

TECHNICAL MEMORANDUM

SUBJECT: **Green River Basin Plan II**
Wyoming Depletions in the Little Snake River Basin

DATE: August 6, 2010

PREPARED BY: Updated by WWC Engineering with input from Larry Hicks, based on the 2001 States West Water Resources Corporation version

Introduction

The Little Snake River is not directly tributary to the Green River in Wyoming. It is tributary to the Yampa River which ultimately flows into the Green at Dinosaur National Monument in northwestern Colorado. A programmatic biological opinion was prepared by the US Fish and Wildlife Service, Mountain-Prairie Region (6) in 2004 to address the potential effects of the “Management Plan for Recovery of the Endangered Fishes of the Yampa River Basin and Continuation of Existing Human Water Uses and Future Water Development.” The purpose of the Management Plan is to allow for the use and future development of Yampa River Valley water resources and to protect and promote the recovery of the four endangered fish species which reside in the Upper Colorado River Basin. The development of the Management Plan has and is occurring as an activity of the ongoing Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin, which has been ongoing since 1988. The State of Wyoming is a participant in the Recovery Program, in developing the Management Plan, and in continuing to provide updates of the amount of annual water demand, quantify average annual depletions, and project future depletions every five years (Roehm, 2004). This continuous monitoring of consumptive use in the Little Snake River is integral to estimating the amount of water consumed downstream in the Yampa River Basin and is required under the terms of the Recovery Plan, Management Plan, and Programmatic Biological Opinion. This memorandum documents current estimates of depletions due to activities in the Little Snake River Basin, and presents estimates of depletions out to year 2055.

The average annual water yield from the Little Snake River Basin without depletions is 465,337 acre-feet (Frantz, 2010). Sources of depletions in Wyoming include irrigated agriculture, environmental use, municipal use, and transbasin diversions for the City of Cheyenne. Total depletions in the Little Snake River Basin have grown from 42,583 acre-feet in 2001 to 46,267 acre-feet in 2010.

No current depletions are explicitly associated with either industrial or domestic uses. Industrial uses are small and generally included within municipal demand estimates but are expected to increase. Domestic uses are also small and are comprised of individual small wells serving residential populations. Thus domestic uses will not significantly affect surface water flows. Therefore, determination of current and future demands consists of updating

municipal, agricultural and City of Cheyenne depletions, and projecting them out to year 2055. Additional depletions are estimated for future environmental and industrial uses.

Municipal Depletions

Municipal water use in the Little Snake River Basin is by the towns of Baggs and Dixon. Between the two, a total of 53.1 acre-feet of water is currently depleted (27.8 acre-feet for Baggs and 25.3 acre-feet for Dixon) (WWC Engineering, Municipal Use Memo, 2009). Current population estimates are 354 for Baggs and 81 for Dixon as estimated by the Wyoming Department of Administration and Information (WDAI). Based upon these numbers, the current use rate is 0.08 acre-feet/person-year for Baggs and .31 acre-feet/person-year for Dixon. To project these depletions to year 2055, population projections from the Green River Basin Plan II Population Projections Memo were used. While this memo proposes three growth scenarios, only the moderate growth scenario is used herein. This scenario is based on Wyoming Department of Administration and Information (WDAI) Division of Economic Analysis projections. Baggs and Dixon are forecasted to experience a modest decline in population in the WDAI projections. In 2055 the estimated population in Baggs is 275 and in Dixon is 60 (WWC Engineering, Population Projections Memo, 2009).

Therefore, projecting municipal demands consists of taking existing use and decreasing it by the expected percentage population decrease. Annual depletion for Baggs and Dixon is expected to decrease to 22 and 19 acre-feet per year in 2055, respectively.

City of Cheyenne Depletions

Part of the City of Cheyenne's water supply system is comprised of the Stage I and Stage II Projects consisting of collection and transmission systems in the Little Snake River Drainage. Water is collected from several tributaries of the Little Snake River and delivered to a tunnel that transports the water under the Continental Divide to Hog Park Reservoir in the North Platte River Basin. Storage in Hog Park Reservoir is released to replace water diverted to Cheyenne through the Rob Roy supply components of the Stage I and II Projects, which transport water from the North Platte River Basin to the South Platte River Basin. The current amount of water diverted from the Little Snake Basin, based on the 2003-2007 usage period, is 15,308 acre-feet per year (WWC Engineering, Municipal Use Memo, 2009).

