TECHNICAL MEMORANDUM

SUBJECT: **Green River Basin Plan**
                  Population Projections

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Introduction

This memorandum presents population projections for the Green River Basin and its communities and rural areas for the time period from 2000 through 2030. The projections provide a basis for estimating municipal and domestic water needs in the Basin over the next 30 years. They also provide a basis for assessing water-based recreational resource needs.

The river basin planning process developed by the Wyoming Water Development Commission (WWDC) specifies that population projections be developed 30 years into the future for each river basin for each of three planning scenarios:

1. Low Growth

2. Moderate Growth

3. High Growth

The rationale and approach employed in developing population projections for the Green River Basin are described below.

Rationale and Approach

Generally, there are three commonly accepted methods for producing population projections: 1) time series analyses, 2) cohort survival analyses, and 3) employment-driven approaches. Each approach has advantages and disadvantages that must be evaluated in specific planning applications. Some methods combine more than one of the three approaches to produce projections.

Time series analyses typically involve assessing past growth trends and using those trends to project population into the future. Analytical methods used with this approach include computing average annual historical growth rates and fitting linear or non-linear equations to historical population data or indicators of population growth such as school enrollments, sales tax revenues, or other variables. Projections are usually based upon the assumption that future population changes will mimic past average annual growth rates or trends. The time

series approach is relatively easy to implement, and its results are easily understandable. Its main disadvantage is that it does not explicitly consider the three primary

determinants of regional population change: mortality rates, fertility rates, and migration patterns. Instead, the method implicitly assumes that past trends in relationships among these variables will continue into the future.

The cohort survival approach explicitly recognizes the three primary determinants of population change and requires forecasts of future mortality and fertility rates as well as net migration patterns. Projections of mortality and fertility rates by age and sex group (cohort) are available from the U.S. Census Bureau (USCB), as are projections of net migration patterns for different regions of the country. Projections of change for each cohort can be combined to produce forecasts of future population for a given geographic area. The advantage of the cohort survival approach is that it explicitly recognizes the determinants of population change and takes them into account in developing projections. Its primary disadvantage is that in rural areas with relatively small population bases, the effects of changing migration patterns over time can overwhelm the effects of changes in mortality and fertility rates, thus making the projections extremely sensitive to assumptions about future net migration patterns.

Employment-driven approaches to population projections are based upon the assumption that net migration patterns are primarily determined by job availability, and that job availability can be projected into the future with reasonable accuracy. Thus, if we could accurately project how many jobs would be available in the Green River Basin in the year 2030, we could estimate population in that year based upon estimates of how many people would be associated with each job. Estimates of the number of persons associated with each job may or may not explicitly take into account such factors as labor force participation rates, fertility rates, and mortality rates. If these factors are taken into account, the employment-driven approach becomes a special case of the cohort survival approach where net migration estimates are based upon employment forecasts.

The employment-driven approach incorporating labor force participation, fertility, and mortality rate changes is the most sophisticated approach commonly used for projecting regional population changes and can provide relatively accurate forecasts over relatively short time frames. Its primary disadvantage lies in the difficulty of forecasting economic activity and associated labor requirements by economic sector over long time periods. Even if future economic activity by sector could be forecast reliably 30 years into the future (a doubtful proposition), technological changes that affect the amount of labor needed by each sector often cannot be forecast reliably. For example, Wyoming's Powder River Basin has become the world's leading coal producer in recent decades with little growth in employment opportunities because of productivity gains associated with mechanized mining equipment. Accurately forecasting current levels of mining employment in the Powder River Basin 30 years ago would have been very difficult because the technology that determines current employment levels did not exist then.

Another disadvantage of the employment-driven approach is that migration patterns in the United States in recent decades have become less dependent upon local job availability and more dependent upon amenities and lifestyle variables such as climate, local infrastructure, crime rates, and scenic attributes. Many industries and jobs in the U.S. economy are now "portable" in the sense that they can be shifted from one locale to another based upon amenities or lifestyle variables with little change in competitive advantage.

