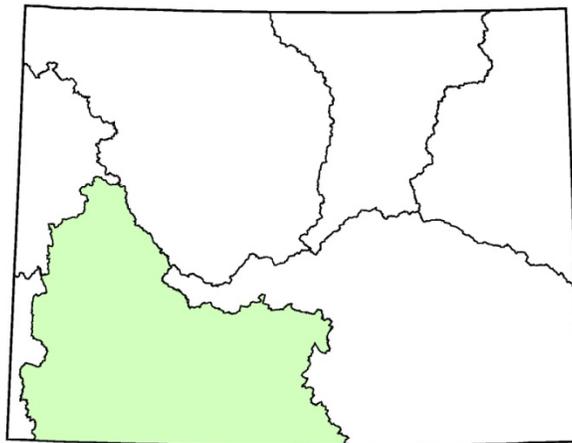


Green River Basin Plan

Executive Summary

December 2010



Prepared for:

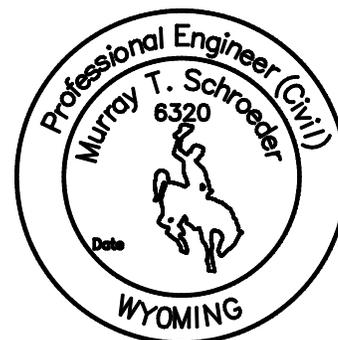
Wyoming Water Development Commission
Basin Planning Program

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Table of Contents

1.0 INTRODUCTION	1
2.0 WEB TOOL	1
3.0 SETTING	1
BASIN AREA.....	1
CLIMATE.....	2
POPULATION	2
ECONOMIC ACTIVITY	2
LEGAL AND INSTITUTIONAL ISSUES	2
4.0 WATER RESOURCES	4
SURFACE WATER QUANTITY.....	4
SURFACE WATER QUALITY.....	4
GROUNDWATER QUANTITY AND QUALITY	4
5.0 WATER USE	6
AGRICULTURAL	6
MUNICIPAL AND DOMESTIC	6
INDUSTRIAL.....	6
RECREATIONAL.....	6
ENVIRONMENTAL.....	7
EVAPORATION	7
SUMMARY	7
6.0 PROJECTIONS	10
7.0 AVAILABILITY	11
SURFACE WATER	11
GROUNDWATER	11
8.0 STRATEGIES & RECOMMENDATIONS	13



I, Murray T. Schroeder, a Wyoming registered Professional Engineer, certify that this report was prepared by me or under my direct supervision. (The original signature and stamp are available at the Water Development Office.)

1.0 INTRODUCTION

The 2010 Green River Basin Plan presents a basinwide perspective on water resources, updating the 2001 Green River Basin Plan. The modern plan includes information on the basin's socio-economic situation; discussion about institutional constraints on water use; a description of the basin's water resources, how these resources are presently being used, and how they are projected to be used in the future; information on the location and amounts of available unused water resources; and finally, an identification of the water issues affecting the basin and potential strategies for addressing those issues.

This executive summary does not attempt to summarize all aspects of the Plan. Rather, this executive summary presents critical information and data from the Plan, including comparisons with data published in the 2001 Basin Plan. The reader is encouraged to consult the Plan and supporting technical memoranda for detailed information.

2.0 WEB TOOL

This 2010 Green River Basin Plan is available to view and download at <http://waterplan.state.wy.us/plan/green/green-plan.html>. In addition to the executive summary and final report, technical memoranda, hydrologic models, and related GIS data are also available for download. Additionally, data tables from the Statewide Framework Water Plan were revised with new values derived and are available at <http://waterplan.state.wy.us/plan/statewide/tables/tables.html>. The values in these updated tables represent the most recent data available at the time of publication.

3.0 SETTING

The physical, social, and economic character of the Basin is described by drainage basin size, general land uses, general weather patterns, institutional constraints and other items. Most of these characteristics have changed little since the 2001 Basin Plan, with the following notable exceptions:

BASIN AREA

Modern geographic information systems (GIS) software data coverages were used to estimate Green River Basin land areas by county. The total area of the Green River Basin in Wyoming is about 17,149 square miles and the area of the Great Divide Basin is about 3,897 square miles. The total planning area considered in this plan is 21,046 square miles.

