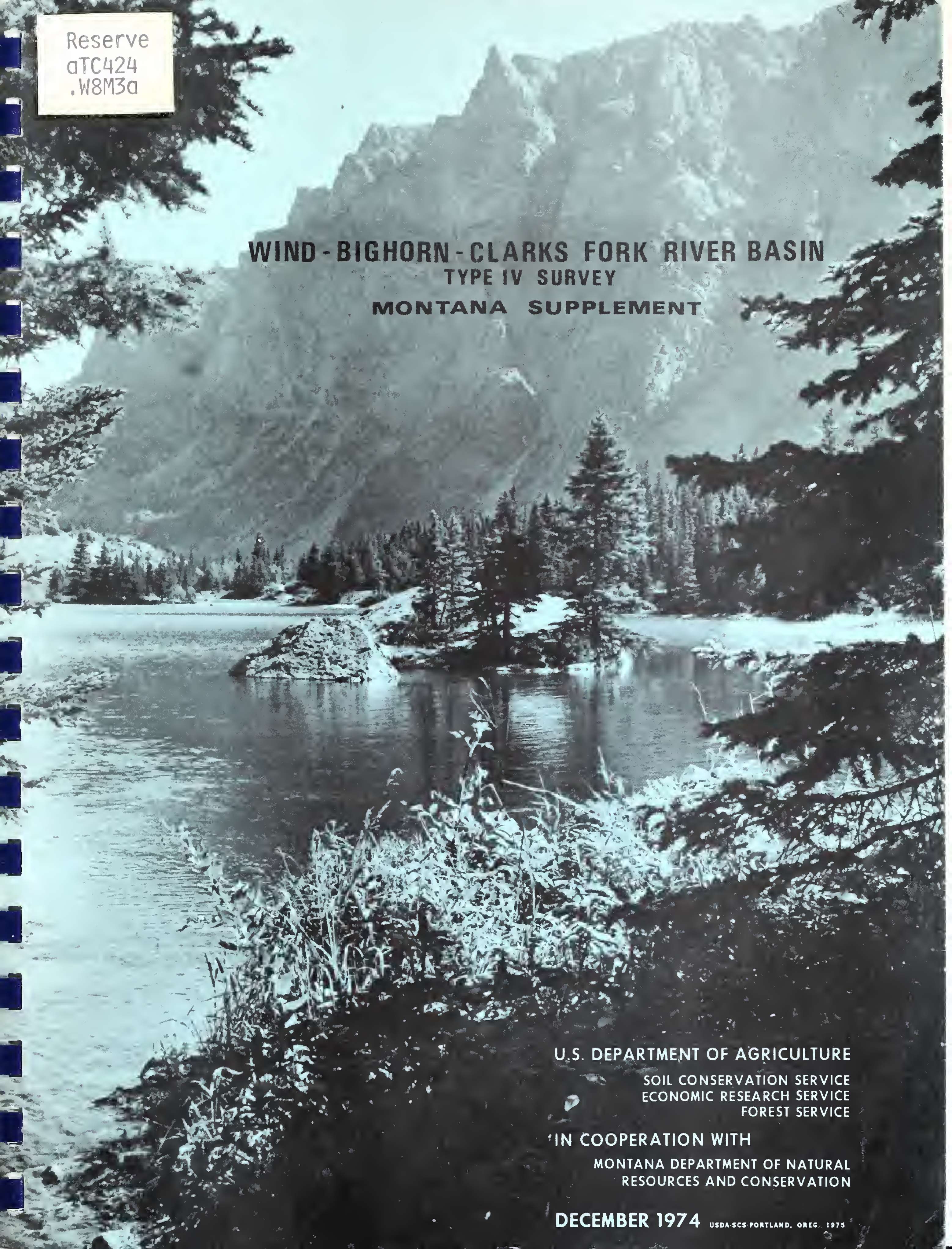


WIND-BIGHORN-CLARKS FORK RIVER BASIN
TYPE IV SURVEY
MONTANA SUPPLEMENT

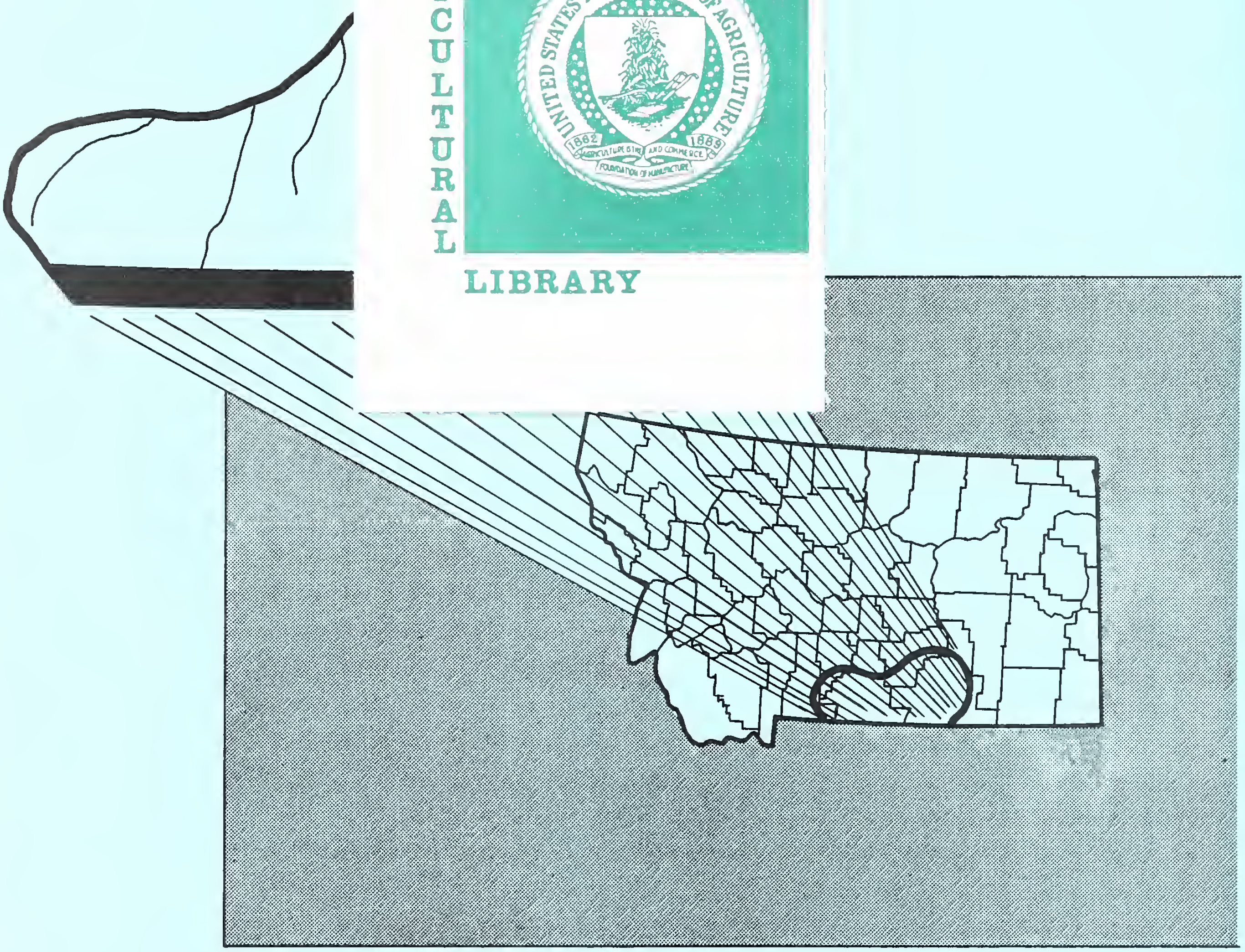
U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE

IN COOPERATION WITH

MONTANA DEPARTMENT OF NATURAL
RESOURCES AND CONSERVATION

DECEMBER 1974 USDA-SCS-PORTLAND, OREG. 1975



Cover Photo: Elk Lake at the head of East Rosebud Creek in the Beartooth Primitive Area.
USDA-FOREST SERVICE PHOTO

ADDENDUM

WIND-BIGHORN-CLARKS FORK RIVER BASIN
TYPE IV STUDY REPORTS

In accordance with Advisory RB-3 of February 4, 1974, and WTSC Advisory RB-PO-2 which refers to the Water Resource Development Act of 1973, the following statement is submitted:

> Potential projects described in this report have been evaluated at 5-5/8 percent discount rate.

The Wyoming Supplement Interim Report for this study was submitted to the Washington Advisory Committee in March 1973 and constituted a "draft report transmitted to WAC for review."

MONTANA SUPPLEMENT

to the

WIND-BIGHORN-CLARKS FORK RIVER BASIN REPORT

USDA WATER AND RELATED LAND RESOURCES REPORT

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

in cooperation with

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

DECEMBER 1974

Bozeman, Montana

Under Direction of

USDA FIELD ADVISORY COMMITTEE

WIND-BIGHORN-CLARKS FORK RIVER BASIN
MONTANA SUPPLEMENT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA MAPS, FIGURES, AND TABLES

FIGURES

TABLES

I. INTRODUCTION

This report presents data on water and related land resources in the Montana portion of the Wind-Bighorn-Clarks Fork River Basin (hereafter referred to as Basin). Basin area includes the Bighorn and Clarks Fork River drainages and all of the south-bank drainages of the Yellowstone River from and including the Little Bighorn and Tullock Creek on the east through the Stillwater River on the west. Most of the water inventoried in this study enters Montana from Wyoming in the Bighorn and Clarks Fork Rivers. Total area in the overall Basin is 18,167,993 acres, including 13,179,045 acres in Wyoming and 4,988,948 acres in Montana. The Basin area in Montana includes all of Carbon County, most of Big Horn County, and parts of Stillwater, Yellowstone, Sweet Grass, Park, and Treasure Counties.

The purpose of this study is to outline a coordinated and orderly program for the conservation, development, utilization, and management of the water and related land resources of the Basin. Data presented here will be helpful in administration of the Yellowstone River Compact, development of the Montana State Water Plan, and assisting state and local agencies in developing optimum use of the Basin's natural resources. The report provides the U. S. Department of Agriculture with information it needs for resource development under various on-going programs and will be useful toward implementation of new USDA programs. Data for multiple use planning and resource management are included on outdoor recreation, conservation district programs, Conservation Operations, Great Plains Conservation, Watershed Investigation and Planning, general and detailed installation services for structural conservation measures, land treatment under Agricultural Stabilization and Conservation Service programs, Resource Conservation and Development project measures, National Forest management programs, state-federal forestry programs, and rural electrification projects.

Participation of the U. S. Department of Agriculture was authorized under provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566), 83d Congress, as amended and supplemented. This Act authorizes the Department to cooperate with other federal, state, and local agencies in making investigations and surveys of watersheds and rivers as a basis for development of coordinated programs. Participation of the Montana Department of Natural Resources and Conservation is authorized under Title 89, chapters 1 and 35, Revised Codes of Montana, 1947.

Data were developed by field technicians of the Forest Service, Economic Research Service, and Soil Conservation Service, with additional data interpreted from secondary sources. Particular emphasis was placed on field investigation of potential PL-566 projects and multiple use development opportunities. In addition, acknowledgement is given for data provided by other agencies. At the local level, individuals and officials of counties, municipalities, conservation districts, irrigation companies, and newspapers also provided assistance. State agencies included Montana Department of Natural Resources and Conservation as sponsor, Fish and Game Department, Department of Health and Environmental Sciences, Department of State Lands, Division of Planning and Economic Development, and Bureau of Mines and Geology. Other USDA agencies included Agricultural Stabilization and Conservation Service, Montana Cooperative Extension Service, Farmers Home Administration, Statistical Reporting Service, and Rural Electrification Administration. U. S. Department of the Interior agencies included Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, Geological Survey, U. S. Fish and Wildlife Service, and National Park Service. Other federal agencies supplying data included the Department of Commerce and Bureau of Public Roads.

II. NATURAL RESOURCES OF THE BASIN

LOCATION AND SIZE

The Wind-Bighorn-Clarks Fork River Basin lies in northcentral Wyoming and southcentral Montana. The Montana portion is just northeast of Yellowstone Park and contains all Carbon County, 72 percent Big Horn County, 40 percent Stillwater County, 39 percent Yellowstone County, 7 percent Sweet Grass County, 4 percent Park County, and 13 percent Treasure County. See map II-1. The Basin area in Montana approximates 7,795 square miles. See table II-1 and table II-2.

CLIMATE

The Basin climate in Montana varies from humid alpine above 12,000 feet in elevation with over 70 inches annual precipitation to arid around 4,000 feet near Belfry, Montana, with less than six inches annual precipitation. As a result, Basin vegetation varies from alpine tundra through conifer forests to desert shrub. A more comprehensive orientation is shown on map II-2. Growing seasons are more closely related to elevation than to latitude. Based on 28-degree minimum temperature, the mean growing season at Red Lodge is 134 days at an elevation of 5,762 feet compared with 154 days at Bridger at an elevation of 3,720 feet, and 163 days near Billings.

Daily average temperatures during the June-September recreational period range from 54°F. to 81°F. at Billings with a long-term average of 63°F. October-November hunting season temperatures vary from 24° to 54° with an average of 43°. At Red Lodge the June-September range is 42° to 71° with an average of 59°. October-November range is 21° to 51° with an average of 39°. December-January temperatures range from 2° to 36° with an average of 24° during the skiing season. Summer days at lower elevations are often hot, yet nights cool off to the extent that blankets are needed for sleeping. Big game season daytime temperatures in the shade are cool enough to keep the meat from spoiling and cold enough at night to require heated tents or campers. At the upper elevations, frost and snow can occur any night of the year.

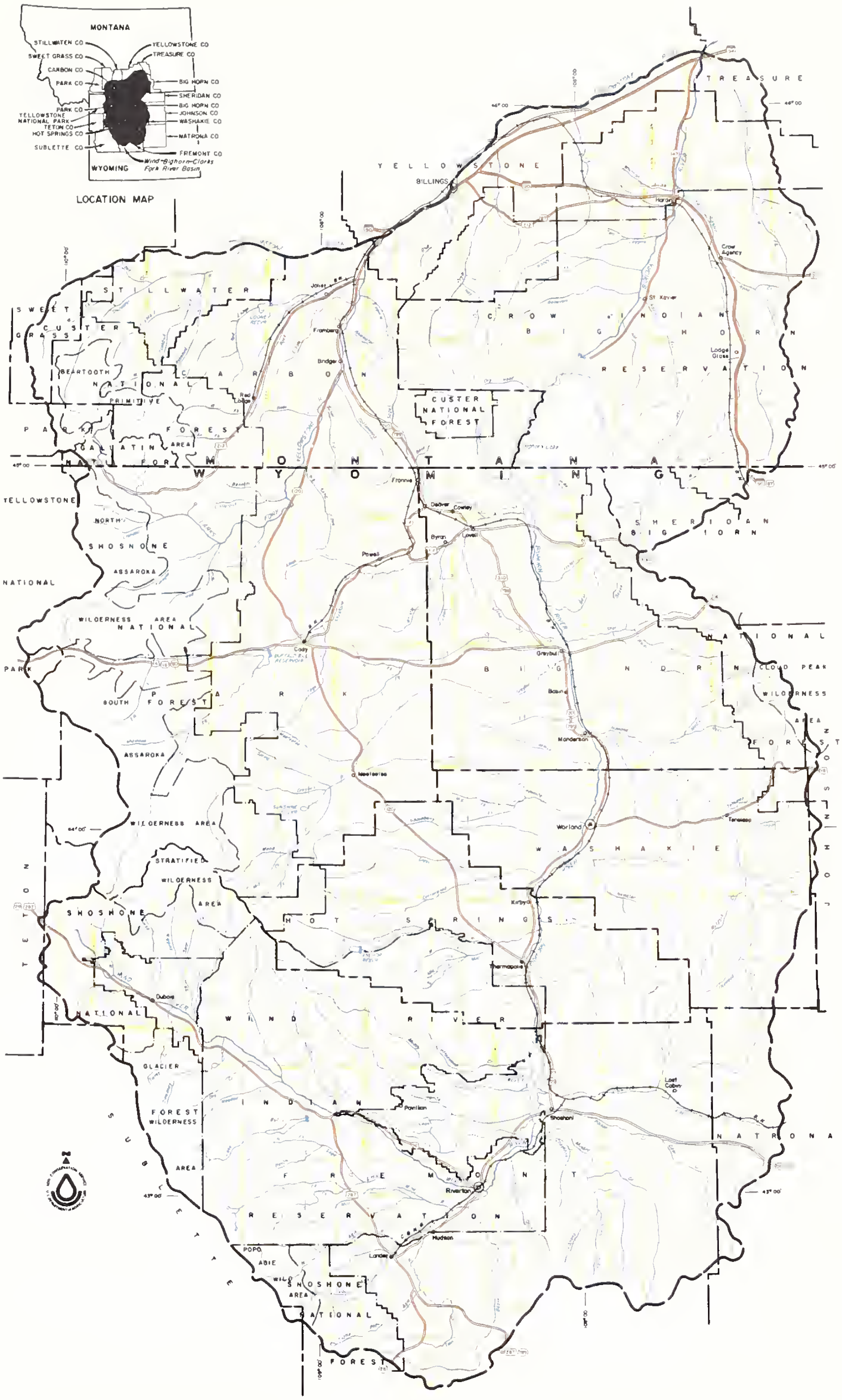
PHYSIOGRAPHY AND GEOLOGY

Topographic features of the Basin have an extreme range from the flat valley bottoms of the Bighorn and Clarks Fork Rivers with around 3,000 feet elevation to the high mountainous plateaus and craggy peaks of the Beartooth and Absaroka Mountains with elevations up to 12,799 feet. The Pryor Mountains, with less spectacular yet scenic peaks of up to 8,786 feet elevation, separate the two principal rivers. Along the southeast end of the Pryors lies the deeply incised Bighorn Canyon which now holds the waters of Bighorn Lake. This magnificent canyon was relatively inaccessible before the construction of Yellowtail Dam.

TABLE II-1--SURFACE OWNERSHIP AND ADMINISTRATION BY COUNTY 1/
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County & Unit	County Total	Indian Trust Lands	Other Private	State Fish & Game	Other State	National Forest	Bureau of Land Manage-ment	Bureau of Reclama-tion	Other Federal Agencies	Percent of County in Basin
Big Horn										
Acres	2,325,740	1,330,639	937,572	316	45,632	---	---	10,921	660	
Percent	100	57.2	40.3	---	2.0			0.5	---	72
Carbon										
Acres	1,324,800	---	721,410	340	44,081	330,578	205,218	---	23,173	
Percent	100		54.4	---	3.3	25.0	15.5		1.7	100
Park										
Acres	69,050	---	3,635	---	---	65,415	---	---	---	
Percent	100		5.3			94.7				4
Stillwater										
Acres	462,024	---	259,722	515	7,443	188,544	5,800	---	---	
Percent	100		56.2	0.1	1.6	40.8	1.3			40
Sweet Grass										
Acres	77,049	---	2,079	---	320	74,650	---	---	---	
Percent	100		2.7		0.4	96.9				7
Treasure										
Acres	79,312	---	75,792	---	3,520	---	---	---	---	
Percent	100		95.6		4.4					13
Yellowstone										
Acres	650,973	134,163	491,314	---	21,481	---	4,015	---	---	
Percent	100	20.6	75.5		3.3		0.6			39
TOTALS										
Acres	4,988,948	1,464,802	2,491,524	1,171	122,477	659,187	215,033	10,921	23,833	XXX
Percent	100	29.6	49.9	---	2.4	13.2	4.3	0.2	0.4	XXX

1/ Includes Water Area.



MAP II-1

PROJECT MAP

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

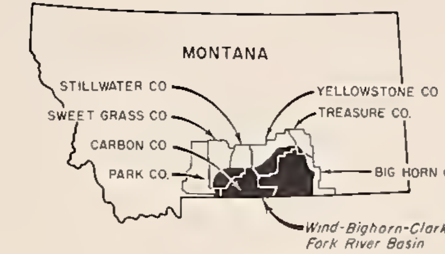
USDA-SCS-PORTLAND, OREG. 1973

M7-0-22915-L

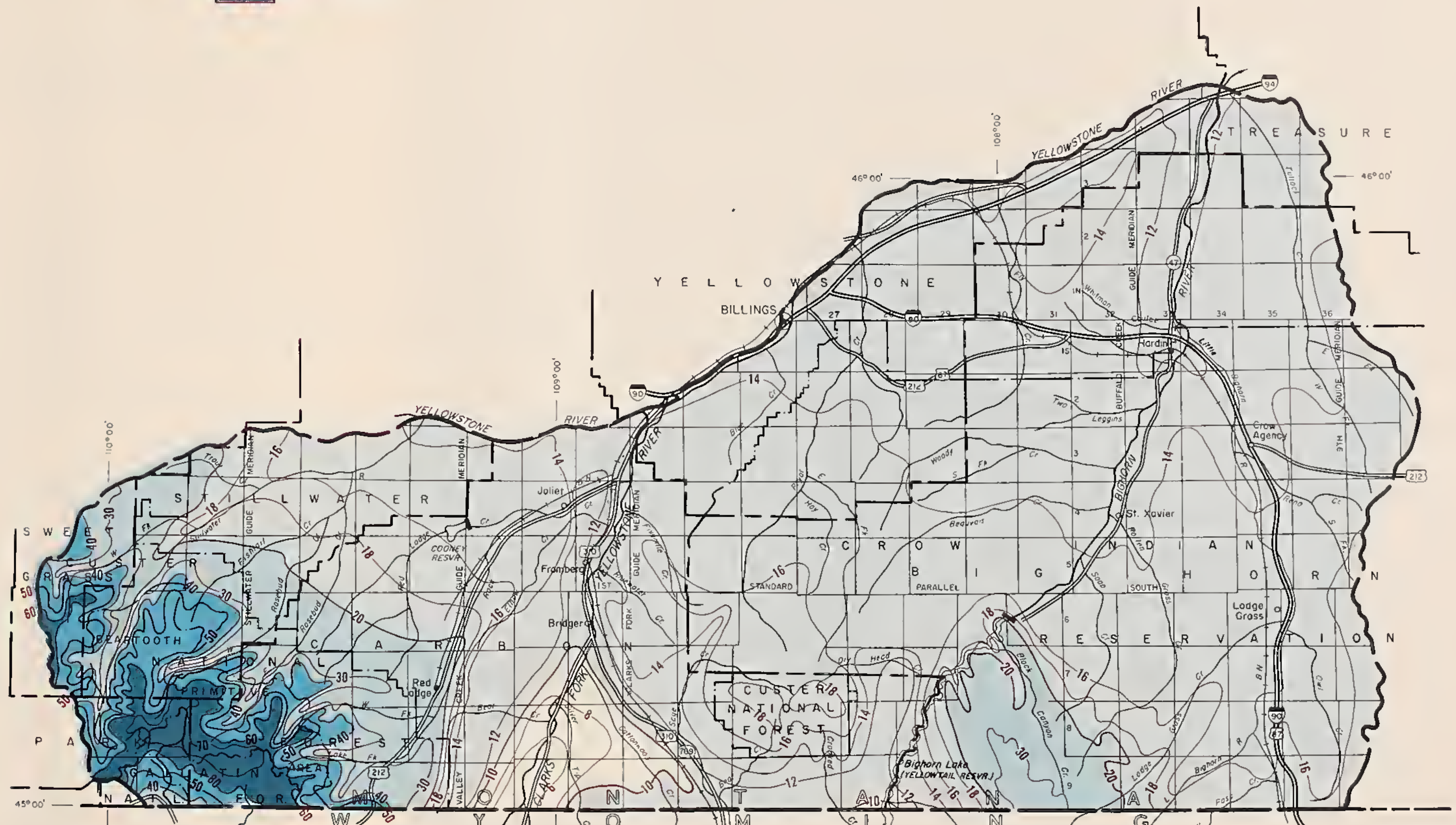
LEGEND

Average Annual Precipitation

- 0 to 10 inches
- 10 to 20 inches
- 20 to 40 inches
- 40 to 60 inches
- Over 60 inches



LOCATION MAP



MAP II-2

AVERAGE ANNUAL PRECIPITATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914A-N

Many more miles of the Canyon's sandstone and limestone cliffs can now be viewed from the comfort of a boat.

The rugged high elevation plateaus southwest of Red Lodge are above timberline and consist of rocky peaks, alpine meadows, and

TABLE II-2--AREAS OF RIVER BASIN BY SUBBASIN
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Subbasin	Area (acres)
Stillwater	676,681
Yellowstone Minor Drainages	935,209
Clarks Fork	976,328
Big Horn	1,763,009
Little Bighorn	637,721
Montana TOTAL	4,988,948

Source: River Basin Planning Staff

basins carved by recent glaciers. Most of the scenic wild beauty of this high country's lakes and remnant glaciers is accessible only by trails. Much of the roadless area has been designated as Primitive Area and is under study by the Forest Service for Wilderness classification. The car-bound tourist is afforded a partial glimpse of this "Big Sky" wonderland as he travels the spectacular route to Yellowstone Park over the Beartooth highway between Red Lodge and Cooke City.

Melting snows and glaciers of the Basin high country feed hundreds of lakes and the streams and rivers. Streams generally flow north and east to join the Yellowstone River which eventually becomes part of the flows of the Missouri and Mississippi Rivers. The Stillwater River enters the Yellowstone River near Columbus, the Clarks Fork River enters near Laurel, and the Bighorn River enters the Yellowstone near the old settlement of Big Horn just east of Custer, Montana. The larger lakes of the area are either man-made or have been enlarged by man. They include Bighorn Lake, Mystic Lake, Cooney Reservoir, and Willow Creek Reservoir near Lodge Grass.

The geologic history of the Basin is a complex record of sedimentation, uplift, igneous intrusion, folding, faulting, and erosion. In the Montana portion of the Basin, at least 30 separate geologic formations, ranging in age from Precambrian to Tertiary, have been identified. The formations are mostly sandstone, shale, and limestone. Some ancient schist, gneiss, and metamorphosed granitic rocks are present in an uplifted block constituting the Beartooth Plateau. There are exposures of intrusive and extrusive igneous rocks; the layered igneous ultrabasic rocks of the Stillwater Complex extend southeast along the plateau front from the West Fork Stillwater River to Fishtail Creek, and smaller intrusive dikes and sills are emplaced within and across older volcanic and sedimentary rocks.

MINERAL RESOURCES

Several mineral commodities have been developed in the Beartooth and Pryor Mountains regions, and deposits of fossil fuels within the Basin are significant. The more important mineral resources include bentonite, coal, gypsum, chromite, copper and nickel, clay, uranium, oil and gas, limestone, and sandstone. Most of these commodities, however, are not in current production.

a. Bentonite--deposits of bentonite are extensive in Upper Cretaceous strata east of the Clarks Fork River.

b. Coal--eight significant coal seams are present in the Red Lodge field, and three discontinuous seams are present in the Bridger field. Both fields are in Carbon County. Coal seams of the Red Lodge field are in the Fort Union Formation of Paleocene age, are of good quality, and are classed as high subbituminous to low bituminous. The beds are 3-1/2 to 10 feet thick and all eight have been mined. Coal seams of the Bridger field are in the Eagle Sandstone, of upper Cretaceous age, are of medium quality, low bituminous in rank, and range from 2-1/2 to 6 feet thick. Underground mining has been successful in both the Red Lodge and Bridger fields, and coal has also been produced from the Silvertip and Stillwater coal deposits in Carbon and Stillwater Counties.

Production of coal in the western Bighorn Basin in the near future is unlikely because of higher costs of underground mining as compared to production costs from the large surface-mineable coal fields in Big Horn, Rosebud, and Powder River Counties to the east of the study area. Cost of mine-mouth coal from underground mining is about four times that of mine-mouth coal produced by a large surface mine. Surface mining of coal from the deep-lying seams in Carbon County does not seem practical, which leads to the conclusion that coal production in the study area is unlikely.

c. Gypsum--the Chugwater Formation, of Triassic age, contains gypsum deposits of good quality near Bridger. This formation crops out extensively in the East Pryor Mountains, and gypsum is reported at different levels.

d. Chromite--deposits of low-grade (low chromium-iron ratio) chromite in the Stillwater Complex of southern Stillwater County are very large. These deposits were mined during the emergency period of World War II and for a few years thereafter. At present, however, Montana chromite cannot compete with higher-grade foreign ore.

e. Copper and Nickel--a large, low-grade deposit of copper-nickel-chromite containing platinum as an accessory mineral occurs in the Stillwater drainage (Stillwater Complex) south of Nye. Core drilling in 1969 disclosed sufficient reserves to justify additional work and probable future production.

f. Clay--good quality clay was used in brick manufacture at Fromberg. This clay and other deposits in the Fort Union Formation are known to be of suitable quality for brickmaking.

g. Uranium--the upper part of the Madison Limestone, of Mississippian age, near the Madison-Amsden contact on East Pryor Mountain and on upper Hough Creek southwest of Pryor, contains uranium minerals. The uranium deposits are in caverns and sinkholes in the limestone, and are of good grade, but small size. Fluorite is associated with the uranium, but the deposits are not known to be commercial.

h. Oil and Gas--oil and gas resources in the northern part of the Bighorn Basin are not extensive, but both are being produced. The Elk Basin area along the Montana-Wyoming border is in full production; the Hardin field in Big Horn County is less active. Sulfur is produced as a by-product in the Elk Basin field. Dry Creek Basin in Carbon County has potential for development of both oil and gas.

i. Limestone--the Madison Formation near Warren provides limestone principally for sugar refining. Some limestone is cut for building stone.

j. Sandstone--sandstone was formerly quarried from the Lennep Formation near Columbus. As interest in building stone increases, this resource may come back into use.

