

Northeast Wyoming River Basins Plan Executive Summary



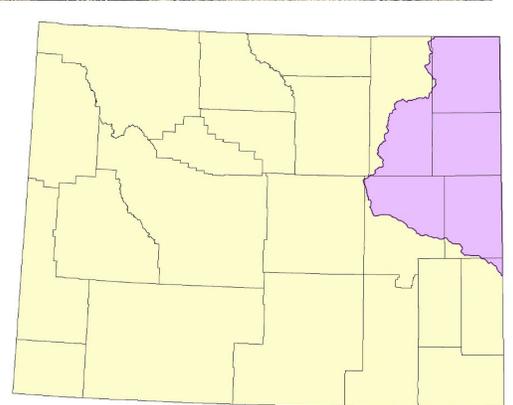
Prepared for:

**Wyoming Water Development Commission
Basin Planning Program**



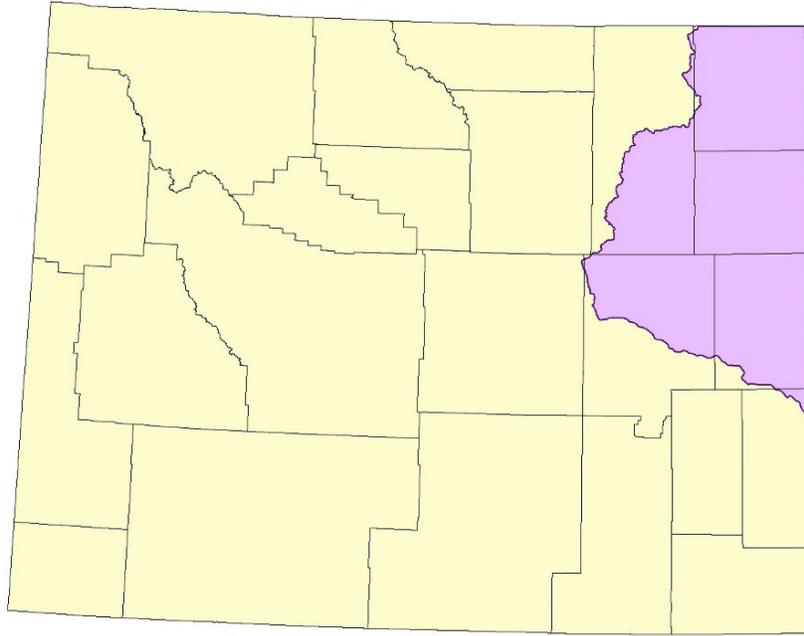
Prepared by:

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Project Scope

The *Northeast Wyoming River Basins Plan* document is one of four River Basin Plans thus far completed by the Wyoming Water Development Commission as authorized by the Wyoming Legislature in 1999. The plans for the Bear River Basin and Green River Basin were completed in 2001, and the plan for the Powder/Tongue River Basin is being completed concurrently with the Northeast Wyoming River Basins Plan. The Wind/Big Horn River Basin and the Snake/Salt River Basin plans were initiated in 2002 and the plan for the North Platte River will commence in the near future. It is the express desire of the program to revisit and update the basin planning documents every five years.

This planning document presents current and projected future uses of water in Wyoming's Northeast Wyoming River Basins. Uses inventoried and analyzed in this plan include agricultural, municipal, industrial, environmental, and recreational. Surface and ground water uses are both described, as is overall water quality. Given current uses, the availability of surface water and ground water to meet estimated future requirements is analyzed. The current institutional and legal framework of water development and management is presented.

The primary products of this planning study are technical memoranda prepared for the large number of topics addressed in the plan. These memoranda provide detailed descriptions of the data collected, source references, analyses performed, tools developed, and the results of each investigation required to fully explore the water resources within the planning area. The intent of this Executive Summary, and the associated Final Report, is to describe the planning study in sufficient detail for the reader to gain a general understanding of the investigations that were performed and the results of those investigations. For detailed information on a specific topic the reader is directed to the technical memorandum prepared for that topic.