CLIMATE

The 2010 Plan incorporates several exhibits depicting modern climate data, including precipitation and temperature information, updating and expanding on that which was presented in the 2001 Plan. Figure ES-1 illustrates how precipitation patterns have changed across the basin in comparison to the 2001 Plan. The figure shows a general basin wide decrease in annual precipitation after the year 2000. This decreased precipitation correlates well with reductions in overall basin water supplies during the same period.

POPULATION

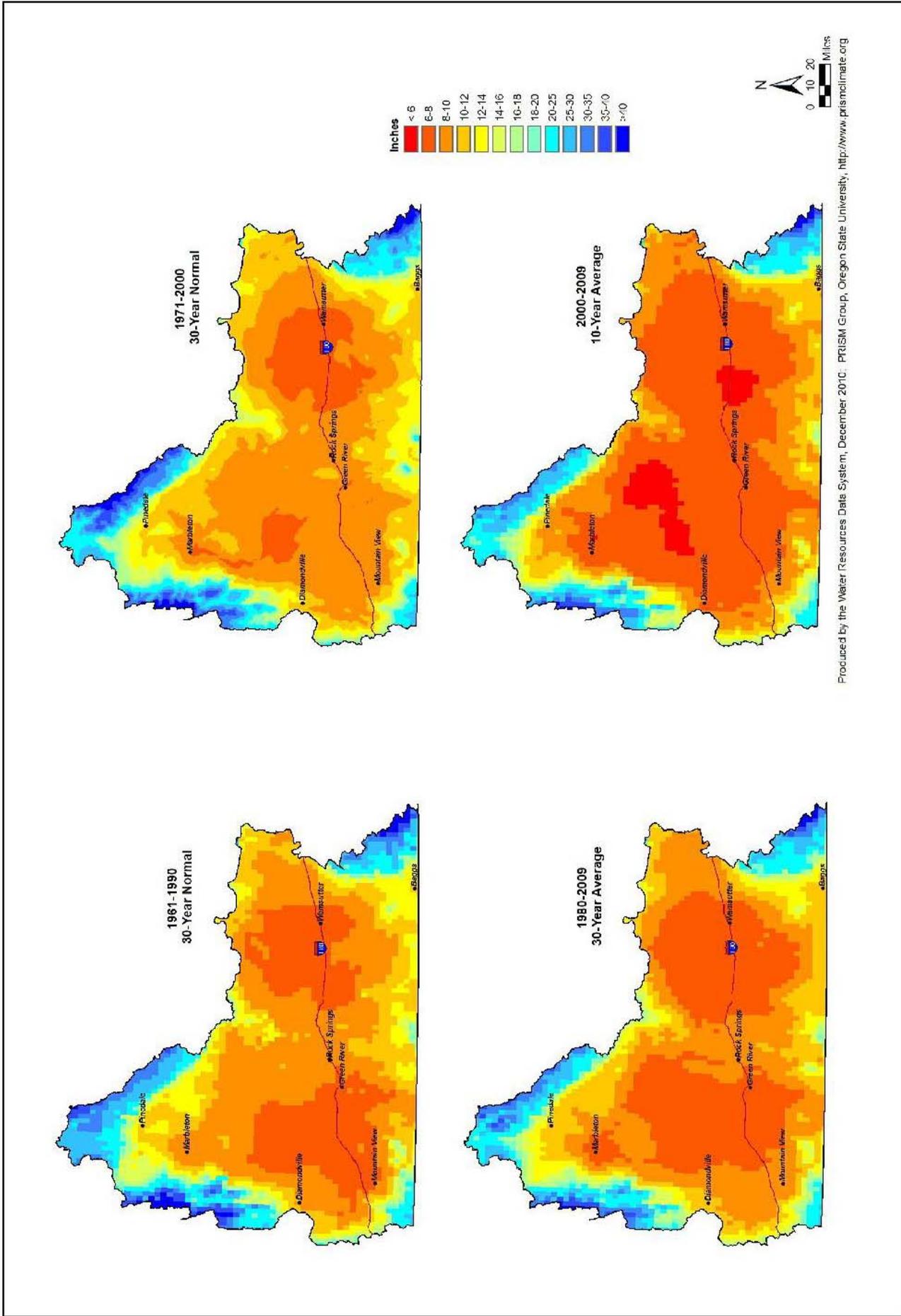
Basin population was estimated at 60,283 in 2005, the baseline year for this 2010 Plan. This compares to the 58,267 reported in the 2001 Plan. This modest increase in population is in part responsible for changes in water demand and patterns of water use.