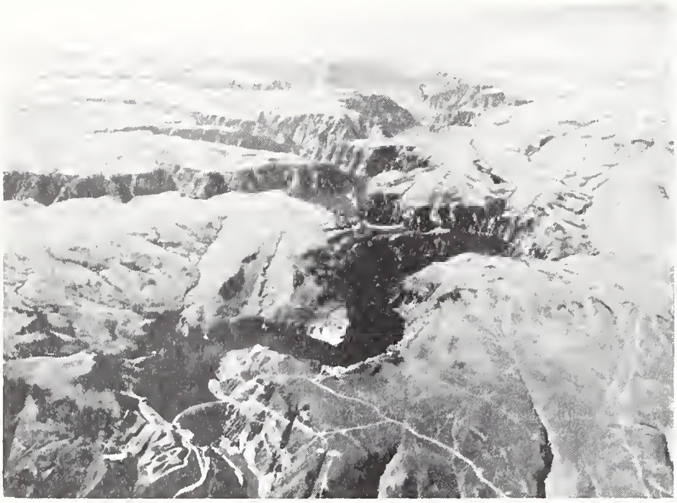
The U. S. Geological Survey and the U. S. Bureau of Mines are investigating the mineral resources of the Beartooth Primitive Area prior to a determination as to whether this area should be included in the Wilderness System. A Wilderness Area designation would exclude development of mining claims after 1983.

Rocks exposed in the Basin range in age from Quaternary to some of the oldest Precambrian rocks in Montana. The young Quaternary material is unconsolidated water-laid alluvium and colluvium. Rocks here represent every geologic period except the Silurian. Except for igneous and metamorphic rocks in the Beartooth Mountains, they are predominantly sedimentary types deposited in both continental and marine environments on a constantly changing earth. Precambrian metamorphic rocks in the Beartooth Mountain areas are crystalline types formed by heat and pressure probably over 1,000 million years ago and also underlie sedimentary rocks in the remainder of the Basin.

Tectonic movements of the earth's crust have occurred here since the beginning of geologic time. The greatest changes have been in the mountainous areas. Structural trends are believed related to patterns established in Precambrian time, but were largely rejuvenated during the early Tertiary period, about 65 million years ago. Large-scale thrust-faulting and folding took place at this time and resulted in the present basin-and-range tectonic pattern typical of the middle Rocky Mountain region.

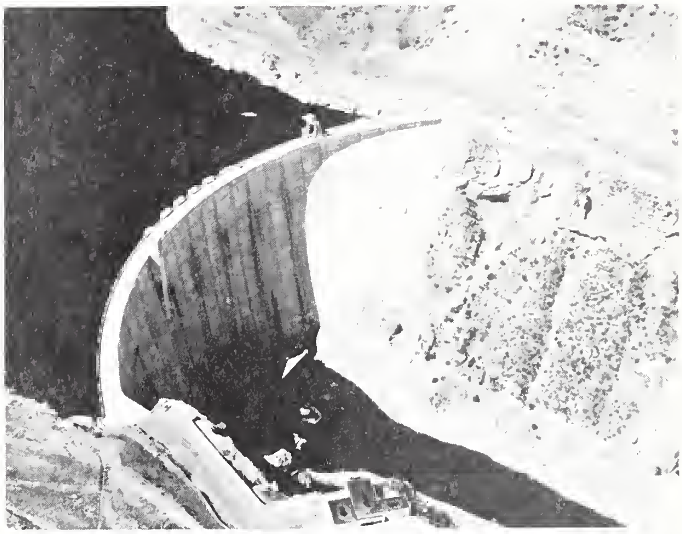
The greatest tectonic movement took place in the Beartooth, Pryor, and Bighorn Mountain areas where an excess of four miles of vertical uplift has taken place since Cambrian time. The Flathead Sandstone of Cambrian age lies on metamorphic rocks on the Beartooth Plateau at an elevation of 12,000 feet, while north of the Beartooth Overthrust near Red Lodge, this formation is 10,000 feet below sea level. Relatively young Wasatch and Fort Union Formations, 40-65 million years of age, outcrop on the north side of the fault.

Other prominent structures in and adjacent to the Basin have undergone less movement, but are important geologic features. Vertical movement has taken place along the Nye-Bowler Lineament, the Fromberg Fault Zone, the Lake Basin Fault Zone, the Reed Point Syncline, the Ashland Syncline, and the Powder River Basin. These crystal changes have developed anticlines, synclines, and faults that affect mineral, water, and other resources.



Over 47 miles of magnificent canyons can now be viewed from the comfort of a boat on Bighorn Lake. Most of this area was accessible only by foot prior to construction of Yellowtail Dam.

BUREAU OF RECLAMATION PHOTO



The graceful arch of Yellowtail Dam rises 525 feet from the Bighorn River bed.

BUREAU OF RECLAMATION PHOTO

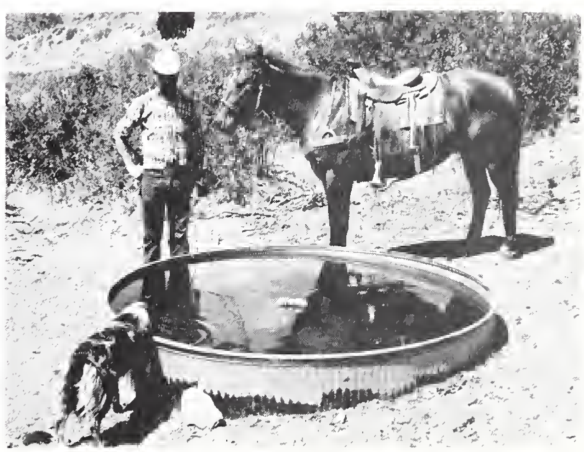
Boat launching ramp at mile 47 on Horseshoe Bend of Bighorn Lake is readily accessible from U. S. Highway 14A near Lovell, Wyoming.

BUREAU OF RECLAMATION PHOTO

Above: Herefords grazing in an open park in Custer National Forest. USDA-FOREST SERVICE PHOTO

SCS PHOTO 11-P569-2

Stockwater ponds and spring developments are a necessity in managing range use in the arid and semi-arid parts of the Basin.



SCS PHOTO 11-P196-10

Glacial deposits of Pleistocene age and terraces are prominent along some of the larger drainages. Glaciation occurred primarily in the Beartooth Mountains and adjacent areas. Several levels of stream terraces, underlain by sand and gravel deposits, occur along most of the major streams; development is best, however, near the mountains. Unconsolidated alluvium occurs in the flood plains of all streams, valuable in many locations for obtaining ground water.

LAND RESOURCES

Soils

The influences of climate, vegetation, and topography on parent materials are apparent in the soils of the area. Cropland soils in the Basin were classified into 19 soil productivity divisions for projecting development and production potential and for correlation with current production. These productivity divisions consist of groups of similar land capability units as contained in the Conservation Needs Inventory. By recalling data on their present use and production and conservation treatment needed, it is possible to project some degree of change in production from accomplishing those treatment practices. These changes are shown in chapter VIII. A generalized physical description of basin soils is presented on map II-3.

Land Ownership and Administration

The ownership pattern in the Basin has had considerable effect on the resource development. Ownership and administration of land includes 49.94 percent private non-Indian, 29.36 percent Indian Trust, 2.46 percent State of Montana, 0.02 percent Montana Fish and Game, 13.21 percent National Forest, 4.31 percent Bureau of Land Management, 0.22 percent Bureau of Reclamation, and 0.48 percent Other Federal. See Land Ownership Map II-4 and tables II-1 and II-3.

Vegetative Cover and Land Use

About 66 percent of the 7,795 square miles of the Basin in Montana is dominated by grass cover. Grass is an exceptionally important commodity as it supports large numbers of livestock which contribute more to agricultural income than any other product. Because of climatic, topographic, or other limitations, federal lands are used predominantly for grazing, forestry, fish and wildlife production, recreation, and mining. Livestock use on National Forest lands provides 15,000 animal unit months (AUM's) of summer forage on 48,850 acres. The Bureau of Land Management obtains 29,000 AUM's of use from 215,000 acres at lower elevations. Indian lands totaling 1,120,000 acres are grazed to yield 312,000 AUM's of use during the year. The remaining 1,788,000 acres of private range yield about 445,000 AUM's of grazing. Total yield of range in the Basin is estimated at 801,000 AUM's.

TABLE II-3--LAND SURFACE OWNERSHIP AND ADMINISTRATION BY WATERSHEDS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Acres in Watershed	Private 1/	State	Fish & Game	National Forest	Bureau of Land Mgmt.	Indian Trust	Bureau of Reclamation	Other Fed. Agencies
		- - - - - - - -	- - - - - - - -	- - - - -	- - - a	c r e s - - -	- - - - - - - -	- - - - -	- - - - - - - -	- - - - - -
	Stillwater Subbasin									
14b-1	Upper Stillwater River	213,460	16,354	436	---	196,510	160	---	---	---
14b-2	Fishtail to Butcher Cr.	258,165	103,920	3,449	---	148,974	1,822	---	---	---
14b-3	Lower Stillwater River	123,120	95,900	2,926	494	20,500	3,300	---	---	---
14b-4	Shane-Beaver Cr.	81,936	79,153	2,092	21	---	670	---	---	---
	Subbasin Total	676,681	295,327	8,903	515	365,984	5,952	---	---	---
	Yellowstone Minor Drainages									
14-22	Cow-Bellion Cr.	63,436	60,372	1,790	---	---	1,274	---	---	---
14-27	Blue-Duck Cr.	118,570	111,915	4,469	---	---	1,920	266	---	---
14-31	Arrow Cr.	72,869	69,506	3,323	---	---	40	---	---	---
14-32	Fly Cr.	179,151	149,757	5,600	---	---	130	23,664	---	---
14-36	Lost Boy Cr.	90,339	84,794	5,400	---	---	145	---	---	---
14-37	Custer Drainage	21,422	20,502	920	---	---	---	---	---	---
14d-1	Upper Pryor Cr.	220,202	59,483	499	195	---	---	160,025	---	---
14d-2	Lower Pryor Cr.	169,220	111,933	3,600	---	---	620	53,067	---	---
	Subbasin Total	935,209	668,262	25,601	195	---	4,129	237,022	---	---
	Clarks Fork Subbasin									
14c-3	Clarks Fork-Zimmer Cr.	73,865	2,420	---	---	71,445	---	---	---	---
14c-4	Pat O'Hara Cr.	797	797	---	---	---	---	---	---	---
14c-4a	Big Sand Coulee	13,352	4,118	840	---	---	8,394	---	---	---
14c-5	Line Cr.	11,957	240	---	---	11,577	140	---	---	---
14c-6	N.F. Cherry-Silvertip Cr.	153,942	67,081	7,651	---	---	79,210	---	---	---
14c-7	Clarks Fork-Ruby Cr.	169,220	127,924	7,288	---	5,124	28,884	---	---	---
14c-8	Upper Rock Cr.	120,929	7,192	752	---	112,825	160	---	---	---
14c-9	Red Lodge-Rock Cr.	207,780	178,269	10,292	250	18,276	693	---	---	---
14c-1C	Elbow-Lower Rock Cr.	91,302	88,402	2,541	---	---	359	---	---	---
14c-11	Lower Clarks Fork, E.Side	133,184	111,346	6,296	90	---	9,104	6,348	---	---
	Subbasin Total	976,328	587,789	35,660	340	219,247	126,944	6,348	---	---

See footnote on following page.

TABLE II-3--LAND SURFACE OWNERSHIP AND ADMINISTRATION BY WATERSHEDS (Cont'd)

Watershed Number	Watershed Name	Acres in Watershed	Private 1/	State	Fish & Game	National Forest	Bureau of Land Mgmt.	Indian Trust	Bureau of Reclamation	Other Fed. Agencies
	Bighorn Subbasin	- - -	- - -	- - -	- - -	a c r e s	- - -	- - -	- - -	- - -
14e6-8	Sage Cr.	150,687	44,862	3,780	---	41,348	28,876	31,821	---	---
14e6-8a	Dry Cr.	9,233	---	731	---	---	8,502	---	---	---
14e-27	Crooked Cr.	63,869	1,011	1,840	---	23,705	36,593	---	---	720
14e-28	Porcupine Cr.	19,031	---	---	---	---	---	18,325	706	---
14e-30	Dryhead Cr. to Wyo.	112,625	42,064	2,180	---	8,903	3,917	32,283	825	22,453
14e-31	Black Canyon Cr.	146,037	---	---	---	---	---	140,037	6,000	---
14e-32	Soap Cr.	112,493	29,709	1,080	---	---	---	80,294	1,410	---
14e-33	Beauvais Cr.	211,168	59,615	4,938	---	---	---	144,635	1,980	---
14e-34	Rotten Grass Cr.	166,629	47,521	1,819	121	---	---	117,168	---	---
14e-35	Two Leggins-Woody Cr.	163,807	38,361	5,968	---	---	---	119,478	---	---
14e-36	Warren Bench	6,808	2,229	---	---	---	---	4,579	---	---
14e-37	West Side Bighorn River	152,414	146,718	5,520	---	---	120	56	---	---
14e-37a	Two Leggins Irr. Unit	32,781	30,056	369	---	---	---	2,356	---	---
14e-38	East Side Bighorn River	117,308	94,144	5,865	---	---	---	17,299	---	---
14e-39	Upper Tullock Cr.	137,867	25,226	2,280	---	---	---	110,361	---	---
14e-40	Lower Tullock Cr.	160,252	150,985	8,506	---	---	---	761	---	---
	Subbasin Total	1,763,009	712,501	44,876	121	73,956	78,008	819,453	10,921	23,173
	Little Bighorn Subbasin									
14e7-1	Little Bighorn River	88,346	39,082	2,800	---	---	---	46,464	---	---
14e7-2	Pass Cr.	14,348	8,632	---	---	---	---	5,716	---	---
14e7-3	Lodge Grass Cr.	108,938	25,797	2,589	---	---	---	80,552	---	---
14e7-4	Owl Cr.	158,559	64,140	29	---	---	---	94,390	---	---
14e7-5	Little Bighorn E. Side	141,321	43,691	1,920	---	---	---	95,050	---	660
14e7-6	Little Bighorn W. Side	126,209	46,303	99	---	---	---	79,807	---	---
	Subbasin Total	637,721	227,645	7,437	---	---	---	401,979	---	660
	Summary									
Stillwater Basin		676,681	295,327	8,903	515	365,984	5,952	---	---	---
Yellowstone Minor Drainages		935,209	668,262	25,601	195	---	4,129	237,022	---	---
Clarks Fork Subbasin		976,328	587,789	35,660	340	219,247	126,944	6,348	---	---
Bighorn Subbasin		1,763,009	712,501	44,876	121	73,956	78,008	819,453	10,921	23,173
Little Bighorn Subbasin		637,721	227,645	7,437	---	---	---	401,979	---	660
TOTAL		4,988,948	2,491,524	122,477	1,171	659,187	215,033	1,464,802	10,921	23,833

1/ Does not include Indian Trust lands.

Source: River Basin Planning Staff and land administration agencies.

TABLE II-4--VEGETATIVE ASPECT AND LAND USE BY WATERSHEDS
in the
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Grass	Dry Cropland	Irr. Cropland	Trees	Brush	Alpine & Barren	Urban & Builtup	Water	Total Acres
		acres								
	Stillwater Subbasin									
14b-1	Upper Stillwater River	91,042	15	768	113,303	--	6,700	361	1,271	213,460
14b-2	Fishtail to Butcher Cr.	127,447	3,330	18,843	77,451	--	27,000	1,918	2,176	258,165
14b-3	Lower Stillwater River	97,160	3,321	5,490	15,692	--	--	1,191	266	123,120
14b-4	Shane-Beaver Cr.	57,695	13,149	4,151	5,632	--	--	1,064	245	81,936
	Subbasin Total	373,344	19,815	29,252	212,078	--	33,700	4,534	3,958	676,681
	Yellowstone Minor Drainages									
14-22	Cow-Bellion Cr.	25,236	14,248	1,610	21,330	--	--	637	375	63,436
14-27	Blue-Duck Cr.	87,350	24,967	3,124	250	--	--	2,193	686	118,570
14-31	Arrow Cr.	37,852	1,269	27,990	2,600	--	--	3,009	149	72,869
14-32	Fly Cr.	132,987	17,026	1,250	26,230	--	--	1,577	81	179,151
14-36	Lost Boy Cr.	62,915	3,533	1,058	21,700	--	--	1,043	90	90,339
14-37	Custer Drainage	14,592	1,076	2,200	2,780	--	--	590	184	21,422
14d-1	Upper Pryor Cr.	171,819	26,921	1,371	19,140	--	--	723	228	220,202
14d-2	Lower Pryor Cr.	135,598	14,588	1,348	16,230	--	--	1,224	232	169,220
	Subbasin Total	668,349	103,628	39,951	110,260	--	--	10,996	2,025	935,209
	Clarks Fork Subbasin									
14c-3	Clarks Fork-Zimmer Cr.	1,328	--	--	29,000	--	37,593	72	5,872	73,865
14c-4	Pat O'Hara Cr.	449	215	112	--	--	--	9	12	797
14c-4a	Big Sand Coulee	917	741	968	--	10,462	--	122	142	13,352
14c-5	Line Cr.	3,459	--	--	5,900	2,292	299	--	7	11,957
14c-6	N.F. Cherry-Silvertip Cr.	21,596	2,232	10,633	5,850	111,994	--	1,487	150	153,942
14c-7	Clarks Fork-Ruby Cr.	96,991	4,124	11,385	7,660	47,229	--	1,511	320	169,220
14c-8	Upper Rock Cr.	69,315	652	40	32,413	--	16,948	684	877	120,929
14c-9	Red Lodge-Rock Cr.	119,076	27,464	39,308	16,570	--	--	3,897	1,465	207,780
14c-10	Elbow-Lower Rock Cr.	44,318	20,865	19,100	3,770	--	--	2,849	400	91,302
14c-11	Lower Clarks Fork E. Side	102,064	19,199	7,082	3,842	--	--	711	286	133,184
	Subbasin Total	459,513	75,492	88,628	105,005	171,977	54,840	11,342	9,531	976,328

TABLE II-4--VEGETATIVE ASPECT & LAND USE BY WATERSHEDS (Cont'd)

Watershed Number	Watershed Name	Grass	Dry Cropland	Irr. Cropland	Trees	Brush	Alpine & Barren	Urban & Builtup	Water	Total Acres
		acres								
	Bighorn Subbasin									
14e6-8	Sage Cr.	83,539	1,171	1,449	47,120	16,540	--	686	182	150,687
14e6-8a	Dry Cr.	5,918	--	--	--	3,288	--	27	--	9,233
14e-27	Crooked Cr.	31,870	--	332	27,200	4,384	--	63	20	63,869
14e-28	Porcupine Cr.	4,491	--	--	3,031	10,960	199	--	350	19,031
14e-30	Dryhead Cr. to Wyo.	77,998	--	134	26,905	2,989	--	144	4,455	112,625
14e-31	Black Canyon Cr.	81,659	--	--	19,835	37,863	1,495	315	4,870	146,037
14e-32	Soap Cr.	93,892	6,089	4,507	6,520	--	--	875	610	112,493
14e-33	Beauvais Cr.	164,624	30,745	1,122	13,360	--	--	351	966	211,168
14e-34	Rottén Grass Cr.	128,322	6,520	17,088	13,040	--	--	1,189	470	166,629
14e-35	Two Leggins-Woody Cr.	140,386	16,163	15	6,832	--	--	302	109	163,807
14e-36	Warren Bench	2,226	4,485	--	10	--	--	27	60	6,808
14e-37	West Side Bighorn River	111,631	22,592	3,606	12,820	--	--	1,680	85	152,414
14e-37a	Two Leggins Irr. Unit	685	1,070	27,085	1,100	--	--	2,481	360	32,781
14e-38	East Side Bighorn River	108,688	3,142	321	4,620	--	--	252	285	117,308
14e-39	Upper Tullock Cr.	123,431	--	--	14,240	--	--	186	10	137,867
14e-40	Lower Tullock Cr.	148,817	3,966	795	5,876	--	--	658	140	160,252
	Subbasin Total	1,308,177	95,943	56,454	202,509	76,024	1,694	9,236	12,972	1,763,009
	Little Bighorn Subbasin									
14e7-1	Little Bighorn	60,310	5,960	6,773	11,520	--	2,790	853	140	88,346
14e7-2	Pass Cr.	10,363	1,753	696	1,250	--	--	266	20	14,348
14e7-3	Lodge Grass Cr.	78,066	8,258	2,234	17,280	--	598	1,602	900	108,938
14e7-4	Owl Cr.	130,106	8,004	1,042	18,430	--	--	918	59	158,559
14e7-5	Little Bighorn E. Side	129,197	4,326	250	6,080	--	--	1,328	140	141,321
14e7-6	Little Bighorn W. Side	91,681	21,377	6,139	4,610	--	--	2,262	140	126,209
	Subbasin Total	499,723	49,678	17,134	59,170	--	3,388	7,229	1,399	637,721
	Summary									
Stillwater Subbasin		373,344	19,815	29,252	212,078	--	33,700	4,534	3,958	676,681
Yellowstone Minor Drainages		668,349	103,628	39,951	110,260	--	--	10,996	2,025	935,209
Clarks Fork Subbasin		459,513	75,492	88,628	105,005	171,977	54,840	11,342	9,531	976,328
Bighorn Subbasin		1,308,177	95,943	56,454	202,509	76,024	1,694	9,236	12,972	1,763,009
Little Bighorn Subbasin		499,723	49,678	17,134	59,170	--	3,388	7,229	1,399	637,721
TOTALS		3,309,106	344,556	231,419	689,022	248,001	93,622	43,337	29,885	4,988,948

Source: River Basin Planning Staff

Note: The terms "grass" and "brush" refer to dominant species in the vegetative cover as defined by BLM. "Trees" refers to lands with over 10 percent canopy of either upland forests or wooded bottom lands as defined by FS. Alpine and barren lands are basically rock outcropping or unvegetated badlands. Urban and builtup includes towns, airports, roads, highways, railroads, and industrial sites.

TABLE II-5--FORESTED LAND AREA BY STAND SIZE CLASS AND OWNERSHIP, 1971

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Stand Class	Total	National Forest	Public Domain	Indian Trust Land	State & Private
	acres				
Sawtimber	105,075	53,266	---	21,051	30,758
Poles	65,281	42,452	---	2,615	20,214
Seedlings & Saplings	99,311	82,611	---	292	16,408
SUBTOTAL - Commercial	270,967	178,329	1,300	23,958	67,380
Non-commercial	285,827	67,300	7,900	53,650	156,977
Reserved	59,390	59,390	NA	NA	NA
TOTAL	616,184	305,019	9,200	77,608	224,357

Source: River Basin Planning Staff and land administration agencies.

LEGEND

SOILS OF THE MOUNTAINS, MOUNTAIN VALLEYS AND MOUNTAIN FOOTHILLS

C-1 Cryoborolls-Cryoborolfs-Rock outcrop association: steep and very steep, shallow and moderately deep, well-drained soils and rock outcrops on tops and sides of mountains.

C-3 Cryoborolls-Rock outcrop associatian: steep, shallow to deep, well-drained soils and rock outcrops on dissected mountain fronts and rounded knolls and ridges of mountains.

C-4 Cryorthents-Cryoborolls association: nearly level to steep, shallow to deep, well-drained soils on terraces and fans in valleys and on dissected uplands of the mountains.

SOILS OF THE MOUNTAIN FOOTHILLS AND DESERTIC BASINS

F-1 Haplargids-Argiborolls association: nearly level to steep, deep, well-drained soils on terraces, fans and till plains of the mountain foothills.

F-2 Haplargids-Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills and on uplands in desertic basins.

F-5 Ustorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills.

F-6 Ustorthents-Argiborolls-Haploborolls association: nearly level to very steep, shallow to deep, well-drained soils on mountain foothills

F-7 Ustifluvents-Argiborolls-Haploborolls association: nearly level to rolling, deep, well and moderately well-drained soils on flood plains, terraces and fans on mountain foothills.

F-8 Ustorthents-Argiborolls association: rolling and steep, shallow to deep, well-drained soils on mountain foothills.

SOILS OF THE DESERTIC BASINS AND UPLANDS

M-1 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on terraces and fans of desertic basins.

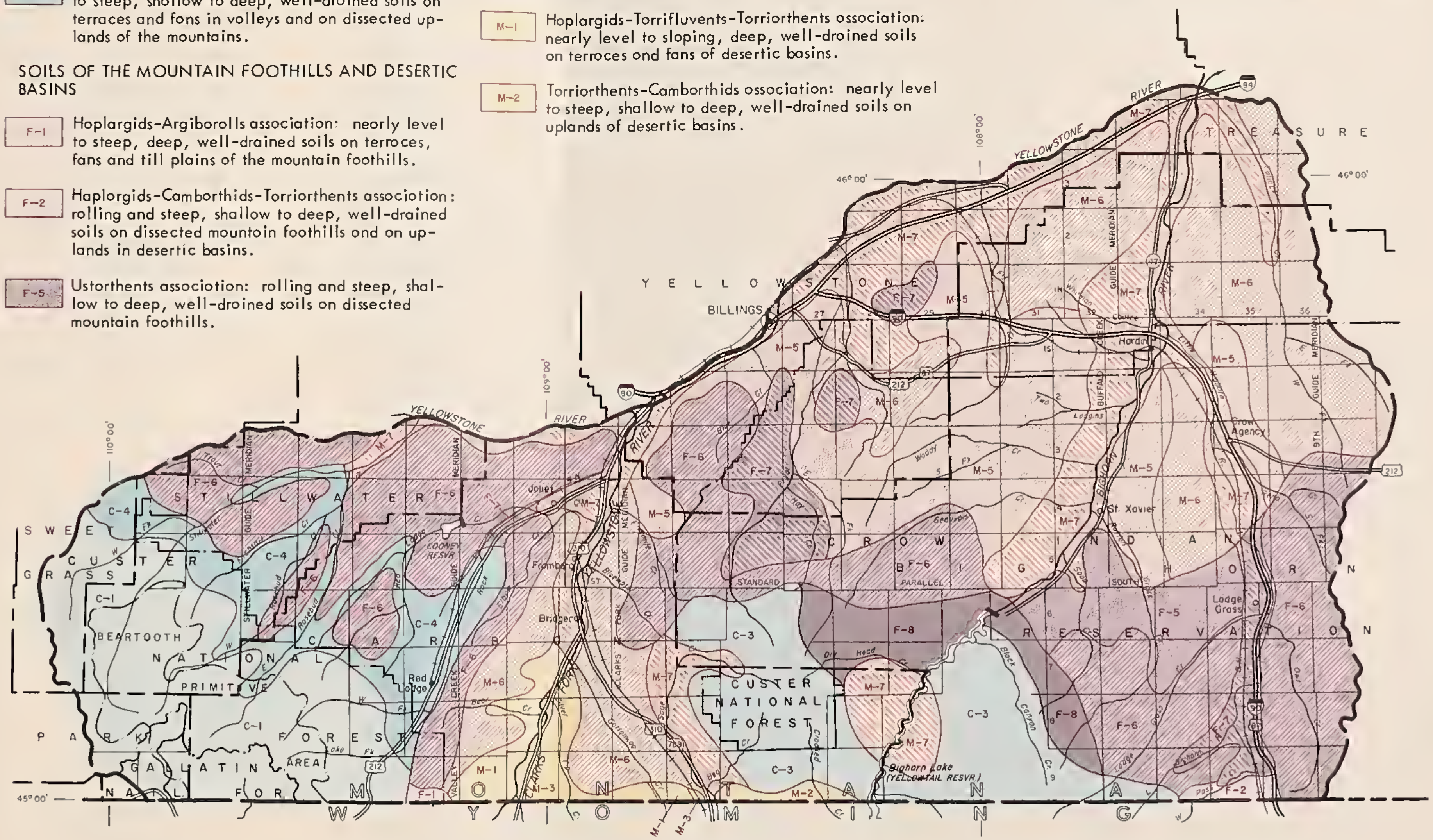
M-2 Torriorthents-Camborthids association: nearly level to steep, shallow to deep, well-drained soils on uplands of desertic basins.

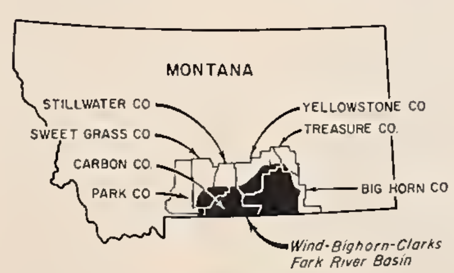
M-3 Haplargids-Natrargids-Torriorthents association: undulating to steep, shallow to deep, well-drained soils in desertic basins and on uplands.

M-5 Torriorthents association: nearly level to steep, shallow to deep, well-drained soils on uplands.

M-6 Haplargids-Torriorthents-Argiustolls association: nearly level to very steep, shallow to deep, well-drained soils on dissected uplands.

M-7 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on flood plains, terraces and fans in uplands.





