WATER RESOURCES EVALUATION
WATER RIGHTS IN CLOSED BASINS

prepared by

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for

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Executive Summary

Background

Growth, climate and a Montana Supreme Court decision have focused significant attention on the issue of ground water appropriations in closed basins. Closed basins and associated counties and rivers include:

Closed Basin	Counties	Rivers
Upper Missouri	Gallatin	Gallatin
	Broadwater	Missouri
	Meagher	Smith
	Lewis and Clark	Dearborn
	Cascade	Sun
Madison / Jefferson	Madison	Madison
	Jefferson	Jefferson
	Beaverhead	Beaverhead
		Big Hole
		Boulder
		Ruby
Upper Clark Fork	Deer Lodge	Clark Fork
	Granite	Blackfoot
	Powell	Flint / Rock Creeks
	Missoula	
Bitterroot	Bitterroot	Bitterroot
Teton	Teton	Teton

See Figure ES-1 for these closed basins. Population growth in Montana, especially in high growth counties, has been high over the recent past. Key population data (US Census) include:

	1990	2000	Percent Change per year 1990 to 2000	2006 Estimate	Percent Change per year 2000 to 2006
Montana	799,065	902,165	1.29%	944,632	0.78%
Ravalli County	25,010	36,070	4.42%	40,582	2.08%
Gallatin County	50,463	67,831	3.44%	80,921	3.22%

Over the same time period, the climate in Montana seems to have warmed. To further complicate matters, much of the state has experienced a significant period of drought since the late 1990s. Naturally, this drought has led to reduced streamflows. Some have mistakenly attributed the drought related streamflow reductions to housing development growth and its attendant groundwater demands.

In 2006, the Montana Supreme Court decision (Trout Unlimited v. DNRC, 2006 MT 72) (TU Decision) negated the methodology used by DNRC regarding "direct and immediate" considerations in the appropriation process for ground water in closed basins.

The above factors have been an impetus on the part of several different entities to impose restrictions on groundwater development. This impetus is based upon concerns that ground-water development is adversely impacting streams in Montana. That has led in turn to legislation termed passed by the 2007 Legislature, House Bill 831 (HB831).

In order to provide better information for assessing the relevance, or lack thereof, for proposed legislation, NE&W conducted a watershed evaluation of the Gallatin Valley using basic water budgeting methodology. This culminated in the report "Gallatin Valley Water Resources Evaluation, A Test of the Rationale of Montana Department of Natural Resources & Conservation Proposed Legislation to Amend Montana Water Law" (NE&W, 2007).

NE&W has since been retained to do the following:

- Expand the Water Resources Evaluation Report for the Gallatin Valley by conducting a more detailed analysis.

- Evaluate the conditions in three additional high growth areas which include Bitterroot Valley (Ravalli County), Missoula County, and Lewis and Clark

County.

Study Objectives

The objectives of this report are to:

- Evaluate the implications of HB831 from a technical perspective.

- Present the results of each study area (Lewis and Clark County, Bitterroot Valley, Missoula County, and Gallatin Valley); and

- Develop recommendations for assisting water policy decision makers in establishing practical water policy law and rules that both protective of the rights of existing appropriators, and at the same time, consider overall water budgeting factors in the process.

Water Budgeting Approach

The primary tool employed in the current study is a water budgeting approach, which is standard procedure for watershed evaluations. A water budget is the numerical accounting of the inputs and outputs of water over a set volume (control volume). In other terms, it may be considered to be a quantification of all or a portion of the hydrologic cycle. The water-budget equation is simple, universal, and adaptable because it relies on few assumptions as to the mechanisms of water movement and storage. A basic water budget for a watershed can be expressed as follows (from USGS, 2007):

$$\mathbf{P + Q_{in} = ET + \Delta S + Q_{out}}$$

where

P	is precipitation,
$\mathbf{Q_{in}}$	is water flow into the watershed,
ET	is evapotranspiration (the sum of evaporation from soils, surface-water bodies, and plants),
$\mathbf{\Delta S}$	is change in water storage, and
$\mathbf{Q_{out}}$	is water flow out of the watershed.

The water budget can be applied to various scales, for example, it can be state-wide or it can be at a subbasin scale, such as the Bitterroot Valley. Often, specific data are not available, and inputs or outputs must be estimated as closely as is practical.

According to the U.S. Geological Survey (2007):

> Water budgets provide a means for evaluating availability and sustainability of a water supply. A water budget simply states that the rate of change in water stored in an area, such as a watershed, is balanced by the rate at which water flows into and out of the area. <u>An understanding of water budgets and underlying hydrologic processes provides a foundation for effective water-resource and environmental planning and management. Observed changes in water budgets of an area over time can be used to assess the effects of climate variability and human activities on water resources.</u> [Underlined for emphasis].

Results of Analysis

Some key observations include the following:

- Streamflows are mainly dependent upon the snowpack conditions. The streamflows of the Bitterroot, Clark Fork, Missouri and the Gallatin Rivers all mirror those snowpack condition trends over time.

- The most dominant human induced factors from a water consumption perspective observed in the evaluation include the following:

    - Agricultural irrigation and
    - Reservoir evaporation (primarily in the Upper Missouri River Basin).

- Public water supply demands and self-supplied well demands are comparatively small from a water budget perspective. See Figures ES-4 through ES-7.

- The nature of land use changes are a factor in the overall water budgeting evaluation. For instance, if there is an overall reduction in irrigated acreage, this can lead to a reduction in net consumptive use. On the other hand, if there is an increase in irrigated acreage, then there can be an increase in consumptive use. It is likely that net consumptive use has decreased in the Gallatin Valley, Ravalli County, and Missoula County because of land transformations. See Figure ES-8.

- Groundwater level changes are mainly due to natural factors in areas that were evaluated in this study. There is no evidence of long-term ground-water level declines that can be attributed to exempt wells. Any changes that were observed are primarily from long-term drought.

The plots shown in Figures ES-4 through ES-7 demonstrate that the primary reasons why detectable impacts to stream flows from groundwater development are not observed; groundwater development generally represents an inconsequential component of the overall water budget.

Finally, the interpretations that have been developed for the study areas described are by no means unique in Montana, as Figure ES-9 shows. The total amount of runoff from Montana rivers averages about 43,800,000 acre-feet per year (Cannon and Johnson, U.S. Geological Survey). A relatively small fraction of that water is consumptively used. Cannon and Johnson reported that the total consumptive use in Montana in 2000 was about 2,662,000 acre feet. Hence, about 6 percent of the total runoff in Montana was consumptively used. Nearly all of this consumption was associated with agriculture. The amount of water used for public water supplies, self-supplied wells, and household consumption is inconsequential compared to stream flow in Montana.

Recommendations

Based upon the current study, NE&W recommendations are as follows:

- Recognize that the water budget in Montana is overwhelmingly dominated by climatic factors and agricultural surface water use. In effect, any changes in groundwater use that transpire in the next five to 10 years will not substantively change this water budget.

- Information gathered from baseline watershed evaluations could be used to develop a "level of significance" criterium to determine what is acceptable in a beneficial use application. For instance, if an application for a subdivision is projected to affect stream flow at 0.01 percent of that stream's flow, is that significant? Would this type of change cause any adverse impact?

- Assess the viability of water banking options. For instance, it may be appropriate to encourage those who wish to develop land to place their irrigation water in a water bank. That water could be drafted upon for public water supply uses, fishery and wildlife uses, etc.

- Regular delineation of water use, including irrigated areas, would assist in understanding potential trends or lack thereof on the overall water budget.

Information could then be coupled with the water budgeting process to provide information at the state and local scales to assist decision makers, water users, and their representatives.