Given the inherent shortcomings of all three population projection methodologies, there is no compelling reason to generate population projections for the Green River Basin using one method to the exclusion of others. Instead, the approach taken for this study involves using three different methods to create a range of projections representative of low, moderate, and high growth scenarios.

One of the methods involves refining and extending population forecasts for Wyoming cities, towns, and counties prepared by the Wyoming Department of Administration and Information (WDAI). The WDAI methodology incorporates elements of all three approaches described above. The second method involves refining and allocating to the Basin the population projections for the state of Wyoming prepared by the USCB. These projections were developed using the cohort survival approach with net migration pattern based upon address changes reported on federal tax returns. The third method involves a time series analysis of past population trends in the Basin to estimate a likely maximum rate of future population growth.

A primary objective of incorporating the state and federal projections into the analysis is to provide a basis for comparability with population projections for other river basins in the state. To the extent that the state and federal projections can be incorporated into the planning scenarios for other basins, there will be a consistent, comparable set of assumptions for population projections from basin to basin.

Current Population Estimates

The first step in developing population projections for the Basin was to estimate its current population. Estimates are necessary because the results of the 2000 census are not available as of the date of this report. Furthermore, it would be useful to have a consistent data source for the current population of all river basins in the state, and the results of the 2000 census may not be current when other basin plans are developed.

The Division of Economic Analysis of the WDAI produces estimates of the population of Wyoming's counties, cities, and towns on an annual basis, and projects those estimates 10 years into the future. These estimates and forecasts are available from a WDAI web site (WDAI, 1999). The WDAI forecasts for the year 2000 were used as current population estimates for this report and could be used to develop comparable current population baselines in other basins.

Because the geographical boundaries of the Green River Basin do not adhere to county lines, it was necessary to adjust the WADI county population estimates by to reflect only the proportion of each county that lies within the Basin's boundaries. That adjustment process was as follows:

- Cities and towns were classified as within or without the Basin using maps, and their populations were allocated accordingly.

- Each county's rural population was estimated by subtracting the populations of all cities and towns from the county total.

- A proportion of the rural population of each county was allocated to the Basin based upon the proportion of the land area in each county that is in the Basin.

- The proportion of each county's land area that is in the Basin was estimated from data contained in Table I-4 of Water Planning Report No. 3 (Wyoming State Engineer's Office [WSEO], 1970) and county acreage figures reported in the 1999 Wyoming Official Highway Map.

The only exceptions to this procedure involve Fremont and Teton Counties, each of which have a very small portion of rural land in the Basin. In both cases, these lands are in remote, lightly populated areas. As a result, a decision was made to exclude Fremont and Teton Counties from the Basin population projections.

Based upon the methodology described above, the total current population of Wyoming's Green River Basin is estimated to be 61,100 persons. This estimate represents an increase of 111 percent over the 1970 total of

