TECHNICAL MEMORANDUM

SUBJECT: **Green River Basin Plan**
Irrigation Water Needs and Demand Projections

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Introduction

This memorandum presents projections of irrigation water requirements in the Green River Basin for the period from 2000 through 2030. Following guidelines established by the Wyoming Water Development Commission, projections were developed for three planning scenarios:

1. Low Growth
2. Moderate Growth
3. High Growth

The projections for each scenario were developed judgmentally based upon a review and analysis of available literature and data as well as input from irrigators and agriculture industry professionals. Although consideration was given to using econometric models for projecting future irrigation water needs, the factors that influence irrigation water needs and the ability of irrigators to satisfy those needs are not amenable to quantification in multivariate economic models.[1] For this reason, the factors influencing irrigation water needs in the Basin are first described in qualitative terms in this memorandum, and then are used as the basis for formulating quantitative projections of future needs for the low, moderate, and high growth scenarios.

Background

Irrigated agricultural production is the largest user of water in the Green River Basin. Currently, Basin irrigators consumptively use an average of 401,000 acre-feet of water in an average year. This figure will rise to 408,000 acre-feet when High Savery Reservoir in the Little Snake Basin comes on line in the near future. Irrigation water consumption varies considerably from year to year, however, depending upon water availability, rainfall, and other climatic conditions. In a typical dry year, Basin-wide irrigation water

[1] Econometric models are statistical models that relate the variable to be forecast, in this case irrigation water requirements, to other variables for which future values are more easily forecast, such as beef consumption.

consumption drops to about 375,000 acre-feet. In a typical wet year, consumption rises to about 432,000 acre-feet annually (Tyrrell, 2000a).

The Wyoming Water Planning Program (WWPP) estimated that there were about 330,000 acres of land under irrigation in the Basin in 1970 (WWPP, 1970). The estimate of irrigated acreage developed for this study puts the current irrigated acreage total at 321,500 acres, a slight decrease from the 1970 estimate (O'Grady, et.al, 2000). It is not clear whether the difference in the two estimates is due to the fact that better data from aerial and satellite photography is available now than in 1970, or whether a small amount of acreage has gone out of production due to salinity or alkalinity problems. It is interesting to note, however, that the WWPP estimated that about 9,000 acres of marginal irrigated land in the Basin would go out of production due to salinity and alkalinity problems, an estimate that is consistent with the current acreage estimate assuming that new lands have not been brought into production to replace those removed from use.

The vast majority of irrigated land is devoted to the production of forage crops (alfalfa, grass hay, and irrigated pasture) in support of livestock operations. Small amounts of grain are grown on irrigated acreage along the Black's Fork and Smith's Fork Rivers, the lower Little Snake Basin, and in the Eden Valley area, but the percentages of irrigated land devoted to grain production in these areas are less than three percent. In other parts of the Basin, forage crops constitute effectively 100 percent of irrigated agricultural production (Tyrrell, 2000b).

Not all of the 321,500 acres of irrigated land in the Basin is mechanically harvested each year. Some land is devoted to irrigated pasture while other land is only irrigated on an intermittent basis. Figure 1 shows estimates of harvested forage acreage in the Basin for the period from 1979 through 1999 as developed by the Wyoming Agricultural Statistics Service (WASS, various years).[2] That figure shows that the number of acres of forage crops harvested each year varies from a low of slightly under 250,000 acres to a high of over 300,000. The distribution of harvested forage acreage by county is depicted in Figure 2. That figure shows that Sublette County is the largest forage producer in the Basin, producing over 40 percent of all forage harvested during the period from 1979 through 1999. Uinta County is the second largest producer with 20 percent of the total, followed by Lincoln, Carbon, and Sweetwater Counties in that order.

Almost all irrigated lands in the Basin are served by surface water sources. Although there are a number of reservoirs in the Basin that store irrigation water, the availability of storage varies widely across the Basin, and agricultural production in some parts of the Basin is limited by inadequate or non-existent storage facilities. The Eden-Farson area and the New Fork River valley have the largest ratio of storage to irrigated acreage in the Basin. There are about 2.5 acre-feet of storage per irrigated acre in the Eden-Farson area and about 1.8 acre-feet of storage per irrigated acre in the New Fork River Valley (Tyrrell, 2000c). When High Savery Reservoir is constructed in the Little Snake

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[2] WASS county-level harvested acreage data were adjusted to Basin-wide estimates based upon the proportion of land area in each county that falls within the Basin.

Drainage, there will be an average of 1.1 acre-feet of storage for each of the approximately 16,000 irrigated acres there.[3] Other areas of the Basin have less than one acre-foot of storage per irrigated acre. In the Bridger Valley, reservoirs on the Black's Fork and Smith's Fork Rivers provide an average of 0.7 acre-feet of storage per irrigated acre. Along the Henry's Fork, the storage to acreage ratio is 0.4, and along the Ham's Fork it is 0.1. The lack of storage is most notable on tributaries entering the Green River from the west above Fontenelle Reservoir (hereafter referred as the northwest tributaries). Only three small private reservoirs are located in this part of the Basin, and over 80,000 acres of irrigated lands suffer from late season and dry year irrigation water shortages. The storage to irrigated acreage ratio in this area is less than 0.1 acre-feet per acre.

A complete description of reservoir facilities in the Basin is contained in a separate technical memorandum on that subject (Tyrrell, 2000c).

Trends in Livestock Production

Trends in cattle and sheep inventories in the Basin are depicted in Figure 3. These estimates were developed from WASS county estimates adjusted to Basin totals based upon the amount of land area in each county that is in the Basin. The middle trend line in Figure 3 shows that the cattle inventory in the Green River Basin has been increasing in recent years. Cattle numbers (as measured on January 1 of each year) have increased from about 250,000 in 1979 to about 300,000 today, an increase of 20 percent. The bottom trend line in Figure 3 shows that sheep inventories in the Basin have been decreasing over roughly the same period that cattle numbers have been increasing. Sheep numbers peaked at about 230,000 head in the early 1980s and have declined to about 135,00 head today, a decrease of about 40 percent. These trends are indicative of the fact that sheep production has become relatively unprofitable in recent years, causing some ranchers to shift from sheep to cattle for at least some of their production.

The top trend line in Figure 3 is an estimate of the total number of animal units in the Basin using the conversion factor that five sheep are roughly the equivalent of one cow in terms of forage requirements (Sedivec, 1996). That line shows that the total number of animal units in the Basin has increased slightly over the past 20 years, indicating that the decline in sheep inventories has been more than offset by increases in cattle inventories on an animal-unit basis.