- Use the results from the basin or subwatershed evaluations to determine if there are conjunctive surface water/groundwater management measures that could be implemented. For instance, the possibility exists that ground-water pumping (e.g., supplemental irrigation) could be coupled with leaving surface water in streams during critical low streamflow periods.

Summary

Water budget evaluations of Lewis and Clark, Ravalli, and Missoula Counties and the Gallatin Valley were performed. Databases evaluated include the following:

- Climatic data (precipitation including Snotel and Local Climate Data)
- Streamflow (focus on long-term streamflow data collected for the relevant streams)
- Groundwater level data (Montana Bureau of Mines and Geology GWIC data)

Based upon that evaluation, the following were key findings:

- Stream flows depend principally upon each given year's mountain snow pack in the subbasins that were evaluated. Snow pack as measured by water equivalent since the late 1990s has been below average. This has led to a period of lower than average stream flows.

- By far the most significant human related influence on stream flow in the watersheds examined are surfacewater diversions for irrigation. Reservoir evaporation was a significant factor for Lewis and Clark County in the Upper Missouri River basin. Groundwater use is very small when compared to stream flow diversions.

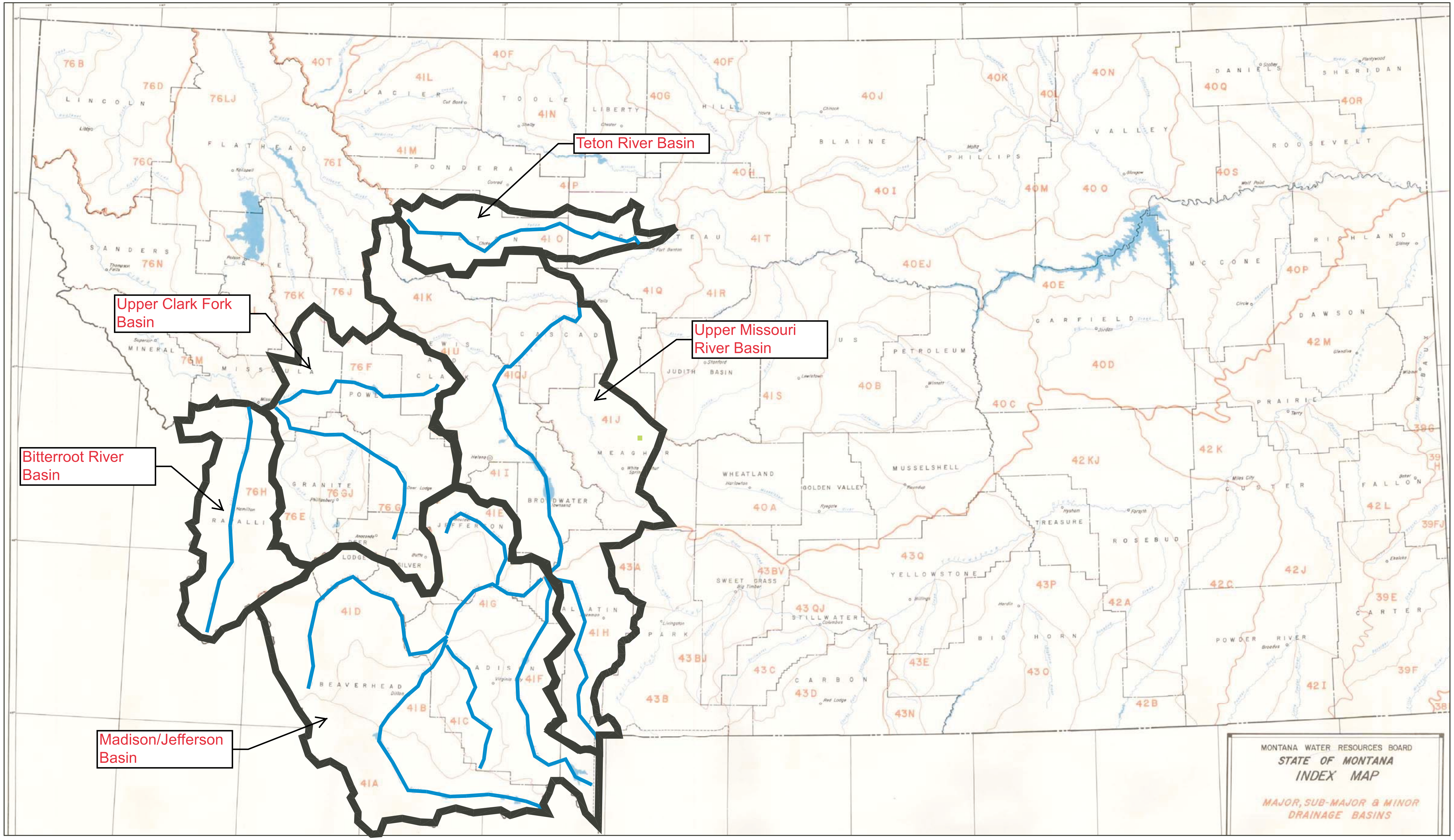
- Ground-water levels and, hence, aquifer storage have remained relatively constant from year to year for all watersheds that were examined.

- There is no evidence that the overall consumptive water use has increased with the growth of subdivisions and with their accompanying use of ground water. The primary reason for this is that many of these subdivisions have been placed in areas where agricultural irrigation activity has occurred historically.

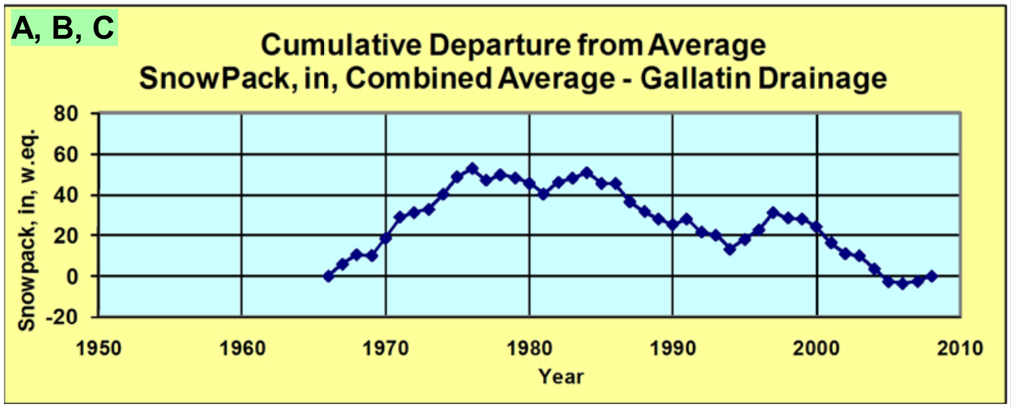
- A followup analysis of the Gallatin Valley, which included a detailed evaluation of drought conditions, provided no evidence that stream flows have changed in response to factors other than climatic conditions.

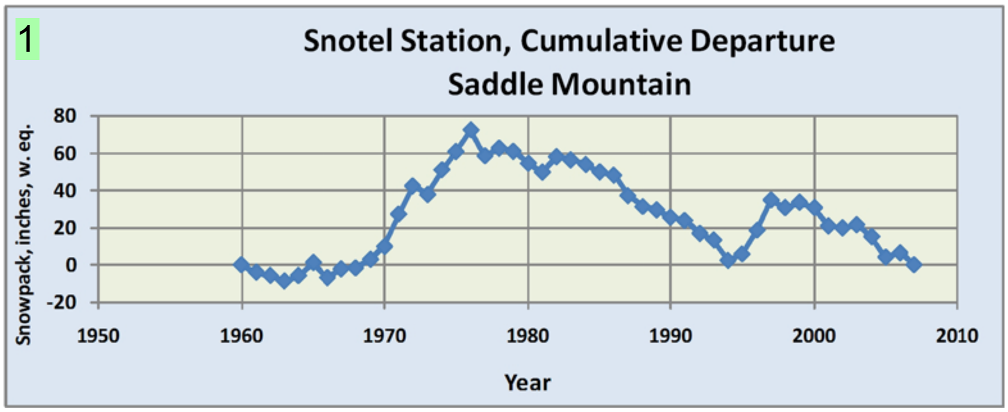
- It is concluded via water budgeting assessments that there is no measurable evidence of so-called “cumulative impacts” of exempt wells, public water supply wells or even agricultural irrigation wells on stream flows in any of the watersheds evaluated. In effect, any net cumulative effect, if it exists, is simply too small to be discerned.