Basin Description

The study area of the Northeast Wyoming River Basins Plan includes the drainages of the Little Missouri River, Belle Fourche River, Cheyenne River, and Niobrara River. These river basins encompass all or part of Campbell, Crook, Weston, Converse, and Niobrara counties as well as minor parts of Natrona and Goshen counties in northeast Wyoming. The planning area is shown on Figure 1.

Climate throughout the Basin varies, but generally follows the pattern of a high desert region. Annual precipitation in the range of 13 to 15 inches is the norm for the majority of the planning area.

The major rivers and streams in the study area include the following:

- Little Missouri River Basin – Little Missouri River
- Belle Fourche River Basin – Belle Fourche River, Redwater Creek, Beaver Creek, Blacktail Creek, Lytle Creek, Miller Creek, Inyan Kara Creek, Donkey Creek, and Arch Creek
- Cheyenne River Basin – Cheyenne River, Antelope Creek, Lightning Creek, Lance Creek, Beaver Creek, and Stockade Beaver Creek
- Niobrara River Basin – Niobrara River

The largest storage facility developed in the Northeast Wyoming Planning area is Keyhole Reservoir on the Belle Fourche River. Other reservoirs having significant capacity include Gillette Reservoir on Donkey Creek, Betty No. 1 Reservoir on Antelope Creek, Spencer Reservoir on Stockade Beaver Creek, Klodt Reservoir on Mush Creek, and Tract 37 Reservoir on the North Fork of the Little Missouri River.

Water Law and Interstate Compacts

The Wyoming constitution establishes water in the state to be the property of the state. Consequently, all development and management of water resources in Wyoming is governed by the water laws embodied in the Constitution and Statutes. These water laws are recognized as inviolate in the river basin planning program.

Interstate compacts controlling the development and use of water in the study area include the Belle Fourche River Compact of 1943 and the Upper Niobrara River Compact of 1962. Compacts have also been developed for the Cheyenne River and the Little Missouri River, but these agreements have yet to be fully ratified.

The Belle Fourche River Compact of 1943 divides the water between Wyoming and South Dakota. The compact recognizes all rights in Wyoming existing as of the date of the compact, and permits Wyoming unlimited use for stock water reservoirs not exceeding twenty acre-feet in capacity. Wyoming is allowed to deplete the flow of the Belle Fourche River under the conditions existing as of the date of the Compact by an additional 10%. No reservoir constructed subsequent to the date of the compact solely to utilize the water allocated to Wyoming shall have a capacity greater than 1,000 acre-feet.

The Upper Niobrara River Compact of 1962 between Wyoming and Nebraska provides that stock water reservoirs not larger than twenty acre-feet capacity in Wyoming shall not be restricted. No restrictions are placed on diversion or storage of water in Wyoming except on the main stem of the Niobrara River east of Range 62 West and on Van Tassel Creek south of Section 27, Township 32 North, Range 60 West. In this area direct diversions are regulated on an interstate priority basis with lands in Nebraska west of Range 55 West, and storage reservoirs with priority dates prior to August 1, 1957, may store water only during the period of October 1 to June 1, while storage reservoirs with priority dates after August 1, 1957, may store a maximum of 500 acre-feet in any water year with dates of storage limited to the period of

October 1 to May 1. Ground water development is recognized to be a significant factor and the compact provides for investigation of this resource and possible apportionment at a later date.

Agricultural Water Use

Irrigated agriculture in the planning area is primarily associated with forage production for the livestock industry. Ranchers depend on irrigated cropland to provide winter feed and summer grazing for their stock. Alfalfa, grass hay, and pasture grass are the dominant crops grown in the planning area. Lesser amounts of small grains and corn are also produced. In total, 77,350 acres of land are actively irrigated in the planning area. Of this total, 13,036 acres are served from ground water and the remainder is served from surface water supplies.

The depletion of water by irrigation is primarily dependent on the number of acres irrigated, the crop water demands, and the amount of water available to meet these demands. Surface water depletions for wet, normal, and dry years total 71,000 acre-feet, 69,000 acre-feet, and 65,000 acre-feet respectively. Ground water depletions for wet, normal, and dry years total 17,000 acre-feet, 17,000 acre-feet, and 11,000 acre-feet respectively.