ECONOMIC ACTIVITY

Statistics are presented in the 2010 Plan that illustrate economic contributions of agricultural, industry and recreational on the basin's economy. Data such as this were not included in the 2001 plan, and no comparison of basin economics in the two plans could be made.

LEGAL AND INSTITUTIONAL ISSUES

This 2010 Plan contains much of the same discussion of legal framework that was presented in 2001 but has been updated to include information on the High Savery Reservoir Contract and current information on the Upper Colorado River Recovery Implementation Program.



Produced by the Water Resources Data System, December 2010; PRISM Group, Oregon State University, <http://www.prismclimate.org>



Figure ES-1
Annual Precipitation Comparisons

4.0 WATER RESOURCES

The 2010 Plan summarizes the quantity and quality of the Green River Basin's surface water and groundwater resources.

SURFACE WATER QUANTITY

Table ES-1 presents an estimate of the Basin's total surface water resources. The total annual surface water resource prior to depletions by known uses is about 2,381,000 acre-feet. This amount is about 235,000 acre-feet per year less than the amount estimated in the 2001 Plan. The difference (about 10% less) is attributed to the general decrease in precipitation across the basin which occurred between 2000 and 2010. This modern day plan used a period of water supply record that included many of the extremely dry years in the 2000's. Thus, modeling to estimate water availability for future uses included many more dry years than available for use in the 2001 Plan.

SURFACE WATER QUALITY

This 2010 Plan characterizes the basin's surface water quality, in part, using the impaired water body listing compiled for the Wyoming Water Quality Assessment and Impaired Waters List (2010 Integrated 305(b) and 303(d) report). The basin as a whole has generally excellent surface water quality, with some exceptions as noted in the report identified above.

GROUNDWATER QUANTITY AND QUALITY

In support of this Basin Plan, the Wyoming Geological Survey completed a basin-wide inventory of groundwater and published the results in the *2009 Available Groundwater Determination Technical Memorandum*. Groundwater resources occur within both unconsolidated deposits and bedrock formations of the Basin and show a wide range of variability in quantity and quality. The most productive aquifers in the Basin include the Cenozoic alluvium and sandstone that may produce 500-1000 gallons per minute to wells. However, 95 percent of wells in the Basin yield 25 gallons per minute or less. Extensive additional information on the distribution and quality of groundwater is contained in the referenced report.

Table ES-1 - Total Surface Water Flow – Average Depletions Compared to Dry, Wet and Normal Flow Years

Sector of Water Use¹	Depletions Acre-Feet		
Agricultural ²	389,324		
Municipal ³	21,859		
Domestic ⁴	0		
Industrial ⁵	56,833		
Recreational	non-consumptive		
Environmental	non-consumptive		
In-State Reservoir Evaporation ⁶	121,300		
Total Depletions	589,316		
	Flow Leaving Green River Basin (Acre-Feet)⁷		
River	Dry Year	Normal Year	Wet Year
Green River	595,000	1,138,000	1,806,000
Little Snake River	177,000	407,000	642,000
Black's Fork River	67,000	195,000	398,000
Henry's Fork River	24,000	52,000	118,000
Total	863,000	1,792,000	2,964,000
Total Streamflow Volume plus Average Depletion	1,452,316	2,381,316	3,553,316
GRBP I Green River Total ⁸	1,543,000	2,617,000	3,746,000
Change since 2001	-90,684	-235,684	-192,684

¹ Depletion estimates for each water use sector are from Chapter 5

² Agricultural surface water depletions consist of the irrigation depletion estimate, 396,246 ac-ft/yr, less the WSGS estimate for groundwater use for irrigation, 7,800 ac-ft/yr, plus one half of total stock use assuming that approximately 50% stock use is groundwater and the remaining 50% is surface water

³ Municipal use of 6,578 from Table 5-8 and 15,281 Cheyenne Diversions from Table 5-10

⁴ No domestic depletions from Table 5-8.