Figure 1
Actual and Projected Population
Green River Basin
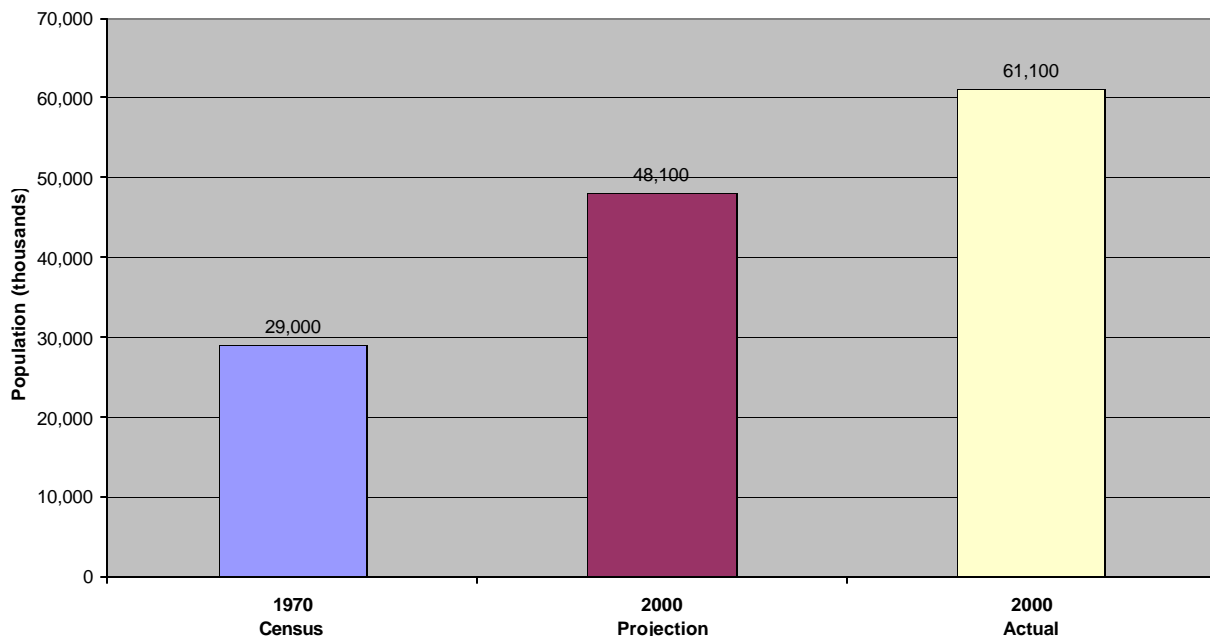
approximately 29,000 persons. Figure 1 shows these population totals along with a population forecast for the year 2000 taken from Water Planning Report No. 3, the 1970 water planning document for the Basin. That forecast is 48,100 persons, or 21 percent lower than the current estimate for the Basin. The forecast from Water Planning Report No. 3 apparently did not anticipate the extent of population growth that resulted from energy and mineral development in the basin during the 1970s and early 1980s.

The geographical distribution of the Basin's current population by county is depicted in Figure 2. That figure shows that almost two-thirds of the Basin's current population (64.7 percent) resides in Sweetwater County. Lincoln, Sublette, and Uinta Counties each have between 8 and 13 percent of the Basin's population, while Carbon County has only 1.5 percent. The relatively large population concentration in Sweetwater County is attributable to the fact that it contains the two largest communities in the Basin, Rock Springs and Green River. These two cities, with a combined population of about 32,500, account for 53 percent of the Basin's current population.

Figure 2
Distribution of Current Population
Green River Basin
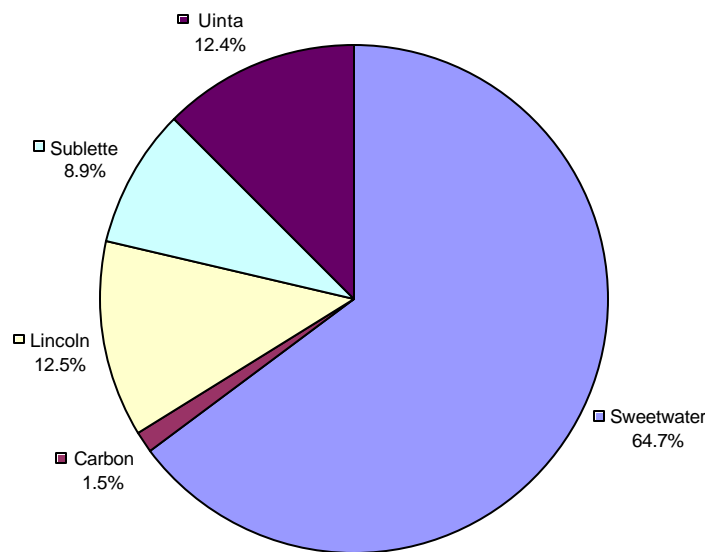
Extended WDAI Population Projections