Maximum annual capacity of the Stage I/II system is dictated by the larger of the potential yield of this system (21,000 acre-feet, Black and Veatch, 1994) versus the one-fill limitation on Hog Park Reservoir (22,656 acre-feet). In this case, maximum potential depletion allowed to the Little Snake River Basin is therefore 22,656 acre-feet. The City of Cheyenne has no current plan to enlarge the Stage I/II system and its capacity will be reached in the 2055 time frame under each of the high, mid, and low growth estimates from the Green River Basin Plan II Municipal Use Projections Memo (WWC Engineering, 2009).

Agricultural Depletions

Agricultural depletions arise from the consumptive use of water by irrigated crops and pasture. Determination of this depletion requires estimates of the current irrigated acreage in the basin and of actual crop consumptive requirements (also known as consumptive irrigation requirement, CIR).

The recent Wyoming Water Rights Attribution GeoDataBase study effort estimates the average total irrigated acreage for wet and dry years in the Little Snake River Basin as 15,074 acres (Leonard Rice Consulting Engineers, 2009). The bulk of the irrigated land is devoted to the production of forage crops (alfalfa, grass hay, and irrigated pasture). It is estimated that eighty-nine percent of crops in the Little Snake River Basin is grass pasture and eleven percent is alfalfa (Leonard Rice Consulting Engineers, 2009). Small amounts of grain are grown on irrigated acreage along the lower Little Snake River Basin; the irrigated acreage devoted to grain production is less than three percent (WWC Engineering, Irrigation Water Needs and Demands Projection Memo, 2009).

Climate station data were used in the WYRAG memorandum to estimate consumptive use requirements of crops in different areas of the Green River Basin because crop irrigation requirement is determined by climate; the climate station in Baggs was used to calculate consumptive use requirements for the Little Snake River Basin. It is important to note that maximum consumptive use of crops is only achieved with a full water supply; it is estimated that irrigation operations in the Little Snake River are about four percent short in both wet and dry years (Leonard Rice Consulting Engineers, 2009).

Under the cropping and irrigated lands percentages given above, the total crop-weighted CIR and the actual consumptive use based upon diversion records is presented below:

Average Annual Basin Results (1971-2007) For Representative Wet and Dry Year Acreages

Little Snake River Basin	Wet Year (1997)		Dry Year (2002)	
	CIR	Actual CU	CIR	Actual CU
	Acre-Feet			
	30,407	29,096	29,398	28,097

Source: WYWRAG Agricultural Use Memorandum, 2009

For this memorandum, the average of wet and dry years is used for the current depletion estimate (28,596 acre-feet).

High Savery Dam

High Savery Dam was completed on November 15, 2003. The reservoir primarily serves agricultural uses with a 12,000 acre-foot yield of late season irrigation water from a 15,661.2

acre-foot irrigation and recreation pool. Additional uses include 1,000 acre-feet for municipal and environmental use and 5,724 acre feet for fisheries. About 869 acre-feet per year evaporation is attributable to this reservoir (States West Water Resources, 2001). This project provides supplemental late-season water to existing lands. Contractual water subscription by irrigators for High Savery Reservoir water indicates a demand for an additional 5,000 acre-feet of late season irrigation water. Hydrologic modeling and crop water demand estimates including High Savery conducted by States West Engineering (in press, 2009) quantified the pre- High Savery Reservoir deficiency of late season irrigation water at approximately 5,000 acre-feet.

Other Projects

In 1995, several dikes were permitted on Muddy Creek by the Little Snake River Conservation District with assistance from several state and federal agencies, including the Wyoming Water Development Commission, the Bureau of Reclamation, and the Bureau of Land Management. These dikes, and the impoundments behind them, are permitted for stock and wetland purposes and have since been constructed. For the original 3 impoundments approximately 62 acres are inundated less than 30 inches deep. This results in a total net evaporative depletion of approximately 155 acre-feet per year (assuming 30 inches of annual net evaporation). These dikes operate under the one fill rule of state water law.