The distributions of cattle and sheep by county are depicted in Figures 4 and 5. These figures reflect average annual livestock inventories over the period from 1979 through 1999. Figure 4 shows that Sublette County has been the largest cattle producer, with about 35 percent of the Basin-wide cattle inventories over the past 20 years. Carbon and

[3] High Savery Reservoir will serve approximately 80 percent of the irrigated lands in the Little Snake Drainage. The 3,200 acres of irrigated land not served by the reservoir obvious will not receive the average storage benefit of 1.1 acre feet, while the remaining 12,800 acres will have 1.4 acre-feet of storage per irrigated acre.

Uinta Counties have each been responsible for about 20 percent of cattle production during that period, followed by Lincoln and Sweetwater Counties, with 13 and 12 percent respectively.

Average sheep inventories by county are depicted in Figure 5. That figure shows that Uinta and Sweetwater Counties have been the largest sheep producers in the Basin. These two counties accounted for 62 percent of all sheep production in the Basin during the period from 1979 through 1999. Carbon and Lincoln Counties accounted for another 30 percent of production during that period, while Sublette County accounted for only eight percent.

There appear to be several interrelated reasons why livestock production in the Basin has increased only slightly over the past two decades. One limiting factor with respect to herd size is the availability of summer range on federal lands, which constitute a large proportion of rangeland in the Basin. Both the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) have become more conservative in recent years with respect to the management of federal grazing allotments in response to increasing environmental pressures (Brown, 2000). There has been little opportunity for producers with federal grazing allotments to increase their production on federal lands, and in some cases federal grazing rights have been restricted.

The only alternative available for increased livestock production in the Basin in recent years has been more intensive use and management of private lands, which can involve either increasing forage production on existing irrigated acreage or bringing new acreage into production. Bringing new irrigated acreage into production is a capital-intensive project that has not been financially feasible for most producers. There has been some increase in forage production on existing irrigated lands through more use of fertilizer and better water management practices (Peterson, 2000). This increased production has presumably provided additional winter feed to support recent increases in cattle numbers.

Future Water Needs and Demands

In discussing the future of irrigation in the Green River Basin, it is necessary to distinguish between needs and demands for irrigation water. A need for additional irrigation water is an identifiable current or future use that would enhance the economic well being of the irrigator and/or the economy of the Basin as a whole. Demands are distinguished from needs by the fact that they are measured in relationship to price. To give a simple example, an irrigator may need additional irrigation water in a dry year to grow enough hay to provide winter feed for his cattle. If additional water costs $500 per acre-foot, however, the irrigator’s demand for additional water would probably be zero because it would be more cost-effective to either buy additional forage from other producers or reduce the size of his herd.

In analyzing municipal and industrial water uses, needs and demands are often viewed interchangeably. The cost of water is usually a relatively minor part of the costs involved in water intensive manufacturing processes such as electric power production and soda ash production. As a result, it can be assumed that manufacturers will demand the water that they need to expand production over a reasonable range of prices. Similarly, municipal needs are usually assumed to be essential and thus will be translated into demands over a reasonable price range. That convention was used for projecting municipal and industrial demands in this planning study.

Irrigated agriculture, however, is an industry in which producers are very sensitive to the price of water, and their demands for water can change dramatically as a function of price.[4] For that reason, this section of the memorandum discusses both irrigation water needs in the Basin and the circumstances under which those needs may be translated into future demands

Meetings with irrigators in the Basin and discussions with agricultural industry professionals indicate that there are several reasons why more water is needed now or may be needed in the future for irrigated crop production. One pressing current need is for storage water to meet late season and dry year crop requirements in those parts of the Basin where storage is not available or is inadequate to fully meet irrigation requirements. An analysis by States West Water Resources Corporation indicates that in an average water year, the consumptive use of irrigation water in the Basin falls approximately 75,500 acre-fee short of what is needed to provide a full water supply to existing crops (States West, 2000). Of that shortage, approximately 52,000 acre-feet, or 69 percent of the total, occurs on irrigated lands along the northwest tributaries. Additional storage on those tributaries would greatly stabilize forage production and allow ranchers to operate more profitably.

Additional storage would also allow some operators to adjust more readily to potential future changes in the management of federal grazing allotments. If access to forage on federal lands is further restricted in the future, the only alternative available to ranchers for keeping their operations at current production levels will be to increase forage production on private lands. This increase in production would require more intensive management of private land resources and more irrigation water. In some areas, additional irrigation water would allow producers to expand their cattle herds on private holdings or grow additional hay for sale outside of the Basin. Overall, the Basin has more irrigable land than it has available water at the right time and in the right location to irrigate that land.

The biggest practical problem associated with fulfilling the need for additional irrigation water in the Basin is that the returns to forage production in recent decades have not been sufficient to offset the costs of new water storage projects. Studies of returns to irrigation water in the Little Snake Drainage and in other parts of Wyoming indicate that one acre-foot of irrigation water used for forage production in relatively high altitude areas of the state can be expected to generate a $15 to $25 increase in net farm income (Western Research Corporation, 1989). The cost of developing new storage can be significantly

[4] In economic jargon, irrigators tend to have highly elastic demand curves with respect to irrigation water.

higher than that figure even under very favorable circumstances. For example, the recently completed Greybull Dam and Reservoir in the Big Horn River Basin of Wyoming is considered a very cost-effective project from a cost per acre-foot of yield perspective. The project's total cost was approximately $25 million for 25,000 acre-feet of storage, or about $1,000 per acre-foot of storage (Tyrrell, 2000d). On an annual basis, the project's cost is equivalent to $63.44 for each acre-foot of reservoir storage, excluding O & M charges.[5] Current WWDC guidelines for new water project developments in Wyoming allow for up to a 50 percent state grant for project construction. If new irrigation water projects were developed in the Green River Basin with WWDC assistance, the total cost of water would probably be at least $63.44 per acre-foot annually. Under current WWDC guidelines, irrigators would be responsible for annual payments of at least $31.72 per acre-foot of water plus O&M charges. Irrigators in the Big Horn Basin can repay costs of this magnitude because they predominantly grow higher valued cash crops such as dry beans and sugar beets. However, these costs exceed the magnitude of returns that most producers in the Green River Basin would realize from additional forage production under current market conditions.

Future demands for additional irrigation water in the Green River Basin are thus largely dependent upon factors that might either increase the returns that Basin irrigators receive from irrigation or reduce the cost to them of developing new storage. Possibilities for increasing economic returns to irrigated agriculture in the Basin include diversifying cropping patterns into higher valued crops, the possibility that hay prices may rise to the point that it would be profitable to export hay from the Basin to other domestic markets, and the possibility that cattle prices may rise significantly over the next 30 years.

