010	Population 2010	Water class 2010	Information 2010	Complexity 2010	Ecological	Aquifer systems 2010	Efficiency 2010	Diversity 2010	Controlled area 2010	Match Funds committed 2010	Matching funds requested 2010		TOTAL SCORE 2010
					rank 1-5	rank 1-5	5=Yes 1=No	5=Yes 0=No	rank 1-5	5=Yes 0=No	rank 1-5	rank 1-5	rank 1-3	rank 1-3	rank 1-4	basin=1 bedrock=2 both=3	No score (+ or - for tie break)	Complex =3 simple=1	5=Yes 0=No	match=5, no=0	2=Yes 0=No		
	Project Priority for FY2012-FY2013		0																				
41	Stevensville Bitterroot River	Ravalli	1		3	5	5	5	2	5	2	4	3	2	1	1		3	0	0	0		41
37	Boulder River Valley	Jefferson	2		1	2	5	5	1	5	1	4	2	2	3	1		2	0	5	2		41
7	Hamilton	Ravali	3		3	5	5	5	2	5	2	4	3	1	3	1		1	0	0	0		40
16	Manhattan	Gallatin	4		4	5	5	0	3	5	4	4	1	2	1	3		3	0	0	0		40
33	Coalbed Methane	Big Horn/Rosebud/Powder River	5		1	1	0	5	5	5	1	3.5	3	3	2.5	2		2	5	0	0		39
39	Madison Valley Ennis to Three Forks	Gallatin/Madison	6		3	3.5	5	5	1	5	2.5	4	2	1	2	1		3	0	0	0		38
34	North Fork Flathead River	Flathead	7		5	5	0	0	2	0	4	5	1	2	4	2		2	0	5	0		37
27	West Billings	Yellowstone	8		3	4	0	5	1	0	5	4	3	2	1	1		2	0	5	0		36
14	Townsend, Toston	Lewis&Clark/Broadwater	9		3	3.5	5	5	1	5	2	4	1	2	2.5	1		1	0	0	0		36
36	Big Sky	Gallatin/Madison	10		4	3.5	5	5	1	0	2.5	4	1	3	2.5	2		2	0	0	0		35.5
	Project for future evaluation																						
21	Belt, Monarch	Cascade			1	2	0	5	1	0	3	3	1	2	3	3		1	0	0	0		
32	Buried river channel aquifer	Richland			1	1	0	5	3	5	1	4	2	2	1.5	3		2	0	0	2		
31	Clear Lake aquifer	Sheridan			1	1	0	5	2	5	1	3	3	2	1.5	3		2	0	5	0		
28	East Billings	Yellowstone			3	4	0	0	1	0	5	4	3	2	2	1		2	0	0	0		
1	Eureka	Lincoln			3	3	0	0	2	0	1	4	1	2	2.5	3		1	0	0	0		
30	Flaxville Gravels	Valley/Roosevelt			1	1	0	0	1	5	1	4	2	2	2.5	1		1	0	0	0		
8	Georgetown Lake	Granite/Deerlodge			1	1	5	5	1	0	1	4.5	1	2	2	3		1	0	0	0		
11	Greenfield Bench	Teton			1	1	5	5	1	5	1	4	3	2	1.5	2		3	0	0	0		
40	Jefferson River groundwater	Jefferson/Madison			1.5	2	5	5	1	5	1	4	2	1	2	1		1	0	0	0		
22	Little Belt Mountains	Judith Basin/Fergus			1	1	0	0	1	0	1	3.5	1	2	2	2		1	0	5	0		
38	Madison Valley Quake Lake to Ennis Lake	Madison			2	2	5	5	1	5	1	4	2	1	3	1		1	0	0	0		
5	Missoula Valley	Missoula			2	4	5	0	3	0	4	4	3	3	1.5	1		2	0	0	0		
4	Noxon	Sanders			2	2	0	0	1	0	1	4	1	1	2	3		1	0	0	0		
26	Park City	Stillwater			1	2	0	0	1	0	1	4	1	2	1	3		1	0	0	0		
19	Pine Creek	Park			1	2	0	0	1	0	1	4	1	2	2.5	3		1	0	0	0		
10	Priest Butte Lake	Teton			1	1	5	5	1	5	1	4	1	2	1.5	1		1	0	0	0		
25	Pryor Mountains	Carbon			1	2	0	0	1	5	1	4	1	2	2	3		1	0	0	0		
24	Rock Creek terrace aquifer	Carbon			1	2	5	0	1	0	1	4.5	2	2	1.5	1		1	0	0	0		
29	Roundup	Musselshell			1	1	5	5	1	0	1	3	1	2	1.5	3		1	0	0	0		
	Shields Valley	Park																					
3	Smith Valley	Flathead			5	5	0	0	1	0	4	3.5	2	2	2	1		1	0	0	0		
23	Stillwater Valley	Stillwater			1	2	0	5	1	5	1	4	2	2	2.5	3		2	0	0	0		
9	Summit Valley	Silver Bow			1	2	5	5	2	0	2	4.5	2	1	1.5	3		2	0	0	0		
15	Three Forks	Broadwater			2	2	5	5	1	0	1	4	1	2	2	1		1	0	0	0		
20	West Yellowstone	Madison			2	2	5	5	1	0	1	4	1	2	3	3		1	5	0	0		
	Yellowstone Park Madison	Gallatin/Park																					