The Division of Economic Analysis of the WDAI produces population forecasts for Wyoming counties, cities, and towns. The county population forecasts are based upon time series data from which growth rates are derived from variables such as population, sales tax collections, and school enrollments. These growth rates are used to forecast individual county population totals, and these county totals are adjusted to make them consistent with state-level population forecasts that incorporate elements of the cohort survival and employment-driven approaches. Population projections for cities and towns within each county are based upon population "shares" as derived from census counts or estimates.

The state-level forecasts are employment-driven with respect to magnitude, although they explicitly take into account fertility, mortality, and migration patterns by cohort. The state population forecast totals are controlled to match employment projections produced by Wharton Econometric Forecast Associates under contract with

the Division of Economic Analysis. Thus, the total county-level projections are essentially employment-driven also.

The Division of Economic Analysis forecasts population only 10 or fewer years into the future because of the uncertainties associated with such projections. Its most recent projections are through the year 2008 and are relatively conservative, a reflection of the relatively slow economic growth that the Basin and many other parts of the state have witnessed in recent years. A reasonable set of low growth rate population projections for the Green River Basin can be derived by computing the WDAI's average annual population growth rates for Green River Basin communities and rural areas for the period from 1990 through 2008 and extending those growth rates through the year 2030.

Allocation of U.S. Census Bureau Projections

The USCB periodically produces population forecasts for each of the 50 states using the cohort survival approach. The most recent forecasts for the state of Wyoming are two sets of population projections through the year 2025, the Series A forecasts and the Series B forecasts (USCB, 1999). Both series of projections use the cohort-survival approach and incorporate the USCB's "middle series" projections of fertility and mortality rates by cohort for each state. Both series also use migration patterns based upon recent data (early 1990s) concerning address changes reported on federal income tax returns. The only difference between the Series A and Series B projections is that the latter are adjusted slightly to make them more consistent with employment projections by state issued by the Bureau of Economic Analysis of the U.S. Department of Commerce. There is no significant difference between the Series A and Series B population forecasts for the state of Wyoming.

Both series of projections indicate moderate future population growth for Wyoming based upon migration patterns in the early 1990s. During that period, there was a moderate influx of new residents into some parts of Wyoming from elsewhere in the country. The effects of this migration pattern are apparent in parts of the Green River Basin, including the Pinedale area. The USCB projections are based upon the assumption that this moderate rate of net in-migration will continue into the future, and that fertility and mortality rates for the state will follow the USCB's middle series projections.

A reasonable set of moderate growth population projections for the Green River Basin can be developed from the USCB's Series A projections for Wyoming using the following methodology:

- Use the WDAI population forecasts to estimate the percentage change in the Green River Basin's population from 1990 to 2008, as well as the corresponding percentage changes for communities and rural areas of each county.

- Use the WDAI population forecasts to compute a percentage change in Wyoming's population from 1990 to 2008.

- Compute a relative growth rate (RGR) for each Green River Basin community or area relative to the state as the ratio of the percentage changes described above.

- Use the annual growth rates for Wyoming's population derived from the USCB's Series A projections multiplied by the RGRs described above for each community and rural area to derive estimated annual population growth rates in the Basin for the post-2008 period.

Historical Growth Projections

A third set of Green River Basin population projections was created by assuming that the area would experience a total population increase during the period from 2000 to 2030 that is of the same magnitude that occurred during the 30-year period form 1960 to 1990. From 1960 to 1990, the population of the Basin grew from 29,000 to 58,100, an increase of 29,100 persons. That increase came about largely in the 1970s and early 1980s as a result of rapid development of energy and mineral resources in the Basin, and the associated influx of workers. If a similar increase in energy and mineral development were to occur again in the next 30 years, it is possible that Basin population could increase by another 29,000 to 30,000 persons, resulting in a Basinwide population of approximately 90,000 persons by the year 2030. Although the possibility of the Basin experiencing a return to the boom conditions of the 1970s seems remote under present circumstances, the assumption that it might happen is a reasonable basis for a high growth scenario for population forecasting.