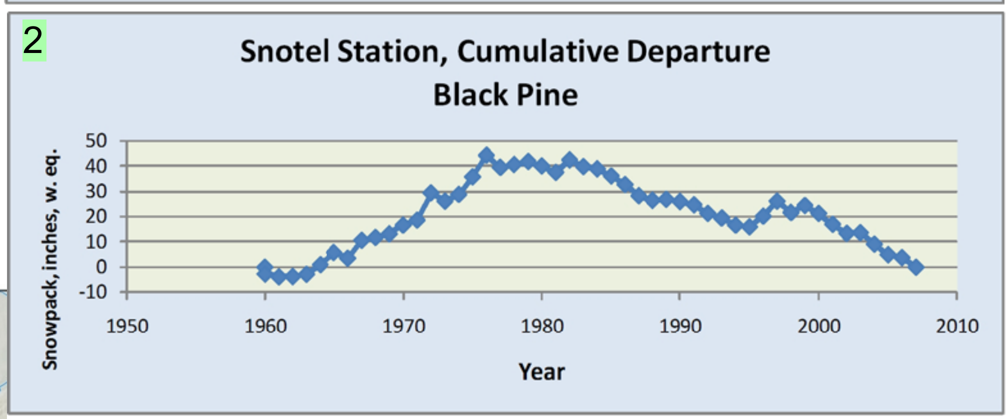
- Projections were made on future water demands on ground water. Based upon these projections, the impacts of ground-water development by 2030 will not be measurable or observable in streams.



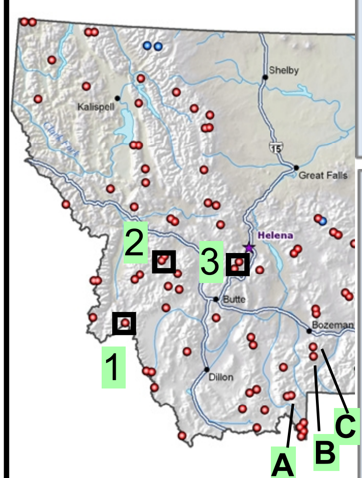
Date: 05/05/08 **File c:\gvs-II\Fig_ES-1** **Issued for MAR et al**	NICKLIN EARTH & WATER, INC.	**Closed Basins in Montana** **Water Resources Evaluation**	**Figure ES-1**