⁵ Industrial depletion from Table 5-13.

⁶ Evaporation estimate from 2001 Green River Basin Water Plan.

⁷ From Table 2 in "Available Surface Water Determination," tech. memo, AECOM, 2010.

⁸ GRBP I Total Flow is from the 2007 Wyoming Framework Water Plan, Vol. 1, WWC Engineering

5.0 WATER USE

Existing water use is described and quantified in the following six sectors: Agricultural, Municipal & Domestic, Industrial, Recreational, Environmental, and Reservoir Evaporation.

AGRICULTURAL

Agricultural water use, including irrigation and livestock watering, accounts for the vast majority of water consumption in the Green River Basin. As part of this 2010 Plan, the Wyoming State Engineer's Office prepared an estimate of consumptive use for wet years and dry years. (The methods used to prepare this estimate are different than those used in 2001). Estimates of irrigated acreage are provided in Table ES-2, along with corresponding estimates from the 2001 Plan. The average of dry and wet year irrigated acreage is 334,500 acres, about 1.2 percent higher than 2001. This 334,500 acres consumes approximately 396,246 acre-feet of water per year. The approximate distribution of irrigated lands is shown in Figure ES-2.

Livestock consumption is estimated to be 1,755 acre-feet per year.

MUNICIPAL AND DOMESTIC

Municipal water uses are satisfied by surface water and groundwater. Domestic water use includes use by rural homes served almost exclusively by groundwater wells permitted for domestic use and public water supply systems that serve rural subdivisions, commercial establishments, parks, campgrounds, and other smaller uses. Total use in this sector is about 25,790 acre-feet per year, compared to 24,643 acre-feet per year reported in the 2001 Plan.

INDUSTRIAL

Industrial uses in the Basin include water needed for power plant cooling and mineral extraction. The Basin-wide use in this sector has decreased from 68,066 acre-feet per year in 2001 to about 58,787 acre-feet per year. However, for reasons explained in the Plan, the apparent decrease may be due to lack of data.

RECREATIONAL

Recreational uses of water are mostly nonconsumptive and include boating, fishing, swimming, skiing, golfing, and waterfowl hunting, as well as activities such as camping, hiking, and wildlife watching that are enhanced by water in streams, lakes, and rivers. While consumption of water is usually not involved, the existence of a sufficient water supply is important for a quality experience.

Two recreational uses that consume water are golfing and skiing. The primary consumptive water use for golfing is irrigation of greens and fairways, although this

water is included in municipal water use estimates because golf courses are served by municipal systems. The major consumption for skiing is evaporation during the snowmaking process.

ENVIRONMENTAL

About 1.5 million acres of land in the Green River Basin rely on water from streams, reservoirs, and irrigation to support a variety of environmental water needs. These environmental needs include but are not necessarily limited to instream flow water rights, minimum reservoir pools, instream bypasses designated for enhancement of fisheries and wildlife habitat, wetlands, direct wildlife consumption, evaporation from conservation pools and maintenance of riparian areas.

EVAPORATION

The Green River Basin contains many large reservoirs used for multiple purposes including storage for irrigation, municipal, industrial, recreational, fish propagation and flood control uses, among others. For the modern report, estimates of evaporation were not re-calculated from the estimates provided in the 2001 Plan (88,500 acre-feet per year).

SUMMARY

Table ES-3 presents a summary of the water uses by sector for both the current Plan and the 2001 Plan. As shown, overall the total water use in the basin is about 2% less than in 2001.

Table ES-2 - Irrigated Acreage by Sub-basin

Sub-basin	Wet Year	Dry Year	2001 GRB Plan
	Acres		
Upper & Mainstem Green River	143,293	126,844	133,372
New Fork	57,900	55,457	52,707
Big/Little Sandy Rivers	19,951	16,241	22,506
Green River Below Fontenelle	1,373	1,097	2,042
Blacks Fork	88,972	63,978	75,173
Hams Fork	12,746	10,811	10,287
Henry's Fork	19,735	15,057	16,690
Little Snake	15,423	14,725	16,959
Vermillion/Salt Wells Creeks	3,180	2,160	674
Total	362,573	306,369	330,410
Average Total Irrigated Acres	334,500		330,410

Source: Leonard Rice Engineers, Inc. 2009

Notes: Sub-basin names are those used in the source document and commonly used by SEO.