LOCATION MAP

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

MAP II-3

GENERALIZED SOIL MAP

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

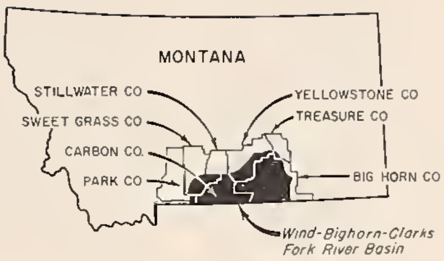
APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

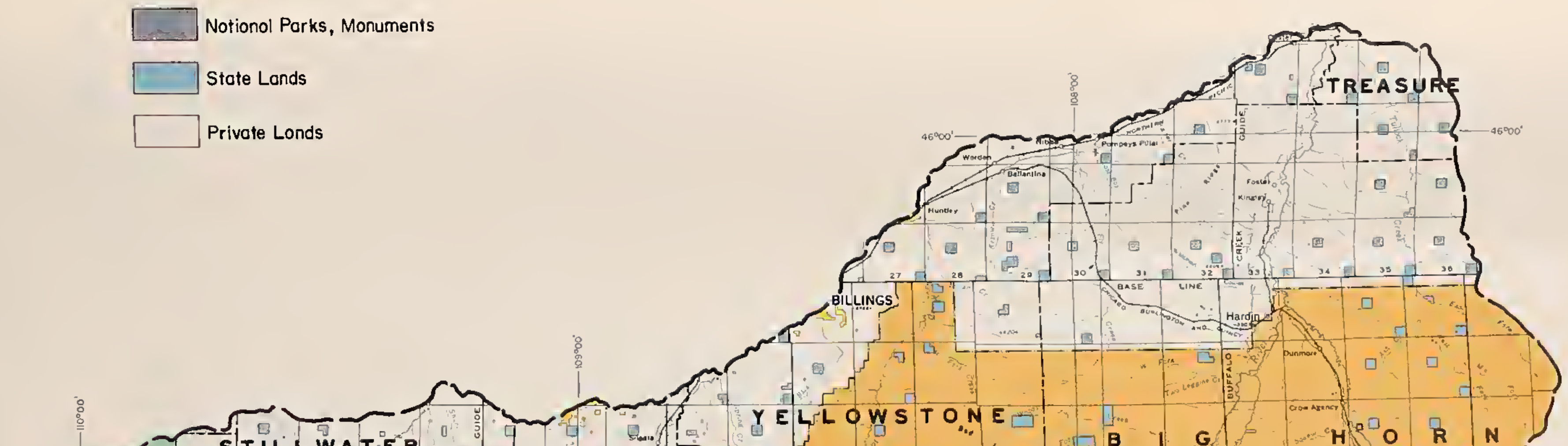
M7-E-22914B-N



LOCATION MAP

LEGEND

- Public Lands
- Acquired Londs
- Indian Reservatians
- Notionol Forests
- Notionol Parks, Monuments
- State Lands
- Private Londs



MAP II-4

LAND OWNERSHIP & ADMINISTATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914C-N

In addition to the forage production of the grass and brush land, there is considerable value from watershed protection. The better the vegetative cover, the less the erosion and sediment production and the better the quality of runoff water for fishery and other purposes. At present, about one million acres of range are adequately treated while about two and one-half million acres need additional and continuing land treatment.

In descending order, additional vegetative aspects and land uses are: trees, 14 percent; dry cropland, 7 percent; brush, 5 percent; irrigated crops, 4 percent; alpine and barren, 2 percent; urban and builtup, 1 percent; and water, 1 percent. There are about 28,000 acres of highway and county road rights-of-way included in the urban and builtup category. See table II-4 (Vegetative Aspect by Watersheds), map II-5 (Vegetative Aspect), and map II-6 (Irrigable and Irrigated Lands).

Forested Land

Forested lands in the Montana portion of the Wind-Bighorn Basin total about 616,184 acres.1/ The breakdown of land ownership and administration of forested land is shown in table II-5 indicating the majority is federally administered. Of the total forested land, 59,390 acres have been set aside in the Beartooth Primitive Area. In addition to the removal of these acres from timber production, another 285,827 acres have been classified as noncommercial forest due to unproductive sites, lack of access, steepness of slopes, etc. This leaves only 270,967 acres from which timber harvest may presently be taken.

Less than half these producing acres (table II-5) are stocked with sawtimber size trees (11 inches and over). The remainder shows 24 percent in the 5- to 11-inch size class and 37 percent in the less

1/ Forested lands are defined in this report as land at least 10 percent stocked by trees of any size and capable of producing timber or other wood products or of exerting significant influence on climate and water regimes. However, lands from which trees have been removed to less than 10 percent stocking which have not been developed for other uses are still defined as forest lands. These numbers will not necessarily agree with the numbers in table II-4 which were derived under different criteria. Commercial forest land is that which is capable of producing an economically usable harvest of wood (usually at least 20 cubic feet per acre per year) and is not withdrawn or reserved from cutting.

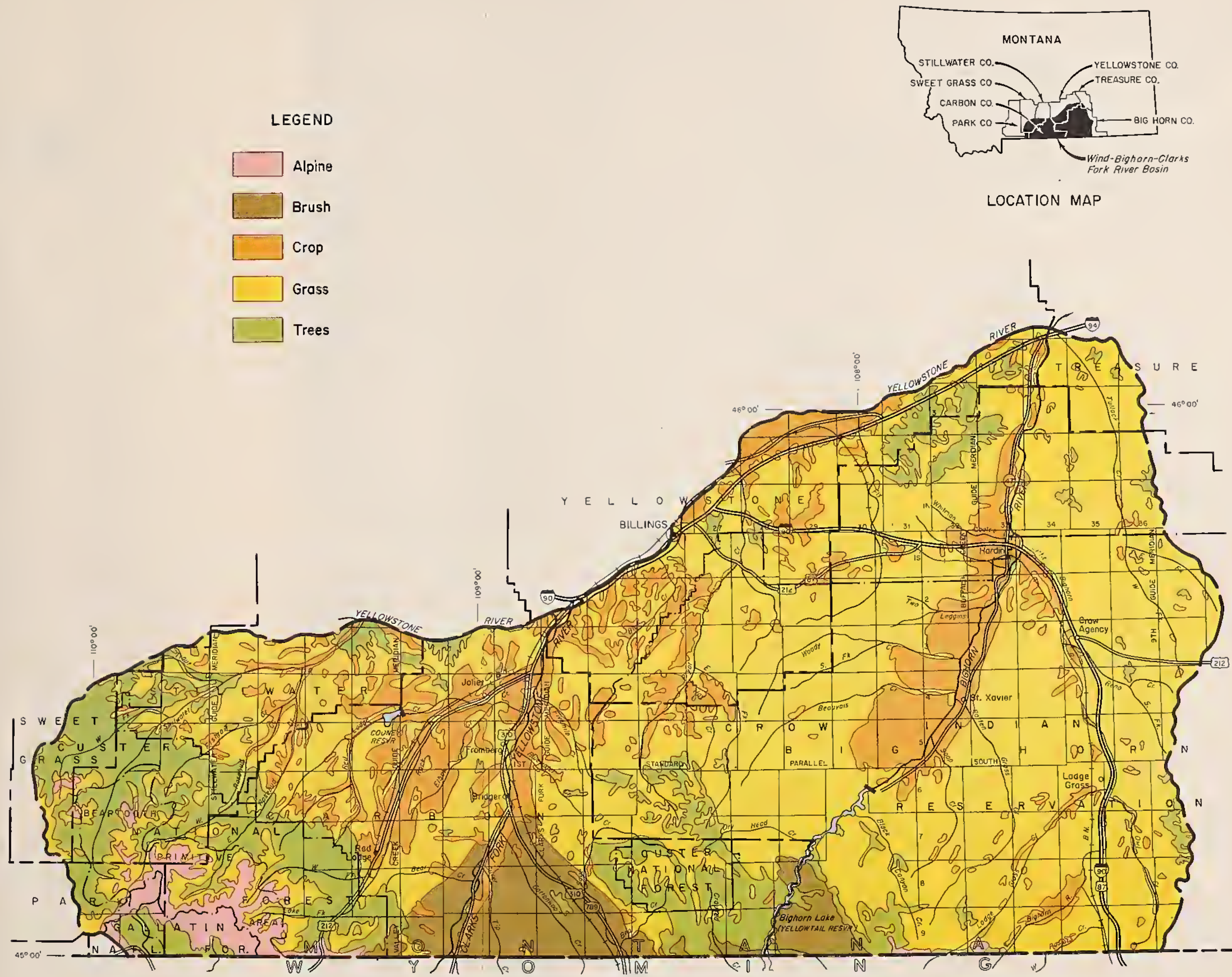
than 5-inch size class. However, these figures do not necessarily mean that the smaller trees will grow to sawtimber size with time. Much of the smaller timber is composed of stagnated stands which are relatively old, that will not significantly increase growth even if thinned. Therefore, the availability of timber for future harvest is not consistent within the figures shown on an acre-for-acre basis.

The primary species of trees in the Basin are shown in table II-6. The use of cut timber does not differentiate among species to a significant degree.

TABLE II-6--FORESTED LAND BY TYPE AND OWNERSHIP
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Forest Type	National Forest	Public Domain	Indian Trust Land	State & Private
	Acres			
Lodgepole Pine	48,149	NA	NA	NA
Spruce	19,616	do	do	do
Alpine Fir	21,399	do	do	do
Douglas-Fir	64,198	do	do	do
Ponderosa Pine	2,496	do	do	do
Whitebark-limber Pine	21,400	do	do	do
Other	1,071	do	do	do
Noncommercial	67,300	7,900	53,650	156,977
Reserved	59,390	NA	NA	NA
TOTAL	305,019	9,200	77,608	224,357

Source: U. S. Forest Service



MAP II-5

VEGETATIVE ASPECT

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

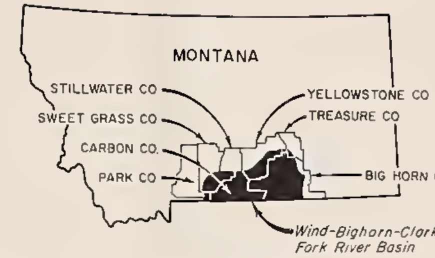
APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

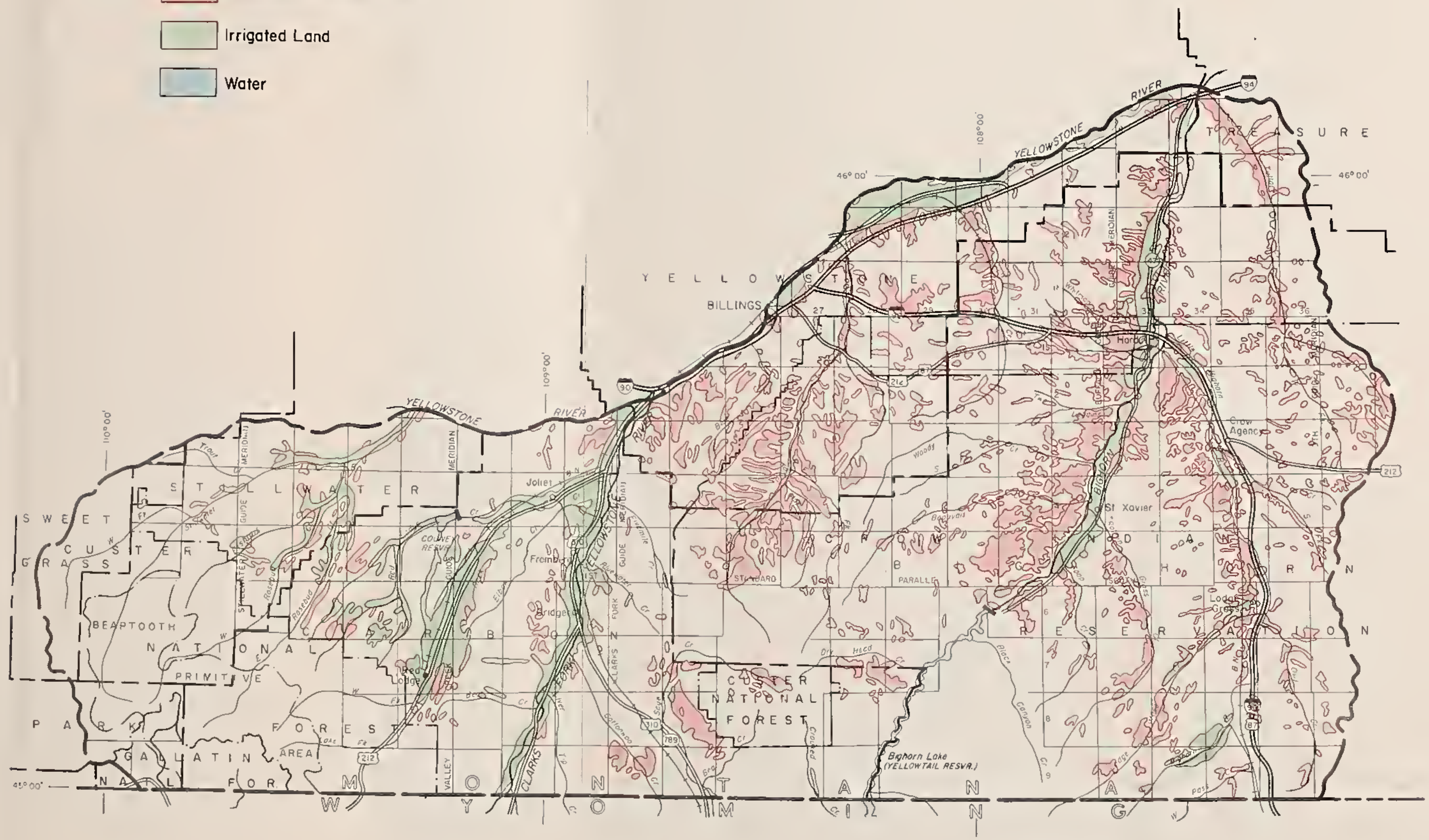
M7-E-22914D-N



LOCATION MAP

LEGEND

- Potentially Irrigable Land
- Irrigated Land
- Water



MAP II-6

IRRIGABLE AND IRRIGATED LAND

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1 : 1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914 E-N

WATER RESOURCES

Surface Water Supplies

Water resources available for use in the Montana part of the Basin depend largely on melting snows in the high country and on Yellowstone River Compact water entering from Wyoming in the Bighorn, Little Bighorn, and Clarks Fork Rivers. Snowmelt runoff is augmented to a lesser degree by summer rainstorms. Surface water quality is suitable for most purposes. Water yield from the high country ranges up to 2,700 acre-feet per square mile per year as contrasted to almost zero yield from the desert and semidesert lower elevations. See map II-7. Seasonal distribution of runoff is typical of western mountainous snowpack drainages. More water is available during the spring and early summer months than can be used on the irrigable lands through direct diversion. Flows drop rapidly, as the snowmelt is depleted, leaving a water deficit during late summer and early fall. See typical hydrographs shown in figure II-1. See tables II-7 and II-8.

Irrigated lands in the Basin were inventoried by four types of systems and availability of water. Type I lands are defined as those with a relatively adequate supply and improved conveyance systems. Type II lands are those with less efficient systems and water management. Water supply ranges from severe shortages to nearly adequate. Type III's are the "mountain meadow" lands which are short of water after the initial runoff. Normally, they receive only one irrigation. Because of the water shortages, other inputs are minimal and productivity is low. Type IV lands are those with various types of water-spreading systems. They may go through an entire growing season without irrigation. Some of the lands have regular flood irrigation systems, but are used only when water is available from runoff. See table II-9.

Water use and management are affected by the seasonality of supply, the original pattern of appropriation and development, the limitation of cropping alternatives, and the diversity of soil types irrigated and through which canals are constructed. Water conveyance efficiencies range from 80 percent on heavy soils to 20 percent on lighter soils. On-farm application efficiencies range from 60 percent on the better-developed, nearly level bottom lands to 15 percent for steeper mountain meadow irrigation. As a result of the combination of these efficiencies, overall project efficiencies range from a high of 48 percent to a low of 7 or 8 percent. In other words, for each acre-foot of irrigation water used by the crop, it requires diversion of from 2.86 acre-feet of water at 35 percent efficiency to 12.5 acre-feet of water at 8 percent efficiency.

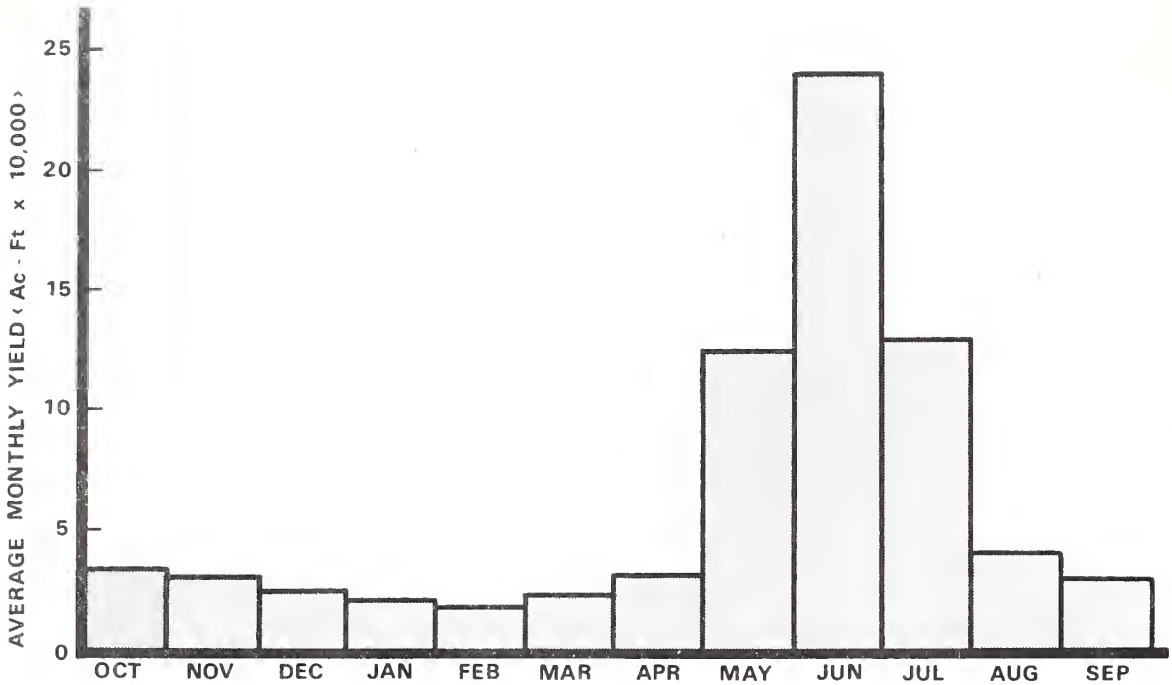


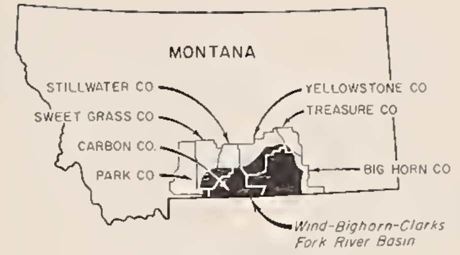
FIGURE II-1 -- TYPICAL WATER YIELD HYDROGRAPH

TABLE II-7--WATER SURFACE AREA BY SUBBASIN
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Subbasin	Surface Acres of Lakes, Ponds and Reservoirs	Miles of Live Streams and Rivers
	- - acres - - -	- - miles - -
Stillwater Subbasin	3,958	338
Yellowstone Minor Drainages	2,025	129
Clarks Fork Subbasin	9,531	409
Bighorn Subbasin	12,972	402
Little Bighorn Subbasin	1,399	173
Total	29,885	1,451 1/

Source: River Basin Planning Staff

1/ Does not include 119 miles of Yellowstone River.

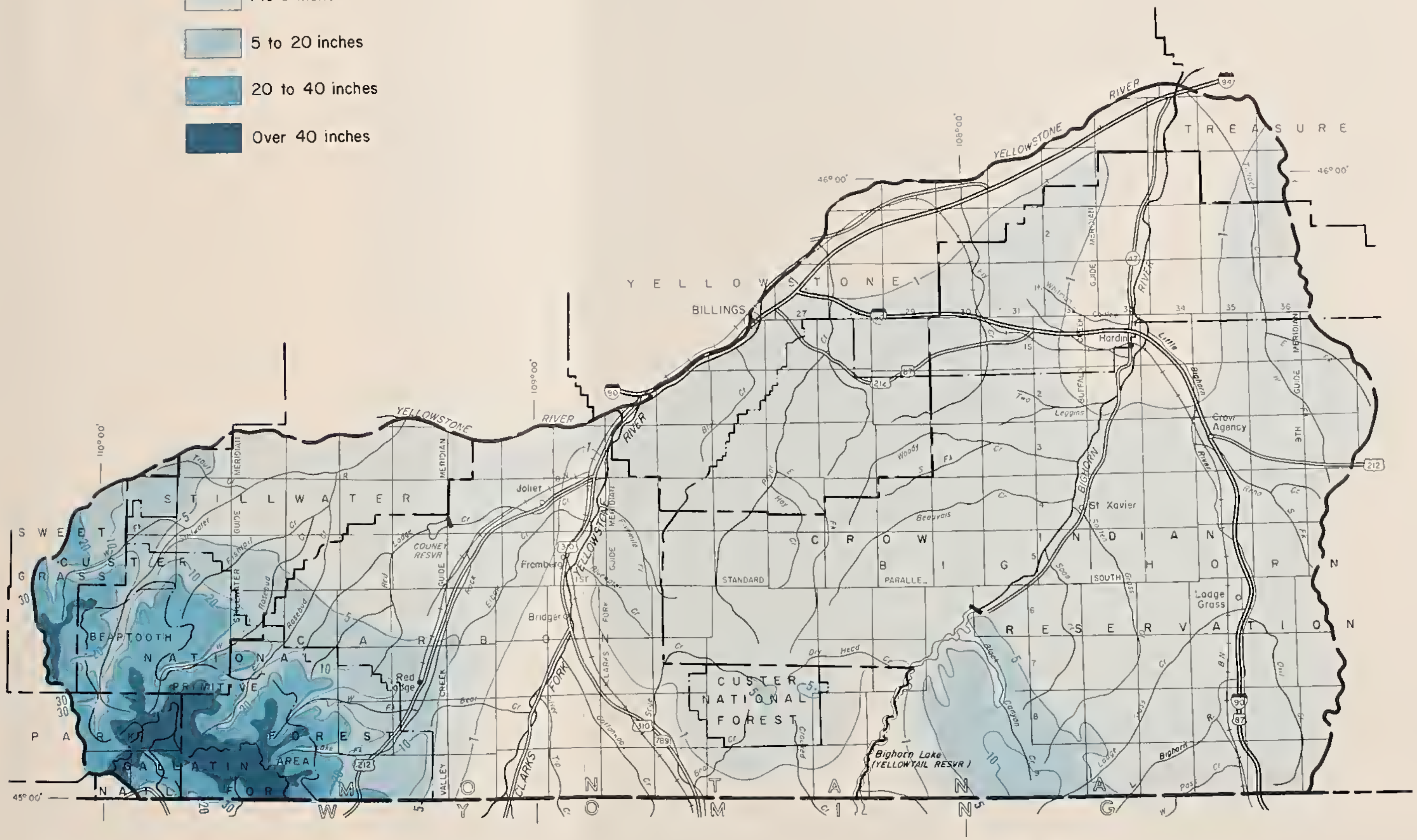


LOCATION MAP

LEGEND

—30— Average Annual Water Yield in Inches

- Less than 1 inch
- 1 to 5 inches
- 5 to 20 inches
- 20 to 40 inches
- Over 40 inches



MAP II-7

AVERAGE ANNUAL WATER YIELD

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914 F-N

TABLE II-8--ESTIMATED SURFACE WATER RESOURCES, 1970
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

50 PERCENT CHANCE

Watershed Numbers	Hydrologic Subareas	Phreatophyte Area (Acres)	Presently Irrigated Land (Acres)	Total Native Water Yield [1] (Acre-Feet)	Flows From Upstream Sources	Phreatophyte Depletion	Reservoir Effect and Evaporation	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point
	Stillwater Subbasin									
14b-1	Upper Stillwater River	1,568	768	397,590	0	4,700	0	392,890	1,230	391,660
14b-2	Fishtail to Butcher Cr.	1,510	18,843	367,370	0	6,040	0	361,330	30,150	331,180
	Diversion to Red Lodge Cr.								16,700	
14b-3	Lower Stillwater River	760	5,490	61,370	0	3,420	0	57,950	8,780	49,170
14b-4	Shane-Beaver Cr.	920	4,151	24,070	0	4,600	0	19,470	6,640	12,830
	Subbasin Total	4,758	29,252	850,400	0	18,760	0	831,640	63,500	768,140
	Yellowstone Minor Drainages									
14-22	Cow-Bellion Creek	978	1,610	4,660	4,000,000[4]	6,850	0	3,997,810	2,580	3,995,230
14-27	Blue-Duck Creek	410	3,124	8,720	813,930[2]	2,870	0	819,780	5,000	814,780
14-31	Arrow Creek	400	27,990	5,360	0	3,000	0	2,360	44,780[4]	0
14-32	Fly Creek	230	1,250	13,170	0	1,730	0	11,440	2,000	9,440
14-36	Lost Boy Creek	340	1,058	6,690	0	2,550	0	4,140	1,700	2,440
14-37	Custer Drainage	170	2,200	1,570	0	1,280	0	290	3,520[4]	0
14d-1	Upper Pryor Creek	580	1,371	46,120	0	2,900	0	43,220	2,190	41,030
14d-2	Lower Pryor Creek	680	1,348	12,340	0	4,080	0	8,260	2,160	6,100
	Subbasin Total	3,788	39,951	98,630	4,813,930	25,260	0	4,887,300	63,930	4,823,370
	Clarks Fork Subbasin									
14c-3	Clarks Fork-Zimmer Cr.	2,216	0	223,460[9]		6,660[9]	0	216,800[9]	0	216,800[9]
14c-5	Line Creek	26	0	14,000[9]	0	100[9]	0	13,900[9]	0	13,900[9]
	Clarks Fork River				660,000[3]			660,000[3]		660,000[3]
14c-4	Pat O'Hara Cr.	2	112	20	0	20	0	0	180[2]	0
14c-4a	Big Sand Coulee	29	968	270	3,200[3]	290	0	3,180	1,550	1,630
14c-6	N.F. Cherry-Silvertip Cr.	510	10,633	6,600	1,800[3]	2,300	0	6,100	17,010[2]	0
14c-7	Clarks Fork-Ruby Cr.	380	11,385	44,350	0	2,280	0	42,070	18,220	23,850
14c-8	Upper Rock Cr.	3,628	40	147,350	31,500[3]	18,140	0	160,710	60	160,650
14c-9	Red Lodge--Rock Cr.	6,508	39,308	74,410	16,700[5]	32,540	3,200	55,370	62,890[6]	0
14c-10	Elbow-Lower Rock Cr.	1,294	19,100	11,800	0	7,760	0	4,040	28,830[6]	0
14c-11	Lower Clarks Fork E. Side	820	7,082	28,270	0	5,740	0	22,530	11,330	11,200
	Subbasin Total	15,413	88,628	313,070	713,200	69,070	3,200	954,000	140,070	813,930

80 PERCENT CHANCE

Watershed Numbers	Hydrologic Subareas	Total Native Water Yield [1] (Acre-Feet)	Flows From Upstream Sources	Phreatophyte Depletion	Reservoir Effect and Evaporation	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point
	Stillwater Subbasin							
14b-1	Upper Stillwater River	328,790	0	4,700	0	324,090	1,230	322,860
14b-2	Fishtail to Butcher Cr.	302,430	0	6,040	0	296,390	30,150	266,240
	Diversion to Red Lodge Cr.						24,510	
14b-3	Lower Stillwater River	50,390	0	3,420	0	46,970	8,780	38,190
14b-4	Shane-Beaver Cr.	19,770	0	4,600	0	15,170	6,640	8,530
	Subbasin Total	701,380	0	18,760	0	682,620	71,310	611,310
	Yellowstone Minor Drainages							
14-22	Cow-Bellion Creek	3,350	3,400,000[4]	6,850	0	3,396,500	2,580	3,393,920
14-27	Blue-Duck Creek	6,270	676,230[2]	2,870	0	679,630	5,000	674,630
14-31	Arrow Creek	3,850	0	3,000	0	850	44,780[4]	0
14-32	Fly Creek	9,470	0	1,730	0	7,740	2,000	5,740
14-36	Lost Boy Creek	4,780	0	2,550[4]	0	2,230	1,700[4]	530
14-37	Custer Drainage	1,130	0	1,280	0	0	3,520	0
14d-1	Upper Pryor Creek	31,490	0	2,900	0	28,590	2,190	26,400
14d-2	Lower Pryor Creek	9,220	0	4,080	0	5,140	2,160	2,980
	Subbasin Total	69,560	4,076,230	25,260	0	4,120,530	63,930	4,056,600
	Clarks Fork Subbasin							
14c-3	Clarks Fork-Zimmer Cr.	183,960[9]		6,660[9]	0	177,300[9]	0	177,300[9]
14c-5	Line Creek	12,000[9]	0	100[9]	0	11,900[9]	0	11,900[9]
	Clarks Fork River		560,000[3]			560,000[3]		560,000[3]
14c-4	Pat O'Hara Cr.	20	0	20	0	0	180[2]	0
14c-4a	Big Sand Coulee	230	2,200[3]	290	0	2,140	1,550	590
14c-6	N.F. Cherry-Silvertip Cr.	5,530	1,300[3]	2,300	0	4,530	17,010[2]	0
14c-7	Clarks Fork-Ruby Cr.	35,320	0	2,280	0	33,040	18,220	14,820
14c-8	Upper Rock Cr.	141,460	26,000	18,140	0	149,320	60	149,260
14c-9	Red Lodge--Rock Cr.	59,280	24,510[5]	32,540	2,400	48,850	62,890[6]	0
14c-10	Elbow-Lower Rock Cr.	9,400	0	7,760	0	1,640	28,830[6]	0
14c-11	Lower Clarks Fork E. Side	22,520	0	5,740	0	16,780	11,330	5,450
	Subbasin Total	273,760	614,010	69,070	2,400	816,300	140,070	676,230

See footnotes on following page.

