TECHNICAL MEMORANDUM

SUBJECT: **Green River Basin Plan**
Basin Water Use Profile - Agricultural

PREPARED BY: States West Water Resources Corporation

Introduction

This memorandum presents estimates of current water use by agricultural practices in the Green River Basin of Wyoming (including the Little Snake and Great Divide Basins). In large part the work herein relies upon other technical memoranda prepared for this project, in particular those relating to cropping patterns, irrigated lands mapping, reservoirs and surface water modeling (surface water availability). These other memoranda are cited where appropriate.

History of Agricultural Practices in the Basin

The Green River Basin of Wyoming has seen the use of water for beneficial agricultural purposes since Territorial days. Irrigated agriculture was the first large user of surface water in the basin (and the entire state, for that matter), and it remains the largest water consumer in the basin and the state. In the 1970 Framework Water Plan (Wyoming Water Planning Program, 1970), the depletion attributable to agricultural uses totaled 267,900 acre-feet (90 percent) of the total depletion of 296,100 acre-feet in the basin. In the most recent Bureau of Reclamation Consumptive Uses and Losses Report (CULR)(USBR, September 1998) irrigation depletions in Wyoming's Green River Basin were calculated to average 399,000 acre-feet for the 1986-1990 period, or about 79 percent of Wyoming's total estimated depletions of 502,000 acre-feet per year for the same period. The reason irrigation depletion estimates by the USBR exceed 1970 Framework Plan estimates, given that irrigated acres have not equally increased, is uncertain but probably is due to revised consumptive requirement values and the construction of reservoirs (e.g. Meeks Cabin and Stateline Reservoirs and Fremont Lake enlargement) which provide late season water. The reason irrigation depletions have reduced as a percentage of total basin use is largely attributable to increases in industrial use.

Historically, irrigation diversions occurred where lands "susceptible of irrigation" lay near a reliable watercourse from which water could be diverted with the least work. Bottomlands were developed first because of the relative ease with which they could be put under irrigation from a ditch. Reservoirs for irrigation water storage (and other uses) were constructed as direct flow rights eventually exceeded the reliable supply of streams. In the words of Elwood Mead in his first report as Territorial Engineer, storage was needed "…to hold the waste water of winter and the surplus from the summer floods….On many of our streams is already felt the pressing need for an auxiliary summer supply which the reservoir would furnish." Oftentimes, reservoir storage was developed in mountainous terrain where water levels in existing alpine lakes could easily be raised by the simple addition of a dike or small dam at the natural outlet. Fremont Lake near Pinedale is such an example.

Because of the relative aridity of the central Green River Basin, irrigation first began along the tributaries leading from the various mountain ranges that fringe the basin. These included, as examples, the Little Snake, New Fork and Blacks Fork Rivers as well as other tributaries such as the Piney Creeks west of Big Piney, Smith's Fork Creek near Lyman and the Ham's Fork. These and smaller streams and creeks not only provided water nearer the source, but headgates located thereon were less susceptible to washout and therefore more easily maintained than those constructed on the mainstem of the Green River. As well, the creek banks were lower, resulting in more easily built structures. As happened early on in much of Wyoming, tributaries were more quickly developed than the larger watercourses they fed.

Today, the development of irrigation works in the basin still is defined by these early efforts. The bulk of irrigation in the basin occurs along tributaries, with the primary agricultural areas located in the Little Snake, Black's Fork, Big Sandy and New Fork River valleys as well as along the numerous streams emanating from the northwest (Piney Creeks and others).

Methodology

Approach Determination of actual irrigation depletions is a difficult undertaking. Ideally, each stream segment or tributary where irrigation occurred would have continuous records of diversions and streamflow for a period of ten or twenty years (including dry and wet years), local weather stations to accurately measure precipitation, and lysimeter (consumptive use) data obtained contemporaneously with the streamflow and diversion records. As the reader may imagine, such is usually not the case and it is not so in the Green River Basin. Estimates are necessarily made from incomplete records and sometimes inconsistent data, which is not unusual based on the experience of the team with other projects. Examples of issues that required consideration in this work include:

- Less than ten percent of the irrigation canals in the basin had diversion records of sufficient duration and detail to be of value in this analysis.

- Interviews regarding irrigation operations were very instructive and valuable. However, based on responses from districts and individual irrigators, a minority of the basin's irrigated acres were represented in this effort.

- Diversion records can be misleading. For example, the First Mesa and Westside canals provide the most detailed historic diversion records in the Little Snake River basin. However, as some of the earliest rights in the basin, these ditches show virtually uninterrupted flow throughout most of the recent irrigation seasons. Basing irrigation supply characteristics on the records of these ditches would significantly overestimate diversions (and hence CIR) in the basin as a whole because they do not represent other headgates that routinely run out of water by early July. In addition, although measuring devices in these two major ditches show flow at all times, the records do not show when turnouts are closed for haying resulting in at least part of that water returning to the river. Therefore, subjective interpretation is required when reviewing the records to estimate when water diverted is actually applied to crops.