They are not the same as HUC-4 sub-basins shown on Figure 5-2.

The irrigated acreage assessment above did not include lands in the Great Divide Basin.

Table ES-3 - Summary of Change in Water Use

Sector of Use	Type of Use	GRBP I 2001	GRBP II 2010	% Difference
		Acres/Year		
Agricultural	Irrigation ¹	401,034	396,246	-1
	Stock	N/A	1,755	N/A
Municipal	Surface Water ²	6,539	6,578	0.60
	Groundwater	812	884	9
	City of Cheyenne Diversions	14,388	15,281	6
Domestic	Surface Water	≈0	≈0	0
	Groundwater ³	2,904	3,047	5
Industrial	Surface Water	66,491	56,833	-15
	Groundwater	1,575	1,954	24
Recreational		Non-consumptive		0
Environmental		2,000	Non-consumptive ⁴	N/A
Evaporation	Main Stem	88,500	88,500	0
	In State	32,800	32,800	0
TOTAL		617,043	603,878	-2

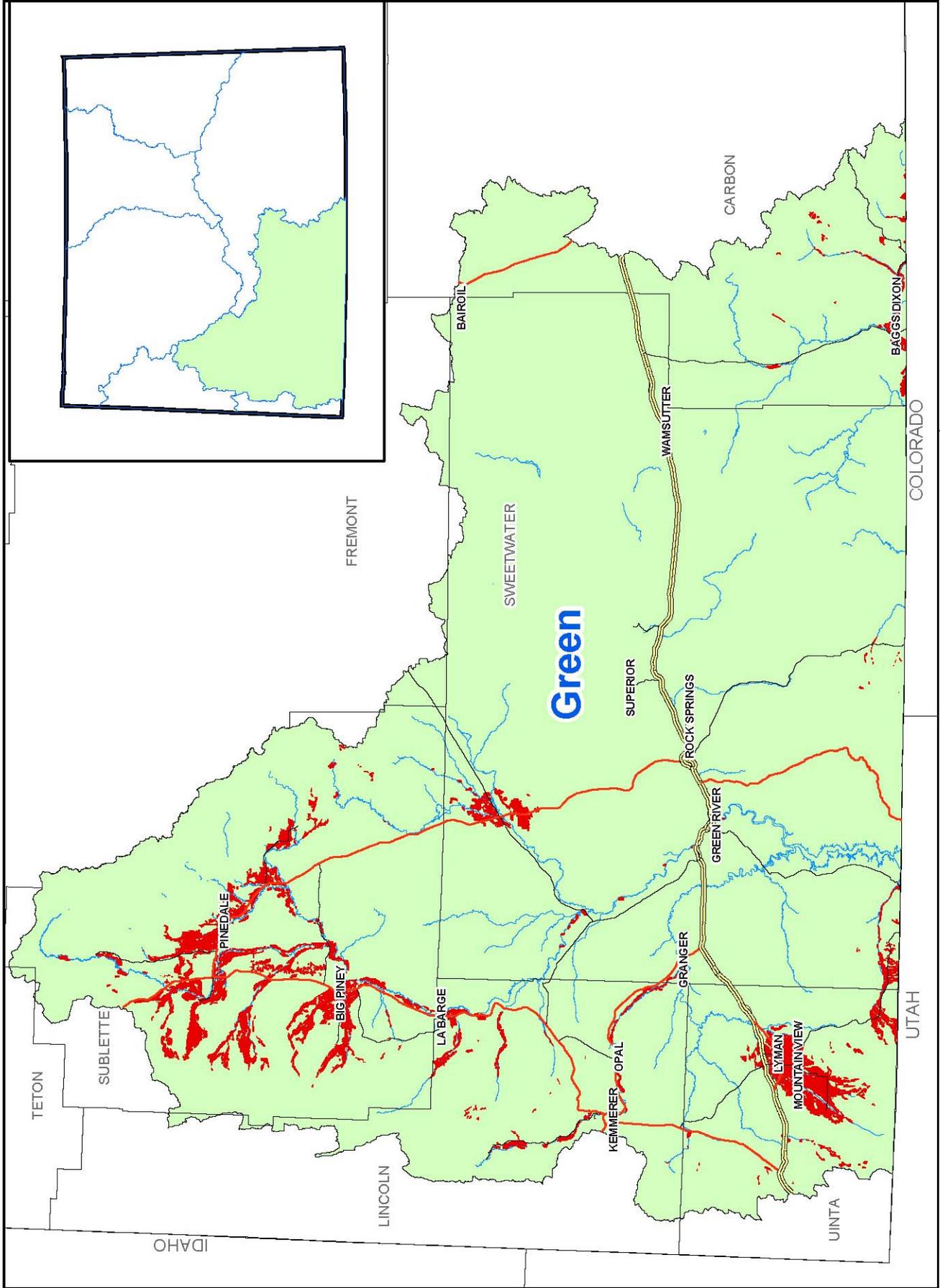
¹ Water use values based upon normal year estimates of surface water and groundwater use.