TABLE 11-8--ESTIMATED SURFACE WATER RESOURCES, 1970 (Continued)

Watershed Numbers	Hydrologic Subareas	Phreato-phyte Area	Presently Irrigated Land	50 PERCENT CHANCE: Total Native Water Yield 1/	Flows From Upstream Sources 3/	Phreato-phyte Depletion	Reservoir Effect and Evapora-tion	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point	80 PERCENT CHANCE: Total Native Water Yield 1/	Flows From Upstream Sources 3/	Phreato-phyte Depletion	Reservoir Effect and Evapora-tion	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point
		-------Acres-------		- - - - Acre-Feet - - - -							- - - - Acre-Feet - - - -						
	Bighorn Subbasin																
14e6-8	Sage Creek	440	1,449	22,340 9/	0	3,080 9/	0	19,260 9/	2,320 9/	16,940 9/	16,320 9/	0	3,080 9/	0	13,240 9/	2,320 9/	10,920 9/
14e6-8a	Dry Creek	20	0	690 9/	0	140 9/	0	550 9/	0	550 9/	500 9/	0	140 9/	0	360 9/	0	360 9/
14e-27	Crooked Creek	200	332	14,200 9/	0	1,200 9/	0	13,000 9/	530 9/	12,470 9/	10,380 9/	0	1,200 9/	0	9,180 9/	530 9/	8,650 9/
	Bighorn River	0	0	0	2,362,000	0	0	2,362,000	0	2,362,000	0	1,800,000	0	0	1,800,000	0	1,800,000
14e-28	Porcupine Creek	20	0	3,090	34,000	120	0	36,970	0	36,970	1,500	27,000	120	0	28,380	0	28,380
14e-30	Dryhead Creek to Wyoming	580	134	16,030	0	4,060	0	11,970	220	11,750	7,170	0	4,060	0	3,110	220	2,890
14e-31	Black Canyon Creek	100	0	41,560	0	700	0	40,860	0	40,860	17,410	0	700	0	16,710	0	16,710
	Yellowtail Reservoir	0	0	0	0	0	26,000	0	0	0	0	0	0	20,000	0	0	0
14e-32	Soap Creek	700	4,507	19,790	0	5,250	0	14,540	7,210	7,330	8,800	0	5,250	0	3,550	7,210 7/	0
14e-33	Beauvais Creek	1,220	1,122	23,760	0	9,150	0	14,610	1,800	12,810	9,550	0	9,150	0	400	1,800 7/	0
14e-34	Rotten Grass Creek	1,140	17,088	26,830	0	4,630	0	22,200	27,340 7/	0	10,910	0	4,630	0	6,280	27,340 7/	0
14e-35	Two Leggins-Woody Creek	920	15	12,740	0	4,560	0	8,180	20	8,160	5,680	0	4,560	0	1,120	20	1,100
14e-36	Warren Bench	40	0	230	0	190	0	40	0	40	190	0	190	0	0	0	0
	Little Bighorn River	0	0	0	174,150	0	0	174,150	0	174,150	0	124,370	0	0	124,370	0	124,370
14e-37	West Side Bighorn River	830	3,606	5,270	0	6,230 7/	0	0	5,770 7/	0	2,260 7/	0	6,230 7/	0	0	5,770 7/	0
14e-37a	Two Leggins Irrigation Unit	1,560	27,085	1,130	0	11,700 7/	0	0	43,340 7/	0	500	0	11,700 7/	0	0	43,340 7/	0
14e-38	East Side Bighorn River	1,780	321	4,050	0	13,350 7/	0	0	510 7/	0	1,810	0	13,350 7/	0	0	510 7/	0
14e-39	Upper Tullock Creek	500	0	4,760	0	3,000	0	1,760	0	1,760	3,000	0	3,000	0	0	0	0
14e-40	Lower Tullock Creek	500	795	5,680	0	3,750	0	1,930	1,170	760	4,920	0	3,750	0	1,170	1,170	0
	Subbasin Total	10,550	56,454	164,920	2,570,150	66,690	26,000	2,642,380	87,380	2,555,000	73,700	1,951,370	66,690	20,000	1,938,380	87,380	1,851,000
	Little Bighorn Subbasin																
14e7-1	Little Bighorn River	1,560	6,773	26,660	102,000	9,080	0	119,580	10,840	108,740	24,780	82,000	9,080	0	97,700	10,840	86,860
14e7-2	Pass Creek	350	696	3,720	23,500	1,570	0	25,650	1,110	24,540	3,240	18,900	1,570	0	20,570	1,110	19,460
14e7-3	Lodge Grass Creek	2,550	2,234	33,960	12,800	15,400	1,200	30,160	3,750	26,410	29,050	10,300	15,400	1,000	22,950	3,750	19,200
14e7-4	Owl Creek	2,690	1,042	21,170	0	7,930	0	13,240	1,670	11,570	18,470	0	7,930	0	10,540	1,670	8,870
14e7-5	Little Bighorn East Side	900	250	13,040	0	6,300	0	6,740	400 8/	6,340	5,960	0	6,300 8/	0	0	400 8/	0
14e7-6	Little Bighorn West Side	640	6,139	10,850	0	4,480	0	6,370	9,820 8/	0	5,020	0	4,480	0	540	9,820 8/	0
	Subbasin Total	8,690	17,134	109,400	138,300	44,760	1,200	201,740	27,590	174,150	86,520	111,200	44,760	1,000	151,960	27,590	124,370
SUMMARY																	
	Stillwater Subbasin	4,758	29,252	850,400	0	18,760	0	831,640	63,500	768,140	701,380	0	18,760	0	682,620	71,310	611,310
	Yellowstone Minor Drainages	3,788	39,951	98,630	4,813,930	25,260	0	4,887,300	63,930	4,823,370	69,560	4,076,230	25,260	0	4,120,530	63,930	4,056,600
	Clarks Fork Subbasin	15,413	88,628	313,070	713,200	69,070	3,200	954,000	140,070	813,930	273,760	614,010	69,070	2,400	816,300	140,070	676,230
	Bighorn Subbasin	10,550	56,454	164,920	2,570,150	66,690	26,000	2,642,380	87,380	2,555,000	73,700	1,951,370	66,690	20,000	1,938,380	87,380	1,851,000
	Little Bighorn Subbasin	8,690	17,134	109,400	138,300	44,760	1,200	201,740	27,590	174,150	86,520	111,200	44,760	1,000	151,960	27,590	124,370
TOTAL		43,199	231,419	1,536,420	XXXXXXXXX	224,540	30,400	XXXXXXXXX	382,470	XXXXXXXXX	1,204,920	XXXXXXXX	224,540	23,400	XXXXXXXXX	390,280	XXXXXXXXX

Source: River Basin Planning Staff

1/ Except that inflow required to supply evaporation from flowing streams, ponds, and small lakes is not estimated.
2/ Supplied from flow of Clarks Fork River.
3/ Streamflow entering watershed from Wyoming.
4/ Supplied from flow of Yellowstone River.
5/ Diversion from East Rosebud River.
6/ Supplied from flow of Rock Creek and Cooney Reservoir storage.
7/ Supplied from flow of Bighorn River and Yellowtail Reservoir storage.
8/ Supplied from flow of Little Bighorn River.
9/ Flow crossing state line into Wyoming. Figures are not additive into subbasin totals.

TABLE II-9 --IRRIGATED LANDS BY TYPE OF IRRIGATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Type of Irrigation I	II	III	IV	Total
		- - - - - - - - acres - - - -				
	Stillwater Subbasin					
14b-1	Upper Stillwater River	--	--	768	--	768
14b-2	Fishtail to Butcher Cr.	1,504	12,811	4,528	--	18,843
14b-3	Lower Stillwater River	--	3,843	1,647	--	5,490
14b-4	Shane-Beaver Cr.	--	2,906	1,245	--	4,151
	Subbasin Total	1,504	19,560	8,188	--	29,252
	Yellowstone Minor Drainages					
14-22	Cow-Bellion Cr.	519	1,091	--	--	1,610
14-27	Blue-Duck Cr.	1,093	2,031	--	--	3,124
14-31	Arrow Cr.	19,593	8,397	--	--	27,990
14-32	Fly Cr.	500	500	125	125	1,250
14-36	Lost Boy Cr.	423	529	--	106	1,058
14-37	Custer Drainage	1,430	770	--	--	2,200
14d-1	Upper Pryor Cr.	10	1,361	--	--	1,371
14d-2	Lower Pryor Cr.	809	539	--	--	1,348
	Subbasin Total	24,377	15,218	125	231	39,951
	Clarks Fork Subbasin					
14c-3	Clarks Fork-Zimmer Cr.	--	--	--	--	--
14c-4	Pat O'Hara Cr.	56	56	--	--	112
14c-4a	Big Sand Coulee	726	242	--	--	968
14c-5	Line Cr.	--	--	--	--	--
14c-6	N.F. Cherry-Silvertip Cr.	10,633	--	--	--	10,633
14c-7	Clarks Fork-Ruby Cr.	9,108	2,277	--	--	11,385
14c-8	Upper Rock Cr.	--	--	40	--	40
14c-9	Red Lodge-Rock Cr.	7,862	31,446	--	--	39,308
14c-10	Elbow-Lower Rock Cr.	15,280	3,820	--	--	19,100
14c-11	Lower Clarks Fork E. Side	6,309	773	--	--	7,082
	Subbasin Total	49,974	38,614	40	--	88,628

TABLE II-9--IRRIGATED LANDS BY TYPE OF IRRIGATION (Cont'd)
(Montana)

Watershed Number	Watershed Name	Type of Irrigation I	II	III	IV	Total
		acres				
	Bighorn Subbasin					
14e6-8	Sage Cr.	273	1,176	--	--	1,449
14e6-8a	Dry Cr.	--	--	--	--	--
14e-27	Crooked Cr.	--	--	332	--	332
14e-28	Porcupine Cr.	--	--	--	--	--
14e-30	Dryhead Cr. to Wyo.	--	--	134	--	134
14e-31	Black Canyon Cr.	--	--	--	--	--
14e-32	Soap Cr.	1,803	2,479	225	--	4,507
14e-33	Beauvais Cr.	--	1,010	112	--	1,122
14e-34	Rotten Grass Cr.	11,107	5,126	855	--	17,088
14e-35	Two Leggins-Woody Cr.	--	--	--	15	15
14e-36	Warren Bench	--	--	--	--	--
14e-37	West Side Bighorn River	2,356	1,250	--	--	3,606
14e-37a	Two Leggins Irr. Unit	18,960	8,125	--	--	27,085
14e-38	East Side Bighorn River	--	321	--	--	321
14e-39	Upper Tullock Cr.	--	--	--	--	--
14e-40	Lower Tullock Cr.	406	174	--	215	795
	Subbasin Total	34,905	19,661	1,658	230	56,454
	Little Bighorn Subbasin					
14e7-1	Little Bighorn River	--	6,773	--	--	6,773
14e7-2	Pass Cr.	--	557	139	--	696
14e7-3	Lodge Grass Cr.	--	2,234	--	--	2,234
14e7-4	Owl Cr.	--	1,042	--	--	1,042
14e7-5	Little Bighorn E. Side	--	250	--	--	250
14e7-6	Little Bighorn W. Side	3,683	2,456	--	--	6,139
	Subbasin Total	3,683	13,312	139	--	17,134
	Summary					
Stillwater Subbasin		1,504	19,560	8,188	--	29,252
Yellowstone Minor Drainages		24,377	15,218	125	231	39,951
Clarks Fork Subbasin		49,974	38,614	40	--	88,628
Bighorn Subbasin		34,905	19,661	1,658	230	56,454
Little Bighorn Subbasin		3,683	13,312	139	--	17,134
TOTALS		114,443	106,365	10,150	461	231,419

Source: River Basin Planning Staff

Quality of Water

The quality of surface water and shallow ground water is suitable for irrigation in most places in the Basin. These waters are considered "hard" in that they generally contain considerably higher concentrations of calcium and magnesium ions than of sodium ions. Such waters are suitable for irrigation of most soils. "Soft" waters that have higher concentrations of sodium ions than of calcium and magnesium ions tend to deflocculate clay in the soil, dissolve humus, and cause puddling and water logging conditions. Water close to the Beartooth Mountains is low in dissolved solids and is relatively soft, but salt concentrations closer to the Yellowstone River have been increased by ground-water return flows.

The quality of ground water is generally good except where it flows through saline shales. In such areas the yield from wells is not sufficient to consider its use for irrigation and excessive salts often make it unusable for human and livestock consumption. See maps II-8 and II-9.

Water derived from bedrock aquifers is normally soft, containing a high ratio of sodium to calcium-magnesium and is considered generally unsatisfactory for irrigation. Water is satisfactory for domestic and stock use if the quantity of dissolved solids is not excessive. Very deep aquifers tend to be lower in quality for two reasons: (1) they have greater opportunity for contamination by salts from poor recharge sources such as marine shales; (2) deep water moves through the rocks more slowly, which gives it greater opportunity to dissolve minerals from the aquifers. Ground water can range widely in quality within a relatively short distance because permeabilities within an aquifer may change rapidly, particularly in the Tertiary formations.

Ground water from the Chugwater, Madison, and Amsden formations is an exception to the general "soft water" rule. This water is very hard, coming from formations which are high in calcium and magnesium carbonates. It is generally satisfactory for irrigation on well-drained soils. Spring water is utilized at the Montana Department of Fish and Game fish hatchery on Bluewater Creek. These artesian aquifers in fractured zones show the greatest potential for future development of large volumes of ground water.

Alluvial ground water in the eastern portion of the Basin in Montana is normally very hard and high in dissolved solids. Effluent recharge from adjacent shaly bedrock and irrigation return waters is usually not of potable quality. The water is generally satisfactory for irrigation when there is recharge from surface flow to the aquifer and when used on well-drained soils. Ground water in the Big Horn Valley is too high in salts for domestic and stock use and very little is used north of St. Xavier.

Ground-Water Supplies

Ground water is widely used throughout the Basin as a source of domestic, industrial, irrigation, municipal, and livestock water. A ground-water inventory was made and relevant maps were constructed. Formation symbols, geologic structures, and the outline of areas covered by publications that pertain to ground-water studies are shown. An indication of general ground-water quality is mentioned in the description. Maps II-8 and II-9 and the stratigraphic legend show potential aquifers from which water can usually be obtained from wells and springs.

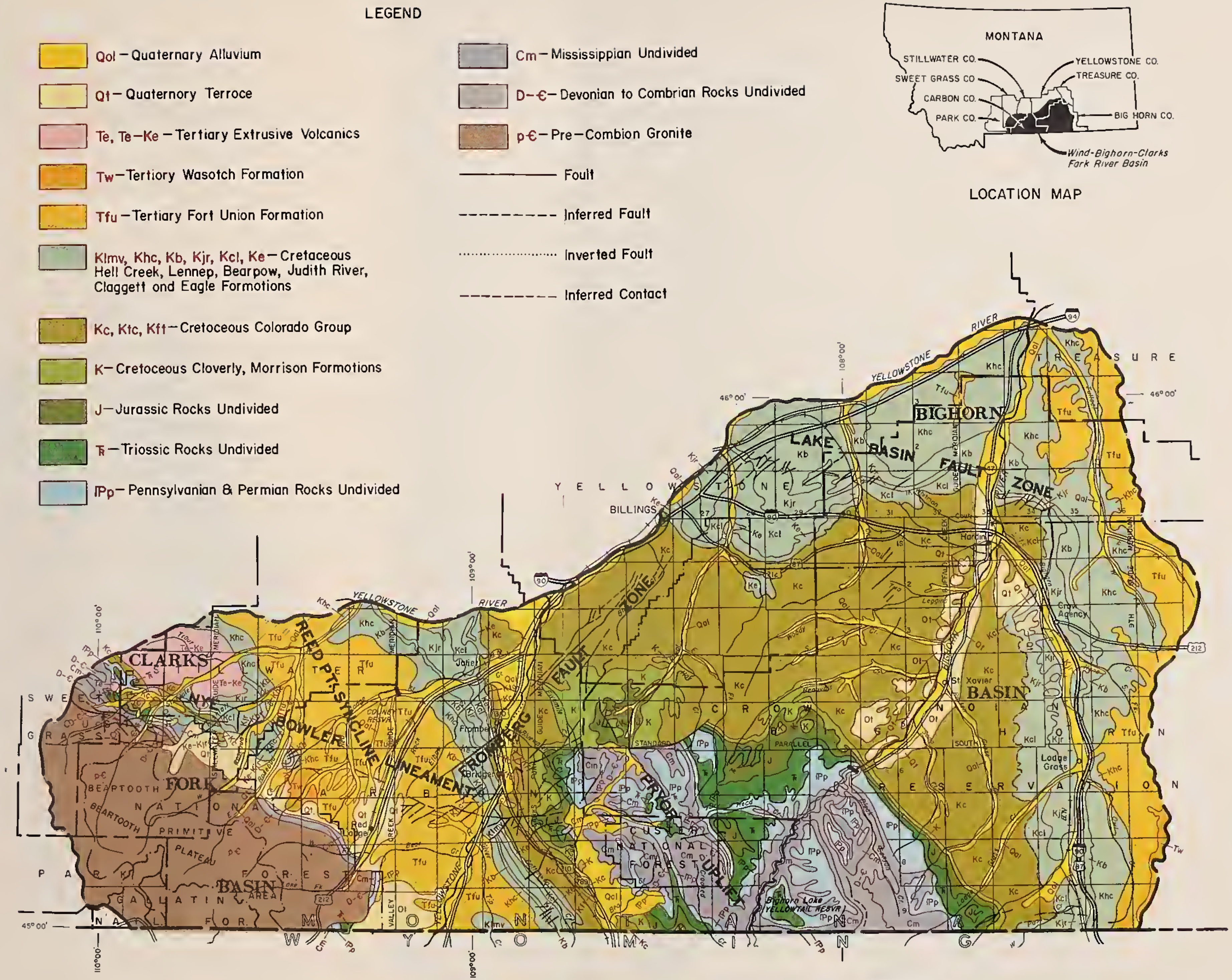
Map II-9 shows the availability of water from bedrock aquifers, depth of the regional water table, and anticipated total depth for wells. Most wells drilled to bedrock yield less than 25 gallons per minute per foot of drawdown. Many yield less than three gpm per foot of drawdown. The Chugwater-Tensleep-Madison series is capable of yielding water around 25 gpm when conditions are favorable. The Madison is cavernous at some locations, and these rocks are normally fractured because of their brittle nature. At locations of large hydrostatic head and large void ratio, substantial yields are possible. One well on Bluewater Creek flows 8.3 cubic feet per second (cfs) or 3,700 gpm.

Moderately large yields are possible from the alluvium at some locations. The greatest yields are obtained close to the mountains where a greater abundance of sand and gravel exists. Yields average about 300 gpm per well or an average of 10 gpm per foot of drawdown. Exceptional wells of 1,000-2,000 gpm have been reported. There is an opportunity for development of a greater number of irrigation and industrial wells from alluvial sources. At some locations, there may be a conflict between ground-water and surface water rights.

Areas of high elevation in the Pryor and Bighorn Mountains have a deep regional water table. Well depths and pump lifts must necessarily be great except where shallow developments are possible from perched water tables.

Metamorphic and volcanic rocks in the Beartooth uplifted areas are normally hard and have low permeability except in the zone of surficial weathering. Best chances of domestic and stock water development are in the valley areas.

Areas of shale formations are shown on the map. Wells in these formations must normally be deep to penetrate the shale and obtain water from underlying aquifers. Occasionally there is an opportunity to obtain water from alluvial material when it is recharged with good quality water. Water within shale aquifers normally has too high a



MAP II-8

GENERALIZED GEOLOGY

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

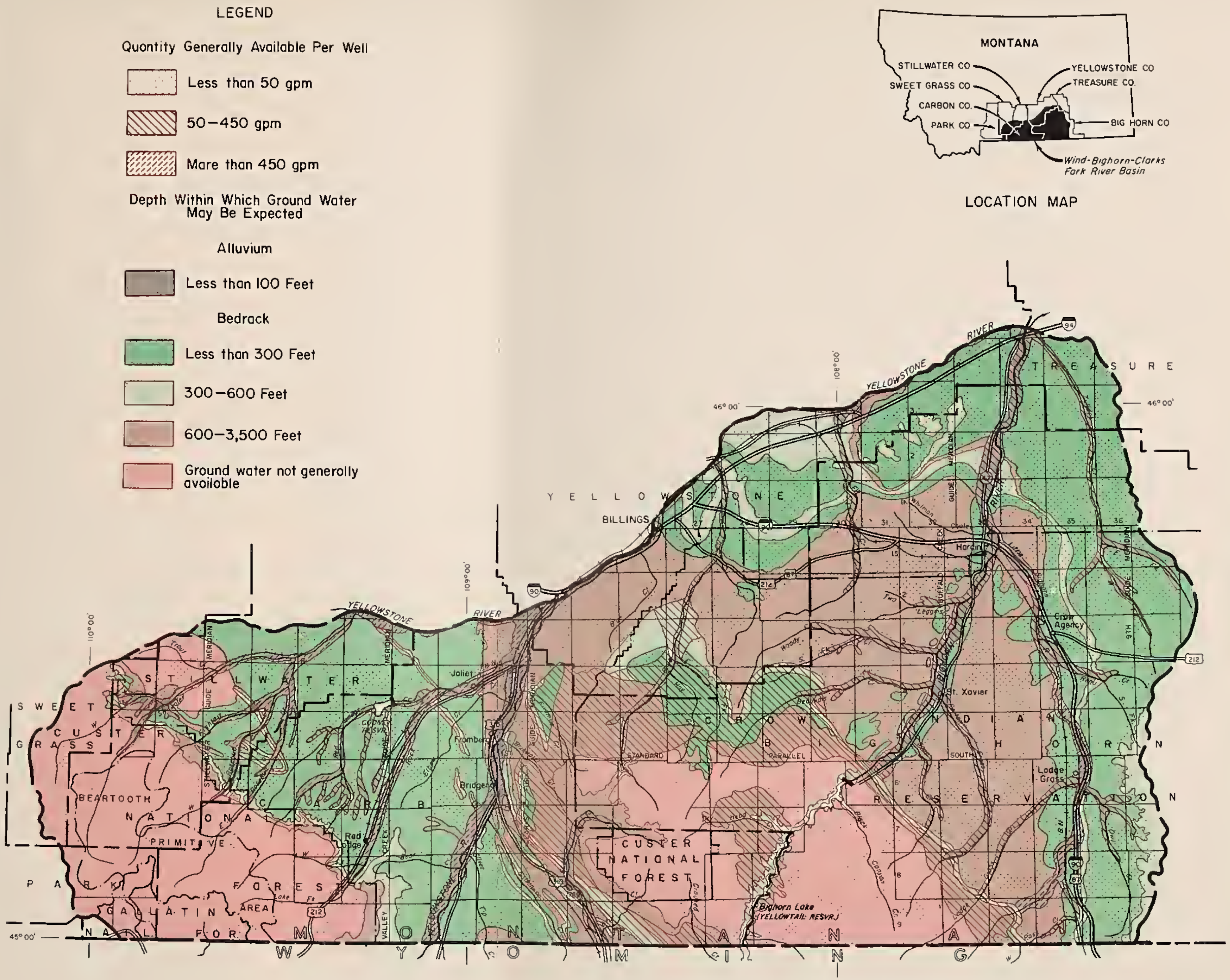
APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914G-N



MAP II-9

GENERAL AVAILABILITY OF GROUND WATER

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914H-N

STRATIGRAPHIC LEGEND
FOR GENERAL AVAILABILITY OF GROUNDWATER MAP
WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA PORTION

AGE			FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY			Valley Alluvium	Water Bearing	** 50 - 450+ gpm	Fair to Good
			River Terrace	Water Bearing	Less than 50 gpm	Fair to Good
TERTIARY	EOCENE PALEOCENE		Wasatch-Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		*Extrusive Pyroclastics	Non-Water Bearing		
			Hell Creek Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
			Lennep Sandstone	Water Bearing	Less than 50 gpm	Fair to Good
			*Bearpaw Shale	Non-Water Bearing		
			Judith River Formation	Water Bearing	Less than 50 gpm	Poor to Fair
			*Claggett Shale	2/ Non-Water Bearing	2/ Less than 50 gpm	Poor to Fair
			Eagle Sandstone	Water Bearing	*** Less than 50 gpm	Fair to Good
		COLORADO GROUP	Telegraph Creek Formation	Water Bearing	Less than 50 gpm	Fair to Poor
			Niobrara Formation	Non-Water Bearing		
			*Cody Shale	Non-Water Bearing		
			*Carlile Shale	Non-Water Bearing		
			*Greenhorn Formation	Non-Water Bearing		
			Frontier Formation	Non-Water Bearing		
	LOWER		Frontier, Torchlight Member	Water Bearing	*** Less than 50 gpm	Poor
			Belle Fourche Shale	Non-Water Bearing		
			*Mowry Shale	Non-Water Bearing		
			Muddy Sandstone	Water Bearing	Less than 50 gpm	Poor
			*Thermopolis Shale	Non-Water Bearing		
			Cloverly Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC			Morrison Formation	Water Bearing	Less than 50 gpm	Poor to Fair
			Swift Formation	Water Bearing	Less than 50 gpm	Poor to Fair
			Rierdon Formation	Non-Water Bearing		
			Sundance Formation	Water Bearing	Less than 50 gpm	Poor
			*Gypsum Spring-Piper Formation	Non-Water Bearing		
TRIASSIC			*Chugwater Formation	Non-Water Bearing		
			*Dinwoody Formation	Non-Water Bearing		
PERMIAN			Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN			Tensleep Sandstone	Water Bearing	*** 50 - 450 gpm	Fair to Good
			Amsden Formation	Water Bearing	*** 50 - 450 gpm	Fair to Good
MISSISSIPPIAN			Madison Group	Water Bearing	*** 50 - 450 gpm	Good
DEVONIAN			Jefferson Limestone	Water Bearing	*** Less than 50 gpm	Good
ORDOVICIAN			*Big Horn Dolomite	Non-Water Bearing		
CAMBRIAN			Gallatin Limestone	Water Bearing	*** Less than 50 gpm	Poor to Fair
			Gros Ventre Formation	Non-Water Bearing		
			*Flathead Quartzite	Water Bearing	*** 50 - 450 gpm	Good
PRECAMBRIAN			*Metamorphic & Igneous Rocks	Non-Water Bearing		

* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.

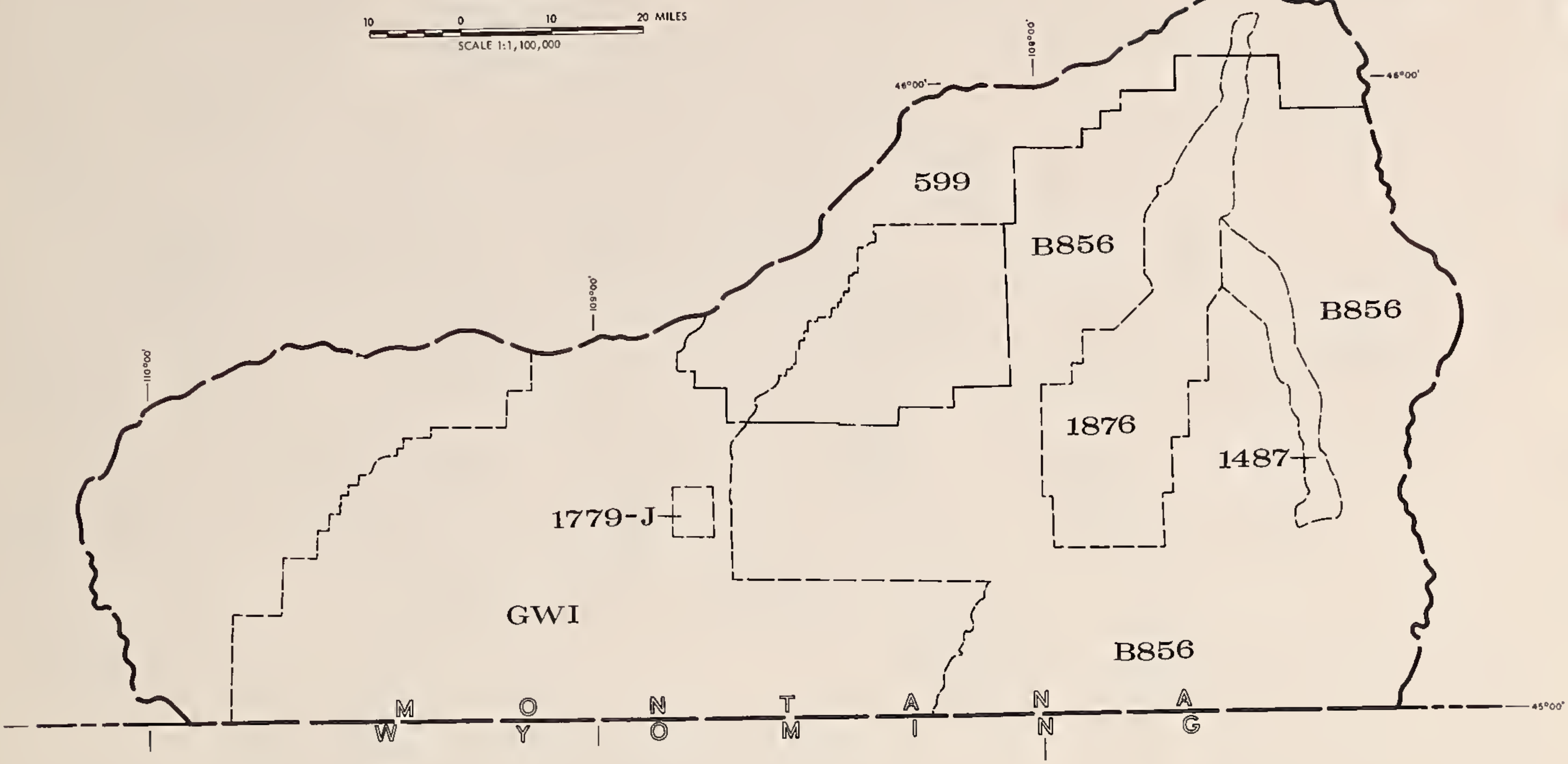
2/ Parkman Sandstone member of Claggett may be water bearing.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-N-22914H

AREAS COVERED BY GROUND WATER REPORTS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
MONTANA

APRIL 1973



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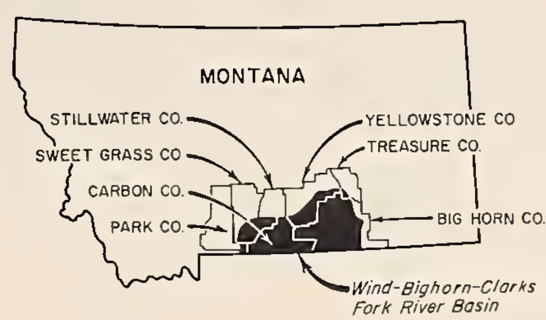
MONTANA

599	USGS Water Supply Paper 599, Ground Water in Yellowstone and Treasure Counties, Montana; G.M. Hall and C.S. Howard, 1929.
B856	USGS Bulletin 856. Geology of Big Horn County and the Crow Indian Reservation, Montana, 1935; W.T. Thom, Jr., G.M. Hall, C.H. Wegemann, and G.F. Moulton.
1487	USGS Water Supply Paper 1487, Geology and Ground Water Resources of the Lower Little Big Horn River Valley, Big Horn County, Montana; E.A. Moulder, M.F. Klug, D.A. Morris and F.A. Swenson, 1960.
1779-J	USGS Water Supply Paper 1779-J, Geology and Water Resources of the Bluewater Springs Area, Carbon County, Montana; E.A. Zimmerman, 1964.
1876	USGS Water Supply Paper 1876, Geology and Ground Water Resources of the Lower Big Horn Valley, Montana; L.J. Hamilton and Q.F. Paulson, 1968.
GWI	Ground Water Inventory, Carbon County, Montana, Montana Water Resources Board, 1969.