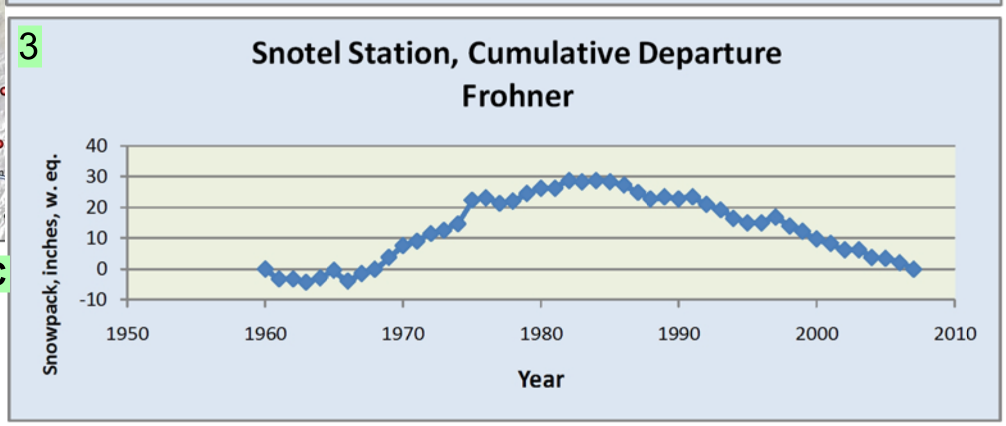






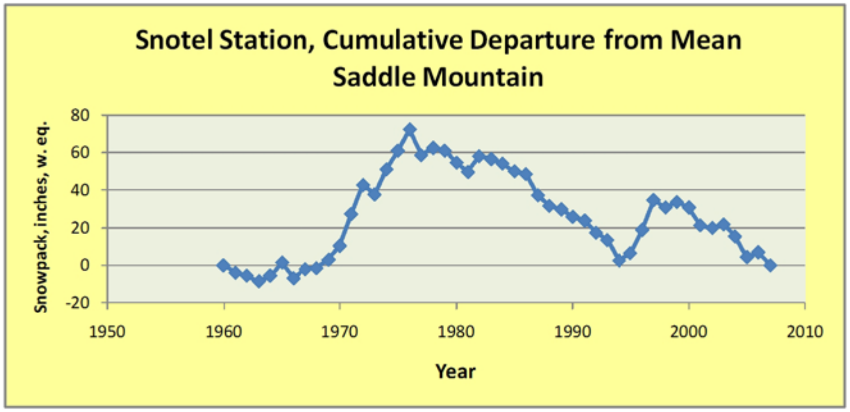
Snotel Stations Western Montana

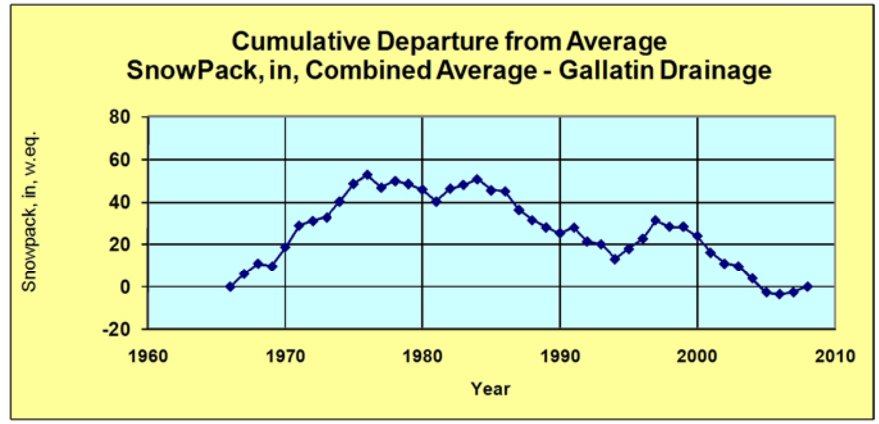


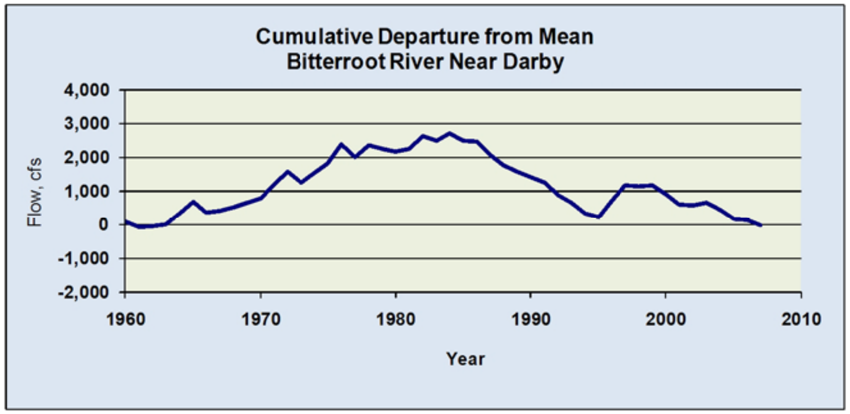


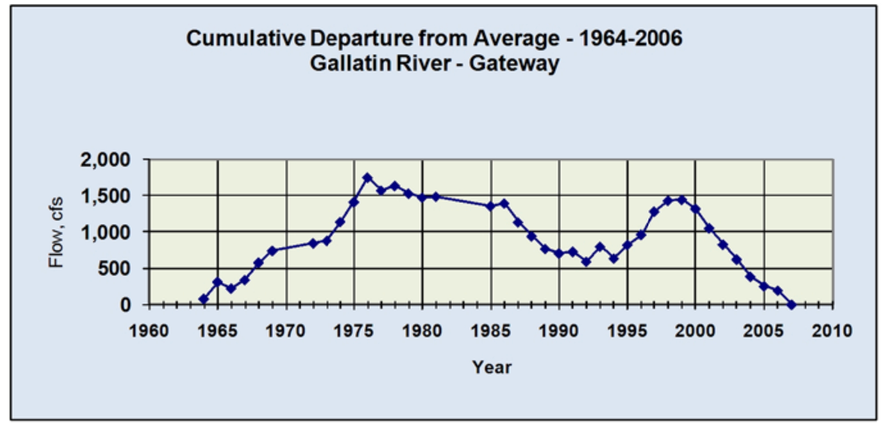
Note that the cumulative departure plots at the designated Snotel locations show similar trends for snowpack. Other Snotel stations located in southwestern Montana showed similar responses to those stations shown above.

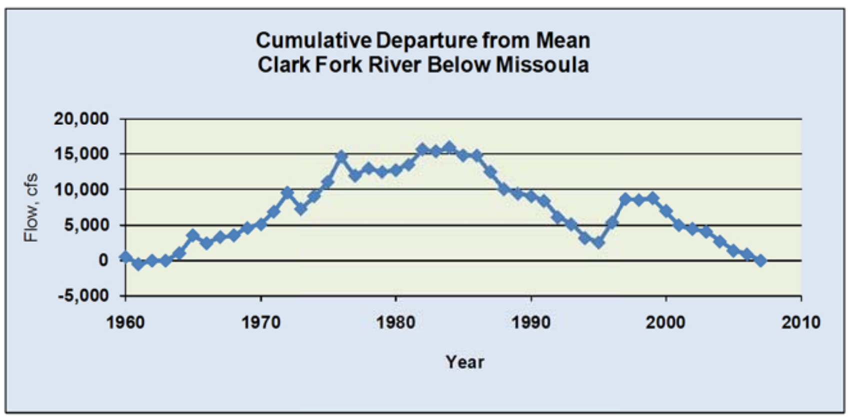
Date: 05/23/08 **File c:\gvs-II\Fig_ES-2** **Issued for MAR et al**	**NICKLIN** **EARTH & WATER, INC.**	**A Comparison** **Snowpack Cumulative Departure** **Other Basins Compared To** **Snotel Stations Gallatin Drainage**	Figure ES-2





