Review Comments on the MBMG report *Preliminary Draft Case Study Report to the 60th Legislature Water Policy Interim Committee*

Comments by DNRC Staff

The following are comments by the Department of Natural Resources and Conservation (DNRC) on the report *Preliminary Draft Case Study Report to the 60th Legislature Water Policy Interim Committee*. The main points are:

- The overall approach of field data collection and analysis including modeling conducted for the Beaverhead River Case Study provides a sound template for potential future studies.
- The primary limitation of the Beaverhead River and Gallatin case Studies is that the length of time used in modeling was insufficient to evaluate the full surface-water depletion effects of ground-water pumping.
- The gross basin water balance approach in the Gallatin and Bitterroot case studies does not reveal perennial water shortages during the late summer on main stem rivers and tributaries within the valley.
- The effects of ground-water pumping should be modeled independent from pre-existing conditions, including return flows from surface water irrigation and recharge from precipitation, that do not depend on ground-water levels.
- Care should be taken in drawing conclusions about connection between ground water and surface water from relatively short duration aquifer tests. Tests conducted for the Beaverhead River Case Study do not reveal connections that exist over larger areas or emerge after longer periods of pumping.
- MBMG generally does not consider the impacts of ground-water pumping on senior water users and provides only limited evaluations of mitigation strategies. Potential future studies should focus on mitigation strategies that offset new consumptive uses by reducing historic consumption while offsetting the amount, timing and location of depletion effects on surface water.
- Mitigation proposed for the Gallatin Valley Case Study does not address recurrent water shortages or the long-term effects of ground-water pumping on surface water flows.
- Mitigation needs to provide legally available water to offset depletion effects of new uses and address the problem of ground water pumping out of priority.
- The statistical analysis, evaluation of changes in ground-water storage and comparison of annual water balance components under the Bitterroot Watershed Case Study are insufficient to provide information for evaluating the effects of ground-water pumping on senior water users or policymaking.
- The relatively large amount of information available for the Bitterroot Watershed should be used to construct a numerical model to simulate the effects of ground-water pumping on stream flows and senior water users, and to evaluate mitigation strategies.

Comments on Lower Beaverhead River Case Study

Introduction The lower Beaverhead River sub-basin is one of three case studies conducted by MBMG for HB831. Numerous applications for ground-water appropriations are pending in this area and thus provide MBMG an opportunity to evaluate a range of hydrogeologic conditions common to closed basins. Objectives include an evaluation of ground-water and surface-water interactions on the Beaverhead River and an assessment of stream depletion by ground-water pumping.

Methods MBMG drilled 13 wells at 3 sites for the Beaverhead case study. Two sites were selected near the Beaverhead River and the last site was in the proximity of an irrigation well to monitor impacts from pumping. At the first site near the river, both shallow and deep production wells were drilled to test the interconnection of the uppermost sand and gravel aquifer and the deeper sandstone and siltstone aquifer separated by a 30-foot thick clay layer.

The second drilling site was selected near the East Bench Canal in the Spring Creek drainage about one-half mile from a deep irrigation well. Objectives of drilling at this site were not only to conduct an aquifer test to examine results between a multi-screened well (irrigation well) and a well screened in a discrete aquifer, but also to determine interconnection the production zone and other water-bearing units above and below the production zone. Three wells were drilled in the production zone, one in a deeper zone, and one in a shallower zone.

The third drilling site was located about one mile southwest of the Beaverhead River flood plain on sloping bench land where 190-ft and 400-ft wells were completed near an existing irrigation well. The goal of drilling wells at this location was to observe effects from a nearby pumped irrigation well throughout a growing season.

Results of Aquifer Testing at site one near the Beaverhead River, all four wells completed in the shallow aquifer showed rapid response to pumping. Surprisingly, none of the monitored wells observed a recharge effect from the nearby Beaverhead River, thus suggesting no hydraulic connection with the river. MBMG contends that lower permeability silts and clays accumulated on the river bed may be locally restricting vertical leakage from the river. However, it is very likely that, with continued pumping, recharge effects would be observed as time progressed. MBMG further reports that all shallow wells show similar water-level fluctuations attributed to fluctuations in river stage, thus indicating an interconnection between ground water and surface water. Also not surprising is the fact that no response was observed in the two wells completed in the deep aquifer when the shallow production well was pumped. Similarly, only the monitoring well completed in the deeper aquifer below the clay layer responded to pumping the deep aquifer. No responses were observed in shallow wells. Lack of response suggests at least localized isolation between the shallow and deep aquifers. However, the clay stratum separating the two water-bearing zones disappears down river and the two zones merge into a continuous unit into which drawdown from either the shallow or deep aquifer may propagate.