Since 1995 an additional eight dikes and impoundments have been constructed on Muddy Creek with a total of 276 surface acres. Net evaporation is estimated at 690 acre feet-annually, assuming 30 inches of net evaporation.

Based on the information above, total existing depletion in this Other Projects category is about 845 ac-ft per year.

Future Depletions

The projects listed below were envisioned in large part with input from the Little Snake River Conservation District (Larry Hicks, Pers. Comm., 2010), and reflect District plans and desired ability to further develop the water resources of the Basin.

Environmental Uses

Additional Wetlands Construction

The Little Snake River Conservation District has demonstrated the desire and ability to construct wetland habitat for wildlife, stock and riparian benefits. As detailed above under “Other Projects”, existing depletions related to wetlands are on the order of 845 ac-ft per year. Future efforts by the District are anticipated to increase the amount of wetlands by a factor of three, thus creating a future depletion on the order of 2,535 acre-feet per year.

Little Snake River Basin Small Reservoirs Project

A feasibility report evaluating several small reservoirs in the Basin was completed by Lidstone and Anderson in 1998. This report, sponsored by the Little Snake River Conservation District, looked at the feasibility of constructing up to 34 small impoundments for purposes of stock watering, rangeland improvement, and wildlife enhancement. The study resulted in a list of 12 reservoir sites to be considered for Level III design and construction funding. Since 2000, four of those identified reservoirs including Ketchum Buttes 25, Smiley Draw 27, Browns Hill 21, and Garden Gulch 32 have all been constructed. State Engineer records indicate reservoir surface areas of 10.6, 8.9, 2.7, 16.3 acres, respectively (for a total of 38.5 acres). Assuming a net evaporation of 30 inches, the total depletions for these impoundments is about 96.25 acre-feet per year. The other identified impoundments for possible future construction are as follows:

Reservoirs For Possible Future Construction

Reservoirs For Possible Future Construction	Surface Area	Depletion
	acres	acre-feet
Blue Gap 16	50.1	125
Blue Gap 27	14.6	36
Garden Gultch 3	2.8	7
Ketchum Buttes 34	5.5	14
Peach Orchard Flat 34	88.6	222
Pine Grove Ranch 1	7.7	19
Pole Gulch 27	0.7	2
Riner 28	52.2	131
Total	222.2	556

Depletions estimated based on 30-inch net evaporation per year

Thus, the total future depletions, related to the small reservoirs discussed here, is 652 acre-feet per year.

Agricultural Uses

Miscellaneous Stock Reservoirs

The Little Snake River Conservation District has indicated that due to siltation and other causes of loss, stock reservoirs are being replaced and will continue to be replaced over the next 50 years. Since 2001 twelve new stock ponds have been constructed with an average capacity of 5 acre-feet of water. Hundreds of stock reservoirs currently exist in the Basin, and at a construction rate of five per year over 225 new ponds will be constructed by 2055. These new ponds will vary in size, and it is estimated that up to 2,000 acre-feet of depletion will be attributable to their construction and storage.

Dolan Mesa Canal

Currently there is a water right and one enlargement for an irrigation supply project from Savery Creek, the Dolan Mesa Canal. Together, these rights are permitted to serve 1,600 acres. The lands are currently only being attempted to be irrigated, but the possibility exists that the current or subsequent owners may try to bring the lands under irrigation. If all 1,600 acres were irrigated, depletion estimates (using 1.66 feet of CIR) would total 2,656 acre-feet. A feasibility Level II study was conducted for the WWDC on this project in 2003; it is still under consideration (Gannett Fleming, 2003).

Willow Creek Storage

Users in the State of Colorado are seeking to implement a storage project on Willow Creek, which flows into the Little Snake River south of Dixon, WY. The Little Snake River Conservation District has expressed interest in becoming a joint applicant in the project to increase its size and serve lands in Wyoming. Under a Willow Creek reservoir, approximately 1000 acres would be served. The depletion associated with this use would amount to approximately 1,660 acre-feet, based on 1.66 feet of annual CIR. A feasibility Level II study was conducted for the WWDC on this project in 2003; it is also still under consideration (Gannett Fleming, 2003).