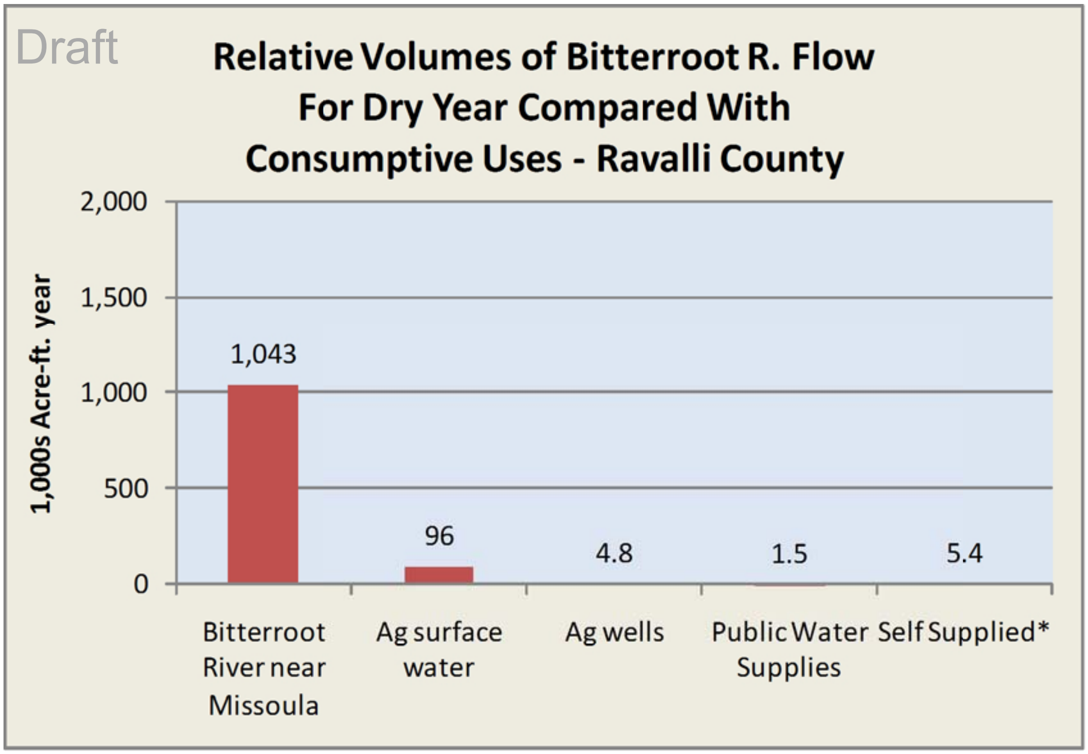


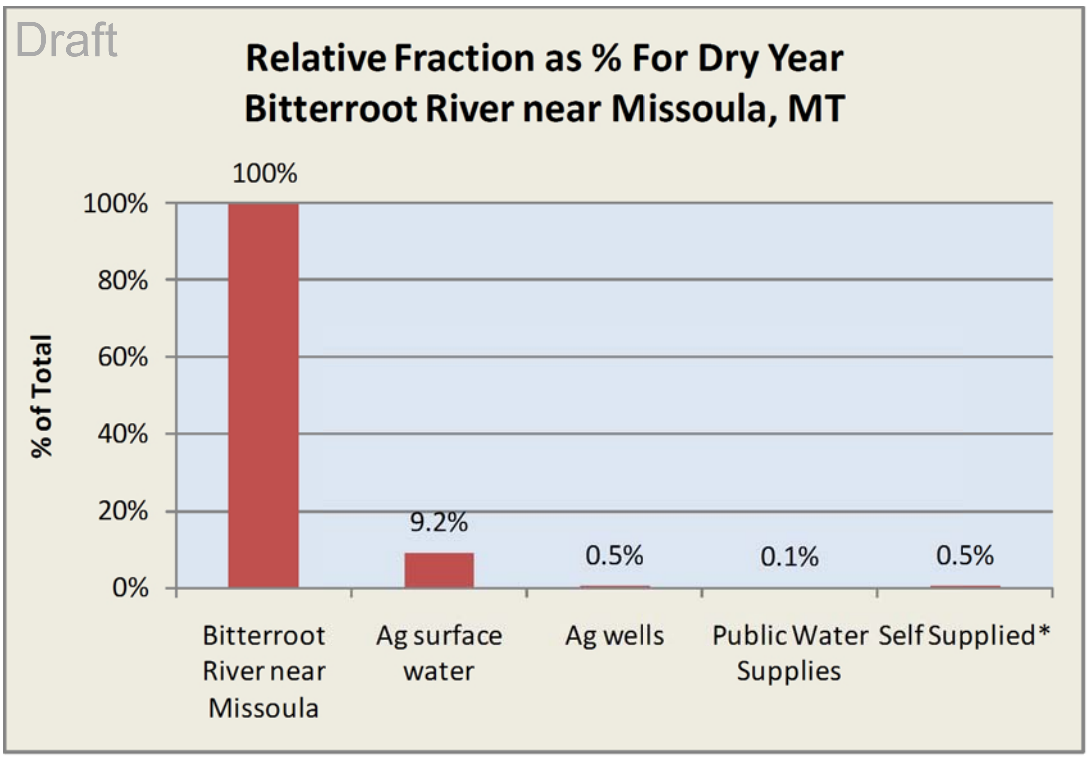




Note that the streamflow cumulative departure plots tend to mirror snowpack conditions at the Snotel stations which demonstrates that climate dominates in the streams that were evaluated. This figure also demonstrates that the observations made in the Gallatin Valley apply to the other watersheds that were evaluated.

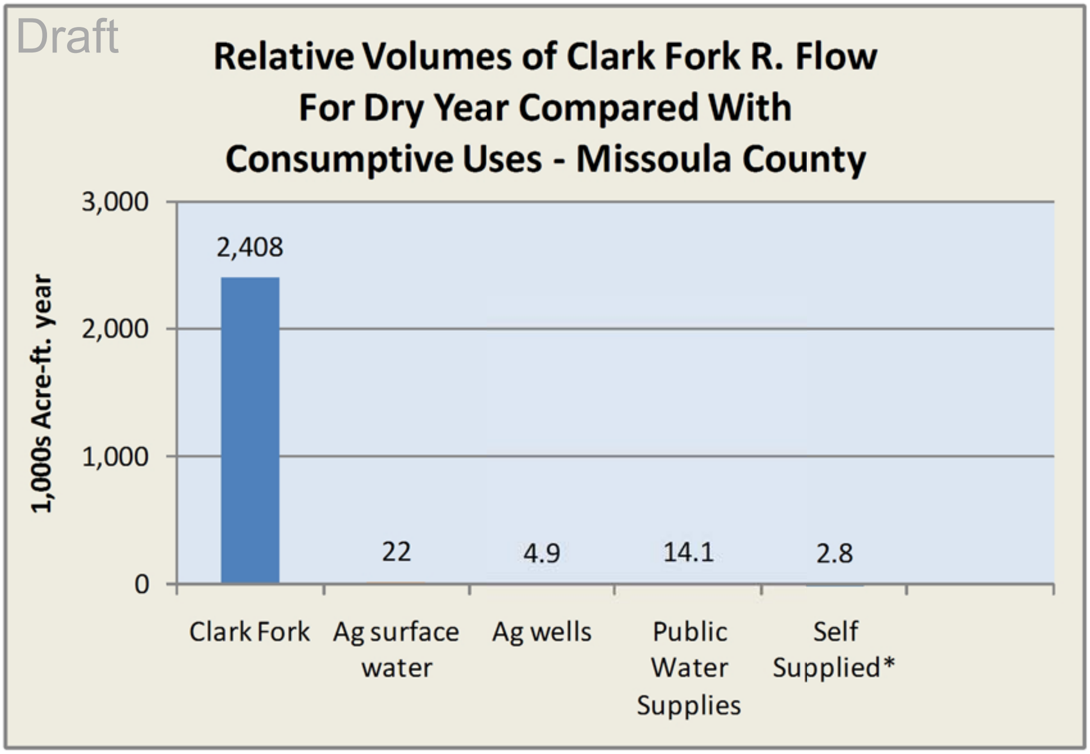
Date: 05/23/08 File c:\gvs-II\Fig_ES-03 Issued for MAR et al	NICKLIN EARTH & WATER, INC.	**Comparison of Cumulative Departure Plots Snotel and Streamflow Selected Gaging Stations, Closed Basins**	**Figure ES-3**

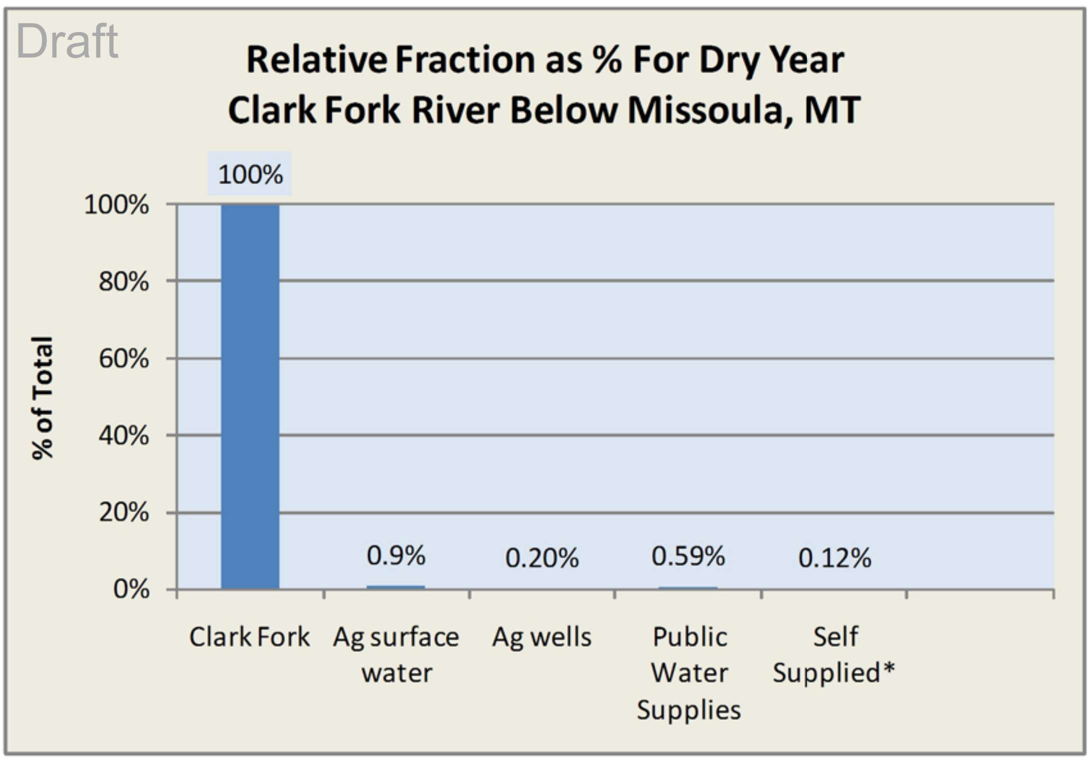




Notes: Clark Fork is flow as measured at the Bitterroot River near Missoula gaging station (uses 2001 flows).
Consumptive use is based upon information adapted from Cannon and Johnson (2004) and as modified by NE&W.
Data from DNRC memorandum on consumptive use for exempt wells is considered in these plots.
* Self supplied wells include exempt wells.