LOCATION MAP

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

M7-E-22914H-N

concentration of salts for human and stock consumption. Aquifers beneath the shale usually have artesian pressure connected to recharge areas adjacent to the mountains. Consequently, wells may flow or have a small pump lift.

Large terraces adjacent to stream valleys are underlain by sand and gravel and often offer the opportunity for a shallow well or a spring development. Large yields are possible when conditions are favorable. Terrace material overlying shale, however, may contain a high concentration of salts derived from downward percolating water from precipitation and/or irrigation and impaired drainage.

Sandstones in the Wasatch, Fort Union, and Hell Creek Formations are lenticular and irregular. An average of 5 to 10 feet of sandstone exists per 100 feet of thickness in these formations. Wells located in these formations will encounter different geologic conditions; as a result, the ground-water potential of each well site requires individual evaluation. Map II-9 is generalized and does not show local detail.

FISH AND WILDLIFE HABITAT AND POPULATIONS

A variety of game habitat occurs in the Basin, ranging from rough alpine crags to vast grassland-sagebrush plains. Streams of varying size and gradient bisect this topography forming both narrow, steep-sided canyons and restricted alluvial valleys. Vegetative cover includes alpine growth, dense coniferous forests, typical semidesert shrub and grasslands, and dryland and irrigated farming.

Improved land management measures such as grassed waterways and water developments have provided wildlife with better habitat conditions. Timber harvest on forested lands often permits the improved growth rate and establishment of shrubs, forbs, and grass to provide increased forage. Controlled burning of areas is also of benefit as it eliminates many of the slash obstacles existing in a harvested area and improves the availability of nutrients for new plant growth. Fringes or strips of timber need to be left for wildlife cover and to improve snow-trap holding characteristics of the harvested areas.

Cropland throughout the study area has generally benefited small game. Breaking up of large habitat types for crop production has created additional "edge" and diversified habitat, especially on irrigated lands. The spreading of water on bottom and benchlands has created additional habitat for several species, especially pheasants, when cereal grains are involved. Some fur animals and white-tailed deer have benefited with river bottom irrigation. However, the use of "clean" farming techniques has been particularly destructive of willows, cover for deer and fur animals, on canals and drains and minimized these gains.

Deer are well distributed throughout the area. Both mule and white-tailed deer are common in most of their respective habitats. An exception is the Crow Indian Reservation where over-hunting has decimated deer populations, thus leaving much excellent deer habitat unused. See table II-10 and figure II-2.

TABLE II-10--ACRES OF BIG GAME RANGE AND GAME POPULATIONS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Game Species	Estimated Acres of Range	Estimated Population
Elk	1,087,000	600
Deer	4,989,000	22,000
Antelope	3,524,000	5,000
Moose	416,000	400
Bighorn Sheep	620,000	500
Rocky Mountain Goats	96,000	400
Bear	908,000	500

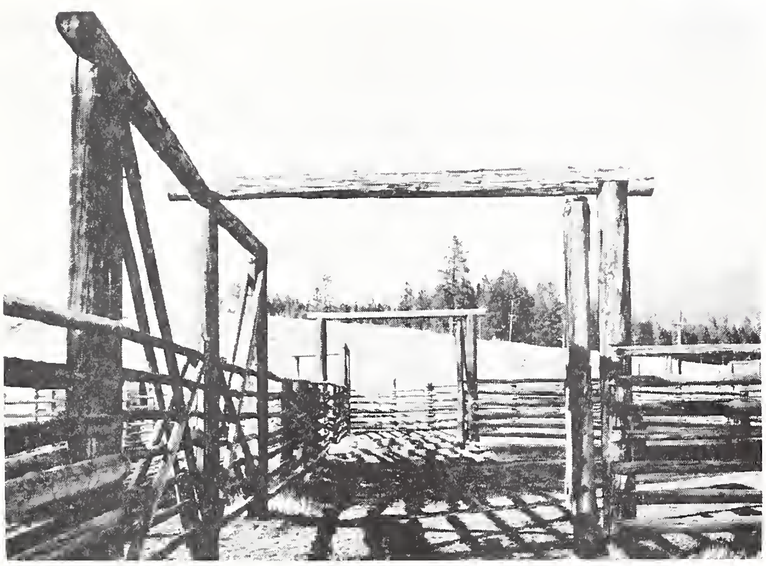
Sources: Acres of Range adapted from Missouri River Basin Framework Study; Population figures from Montana Department of Fish and Game. Wildlife habitat ranges are shown in figure II-2.

Elk, very popular but scarce big game animals, are scattered throughout the Beartooth and Pryor Mountains. Antelope continue to decrease as habitat is destroyed or degraded through land use change, fencing, and overgrazing. Moose, bighorn sheep, and Rocky Mountain goat populations are confined by their specialized habitat requirements to the mountainous portions of the subbasin.

Bear populations are low and their range more or less coincides with the mountain forest habitat. See figure II-2. A small portion of the southwestern part of the Beartooth plateau serves as habitat for the grizzly bear which is classified as a rare species. Because of incompatability between grizzlies and man, minimization of contact is necessary if we are to maintain populations of this rare animal.

Thinning overcrowded stands to increase growth and quality.
USDA-FOREST SERVICE PHOTO

Debarking poles for use as fence posts--Custer National Forest. USDA-FOREST SERVICE PHOTO



Lodgepole corral. During the development of the West, lodgepole's highest use was for corrals and fences, but now it is used for power poles, woodpulp, and panels for interior finishing.
USDA-FOREST SERVICE PHOTO

Bull elk during rutting season in the high country.
SCS PHOTO 11-P106S-6

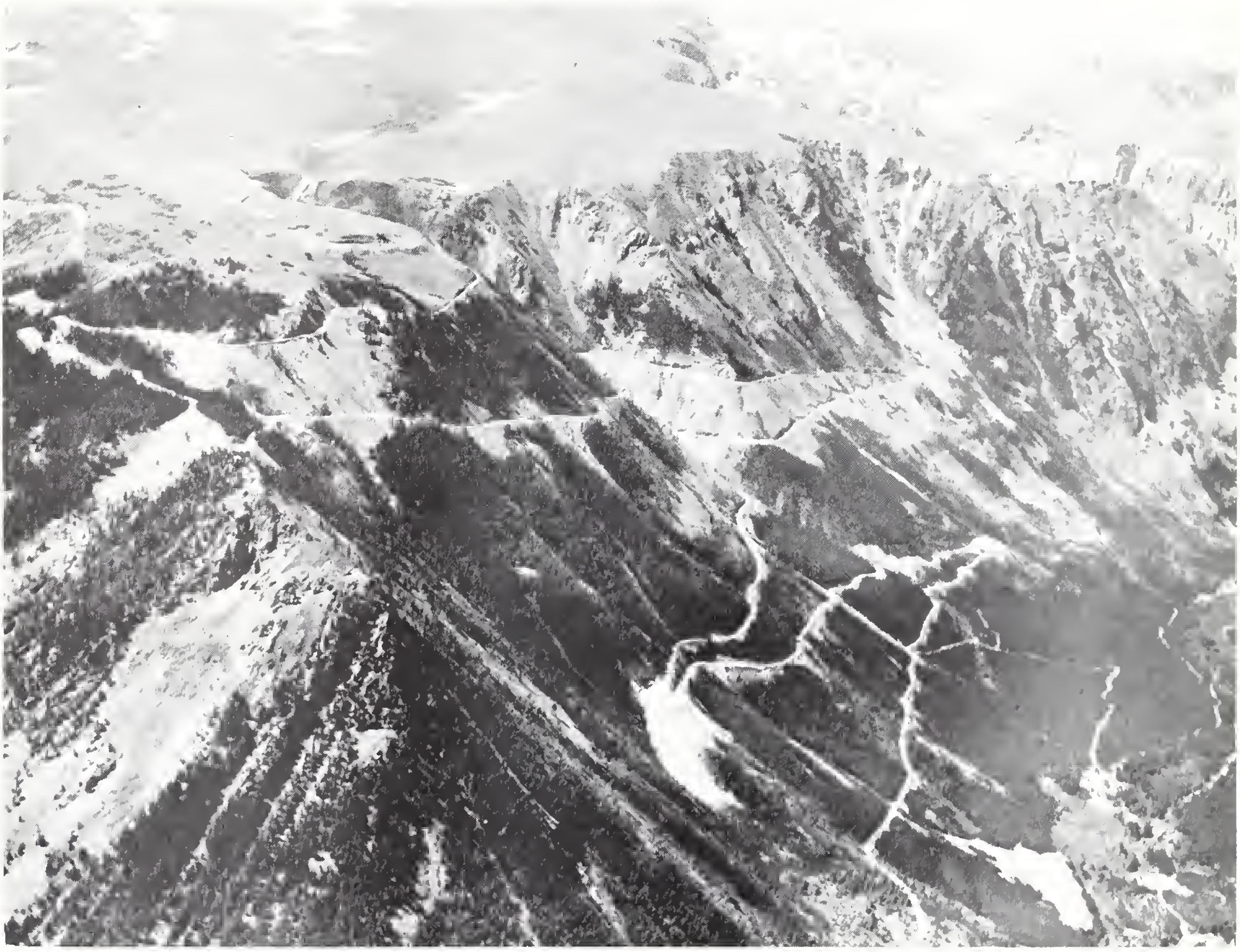
Bighorn ram on winter range.
SCS PHOTO

Two more trout to a limit. Farm pond in Big Horn County.
SCS PHOTO 11-P354-10

White-tailed deer are found along streams at lower elevations in the Basin.
USDA-FOREST SERVICE PHOTO

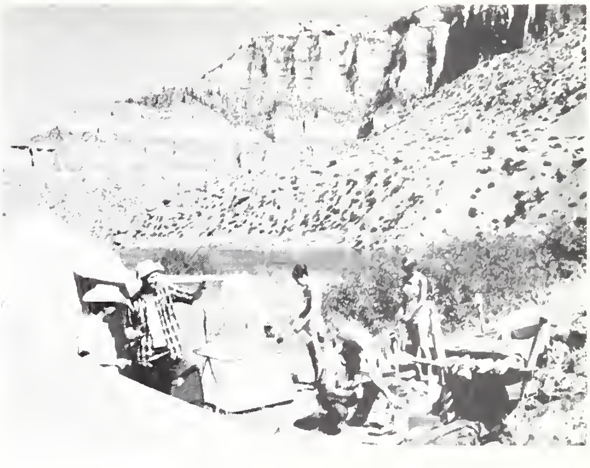
Snowshoe rabbit in summer coloration. USDA-FOREST SERVICE PHOTO

Foxes range from timbered uplands to open prairie.
USDA-FOREST SERVICE PHOTO

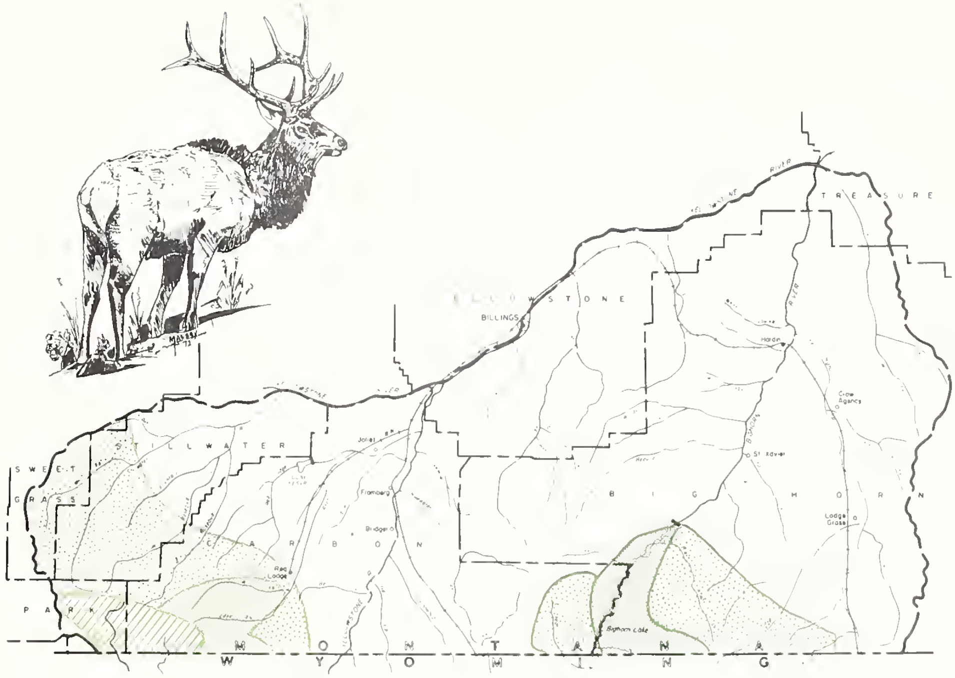


From Rock Creek valley to the alpine tundra over the switchbacks of the Beartooth Highway. USDA - FOREST SERVICE PHOTO

An alpine lake on the Beartooth plateau. USDA-FOREST SERVICE PHOTO

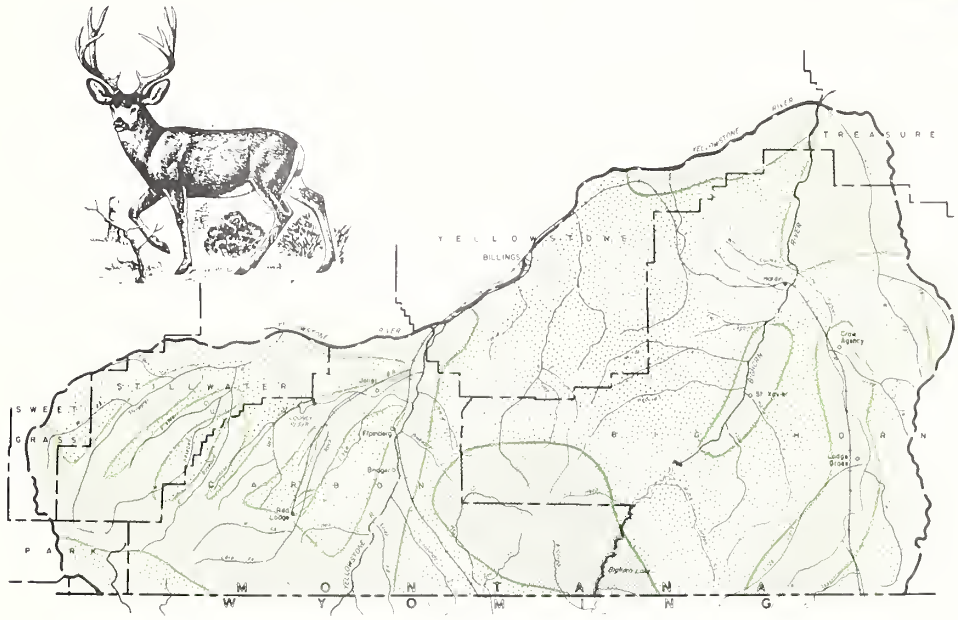


Big Bull Elk Canyon camp in Bighorn National Recreation area. BUREAU OF RECLAMATION PHOTO



A. ROCKY MOUNTAIN ELK

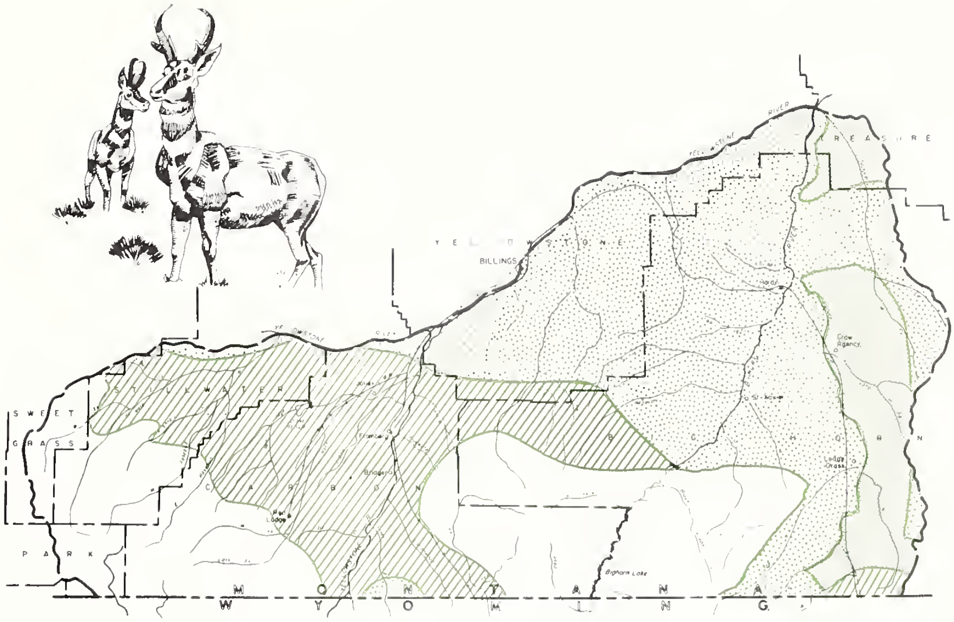
HABITAT VALUE
HIGH
MEDIUM
LOW



B. MULE & WHITE-TAILED DEER

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



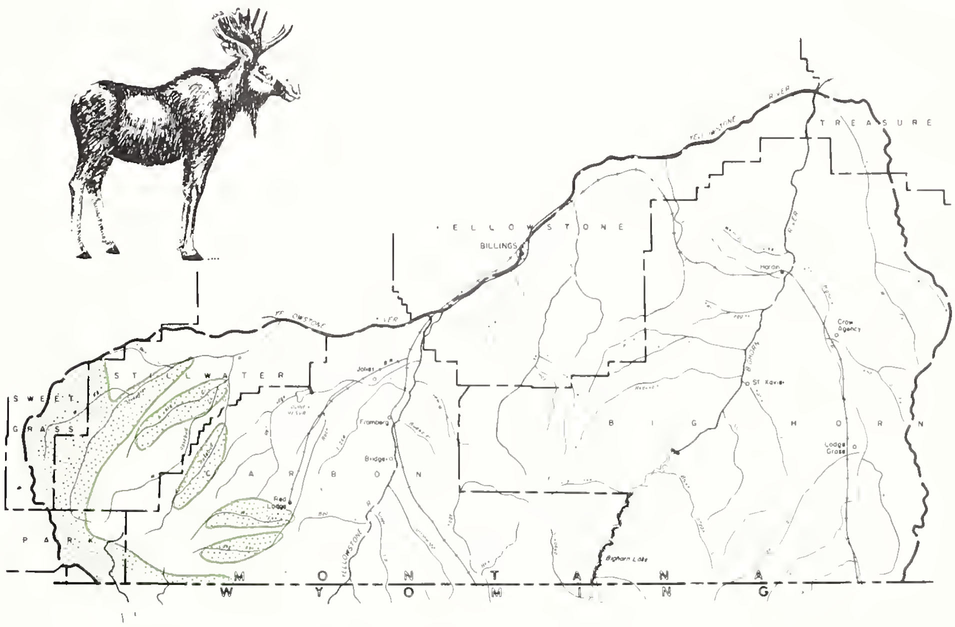
C. PRONGHORN ANTELOPE

HABITAT VALUE

HIGH

MEDIUM

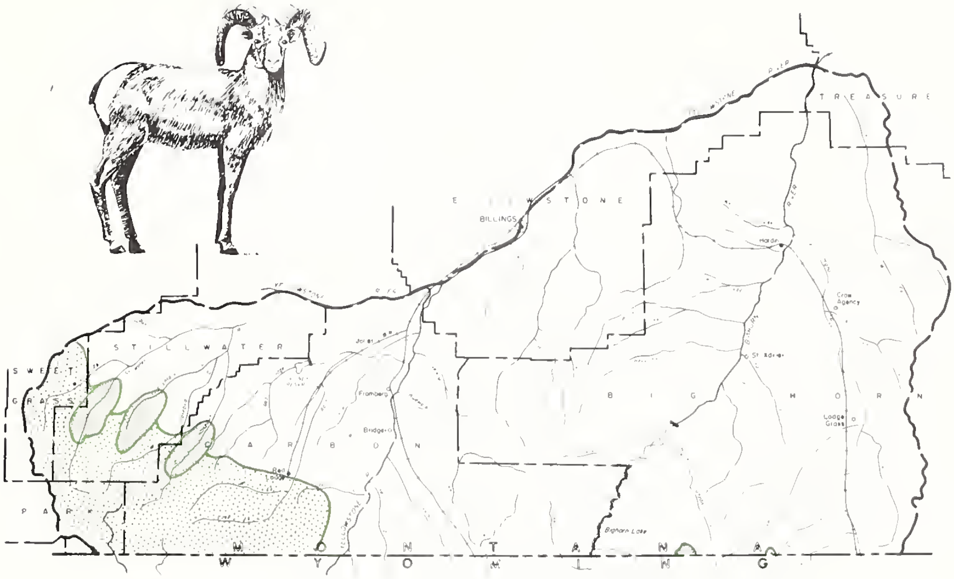
LOW



D. SHIRAS MOOSE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



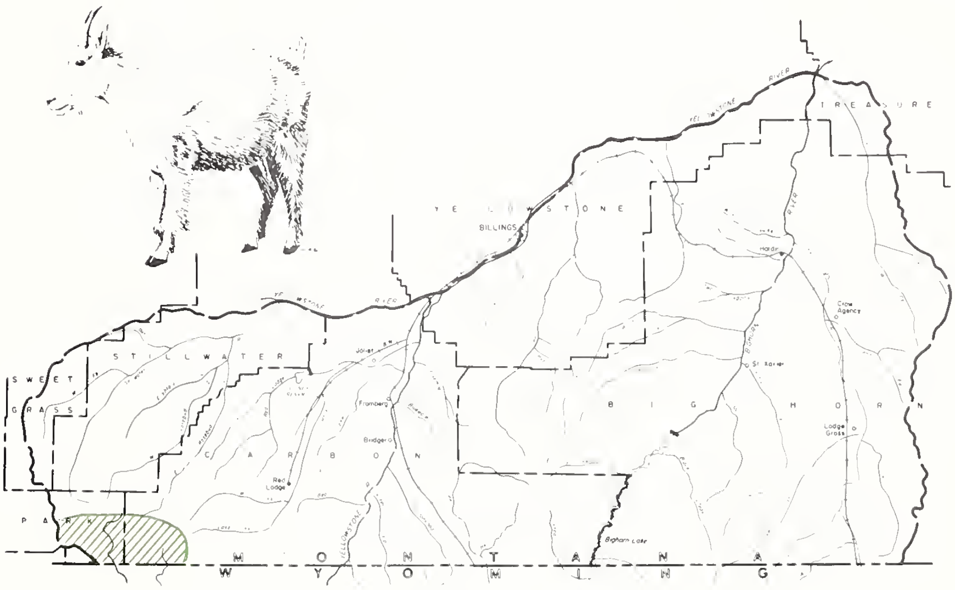
E. BIGHORN SHEEP

HABITAT VALUE

HIGH

MEDIUM

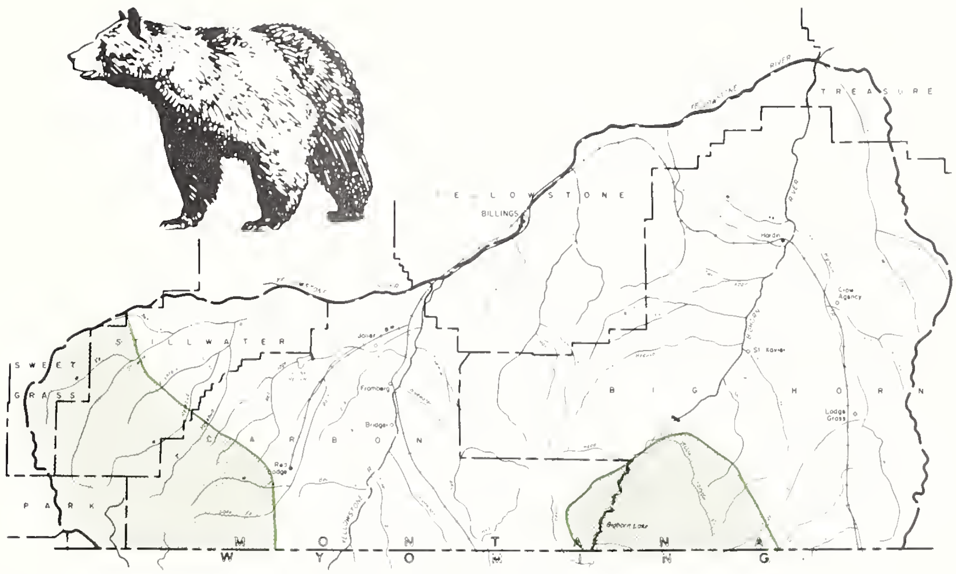
LOW



F. MOUNTAIN GOAT

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



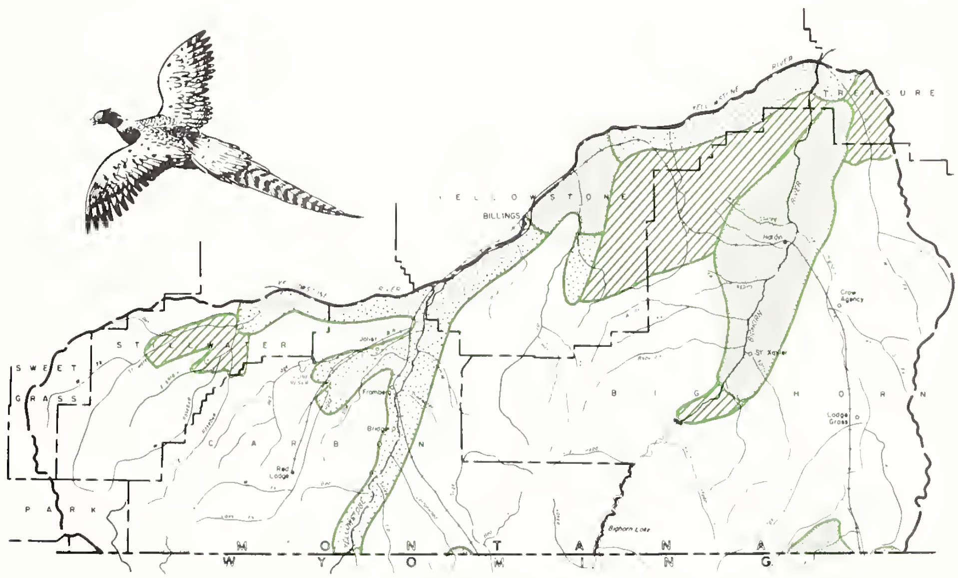
G. BEAR

HABITAT VALUE

HIGH

MEDIUM

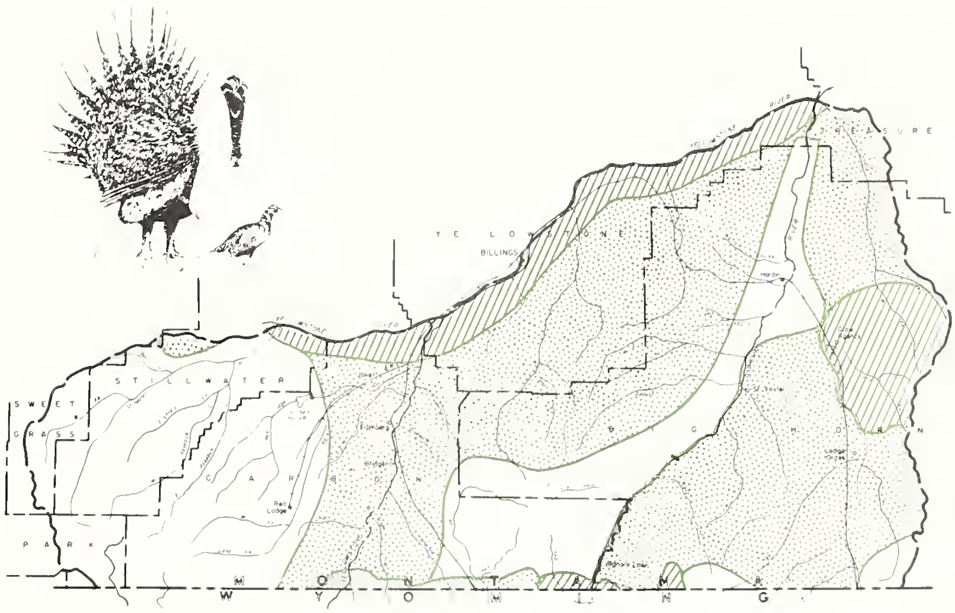
LOW



H. RING-NECKED PHEASANT

FIGURE II-2 WILDLIFE HABITAT

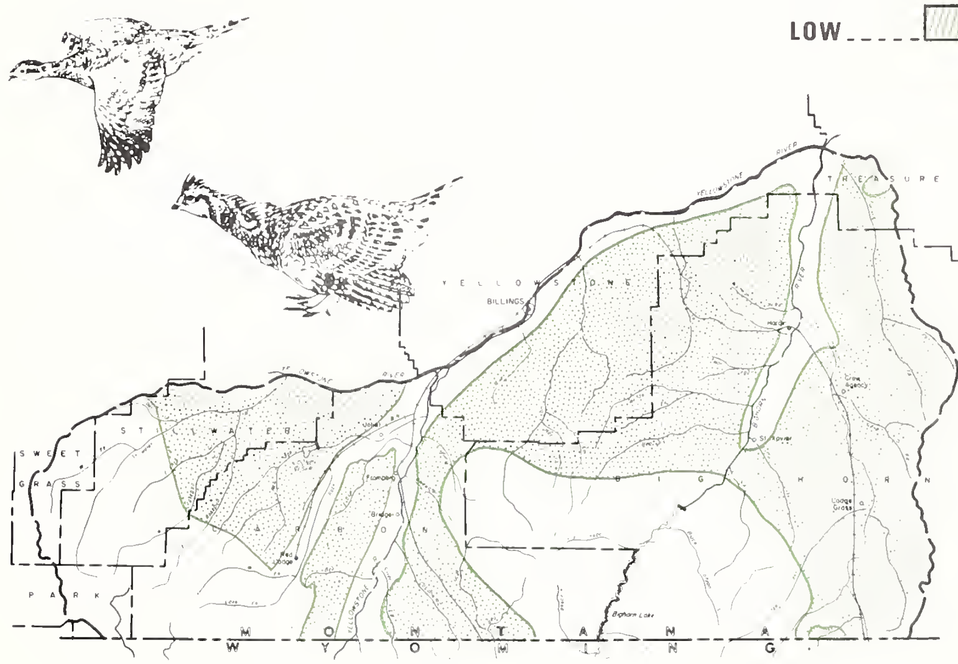
Source: Adapted from Missouri River Basin Framework Study