At site two in the Spring Creek drainage, all five monitoring wells, completed in three water-bearing zones, responded to pumping, thus indicating hydraulic interconnection. Site three was not discussed under aquifer-testing results.

Results of Ground-Water Flow Mapping and Hydrogeologic Cross-Sections A composite water level map was constructed for the northern part of the study area based on existing information. As expected, the ground-water gradient is steeper in upland areas and gentler in lowland valley areas. The wider-spaced contour lines in the valley area indicate that the alluvium is more transmissive than finer-grained silt- and clay-rich sediments in the upland areas. Results also showed that ground water flow direction in upland areas is toward the valley and flow is in the down-valley direction in lowland areas.

Geologic cross-section diagrams were constructed from drillers' logs. A longitudinal profile down the axis the Beaverhead River valley from Dillon to Beaverhead Rock showed the uppermost 40 feet to be unconfined sand and gravel aquifer with interbedded lenses of clay and silt. The unconfined aquifer is hydraulically connected with the Beaverhead River. Drillers' logs for deeper wells indicate semi-confined low-permeability silt and clay strata beneath the shallow alluvial aquifer. Wells completed in the deeper aquifer are not in intimate contact with surface water; however, effects of drawdown from long-term pumping can eventually propagate through confining strata to impact surface water.

The Beaverhead River is believed to be a losing stream from Dillon north to near Beaverhead Rock. At this point, the valley becomes constricted and forces ground water to the land surface, thus accounting for extensive wetland areas near Beaverhead Rock. In addition, stream flow increases in this area as the river transitions to a gaining stream.

Another geologic cross-section extending northwest-southeast across the Beaverhead River Valley indicates wide variability of Tertiary-age sediments. Volcanic rock and thick clay strata interbedded with sand and gravel layers are the dominant lithologic units. Clay strata can provide localized aquifer confinement, but because of their discontinuous nature, aquifer confinement is not extensive and interbedded sand and gravel strata provide conduits for the movement of ground water and propagation of drawdown.

<u>Results of Stream Depletion Modeling</u> MBMG states that connection between ground water and surface water is a fact. They discuss sustained yield and acknowledge that it does not equate to basin recharge alone, but also to reduced aquifer discharge to surface water or some combination thereof. MBMG's objective of conducting ground-water modeling simulations was to evaluate the effects of ground-water pumping on stream flow in the lower Beaverhead River sub-basin. Their analyses consisted of their shallow production well 2B on the Beaverhead River floodplain and four irrigation wells as representing four different hydrologic conditions.

The first scenario included steady-state pumping of well 2B until maximum drawdown and stream depletion were obtained. Results indicate that stream depletion occurs both up- and down-stream and most of the water pumped from well 2B is captured by reducing discharge to the river. A transient simulation indicates that stream depletion begins soon after pumping starts and approaches the discharge rate soon thereafter. However, pumping ends after 30 days and stream depletion continues to develop through a 150-day recovery period, thus demonstrating that depletion can require a significant period of time to develop and may persist long after pumping ends. Reported results are in agreement with hydrogeologic principles presented in the professional literature.

The second stream depletion simulation involved pumping a deep irrigation well (IR 3) located within the floodplain about 1,800 feet from the river, but completed in deeper Tertiary-age sediments. Numeric computer modeling simulated pumping of the well for 30 days and then allowed recovery for another 120 days. Maximum rate of stream depletion after 30 days of pumping amounted to about 17 percent of the well discharge rate. In comparison, a more simplistic analytical model produced almost identical results under the same pumping scenario.

Although MBMG did not provide detailed discussion, these simulations again produced results in agreement with hydrogeologic principles; that is, 1) less stream depletion will be produced in a given period of time as distance between the well and stream increase, 2) a greater time delay is necessary for stream depletion to appear from a more distant well, and 3) that a longer period of time will be required for the rate of stream depletion to equal the discharge rate of the well.