Although there are some opportunities for diversifying cropping patterns in the Basin, it is doubtful that diversification out of forage production will occur on a wide enough scale over the next 30 years to warrant significant new water development projects. Most of the Basin above Fontenelle Reservoir is characterized by high elevations, cool nights, and a short growing season, making forage crops the only practical alternative. Grains can be grown in some parts of the Basin, and Coors currently has some malting barley contracts in the Eden-Farson area. Malting barley is the only grain crop with significantly higher returns than alfalfa, however, and is typically grown in rotation with alfalfa in relatively small quantities. Increased malt barley production alone would probably not increase net returns to irrigation enough to warrant the construction of additional storage projects, especially since it requires less irrigation water than hay crops.

Specialty crops, such as alfalfa seed or seed potatoes, could possibly be grown in some of the lower elevation areas of the Basin. Seed alfalfa production is moving into Wyoming's Big Horn Basin, where acreage has grown from 2,000 to 15,000 acres in recent years (Gray, 2000). Nevertheless, the Green River Basin will always have a competitive disadvantage with respect to specialty crops compared to lower elevation areas such as Wyoming's Big Horn Basin or lower North Platte River Basin.

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[5] Annual costs were computed by amortizing the $25 million construction cost over 50 years at six percent interest and dividing by 25,000 acre-feet.

Some trends in the agricultural industry in the western U.S. suggest that certain types of forage production will become more valuable in the future as cash crops. Population pressures in Arizona, California, and parts of Idaho, Oregon, and Washington are increasingly displacing agricultural production in those states; especially forage production. As more agricultural land is taken from production in the future, there will be less hay production because it is among the lower valued crops that can be grown in lower elevation areas. This trend has already resulted in a large exodus of dairy producers from California to states such as Idaho, Nebraska, and western Kansas because of the lack of alfalfa in California. Dairy producers in the Boise, Idaho area and along the Colorado Front Range are now having difficulty securing enough alfalfa locally and are relying upon imports from other states or are relocating to hay producing areas. One dairy recently moved into the Riverton area in Wyoming and another is considering relocation to Torrington (Gray, 2000).

Wyoming is currently a net exporter of alfalfa and Timothy grass hay. No official statistics are available on the magnitude of hay exports from Wyoming, but some experts put the figure at about 25 percent, and expect that percentage to increase in the future. The largest market for Wyoming hay is now Colorado, but some producers in the Big Horn Basin are shipping hay by rail to dairies as far away as Florida and other east coast states (Gray, 2000). The Green River Basin is in an ideal location for hay production as a cash crop for several reasons. First, producers have ready access to rail and truck shipping facilities along I-80 and the Union Pacific rail line through the southern part of the Basin. Second, the Basin is capable of producing high quality, low fiber content hay.

The types of hay expected to be in high demand in the future are alfalfa for dairies and Timothy hay for horses. Although alfalfa prices have been somewhat depressed in recent years, that trend is expected to reverse in the future as more land is taken out of production in fast-growing western states. Timothy hay is already bringing prices as high as $180 per ton in some parts of Wyoming (Gray, 2000). Alfalfa hay can be grown in lower elevation areas of the Basin, and Timothy hay can be grown in higher elevation areas. If future market prices for these crops stabilize at levels of well over $100 per ton, it may become practical for Green River Basin producers to develop additional storage and expand production of these crops for export markets. Timothy hay producers would have to build storage sheds to house the crop until it is sold because it is subject to moisture degradation, but few other changes to current production practices would be needed to expand production of these crops.

Two other events could translate into more demand for irrigation water in the Basin over the next 30 years, a significant and long-term increase in cattle prices and/or an increase in the amount of financial assistance available to producers for reservoir construction from state and federal agencies.

Cattle prices have increased somewhat in recent years as per capita beef consumption in the U.S. has stabilized at around 67 pounds after many years of decline. But according to the Cattleman's Beef Production and Research Board, per-capita consumption is not expected to increase in the future and will most likely decrease from today's levels

(Lambert, 2000). The USDA, however, is forecasting a significant increase in exports of U.S. beef over the next 10 years (USDA, 2000). The basis of this projection is the fact that demand for high quality beef in Pacific Rim nations is expected to increase significantly in the future as the economies of these countries recover from the 1998 financial crisis that affected the region. The U. S. has been and will continue to be the primary source of high quality beef for export, including exports for the hotel-restaurant market, primarily because of the availability of grain and feedlots for fattening. Although Argentina, Australia, and Brazil are also expected to increase their beef exports in the future, these exports will be composed primarily of lower quality grass fed beef, some of which will be imported by the U.S. for use in processed foods and hamburger.

Although the U.S. is now a net importer of beef, the USDA projects that the U.S. will become a net exporter of beef by the year 2010. The net effect of expanded overseas markets for quality beef is expected to be an increase in cattle prices over the next 10 years that could well extend further into the future. According to USDA projections, cash returns above expenses to cow-calf enterprises are expected to increase from an annual average of $32.02 per cow in 1999 and 2000 to $47.14 per cow during 2008 and 2009. This 47 percent increase in net returns, if extended over a significant time frame, could make additional storage affordable to some Green River Basin cattle producers.

The prospects for increased federal assistance for reservoir construction seem more remote than the projected increase in cattle prices. Federal assistance for agriculture and new reservoir construction has been declining in recent years, and there are no indications that this situation will change over the planning horizon. The WWDC also has tightened its funding criteria for new water project construction in recent years. This tightening has been primarily motivated by budget constraints, however, and the possibility exists that more state funds may be allocated to water development over the next 30 years than are available under current economic conditions.

For the reasons discussed above, the low, moderate, and high growth scenarios for future irrigation water demand in the Basin are based upon varying assumptions concerning the financial returns to beef and forage production and the availability of WWDC assistance for new project construction. Those scenarios are described in the following sections of this memorandum.

Low Growth Scenario

The low growth scenario is based upon the assumptions that irrigation in the Basin will continue to be dominated by forage production for winter livestock feed and that cattle and forage prices will not make sustained increases over the next 30 years relative to reservoir construction costs. This scenario also projects no increase in state funding available for new project construction and no change in WWDC criteria for financial assistance to project sponsors. As a result, irrigators will probably be unwilling to make long-term financial commitments to develop new storage following WWDC funding guidelines.