  Interestingly, diversion records can also show widely varying operation that appears independent of whether a wet or dry year is experienced. As one example, 1983 is recorded generally as a "wet" year thoughout the basin while 1994 is a "dry" year. Measured diversions on the Musselman ditch (North Piney Creek) are higher, on average, in September 1994 (1.46 cfs estimated) than in the same month of 1983 (1.37 cfs estimated), based on spot measurements. Even if the actual diversions were roughly equal, one could not tell by the diversion records whether or not a dry or wet year were experienced. At the same ditch in 1996, a normal runoff year, diversions in August and September were significantly below both the 1983 and 1994 values.

- Assistance from reservoir releases exist but are difficult to quantify. Many reservoirs permitted for irrigation are not monitored regularly for content or releases. The effect of many reservoirs, if paper evidence is sought, is in the diversion records of headgates below them, where irrigation can occur longer with the reservoir than without. Of course, this requires the headgate records be kept as well.

From the foregoing, assumptions were necessary regarding primarily the number of days diversions were in use. These assumptions, however, were made with the input of irrigators and State Engineer's Office personnel for those ditches with which they were familiar.

Storage Water

The majority of water in storage reservoirs within the Green River Basin is permitted for irrigation use. Other users, such as industry, municipal and recreation, are small in comparison (Tyrrell, 2000b). In sub-basins where storage is available, irrigation seasons are often lengthened and summer supplies more reliable than in other areas. For this reason, consumptive use of water for irrigation is typically higher in sub-basins with storage than without. In general, however, the amount of storage water for irrigation is less in the Green River basin, on a per acre basis, than in other basins in Wyoming. The largest reservoir in the interior of the basin, Fontenelle Reservoir, is downstream of virtually all of the upper Green River irrigated areas, unavailable to other sub-basins, and therefore is virtually unused for irrigation.

Since the Framework Plan was published several reservoirs have been constructed in the basin to assist with irrigation supplies. These include Viva Naughton, Meeks Cabin and Stateline Reservoirs. Meeks Cabin and Stateline provide supplemental irrigation water and are permitted as such. Viva Naughton is permitted for industrial use, but through informal agreements releases are made to assist Ham's Fork irrigators when supplies are available. Also since 1970, enlargements to Boulder Lake, Fremont Lake and Fontenelle Reservoir have been constructed. In the case of Fontenelle Reservoir, the enlargement only activated previously inactive capacity and was not a physical enlargement. More recently, in 1997, ownership of Middle Piney Lake was transferred to the U.S. Forest Service. Since that time Middle Piney has not been used, or available, for supplemental irrigation supply.

The technical memorandum entitled Major Reservoir Information (Tyrrell 2000b) describes the larger (>1,000 AF) reservoirs in the basin as well as some smaller ones. Aside from Fontenelle (little irrigation use), Flaming Gorge (out of state), Viva Naughton (industrial), Kemmerer No. 1 (municipal) and High Savery (yet to be constructed) Reservoirs, the basin contains approximately 212,000 acre-feet of storage primarily devoted to supplemental irrigation supply (see discussion of sub-basins to follow). The distribution of this storage within the basin is uneven, meaning that some irrigated areas are well served by one or several reservoirs above them while others are devoid of storage of any size.

It is important in estimating depletions associated with irrigation to know which lands benefit from storage and which are totally at the mercy of natural runoff. In the discussions to follow the irrigated acre numbers are actually those lands under ditch and actively, intentionally irrigated. In the agricultural use calculations all acres are used, including subirrigated lands and those benefiting from return flows, because these acres represent depletions due to “acts of man.”

The Little Snake River basin contains no major impoundments at present. High Savery Reservoir is currently in the final design phase and construction is anticipated to be completed in 2003. Until then, the Little Snake River valley must continue to irrigate based on “run of the river” water, without benefit of supplemental storage. When High Savery is constructed, its irrigation pool of 17,430.2 are-feet will provide a storage ratio of 1.1 acre feet per acre for the basin’s 15,483 irrigated acres.

The Henry’s Fork valley makes use of some smaller reservoirs in Utah with Wyoming permits. However, in the opinion of the State Engineer’s Office personnel, these reservoirs are relatively small and cannot sustain lands with a full supply for long periods. These reservoirs include Hoop Lake, Island Lake and Beaver Meadow Lake with a total storage among the three of 6,180 acre-feet. Henry’s Fork is essentially operated as a “run of the river” system, with a storage ratio of 0.41 acre-foot of storage per acre of irrigated land (15,086 acres).