I. SAGE GROUSE

HABITAT VALUE

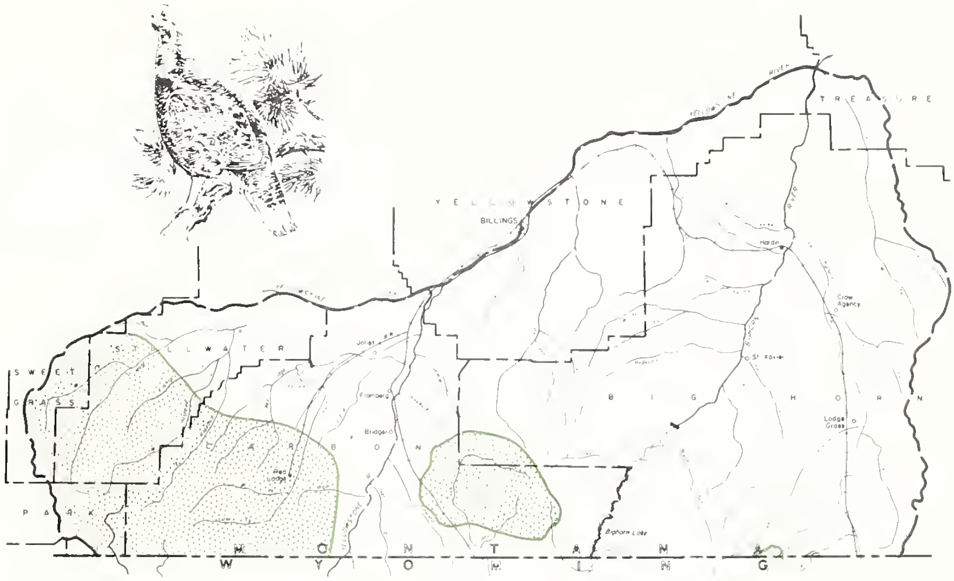
HIGH
MEDIUM
LOW



J. SHARP-TAILED GROUSE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



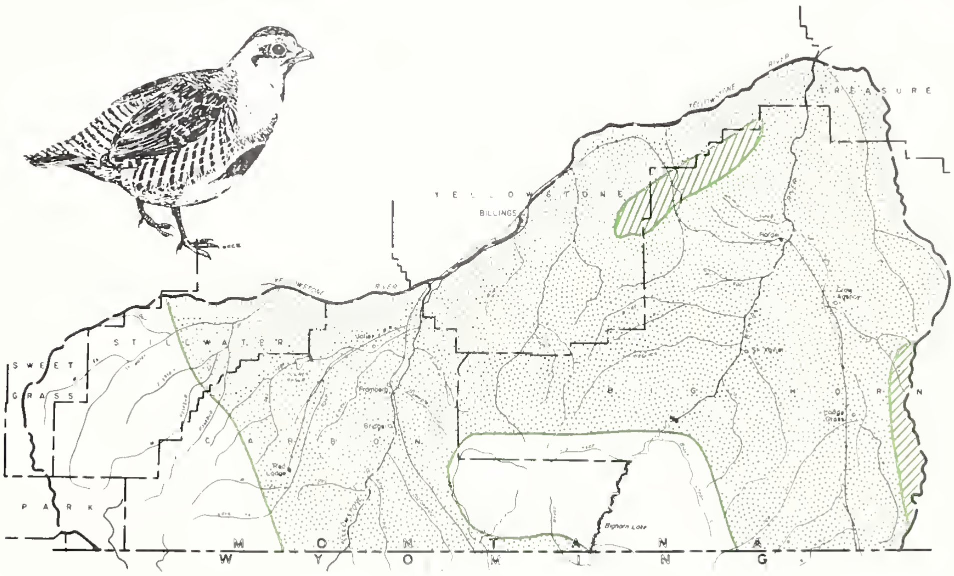
K. MOUNTAIN GROUSE

HABITAT VALUE

HIGH

MEDIUM

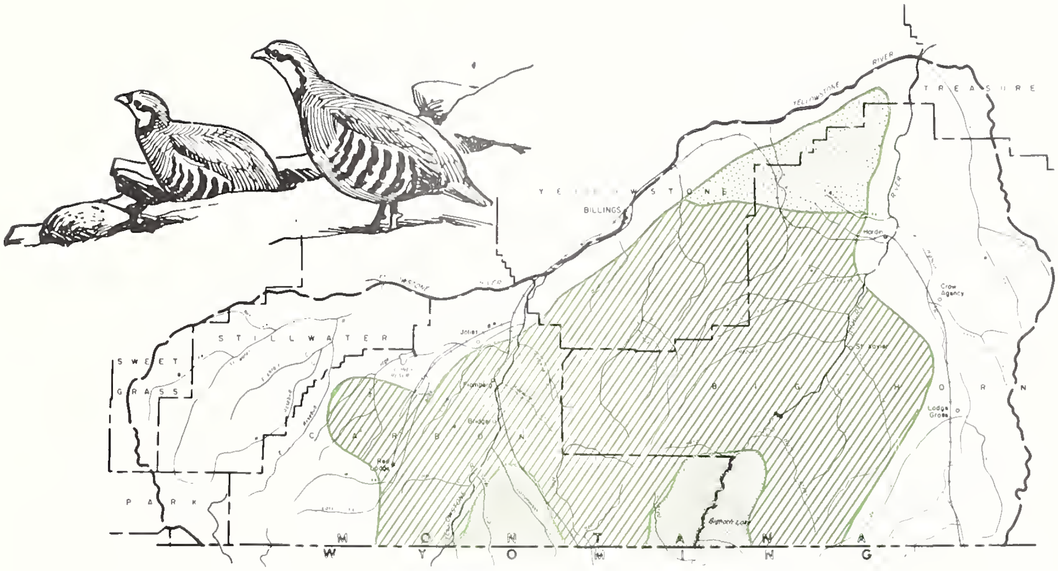
LOW



L. GRAY (HUNGARIAN) PARTRIDGE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



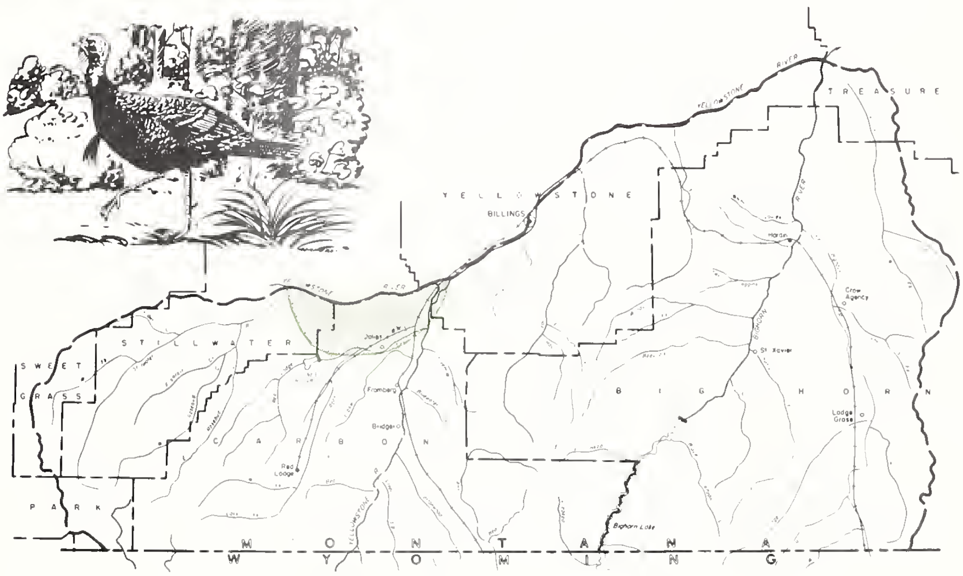
M. CHUKAR PARTRIDGE

HABITAT VALUE

HIGH

MEDIUM

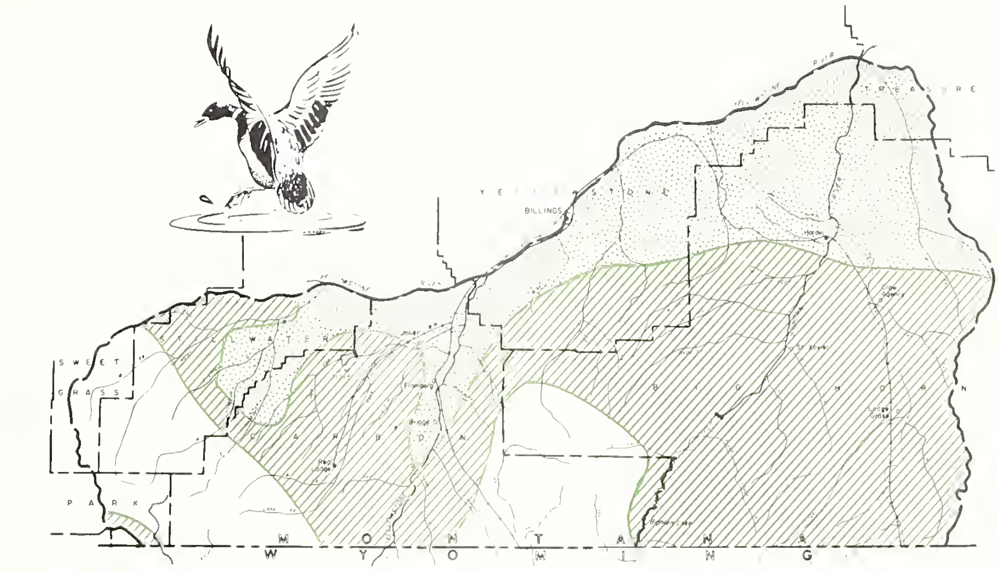
LOW



N. MERRIAM'S TURKEY

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



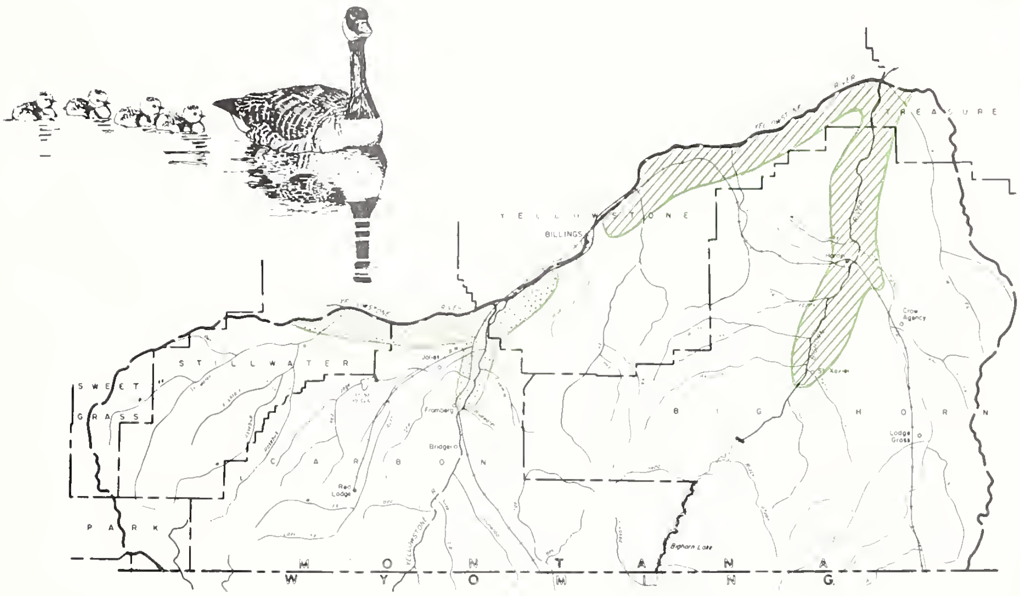
O. DUCKS

HABITAT VALUE

HIGH ----

MEDIUM --

LOW -----



P. GEESE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study

Mountain lions are found throughout the river basin area and are most common in the timbered, mountainous regions. Their numbers fluctuate locally as food sources, mainly deer, fluctuate. Their far-ranging habits and territorial behavior preclude dense populations of lions.

Furbearing mammals in the Basin include coyote, bobcat, fox, jackrabbit, skunk, pine marten, canada lynx, beaver, muskrat, and raccoon. Skunk populations in recent years have been high. Mink, beaver, and muskrat are the major fur animals of value to the trapper.

Big game presently provide the greatest amount of recreational hunting in the Basin. The great variety of big game animals affords "quality" hunting opportunities. Over 80 percent of all licensed hunters seek deer. Presently, hunting success is very high. Antelope are utilized to the fullest extent possible and hunting success is high. Harvest control is being employed to maintain populations. Goats and bighorn sheep are in limited supply, but these species have increased slightly over the past few years. Due to licensing restrictions, only about 10 percent of the hunting for sheep and goats is by nonresidents. The moose kill is low, but moose hunter success has been relatively high in proportion to the few moose permits issued each year. Hunter success is often used as a gage of game populations. Bear hunting, for the most part, is in conjunction with other big game hunting, especially for elk.

Upland game birds hunted in the Basin include ring-necked pheasant, sage grouse, sharp-tailed grouse, and mountain grouse (blue, ruffed, and Franklin's), gray partridge, chukar, and wild turkey. Populations of all game birds have fluctuated markedly due to natural conditions.

Montana Department of Fish and Game surveys indicate that over 10,000 upland game birds are bagged each year with ring-neck pheasant and gray partridge comprising about 60 percent of the take. Sharp-tailed and sage grouse account for about 25 percent of the total bag.

Most upland game hunting is enjoyed by local hunters and "mixed bag" hunting is very common. Some seasons are arranged to provide opportunity to hunt more than one species during a single trip. Sage grouse harvests are generally restricted to small, accessible localities, with little or no hunting occurring in most of the more inaccessible areas. Chukar hunting promises to become more popular as this species becomes more widely distributed. Turkey populations are expanding and additional hunting opportunities may result. All of the upland game species are generally underutilized. Mourning doves are protected and cottontail populations remain virtually unutilized. See table II-11.

The coyote has been subject to almost continuous control programs, and the jackrabbit is hunted extensively as a night sport and for fur when populations are high. The low market value of all furs prevailing in recent years has greatly reduced public interest in trapping. Only

TABLE II-11--ACRES OF UPLAND GAME RANGE
in the
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Game Species	Estimated Acres of Range
Ring-necked Pheasant	1,471,000
Sage Grouse	3,217,000
Sharp-tailed Grouse	2,840,000
Blue Grouse	1,030,000
Ruffed Grouse	1,030,000
White-tailed Ptarmigan	100,000
Gray (Hungarian) Partridge	3,742,000
Chukar Partridge	2,680,000
Merriam's Turkey	147,000
Cottontail Rabbit	3,000,000

Source: Adapted from Missouri River Basin Framework Study.

those landowners who incur damage from beaver, muskrat, mink, or raccoon, plus "hobby" trappers and a very few professional trappers exert any pressure on populations. Bobcats are hunted with dogs for sport and are commonly taken in predator control activities. The mountain furbearers, such as the marten, are rarely taken.

The complex of wetlands in the Basin from high mountain lakes with restricted summer use to low land lakes, reservoirs, stream habitat, irrigation canals and drains, stock ponds, and marshes are important to production of waterfowl.

The shortgrass prairies are becoming more suitable as waterfowl habitat areas because of land use changes on ranch lands. Each year, more and more ranchers are constructing stock ponds to trap spring runoff. These ponds are used extensively by waterfowl and other wildlife.

Waterfowl production in the prairie is dependent on the amount of precipitation that falls during winter and spring. Use escalates in those years that early spring moisture is adequate to fill stock ponds and natural depressions.

Excellent habitat for nongame birds exists throughout the Basin occupying about all vegetative zones. Most nongame birds in the area are classified as song birds and are protected by Montana law.

Trout streams in the Basin, particularly Rock Creek and the Stillwater River and its tributaries, are known for their high quality fishing. Other important fishing streams are the West Rosebud, East Rosebud, and the West Fork of the Stillwater. See table II-12 and map II-10. Many of the small creeks of the Basin provide good fishing as well. These waters have a variety of trout, the most common being rainbow and brown. Native cutthroat and brook trout are more common in the high mountain lakes and streams. New water areas of increasing importance to the angler are Bighorn Lake, its afterbay, and the Bighorn River from Yellowtail Dam to Hardin. This new fisheries addition provides excellent fishing for walleye, rainbow trout, brown trout, and lake trout.

Man-made impoundments and natural lakes provide excellent fishing opportunities for brook and rainbow trout. Additional impoundments are being built in the Basin, providing more fishing opportunities.

There are many mountain lakes on the 11,000-foot-high Beartooth plateau. These lakes provide a variety of excellent fishing. Many lakes are accessible only by foot, while others can be reached by horse or four-wheel drive vehicles. Back country lakes provide excellent fishing for cutthroat, brook, rainbow, and golden trout, in addition to grayling. See table II-13.

QUALITY OF THE NATURAL ENVIRONMENT

The scenic beauty of the Basin takes on many land forms from the barren shale badlands along the south slopes of the Pryors through timbered uplands to the alpine tundra of the Beartooth plateau. Most of this area is unspoiled by man because of its ruggedness and inaccessibility. Lower elevations may be characterized by desertic badlands, shortgrass prairie, or cultivated cropland depending on soil types and water availability. Increases in elevation lead one to increased vegetative cover with several species of trees to be found--various pines, firs, and Douglas-fir. Continuing upward on the land leads one to massive rock canyons in the western portion of the Basin topped by a large alpine tundra plateau. This is reached by the Cooke City highway. Many areas will require additional supervision as recreational pressures increase. The relatively low productivity of desert and tundra areas makes them more fragile than areas with higher rainfall and/or longer growing seasons. A desert shrub or a dwarf sub-alpine

TABLE II-12--SUMMARY OF STREAM MILES BY FISHERY CLASS 1/
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County	Fishery Class 2/					Total
	1	2	3	4	5	
	Miles					
Carbon	0	39	0	120	0	159
Stillwater	0	51	48	16	0	115
Sweet Grass	0	4	0	0	0	4
Park	0	6	0	0	0	6
Yellowstone	0	3	0	38	0	41
Big Horn	0	76	0	92	0	168
Treasure	0	0	0	3	0	3
TOTALS	0	179	48	269	0	496

1/ Source: Montana Department of Fish and Game

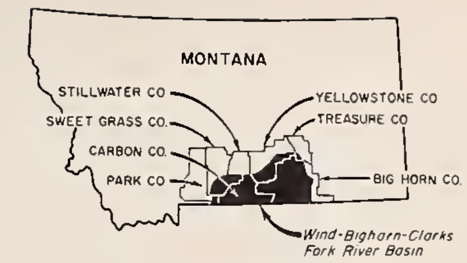
2/ Fishery classes are those set by the Bureau of Sport Fisheries and Wildlife as based on availability of access, esthetics, use, and productivity.
Class 1--Streams of national as well as statewide value.
Class 2--Streams of statewide value.
Class 3--Streams of value to large districts of the state.
Class 4--Streams of value to smaller districts such as counties.
Class 5--Streams of restricted value or not yet classified.

STREAM FISHERY CLASSIFICATION

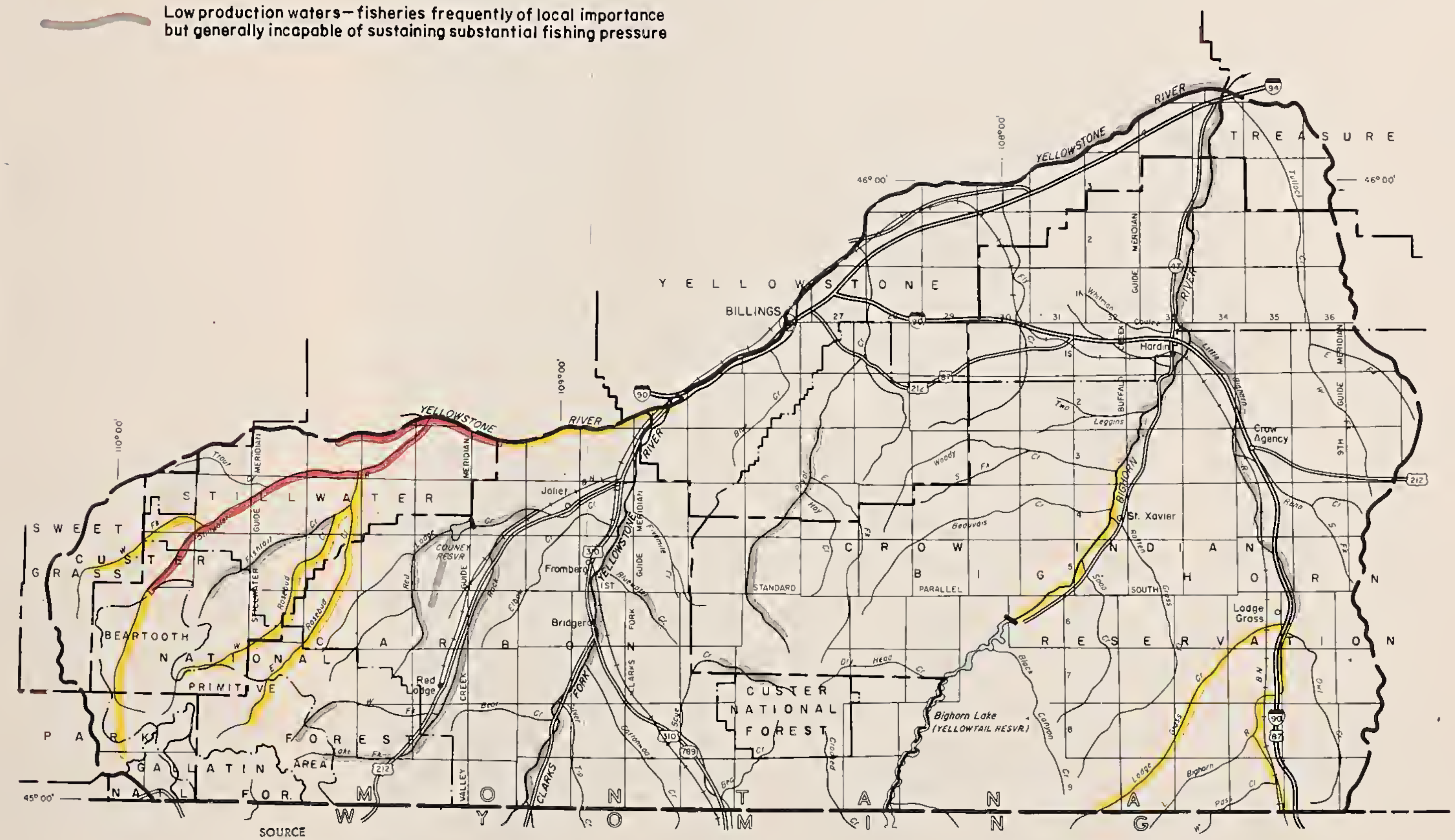
Very good trout waters – fisheries of statewide importance

Important trout waters – fisheries of regional importance

Low production waters – fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure



LOCATION MAP



SOURCE
Bureau of Sport Fisheries and Wildlife
Montana State University
Montana Fish and Game Department

MAP II-10

STREAM FISHERY CLASSIFICATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914J

TABLE II-13--NUMBERS OF LAKES, RESERVOIRS, AND PONDS WITH FISHERIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County	Natural Alpine Lakes	Alpine Reser- voirs	Natural Lowland Lakes	Lowland Reser- voirs	Farm Ponds Cold Water	Farm Ponds Warm Water	Total
	- - - - - -	- - - - - -	- - - - - -	Number	- - - - - -	- - - - - -	- - - - - -
Sweet Grass					10		10
Park							
Stillwater	45	1	3		10		59
Carbon	77	1	3	1	27		109
Yellowstone					15	2	17
Big Horn				2	13	1	16
Treasure					6		6
TOTALS	122	2	6	3	81	3	217

Source: Montana Department of Fish and Game

tree may be several decades old and be no larger than a four-year-old seedling growing in a less severe environment. If it is once destroyed, renewal of such fragile desert or alpine vegetation through natural means may take several years to several generations.

The lack of industrial activity within the Basin contributes to its high environmental quality and attraction to outsiders. Water quality is quite variable, due primarily to differences in natural degradation such as erosion and salinity. Historic abuse of this area has contributed to erosion and saline return flows. A very low percentage of the total sediment production is attributable to any actions of man. In fact, total sediment yield has decreased because of land treatment, farm ponds, and reservoirs. Air quality is excellent, although transient pollution from nearby Billings has recently become noticeable. Low population density is one by-product of an economically inactive area which is enjoyed by Basin residents and visitors. However, these features may mean relatively little to those unemployed within the area. Scenery does not pay grocery bills.

RECREATIONAL RESOURCES

The recreational features of the Basin are great resources for meeting the increasing demands for wildland recreational activities.

Red Lodge, in southern Carbon County, is the starting point of the 11,000-foot-high Beartooth highway, winding its way to scenic Cooke City and the northeast entrance to Yellowstone National Park. The fact that an alpine vegetation type may be viewed from a passenger car, a relatively rare opportunity, is reason to consider designating this route a National Scenic Highway. Each summer, during the height of the tourist season, Red Lodge hosts the famous week-long Festival of Nations produced by the many nationalities in the area. Six miles west of town is the Red Lodge Mountain (previously called Grizzly Peak) Ski Area. Its triple chair lift provides skiers with a 2,000-foot gain in elevation to enjoy numerous runs.

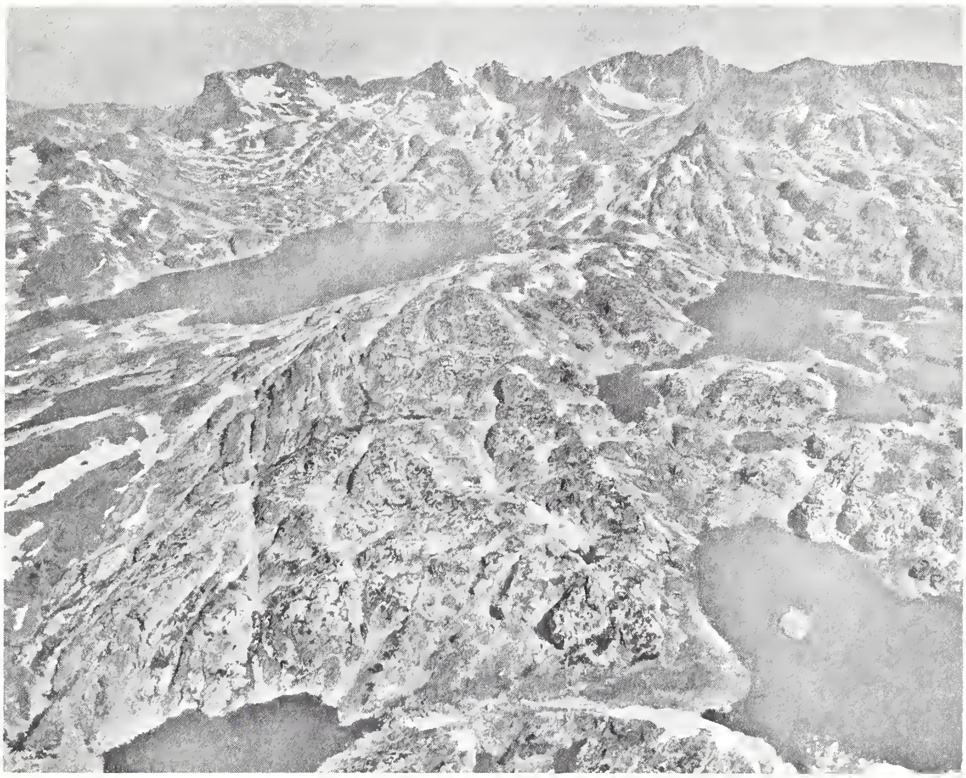
National Forest lands provide extensive recreational opportunities and a number of facilities. There are several camping and picnic areas in the various drainages of the Beartooth Mountains. Trailhead facilities are also provided in several places which further encourages wide use of the Beartooth Primitive Area. This is one of the few primitive areas where the user may have the rare opportunity to glimpse the grizzly bear. The use of the primitive area by recreationists provides employment for numerous outfitters and their hired hands. The attraction of these forest lands has led to increasing development of summer and retirement homes within the Basin area.

