WATER RESOURCES EVALUATIONS:
WATER USES IN CLOSED BASINS

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Executive Summary

Full Report Available at:
http://montanarealtors.org/sites/mar/files/Political_Affairs/2011_Water_Resources_Evaluation_Update_FINAL_SM.pdf

Background

Growth, climate, and a Montana Supreme Court decision have focused significant attention on the issue of groundwater 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	Ravalli	Bitterroot
Teton	Teton	Teton

Population growth in Montana, especially in high growth counties, has been high over the recent past. Key population data (U.S. Census) include:

	1990	2000	Percent Change per year 1990 to 2000	2010 Estimate	Percent Change per year 2000 to 2010
Montana	799,065	902,165	1.29%	989,415	0.97%
Ravalli County	25,010	36,070	4.42%	40,212	1.15%
Missoula County	78,687	95,802	2.18%	109,299	1.41%
Lewis and Clark County	47,495	55,716	1.73%	63,395	1.38%
Gallatin County	50,463	67,831	3.44%	89,513	3.20%

Over the same time period, there have been concerns related to climate change and its potential effects on Montana's water resources. Much of the state has experienced a significant period of drought since the late 1990s to about 2007. Naturally, this drought led to reduced streamflows. Some have mistakenly attributed the drought-related streamflow reductions to development for population growth and its attendant groundwater demands. In 2006, the Montana Supreme Court decision *Trout Unlimited v. DNRC*, negated the methodology used by Montana Department of Natural Resources and Conservation (DNRC) regarding "direct and immediate" considerations in the appropriation process for groundwater in closed basins. The above factors have been an impetus on the part of several different entities to promote restrictions on groundwater development. This impetus is based upon concerns that groundwater development is adversely impacting streams in Montana. That has led, in turn, to legislation passed by the 2007 Legislature, House Bill 831.

In order to provide an assessment of groundwater availability and groundwater development impacts on streamflows, Nicklin Earth & Water, Inc. (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). In 2008, NE&W was then retained to evaluate the conditions in three additional high growth areas Ravalli County (Bitterroot Watershed), Missoula County, and Lewis and Clark County which evaluated available data through 2007. Since then, additional data have accrued so that it justifies updating the 2008 report to present conditions. This last update will hereafter be referred to as the 2011 study. The information set forth in this 2011 study supersedes both the 2007 and 2008 reports and also incorporates the Gallatin Valley.

Study Objectives

The objectives of this report are to 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 are 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):

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

where

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

The water budget can be applied to various scales; for example, it can be statewide or 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. 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. [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, and Missouri Rivers all mirror those snowpack condition trends over time (see Figures ES-2 and ES-3).

- 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 and individual well demands are comparatively small from a water budget perspective. See Figures ES-4 through ES-6. There is no evidence of cumulative impacts to streamflows on a watershed scale. Although very localized affects may occur in a few instances, any net cumulative effect at the water shed scale, if it exists, is simply too small to be discerned.

- 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 Ravalli and Missoula Counties because of land transformations. See Figure ES-7.

- Groundwater level changes are mainly due to natural factors in areas that were evaluated in this study. Groundwater levels and aquifer storage have remained relatively constant from year-to-year for the watersheds examined. One exception to this is the localized area known as the Helena North Hills in Lewis and Clark County.

The plots shown in Figures ES-4 through ES-6 demonstrate that the primary reasons why detectable impacts to streamflows 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 2-2 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, individual wells, and household consumption is inconsequential compared to streamflow in Montana.

Recommendations

Based upon the current studies, 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 streamflow 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 levels 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 groundwater 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, Missoula, and Gallatin Counties were performed. Databases evaluated include climatic data (precipitation including SNOTEL and local climate data), streamflow (focus on long-term streamflow data collected for the relevant streams), and groundwater level data (Montana Bureau of Mines and Geology GWIC data).

Based upon that evaluation, the following were key findings:

- Streamflows depend principally upon each given year's mountain snowpack in the subbasins that were evaluated. Snowpack as measured by water equivalent since the late 1990s has been below average. This has led to a period of lower than average streamflows.

- By far the most significant human-related influence on streamflow in the watersheds examined is surface water 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 streamflow diversions for agriculture.

- Groundwater 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 their accompanying use of groundwater. The primary reason for this is that many of these subdivisions have been placed in areas where agricultural irrigation activity has historically occurred.

- 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 streamflows at the watershed scale for any of the watersheds evaluated. In effect, any net cumulative effect is simply too small to be discerned.

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