The Black’s Fork/Smith’s Fork valley (Bridger Valley) benefits from Meeks Cabin and Stateline Dams. There are other smaller reservoirs in the valley as well (e.g. Paterson Lake). While local irrigators could use more supplemental water in dry years, it is certain that these structures already extend the season and add reliability to the irrigation system that would otherwise not exist. With these three reservoirs alone, there is a storage ratio of 0.84 acre-foot per acre of irrigated land (48,808 acre-feet of storage over 58,007 irrigated acres, not counting Muddy Creek).

Viva Naughton Reservoir, while permitted as an industrial reservoir, provides irrigation benefits on the Ham’s Fork through informal assistance to irrigators. Releases are made from this reservoir if the owner (Naughton) can do so without jeopardizing its carryover storage needs for cooling water. According to observers, this informal relationship has great local importance because without it many downstream irrigators would not survive “run of the river” operation. Because this reservoir is not permitted for irrigation to any extent (3,072 acre-feet of enlargement 7476R has been constructed; 39 percent of this enlargement is permitted for irrigation), the permitted irrigation storage ratio in this basin is about 0.12 acre-foot per acre (using 9,942 irrigated acres).

In the Farson/Eden area, irrigation is dependent on Big Sandy and Eden Reservoirs. These two impoundments provide a total storage of 51,890 acre-feet at the present time, with Eden held 6,300 acre-feet below its maximum capacity because of dam safety concerns. Higher in the Little Sandy River basin Elkhorn (Little Sandy), Black Joe and Pacific Reservoirs No’s. 1 and 2 add approximately 4,053 acre-feet of storage. With a total of 21,318 irrigated acres in the basin (including incidental irrigation as defined earlier) this area benefits from a storage ratio of 2.6 acre-feet per acre.

The New Fork River valley benefits from storage created and enhanced on tributaries flowing from the Wind River Mountains. Several reservoirs, including Fremont, New Fork, Willow and Boulder Lakes, are natural morainal lakes raised by the addition of small dams at the natural outlets. As deep, natural lakes formed by glacial moraines, these lakes were obvious candidates for raising because the addition of small dams at the outlet could impound significant amounts of water with only a few feet of height on top of already large water surfaces. These reservoirs provide about 92,355 acre-feet of permitted storage. Higher in the mountains, Divide and Silver Lakes add approximately 1,960 acre-feet. For the 50,447 irrigated acres in the New Fork River basin, the storage ratio is 1.87 acre-feet per acre of irrigated land.

The Upper Green River basin exclusive of the New Fork River is a part of the overall basin little served by storage. This region starts in the south with Slate and Fontenelle Creeks and includes LaBarge Creek, Dry, South, Middle and North Piney Creeks, Cottonwood, Horse and Beaver Creeks and the upper Green River to Green River Lakes. McNinch No. 1 and 2, Middle Piney and Sixty Seven Reservoirs are the larger impoundments in this area, and Middle Piney has been removed from irrigation supply and given to the U.S. Forest Service. Sixty Seven is under private ownership and is permitted only for stock and domestic uses. Not including Middle Piney, the other three reservoirs total 6,495 acre-feet of storage. With 119,302 irrigated acres in this region, over 40 percent of the total irrigated acres in Wyoming's Green River basin, the storage ratio is only 0.05 acre-foot per irrigated acre.

Agricultural Uses – Typical Crops

The Green River Basin of Wyoming is primarily a producer of forage for livestock. By far the most common use of irrigation is in the growth of grass hay for harvest and pasture (Tyrrell, 2000a). Alfalfa is grown in areas where the growing season and water supplies allow. Small grains and cash crops are very limited in extent and in no sub-basin do they comprise more than three percent of the irrigated acres.

Water supply and growing season are the factors most often given for the predominance of grasses under irrigation. In this sense, irrigated agriculture is tied very closely to the livestock industry because the only viable use for the hay is as forage. Typically the forage is used by the producers' herds although some is disposed through local sale or export from the basin.

Consumptive Use

The depletion of water by irrigation is estimated, in general terms, using available water supply, the consumptive demand of the crops irrigated and the number of irrigated acres in the basin. The irrigated acres determined for the basin are described in a separate memorandum (O'Grady, et al, 2000). The consumptive use of those lands is described in more detail herein.

To determine the amount of water consumed via irrigation, the concepts of consumptive use (CU) and consumptive irrigation demand (CIR) must be described. In essence, CU describes the total water uptake of a crop, and varies due to several climatologic factors as well as plant stage. A formal definition can be found in Pochop et al. (1992). CIR is that amount of the total CU needed to be applied by irrigation. In other words, CIR satisfies that part of CU not met by effective precipitation. Therefore, the CIR of a crop describes, in average terms, the amount of water that man must apply for a full harvest. It also, therefore, is the upper limit to the amount of depletion agricultural practices will create. Pochop publishes CIR values for several crops at several stations within the Green River Basin.