Under this scenario, there will probably be a small reduction in total irrigated acreage in the Basin as some lands are taken out of production due to alkalinity and salinity problems, and other lands are sold for home sites in the more scenic parts of the Basin. Overall forage production will probably increase somewhat as irrigators adopt better water management techniques and take advantage of new production practices. This increase in forage production may allow cattle numbers to increase modestly over the planning horizon. Sheep numbers are expected to stabilize at some point in the future and may even increase somewhat as producers adopt new marketing and production practices (Stumbaugh, 2000). Numerically, total consumptive water use for irrigation in the Basin is expected to remain relatively constant at 408,000 acre-feet in an average year.[6]

Moderate Growth Scenario

The moderate growth scenario is based upon the reasonably foreseeable possibility that cattle prices will increase significantly over the next 10 years as forecast by the USDA in response to increased demand for high quality beef in Pacific Rim markets (USDA, 2000). Cattle prices are projected to stabilize at these higher prices over the planning horizon and thus provide a financial incentive for ranchers in water-short areas of the Basin to develop storage facilities for dry year and late season water supplies. This scenario also assumes that the State of Wyoming will solve its long-term revenue problems over the 30-year planning horizon, thus allowing water development funds to be used exclusively for that purpose. As a result, the WWDC will increase its financial commitment to new storage projects from a current level of 50 percent to 75 percent.

The combination of higher cattle prices and increased WWDC assistance will allow irrigators to develop and fund some new storage projects in those parts of the Basin that are in the greatest need. A logical place for such developments to take place is along northwest tributaries of the Upper Green River, including Cottonwood Creek, Fontenelle Creek, Horse Creek, LaBarge Creek, and Piney Creek. This area has less storage per irrigated acre than any other part of the Basin, and irrigators market almost all of their hay through cattle. These producers suffer water shortages during dry years and are chronically short of late season irrigation water. As a result, they would have a large incentive to develop new storage if cattle prices increase as projected.

A pre-feasibility study of potential reservoir sites in this area was prepared for the WWDC in 1983 by the ARIX Corporation (ARIX, 1983). That study identified eight potential reservoir sites that could be developed at costs ranging from $270 to $1,066 per acre-foot of storage (in 1983 dollars). If all eight of the sites were developed, a total of about 50,000 acre-feet of additional storage would be available for delivering supplemental irrigation water. These sites are located along Cottonwood Creek, Piney Creek, and La Barge Creek. Other potential sites are known to exist in the area but have not been studied (ARIX, 1983). Reservoir construction costs and permitting requirements have changed considerably since 1983, and all of the sites studied by ARIX

[6] This figure includes 7,000 acre-feet of consumptive use associated with High Savary Reservoir which will come on line in the near future in the Little Snake Drainage.

may not be financially or environmentally feasible for future development. It seems likely, however, that some of the more cost effective sites identified by the AXIR study (or alternatives that may be considered as the current plan is being implemented) could be developed if financial returns to cow-calf operations and WWDC assistance increase as projected over the planning horizon.

The three most cost-effective sites identified by ARIX would provide approximately 25,000 acre-feet of storage at an average construction cost of $370 per acre-foot (1983 dollars). The moderate growth scenario is based upon the assumption that an additional 25,000 acre-feet of storage is developed along tributaries of the Upper Green at sites identified by ARIX or at alternative sites identified as the Green River Basin Water Plan is implemented during the coming three decades. Reservoirs with 25,000 acre-feet of storage would increase irrigation depletions in the Basin by 8,000 to 12,000 acre-feet annually (Tyrrell, 2000d). As a result, annual irrigation depletions in the Basin would increase from about 408,000 acre-feet annually (low growth scenario) to between 416,000 and 420,000 acre-feet.

In addition to new developments along the northwest tributaries, the Little Snake River Conservation District and private landowners in the Little Snake Drainage have plans to bring some additional acreage into agricultural production in the future. These plans include a number of small reservoirs on tributaries to the Little Snake River, and are described in a separate technical memorandum (Tyrrell, 2000e). If fully developed, these projects would result in a total irrigation depletion increase of about 10,000 acre-feet annually. For purposes of projecting future water use under the moderate growth scenario, it was assumed that 50 percent of the Little Snake projects would be developed over the 30-year planning horizon, with annual depletions of 5,000 acre-feet. Adding these depletion increases to those along the northwest tributaries yields a Basin-wide average annual irrigation depletion estimate of between 421,000 and 425,000 acre-feet for the moderate growth scenario.

High Growth Scenario

The high growth scenario is based not only upon the reasonably foreseeable possibility that cattle prices will increase over the planning horizon, but that reductions in forage production in high growth areas of the west will drive forage prices high enough to encourage Basin irrigators to produce alfalfa and Timothy hay as cash crops. Alfalfa production could be expanded in lower elevation areas of the Basin and the hay shipped out of the Basin to dairies in other states. Some new lands may be brought under irrigation as a result.[7] In higher elevation areas of the Basin, irrigators could diversify into Timothy hay as a cash crop in addition to producing mixed grass hay for winter feed. Some of the Timothy hay would be exported out of the Basin to surrounding states.

If forage prices stabilize at higher levels and WWDC funding is increased in the future, additional storage could be developed in the Basin to support increased forage production as a cash crop. The amount of additional storage that would be developed and the

[7] A map of potentially irrigable lands in the Basin is included as Figure 6 in this memorandum.

amount of additional water that would be consumptively used under this scenario are difficult to estimate because the outcome depends not only upon future financial returns to forage and beef production, but also upon the cost of developing additional storage in those areas where unappropriated water is available. A survey of members of the Greybull Valley Irrigation District in Wyoming's Big Horn River Basin suggests that irrigators are very sensitive to the cost of irrigation water (GEI Consultants, 1994). As a result, they tend to demand relatively large amounts of water at relatively low prices and very little water at relatively high prices. Irrigators in the Green River Basin are likely to be equally sensitive to irrigation water costs, which are a controlling factor in the level of future development under the high growth scenario.

Unfortunately, little is known about potential water development costs in the Basin beyond the ARIX (1983) study of storage sites along the northwest tributaries and studies in the Little Snake Drainage undertaken by the Little Snake River Water Conservation District. As a result, it is possible to make only very general approximations of how much additional water would be developed and used for irrigation under the High Growth Scenario.

The preliminary water use projections for this scenario are that an additional 26,000 to 34,000 acre-feet of irrigation water will be consumptively used annually relative to the low growth scenario, bringing average annual consumptive use by Basin irrigators to between 434,000 and 442,000 acre-feet annually. An increase of 8,000 to 12,000 acre-feet annually is associated with new storage projects along the northwest tributaries as described under the moderate growth scenario. Another 10,000 acre-feet of increased consumptive use are associated with future projects identified by the Little Snake River Water Conservation District (Tyrrell, 2000e). The remaining 8,000 to 12,000 acre-feet of new consumptive use is projected to occur in other parts of the Basin as cost-effective reservoir sites are identified during site-specific studies associated with an ongoing water planning process in the Basin.

These estimates should be considered first approximations of demand estimates that will be refined as more water development cost information becomes available.