Cottonwood Creek

The Little Snake River Conservation District has indicated that a project is being considered that would have its source of supply water from Cottonwood Creek, tributary to the Little Snake River north of Dixon, WY. The project would add 500 acres of irrigation. The depletion associated with this use would amount to approximately 830 acre-feet, assuming 1.66 feet of annual CIR. A feasibility Level II study was conducted for the WWDC on this project in 2003 and it is still under consideration (Gannett Fleming, 2003).

Grieve Reservoir

Grieve Reservoir, which washed out in the summer of 1984, is being considered for rehabilitation and enlargement. This reservoir, if enlarged, is anticipated to serve an additional 300 acres beyond to the original acreage irrigated prior to the wash out. The depletion associated with this use would amount to approximately 500 acre-feet. This WWDC-funded project was undergoing final design. However, several geotechnical issues came to light including complications with the State Highway 70 right of way and utilities; the project is currently being reconfigured to a smaller impoundment, which would reduce the above estimated depletion by an unknown amount.

Muddy Creek

The Muddy Creek Watershed is a candidate for diversions to irrigate up to 1,200 acres of pasture in the lower reaches north of Baggs, WY. This project would result in depletions amounting to approximately 2,100 acre-feet, assuming 1.77 feet of annual CIR.

Focus Ranch

The Focus Ranch property has a need for supplemental irrigation for 200 acres. The source for this water, likely from storage, is the Roaring Fork near the National Forest boundary. At 0.5 acre-foot per acre supplemental need, this project would result in a depletion of approximately 100 acre-feet.

Pothook – Beaver Ditch

The Little Snake River Conservation District has indicated that a project irrigating approximately 400 acres could be brought into production near the confluence of Savery Creek and the Little Snake River. These lands may once have been considered to be served by the Beaver Ditch under an earlier study by the USBR as part of the Savery-Pothook Project. This project would result in depletions amounting to approximately 700 acre-feet, assuming 1.77 feet of annual CIR.

Agricultural Uses Summary

For the reader's convenience, the following list summarizes the above estimated future depletions for this category:

Miscellaneous Stock Reservoirs	2,000 acre-feet
Dolan Mesa Canal	2,656 acre-feet
Willow Creek Storage	1,660 acre-feet
Cottonwood Creek	830 acre-feet
Grieve Reservoir	500 acre-feet
Muddy Creek	2,100 acre-feet
Focus Ranch	100 acre-feet
Pothook-Beaver Ditch	700 acre-feet
TOTAL	10,546 acre-feet

Industrial Uses

Depletions due to industrial use are effectively nonexistent currently in the Little Snake River Basin, but are expected to increase in the future.

Potential future large industrial uses of water in the Little Snake River Basin include uses for oil shale recovery. The Kinney Rim area in Southeastern Sweetwater County has recoverable quantities of oil shale. Current extraction and process techniques for oil shale recovery require large amounts of water. The closest source of water sufficient to meet such an anticipated future demand is the Little Snake River. Another industrial use that will continue to increase is the use of both surface and ground water for drilling fluids. Over 20,000 natural gas wells are currently in the planning phase in the Atlantic Rim, Continental Divide Creston, and Hiawatha EIS conducted by the Bureau of Land Management. Several companies have pilot water treatment projects under way to treat coalbed methane produced water and discharge into tributaries of the Little Snake River in both Wyoming and Colorado.

Industrial use projections outlined in the Industrial Use Projections Memo (WWC, 2009) are used as a starting point to project future industrial use depletions to year 2055 for the Little Snake River Basin. The calculated industrial use projections do not purport to guess in what areas of the Basin industrial use will grow; only that the growth will probably come from established industries. The Industrial Use Projections Memo also proposes three growth scenarios; only the moderate growth scenario is used herein (as was done with the projections for municipal use as described above). A reasonable approach given the non-spatial nature of industrial demand projections for the Green River Basin is to assign growth in industrial water demand on an area-weighted basis. To do otherwise would effectively discount that industrial growth will likely occur in the Little Snake River Basin. Wyoming's portion of the Little Snake River drainage (approx. 852,000 acres) is about 6.4 percent of the land area of the portion of the Green River Basin located in Wyoming (approx. 13,349,000 acres) (States West Water Resources, 2001). Applying the above discussed basin area percentage (6.4 percent) to the moderate industrial growth projection of 123,700 acre-feet per year yields 7,917 acre-feet, rounded to 8,000 acre-feet per year of industrial water demand in the year 2055. Maintaining the State of Wyoming's ability to provide industrial water when demand arises in the next 50 years is critically important. Based on the above, the future depletion estimate includes 8,000 acre-feet per year.