In the past, the Pryor Mountain area of eastern Carbon County has not been fully utilized because of inaccessibility. Most of this area is publicly owned and administered by the U. S. Forest Service, Bureau of Land Management, and National Park Service. The area has few camping and picnic facilities. Ice caves, limestone caverns, scenic overlooks, Indian vision quests, and Crooked Creek Canyon are some of the points of interest. This is a heavy use area for upland bird and deer hunting in the fall and snowmobiling in the winter.

On the southern flank of the Pryor Mountains is Pryor Mountain Wild Horse Range with observation points to view the behavior of this once domesticated animal. The existence of this range is significant on a national scale as it is one of two formally recognized wild horse ranges in the country--the result of a national controversy. Bighorn Canyon National Recreation Area is a major attraction in the region. Its steep-walled canyon, hundreds of feet deep, was cut through by the Bighorn River, separating the Pryor Mountains to the west and the Bighorn Mountains to the east.

The Pryors provide a unique opportunity for the student of archeology, history, and lore of the old west. Studies indicate the area was inhabited by man more than 9,000 years ago. Chief Joseph traveled through the region when he was being pursued by the U. S. Army. This area is being studied for its archeological value and need for preservation.

The forested areas of the Basin are islands of green in a semiarid country. The varied recreational opportunities and wildlife of the forests and alpine regions attract large numbers of visitors and are important to the tourist industry. These forested areas are also important as local playgrounds and contribute significantly to the social and physical well-being of the people in the Basin.



High mountain lakes near Granite Peak are typical of higher elevations. USDA - FOREST SERVICE PHOTO

Lower elevation lakes are generally larger and surrounded by trees. SCS PHOTO

PLATE 8

Lake at the headwaters of Rosebud Creek. USDA-FOREST SERVICE PHOTO

Russell Lake--Beartooth Primitive Area. USDA-FOREST SERVICE PHOTO

PLATE 9

Picnicking and camping are among the more important uses of national forest lands in the Basin. USDA - FOREST SERVICE PHOTOS

PLATE 10

Curious but spooky--inhabitants of the Pryor Mountain Wild Horse Range--where "jackrabbits have to carry lunches."

BUREAU OF LAND MANAGEMENT PHOTO

PLATE 11

III. ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

The first record of white man's entry into the Basin was made in 1743 when Chevalier de la Verendrye passed through this Indian territory in search of a route to the Pacific. The next white men came in 1804 in search of furs and gold. The Lewis and Clark Expedition journeyed down the Yellowstone River during the summer of 1806. The following year John Colter spent some time in the area drumming up fur trade for Manuel Liza, and in subsequent years the area was explored by many other fur traders and trappers. Other than these, very few white men saw the Basin until the trails were blazed by Jim Bridger and John Bozeman in 1864, linking the North Platte River with the Three Forks on the Missouri River. The Bozeman Trail crossed the Bighorn River at Fort C. F. Smith near the mouth of the Bighorn Canyon and proceeded northwesterly to the Yellowstone River around the north toe of the Pryor Mountains.

The Sioux, Crow, Shoshone, and Northern Cheyenne Indians resented the western incursion of settlers and the wanton slaughter of buffalo. A peace treaty was signed on Horse Creek near the mouth of the Bighorn River in 1851, but the history of the area was destined to be written in blood. The Indians were content with occasional isolated forays until 1863 when the Sioux went back on the warpath. This warfare continued until the government, forced to call a halt to the whole business, drew up the Fort Laramie Treaty of 1868 which relinquished all Indian claims to the lands east of the Bighorn Mountains and north of the North Platte River. The Sioux moved north and the stage was set for the crushing climax. The fight between the Sioux tribes and Custer's troops on June 25 and 26, 1876, was the climax of a series of battles fought earlier that year. The Custer Massacre on the Little Bighorn brought massive retaliatory action to end the Sioux wars. Fort Custer was established at the confluence of the Little Bighorn and Bighorn Rivers in 1877. Also in 1877, Chief Joseph and his Nez Perces made their famous retreat down the Clarks Fork River from the area of the present Yellowstone Park.

The 1868 treaty with the Crows at Fort Laramie set up the original reservation boundaries to include all land in Montana lying west of the 107th degree of longitude and south of the midchannel of the Yellowstone River. The 107th meridian is still the eastern boundary of the greatly reduced reservation.

In 1877 a small area of the reservation was set aside near Red Lodge for the development of coal. Mines were opened that year by the Rocky Fork Coal Company to produce coal for the Northern Pacific Railroad which had just been built along the Yellowstone River. The opening of the mines and railroad development brought the flood of settlers who set up a clamor for opening the reservation for homesteads. Through a series of treaties the Indians ceded most of the western part of the reservation to the government and it was opened for settlement in 1892.

The northern area of the Bighorn Valley and lands along the Yellowstone River were ceded to the government in 1904 and were opened to homesteaders in 1906.

The first agricultural development came in the 1880-1890 decade with the influx of large cattle companies with herds as large as 30,000 head. Sheep raising had its beginning in 1901 when large company-owned flocks were brought into the area.

The first recorded appropriation of water in the Basin was made on April 1, 1881, near the mouth of the Clarks Fork River in Yellowstone County by John Young, Wilder M. Nutting, W. Bade, A. H. Mallory, L. A. Nutting, and L. Nutting for the purpose of milling, manufacturing, and irrigation. The water was to be diverted from the Yellowstone River. The first recorded development of water from streams within the Basin consisted of the Reno Unit of the Crow Indian Project in 1885 in Big Horn County. The first appropriation in Carbon County was made in 1891 by Irvin H. Will about seven miles south of Belfry on the Clarks Fork River. On August 1, 1893, M. E. Garrigus, M. F. Garrigus, and others made the first appropriation of Stillwater River water. After these earlier developments came a rash of water appropriations and ditch construction. The largest development was the Huntley Project which started in 1905 and was developed over the years to irrigate 28,143 project acres and 1,097 nonproject acres with water from the Yellowstone.

GENERAL DESCRIPTION

The population of the Basin in 1970 is estimated at 21,769 persons. Of this population, about 3,800 are Indians on or near the Crow Reservation. Other than for the reservation and the "bedroom-satellite" areas around Billings, the Basin is a population-losing area.

In order to provide meaningful information about economic activity and social characteristics of the area, published materials were utilized extensively. Data from secondary sources are generally not available for areas smaller than a county or a group of counties. Therefore, three counties believed to be representative of the Basin are used as the geographic unit for economic study. The three counties are Big Horn, Carbon, and Stillwater. Population, employment, and income are the more important economic indicators. These elements are described historically, measured in terms of present status and projected to 1980, 2000, and 2020. Other economic and social factors such as migration, ethnic groups, education, etc., are described and shown historically only.

Population

Population of the three-county study area declined from 1920 to 1930; increased about 600 persons during the 1930's, and then declined to the present time. The 1970 population count was 21,769. Only Big Horn County had an overall increase in population during the past 50 years. Part of the increase from 1950-60 occurred during the construction phase of Yellowtail Dam, followed by a population decrease after the dam was completed. There was a drastic loss of population in Carbon County following the closing of the coal mines after World War II. Other than for those fluctuations, the Basin has shown the steady population decline. Total population for the three counties is shown in table III-1. Basin residents are predominantly rural, although the population is becoming more urban-oriented. This trend toward urbanization reflects a migration from rural agricultural sectors and is characteristic of most areas in the United States. In 1970, about 13 percent of the population in the three counties could be considered urban as compared to 11 percent in 1940. Hardin is the only town with sufficient population to qualify as an urban area. Population by rural and urban categories is shown in table III-2.

TABLE III-1--TOTAL POPULATION OF THREE MONTANA COUNTIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County	1920	1930	1940	1950	1960	1970
Big Horn	7,015	8,543	10,419	9,824	10,007	10,057
Carbon	15,279	12,571	11,865	10,241	8,317	7,080
Stillwater	7,630	6,253	5,694	5,416	5,526	4,632
TOTAL	29,924	27,367	27,978	25,481	23,850	21,769

Source: U. S. Census of Population

In 1970 there was a total of eight incorporated places varying in size from 31 persons in Bearcreek to 2,733 in Hardin. In table III-3, incorporated places are shown according to their size class in 1970, thus revealing what changes have occurred since 1940.

The rural orientation of the area is also revealed by population density. There are about 2.4 persons per square mile in the three-county area as compared to 4.7 persons per square mile for the state of Montana

TABLE III-2--POPULATION BY RURAL AND URBAN CATEGORIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Category	1940	1950	1960	1970
Urban	2,950	2,730	2,789	2,733
Rural Farm	14,496	11,273	8,149	6,458
Rural Nonfarm	10,532	11,478	12,912	12,578
Total	27,978	25,481	23,850	21,769

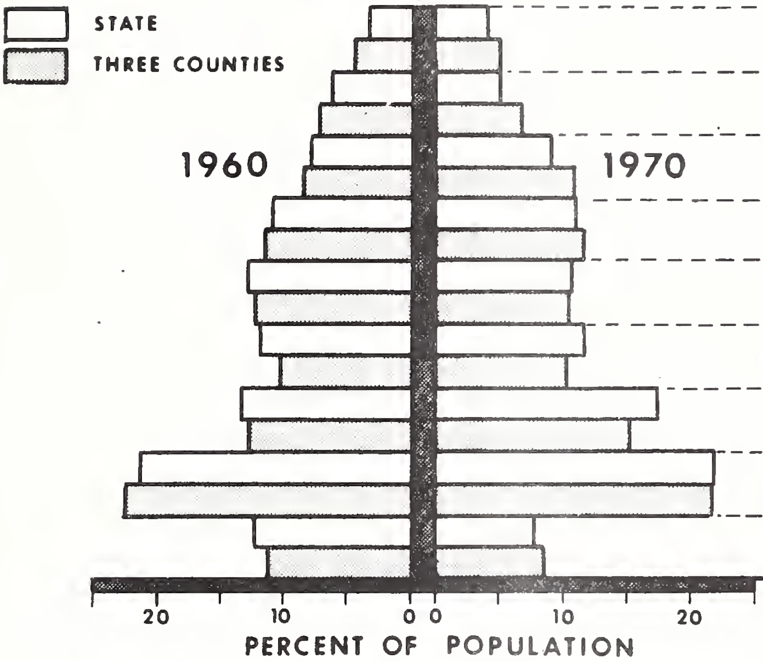
Source: U. S. Census of Population

TABLE III-3--POPULATION OF TOWNS BY SIZE CLASS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Size Class 1/	Number Of Towns	Year 1940	1950	1960	1970
Less than 500	3	1,333	1,014	880	807
500-999	2	1,622	1,390	1,511	1,523
1,000-2,499	2	3,912	3,827	3,559	3,017
2,500-5,000	1	1,886	2,306	2,789	2,733
Over 5,000	0	--	--	--	--
Total	8	8,753	8,537	8,739	8,080

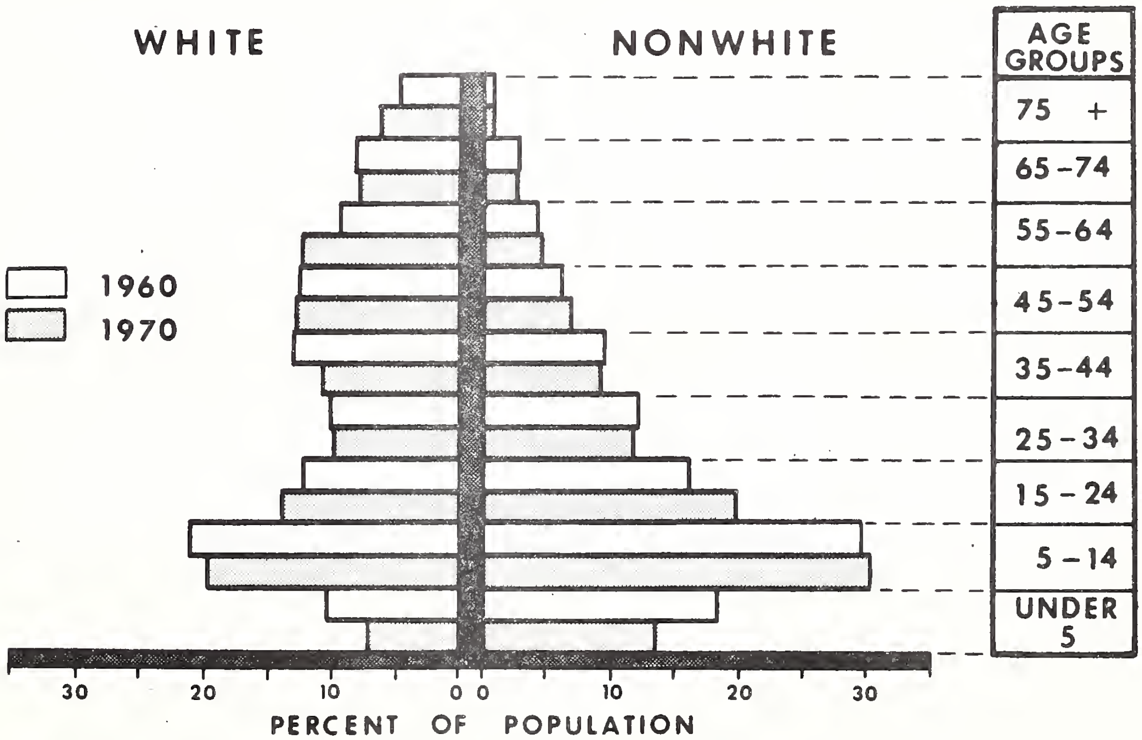
Source: U. S. Census of Population
1/ Population of towns in 1970 determined size class for all years shown above.

FIGURE III-1--PERCENT OF POPULATION BY AGE GROUPS, 1960 AND 1970
FOR THE STATE OF MONTANA AND MONTANA SUBBASIN
WIND-BIGHORN-CLARKS FORK RIVER BASIN



AGE GROUPS	% CHANGE 1960-70	
	3 CO'S	STATE
75 +	+16.9	+33.4
65-74	-11.7	-9.7
55-64	+17.3	+21.6
45-54	-6.7	+6.2
35-44	-23.9	-12.8
25-34	-9.1	-0.9
15-24	+8.4	+34.9
5-14	-11.8	+4.7
UNDER 5	-33.5	-31.4

FIGURE III-2--PERCENT DISTRIBUTION OF POPULATION BY AGE GROUPS
AND BY RACE, 1960 AND 1970, MONTANA SUBBASIN



and 57 persons per square mile for the United States. Big Horn County contains most of the Crow Reservation. Currently, 18 percent of the total population and 20 percent of the rural people are Indian. The number of Indians increased from 3,455 in 1960 to 3,969 in 1970. Nearly 96 percent live in rural areas.

From 1960-70 migration patterns have influenced population changes in the study area by a greater amount than birth and death rates. During this decade each of the three counties experienced a net out-migration for a total of 4,165 people. Shifts from farm to nonfarm residency were mentioned earlier; consequently, out-migration has had a profound impact on the number of people on farms. Off-farm employment opportunities, coupled with decreased agricultural labor requirements and increased efficiency in other farm inputs, have resulted in few rural inhabitants. Net migration rates for the past three decades are shown in table III-4.

Numerous side effects result from population migration. Some age groups are influenced more so than others. A large proportion of those who migrate come from the productive age groups; i.e., productive in terms of economic and reproductive capacities. Changes in the composition of area and state populations from 1960 to 1970 are shown in figure III-1.

The Indian population as a whole is quite young when compared to the non-Indians. The median age of Indians in the area in 1970 was 20 years as compared to 31 years for all inhabitants. More than 63 percent of the Indian population is under 25 years of age as contrasted to 41 percent for the non-Indian population. The difference in age composition between whites and nonwhites (primarily Indians) is shown in figure III-2 and table III-5.

The amount of formal education completed is somewhat variable between segments of the population. In 1960 median school years completed for persons 25 years old and over were 10.0, 10.0, and 8.5, respectively, for all residents, rural farm residents, and the nonwhites. By 1970, comparable educational levels were 11.7, 12.1, and 10.0 years, respectively. Nearly every small town has its own grade school and high school. There are seven high schools in Carbon County alone--some of them only six or seven miles apart. Some consolidation for better quality education seems desirable, but as yet no workable or acceptable plan has been presented.

Labor Force and Employment

In 1970, approximately 50 percent of those 16 years of age and older made up the Basin's labor force. The labor force includes employed persons as well as those currently unemployed but seeking

TABLE III-4--COMPONENTS OF POPULATION CHANGE
(1940-1970) FOR THREE COUNTIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Component	Big Horn		Carbon		Stillwater		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1940 Population	10,419		11,865		5,694		27,978	
1940-50:								
Natural Increase[1]	1,508		546		380		2,434	
Net Migration[2]	- 2,103	-20.2	- 2,170	-18.3	- 658	-11.6	- 4,931	-17.6
Population Change	- 595		- 1,624		- 278		- 2,497	
1950 Population	9,824		10,241		5,416		25,481	
1950-60:								
Natural Increase[1]	2,147		608		712		3,467	
Net Migration[2]	- 1,964	-20.0	- 2,532	-24.7	- 602	-11.1	- 5,098	-20.0
Population Change	183		- 1,924		110		- 1,631	
1960 Population	10,007		8,317		5,526		23,850	
1960-70:								
Natural Increase[1]	1,824		114		146		2,084	
Net Migration[2]	- 1,774	-17.7	- 1,351	-16.2	-1,040	-18.8	- 4,165	-17.5
Population Change	50		- 1,237		- 894		- 2,081	
1970 Population	10,057		7,080		4,632		21,769	

Source: U. S. Census of Population
1/ Births to resident mothers minus deaths of residents.
2/ Population change minus natural increase.

TABLE III-5--PERCENT DISTRIBUTION OF POPULATION BY AGE GROUPS AND BY RACE (1960 AND 1970) WIND-BIGHORN-CLARKS FORK RIVER BASIN (Montana)

Age Group	Whites		Non-White	
	1960	1970	1960	1970
	Percent			
75+	4.5	6.1	.9	0.6
65-74	7.9	7.9	2.9	2.8
55-64	9.2	12.3	4.2	4.8
45-54	12.4	12.8	6.1	7.0
35-44	12.8	10.5	9.5	9.2
25-34	10.0	9.9	12.3	11.9
15-24	12.0	13.9	16.2	19.9
5-14	21.1	19.6	29.5	30.2
Under 5	10.1	7.0	18.4	13.6
TOTAL	100.0	100.0	100.0	100.0

Source: U. S. Census of Population

employment. A major portion of the labor force is in the 25-64 age group. This age group is gradually becoming a larger part of the total because there is a tendency for young workers to delay their entry to the labor force because of educational opportunities and job training requirements. Also, improved retirement benefits have attracted older workers to withdraw from the labor force.

The 5.0 percent unemployment rate of the Basin area is comparable to the national average. There are numerous workers whose labor is underutilized, thus their income is less than it might be. Underemployment differs from unemployment only in that human resources are utilized to some extent. An unemployed person cannot find work while an underemployed individual can find work, but at an amount less than he desires. One cause of underemployment is hidden because some people do not look for jobs. If there is a lack of employment opportunities, they withdraw from the labor force and are not counted as unemployed. Another cause is the immobility of people, especially those above 45 years of age. They are reluctant to leave familiar surroundings even if employment opportunities appear elsewhere. The natural surroundings of the Basin area also add to this situation. Fishing and hunting are not readily sacrificed for added income. Also, many jobs are seasonal, leaving people unemployed or underemployed part of the year. Farming, food processing industries, mining, and recreation may provide only seasonal employment. The tourist trade is most heavily concentrated in the summer months, thus affecting many employees.

One technique for measuring underemployment is to determine if incomes are below capacity. County income capacities are measured by age, educational status, and other selected attributes of the labor force. They are compared with similar conditions for the nation as a whole. In 1960, Basin underemployment rates were 24 percent of the male labor force and 28 percent of the female labor force for a combined 25 percent of the total labor force. Severe underemployment exists at 20 percent or over.

It should be noted that in 1940, men accounted for 87 percent of all employees and only 71 percent by 1970. Meanwhile, the number of women employed nearly doubled. One reason for increased female participation is that farm women generally have not been counted as a part of the labor force, even though they may contribute significantly to agricultural output. However, as farm women seek off-farm employment, or as they migrate off farms and obtain jobs, they are counted in the labor force and in total employment. Another reason is the tendency for women who have finished rearing their families to find jobs in service-type industries. More of these jobs are becoming available and quite often they can be filled by female workers with very little specialized training.

Some other reasons for the increasing ratio of women to men in the labor force might be that many jobs that have been lost were of the type that would attract a male head of a household, while many of the new jobs may be of the type that do not provide full family support on the wages paid. Out of necessity, both head of household and nonhead of household women may be willing to accept these positions to augment substandard income levels. In addition, the increased number of women workers may be in part a function of age and "free" time as their family responsibilities lessen. This latter type of increased competition for employment will likely encourage out-migration of the area by younger workers.

Employment and ages of non-Indian workers are typical for agriculturally-oriented areas. There is a small carpet manufacturing plant and a new recreation complex at Crow Agency that has changed the employment pattern of some of the Indians. The low longevity and high birth rate among the Indians produce an age distribution on the reservation much different from the pattern of the rest of the Basin. See figure III-2.

The decline of population from 1940 to 1970 was closely related to fewer farm employment opportunities. Total employment decreased 17 percent during the period while agricultural employment declined 60 percent, table III-6. It should be noted that employees of agriculturally-related firms are not included with agricultural employment, but appear in manufacturing, distributive, and service categories.

TABLE III-6--EMPLOYMENT BY INDUSTRY
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Industry	1940	1950	1960	1970	Percentage Change 40-50	50-60	60-70	Percentage Distribution 1960	1970
	Number								
Agriculture & Forestry	4,975	4,366	2,844	1,990	-12.3	-34.9	-30.0	36.2	28.1
Mining	306	226	258	54	-26.2	+14.2	-79.1	3.3	0.8
Construction	290	450	459	404	+55.2	+ 2.0	-12.0	5.9	5.7
Manufacturing	195	206	363	528	+ 5.6	+76.2	+45.5	4.6	7.5
Food Prod.	(101)	(99)	(143)	(180)	- 2.0	+44.4	+25.9	NA	NA
Lumber Prod.	(44)	(28)	(55)	(53)	-36.4	+96.4	- 3.6	NA	NA
Other Mfg.	(50)	(79)	(165)	(295)	+58.0	+108.9	+78.8	NA	NA
Transportation, Comm. & Utilities	271	416	486	382	+53.5	+16.8	-21.4	6.2	5.4
Wholesale Trade	94	99	88	145	+ 5.3	-11.1	+64.8	1.1	2.0
Retail Trade	839	1,127	1,117	1,264	+34.3	- 0.9	+13.2	14.2	17.8
Finance, Insurance & Real Estate	68	97	157	186	+42.6	+61.9	+18.5	2.0	2.6
Services	1,115	1,131	1,428	1,682	+ 1.4	+26.3	+17.8	18.3	23.7
Government	272	334	379	450	+22.8	+13.5	+18.7	4.8	6.4
Not reported	87	158	268	0	+81.6	+69.6	NA	3.4	NA
Total	8,512	8,610	7,847	7,085	+ 1.2	- 8.9	- 9.7	100.0	100.0
Male	7,397	7,006	5,841	4,996	- 5.3	-16.6	-14.5	75.6	70.5
Female	1,115	1,604	2,006	2,089	+43.9	+25.1	+ 4.1	24.4	29.5
Montana	185,564	220,468	237,598	244,608	+18.8	+ 7.8	+ 3.0	Not Applicable	

Source: U.S. Census of Population

Basic industries of the area include agriculture, forestry, mining, railroad transportation, interstate highway construction, and manufacturing. In 1940, they provided 64 percent of all jobs; by 1970, only 36 percent. A sizeable increase in manufacturing jobs somewhat dampened a further decline. Agriculture and mining are the only major industries in which employment declined steadily for the 30-year period. During the 1940's, sizeable increases in employment were noted in the construction, transportation, communication, utilities, retail trade, finance, insurance, and real estate sectors. Except for retail trade, employment continued upward in these sectors during the decade of the 1950's. Along with agriculture and mining, construction, transportation, communications, and utilities sectors declined in employment between 1960 and 1970.

Economic activity in the business and manufacturing sectors is shown in table III-7. Trends in the number of establishments vary by industry. Incomplete reporting of the dollar value of business activity somewhat obscures any trends. In 1969, 2.7 million barrels of crude oil were produced in the three-county area.

Income

Another measure of well-being in an area is personal income. Total personal income for residents of the three-county area increased from 14 million dollars in 1940 to 51 million dollars in 1968 for an increase of 272 percent, table III-8. Meanwhile, total personal income for the nation rose 775 percent. The heavy reliance upon farm earnings as a source of income has affected the overall rate of growth. Per capita income also rose slightly during the period; however, in 1968 it was 28 percent below the national average.

Personal income normally increases over time for two reasons. The first is increasing production, which implies rising income. The second source is price inflation. It is important to distinguish between the two influences because the latter can exaggerate the growth of income. Inflation is reflected in rising prices of goods and services, as well as in increased money income to individuals, businesses, and government. The implicit price deflator for personal consumption expenditures at the national level was used to eliminate the influence of price inflation. Total personal income after adjustment to a 1967 dollar base, is also shown in table III-8. Income per family in the Basin is lower than that for Montana as a whole. The most significant comparison is that 21.4 percent of the families in Big Horn County and 14.3 percent in Carbon County in 1969 had incomes of less than the poverty level (as defined by the census) as compared to about 10.4 percent in this category for all of Montana. Yellowstone County had about 9.4 percent and Stillwater County 12.5 percent of their families in this poverty level category. Data for Yellowstone County are influenced largely by Billings, while data for Stillwater County may be

TABLE III-7--NUMBER OF BUSINESS ESTABLISHMENTS AND REPORTED ECONOMIC ACTIVITY (1958-67) FOR THREE COUNTIES WIND-BIGHORN-CLARKS FORK RIVER BASIN (Montana)

Item	Unit	1958	1963	1967
Wholesale Trade:				
Establishments	No.	48	40	36
Sales	$Million	7.5	11.4	11.5
Retail Trade:				
Establishments	No.	346	324	272
Sales	$Million	21.8	27.4	26.5
Selected Services:				
Establishments	No.	131	138	118
Receipts	$Million	1.5	2.0	1.8
Mineral Industries:				
Establishments	No.	28	41	21
Value of Shipments and Receipts	$Million	12.1 1/	9.3 1/ 2/	N.A.
Manufacturing:				
Establishments	No.	23	22	17
Value Added	$Million	.320 2/	.51 2/	.4 1/ 2/

Current Dollars

Source: U. S. Census of Business; U. S. Census of Manufactures.

1/ Data for Stillwater County have been withheld to avoid disclosure of individual firms.

2/ Data for Big Horn County have been withheld to avoid disclosure of individual firms.

TABLE III-8--PERSONAL INCOME AND EARNINGS BY BROAD INDUSTRIAL SECTOR FOR SELECTED YEARS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Category	1940	1950	1959	1966	1968	1970
			Thousands of Dollars 2/			
Total Personal Income	13,716	35,728	40,413	48,511	51,098	60,604
Per Capita Income 1/	492	1,397	1,696	2,006	2,133	2,784
Per Capita Income rel. to U.S.=100	83	93	78	68	62	71
Total Earnings	12,308	31,296	32,337	38,593	38,954	44,457 4/
Farm Earnings	7,213	19,229	13,868	14,383	12,692	14,413
Total Nonfarm Earnings	5,095	12,067	18,469	24,210	26,262	30,044 4/
Govt. Earnings	1,833	2,845	5,446	8,879	9,835	12,242
Private Nonfarm Earnings	3,262	9,222	13,023	15,331	16,427	17,802 4/
Manufacturing	127	391	598	699	1,077	2,684
Mining	268	808	1,989	1,149	1,260	895
Contract Con.	255	1,001	1,111	2,426	1,836	891
Trans., Comm. & Public Utilities	383	1,000	1,670	1,868	2,221	2,286
Wholesale & Retail Trade	1,511	4,169	4,939	5,245	5,415	5,401
Finance, Ins. & Real Estate	106	321	608	941	1,054	1,120
Services	612	1,506	1,952	2,749	3,272	3,583
Other	--	26	156	254	292	313
			Thousands of Dollars 3/			
Total Personal Income	34,462	49,280	45,325	49,755	49,322	53,632
Per Capita Income 1/	1,232	1,934	1,916	2,057	2,060	2,464

Source: Office of Business Economics Information System.
1/ Per Capita Income is shown in dollars.
2/ Current dollars.
3/ 1967 constant dollars.
4/ Includes $629,000 of manufacturing and Contract Construction earnings (Stillwater County) not shown separately to avoid disclosure.

influenced by large wheat farms and more well-to-do retirees along the Stillwater River. In Big Horn County, 32 percent of rural nonfarm families have below poverty level incomes. This is the second highest such incidence in the state and is largely influenced by the rural Indian population on the Crow Reservation.

Earnings (wages, salaries, other labor income, and proprietor's income) account for about 73 percent of total personal income in the area. Total earnings are shown by major sectors in table III-8. In 1940, farm earnings were 59 percent of the total and then declined to 32 percent in 1970. The next most important source of basic income is from minerals and petroleum. There is no commercial fishing and only a minor forestry industry. Although the local income is significant, total income from tourism and employment in services to tourists has not been separated from services to agriculture and other sectors of the economy. Income from manufacturing is small and has declined further with the closing of the sugar refinery at Hardin. Heavy construction consists almost entirely of highway building, but in the near future it may involve construction of water conduits or industrial plants to support development of the coal fields of southeastern Montana and northeastern Wyoming. Such construction employment is fundamentally transient in nature and provides a poor basis for Basin development.