Municipal and Domestic Water Use

There are thirty-three public water supply entities in the planning area, consisting of incorporated municipalities, districts, and privately owned water systems. These entities consume approximately 9,100 acre-feet of ground water per year. Domestic use is also satisfied by ground water and is on the order of 2,100 to 3,600 acre-feet per year.

Industrial Water Use

Industrial water use in the Northeast Wyoming River Basins consists of conventional oil and gas production, coalbed methane development, electric power generation, coal mining, and oil refining. These uses deplete approximately 50,700 acre-feet of ground water per year.

Recreational Water Use

Recreational uses associated with the water resources of the Northeast Wyoming River Basins include boating, fishing, and waterfowl hunting. Although these uses are generally non-consumptive, water-based recreation is enhanced through minimum flow releases from reservoirs, minimum pool levels maintained in reservoirs, and instream flow water rights established on streams. Keyhole Reservoir, the largest standing water recreation attraction in the Northeast Wyoming River Basins, supports skiing, fishing, swimming, boating, and camping.

Environmental Water Use

Environmental uses of water in the Northeast Wyoming River Basins are largely non-consumptive. Environmental use topics addressed in this planning study include water administration (minimum flow releases, minimum pool maintenance, and instream flow water rights), environmental concerns associated with water produced by coal bed methane development, and wetland mapping. Concerns expressed by environmental organizations are also presented in the basin plan.

Reservoir Evaporation

The majority of water use from storage reservoirs within the Northeast Wyoming River Basins is for irrigation. Evaporation from these storage reservoirs constitutes another consumptive use of water within the planning area. Evaporation from the 6 key storage facilities (generally larger than 1,000 acre-feet) totals 14,400 acre-feet annually.

Evaporation from stock ponds is considered to be a relatively minor contributor to total water consumption in most river basins in the State. However, given the relative scarcity of surface water in the planning area, together with the large number of stock ponds that exist, the accumulative evaporation loss from these ponds is relatively significant. The total annual evaporation loss from stock ponds is 6,300 acre-feet from 16,600 stock ponds.

Current Water Use Summary

The current water uses in the planning area are summarized as follows:

Water Use		Dry		Normal		Wet	
		(AF/Year)					
		Surface Water	Ground Water	Surface Water	Ground Water	Surface Water	Ground Water
Agricultural		65,000	11,000	69,000	17,000	71,000	17,000
Municipal		---	9,100	---	9,100	---	9,100
Domestic		---	3,600	---	3,600	---	3,600
Industrial	Oil & Gas ¹	---	46,000	---	46,000	---	46,000
	Other ²	---	4,700	---	4,700	---	4,700
Recreation		Non-consumptive					
Environmental		Non-consumptive					
Evaporation	Key Reservoirs	14,000	---	14,000	---	14,000	---
	Stock Ponds	6,300	---	6,300	---	6,300	---
TOTAL		85,300	74,400	89,300	80,400	91,300	80,400

Notes: 1. Includes conventional oil and gas and CBM production water.

2. Includes electricity generation, coal mining, and oil refining.

Available Surface Water

The determination of available surface water was broken down into the following seven tasks for this study:

1. Compilation of Historic Streamflow Records
2. Selection of an appropriate Study Period
3. Extension of Records to represent the entire study period
4. Estimating Natural Flow at Ungaged Model Nodes
5. Determining Streamflows during Wet, Normal, and Dry years
6. Development and Calibration of Spreadsheet Models
7. Determination of Available Surface Water

Records from 34 USGS and SEO streamflow gages were compiled and then extended where records were missing, to provide estimates of streamflow for each month, of each year during the 1970 to 1999 study period. These recorded and estimated streamflows were used to determine the amount of streamflow at additional ungaged locations needed for the water availability models. The annual streamflows were ranked and the years were divided into three hydrologic conditions (dry years, normal years, and wet years). The average flows for each of these three conditions are primary inputs to the models.

Water availability spreadsheet models were developed for the following four sub-basins within the Northeast Wyoming River Basins planning area:

- Belle Fourche River sub-basin
- Redwater Creek sub-basin
- Beaver Creek sub-basin
- Cheyenne River sub-basin

Three models were developed for each sub-basin to represent each of the three hydrologic conditions. The models each represent one calendar year of flows, on a monthly time step. Streamflow, estimated actual diversions, full supply diversions, irrigation returns, and reservoir storage conditions are the basic input data to the models. For all of these data, average values drawn from the dry, normal, or wet years of the study period were computed for use in the spreadsheets.