In practice, a direct-diversion flood-irrigated crop rarely achieves full CIR. Shortage of water supply is the major culprit, because no crop can consume water that isn't there. Other factors reducing theoretical CIR estimates are field drainage (only a perfectly level field can deliver water equally to all plants) and timing (the water must be delivered at some rate approximating the rate of use; too much water at one time results in inefficient use). While water shortage effects can be estimated from stream gaging and diversion records, the other factors are generally the subject of academic research. For this study, CIR reductions due to supply-limited conditions (shortages) are the only corrections made. As an example, Figure 1 shows the distribution of seasonal pasture grass/grass hay CIR by sub-basin.

In the Green River Basin most irrigators get one cutting of grass hay. As seasonal water supplies and growing conditions allow, irrigators will get a second cutting of grass. Where alfalfa is grown, two cuttings are desirable. Even if a second cutting is not obtained, diversion will usually continue (if water is available) in late summer and fall to fill soil profiles and provide stock water. Late season water is also applied to pasture and fields that livestock will be turned into in the fall, in effect allowing for a "second cutting" achieved not by mechanical harvest but by actual feeding by the animals. Because of the variation in precipitation, temperature and frost-free days even in normal years, whether or not more than one cutting is obtained is a matter of speculation. The approach taken herein, therefore, is to assume depletions occur according to published CIR estimates in proportion to the number of days in a particular month in which irrigation is known to occur either from operator interviews, diversion records, or from the experience of the State Engineer's personnel.

Pochop publishes CIR data by month for various crops at seven sites within the Green River Basin proper and at several other sites that lie adjacent to the basin and can be used to interpolate or extrapolate data from within the basin. Mean values from this report were used for "normal" year CIR values. For wet and dry year scenarios, the actual yearly data were obtained from the author. For those years identified as "dry" or "wet" in the "Study Period Selection" memorandum (Frantz, et al, 2000), the corresponding yearly CIR values were ascribed as applicable for calculating "wet" or "dry" year CIR totals. The resulting CIR values were then applied to the number of irrigation days for each scenario to compute the agricultural depletion associated with that scenario. This last correction is needed because Pochop's values assume "…that water application continues after the last cutting—for example, for the development of pasture grass for winter feed. Individual farming practices need to be considered during the fall after the last cutting because in some locations and/or years water is not available late in the season or irrigation is simply discontinued, therefore water use will be lower than for irrigated conditions."

Table 1 shows the CIR values estimated for the various sub-basins assuming a full water supply. These values take into account general variations in cropping patterns described in Tyrrell (2000a), and weighted proportions of grass and alfalfa determined thereby are shown in the table (small grains occur in such small percentages they were assumed to fall under other categories). The values in this table describe irrigation requirements for wet and dry as well as normal years.

Irrigation Days

To estimate the effects of "supply limited" conditions, diversion and streamflow records in the various sub-basins within Wyoming's Green River Basin were reviewed. The goal of this work was to estimate the number of days water is available for diversion. It is important to note that the number of irrigation days established for a sub-basin or tributary is a function both of water supply (and whether or not storage is available) as well as operational decisions such as shutting down a headgate prior to haying. For the normal year case, irrigation days describe the number of days water typically is diverted based on diversion records and interviews. These values are not intended to apply to individual headgates, but rather to a sub-basin or tributary as a whole.

In some cases, diversion records indicate sufficient water for irrigation throughout a normal year. However, State Engineer field personnel are almost unanimous in their opinions that many ditches are turned off at traditional times not only for harvest but for consistent operational scheduling. Actual irrigation days were generally reduced to account for this operational reduction, even if occasional diversion records indicate water use. This decision was made because diversion records vary significantly year to year and the purpose of the calculation was to determine "typical" agricultural use and not "exact" use on a month to month, year to year basis (as might be performed for a long-term modeling exercise).

Tables 2a-2c describe the number of irrigation days estimated for the various sub-basins for normal, wet and dry runoff conditions.

Agricultural Depletion Estimate

Irrigation depletions are defined herein as the consumption of water applied by man to irrigated crops and include consumption by incidentally irrigated areas. Incidentally irrigated areas may be subirrigated or irrigated by surface return flows from managed fields. O'Grady et al (2000) calculated acreages for both categories. While some incidentally irrigated areas may contain willows, small trees or other vegetation, all are treated as crops (grass, in most cases) for consumptive estimates. The relatively small fraction this category comprises of total irrigated acres (about 10 percent), and the difficulty encountered in gathering a detailed breakdown of the various vegetation types, preclude detailed analysis.

As mentioned earlier, depletions are not based on the full consumptive use of a crop, but only on the amount applied by man through irrigation practices. Therefore, consumptive needs met by precipitation are not included. This is the typical approach to irrigation depletions performed and accepted in other basins and states.