² Does not include diversions for the City of Cheyenne.

³ Values reflect the average of the calculated range of domestic groundwater use.

⁴ Environmental was determined Non-consumptive.

Source: State Engineers Office Hydrographers Reports, 2008.



**Figure ES-2
Irrigated Lands**

LEGEND
 Irrigated Lands

Source: Irrigated lands shown are based on GIS coverage developed for 2007 Wyoming Framework Water Plan, which are different than the exact acreages mapped during the SEO Water Rights Attribution Project.

6.0 PROJECTIONS

Water demand was forecasted for 30- and 50-year periods. Future water demands were estimated for low, moderate and high growth scenarios. Table ES-4 presents both the 2001 and 2010 Basin Plan projections for each scenario, along with the estimated amount of water remaining under the Colorado Compact.

Table ES-4 - Summary of Projected Surface Water Depletions and Remaining Compact Allocation

Surface Water	AF/YR					
	2001 Basin Plan 30 Yr Projection			2010 Basin Plan 50 Yr Projection		
	Projected Growth Scenario					
	Low	Moderate	High	Low	Moderate	High
Wyoming's Allocation of the Upper Colorado River Water	833,000	833,000	833,000	847,000	847,000	847,000
Total Estimated Depletions	630,900	682,800	766,700	608,295	680,076	788,675
Remaining Compact Allocation	202,100	150,200	66,300	238,705	166,924	58,325

Notes: Total estimated depletions were prepared using the data from Chapter 6 Tables and the approximations described in the footnotes to Table 7-4.

Wyoming's allocation of the Upper Colorado River Water was estimated by the Wyoming State Engineer's Office, October 1, 2010.

The State has the ability to store 120,000 ac-ft of water in Fontenelle Reservoir. The estimate of remaining compact amount is based on the assumption that the future industrial depletion shown will be met, at least in part, by the State of Wyoming Fontenelle Water Storage account.