The third stream depletion simulation involved pumping deep irrigation wells (IR 1 and 2) completed in deep Tertiary-age sediments located about 1.5 miles from the river on the eastside sloping terrace. Numeric models were run with either IR 1 or 2 pumping for 30 days followed by 120 days of recovery. Results indicate that the maximum rate of stream depletion after 30 days of pumping amounted to about 8 percent of the well discharge rate. Again, the results are no surprise and in agreement with published hydrogeological principles.

The fourth stream depletion simulation involved pumping an irrigation well (IR 4) completed in deep Tertiary-age sediments located about 20,000 feet from the river in the eastside Spring Creek drainage. A numeric model was run using parameters of previous models and resulted in about 7 percent of the well discharge rate represented as stream depletion within the 150-day simulation period. Results are “in line” with previous results.

MBMG correctly concludes from the modeling scenarios that stream depletion decreases as distance between a pumping well and the river increases. They also mention that time to reach maximum stream depletion can be considerable. What is implied, but not discussed, is the fact that, as distance increases, time for full stream depletion to develop must also increase. For a more complete explanation, the fact is that the volume of water discharged from a well (assuming no consumptive use by crops or phreatophtyes) must equal stream depletion. To state that stream depletion becomes insignificant as distance between the well and river increases is an erroneous, misleading conclusion which results in a gross underestimation of the impact. A well pumping near a river will produce the same stream depletion if re-located miles from the river; the differences are that considerably more time is required for the same amount of stream depletion to occur and the seasonal variation in the rate of depletion will decrease. MBMG finally acknowledges these principles in the statement that “….distance from the stream determines when its (i.e. stream depletion) maximum rate will be achieved. It is important, then, that any simulation be of sufficient length in time to evaluate cumulative effects of all wells (or even a single well), particularly those at great distances from the stream.” And finally, MBMG states that “stream depletion is equal to the well discharge; however, the time it takes to reach maximum must be considered”. MBMG, however, did not follow their recommendations in their modeling efforts.

In a final modeling simulation, four irrigation wells are pumped concurrently at rates of 850 gpm, or at a total rate of 7.6 cfs, for 90 days and allowed to recover for 275 days. The cycle is repeated for 3 more years. MBMG’s analyses show that, although depletion increases annually, maximum rate is not attained. Again, the model was not run for a sufficient period of time.

MBMG does not consider the impacts of ground-water pumping on senior water users and provides only a limited evaluation of mitigation strategies. The main objective of future modeling should be to evaluate the impacts on senior water users and consider alternative mitigation strategies that reduce historic consumption to offset consumption for new uses.

The MBMG Lower Beaverhead case study and its interpretations are generally in agreement with hydrogeologic principles applied by the department and support the department in stream depletion evaluation from ground-water development.

Comments on Gallatin Valley Case Study

General Comments

The Gallatin Valley case study is a preliminary assessment of the interaction of ground water and surface water based on published information on overall basin water balance and general aquifer characteristics. A numerical model is used to investigate the effects of return flows from irrigation using surface water and short-term effects on surface water flows resulting from a ground-water pumping scenario. The author of this case study acknowledges that, primarily because of time constraints, the Gallatin Valley case study is not a definitive work; rather he characterizes it as a tool to demonstrate technical methods and the kinds of results they provide. In order to improve upon modeling of the Gallatin Valley, the author identifies a need to account for high spring flows, to incorporate available borehole, aquifer test, and ground-water and surface-water monitoring data, to refine the numerical model grid, to add ditches and canals, and to extend simulations into more and varied time periods. We agree with the general elements the author has identified and support refining and expanding this work to help answer questions that DNRC faces when evaluating plans to mitigate the effects of new water uses in this portion of the Upper Missouri River closed basin. The following comments are provided to convey the DNRC perspective on study needs in the Gallatin Valley and closed basins in general, and to provide specific technical comments for consideration by MBMG.

The primary challenge DNRC faces in closed basins such as the Upper Missouri closure, which the Gallatin Valley is part of, is providing for new appropriations where there is little or no water legally available. Lack of legal water availability has been established through the Missouri River water availability study and is evident in water shortages that require surface water diversions to be curtailed as well as in inadequate flows to support fisheries and hydropower generation. The overall basin water balance presented in the Gallatin Valley case study, although a necessary step in preparing a ground-water flow model does not reveal perennial water shortages within the valley interior or the impacts of ground-water use on senior surface water users during those shortages. Water shortages are primarily a result of natural factors including mountain snowpack and hydrogeologic conditions in the basin; however, the shortages will be exacerbated by depletion caused by ground-water pumping. Furthermore, mitigation proposed in the Gallatin Valley case study does not address water shortages on the Gallatin River within the valley or on tributary streams, long-term impacts of ground-water pumping that cannot be effectively controlled under a priority system, and the need to offset new consumptive uses with reductions of historic water consumption. DNRC believes additional work on the Gallatin Valley case study should focus on strategies that mitigate increased water shortages caused by future uses through changes to existing uses.