Tables 3a-3c present depletion estimates by major sub-basin within Wyoming's Green River Basin. This table is constructed by multiplying irrigated acres by the appropriate monthly CIR and by the percentage of the month irrigation is assumed to occur. These results include the season-extending effects of reservoirs where they exist. Current normal-year irrigation depletion estimates are therein shown to be 401,000 acre-feet per year, with dry-year and wet-year depletions estimated at 375,000 and 432,000 acre-feet, respectively.

References:

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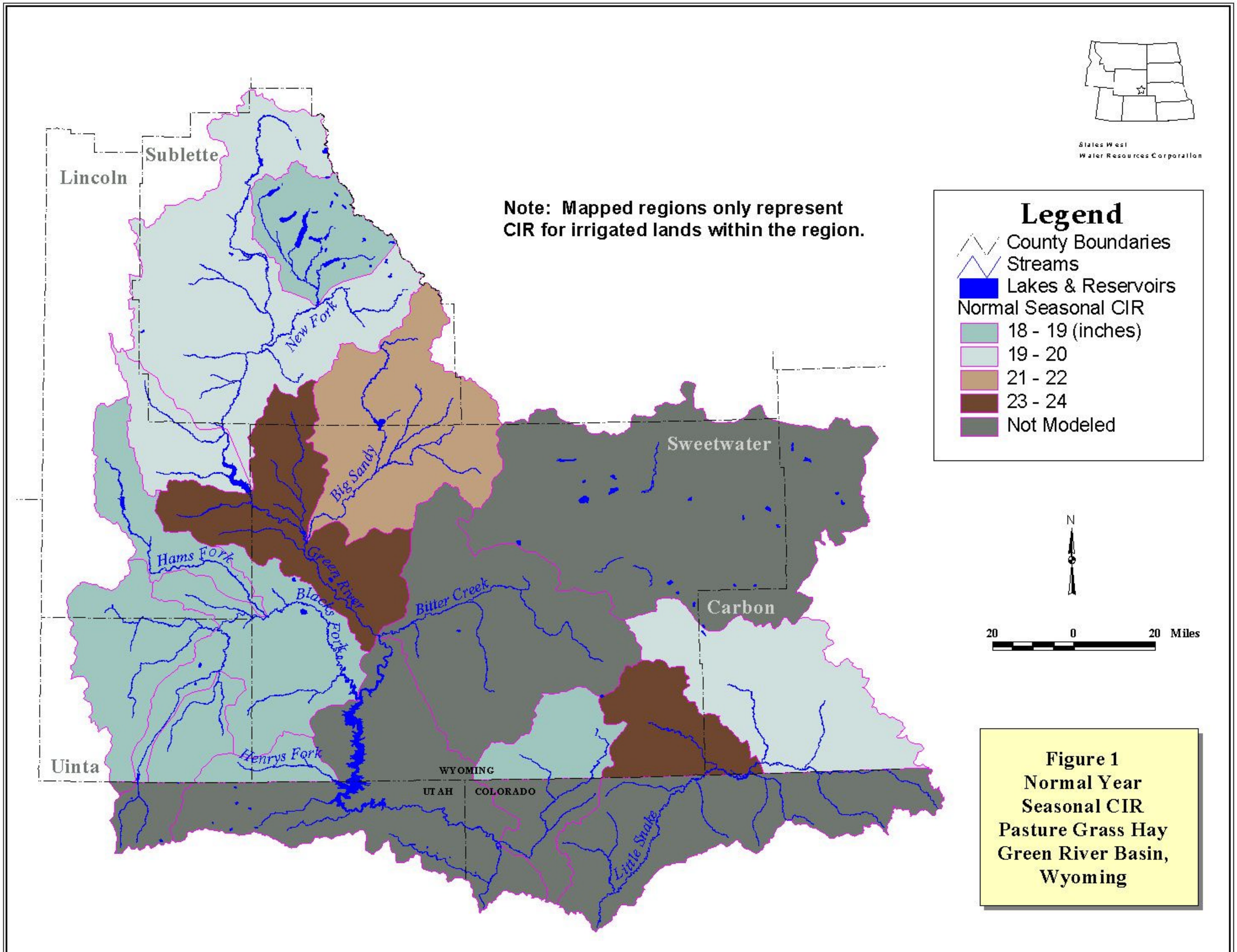