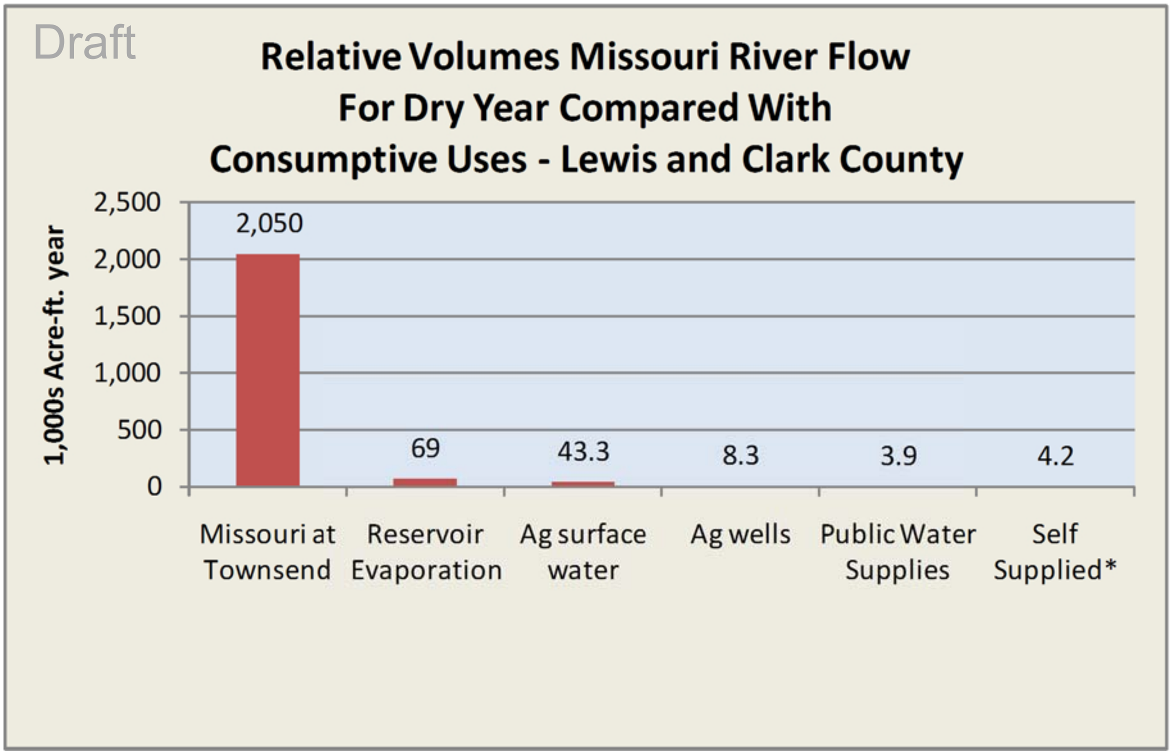
Date: 05/23/08 **File c:\gvs-II\Fig_ES-04** **Issued for MAR et al**	**NICKLIN EARTH & WATER, INC.**	**Surface Water Flows at Bitterroot River Compared to Ravalli County Consumptive Uses**	Figure ES-4

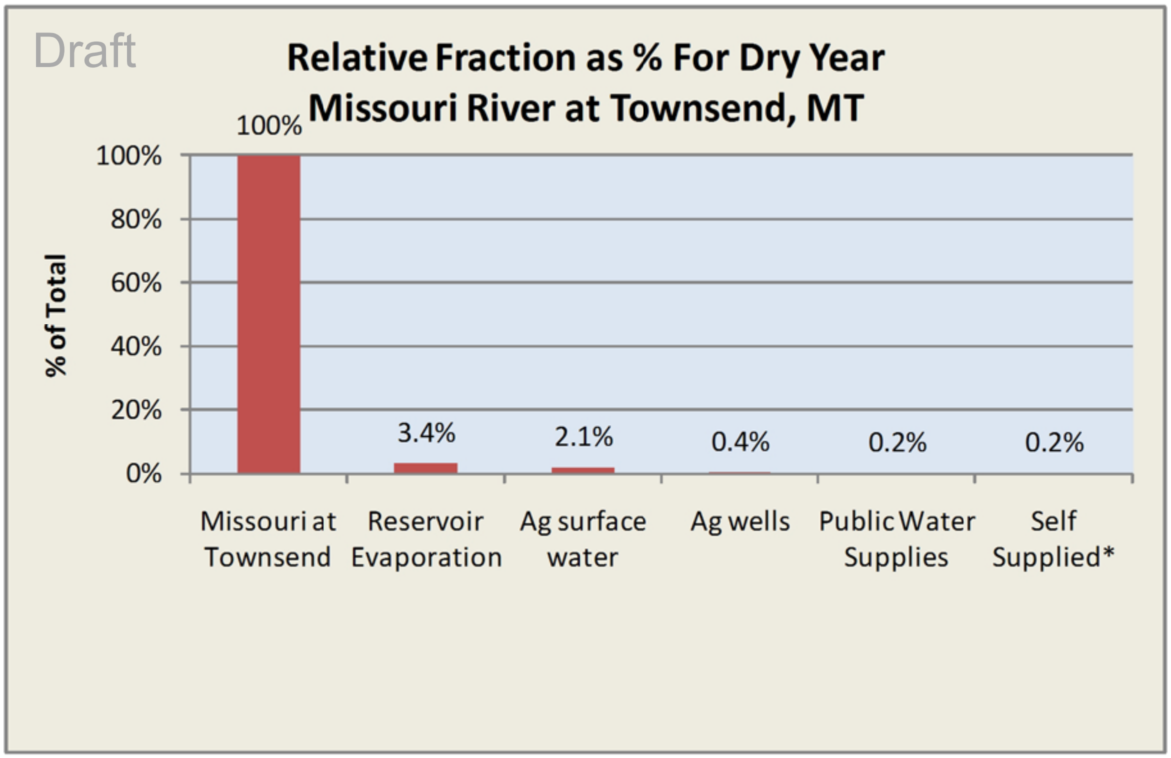




Notes: Clark Fork is flow as measured at the Clark Fork below Missoula gaging station (uses 2001 flows). Consumptive use is based upon information adapted from Cannon and Johnson (2004) and as modified by NE&W.
* Self supplied wells include exempt wells.

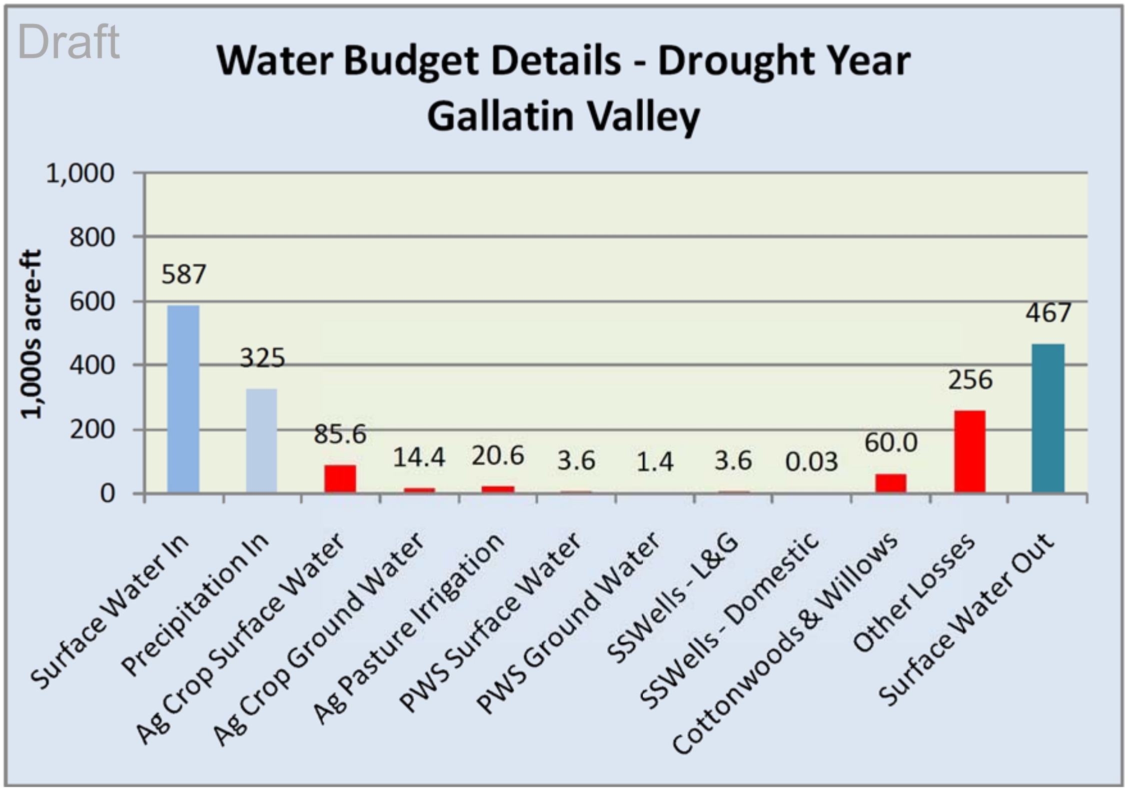
Date: 05/23/08 File c:\gvs-II\Fig_ES-05 Issued for MAR et al	NICKLIN EARTH & WATER, INC.	Surface Water Flows at Clark Fork Compared to Missoula County Consumptive Uses	Figure ES-5