Earlier in this study, a set of high growth projections was developed based upon the assumption that communities and rural areas in the Basin would experience growth **rates** of a similar magnitude to those that occurred form 1960 to 1990. Those historical growth rates, however, were from an era when the base populations of most Basin communities were quite small. As a result, the energy and minerals boom of the period created **percentage** growth rates that were very high. Given the larger population base in the Basin today, it is unlikely that historical growth **rates** will be repeated again, even if a major boom period were to resume. A more reasonable assumption about future high growth involves a fixed population influx assumption similar to the one described in the previous paragraph.

**Low, Moderate, and High Growth Projections**

The three methods described above were used to generate population forecasts through the year 2030 for each community and rural area in the Basin. Generally, the WDAI extended forecasts resulted in the smallest forecast for each community and rural area. The allocated USCB forecasts were generally middle of the road, and the historical growth projections generally produced the largest forecasts. There were some exceptions to these generalities, however. For example, Sublette County's population did not grow much during the period from 1960 to 1990 relative to other parts of the Basin. As a result, the historical growth scenario did not correspond to a reasonable high growth scenario for communities in Sublette County. On the other hand, the extended WDAI forecasts showed significantly faster population growth in Sublette County through the year 2030 than in other parts of the Basin.

To adjust for these anomalies, the high growth scenario for each community and rural area in the Basin was defined as the largest population forecast for 2030 produced by any of the three methods. Similarly, the low

growth scenario was defined as the lowest 2030 population forecast, and the moderate growth scenario was defined as the middle 2030 population forecast.

The results of the low, moderate, and high growth projections for the entire Basin are depicted graphically in Figure 3. That figure shows that the low growth scenario projects a very small Basinwide population increase over the next 30 years. For this scenario, the current Basinwide population of 61,100 is projected to increase to only 62,500 by the year 2030. This projection is consistent with assuming that the relatively stagnant patterns of population change in most parts of the Basin in recent years will continue throughout the planning horizon.