Figure 1
Normal Year
Seasonal CIR
Pasture Grass Hay
Green River Basin,
Wyoming

Table 1. Consumptive Irrigation Requirement (CIR) Estimates

CONSUMPTIVE IRRIGATION REQUIREMENT (INCHES) BY CROP DISTRIBUTION ZONES

Zone	Climate Station 1	Weight	Climate Station 2	Weight	MMH Weight	PGH Weight	Alf Weight		Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Little Snake above Baggs	Big Piney[1]	1.0		0.0	0.89	0	0.11	N	0.00	2.59	5.57	6.02	4.37	1.04	0.00	19.59
								D	0.00	2.27	7.31	6.23	4.22	0.54	0.00	20.57
								W	0.00	3.70	5.29	5.83	4.43	0.37	0.00	19.62
Little Snake below Baggs	Wamsutter	1.0		0.0	0	0.89	0.11	N	0.70	2.96	6.28	6.28	4.82	2.60	0.00	23.62
								D	1.27	3.91	6.71	6.27	4.71	3.22	0.00	26.08
								W	0.33	3.21	3.68	4.99	4.02	1.23	0.00	17.46
Big Sandy	Farson	1.0		0.0	0.35	0.36	0.29	N	0.08	2.96	5.47	6.18	5.01	1.37	0.00	21.07
								D	0.21	3.11	7.35	3.79	3.45	1.48	0.00	19.39
								W	0.00	0.45	4.64	5.59	3.69	0.97	0.00	15.34
New Fork	Pinedale	1.0		0.0	1	0	0	N	0.00	2.37	5.46	5.78	4.32	0.32	0.00	18.25
								D	0.00	1.98	6.42	6.40	4.31	0.56	0.00	19.66
								W	0.00	2.14	4.64	5.21	3.82	0.02	0.00	15.83
Green River abv LaBarge Creek	Big Piney[1]	1.0		0.0	1	0	0	N	0.00	2.67	5.65	6.13	4.46	1.06	0.00	19.97
								D	0.00	2.34	7.41	6.34	4.31	0.56	0.00	20.95
								W	0.00	3.78	5.38	5.94	4.53	0.39	0.00	20.01
Green River - Fontenelle Rsvr to LaBarge Creek	Big Piney[1]	1.0		0.0	0.95	0	0.05	N	0.00	2.64	5.61	6.08	4.42	1.05	0.00	19.80
								D	0.00	2.31	7.36	6.29	4.27	0.55	0.00	20.78
								W	0.00	3.75	5.34	5.89	4.48	0.38	0.00	19.83
Green River - Green River to Fontenelle Rsvr	Farson	1.0		0.0	1	0	0	N	0.09	3.22	6.11	7.11	5.81	1.62	0.00	23.95
								D	0.27	3.38	8.11	4.71	4.17	1.76	0.00	22.40
								W	0.00	0.55	5.21	6.42	4.45	1.11	0.00	17.74
Hams Fork	Kemmerer	1.0		0.0	0	0.95	0.05	N	0.09	2.89	4.83	5.56	4.02	1.57	0.00	18.96
								D	0.00	2.47	5.71	5.99	4.11	1.96	0.00	20.24
								W	0.00	2.64	4.15	4.87	3.29	0.47	0.00	15.42
Muddy Creek	Kemmerer	1.0		0.0	0	1	0	N	0.09	2.88	4.82	5.54	4.01	1.56	0.00	18.90
								D	0.00	2.46	5.69	5.98	4.10	1.96	0.00	20.18
								W	0.00	2.63	4.14	4.86	3.28	0.47	0.00	15.37
Black's Fork	Kemmerer	1.0		0.0	0	0.9	0.1	N	0.10	2.90	4.84	5.57	4.03	1.57	0.00	19.02
								D	0.00	2.48	5.72	6.01	4.12	1.97	0.00	20.30
								W	0.00	2.64	4.17	4.89	3.30	0.47	0.00	15.47
Smith's Fork	Kemmerer	1.0		0.0	0	0.96	0.04	N	0.09	2.89	4.83	5.55	4.02	1.57	0.00	18.95
								D	0.00	2.47	5.70	5.99	4.11	1.96	0.00	20.23
								W	0.00	2.63	4.15	4.87	3.28	0.47	0.00	15.41
Henry's Fork and Vermilion Cr.	Kemmerer	1.0		0.0	0	1	0	N	0.09	2.88	4.82	5.54	4.01	1.56	0.00	18.90
								D	0.00	2.46	5.69	5.98	4.10	1.96	0.00	20.18
								W	0.00	2.63	4.14	4.86	3.28	0.47	0.00	15.37

[1]Pinedale substituted for Big Piney for DRY August, September, and October

N, D and W refer to Normal, Wet and Dry year CIR, according to original data from Pochop.