Specific Comments

The following are specific comments on the Gallatin Valley case study:

Water availability in critical dewatered reaches needs to be evaluated. A gross water budget is presented for the entire Gallatin Valley. This may be a necessary first step, but the variability of water availability and connectivity between ground water and surface water within the valley must be understood to evaluate the effects of ground-water pumping and associated stream depletion on senior water users. Specifically, the losing reach of the Gallatin River between Belgrade and the Central Park Fault experiences water shortages during the irrigation season. Diversions by senior surface water users, often with priority dates prior to 1900, are curtailed by a water commissioner or voluntary efforts due to seasonal water shortages in this reach and, as a result, any depletion to flows will result in increased curtailment. Care should be taken to evaluate the effects of ground-water pumping on flows in this critical reach and all other streams in future modeling.

The impacts of ground-water pumping on water availability to senior water users is not evaluated. The author states “if wells are sufficiently separated by distance or depth from streams, their impact to streams becomes negligible relative to other influences to stream flows …”. The evaluation of stream depletion in the Gallatin Valley Case Study is limited to one year and, therefore does not account for the full depletion effects of ground-water pumping. We agree that uncertainties increase with long-term modeling although we do not agree that long-term modeling is necessarily meaningless as suggested by the author. Ultimately, capture from ground-water pumping will equal the consumption from the new use.

No one disputes that the volume of water pumped from ground water is small relative to the overall water balance of the Gallatin Valley or to other inflows and outflows represented in the basin-scale water balance. However, basic hydraulic principles and modeling conducted for water right applications reveal that ground-water pumping depletes surface water flows and reduces water available to senior water users during seasonal water shortages. Modeling the timing and location of depletion and the implications to senior water users should be the main objective of future investigations.

The influence of seasonal variability in stream flows on capture by ground-water pumping needs to be modeled. The author states that “pumping water out of the ground-water reservoir creates storage space that can be refilled during times of high surface-water flow”. This is true; however the more important consideration is whether recharge will increase to fill the created storage space. Typically, recharge will increase in response to lowered ground water levels only where ground water levels are within a few feet of the surface, where ground-water storage essentially becomes full during seasonal precipitation or where ground water is hydraulically connected to surface water. The first instance results in capture of rejected recharge that may otherwise contribute to surface water flows and the second instance results in either increased losses from or reduced discharge to surface water. Either case results in stream depletion in a basin where water is legally available on limited occasions. Further, transient modeling conducted for this study can be refined to evaluate the seasonal variability of depletion resulting from differences in hydraulic connection between ground water and surface water during spring runoff (see Maddock and Vionnet, 1998). The author of the Gallatin Case Study identifies the need to model smaller water bodies such as canals and drainage ditches. This would be a valuable step in improving our understanding of the seasonally variable hydraulic connection between ground water and surface water, and the location and timing of depletion caused by pumping ground water.

The extent that capture from ground-water pumping is derived from reduced evapotranspiration needs to be evaluated. Ultimately, ground-water pumping will be offset by increased recharge to ground water or, most often, decreased discharge from ground water. Decreased discharge may be manifested in reduced base flow to surface water or decreased consumption by phreatophyte plants; both as a result of water-level drawdown, either beneath stream beds or in areas where phreatophytes grow. Evapotranspiration by phreatophytes also can impact the efficiency of mitigation by consuming water that is intended to replenish depleted surface water flows. Therefore, although total capture caused by pumping ground water may exceed stream depletion by an amount equal to the reduction in phreatophyte consumption, mitigation probably needs to restore phreatophyte consumption in the process of restoring stream flows.

