Upper Clark Fork River Basin Steering Committee
7165 Old Grant Creek Road
Missoula, MT 59808

January 28, 1999

Dear Reader:

Enclosed is the report of the Upper Clark Fork River Basin Steering Committee required by 85-2-338 MCA to be periodically provided to the Montana Legislature.

Sincerely,

Gerald Mueller
Steering Committee Facilitator

Report to the 1999 Montana Legislature

By

The Upper Clark Fork River Basin Steering Committee

February 2, 1999

I. Introduction

The Steering Committee was created in 1991 pursuant to Section 85-2-338 MCA and directed by that statute to prepare by the end of 1994 a water management plan for the Upper Clark Fork River Basin. In December 1994, the Steering Committee adopted and presented to Montana's Governor and Legislature the *Upper Clark Fork River Basin Water Management Plan (Plan)*. The *Plan* set forth two goals:

- To provide for continued planning and management of the waters of the upper Clark Fork River basin rooted at the local level; and
- To balance all of the basin's beneficial water uses.

Several of its recommendations called for action by the Legislature: closing the Upper Clark Fork River Basin to most new surface and groundwater rights, providing an on-going water planning and management mechanism, authorizing an in-stream flow pilot study, and continuing the suspension of the Granite Conservation District's and the Department of Fish, Wildlife, and Park's water reservation applications. All recommendations requiring legislative action were accepted by the 1995 Legislature, except that ground water was not included in the basin closure. Instead of closing ground water, the Legislature directed the Steering Committee to "...prepare and submit a report concerning the relationship between surface water and ground water and cumulative impacts of ground water withdrawals in each subbasin..."

Among the duties assigned by Section 85-2-338 is periodic reports to the Legislature. In the following sections, we provide a brief overview of how the basin water management picture and has changed since 1991. Sections that follow this "State of the Basin" report more detailed discussions of several ongoing efforts. Included are a summary and report of the results and conclusions of a study with particular significance for agriculture because it addressed the effects of irrigation on instream flows in the Flint Creek Valley. Next we report on two of the Steering Committee's primary on-going activities, its partnership with the Montana Department of Environmental Quality (DEQ) in implementing HB546, sometimes called Montana's TMDL law, through voluntary water quality management planning, and its study of the Basin's ground water. Next we provide an update on water leasing activities in the Basin, and summarize other issues addressed by the Steering Committee since the *Plan's* adoption. And finally, we provide a summary of the Steering Committee funding and expenditures to date.

II. Current Water Management Picture

In 1990, prior to the creation of the Steering Committee, a contested case hearing was scheduled to address competing water use issues in the upper Clark Fork Basin. Emotions ran high and trust low as water users prepared to make their arguments and defend their positions. Fish and wildlife managers, recreationists and conservation groups argued that to protect the fishery and other instream values, additional diversions of water from the River and in tributaries should not be allowed. Ranchers and irrigators, hydroelectric utilities, and industrial interests were concerned about their livelihoods, water rights, and the availability of water for future development. A series of drought years and prevailing low streamflow conditions heightened the competition and the universal concern that all water uses could not be sustained indefinitely.

At the same time, water quality concerns in the basin were mounting. The area from Butte to Milltown Dam was designated as the nation's largest Superfund complex due to impacts from historic mining activities. The effects of wastewater discharges on water quality became more apparent as drought reduced the amount of streamflow available for dilution. Nonpoint source pollution from a variety of land use practices continued to impair beneficial water uses in many miles basin streams, and a host of new development activities were being proposed. Congress responded to citizen concerns of declining water quality by calling for a major pollution study of the Clark fork Basin in amendments to the federal Clean Water Act. The State designated the Clark Fork Basin's water quality problems as among its highest priorities.

In 1991, the Steering Committee was officially convened and charged with the daunting task of addressing all of these water supply and water quality problems through a comprehensive, locally-based planning process.

Water resources management in the upper Clark Fork basin presents a much different picture today. In the span of eight years, much has been accomplished to address the many and varied water use and water quality issues of the basin. The Steering Committee, affiliate groups, local partners and basin water users have proven that collaborative approaches can work when all interests are involved in and committed to finding common ground and workable solutions to problems. The following list highlights agreements and actions taken in the Basin since the Steering Committee began its work late in 1991. Some of these are discussed in more detail in later sections of this report.

<u>Water Supply</u>

1. Instream Flows
   - In 1995, at the Steering Committee's recommendation, the Legislature closed the Basin to most new surface water rights;
   - Also in 1995, again at the Steering Committee's recommendation, the Legislature authorized a pilot study of an instream flow leasing program in the Basin; and
   - ARCO has proposed to augment flows in Warm Springs Creek to protect the fishery and instream uses.

2. Water Development
   - In 1997, at the Steering Committee's recommendation, the Legislature amended the Basin water rights closure to allow development of surface water when streamflows are augmented with groundwater;
   - Also in 1997, ownership of the Silver Lake water system and related water rights were transferred to Butte-Silverbow; and
   - Plans are being developed and implemented, respectively, for wastewater reuse in Butte and Deer Lodge.