Figure 3
Low, Moderate, and High Growth Population Projections
Green River Basin
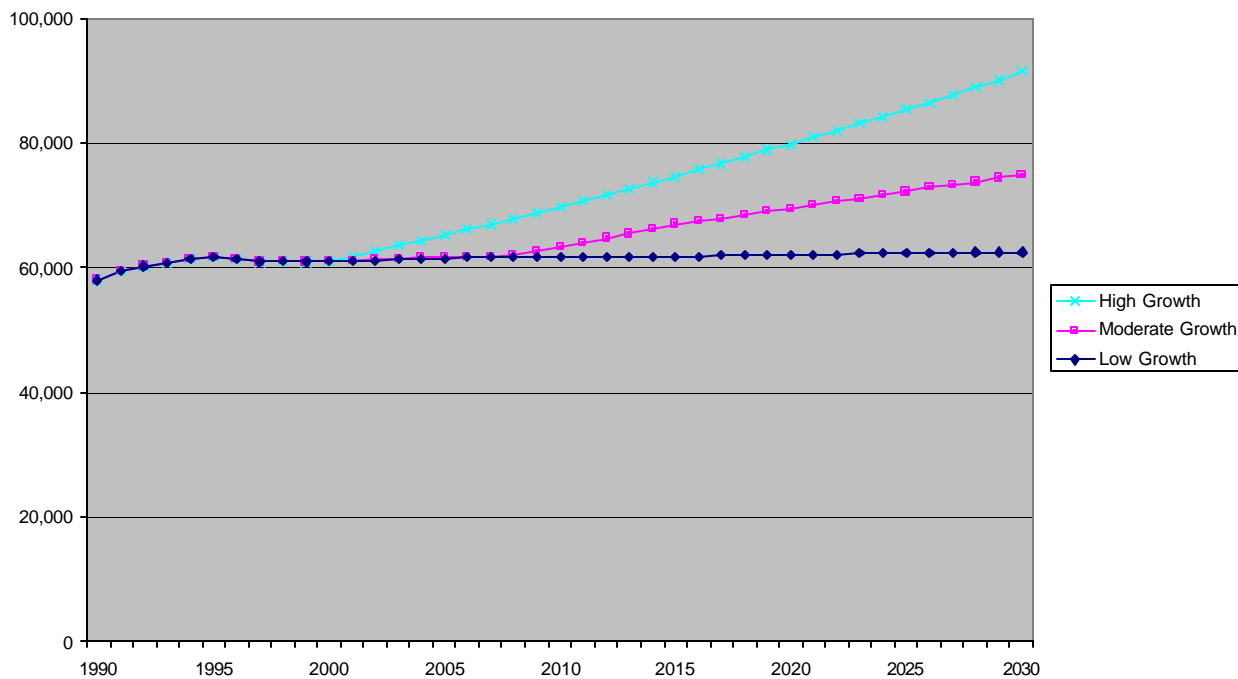
The moderate growth scenario indicates that Basinwide population will increase to a total of 75,000 persons by the year 2030, an increase of about 14,000 over current levels. This projection is consistent with the USCB's forecast that future net migration patterns will be positive for Wyoming and the Green River Basin.

The high growth scenario results show the Basin's population increasing from 61,100 to 91,400 over the next 30 years. This result was predetermined by the assumption that a population influx would occur of a magnitude similar to that experienced during the period from 1960 through 1990.

Low, moderate, and high growth projections for communities and rural areas of the Basin are given in Tables 1 through 3. The results in Table 1 indicate that under low growth assumptions, communities and rural areas in Carbon and Sweetwater Counties will experience small population decreases over the next 30 years, while

there will be modest growth in other parts of the Basin. The moderate growth projections in Table 2 indicate that most parts of the Basin will experience population growth in the range of 20 to 35 percent over the next 30 years, with the exception of the two small communities and the rural portion of Carbon County. The high growth projections (Table 3) indicate that all parts of the Basin will experience at least a 20 percent population increase by 2030, with some areas growing by as much as 70 percent.

Conclusions

The results described above are not intended to be predictions of population growth but rather scenarios for gauging the adequacy of current municipal and domestic water supplies and facilities in the Basin. They also provide benchmarks for gauging future demand for water-based recreation opportunities. To the extent that current water supplies and facilities are adequate to meet needs based upon the low to moderate growth scenarios, there will be little need for future development unless the area economy returns to "boom" conditions reminiscent of the 1970s. To the extent that current water supplies and facilities are inadequate to meet needs based upon the low and moderate growth scenarios, development plans can be formulated to address those needs.

References

U.S. Census Bureau, 1999, "Populations Projections: States, 1995 – 2025," Available World Wide Web @ http://www.census.gov/population/www/projections/stproj.html.

Wyoming Department of Administration and Information, 1999, "Wyoming Population Estimates and Forecasts for Counties, Cities, and Towns," Division of Economic Analysis. Available Worldwide Web @ http://eadiv.state.wy.us/pop/wyc&sc98.htm.