The models do not explicitly account for water rights nor are the models operated based on these legal constraints. Further, the models do not associate supplemental reservoir releases to the specific water users. However, by calibrating the models to historical streamflows at gaged locations, the models can be used to generally represent existing operations. Model inputs can then be modified to estimate the impacts associated with potential future water projects.

The total annual flow, physically available in excess of current Wyoming water demands, is summarized as follows:

Subbasin	Hydrologic Condition		
	Wet Years	Normal Years	Dry Years
Redwater Creek	34,000	26,000	17,000
Beaver Creek	30,000	20,000	14,000
Cheyenne River	103,000	31,000	5,000
Belle Fourche River	151,000	71,000	13,000

The Belle Fourche Compact of 1943 allocates 10% of the unappropriated waters, as of the date of the compact, in the Belle Fourche River to the State of Wyoming, with the remaining 90% being allocated to South Dakota.

Wyoming’s apportionment of the Belle Fourche River under the three hydrologic conditions (wet, normal, and dry years) is summarized as follows:

Hydrologic Condition	Average Annual Apportionment (AF)		
	Belle Fourche River	Redwater Creek	Total
Wet Years	15,600	3,300	18,900
Normal Years	7,400	2,400	9,800
Dry Years	1,100	1,400	2,500

Available Ground Water

The objectives of this element of the study were as follows:

1. Inventory and catalog the Wyoming State Engineer's Office (SEO) ground water permit database for various categories of ground water uses in the planning area, and incorporate the information into GIS data themes.
2. Inventory and document existing published data on ground water studies and ground water planning documents for the planning area.
3. Summarize existing information on aquifers with regards to location, storage, yield and development potential within the planning area.
4. Summarize the potential effects that ground water development might have on the ground water and surface water systems in the basins within the planning area.
5. Characterize coalbed methane development and its short and long-term effects on ground water and surface water supplies within the river basins of the planning area.

The information developed through this study provides a starting point for site specific ground water investigations.

The significance of ground water in the planning area is demonstrated by the 15,793 active ground water permits (as of December 31, 2000) within the planning area. Because of the dynamic nature of coalbed methane (CBM) development, the inventory of permitted CBM wells was updated to reflect data as of December 31, 2001. The number of permits for each use category are summarized below:

- 308 Permitted active agricultural wells with production rates greater than 49 gpm
- 76 Permitted active municipal wells with production rates greater than 49 gpm
- 608 Permitted active industrial and miscellaneous wells with production rates greater than 49 gpm
- 2,760 Active permitted domestic wells
- 6,756 Active permitted stock wells
- 5,285 Permitted coalbed methane wells (6,657 by December 31,2001)

The six major aquifer systems within the planning area are (oldest to youngest): 1) Madison Aquifer System; 2) Dakota Aquifer System; 3) Fox Hills/Lance Aquifer System; 4) Fort Union/Wasatch Aquifer System; 5) Tertiary Aquifer System; and 6) Quaternary Alluvial Aquifer System.

General conclusions regarding ground water development potential of four of these five major aquifer systems are summarized below:

- The Madison Aquifer System may have the most development potential for high yield wells on a sustained basis. Drilling depths and water quality may constrain development at specific locations within the planning area.
- The Fox Hills/Lance Aquifer System may have local potential for development of wells with low to moderate yields. The possible high fluoride content in water from this system might influence the desirability of use for a municipal/public supply without provision for treatment or special management.
- The Fort Union/Wasatch Aquifer System is utilized for most uses in the planning area. The Wyodak-Anderson coal and hydraulically interconnected aquifers of the Aquifer System will be heavily impacted by ground water withdrawals in and near coalbed methane development. The water co-produced with coalbed methane may provide an opportunity for utilization, depending on location, quality and nature of potential use.
- Aquifers in the Quaternary Alluvial Aquifer System may have local development potential if induced infiltration of surface water can be tolerated.