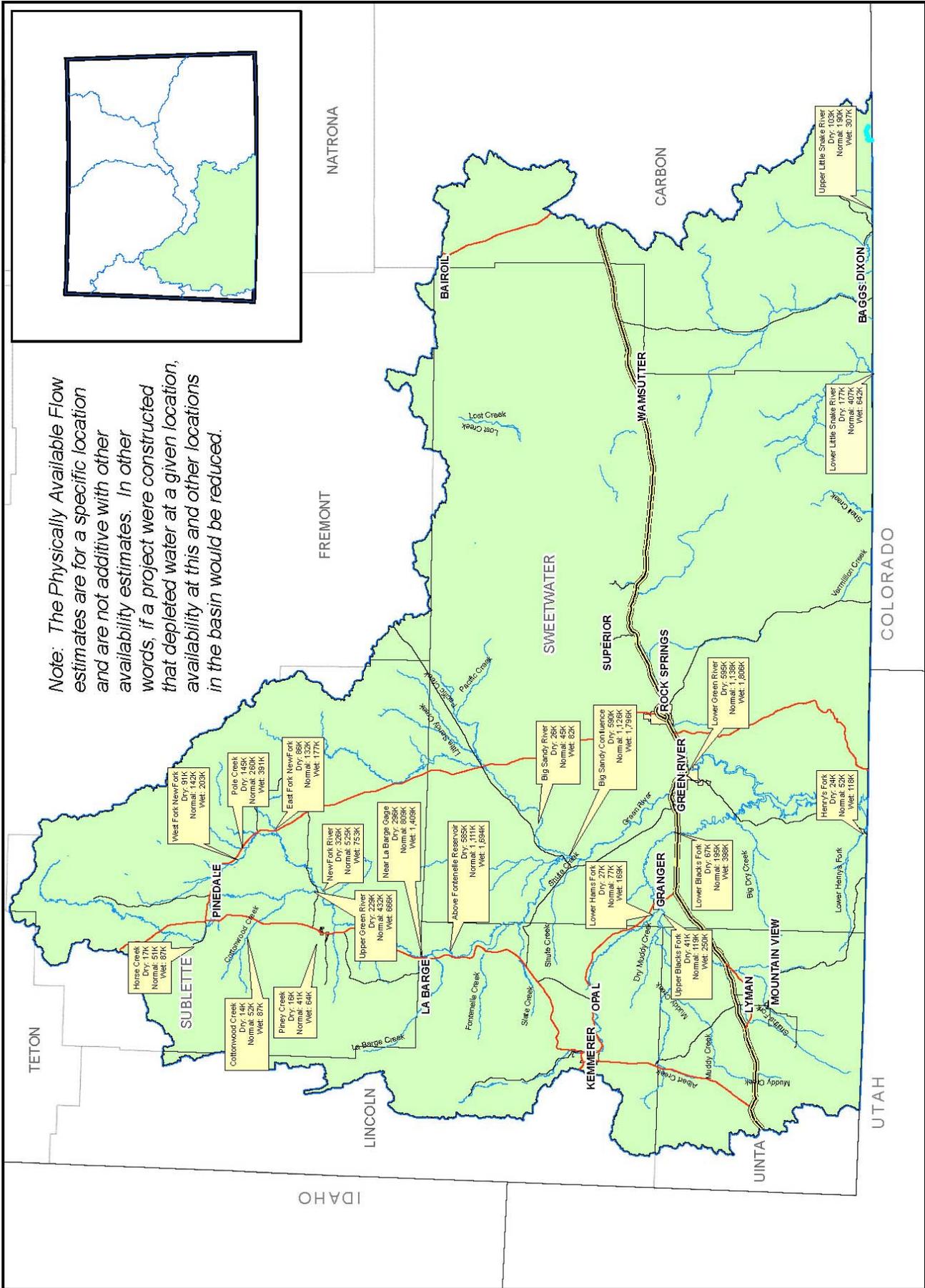
7.0 AVAILABILITY

SURFACE WATER

As in the 2001 Plan, spreadsheet surface water models were used to estimate physically available water supply. The physically available supply is that which is available over and above existing uses, and is different than legal availability. For each Green River sub-basin, availability estimates were developed for three hydrologic conditions: dry, normal, and wet year water supply. The estimates are presented in Figure ES-3.

GROUNDWATER

The availability of groundwater at a given location requires site-specific hydrogeologic analysis; so only a gross estimate of basin-wide groundwater availability was prepared as part of this Plan. Groundwater aquifer discharge to surface water bodies from the Tertiary Aquifer system (the most-used aquifer system in the Green River Basin) is estimated to be 118,000 acre-feet/year. The total estimated quantity of groundwater contained in the Tertiary aquifer system is approximately 1 to 2 billion acre-feet of water as presented in the 2009 *Available Groundwater Determination Report* published in 2008 by the Wyoming State Geological Survey.



8.0 STRATEGIES & RECOMMENDATIONS

The Basin's water users face challenges concerning water use and the challenges go well beyond the need for locating and using more water. Users are faced with challenges related to water quality, infrastructure maintenance, water supply reliability, climate variation, funding, and many others. In addition, the span of water issues and challenges is broad, from relatively small specific problems affecting one particular community to widespread issues potentially impacting users across and even out of the Basin.

The 2010 Plan includes an extensive outline of both broad strategies and specific recommendations for addressing water issues, and they are not presented in this executive summary.