MMH = Mountain Meadow Hay PGH = Pasture Grass Hay Alf = Alfalfa

Table 2a. Estimated Irrigation Days - Normal Year

	Normal Years				
	May	June	July	August	Sept
Upper & Mainstem Green River					
Average	***31***	***30***	***15***	***21***	***30***
% of Month	***100***	***100***	***48***	***68***	***100***
New Fork River					
Average	***24***	***30***	***24***	***14***	***14***
% of Month	***77***	***100***	***77***	***45***	***47***
Piney Creeks					
Average	***24***	***30***	***24***	***7***	***7***
% of Month	***77***	***100***	***77***	***23***	***23***
Blacks Fork					
Average	***15***	***30***	***24***	***24***	***24***
% of Month	***48***	***100***	***77***	***77***	***80***
Henry's Fork					
Average	***15***	***30***	***21***	***7.5***	***15***
% of Month	***48***	***100***	***68***	***24***	***50***
Ham's Fork					
Average	***15***	***30***	***21***	***7.5***	***15***
% of Month	***48***	***100***	***68***	***24***	***50***
Big Sandy					
Average	***15***	***30***	***24***	***24***	***30***
% of Month	***48***	***100***	***77***	***77***	***100***
Little Snake River					
Average	***31***	***30***	***25***	***6***	***5***
% of Month	***100***	***100***	***81***	***19***	***17***
Vermilion/Red/Salt Wells					
Average	***31***	***30***	***25***	***6***	***5***
% of Month	***100***	***100***	***81***	***19***	***17***

Table 2b. Estimated Irrigation Days - Wet Year

	Wet Years				
	May	June	July	August	Sept
Upper & Mainstem Green River					
Average	***31***	***30***	***24***	***31***	***30***
% of Month	***100***	***100***	***77***	***100***	***100***
New Fork River					
Average	***31***	***30***	***24***	***31***	***30***
% of Month	***100***	***100***	***77***	***100***	***100***
Piney Creeks					
Average	***24***	***30***	***24***	***24***	***30***
% of Month	***77***	***100***	***77***	***77***	***100***
Blacks Fork					
Average	***31***	***30***	***24***	***31***	***30***
% of Month	***100***	***100***	***77***	***100***	***100***
Henry's Fork					
Average	***31***	***30***	***24***	***31***	***30***
% of Month	***100***	***100***	***77***	***100***	***100***
Ham's Fork					
Average	***31***	***30***	***24***	***31***	***30***
% of Month	***100***	***100***	***77***	***100***	***100***
Big Sandy					
Average	***31***	***30***	***24***	***31***	***30***
% of Month	***100***	***100***	***77***	***100***	***100***
Little Snake River					
Average	***31***	***30***	***25***	***31***	***30***
% of Month	***100***	***100***	***81***	***100***	***100***
Vermilion/Red/Salt Wells					
Average	***31***	***30***	***25***	***31***	***30***
% of Month	***100***	***100***	***81***	***100***	***100***

Table 2c. Estimated Irrigation Days - Dry Year

	Dry Years				
	May	June	July	August	Sept
Upper & Mainstem Green River					
Average	***15***	***30***	***15***	***21***	***30***
% of Month	***48***	***100***	***48***	***68***	***100***
New Fork River					
Average	***15***	***30***	***24***	***7***	***7***
% of Month	***48***	***100***	***77***	***23***	***23***
Piney Creeks					
Average	***15***	***30***	***15***	***7***	***7***
% of Month	***48***	***100***	***48***	***23***	***23***
Blacks Fork					
Average	***15***	***30***	***24***	***15***	***7***
% of Month	***48***	***100***	***77***	***48***	***23***
Henry's Fork					
Average	***15***	***30***	***24***	***15***	***7***
% of Month	***48***	***100***	***77***	***48***	***23***
Ham's Fork					
Average	***15***	***30***	***21***	***7.5***	***15***
% of Month	***48***	***100***	***68***	***24***	***50***
Big Sandy					
Average	***15***	***30***	***24***	***24***	***30***
% of Month	***48***	***100***	***77***	***77***	***100***
Little Snake River					
Average	***15***	***30***	***15***	***6***	***5***
% of Month	***48***	***100***	***48***	***19***	***17***
Vermilion/Red/Salt Wells					
Average	***15***	***30***	***15***	***6***	***5***
% of Month	***48***	***100***	***48***	***19***	***17***