Summary of Findings

Estimates of consumptive irrigation water use in the Basin are summarized in Figure 7 for current conditions and three future scenarios. The use estimates for the three future scenarios are for the year 2030. The first bar in Figure 7 shows that current consumptive use averages about 401,000 acre-feet annually, although consumption can be higher in a wet year and lower in a dry year. The second bar shows that for the low growth scenario, irrigation water use will rise to an average of 408,000 acre-feet annually by the year 2030. The increase of 7,000 acre-feet annually is over current conditions and is associated with the operation of High Savory Reservoir in the Little Snake Basin. No additional increases are projected for the low growth scenario because, under current economic conditions and WWDC funding criteria, Basin irrigators are unable to finance the construction of new storage facilities.

The third bar in Figure 7 shows that for the moderate growth scenario, consumptive irrigation water use is expected to rise to 423,000 acre-feet annually by the year 2030.[8] This scenario assumes that cattle prices rise significantly in the future as projected by the U.S. Department of Agriculture in response to export demand for high quality U.S. beef for the overseas restaurant and resort market. Furthermore, the WWDC is expected to adopt more favorable criteria for project assistance. As a consequence, irrigators along the northwest tributaries will be able to finance 25,000 acre-feet of new storage to provide late season and dry year irrigation water to lands that are currently water short. Little Snake Drainage irrigators will also be able to implement plans to bring some additional acreage into production there.

The fourth bar in Figure 7 shows that for the high growth scenario, consumptive irrigation water use is expected to rise to 438,000 acre-feet annually by the year 2030.[8] This scenario assumes that, in addition to rising cattle process and more favorable WWDC financing terms, forage prices will increase to the point where forage production for out-of-Basin markets will become profitable. As a consequence, additional lands will be brought into production is some parts of the Basin and an additional 25,000 acre-feet of storage will be built to service those lands.

[8] The projections for the moderate and high growth scenarios in Figure 7 represent the midpoints of the ranges for those scenario projections.

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Figure 1: Total Green River Basin Forage Harvest (1979-1999)

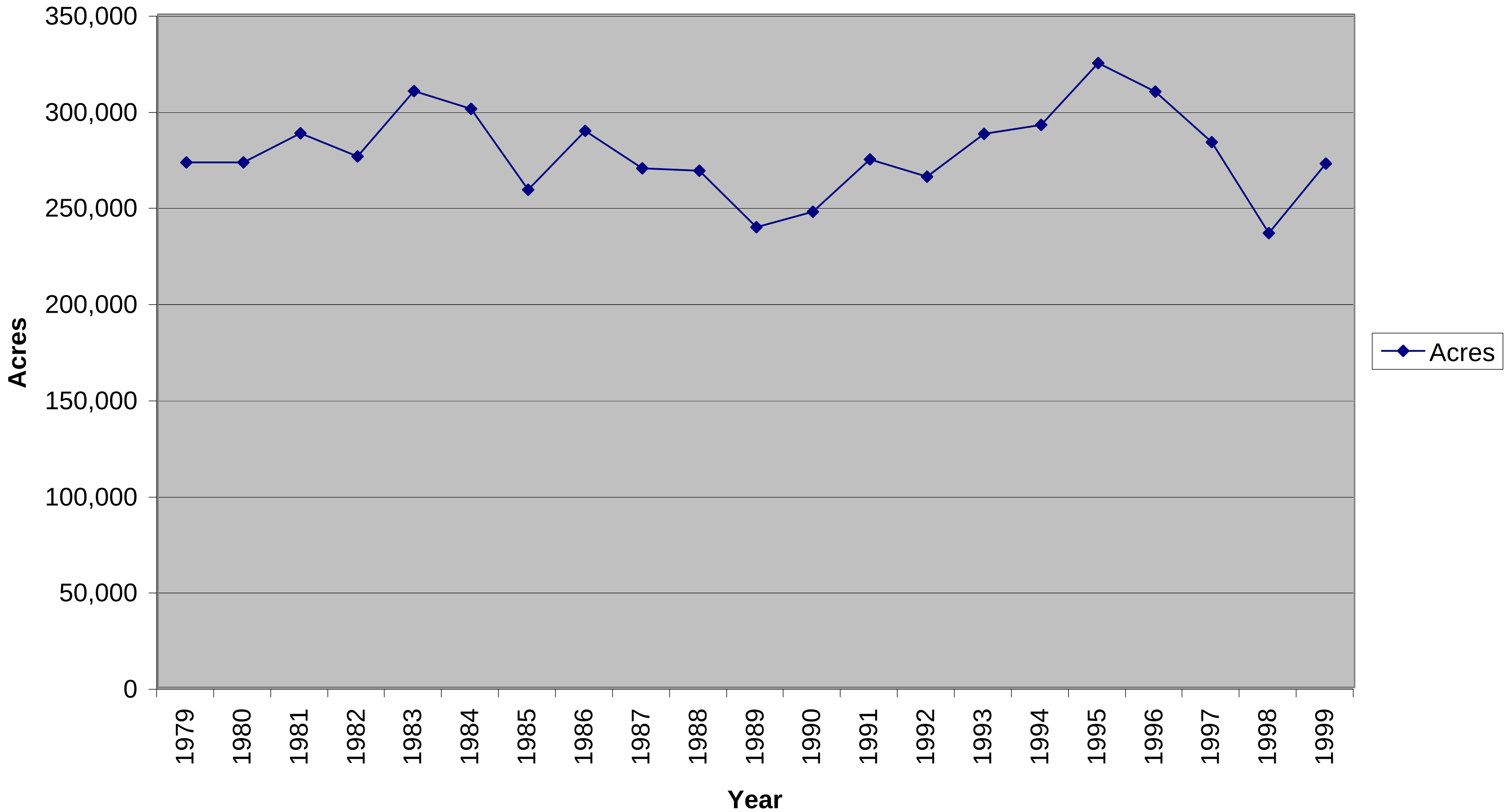


Figure 2: Distribution of Basin Forage Harvest by County (1979-1999 Average)