Stream depletion caused by ground-water pumping needs to be separated from the accretion effects of return flows from surface water irrigation. It appears that surface-water depletions by ground-water pumping are modeled in the Gallatin Case Study simultaneously with surface-water accretions by surface-water irrigation return flows. Return flows from surface water irrigation are part of the existing water supply that is relied on by senior water users and, therefore are not considered by DNRC to be legally available. Further, these effects are independent and need to be modeled separately or, alternatively, accretions from return flows should be modeled as an initial condition to the stream-depletion evaluation (to allow the additive effects of pumping to be modeled independently). Modeling the two together in a transient model without the model first equilibrating to the influence of return flows will result in a significant underestimated of the amount of depletion and an overestimate of the delay until full depletion is realized.

The author calibrates a steady-state model to seasonal low ground-water levels and disregards recharge by irrigation return flows, apparently arguing that the model represents “natural low ground-water setting”. Ground-water levels and surface water flows have been modified by irrigation diversions and returns for 150 years. These diversions and returns have multi-year effects that cannot be separated from “natural conditions”. The author acknowledges that ground-water levels may not return to natural levels.

Future modeling should consider additional scenarios of ground-water pumping and should take advantage of modeling conducted for past and ongoing water right permit applications. The model of ground-water pumping assumes pumping from Tertiary sediments beneath the Madison Plateau, a significant distance from the Gallatin River. Most new appropriation applications are in more recent alluvium much closer to the Gallatin River where modeling for the Utility Solutions application has demonstrated depletion. Depletion from wells farther away will be delayed and likely will not have seasonal fluctuations, but will develop absent unique conditions that are not described in the Gallatin Case Study.

Mitigation strategies that are considered in the future should focus on making water legally available for new uses. The author proposes a mitigation strategy for depletion by 31 high-yield wells of 1.4 cfs. The strategy would be to install another well capable of pumping 1.4 cfs, apparently to pump ground water into surface water only at times when there are water shortages. Problems with this mitigation plan include the following: the 1.4 cfs depletion rate probably is a significant understatement, the mitigation well will create additional depletion that will need to be mitigated, year-round, perennial water shortages that affect senior water users are not addressed and ultimately, depletion is not mitigated because consumption is not reduced.

Comments on Bitterroot Watershed Case Study

MBMG employs three approaches to assess the impact of ground water development on streamflow in the Bitterroot watershed: statistical analysis, changes in ground water storage (long-term water level changes), and a comparison of annual water balance components. While perhaps useful as a first look, or reconnaissance study, these approaches are insufficient in providing useful information for policymaking. In the case of the Bitterroot watershed, it would perhaps be of more value to use the relatively large amount of information available (from MBMG's characterization program, and other sources) in the context of a ground water modeling effort.

Baseflow Statistical Analysis

MBMG has utilized simple statistical analysis to evaluate the relationships between the difference in baseflows (observed between Darby and Missoula) and other factors (cumulative wells, precipitation – location not identified in the report). In this case, the use of statistical models readily available to the public (via Excel) highlights the strengths and weaknesses of the analysis. The strength in this approach lies primarily in its readily accessible use by consultants, public entities, and decision makers. The level of statistical evaluation employed can be easily replicated by outside parties using statistical packages frequently accompanying spreadsheet software (i.e. Excel). However, the simplicity of this approach does not allow for robust, professional level analysis and reporting. Instead, the analysis is limited to a series of single variable regressions with assumed linear relationships and no hypothesis testing. A more robust analysis of the data would have included, at a minimum:

1) An investigation of functional form. Not all relationships between variables are necessarily linear, and in the case of natural phenomenon, seldom are.
2) Multi-variable analysis, evaluating not only the potential relationships of individual independent variables to the dependent variable, but also their interrelationships.
3) Evaluation of delayed effects and impacts. The current analysis assumes no delay between precipitation, ground water development, and impacts to baseflows.
4) Investigation of outliers, one-time events that may skew the results.
5) Examination of event dependent coefficients. The current analysis assumes that any relationship between variables is either constant over the entire timespan, or non-existent. No analysis was performed to examine if, for example, a pre-1970 coefficient is not significantly different from a post-1970 coefficient.

It is also unclear from the report from which weather station the precipitation data were acquired, or whether the data represent an amalgamation of several stations, via a weighted averaging scheme. And finally, the use of the term "significant" in any discussion should be used with caution, especially where statistical analysis is used.

The conclusion of this section is that some of the variability (approx. 35%) in the difference of baseflows can be explained by annual variation in precipitation. The remaining variability, as described by MBMG, "cannot be quantified at this scale with the available data and our current understanding of the ground-water – surface-water system". This is, really, all that can be obtained from this section: The difference in baseflows is dependent on, but only partially explained by variation in precipitation, and more information is needed regarding the interaction between ground water and surface water. With regard to the latter, MBMG has already gathered a wealth of data on the Bitterroot through the characterization program, and is in good position to construct a detailed ground water model of the Bitterroot Basin, or subsections thereof.