Table 3a. Normal Year Agricultural Depletions
Green River Basin Water Plan

River Basin/Sub-basin	Irrigated Acres	Normal Year Depletions, AF May	June	July	Aug	Sep	Total
Upper & Mainstem Green River							
includes Beaver Creeks							
Dry Piney Creek							
Piney Creeks							
Green River above Fontenelle							
Horse Creek							
Cottonwood Creek							
Beaver Creek	121,939	21,015	57,403	48,254	10,231	2,516	**139,419**
Muddy Creek							
LaBarge Creek							
Slate Creek							
Fontenelle Creek	11,433	1,945	5,346	4,488	951	234	**12,963**
New Fork River	52,707	8,053	23,974	19,655	8,573	656	**60,910**
includes Boulder Creeks							
East Fork							
Muddy Creek, trib. East Fork							
New Fork and Willow Creek							
Pine and Pole Creeks							
Silver Creek							
Big/Little Sandy Rivers	22,506	2921	11457	10318	8434	3034	**36,164**
includes Farson/Eden							
Upper Basin							
Green River Below Fontenelle	2,042	265	1,040	936	765	275	**3,281**
Black's Fork	75,173	8,792	30,334	27,029	19,567	7,887	**93,608**
includes Black's Fork							
Smith's Fork and Muddy Creek							
Ham's Fork	10,287	1,199	4,139	3,688	2,670	1,076	**12,772**
Henry's Fork	16,690	1,938	6,697	5,965	4,319	1,739	**20,659**
Little Snake							
above Baggs	11,941	2,582	5,539	4,835	842	172	**13,969**
below Baggs	5,018	1,236	2,624	2,116	390	181	**6,547**
Vermillion/Salt Wells Creeks	674	162	270	251	44	15	**741**
Total	330,410	**50,107**	**148,823**	**127,535**	**56,785**	**17,784**	**401,034**

Table 3b. Wet Year Agricultural Depletions
Green River Basin Water Plan

River Basin/Sub-basin	Irrigated Acres	Wet Year Depletions, AF May	June	July	Aug	Sep	Total
Upper & Mainstem Green River							
includes Beaver Creeks							
Dry Piney Creek							
Piney Creeks							
Green River above Fontenelle							
Horse Creek							
Cottonwood Creek							
Beaver Creek	121,939	29,764	54,635	46,711	35,598	3,912	**170,620**
Muddy Creek							
LaBarge Creek							
Slate Creek							
Fontenelle Creek	11,433	2,763	5,083	4,344	3,307	361	**15,859**
New Fork River	52,707	9,391	20,371	17,710	16,796	97	**64,364**
includes Boulder Creeks							
East Fork							
Muddy Creek, trib. East Fork							
New Fork and Willow Creek							
Pine and Pole Creeks							
Silver Creek							
Big/Little Sandy Rivers	22,506	1032	9771	9322	8337	2082	**30,543**
includes Farson/Eden							
Upper Basin							
Green River Below Fontenelle	2,042	94	887	846	756	189	**2,771**
Black's Fork	75,173	16,567	26,099	23,710	20,666	2,964	**90,007**
includes Black's Fork							
Smith's Fork and Muddy Creek							
Ham's Fork	10,287	2,259	3,561	3,234	2,818	404	**12,276**
Henry's Fork	16,690	3,653	5,760	5,231	4,555	651	**19,851**
Little Snake							
above Baggs	11,941	3,684	5,260	4,679	4,412	371	**18,405**
below Baggs	5,018	1,344	1,539	1,684	1,679	513	**6,759**
Vermillion/Salt Wells Creeks	674	148	233	220	184	26	**810**
Total	330,410	**70,698**	**133,199**	**117,691**	**99,108**	**11,569**	**432,266**

Table 3c. Dry Year Agricultural Depletions
Green River Basin Water Plan

River Basin/Sub-basin	Irrigated Acres	Dry Year Depletions, AF May	June	July	Aug	Sep	Total
Upper & Mainstem Green River							
includes Beaver Creeks							
Dry Piney Creek							
Piney Creeks							
Green River above Fontenelle							
Horse Creek							
Cottonwood Creek							
Beaver Creek	121,939	11,481	75,297	31,173	9,884	1,322	**129,157**
Muddy Creek							
LaBarge Creek							
Slate Creek							
Fontenelle Creek	11,433	1,063	7,016	2,900	918	122	**12,019**
New Fork River	52,707	4,208	28,198	21,746	4,272	571	**58,996**
includes Boulder Creeks							
East Fork							
Muddy Creek, trib. East Fork							
New Fork and Willow Creek							
Pine and Pole Creeks							
Silver Creek							
Big/Little Sandy Rivers	22,506	3067	15210	6839	6055	3301	**34,472**
includes Farson/Eden							
Upper Basin							
Green River Below Fontenelle	2,042	278	1,380	621	549	299	**3,128**
Black's Fork	75,173	7,512	35,836	29,140	12,501	2,877	**87,866**
includes Black's Fork							
Smith's Fork and Muddy Creek							
Ham's Fork	10,287	1,024	4,891	3,977	1,706	393	**11,990**
Henry's Fork	16,690	1,656	7,914	6,434	2,759	635	**19,397**
Little Snake							
above Baggs	11,941	1,094	7,272	3,000	813	90	**12,269**
below Baggs	5,018	790	2,807	1,268	381	224	**5,471**
Vermillion/Salt Wells Creeks	674	67	320	162	45	18	**612**
Total	330,410	**32,241**	**186,141**	**107,259**	**39,882**	**9,853**	**375,377**