Out of total of 15,793 active ground water permits inventoried in December 31, 2000 for the Basin Plan, 10,508 of the permits were for WWDC categories other than coalbed methane development (agricultural, municipal, industrial, domestic and stock). Possible impacts of further development for these uses could include:

- Depletion of surface water that is interconnected with aquifer systems. The principal aquifer systems of concern with respect to this impact include the Madison and the Quaternary Alluvial Aquifer Systems.
- Interference problems between wells and / or aquifer depletion problems related to domestic and stock well densities.
- Aquifer depletion where aquifers are used for secondary oil and gas recovery operations.
- Water quality impacts due to oil and gas drilling and recovery operations and leakage through inadequate or failed plugging of production wells.

A total of 6,657 permitted coalbed methane wells (December 31, 2001) were identified. Possible impacts of coalbed methane development include:

- The dewatering of aquifers and the lowering of water levels and yields in production wells located in the vicinity of coalbed methane development.
- Methane seepage into wells and structures in the proximity of coalbed methane development that could pose a health and safety hazard to residents.
- Increased infiltration of water from coalbed methane production into shallow alluvial ground water systems that could aggravate subsurface structure problems.
- Increased infiltration of water from coalbed methane production into shallow ground water systems that could impact the quality and use of ground water from shallow systems.
- Impacts to surface coal mining operations.

Possible surface water related impacts that have been identified could include:

- Change in drainage characteristics from ephemeral to perennial. This could result in an increase in the erosion potential and sedimentation problems in receiving drainages.
- Increased flooding potential in receiving drainages. Higher flows could also impede landowner access associated with their operations.
- Alteration of the chemical characteristics of receiving surface waters due to coalbed methane generated water. This could include a change due to increased salinity and sodium content that could impact irrigation practices and the utilization of surface water for irrigation.

Irrigation Use Projections

To assess future water needs in the Northeast Wyoming River Basins, projections of future water demands were developed for major water use categories through the year 2030. The projected consumptive water use was determined for low, moderate, and high growth scenarios.

Future irrigation water use depends upon factors such as crop and livestock prices, the cost of developing new water storage and delivery systems, and compact limitations. The low growth scenario projects no significant changes in those factors, and thus no future increase in surface irrigation water use. The moderate and high growth scenarios project moderate increases in surface irrigation water use based upon projected increases in crop and livestock prices and the possibility of increased state assistance for developing new irrigation water supplies.

Consumptive use of surface water could rise from a current level of 69,500 acre-feet annually to as much as 75,700 acre-feet by the year 2030. Groundwater irrigation depletions, which currently total 16,900 acre-feet of water annually, could rise to as much as 20,800 acre-feet by that date.

Municipal and Domestic Use Projections

Municipal and domestic water needs in Northeast Wyoming are satisfied by groundwater. Future demands for municipal and domestic water are closely tied to the future population levels in the planning area. Three population-forecasting methods were used to develop low, moderate, and high growth population projections for communities and rural areas through the year 2030. Based upon these projections, municipal and domestic water use is expected to grow from a current level of 12,700 acre-feet annually to 14,600 acre-feet annually by 2030 for the low growth scenario. For the moderate and high growth scenarios, the increases are to 16,100 and 18,200 acre-feet respectively. The high growth scenario projection corresponds to a 43 percent increase in water use over the planning horizon.

Industrial Use Projections

There are no large industrial users of surface water in the planning area. Industries such as electric power production, oil and gas development, and mining use all make use of groundwater. Industrial usage of groundwater is expected to increase significantly in the future with the construction of additional coal-fired electric generating facilities, as well as coal-conversion facilities designed to produce synthetic fuels and/or increase the heat content of coal. For the low growth scenario, such developments are expected to increase the industrial use of groundwater from a current level of 900 acre-feet annually to 3,700 acre-feet by 2030. For the moderate and high growth scenarios, industrial water demand is expected to increase to between 9,100 and 17,300 acre-feet annually by 2030.