3. Water Use Monitoring
   - The Steering Committee has formed a groundwater committee that is compiling existing information about Basin groundwater use.

4. Water Rights
   - The Avista Corporation initiated a collaborative process to involve water interests from the entire Clark Fork Basin in the re-licensing of its Cabinet Gorge and Noxon hydroelectric projects. The State and Avista this month reached an agreement regarding the exercise of Avista's water rights associated with these projects.

5. Dispute Resolution
   - The Steering Committee has provided a continuing forum in which basin water users and agencies can raise and discuss water rights issues.

Water Quality:

1. Nonpoint Source Pollution
   - As discussed below, the Steering Committee has initiated both pilot voluntary water quality management (i.e. TMDL) projects public education forums focused on the State's 303(d) list.

2. Point Source Pollution
   - The Deer Lodge and Butte wastewater reuse projects will reduce nutrient discharges to the Clark Fork River;
   - Butte-Silverbow adopted a phosphate detergent bans, and phosphate detergents are no longer being sold in the Basin;
   - The Tri-State Implementation Council adopted the Clark Fork Voluntary Nutrient Reduction Program; and
   - Discussions have begun with the town of Drummond to consider including in its pending upgrade of its sewage lagoon either a land application of sewage effluent similar to that adopted by Deer Lodge or a constructed wetlands project.

3. Water Quality Monitoring
   - The Tri-State Council has developed a water quality monitoring program as a part of the Clark Fork Voluntary Nutrient Reduction Program

III. Flint Creek Return Flow Study

It is common knowledge that agriculture is the largest user of water in Montana, accounting for on the order of 90% of the total diversion of water from Montana's rivers and streams. It is also commonly assumed that irrigation withdrawals necessarily harm rivers and streams and the fishery they support. A second common assumption is that the best way to reduce agriculture's harmful impact is by increasing irrigation efficiency by converting from flood irrigation to sprinkler systems. Farmers and ranchers often dispute both of these assumptions, and particularly the simple equivalency of irrigation withdrawals with harm. They argue that irrigation actually consumes only a fraction of the water diverted, and that water not consumed returns to rivers and streams at a later time when natural stream flows would otherwise be lower, thereby benefitting fisheries and aquatic ecosystems. Some also argue that depending on the specific circumstances, conversion of flood to sprinkler irrigation may eliminate or reduce return flows that benefit both downstream irrigators and instream flows.

With encouragement from Steering Committee members, the Montana Department of Natural Resources and Conservation, the U.S. Geological Survey, and the Bureau of Reclamation conducted a study of return flows in the Flint Creek Valley to understand and document the role of irrigation return flows. The Flint Creek Citizens Advisory Committee provided assistance to the study and information about where return flows actually occur. Based on this study the Bureau of Reclamation is developing a computer model of the hydrology of the Flint Creek Valley including return flows. When completed, this model will allow Valley water users to analyze various water management ideas. The executive summary of the DNRC report on the study, including its results and conclusions, and an article written about the study for the *Philipsburg Mail* by two DNRC hydrologists are included, respectively, in Appendix A and B.

IV. Voluntary Water Quality Management Planning

One of the Steering Committee's primary on-going activities is voluntary water quality management planning. The 1997 Legislature passed HB 546 giving the DEQ three years to identify those Montana water bodies that have water quality problems and ten years develop plans to address them. This act also directed DEQ to work with local watershed advisory groups such as the Steering Committee in developing and revising the list of water bodies with water quality problems and in developing water quality management plans to address them. The Steering Committee accepted DEQ's offer to act as a partner in this effort to further the *Plan's* goals, rooting Basin water planning and management at the local level and balancing all beneficial water uses.

To guide its water quality management planning activities, the Steering Committee has adopted a work plan with two objectives. The first is the examination by local Basin water users of the state's list of water bodies with problems, i.e. those that either are not meeting water quality standards and are therefore "impaired," or which are likely not to meet the standards and are "threatened." This list is called the "303(d) list." The Steering Committee will hold a series of meetings throughout the Basin beginning in the fall of 1998 focused on the 303(d) list. These meetings will allow local water users to become acquainted with the 303(d) list and the data and processes that resulted in their local streams or water bodies being included on it. The local water users will also be afforded the opportunity to question the list and provide information that may relate to possible removal of specific listings.

The second objective is the development of pilot water quality management plans so that local water users and agencies can learn effective steps for developing plans leading to removal of basin water bodies from the 303(d) list. The Steering Committee is in the process of selecting a small number of candidate stream segments from DEQ's 303(d) list for immediate development of plans to correct the impairment and eliminate the actual or threatened non-support of one or more water uses. The Steering Committee will meet with the candidate stream water users and other potential partners and cooperators to seek their agreement for the pilot development. The pilots will be run on a strictly voluntary basis. If the local water users are not supportive, development of the water quality management plan will not proceed. The Steering Committee does not recommend that local water users participate in a pilot unless they see an advantage for doing so. One significant potential advantage is the availability of funding from state and/or federal agencies to support the pilot plan's water quality improvement activities.