Summary

The following table presents a summary of past (2001 Basin Plan), current and future depletion estimates:

Sector of Use	Depletion Estimates		
	2001 Basin Plan	2010 Basin Plan	Year 2055
	acre-feet/year		
Municipal	76	53	41
City of Cheyenne Diversions	14,400	15,808	22,656
Agricultural	26,905	28,596	28,597
High Savery Reservoir	869	869	869
Diked Wetlands	284	845	845
Additional Agricultural Uses	n/a	n/a	10,546
Small Reservoirs	49	96	652
Industrial	0	n/a	8,000
Totals	42,583	46,267	72,206

For comparison, these depletions are compared to annual flows seen at one gage on the Little Snake River. The gage, Little Snake River near Dixon, WY (USGS Station No. 09257000) provides an indication of the annual flows seen in the River. In addition, two tributaries contributing to flow in the river not included in the gage data are Muddy Creek and Willow Creek. Estimates of flows in these tributaries are also provided. Data are taken from USGS reports (CITE), which would already reflect depletions.

Little Snake River Annual Average Available Flow After Depletions

Gage or Tributary	Average Annual Flow
	acre-feet
Little Snake River near Dixon	359,926
Muddy Creek	13,772
Willow Creek	7,098
Total	380,796

Note Concerning Water Availability

These depletions are independent of the amount of water *available* to Wyoming under provisions of the Upper Colorado River Basin Compact and the Colorado River Compact. The State of Wyoming's apportionment of the waters of the Colorado River System exists in perpetuity. Wyoming therefore continues to retain the right to develop all its available water resources under those Compacts in accordance with current governmental permitting requirements.

References

- Black and Veatch, 1994. *Cheyenne Water Supply Master Plan, Level I*, prepared for the Cheyenne Board of Public Utilities and the Wyoming Water Development Commission.
- Frantz, Meg, 2010. *Available Surface Water Determination*, Technical Memorandum, AECOM, Prepared for the Wyoming Water Development Commission Green River Basin Plan II, January 21.
- Gannett Fleming, 2003. *Little Snake River Dams Level II Studies Final Report*, prepared for the Wyoming Water Development Commission, July.
- Hicks, Larry, 2010. *Personal Communication*. January.
- Leonard Rice Consulting Engineers, 2009. *Wyoming WRAG Memorandum, Consumptive Uses Analysis*, Technical Memorandum, June.
- Lidstone and Anderson, Inc., 1998. *Final Report, Little Snake River Basin Small Reservoir Development Project, Level III*, submitted to the Wyoming Water Development Commission, October 30.
- Purcell, Mile, 2000. *Basin Water Use Profile – Municipal*. Technical Memorandum, Purcell Consulting PC, Green River Basin Water Plan, June 22.
- Roehm, G.W. 2004. Management Plan for Endangered Fishes in the Yampa River Basin and Environmental Assessment. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver.
- States West Water Resources Corporation, 2001, *Green River Basin Plan, Technical Memorandum, Wyoming Depletions in the Little Snake River Basin*
- Western Water Consultants, 1992. *Little Snake River Basin Planning Study, Volume III, Irrigation Reservoir Investigations*, prepared for the Wyoming Water Development Commission, December.
- WWC Engineering, 2009. *Major Reservoir Information*, Technical Memoranda, prepared for the Wyoming Water Development Commission Green River Basin Plan II, August.
- WWC Engineering, 2009. *Municipal Water Use Projections*. Technical Memoranda, prepared for the Wyoming Water Development Commission Green River Basin Plan II, May.
- WWC Engineering. 2009. *Irrigation Water Needs and Demand Projections*. Technical Memoranda, prepared for the Wyoming Water Development Commission Green River Basin Plan II, October.

WWC Engineering. 2009. *Population Projections*. Technical Memoranda, prepared for the Wyoming Water Development Commission Green River Basin Plan II, March.

WWC Engineering. 2009. *Basin Water Use Profile – Municipal*, Technical Memoranda, prepared for the Wyoming Water Development Commission Green River Basin Plan II, May.