Changes in Ground-Water Storage

MBMG relies on the long-term observations of three wells to identify changes in water levels over time. The key weaknesses to this argument rest on the limited data available and the lack of detail in the statistical analysis and presentation. With regard to the limited data, it is unclear whether this is the only long-term monitoring data available, or whether these wells represent only a small subset. Even if there are additional wells, they still represent a very small sampling population from which to extract information regarding long-term trends. Any conclusions drawn from such a small sample should be considered cautiously.

As to the statistical analysis, a major limitation to its effectiveness is in the follow through and reporting of the results. Specifically, in addition to not reporting the correlation coefficients associated with the regression analysis, no hypothesis testing was performed on the regression coefficients to show whether or not they are significantly different than zero. Without this additional testing, the conclusion that precipitation exhibits a slight downward trend cannot be substantiated. It may be that the coefficient is not statistically significant, meaning that there is no long-term, linear trend in precipitation over time, yet one or more water levels may exhibit declining trends for the same time period. Without this additional statistical information, the statements regarding the presence or absence of trends have no support.

The final critique of this section is that the focus is on ground water, without extending the conversation to surface water. The conclusion indicates that “long-term trends are stable, indicating little or no depletion of the shallow basin-fill aquifer”. Even a small drop in water levels, corresponding to a minor decline in ground water volume, can greatly impact surface water bodies and senior water rights.

Ground-Water Withdrawals

MBMG inappropriately uses annual statistics to show impacts or relative magnitudes of individual water balance components within the watershed. On an annual basis, certainly there is a large total volume discharging from the Bitterroot watershed. However, the majority of this (55 – 72%) discharges in the spring (SCS, 1972. McMurtrey, et al, 1972) and is not available during much of the irrigation season. Surface water issues arise and are most felt during the irrigation season, when demand is highest and supply is lowest. In the Bitterroot watershed, as with most of the closed basins, there is a large portion of the river where water is in short supply at certain times of the year. The earlier investigation by McMurtrey, et al, notes critical low flows occurring in the Grantsdale-Victor area. Similarly, a study initiated in 1983 for purchasing water from Painted Rocks Reservoir identified reduced stream flows between Hamilton and Stevensville, and critical dewatering frequently occurring between Woodside and Bell crossings. (Dept. of Energy, 1987). Even with the additional water purchased by DFWP, released from Painted Rocks Reservoir as well as Lake Como, and monitored by a water commissioner, the instream goals for this reach are not always met. DFWP still lists the section from river mile 33.7 to 50.8 as chronically dewatered – dewatering is a significant problem in virtually all years.

The second argument presented by MBMG and others uses the annual statistics (Cannon and Johnson, 2004) to illustrate that consumptive ground-water use represents only a minor fraction of annual discharge from the shallow basin-fill aquifer. This is essentially the “de-minimus” argument, which has no legal basis within a closed basin. These basins were closed because they were deemed to be fully or over-appropriated, and as such, any additional reduction in surface water impacts senior water users. While it may be a minor fraction of the annual discharge, consumptive ground-water use does account for 6140 acre-feet per year that in most cases is water junior to surface water diversions that likely get reduced or shut off on an annual basis due to shortages. It follows that as ground water consumptive use increases with development, impacts to surface water (senior) users will increase.

Comments on Evaluation of Hydrogeologic Assessments

From the conclusions, MBMG states that:

"New uses in closed basins are evaluated by including new, permitted uses in each subsequent application's hydrologic assessment. Since each new use results in an increase in depletion, it follows that at some point, the maximum allowable depletion will be reached and no further appropriations should be allowed. However, the cumulative hydrologic effects of prior, current, and potential uses within a closed basin are not considered in an individual assessment.

The current process is focused, as the law requires, on local impacts to senior water uses. It is possible that overall management of the ground-water resource in closed basins in insufficient to prevent over-use."