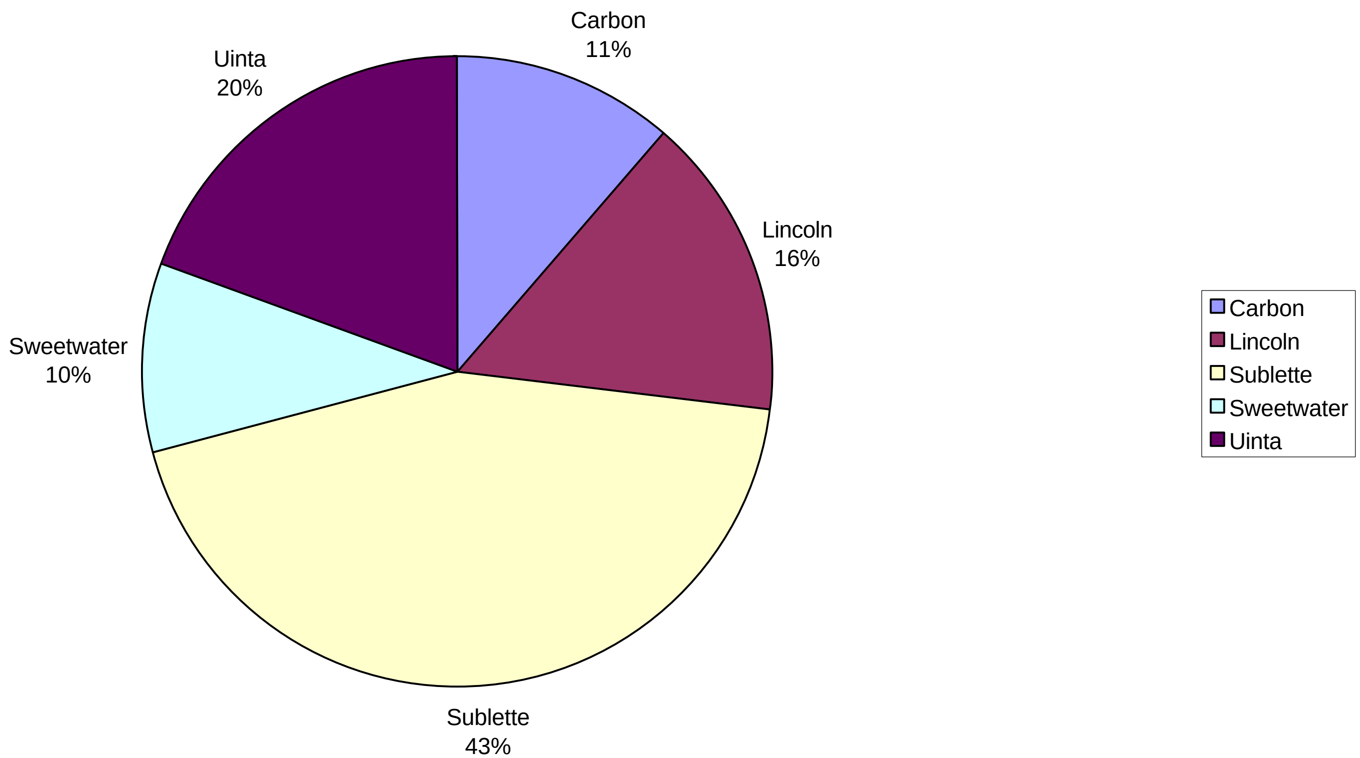


Figure 3: Total Green River Basin Cattle and Sheep Inventories

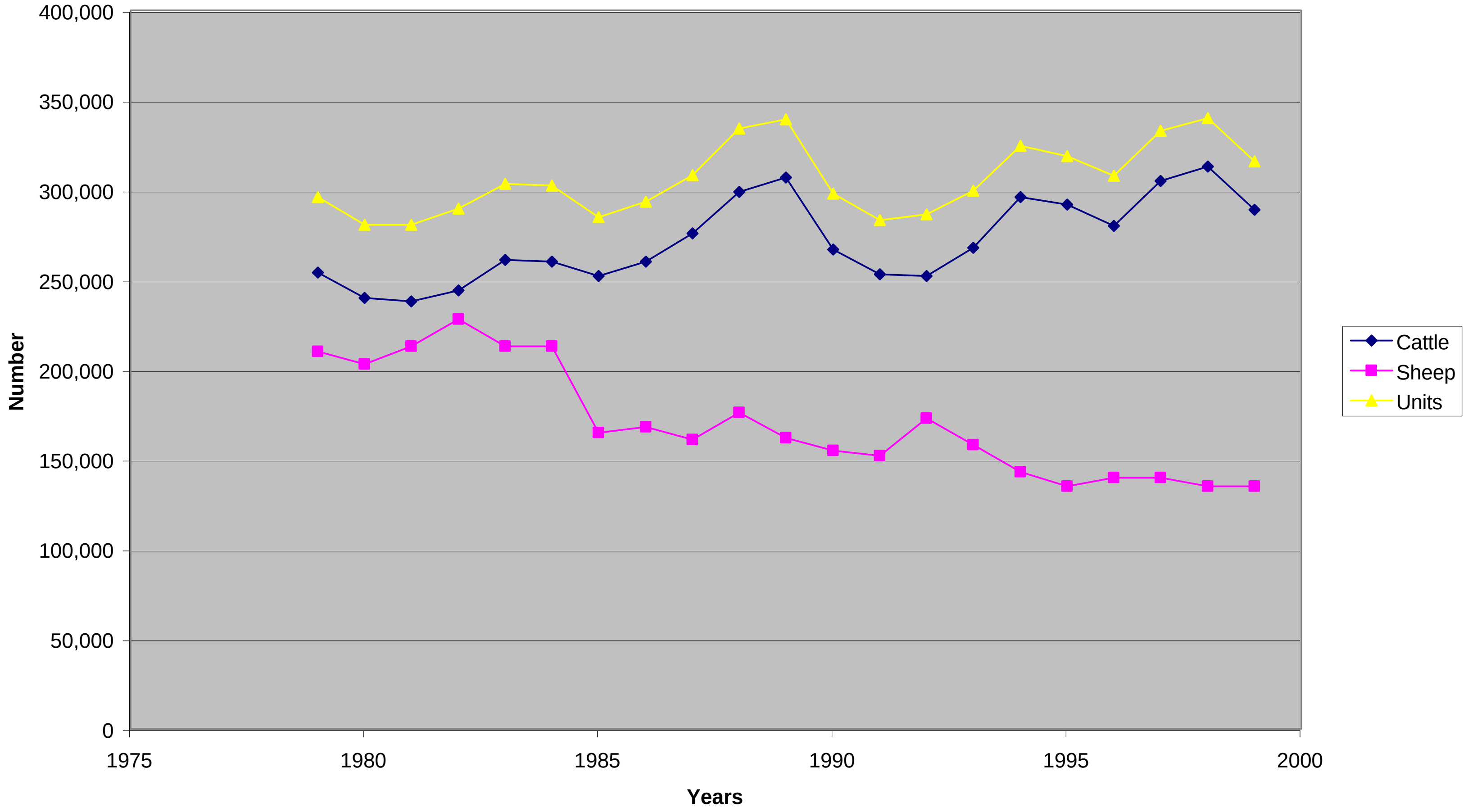