Recreation Use Projections

Fishing is the predominant water-based recreational activity in Northeast Wyoming, and anglers currently engage in approximately 65,000 activity days of fishing each year. Projections developed for this study indicate fishing demand is expected to increase to between 81,000 and 121,000 activity days annually by the year 2030. Northeast Wyoming has limited stream fishery resources and only one large reservoir, Keyhole, to supply recreational opportunities. These limited resources will come under increasing pressure in the future as recreational demand increases as a result of population growth and increases in tourism.

Environmental Use Projections

Environmental water requirements are not directly related to changes in population or tourism, but instead reflect human desires concerning the type of environment in which people want to live. These desires are reflected in environmental programs and regulations promulgated by elected representatives at the local, state and federal levels. Examples include Wyoming’s instream flow statues and minimum reservoir pools dedicated to fish and wildlife enhancement. While generally non-consumptive, environmental needs can conflict with consumptive water demands in some situations. Northeast Wyoming has only limited water resources to meet both consumptive and non-consumptive water demands.

Compact Considerations

Wyoming’s use of surface waters from the Belle Fourche River is subject to limitation by interstate compact. This limitation constrains Wyoming’s ability to develop additional surface water resources to meet future needs in Northeast Wyoming.

Demand Projections Summary

The projected consumptive use of surface water and ground water, for the low, moderate, and high growth scenarios in the following two tables.

Summary of Current and Projected Surface Water and Ground Water Uses

Use	Current		Projected Use by Growth Scenario (Acre-feet/Yr.)					
			Low		Moderate		High	
	Surface Water	Ground Water	Surface Water	Ground Water	Surface Water	Ground Water	Surface Water	Ground Water
Municipal/Domestic	0	12,700	0	14,600	0	16,100	0	18,200
Industrial ¹	negligible	900	negligible	3,700	negligible	9,100	negligible	17,300
Irrigation	69,500	16,900	69,500	16,900	72,800	18,900	75,700	20,800
Evaporation	23,500		23,500		23,500		23,500	
Recreational	(non-consumptive)							
Environmental	(not estimated)							
Total	93,000	30,500	93,000	35,200	96,300	44,100	99,200	56,300

Note 1: Excludes oil, gas, and mining uses.

Future Water Use Opportunities

This river basin plan quantifies water resources available for development and use and identifies current and projected future water needs in the Northeast Wyoming River Basins. The concluding task of this study is to identify future water use opportunities that can be implemented to satisfy the water demands in the Little Missouri River, Belle Fourche River, Cheyenne River, and Niobrara River Basins in Wyoming. The list of potential water use opportunities provided is intended to assist individuals and organizations in finding ways to meet their specific needs.

To further assist the users of this list in identifying potential opportunities to satisfy their demands, a methodology is presented that can be employed to evaluate a specific opportunity on the list relative to similar and related opportunities. The suggested methodology evaluates opportunities according to the likelihood they are desirable, functional, and capable of receiving the support required for development. By using the list of future water use opportunities and employing the evaluation methodology, individuals and organizations will have “a place to start” in their investigation.

The procedure used to complete this task consisted of four steps:

1. Develop screening criteria to evaluate future water use opportunities – the six screening criteria are: 1) water availability; 2) financial feasibility; 3) number of sponsors, beneficiaries, and participants; 4) public acceptance; 5) legal and institutional concerns; and, 6) environmental and recreational benefits.
2. Develop a long-list of future water use opportunities – this list was compiled from published reports and information provided by the members of the Basin Advisory Group (BAG).
3. Develop a short-list of opportunities – projects and opportunities on the long-list were screened to eliminate projects considered to have little likelihood of development.
4. Evaluate the opportunities on the short-list – the projects advancing to the short-list were categorized by location and type, then evaluated using the criteria developed in Step 1 of the process.

Legal and institutional constraints that need to be addressed in water management and development were identified and described in the planning study.

The success of a water development project is also dependent on the ability of the source to meet the water quality needs of the proposed uses. In addition, the project itself must protect existing and potential uses of waters of the State. As a part of this river basin planning process a description of the water quality character of the Northeast Wyoming River Basins was developed. The plan also describes contemporary water quality programs initiated to protect and enhance the quality of surface water in the planning area. Finally, the primary issues related to the quality of water in the planning area are detailed in industrial, agricultural, and municipal categories.