Comments:

1) Depletion that causes adverse effects is not allowed without mitigation in closed basins and, therefore the maximum allowable depletion has been met under most if not all circumstances.
2) Each applicant for a water-use permit is required to demonstrate that in, and of itself, it does not adversely affect senior water users. Cumulative impacts are addressed to the extent that lack of adverse effect is harder to prove with each successive application.
3) Except in a few instances (water reservations), the DNRC cannot consider future use of the resource.
4) The process does include basin-wide impacts, at least with regard to hydropower rights vis-à-vis the Thompson River decision.
5) MBMG does not receive change applications that accompany permit applications and, therefore does not have adequate information to evaluate mitigation plans.

References

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Comments on Montana Bureau of Mines and Geolgoy Case Studies

by

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The following are our comments on the Montana Bureau of Mines and Geology (MBMG) case study reports.

Lower Beaverhead River Case Study

Significance of Depletion

It is agreed that the magnitude of stream depletions tend to be small and within streamflow measurement errors (page 56). The same can be argued in general for most if not all watersheds in Montana as the magnitude of ground-water development is small when compared to stream flows. The development that has occurred tends to fall within measurement error or the noise level from natural flow variations. Also, there are other factors that cannot be ignored including land use transitions which in some instances has lead to a reduction in overall consumptive use.

Figures 33 through 35 and accompanying analysis.

While instructive from an analysis perspective, caution is warranted when interpreting Figures 33 through 35. The primary reason for depletions occurring in the Beaverhead River relates to surface water diversions during the irrigation season. In effect, leaving water in the stream during this critical period of time as a mitigation measure is probably a better method of addressing stream depletions than taking water out of the stream for recharge mitigation purposes.

Generally, stream depletions tend to be less of a concern during the non-irrigation season. Hence, any residual depletion associated with ground-water pumping that extends into the non-irrigation season as represented in Figures 33 through 35 is probably irrelevant.

Also, while it is understood that these figures and other analyses are intended to simplify our understanding, stream flows do not tend to be steady over time. Actual stream flow rates after the end of the irrigation season tend to rebound significantly when surface water is no-longer being diverted. The end of the irrigation season also tends to be the beginning of time (after killing frost) when phreatophytes are no longer drawing water from streams. Hence, the residual stream depletions that extend into the non-irrigation season from irrigation season pumping are in most instances not a problem.

Again, it should be emphasized that using surface water for recharge mitigation purposes typically involves ***diverting or removing*** surface water from the same stream from changing an existing water right. This reduces the immediate surface water availability to another surface water user. Some portion of this recharge water does return as ground-water return flow to the stream during the irrigation season. However, a substantial portion of that recharge water also returns to the stream during the non-irrigation season. Hence, the latter portion is rendered unavailable to the irrigator that depends upon surface water.

In summary, from a senior irrigator's perspective, in most instances it is likely better to leave water in the stream as a surface water mitigation measure than to divert that same water and apply it as a recharge mitigation measure.

Using early spring runoff for mitigation purposes if it can be done is an appropriate means of avoiding the need to divert surface water during the critical irrigation season. However, this may be feasible in some instances and yet not in others.

Also, the discussion on the significance of phreatophyte growth on stream flows is excellent (page 66). Our findings in watershed water use studies demonstrate that phreatophyte consumption of surface and ground water generally grossly exceeds any consumption associated with ground-water development from either land development or from agricultural uses. Thus, caution is warranted in planting willows or cottonwoods along stream corridors as part of vegetation enhancement programs. There are numerous examples in Montana where entities not possessing permits for consumptive use are planting willows for habitat enhancement, which, in effect leads to increased water consumption. Perhaps those entities that do such should be subjected to the same requirements as others when it comes to applications for beneficial use of Montana water.

Ground-Water Use and Development in the Bitterroot Watershed

The findings described in this portion of the MBMG case study are consistent with the findings of the study completed by Nicklin Earth & Water, Inc. entitled "Water Resources Evaluation - Water Rights in Closed Basins" which included a section on the Bitterroot Watershed.

Gallatin Valley Case Study

The findings described in this portion of the case study generally conform with the evaluations conducted in the Gallatin Valley by Nicklin Earth & Water, Inc. This is yet another example of why we would not expect the limited ground-water use that exists in the valley to be manifested in the stream flow measurement records in the Gallatin Valley. Furthermore, as is the case in this and other Montana watersheds, all factors that affect the nature of stream flow (including transitions surface water irrigation) must be considered in water budgeting evaluations before conclusions are made about overall system responses. Ground-water use in the valley is currently only a very small component of that water budgeting under either normal conditions or drought conditions.