V. Ground Water Study

In 1995, the Legislature directed the Steering Committee to "...prepare and submit a report concerning the relationship between surface water and ground water and cumulative impacts of ground water withdrawals in each subbasin..." The Steering Committee's development of this report is not complete. Here we summarize activities to date. We began this study by developing three objectives: 1) investigating groundwater management methods used in other states; 2) investigating existing ground water conditions in the Clark Fork Basin; and 3) improving the knowledge of the Basin's groundwater resources. To meet the first objective, Steering Committee members themselves conducted research related to the management of groundwater resources in other western states and presented their findings to the full Steering Committee for discussion. To meet the third objective, the Steering Committee worked with the Montana Bureau of Mines and Geology (Bureau) and established a priority ranking under the "Montana Groundwater Assessment Program" for the Upper Clark Fork Basin. The Bureau will conduct field investigations in Missoula County in 1998 and 1999, and the remainder of the basin will be examined in 2000. To meet the second objective, the Steering Committee first sponsored several presentations on the fundamentals of geo-hydrology and the basin's ground water resource; it then formed the Groundwater Study Committee to design and oversee implementation of a plan for investigating the Basin's existing ground water conditions. This plan proposed relying on existing resource data to characterize the use and occurrence of ground water in the basin. Through the DNRC, the Steering Committee obtained a U.S. Environmental Protection Agency Regional Geographic Initiative Grant to fund its ground water investigations. The Montana State Library, the Natural Resource Information System's Water Information System (NRIS), the Montana Bureau of Mines and Geology, and the DNRC and other state resource agencies are assisting in the implementation of the plan.

Thus far the Groundwater Study Committee has found records of 8,616 wells within the basin. Of these, 5,447 have recorded water rights. The vast majority of these wells have been constructed in the basin's alluvial aquifer near Basin rivers and streams. Only 3% of these wells are utilized at rates greater than 100 gallons per minute. Demand for groundwater in the Basin has increased 226% since 1960. Water right records indicate that current potential annual use of groundwater is about 75,200 acre feet. The four categories of ground water use are individual domestic, municipal, irrigation, and industrial. Individual domestic use is the most common but its total use ranks fourth at about 8,100 acre feet. Today, irrigation has surpassed municipal use to become the largest user of groundwater at about 24,300 acre feet per year. Total municipal use of ground water ranks second at about 16,800 acre feet. Industrial use ranks third at about 10,400 acre feet.

Four hundred and forty-five new wells have been constructed in the basin since the April 14, 1995, the date of establishment of the permanent basin closure. April 14, 1995 also marked the beginning of the requirement for new ground water permit applicants to file a "groundwater report" demonstrating that new well development would not substantially effect surface water. Only three wells have been subject to DNRC's permitting review since April 14, 1995.

Study results to date indicate that groundwater utilization in the Basin is increasing markedly. Most projects are small in size. The "average" annual demand per groundwater project is less than 2 acre feet per year. However, some post April 14, 1995 projects propose use of considerable quantities of ground water and generated significant local interest. The full potential for Basin ground water use is not yet identified, nor is the cumulative effect of wells on surface waters yet known, especially during periods of low stream flow. In general the studies have been useful although no firm conclusions have been made about the relationship between surface and ground water. The studies are ongoing.

VI. Instream Flow Lease Update

To date only one instream flow lease has been acquired in the upper Clark Fork River Basin pursuant to the 1995 statute establishing the instream flow leasing pilot study. The Montana Department of Fish, Wildlife and Parks (DFWP) leased a portion of its own water right on Cottonwood Creek on the Blackfoot game range for an instream flow. Since 1995, DFWP has also acquired instream flow leases on two streams in the Blackfoot River drainage, Chamberlan Creek and Pearson Creek, using the 1989 leasing statute.

VII. Other Issues Addressed by the Steering Committee Since *Plan* Adoption

In addition to the four previous issues, since the *Plan* was adopted, the Steering Committee agenda has addressed several other topics through its meetings, watershed committees, and newsletter, including:

- Developing flexibility within the Basin's water rights closure to allow water development while protecting existing water rights and instream flows;
- Bull trout recovery and threatened/endangered species listing and its implication for the Upper Clark Fork Basin;
- The transfer of ownership of the Silver Lake Water system to Butte-Silver Bow;
- The problem that developed during summer of 1996 and the subsequent repair and funding for the East Fork Reservoir;
- Initiation of a watershed history of the Flint Creek valley by funding the expenses of a University of Montana History Department graduate student;
- The negotiations by the Montana Reserved Water Compact Commission with the U.S. Forest Service;
- The settlement of the Natural Resource Damage Lawsuit brought by the State against ARCO; and
- The effort by Avista Corp. (formally Washington Water Power) to develop a consultation process regarding the re-licensing of its Noxon Rapids and Cabinet Gorge Hydroelectric Projects, and in particular DNRC proposals regarding Avista Corp.'s water rights and those of Clark Fork Basin water users junior to Avista Corp.