Wyoming State Engineer's Office, 1970, "Wyoming Water Planning Report No. 3: Water and Related Land Resources of the Green River Basin, Wyoming," Wyoming Water Planning Program.

| Table 1 - Green River Basin Population Projections | | | |
| Low Growth Scenario | | | |

| County/ | Population | | Percentage |
Community	2000	2030	Increase
Carbon Cty	923	790	-14.3%
Baggs	249	224	-9.9%
Dixon	66	28	-57.6%
Rural	608	538	-11.5%
Lincoln Cty	7,604	8,930	17.4%
Diamondville	894	1,048	17.2%
Kemmerer	2,979	3,551	19.2%
La Barge	503	591	17.5%
Opal	95	111	16.8%
Rural	3,133	3,630	15.9%
Sublette Cty	5,457	6,448	18.2%
Big Piney	508	604	18.9%
Marbleton	729	867	18.9%
Pinedale	1,353	1,567	15.8%
Rural	2,867	3,410	18.9%
Sweetwater Cty	39,540	38,283	-3.2%
Bairoil	224	224	0.2%
Granger	125	92	-26.5%
Green River	13,035	12,692	-2.6%
Rock Springs	19,380	18,912	-2.4%
Superior	265	268	1.0%
Wamsutter	242	229	-5.3%
Rural	6,269	5,866	-6.4%
Uinta Cty	7,556	8,013	6.0%
Lyman	2,109	2,202	4.4%
Mtn. View	1,376	1,437	4.4%
Rural	4,071	4,374	7.4%
TOTAL BASIN	61,079	62,465	2.3%

Table 2 - Green River Basin Population Projections Moderate Growth Scenario		

County/	Population		Percentage
Community	2000	2030	Increase
Carbon Cty	923	946	2.6%
Baggs	249	293	17.8%
Dixon	66	56	-15.1%
Rural	608	597	-1.8%
Lincoln Cty	7,604	9,519	25.2%
Diamondville	894	1,149	28.5%
Kemmerer	2,979	3,831	28.6%
La Barge	503	646	28.5%
Opal	95	122	28.0%
Rural	3,133	3,771	20.4%
Sublette Cty	5,457	7,349	34.7%
Big Piney	508	696	36.9%
Marbleton	729	994	36.3%
Pinedale	1,353	1,845	36.4%
Rural	2,867	3,814	33.0%
Sweetwater Cty	39,540	47,574	20.3%
Bairoil	224	251	12.1%
Granger	125	122	-2.5%
Green River	13,035	15,716	20.6%
Rock Springs	19,380	23,368	20.6%
Superior	265	297	12.1%
Wamsutter	242	291	20.1%
Rural	6,269	7,530	20.1%
Uinta Cty	7,556	9,542	26.3%
Lyman	2,109	2,668	26.5%
Mtn. View	1,376	1,733	25.9%
Rural	4,071	5,141	26.3%
TOTAL BASIN	61,079	74,930	22.7%

Table 3 - Green River Basin Population Projections High Growth Scenario			
County/	Population		Percentage
Community	2000	2030	Increase
Carbon Cty	923	1,113	20.6%
Baggs	249	322	29.3%
Dixon	66	77	16.6%
Rural	608	714	17.5%
Lincoln Cty	7,604	10,377	36.5%
Diamondville	894	1,361	52.2%
Kemmerer	2,979	3,968	33.2%
La Barge	503	895	78.0%
Opal	95	135	42.2%
Rural	3,133	4,018	28.3%
Sublette Cty	5,457	7,649	40.2%
Big Piney	508	763	50.3%
Marbleton	729	1,041	42.8%
Pinedale	1,353	1,967	45.4%
Rural	2,867	3,878	35.3%
Sweetwater Cty	39,540	60,309	52.5%
Bairoil	224	270	20.6%
Granger	125	151	20.4%
Green River	13,035	22,261	70.8%
Rock Springs	19,380	28,049	44.7%
Superior	265	320	20.9%
Wamsutter	242	372	53.6%
Rural	6,269	8,887	41.8%
Uinta Cty	7,556	11,932	57.9%
Lyman	2,109	3,581	69.8%
Mtn. View	1,376	2,336	69.8%
Rural	4,071	6,016	47.8%
TOTAL BASIN	61,079	91,381	49.6%