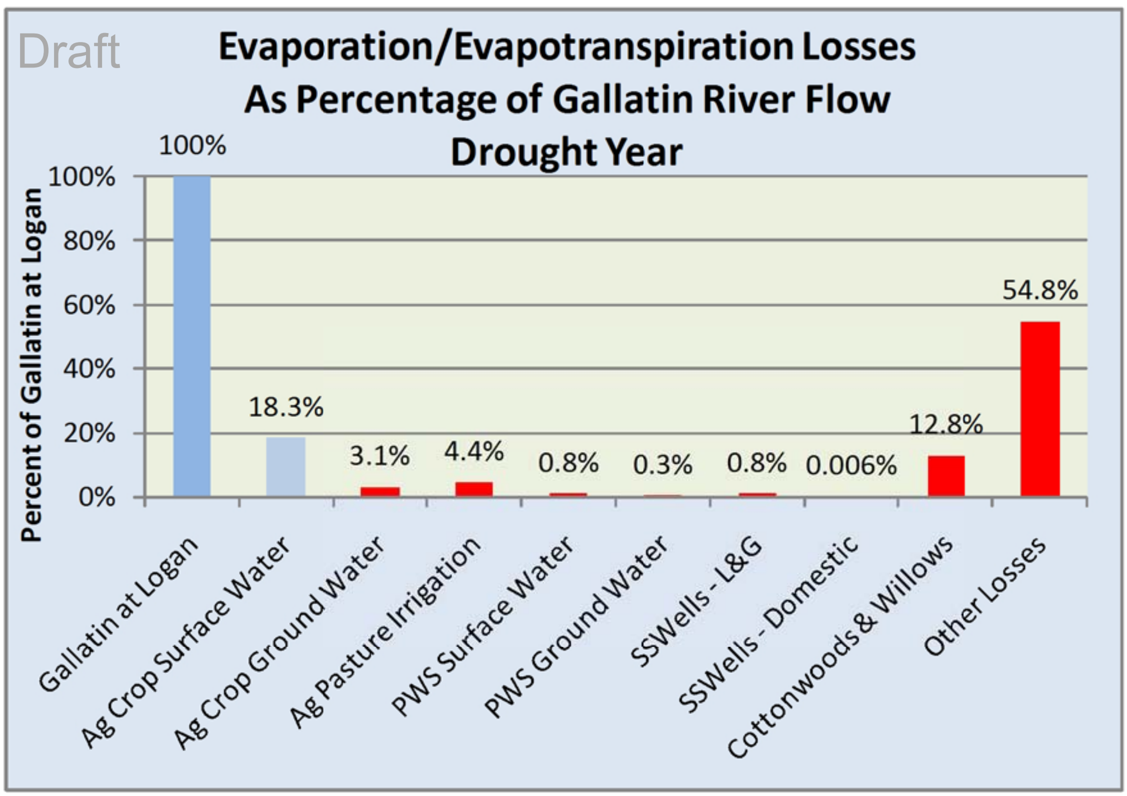




Notes: Missouri River flows are those measured at Toston gaging station for year 2004.
Consumptive use is based upon information adapted from Cannon and Johnson (2004) and as modified by NE&W.
Reservoir evaporation adapted from Cannon and Johnson (2004).
Data from DNRC memorandum on consumptive use for exempt wells considered in these plots.
Note that the consumptive uses are for portions of Lewis and Clark County within Upper Missouri River Basin drainage.
* Self supplied wells include exempt wells.

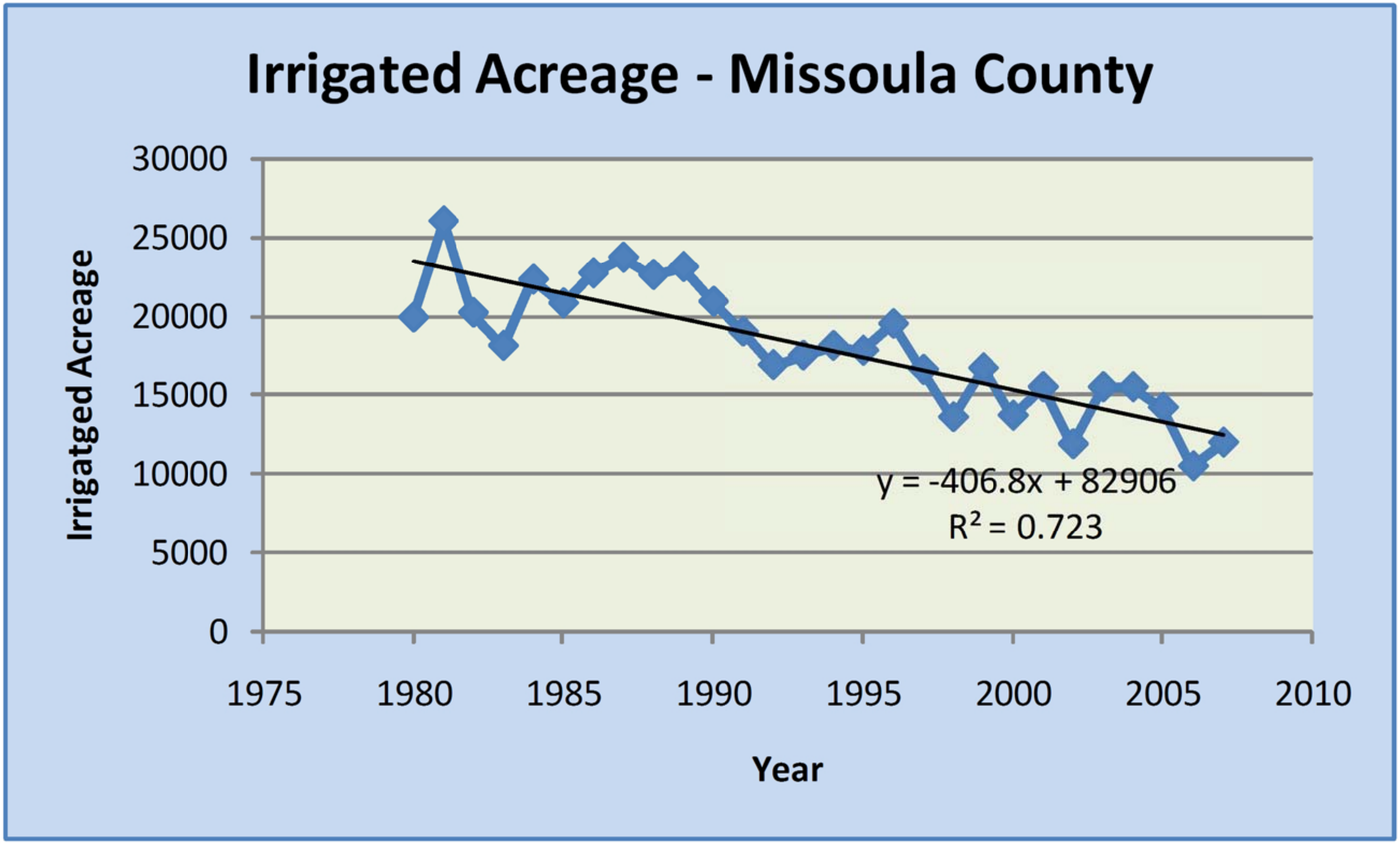
Date: 05/23/08 **File c:\gvs-II\Fig_ES-6** **Issued for MAR et al**	NICKLIN EARTH & WATER, INC.	**Surface Water Flows at Clark Fork Compared to Lewis and Clark County Consumptive Uses**	Figure ES-6