Matrix of GWIP project prioritization, as ranked by the Ground Water Assessment Steering Committee in 2010.



Program Status:

Forty-one projects have been nominated and prioritized by the Ground Water Assessment Steering Committee. Prioritization was based on land use changes, anticipated growth in housing, agriculture, industry, and commercial activities. Seven sites were selected for the 2010-2011 biennium, and those projects are expected to be completed by June 2011.



Program Products:

Every GWIP investigation is expected to produce: (1) a detailed report on the hydrogeologic system and stresses; (2) a computer model that simulates specific hydrogeologic features and future stresses; and (3) a comprehensive set of hydrogeologic data available online through the Ground Water Information Center.

Montana water utilization will be supported by these products, used by scientists and engineers representing agencies, senior water-right holders, new applicants, and other stakeholders. All data that have been collected are currently available to the public at http://mbmggwic.mtech.edu/.

For more detailed and up-to-date information, please see our website:

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

Governing Documents/Committtee

- ***House Bill 52*** *(section 61)*
- ***House Bill 831*** *(section 60)*
- ***Water Policy Committee Website***

Products

- ***Final Case Study***
- ***Project Prioritization Matrix***
- ***GWIP Fact Sheet*** *—April 2010*

Online Data Access

Nominated Projects

2011-2013 Biennium Projects

GWIP goes to the Legislature
—September 8, 2010

Staff

John Metesh— MBMG Research Division Chief
406.496.4159

HB 52 —Ground Water Investigation Program

The 2007/2008 Water Policy Interim Committee (WPIC) recognized that competition for water resources and the lack of detailed information on groundwater/surface water interaction has challenged informed water-resource management and development in Montana. The WPIC found that "continued and expanded study of groundwater resources is vital to shaping statewide policy as well as providing the data necessary for local decisions regarding water." HB 52 was drafted by the WPIC in response to this finding.

The 61st Montana Legislature passed HB 52 with a first biennium appropriation of $4.2 million; based on the program design, this will provide funding for 6 to 8 projects lasting 1 to 3 years.

The Ground Water Investigations Program (GWIP) established by HB 52 will add to Montana's capability to deal with important water-resource issues including:

- stream depletion from groundwater development by subdivisions or changes in irrigation projects,
- cumulative effects of existing and proposed water development on stream flow,
- impacts to groundwater and surface water from changes in irrigation practices or land use,
- implementation of aquifer storage and recovery (ASR) in Montana, and
- evaluating the success of mitigation/offset plans in closed basins.

The Ground Water Investigation Program is in its inaugural stage and will be rapidly evolving over the coming months. The Steering Committee will continue to develop selection criteria and procedures as well as encourage ideas for potential projects from stakeholders and water management agencies.

This website will be updated frequently with new information about the program and individual projects.