Figure 4: Distribution of Green River Basin Cattle by County

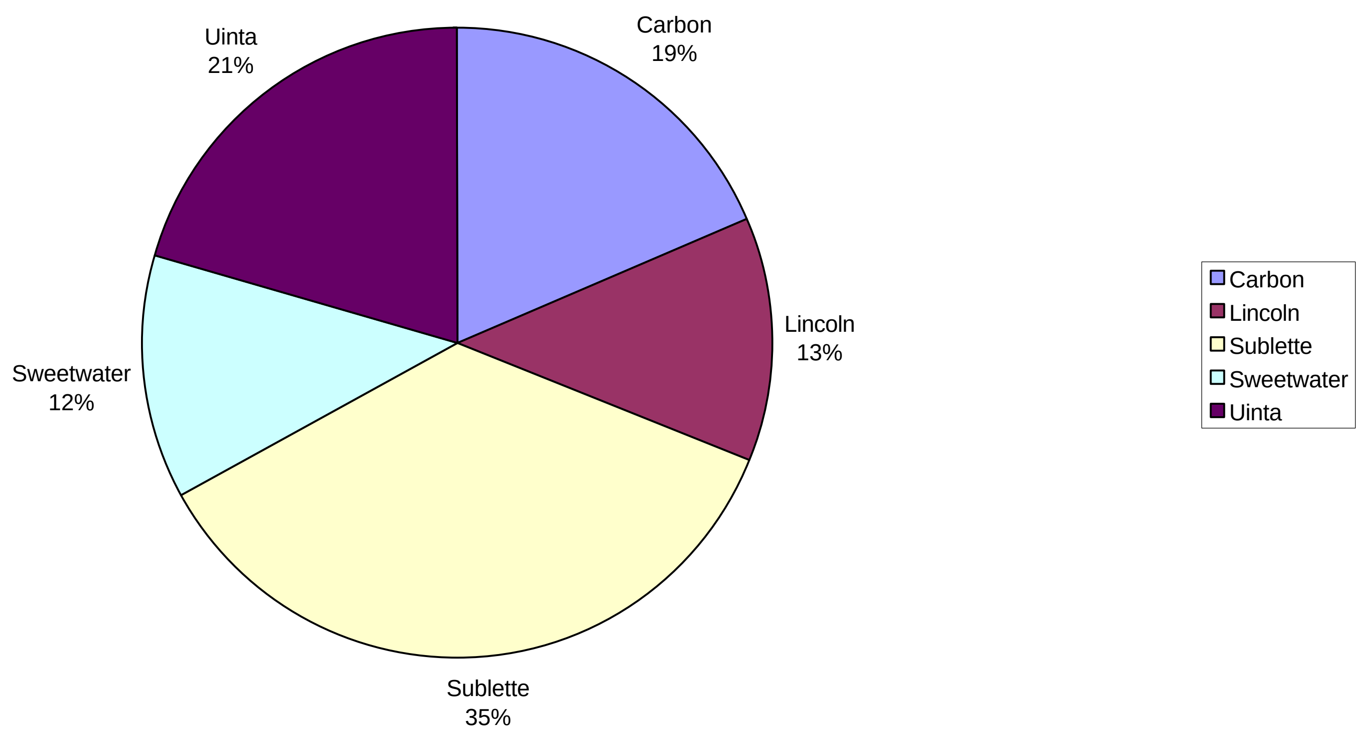
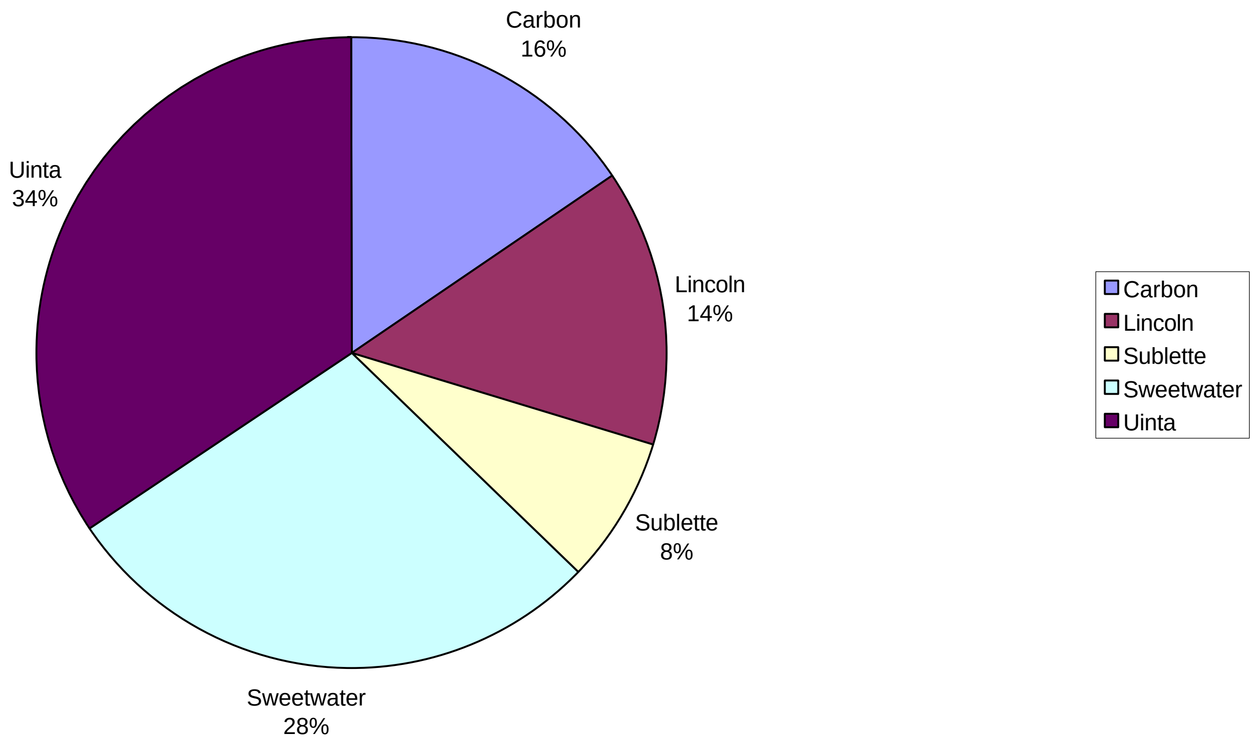
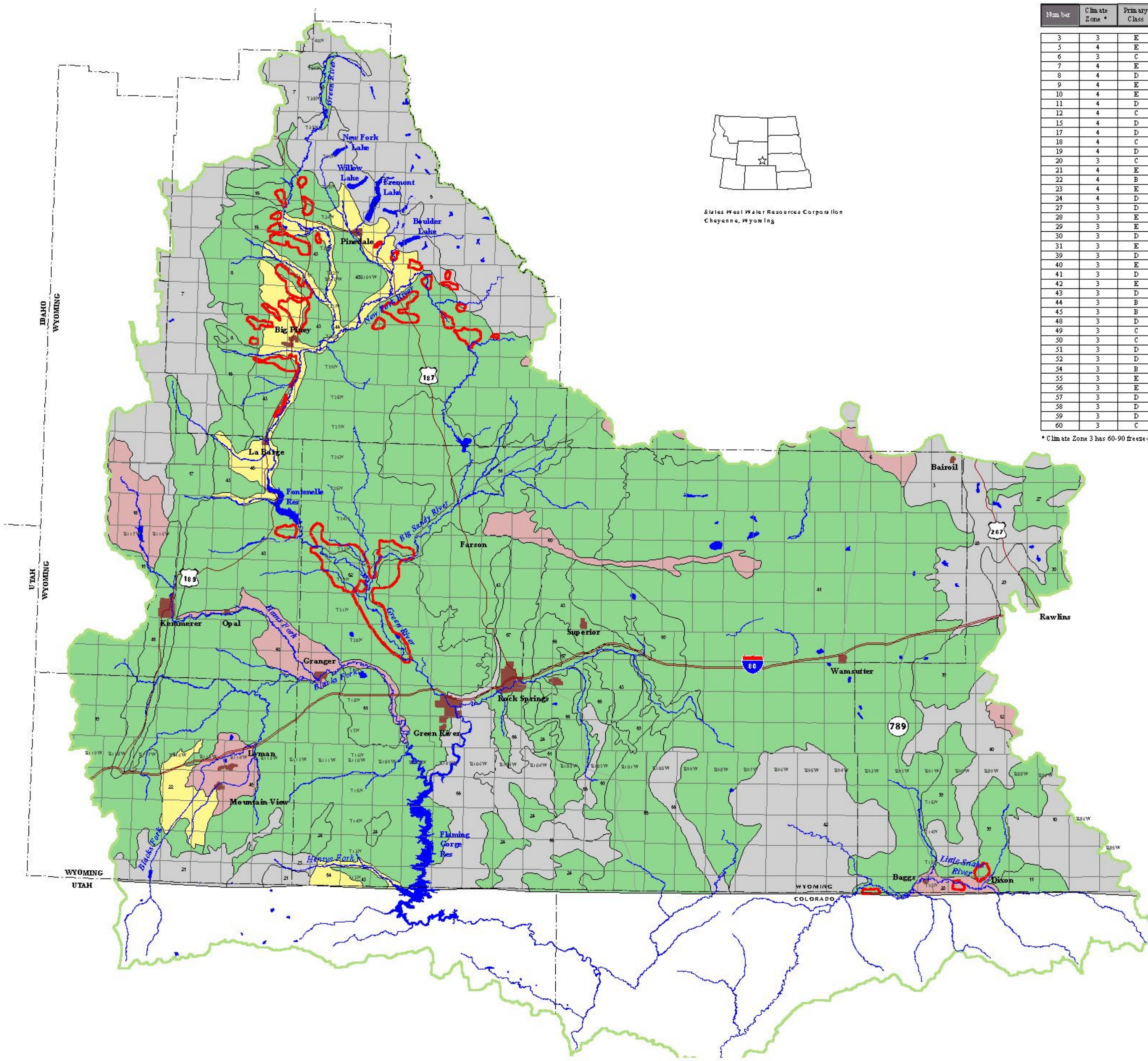