VIII. Funding and Expenditures

As will be described in more detail below, total expenditures in support of the Steering Committee have averaged about $14,700 for the last three years. The sources of this funding included a private non-profit organization, the Northern Lights Research and Education Institute located in Missoula, and the Montana Renewable Resources Grant and Loan Program. Since its inception, the success of the Steering Committee has also depended on literally hundreds of hours of volunteer, unpaid work by Steering Committee members and members of the public.

Funding

Activities of the Steering Committee, including its facilitation and administrative support, is supported through July 1999 by funding from three sources: Northern Lights Research and Education Institute, a grant from the Renewable Resource Grant and Loan Program, and grants from the U.S. Environmental Protection Agency. Each of these will now be discussed separately.

Northern Lights Research and Education Institute

Funding for the Steering Committee from its inception to October of 1995 was provided by the Northern Lights Research and Education Institute (Northern Lights), a non-profit organization based in Missoula. The source of Northern Lights funding was grants from private foundations including the Ford Foundation and the Bullett Foundation and from the Avista Corp. Northern Lights funding relationship with the Steering Committee evolved out of Northern Lights' Clark Fork project that began in 1988. Northern Lights' goals for its Clark Fork project were to:

- Improve management of the Clark Fork Pend Oreille system; and
- Build lasting, growing institutions within the basin committed to the continued improvement of the watershed and the patterns of cooperation which alone can insure that improvement.

Through this project, Northern Lights provided an opportunity for the potential participants in the contested case hearing regarding upper Clark Fork River Basin water reservation applications to negotiate an agreement calling for state legislation that would suspend the water reservation process during a temporary closure of the upper Clark Fork River Basin to most new water rights and for creation of a steering committee charged with drafting a Basin water management plan during the closure. In 1991, the Legislature passed a bill implementing the provisions of the agreement. Northern Lights then continued to fund the Steering Committee's development and adoption of the *Plan*. In 1995, Northern Lights funding support was reduced to providing meals associated with Steering Committee meetings.

Renewable Resource Grant and Loan Program

In May of 1994, the Steering Committee submitted an application for $86,120 for a grant from Montana's Renewable Resource Grant and Loan Program administered by the Montana Department of Natural Resources and Conservation (DNRC). To meet required deadlines, the application had to be submitted prior to completion of the draft of *Plan*. By January 1995 after the *Plan* was adopted and submitted to the Governor and the Legislature and the Steering Committee had a better understanding of the scope of its activities over the next two years, the grant request was reduced by about one fourth to $64,740. The grant for this amount was awarded and the contract signed in October 1995. However, over the next biennium, only just under $19,000 of the grant funds were expended, and the DNRC extended the grant period to include a third year. During the third year, the expenditure pattern set during the first two years was followed, and only $8,900 was spent, leaving almost $36,700 of the grant unspent. The Steering Committee again requested that the grant be extended for a fourth year and offered to return to the program about $19,000 which was unlikely to be expended during that period. The DNRC agreed to the Steering Committee's request, and in August 1998, the grant was extended for another year and $18,925.91 was returned to the Renewable Resource Grant and Loan Program.

EPA Ground Water Grant
Through the DNRC, the Steering Committee obtained a grant for $50,000 from the EPA Region VIII's Ecosystem Protection Program Regional Geographic Initiative (RGI) to fund its study of groundwater and surface water relationships. Ten percent of the grant total, $5,000, is available to the Steering Committee for administrative tasks associated with the ground water study.

DEQ TMDL Grant
Using EPA funds, DEQ has made a grant of $5,000 to the Granite Conservation District to support the Steering Committee's voluntary water quality management planning activities, the examination of 303(d) list by local Basin water users and the development of one or more pilot water quality management plans for streams on this list. These dollars can be used to arrange and conduct the 303(d) list and pilot water quality management plan meetings.

Expenditures
A summary of the Steering expenditures for the years three years beginning August 1995 and ending July 1998 is shown in the following table. The average annual expenditure of funds from the Renewable Resource Grant and Loan Program over this period was $9,350. The four categories of expenditures shown in the table are facilitator, office and operations, Steering Committee meetings, and newsletter. During this same three year period, Northern Lights spent a total of $3,477.48 for meals for those attending Steering Committee meetings. To date, expenditures on the Upper Clark Fork River Basin ground water study using EPA funds have totaled $9,008. All of these expenses have been incurred by the State Library's Natural Resource Information System (NRIS). NRIS is the contractor to DNRC which is managing the EPA grant. Total support for the Steering Committee from all sources was $44,123.27, or about $14,700 per year.