Note: "Other losses" are predominantly evaporation/evapotranspiration and include (1) effective precipitation on irrigated land and (2) evapotranspiration from non-irrigated lands such as rangeland, etc. It also includes other non-accounted for water budget factors.

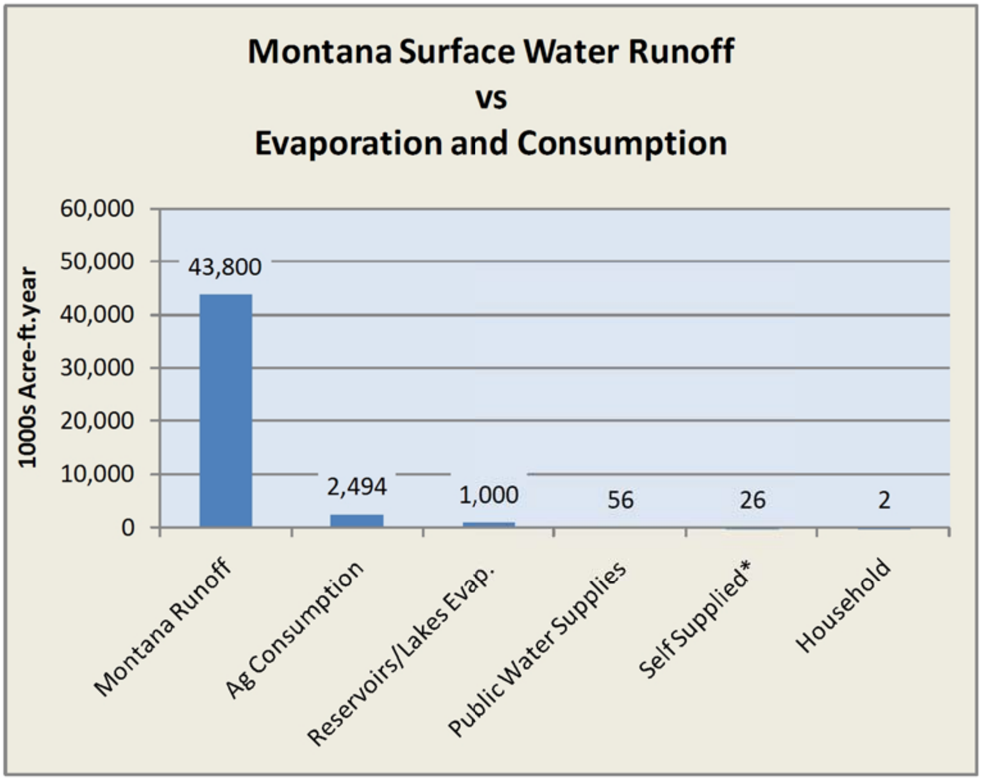
Date: 05/23/08 **File c:\gvs-II\Fig_ES-7** **Issued for MAR et al**	**NICKLIN EARTH & WATER, INC.**	**Surface Water Gallatin River at Logan Compared to Gallatin Valley Evapotranspiration and Consumption (A Detailed Assessment)**	Figure ES-7

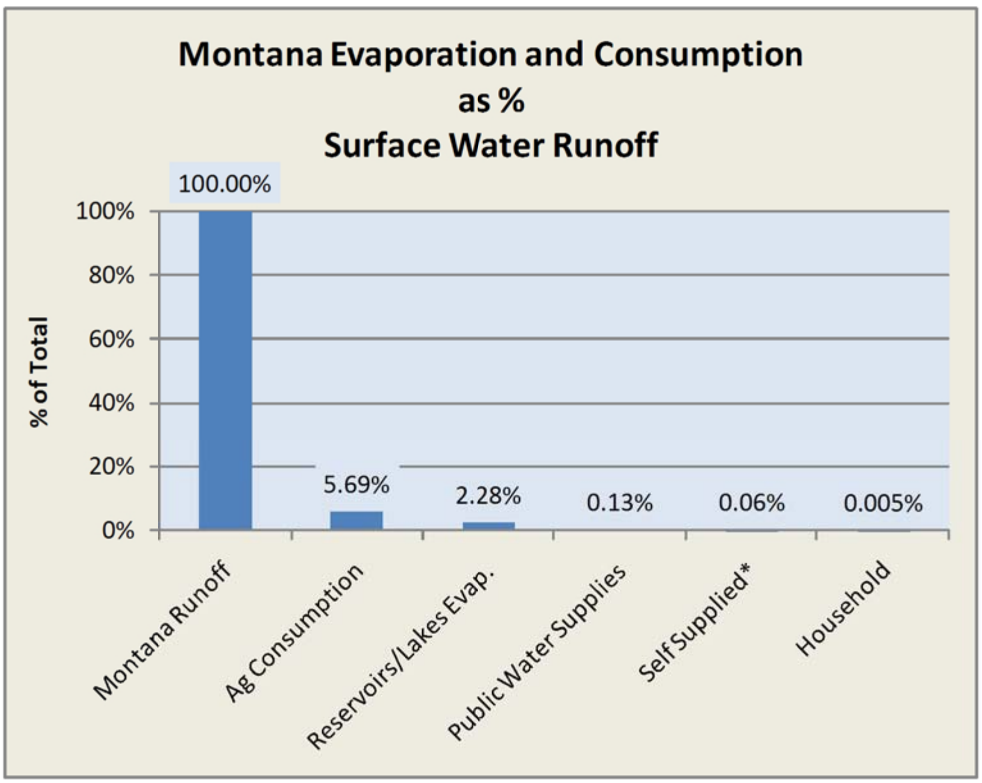


Note that the water budgeting process needs to consider both the accretions and depletions (adding and subtracting) associated with consumptive uses. For Missoula County, the transition from agricultural lands to subdivisions has led to a decline in irrigated cropland of about 10,000 acres. This reduction in irrigated land has likely led to a net overall decline in consumptive use in Missoula County.

Cropland irrigated acreage obtained from U.S. Department of Agriculture National Agricultural Irrigation Statistics Service (2008).

Date: 05/23/08 File c:\gvs-II\Fig_ES-08 Issued for MAR et al	NICKLIN EARTH & WATER, INC.	**Irrigated Crop Acreage Trend Missoula County Since 1980**	**Figure ES-8**





* Both public water supplies and self supplied domestic wells include lawn and garden irrigation. Note that some of the information from categories may overlap. In effect, the projections are for comparison purposes. Information is adapted substantially from Cannon and Johnson, 2004.

Date: 05/05/08 File c:\gvs-II\Fig_ES-9 Issued for MAR et al	NICKLIN EARTH & WATER, INC.	State-wide Surface Water Flows vs Evaporation and Consumption	Figure ES-9