Figure 5: Distribution of Green River Basin Sheep by County





Number	Climate Zone *	Primary Class	Percent of Soil Class in Numbered Region				
			A	B	C	D	E
3	3	E	0	0	0	0	95
5	4	E	0	0	0	0	95
6	3	C	0	0	88	0	0
7	4	E	0	0	0	0	85
8	4	D	0	28	0	26	30
9	4	E	0	0	0	0	89
10	4	E	0	0	0	0	95
11	4	D	0	0	20	35	30
12	4	C	0	0	40	0	40
15	4	D	0	0	0	55	20
17	4	D	0	0	0	44	40
18	4	C	0	0	45	32	0
19	4	D	0	0	0	40	45
20	3	C	0	0	80	0	0
21	4	E	0	0	0	0	100
22	4	B	0	33	27	0	30
23	4	E	0	0	35	0	60
24	4	D	0	0	30	43	0
27	3	D	0	0	0	50	50
28	3	E	0	0	0	0	75
29	3	E	0	0	0	0	75
30	3	D	0	0	40	45	0
31	3	E	0	0	0	0	100
39	3	D	0	0	0	40	40
40	3	E	0	0	0	0	75
41	3	D	0	0	25	48	0
42	3	E	0	0	0	20	75
43	3	D	0	0	0	55	20
44	3	B	0	36	23	0	30
45	3	B	0	35	0	34	0
48	3	D	0	0	30	51	0
49	3	C	0	18	62	0	0
50	3	C	0	30	20	35	0
51	3	D	0	0	30	45	0
52	3	D	20	20	0	45	0
54	3	B	0	50	25	0	0
55	3	E	0	0	0	0	83
56	3	E	0	0	20	0	50
57	3	D	0	25	0	45	0
58	3	D	0	0	26	43	0
59	3	D	0	20	0	42	15
60	3	C	0	0	75	0	0

* Climate Zone 3 has 60-90 freeze-free days, and Climate Zone 4 has < 60 freeze-free days.

Legend

County Boundaries

Streams

Towns & Cities

Irrigable Lands

Source: Wyoming Irrigable Lands (unidentified U.S. Bureau of Reclamation mapping), United States Geological Survey Map, 1981, Scale: 1:1,000,000.

Irrigable Soils (Primary Classification)

See table at left for more specific percentages of soil class within a mapped region.

Source: Irrigable Soils of Wyoming, map and brochure prepared by the Wyoming Water Planning Program (State Engineer's Office) in cooperation with the Wyoming Department of Agriculture. Compiled by the USDA Soil Conservation Service, July, 1974, Scale: 1:500,000.

(A) Soils that have slight or few limitations that restrict their use for irrigated agriculture. (Not a primary soil class in this basin).

(B) Soils that have moderate limitations that reduce choice of crops or require moderate conservation practices.

(C) Soils that have severe limitations that reduce choice of crops or require special conservation practices or both.

(D) Soils that have very severe limitations that restrict the choice of crops or require special practices and management, or both.

(E) Soils having properties that according to the criteria used in the development of this map indicate they should not be irrigated.

Figure 6
Irrigable Soil Classification and Irrigable Lands
Green River Basin
Wyoming

Figure 7: Summary of Consumptive Irrigation Water Use Projections