Clark Fork Project Renewable Grant and Loan Program Budget and Expenditure Summary

	First Year August 1995 - July 1996		Second Year August 1996 - July 1997		Third Year August 1997 - July 1998
	Budget	**Expenditure**	**Budget**	**Expenditure**	**Expenditure**
Facilitator					
Salary	$14,400.00	$6,761.70	$14,400.00	$6,819.00	$6,603.60
Per Diem	$0.00	$35.58	$0.00	$236.87	$76.00
Travel	$1,100.00	$340.90	$1,100.00	$323.71	$571.93
Accountant	$2,400.00	$0.00	$2,400.00	$0.00	$0.00
Office & Operations					
Office Rent	$600.00	$0.00	$600.00	$0.00	$0.00
Fax Charges	$0.00	$27.75	$0.00	$44.25	$39.00
Supplies	$500.00	$10.99	$500.00	$0.00	$20.38
Postage	$1,000.00	$266.62	$2,500.00	$248.28	$188.74
Copies	$1,000.00	$249.03	$1,000.00	$179.85	$157.35
Telephone	$300.00	$51.20	$300.00	$47.68	$54.15
Steering Committee Meetings					
Room Rental	$720.00	$250.00	$720.00	$130.00	$325.00
Lunches	$1,200.00	$0.00	$1,200.00	$0.00	$0.00
Committee Member Mileage	$1,200.00	$0.00	$1,200.00	$0.00	$0.00
Newsletter					
Editing & Layout	$2,000.00	$357.50	$2,000.00	$150.00	$150.00
Printing	$2,000.00	$899.97	$2,000.00	$566.30	$378.70
Postage & Handling	$1,200.00	$642.37	$1,200.00	$357.79	$335.45
Publications			$4,000.00	$0.00	$0.00
Totals	**$29,620.00**	**$9,893.61**	**$35,120.00**	**$9,103.73**	**$8,900.30**

Clark Fork Project Renewable Grant and Loan Program Budget and Expenditure Summary

(Continued)

	Budget	Expended Amount	Unexpended Amount
1st Year	$29,620.00	$10,061.63	$19,558.37
2nd Year	$35,120.00	$9,083.98	$26,036.02
3rd Year	$0.00	$8,900.30	$0.00
Total	$64,740.00	$28,045.91	$36,694.09

EPA Ground Water Study Grant

Natural Resource Information System Expenses through November 1998[1]

Expenditure Category	Amount
Salaries	$5,992.93
Employee Benefits	$1,602.32
Supplies & Materials	$557.03
Communications (telephone)	$255.76
Repair & Maintenance	$400.00
Other Expenses	$200.00
Total	**$9,008.04**

Note 1: All expenses listed have been incurred by the State Library's Natural Resource Information System (NRIS). NRIS is the contractor to DNRC which is managing the EPA grant to fund the study of ground water in the Upper Clark Fork River Basin. The Steering Committee can directly expend up to $5,000, but has not yet spent any of these funds.

Northern Lights Research and Education Institute Funding

	Purpose	Expended Amount
1st Year	Steering committee meals	$2,073.31
2nd Year	Watershed survey, watershed symposium, case studies of the Steering Committee, Steering Committee meals	$3,475.41
3rd Year	Watershed Symposium, Steering committee meals	$1,520.60
Total		$7,069.32

Total Expenditures on Steering Committee Related Items from All Sources

Source	Year 1	Year 2	Year 3	Total
Northern Lights Research & Education Institute	$2,073.31	$3,475.41	$1,520.60	$7,069.32
Renewable Resource Grant & Loan Program	$10,061.63	$9,083.98	$8,900.30	$28,045.91
EPA Ground Water Grant			$9,008.04	$9,008.04
Totals	$12,135.94	$12,561.39	$19,431.94	$44,123.27

Appendix A

Flint Creek Return Flow Study
The Montana Department of Natural Resources and Conservation, in cooperation with the U.S. Geological Survey, conducted a hydrologic investigation to document and better understand the role of irrigation return flows in the Flint Creek basin of southwestern Montana. The study was part of a larger effort to develop a water-use model to measure the effects of future changes in irrigation and reservoir management in the basin. Field work for this study was done from 1994 through 1996.

Study Area and Methods
The study focused on irrigated lands in two basins, the Philipsburg valley and the Drummond valley. The Philipsburg valley is in the upper reaches of Flint Creek and includes about 8,200 acres of irrigated land, at elevations between 5,000 and 6,000 feet. The Drummond valley contains about 17,000 acres of irrigated land, at elevations ranging from about 4,000 feet to 4,600 feet. The two valleys are separated by a narrow canyon. Three major reservoirs, with a combined active storage of about 52,000 acre-feet, play an important role in the Flint Creek basin. One of these, the East Fork Rock Creek Reservoir, is located in the adjacent Rock Creek basin and contributes flows to Flint Creek by a canal.

For the purposes of this study, we divided the basin into four separate hydrologic units, placing boundaries so that all surface water flowing from one unit to the next could be measured at stream flow-gaging stations. Most unit boundaries were also placed where groundwater flow is limited by natural constrictions. For each hydrologic unit, we measured inflows from reservoirs, major tributaries, and mainstem streams. Inflows of numerous smaller tributaries were estimated based on data from gaged tributaries. We measured outflow from each unit with gages, except for outflows from the Hall unit, the lowermost unit where Flint Creek joins the Clark Fork River. Here. a more extensive evaluation of surface and groundwater discharge was required.

To quantify irrigation return flows, we compared daily average hydrographs of inflows and outflows (a more practical method than attempting to measure every irrigation diversion). As irrigation ceased in the fall, the amount by which outflow exceeded inflow in each unit was the return flow. This method quantifies return flows from aquifers charged by excess irrigation water. During summer, when unmeasured diversions and return flows occur simultaneously, only the net loss or gain from each hydrologic unit could be determined using this method.

We also studied groundwater in the basin to supplement the surface-water analysis and to determine how irrigation return flows are stored and released in the subsurface. We evaluated the geologic conditions within the upper few hundred feet of the valley fill by referring to existing well log data and logs from wells drilled during the study. Groundwater levels were monitored at an extensive network of wells throughout the basin. We also relied on geologic cross sections, groundwater maps, and ground-water-level hydrographs, combined with the surface-water analysis, to further interpret groundwater return flows in each hydrologic unit. Sediments in the upper few hundred feet of both the Philipsburg and Drummond valleys are predominately clay and shale. For the most part, appreciable thicknesses of coarse sediments are found only at shallow depths as alluvial deposits or gravelly caps on benches.

Consumptive use by irrigated crops in the Philipsburg valley averages approximately 0.75 acre-feet per acre irrigated; in the Drummond valley the average is between 1.5 and 1.75 acre-feet per acre irrigated. During dry periods, summer inflow into the Flint Creek basin is almost doubled by the water transferred from East Fork Rock Creek Reservoir.

Results

For the years studied, irrigation return flows from the Flint Creek basin averaged between 80 and 100 cubic feet per second (cfs) during October and November. This rate decreased through fall and winter, reaching a lower but still measurable rate by the start of the next irrigation season. The timing and magnitude of groundwater return flows contributed by each of the four hydrologic units was variable. Areas where unsaturated zones are thick and composed of coarse sediments displayed a higher capacity to store excess irrigation water than areas with naturally shallow groundwater levels or less permeable near-surface sediments. A variety of information suggests that irrigation return flows occurred in the shallow, coarse alluvium and gravelly caps, even though groundwater levels in deeper, confined aquifers responded to changes in head in the shallow sediments. Irrigated lands on higher ground in the upper part of the Philipsburg valley and west of Flint Creek in the Drummond valley are underlain by coarse, gravelly sediments. Groundwater can accumulate in these sediments throughout the irrigation season. Groundwater levels rose continuously during summer in some areas. Return flows from these areas were greatest during fall but continued throughout winter.

Flood plain aquifers tended to fill rapidly at the onset of irrigation. In most places, groundwater was maintained at high levels during summer. Once irrigation ceased, however, groundwater drained out of the upper part of Flood plain sediments, and groundwater levels reached low winter levels within about two to three months. Near Philipsburg, groundwater levels are naturally shallow, Igniting the amount of unsaturated sediments available to store groundwater. Return flows in this area were especially rapid in the fall, and modest surface-water gains diminished by the end of November. In the Drummond valley, the alluvium that remained unsaturated varied in thickness from 5 to 25 feet during winter. Naturally, there is more storage potential where groundwater levels are deeper. The vast alluvial Flood plain aquifer in the Drummond valley, which can store considerable amounts of water where the natural water table is deeper, contributed an estimated 20 to 25 percent of fall return flows in the basin.

Conclusions

For downstream irrigators, the more immediate return flows from Flood plain aquifers with shallow water tables may be more valuable than return flows from aquifers that store more water. Once the aquifers with shallow water tables are full, excess irrigation water is forced to return directly to streams and ditches. This return flow is available for immediate use downstream.

Aquifers with more storage potential absorb much of the water diverted during spring, and water diverted during summer continues to charge these aquifers. The benefit to stream flows is not fully realized until fall. Clearly, to maintain stream flows through summer and fall, it is critical during spring runoff to fill aquifers that have high storage potential. Flood irrigation in such areas during July and August, without the spring recharge, would seriously deplete the water supply of Flint Creek.

Modifying water rights from flood irrigation to sprinkler systems would reduce water availability in the Flint Creek basin if more land were put into irrigation. Conversion from flood to sprinkler irrigation on existing irrigated lands would have minimal effect on ranchers who rely on water stored in East Fork Rock Creek Reservoir and Lower Willow Creek Reservoir. But the effect on decreed water right users, who have benefitted from return flows generated by water from both reservoirs, would likely be significant during drought years.

Allowing increased flood irrigation (and to a lesser extent sprinkler irrigation) on new lands-only during spring runoff-would increase water availability during summer. The actual benefits would be dependent on aquifer characteristics and other physical properties associated with such irrigation. The model being completed by the U.S. Bureau of Reclamation will provide greater detail on these issues.

Appendix B
Water Study Details Irrigation Flows in Flint Creek Valley

Editors Note: This is the second of a two-part report on the Flint Creek Valley return flow study, which began in the spring of 1994. The intent of the study is to determine the amount of ground water storage within the Flint Creek Basin that is made available to irrigation. The study also aims to determine the amount of time needed within the basin for excess irrigation water to return to the stream. The Bureau of Reclamation will use this information to develop a computer model of the basin that will assess the affects of future development and changes in irrigation techniques.

By Terry Voeller and Kirk Waren

Following is a brief description of the Flint Creek basin, the techniques used to study return flows in the basin and a detailed description of the return flow patterns.

Flint Creek flows from the mountains through two distinct valleys. The Philipsburg and Drummond valleys are separated by a narrow canyon that runs from north of Philipsburg to Maxville. The cooler temperatures and small number of frost free days in the Philipsburg valley creates a shorter irrigation season and requires significantly less irrigation water than in the lower Drummond valley.

The water users requested that return flows be determined for more specific areas than just the two valleys. But because most irrigation return flows travel through groundwater, we tried to locate areas within the valleys where the natural geology forces groundwater back into Flint Creek. These conditions were found in the Philipsburg valley both where Trout Creek and Flint Creek merge and in the narrow canyon area north of Philipsburg. Also, these conditions were found in the Drummond valley just south of Hall where there is an abrupt increase in the width of the valley.

Determining the total outflow of Flint Creek into River required a large amount of work. Unfortunately, this is not an area where all the groundwater empties into Flint Creek. Therefore, we had to measure the Clark Fork River both upstream and downstream from the effect of Flint Creek. These measurements showed that, during the irrigation season, approximately 1,200 inches (30 cfs) of return flow enter the Clark Fork River directly without going back into Flint Creek first.

To determine, overall, what is return flow water and what is water that would be in Flint Creek without irrigation required measurement of the Flint Creek tributaries. Some tributaries were set up with measuring devices that measured the water flow continuously, but the high cost prohibited doing this on all tributaries. Therefore, the smaller tributaries were measured occasionally during the study period.

One of the larger inflows into Flint Creek is the water that is diverted from East Fork Rock Creek Reservoir. This water is diverted directly below the dam and then conveyed for more than five miles before entering the Flint Creek basin. Measurements show that only 75 percent of the water diverted below the dam actually makes its way into the Flint Creek basin. The other 25 percent seeps through the canal on the East Fork Rock Creek side of the drainage and enters this creek through return flows. This fact is noteworthy for two reasons.

First, Flint Creek water users can only use 75 percent of the water that they divert from East Fork Rock Creek Reservoir. Second, this example shows that ditch leakage can be substantial and is also a contributor to return flows.

As part of the evaluation of the Flint Creek return flow patterns, groundwater levels were measured in 87 wells throughout the Flint Creek basin. Well levels were measured once monthly from the fall of 1994 through 1996. Most of these wells existed previous to the study and were measured after gaining permission from the landowners. In order to obtain data in critical areas, some new wells were also drilled. Because return flows are stored in the groundwater system, the monitoring of groundwater levels and how they relate to the flow of water in the streams is important. The cooperation of the many landowners is greatly appreciated.

During the irrigation season, it would be impossible to account for return flows unless all diversions were measured. It was beyond the scope of this study to measure all diversions.

Therefore, the well levels measured give us an idea of what happens to the water stored underground while irrigation was taking place. Once irrigation ceased, the storage of return flows and how they affect surface water flows is measurable. Return flows are determined by accounting for the total inflows and outflows of a basin. When the outflow of Flint Creek exceeds the entire tributary inflow, the difference is due tot benefits of return flow storage.

In the upper portion of Flint Creek, irrigation is typically "shut off" by the middle of September. Irrigators in the lower part of the basin suddenly have much more water to use for their last month of irrigation. This water availability is due both to irrigation return flows and the fact that water is no longer being used upstream. By sometime in October, irrigation is usually ceased in the entire Flint Creek basin. At this time, return flows enhance Flint Creek somewhere between 3,200 inches (80 cfs) and 4,000 inches (100 cfs).

During a dry year, this is more than double the flow that would be found naturally in Flint Creek if irrigation did not occur. These return flows sustain themselves into November and then rapidly begin to decline as the aquifers begin the process of drying up. By the start of the next irrigation season in May, the return flows into Flint Creek are around 400 inches (10 cfs).

By measuring or accounting for all inflows and outflows of the Philipsburg and Drummond valleys for the entire year, we were also able to account for actual water consumption by plants during a typical irrigation season. Water consumed by crops in the Philipsburg valley average approximately 6,000 acre-feet per year or 0.75 acre-feet of water per acre irrigated.

Within the Drummond valley, water consumed by irrigated crops average between 25,000 and 30,000 acre-feet per year or between 1.5 and 1.75 acre-feet per acre irrigated. Even with this consumption of water, Flint Creek adds on average 125,000 acre-feet of water to the Clark Fork River each year. Of course, during a drought year, the total outflow of Flint Creek is much less.

During these dry years, return flows play a more critical role in the water available for irrigation. The effects of these return flows is discussed in more detail below.

Return flow waters originate from ditch leakage and seepage from the fields during flood irrigation. The storage potential of return flows is related to both the characteristics of the aquifer and the length of travel that the water must go before it reaches the stream. As was explained earlier, the aquifer can be visualized as a large underground sponge that is saturated when flood irrigation occurs. Low storage potential results in near immediate return flows back into Flint Creek. High storage potential allows for excess irrigation water to be stored for later release into Flint Creek well into the winter months following the irrigation season.

If we toured the Flint Creek basin from its headwaters to the confluence with the Clark Fork River, we would see a variety of aquifers and hence, different return flow patterns. The Trout Creek drainage as well as Flint Creek drainage from Georgetown Lake to Fred Burr Creek south of Philipsburg contain substantially thick aquifers that can absorb and store more water.

During the month of June, most of the water applied through flood irrigation fills these aquifers.

Some of the aquifers are so water hungry that groundwater levels continue to rise throughout the entire irrigation season.

It is obvious that an early application of water, in this area, during the spring months, when water is plentiful, is essential. If heavy flood irrigation does not occur early, then water taken out of the creek during the mid to late summer months will be largely used to fill the aquifers.

Typically the flows in the streams are much less in August, so it does not make sense to use a large volume of water during this month just to fill the groundwater. If a rancher in the upper Flint Creek basin applies heavy amounts during the spring months, when water is plentiful, they are actually saving water during the later summer months.

This upper area is a good example of where conversion to sprinkler systems could affect downstream water use in September and October. When irrigation is ceased in this upper end of the basin, the aquifers begin to release their water and enhance Flint Creek flows by 1,200 inches (30 cfs) to 1,400 inches (35 cfs). Effects of return flows in this area can still be observed at the beginning of the next irrigation season.

From Fred Burr Creek to the narrow canyon area that separates the Philipsburg and Drummond valleys, return flow storage is not nearly as significant. There is limited storage potential for irrigation return flow in the relatively small flood plain. In the higher ground west of the flood plain, return flows may be limited by low filtration materials. The return flows after irrigation is "shut-off" are between 600 inches(15 cfs)and 800 inches(200 cfs). These return flows become insignificant sometime in November or December.

Most of the irrigated acreage in the Flint Creek basin occurs in the Drummond valley.

When irrigation is ceased in October, return flows total between 2,400 inches (60 cfs) and 3,000 inches (75 cfs). Much of the return flow is depleted by the end of the year, but some return flow continues into the next irrigation season. These extended return flows come mostly from the benches along the northwest end of the valley that are irrigated with water rights from the Allendale Irrigation Company and East Fork Rock Creek Reservoir water. Some of the aquifers that underlay these high benches are extremely water hungry. In fact groundwater levels continue to increase in these areas during the entire irrigation season.

One aspect of water use in the basin, that cannot be overlooked, is the effect East Fork Rock Creek Reservoir has within the entire Flint Creek drainage. For example, during the middle and late irrigation season of 1994, this reservoir accounted for nearly half the water that entered the entire Flint Creek basin. If the present level of irrigation occurred during 1994, but East Fork Rock Creek Reservoir did not contribute to the basin, Flint Creek would have gone completely dry at Maxville in August and completely dry at the confluence with the Clark Fork River during both July and August. But instead, most water rights were satisfied during the entire summer.

The return flows that result from the irrigation water from East Fork Rock Creek Reservoir are not colored. In fact, there is little doubt that many water users are benefitting from this project whether they pay for it or not. To try to administer these return flows would most likely be a nightmare. It must be pointed out though, that conversion to sprinkler systems by the users of East Fork Rock Creek Reservoir would substantially eliminate flows that many have benefitted from in the past. Over time, there would be more water in the East Fork Rock Creek Reservoir, and less water in the Flint Creek basin.

The people of Granite County will need to decide if they want this to occur, and if it does, what will they want to do with the excess water in the reservoir? The excess water could be used for new irrigation, leased for instream flow, or split between such uses that could help finance the project. In an area as small as Granite County, where agriculture plays a huge role in the economics of the area, these decisions will be critical. We hope that the computer program being developed by the U.S. Bureau of Reclamation will be a useful tool for the people of Granite County when they need to make these decisions.

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