<u>Urban Centers and Transportation</u>

There are no urban centers within the study area; however, Billings exerts considerable influence in the economy of the Basin by providing a cultural center and principal market outlet for agricultural products. It also lends stability to the surrounding area by providing some off-season employment opportunity for farmers and a seasonal labor supply of high school and college youth. The economy of Billings is largely dependent on agriculture, but is stabilized with a sound basic petroleum industry, wholesale outlets, small manufacturing, and transportation industries.

There are community hospitals at Red Lodge, Columbus, and Hardin, with more complete medical facilities at Billings. Most of the towns and some farms use natural gas and electricity supplied by the Montana Power Company. The rest of the Basin is served by rural electric cooperatives. Most farm and town residences have telephone service. Interstate Highways 90 and 94 are still under construction in the Basin. Other highways include U. S. 87, 212, and 310, and State Highways 312, 212, 47, 416, 789, 397, 308, 307, 421, 425, 419, and 420. In addition to highways, the main line of the Burlington Northern Railroad crosses the north end of the Basin and two branch lines of the Burlington Northern traverse the Basin from north to south through Hardin and through Bridger with a spur extending to Red Lodge. There is no scheduled airline service in the Montana part of the Basin, but several airlines serve Billings on regular schedules.

Projections

Total employment and population in the three-county study area are projected to decrease through 2020. The decrease in employment will occur in the agricultural sector with little change in the remaining sectors. Agricultural employment is projected to be 1,550 in 1980; 1,200 in 2000; and 1,100 in 2020. This is a decrease of over 40 percent from 1970 to 2020.

Total population in the three-county area is projected at 19,000 by 2020. This is a decrease of about 15 percent from the 1970 population. Population projections are based upon employment participation rates. By 2020, it is estimated that the population of the nation will more than double. Estimates of per capita income for the projection period are also shown in table III-9.

TABLE III-9--PROJECTED POPULATION, EMPLOYMENT, AND PER CAPITA INCOME
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Item	1970	1980	2000	2020
Population	21,769	20,500	19,500	19,000
Rural Farm	6,458	5,200	4,600	4,300
Employment	7,085	6,700	6,400	6,300
Agricultural	1,990	1,550	1,200	1,100
Other Basic	582	600	600	600
Nonbasic	4,513	4,550	4,600	4,600
Per Capita Income 1/	2,464	3,100	6,100	11,500

Source: OBE Data and Census Data adjusted to local conditions.
1/ 1967 dollars

When all these economic elements are aggregated, a less than encouraging picture of the study area emerges. Population and employment have been declining and probably will continue to decline. The historic economic base of the area will continue to change, showing an increasing dependency of the area on external demand factors to sustain economic activity. Because agricultural activity will continue to be dominated by livestock production, the rate of decrease in agricultural employment should decline and eventually stop. However, the secondary economic impact of the agricultural industry may decrease as farm sizes and incomes increase because these larger units will find it more attractive to acquire more goods and services outside the Basin area.

The above projections reflect an extension of historical trends occurring in major sectors of the area economy. Very recent developments in the mining industry may alter the projections considerably. Large deposits of coal are known to exist throughout southeastern Montana, including the eastern part of Big Horn County. The total resource is estimated at many billions of tons, much of which is recoverable through strip-mining methods. Current annual production is small in relation to the total resource. Production is increasing rapidly and the potential for further development is very good if large quantities of water are delivered to the coal fields.

In order to maintain the level of economic activity, elements other than the traditional economic base will have to increase. Examples include provision of services to part-time and nonresidents of the area pursuing leisure-time activities there. There may also be some spillover effect from the coal development expected east of the Basin. Another spinoff of this latter item may be that many people employed in the coal development will come into or through the Basin to seek recreation.

Manufacturing may continue to expand, but future growth would have to far exceed past growth in order to absorb declining employment from the other sectors. This is not likely to occur, however, due to the locational disadvantage experienced by any large manufacturer. It may be possible to compensate for this with an available labor supply that would accept less-than-average pay scales, lower at-site power costs, or governmental subsidization.

It should be noted that increased employment has been largely in secondary economic industry to service the economic base. This has been a trend nationwide of even greater magnitude. Because of the number of poverty-classified families and the declining relative position of personal income levels in the Basin, there is a strong possibility that growth in these industries will not be as important as in previous periods. If the area is to enjoy growth in a relative sense, it will have to be stimulated from outside the Basin in the form of demand for resources and services available in the area. This will most likely be for mineral and/or recreational purposes.

AGRICULTURE AND RELATED ACTIVITY

Agriculture is an important segment of the study area economy. Although the number of farms and farm operators is declining, agriculture is an expanding industry. It is expanding in terms of total value of production and product diversification, but not in terms of employment. The inverse relationship between increasing agricultural production and declining farm population stems largely from an increase in farm efficiency through the use of conservation programs, improved technology, feed additives, fertilizers, insecticides, and larger farm machinery. Further increases in efficiencies are expected through 2020. Larger quantities of agricultural products will be required as population of the nation increases. Rising per capita income also leads to additional expenditures for selected food items. As incomes grow, consumers tend to upgrade their diets, and this generally means eating more meat, especially beef.

Beef cattle are the principal source of agricultural income in the Basin. Cattle numbers in the Basin on January 1, 1970, were estimated at 265,000 head. Excluding Yellowstone County, cattle numbered about 204,000 with 188,000 head shipped out of the Basin in 1969 and 56,000 shipped into the three-county area for a net export of 132,000 head. Cattle feeding is growing in importance and may provide the market outlet for silage and feed grain expected to be grown on land going out of sugar beet production. There has been some increase in continuous confinement hog production, but total production is not great. Hog population in 1969 was estimated at 22,000 head. Sheep and lambs numbered about 61,000 in 1970. Chickens numbered about 120,000.

According to the Census of Agriculture, the amount of land in farms and ranches has remained relatively constant. In addition to these privately owned lands, livestock producers obtain grazing leases and permits for public lands, thus increasing the total amount of land used for agricultural production. Several other farm characteristics have changed, table III-10. Out-migration of the population, particularly the rural population, has been instrumental in the decline of farm numbers. The remaining farms are larger, produce more, and have a greater capital investment. Average farm size has a limited meaning in the study area because farm and ranch units vary from those specializing in intensively irrigated row crops to those with extensive livestock operations. In 1969, 15 percent of all units were less than 100 acres in size, 47 percent in the 100-999-acre size, 13 percent in the 1,000-1,999-acre size, while 25 percent were in the 2,000-acre or larger category. About 87 percent of the farmland is controlled by farms or ranches larger than 2,000 acres in size.

The per acre value of land and buildings increased two and one-half times between 1954 and 1969. This is partially due to higher land prices and building construction costs, and partially due to other capital investments such as irrigation equipment and drainage systems. The combination of higher price per acre and increased farm size has resulted in an average investment of greater than $150,000 per farm. Large capital requirements are also reflected in farm ownership. The percentage of farmers and ranchers that own only a part of the land they operate rose from 31 percent in 1954 to 40 percent in 1969. Meanwhile, those in the tenant category declined. Apparently some of the farm operators are satisfied to have less than full control of the land resource so they can obtain capital for current operations. Also, the returns to operating capital are higher than the returns to capital invested in land. Little change can be expected in this trend as farm size, land values, and machinery costs continue to increase.

TABLE III-10--CHARACTERISTICS OF FARMS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Item	Unit	1954	1959	1964	1969
Farms	No.	2,354	1,965	1,826	1,667
Average Farm Size	Ac.	1,795	2,422	2,215	2,625
Ownership Class:					
Full Owner	Pct.	45	41	43	44
Part Owner	Pct.	31	38	40	40
Tenants	Pct.	24	21	17	16
Size Class:					
Under 100 Acres	Pct.	15	12	11	15
100-179 Acres	Pct.	16	14	12	10
180-259 Acres	Pct.	8	7	7	6
260-499 Acres	Pct.	17	17	17	16
500-999 Acres	Pct.	15	17	17	15
Over 1,000 Acres	Pct.	29	33	36	38
Value of Land and Buildings:					
Per Farm	Dol.1/	36,605	57,985	93,599	156,614
Per Acre	Dol.1/	23	35	43	60

1/ Current dollars
Source: U. S. Census of Agriculture

SCS PHOTO 11-P1008-2

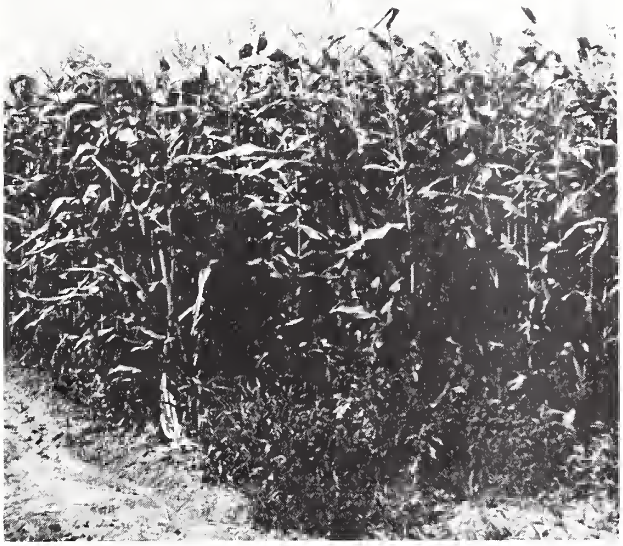
Modern large feedlots are being developed in the Basin to utilize Montana feed for Montana cattle. (Yellowstone County above; Carbon County below)

SCS PHOTO 11-P869-14

Most of the dry cropland is stripcropped and some of it is protected with single-row windbreaks which also provide wildlife habitat. PHOTO 11-8047-8

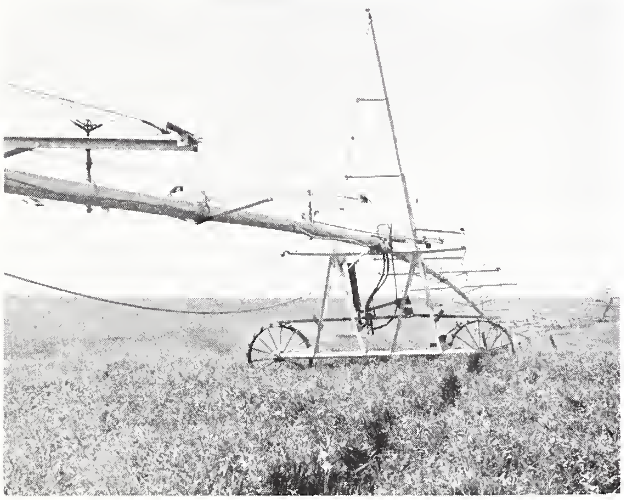
PHOTO BUREAU OF INDIAN AFFAIRS PHOTO

Dryland farming, by nature, is big enterprise farming.



Corn for silage and grain is increasing in importance as beet acreage declines and cattle feeding increases.
SCS PHOTO 11-P203-13

Good yields of alfalfa are possible with full water supplies, good drainage, fertilizer, and good irrigation management. (Clarks Fork Valley)
SCS PHOTO 11-P869-2



Sprinkler systems are bringing land under irrigation that is too rough or has soils unsuitable for irrigation under conventional systems. SCS PHOTO 11-P868-15

Red Lodge Mountain (Grizzly Peak) ski area provides about 65,000 skier days per year to people of all ages and skills.

USDA-FOREST SERVICE PHOTO

PLATE 15

Agriculture also provides many of the primary inputs to other sectors of the economy. Sugar beet refining, food processing plants, marketing, and transportation industries are heavily dependent upon crops and livestock produced locally. The amount of processing performed varies by type of product and can range from little to none as in the case of feed grains to providing a finished product such as sugar. Farmers and their families are an important source of labor. They can supplement farm income with seasonal, part time, and in some cases with full time jobs. Many are within commuting distance to Billings with a standard metropolitan statistical area population of 87,367. In 1969, 493 or 34 percent of the commercial farm operators (sales of $2,500 plus) from the three-county area also worked at jobs away from their farms. About one-half of these operators held jobs 100 or more days per year.

Land Use and Production

There are approximately 4.1 million acres of agricultural land in the Basin that were inventoried during 1967 to determine use and conservation treatment needs.[1/] Most of this land is used to provide roughage, grazing, and feed grains in support of the livestock industry. Land uses include irrigated pasture and cropland, nonirrigated cropland, range, forest, and other agricultural uses. Some additional land will be required for interstate highways and for urban and builtup areas near Billings within the planning horizon of this study. The amount of agricultural cropland is expected to remain close to the present acreage. However, recent significant increases in international agricultural trade are resulting in reactivation of diverted acres and conversion of some rangeland to cropland. At present there are no projections available for the future rates of the foreign trade or the degree of land conversion. There also is expected to be some conversion of nonirrigated cropland to irrigation.

Irrigated crops grown in the Basin include hay, sugar beets, corn, small grains, dry beans, pasture, and canning crops. Dryland crops are mainly wheat, barley, and hay. One of the most abrupt changes in the acreage of individual crops occurred recently with the closing of a sugar beet refinery in Hardin. Feed crops, particularly corn, are now grown on the land formerly planted to sugar beets in that area. The production of corn for grain and corn silage is increasing and is used locally by feedlot operators. Oats, dry beans, and legume seed crop acreage is declining. Competing areas have attracted dry bean and seed production away from the Basin.

Federal farm programs also influence land use. Acreage allotments in the past affected the amount of wheat grown in the Basin more so than any other crop.

1/ Conservation Needs Inventory, Montana, 1967

There are about 231,000 acres now irrigated. Nearly 350,000 acres of cropland are without irrigation facilities. Crop-fallow rotations are practiced for the dryland grain crops primarily because of insufficient rainfall. Present and projected land use on state and private lands are shown in table III-11.

TABLE III-11--PRESENT AND PROJECTED LAND USE
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Land Use	Present 1/	1980	2000	2020
	- - - - - - - - -	(Acres)	- - - - - - - - -	
Irrigated Cropland:	231,419	236,000	250,500	257,000
Wheat	9,850	8,700	8,200	7,500
Barley	12,440	15,000	18,000	20,000
Oats	4,350	3,200	3,000	3,100
Corn, grain	2,900	6,900	13,900	15,000
Silage	13,500	18,000	20,000	22,000
Sugar Beets	10,500	8,400	11,100	13,500
Dry Beans	4,250	3,800	3,300	2,900
Alfalfa Hay	64,270	65,000	65,000	65,000
Other Hay	49,760	48,000	48,000	48,000
Pasture	42,500	43,000	44,000	44,000
Other Crops	6,220	6,000	6,000	6,000
Not Harvested	10,879	10,000	10,000	10,000
Nonirrigated Cropland:	349,522	339,300	347,400	347,000
Wheat	114,200	101,700	106,600	102,600
Barley	39,500	48,000	53,000	57,700
Oats	4,300	3,600	3,800	3,700
Hay	33,500	36,000	34,000	33,000
Fallow	158,022	150,000	150,000	150,000
Range	3,084,493	3,082,900	3,060,300	3,054,200

Source: River Basin Planning Staff
1/ Present cropland use generally represents a 1965-70 weighted average.

The amount of irrigated land is expected to increase from 231,419 acres at present to 236,000 acres in 1980; to 250,500 acres in 2000; and 257,000 acres in 2020. The increase in irrigated land will be used primarily for corn, barley, hay, and pasture. Livestock production will continue to be of major importance and additional roughage and feed grains will be needed.

The amount of nonirrigated cropland is not expected to change appreciably. Land that is suitable for irrigation on public lands may be available for future irrigation development through an exchange agreement; however, this was not considered in the projections.

Productivity per acre has been increasing and can be expected to expand further until 2020. Present and projected crop yields are shown in table III-12. The additional capacity to produce will come about through use of improved crop varieties and management, improved fertilizers and weed control, and application of measures to conserve soil and water resources.

Present and projected production for the major commodities are shown in table III-13. For most crops, present production is a weighted average for the years 1965-70. The amount of grazing on public and Indian Trust lands was obtained through the federal agencies issuing grazing leases and licenses. Currently these lands provide 36 percent of the grazing resource. Current production of livestock commodities was determined by relating inventories and sales for the Basin to state totals and then converted to units of weight.

Projected production from the Basin is based upon the national rate of increase (or decrease) for each commodity and time period. These rates were altered upward or downward for some items based upon a comparison of historical trends between the areas. Upward adjustments were made for corn, oats, and barley. Downward adjustments were made for dry beans and some livestock commodities. Beef, sheep, and wheat approximate the national rate. The national projections are influenced by population growth, income, consumer tastes and preferences, per capita consumption, exports and imports, as well as industrial uses of agricultural products.

Most of the agricultural commodities produced in the Basin, except for feed grains and roughages, are marketed for consumption, processing, or fattening in other localities or states. The largest segment of cattle production in the Basin consists of cow-calf operations that provide feeders to feedlots. Projections of hay and grazing are based upon the amount of each needed to supply an adequate amount of roughage for cattle and sheep. The amount of roughage from range on public and private lands was added to the amount produced on irrigated land and nonirrigated hay. It is assumed that any additional roughage would come from hay, pasture, and silage. Consequently, most of the increase in irrigated acres is reflected in these roughage crops. One exception is beet tops. It is assumed that all beet tops are fed as silage or grazed.

Currently, the amount of grain fed is in excess of production. The deficit of feed grain is expected to continue through 1980. Sugar beet production is projected to decrease slightly by 1980 and then increase through 2020. Beef production is projected to increase 36 percent by 1980 and 146 percent by 2020. Sheep and milk production will decline by 1980 and then increase.

TABLE III-12--PRESENT AND PROJECTED CROP YIELDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Crop	Unit Per Acre	Present Yield	Projected Yields 1980	2000	2020	Index (Present = 100) 1980	2000	2020
Irrigated Crops:								
Wheat	Bu.	41	47	59	72	115	145	175
Barley	Bu.	53	74	93	106	139	175	200
Oats	Bu.	62	80	99	109	130	160	175
Corn, grain	Bu.	71	93	115	135	130	161	190
Sugar Beets	Ton	16.6	20.1	24.1	29.1	121	145	175
Dry Beans	Cwt.	16.5	20.1	23.9	27.6	122	145	167
Silage	Ton	18.1	23.3	28.4	31.1	129	157	172
Alfalfa Hay	Ton	3.0	3.6	4.3	5.0	120	144	166
Other Hay	Ton	2.4	2.8	3.4	4.0	118	140	165
Pasture	FU1/	2,100	2,520	2,940	3,360	120	140	160
Nonirrigated Crops:								
Wheat	Bu.	27	32	36	42	117	133	155
Barley	Bu.	35	40	47	55	113	135	156
Oats	Bu.	37	42	49	56	114	132	150
Hay	Ton	1.3	1.6	1.8	2.0	120	138	154
Range:	FU1/	100	120	141	160	120	141	160

Source: River Basin Planning Staff

1/ Feed Unit: one feed unit is equivalent to one pound of shelled corn.

TABLE III-13--CURRENT AND PROJECTED PRODUCTION AND VALUES OF PRODUCTION WIND-BIGHORN-CLARKS FORK RIVER BASIN (Montana)

Item	Unit	Price1/ Per Unit	Current	1980	2000	2020
Wheat	Bu.	1.78	3,472,900	3,663,000	4,321,000	4,851,000
Barley	Bu.	.74	2,018,500	3,030,000	4,165,000	5,294,000
Oats	Bu.	.55	419,500	407,000	483,000	545,000
Corn, Grain	Bu.	1.25	205,900	641,000	1,598,000	2,025,000
Sugarbeets	Ton	12.17	174,300	169,000	268,000	393,000
Dry Beans	Cwt.	6.00	67,700	76,000	79,000	80,000
Silage	Ton	8.00	244,400	419,000	568,000	684,000
All Hay	Ton	22.00	344,800	426,000	504,000	583,000
Pasture	FU2/3/	.015	86,100	108,360	129,360	147,840
Range	FU2/3/	.015	196,493	235,740	275,000	314,300
Range5/	FU2/3/	.015	160,615	161,311	178,918	178,918
Beef	Lb2/4/	.2288	86,310	117,400	158,100	212,400
Pork	Lb2/4/	.1505	8,184	9,820	12,000	15,000
Sheep	Lb2/4/	.1323	3,147	2,830	3,210	3,780
Wool	Lb2/	.48	598	538	610	718
Milk	Lb2/	.039	30,000	27,200	30,600	35,800
Eggs	Doz.2/	.35	1,508	1,625	2,050	2,567
Poultry	Lb2/4/	.05	300	345	435	540
Aggregate Value of Production	Dol.2/		50,276	63,224	81,783	102,581
Value of Feed Utilized	Dol.2/		18,171	23,573	29,727	34,663
Gross Value of Production	Dol.2/		32,105	39,651	52,056	67,918

Source: River Basin Planning Staff

1/ Current Normalized Price, Interim Price Standards for Planning and Evaluating Water and Land Resources, Water Resources Council, April 1966.

2/ Units in thousands.

3/ A feed unit has the equivalent feeding value as one pound of shelled corn. One Animal Unit Month (AUM) = 450 feed units.

4/ Live Weight Basis.

5/ Grazing obtained through leases and licenses administered by Federal Agencies.

There are numerous considerations inherent in making projections for any area. The foregoing agricultural production projections are based upon national trends and adjusted for local conditions. Any changes in national trends, such as rates in population growth, exports, consumer tastes, and per capita income will be reflected in the nation's level of agricultural output. This, in turn, will likely affect the projections of agricultural production for the study area. Alternative projections which reflect some of the above items are being prepared, but are not available for use in this report. Depending on changes in international trade, increases in agricultural production may or may not result in displacing production in some other area or areas. Large production increases may affect market prices to the extent that total returns to agriculture are lower.

There is the possibility that technology will not be available to increase crop yields to the extent shown in the projections. If yields on cropland are overestimated by 10 percent, an additional 22,000 acres of irrigated and 20,000 of nonirrigated cropland would be needed by 1980 to produce the same amount of output. By the year 2020, an additional 24,000 acres of irrigated and 20,000 acres of nonirrigated cropland would be required. If present estimates of future crop yields are underestimated, then less than the projected acres of new cropland will be needed to provide the same level of output.

The importance of public land as a source of grazing was indicated earlier. It is expected that these lands will remain available for lease to livestock producers. However, if this resource were not available to livestock grazing, other sources of pasture and range would be needed. It would require 8,200 acres of irrigated pasture to replace the amount of grazing that will be utilized on public lands by 1980. By 2020, 6,400 acres of irrigated pasture would replace grazing on public land.

FOREST RESOURCES AND RELATED ECONOMIC ACTIVITY

Forested land makes up over 616,000 acres in the Montana portion of the Basin. Most of the timber resources in the area are located in the western third of the Basin and in the Pryor and Bighorn Mountains. Approximately one-half of the forest land is federally owned. Of the 305,019 acres of national forest timber land, 178,329 acres are classified as commercial. An additional 24,603 acres of commercial quality timber land are located within the Beartooth Primitive Area on the Custer and Gallatin National Forests, but no timber harvest is permitted on these areas. Private, State, and Indian Trust lands account for 91,338 acres, or 34 percent, of the commercial timber land. Acres of commercial and noncommercial forest land by ownership class are shown in tables II-5 and II-6.

Tree species most commonly harvested are Douglas-fir and lodgepole pine. Some Engelmann spruce and alpine fir have been harvested from sites at higher elevations.

Most of the publicly owned forested land in the Basin is located in mountainous terrain. Limitations of accessibility, small tree size, unstable soils, steep and rocky slopes, severe weather, short operating season, and long hauling distance to markets limit the operability of these commercial timber lands. In addition, public reaction against harvest practices as well as increasing recreation pressures have kept timber harvest from public forested lands from exceeding one million board feet in recent years. This situation is expected to continue and may even cause a further decrease in annual harvest.

Most timber harvested in the Basin comes from Indian Trust lands in the Crow Indian Reservation. Due to difficulty in marketing smaller volumes, annual sales are only about five million board feet. This level is anticipated to continue for about five years. However, timber sales from these lands after that time will be very small while the younger stands are allowed to reach maturity. This situation is expected to continue for 20-30 years.

Other private forested lands in the valleys and the foothills of the Basin are found in stringers along watercourses, in small patches, or in inaccessible canyons. The poor quality and small size of much of this timber and its scattered location make much of the resource economically inoperable.

The low volumes of timber available from public and private lands and the widely varying volumes harvestable over time from Indian Trust lands contribute to the difficulty of promoting intrabasin forest industry growth. Two other factors are a lack of available skilled woods workers and the purchase of most timber harvested by processing mills located near, but outside, the Basin.

Of the approximately six million board feet of timber harvested in the Basin, only one-fourth of it is processed by four mills located in Carbon and Stillwater Counties. The primary product is rough (green or dry) lumber which is sold locally. The volume of timber processed in the Basin is not expected to rise due to the anticipated decrease in availability of harvestable timber in five years. In fact, the volume processed may even decrease. In spite of the existence of enough timber volume to support the present mills and perhaps an additional small operation such as a stud mill, the above constraints would preclude economic operation of new facilities.

Consequently, the role of the forest industry in the Basin economy will continue to be slight. The timber produced will merely contribute to larger scale operations located outside the Montana portion of the Basin which can draw on much larger and more productive timber growing areas. This peripheral processing activity is meeting Basin demands for products, although higher quality timber products are being shipped in from outside the area.

Resources from forested lands other than timber have become increasingly significant. The water yielded from these lands has relatively high quality except in mine acid drainage areas, and forest land should be managed so that high quality may be maintained.

OUTDOOR RECREATION

Outdoor recreation particularly on forested lands provides considerable economic benefit to the area. A number of nationally recognized recreational resources exist in the Basin or cause people to travel through it. These are Bighorn Canyon National Recreation Area established around Bighorn Lake, Custer Battlefield National Monument, Beartooth Primitive Area, Pryor Mountain Wild Horse Range (all within the area), and Yellowstone National Park nearby. These attractions, along with others of the area, lure about three times as many people from Montana as from other states. The heaviest use naturally occurs during the summer months of favorable weather, but increasing activity is occurring during the winter in the form of snowmobiling and skiing. For example, 67,000 skiers visited the ski area near Red Lodge in 1971. Preferred activities of people recreating in the area are: resting and relaxing, camping, fishing, pleasure walking, hiking, and driving for pleasure.

The popularity of the Basin area and its proximity to Montana's largest city have contributed to extensive development of recreational residences along the Stillwater River and the upper reaches of the Beartooth range drainages. These types of residences have also begun to appear near the Pryor Mountains. The lower Clarks Fork valley has attracted many retirees due to its location and favorable climate. This characteristic is supported by the fact that 45 percent of the recreationists are over 44 years old and 29 percent are unemployed.

The economic impact of these developments as well as the transient recreational activity are certainly greater than that derived from any other forest land product. Continued efforts to meet the rising recreational demands will likely reinforce this economic relationship. It is certain that both private facilities such as motels, cafes, dude ranches and outfitting services, and public facilities, especially local and state, will increase in the future.

RELATIONSHIP OF ECONOMIC DEVELOPMENT TO WATER RESOURCE DEVELOPMENT

The employment, income, and stability of the economy are directly tied to water resource development. Most of the irrigation development has been accomplished by private ditch companies and individual ranchers. Project development was limited to the Indian reservation and the Huntley irrigation project. Production from irrigated agriculture provides many more jobs than the same area would provide under dryland cropping or ranching. In general, irrigated production is more dependable than that from range or dryland. This stability and higher production provides a base for agriculturally oriented industry and other social developments such as roads, schools, hospitals, and churches. In turn, an area with established social development attracts other investment in light manufacturing and service industries. That has been the pattern of development in the Basin.

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

This chapter presents the problems related to water and land resources that were identified by the river basin planning staff and cooperating state and federal agencies during this study.

EROSION DAMAGE

The severity of erosion damage varies widely in the Basin. Some of the mountain areas and better cropland areas show no recent evidence of any significant erosion. On the other hand, many badland areas were formed entirely by erosion. Considering this wide range of erosion damage, lands are classed into the three erosion hazard categories of "slight," "moderate," and "severe," as determined by their erodibility. These categories are indicated by topography, surface geology, and soil texture, structure, and chemistry. Erosion hazard classes are independent of the ground cover, land use, stream channel characteristics, climate, and runoff. However, vegetative cover, climate, and runoff characteristics of an area can either substantially subdue or exaggerate the extent of erosion.

Slight erosion hazard generally exists on gentle upland slopes (less than 5 percent) with deep, coarse-grained, permeable soils; strongly sloping uplands with massive resistant bedrock surfaces and very shallow rocky soils; and extensive alluvial flood plains composed of mature soils with definite profile development, or aggregated soils with clay and organic binders. As the category suggests, these lands present very few erosion problems.

Moderate erosion hazard areas generally exist on moderate upland slopes (less than 20 percent) with shallow soils containing some rock fragments and alluvial fans or immature flood plains composed of medium-textured mixed soils with some binders.

Severe erosion hazard areas generally exist on steep upland slopes (in excess of 20 percent) with very little flood plain development, composed of deep, single-grained, silty and sandy soil or marine shales and siltstones that are easily dispersed and have high shrink-swell potentials or high sodium concentrations.

The Conservation Needs Inventory conducted in 1966 and published in 1970 shows that 43 percent of the cropland in the Basin counties have moderate erosion hazards and another 16 percent have severe erosion hazards. Nineteen percent of the inventoried pasture, range, private forest, and other lands have moderate erosion hazards and an additional 55 percent have severe erosion hazards. In other words, most of the lands with the least erosion hazards have already moved into crop production while lands with more serious erosion hazards are used for grazing or other extensive purposes. Much of the rangeland has such high erosion hazard that careful range management is needed to prevent land destruction and sediment production.

Most land treatment problems on these erosion hazard soils are concerned with soil cover to minimize water erosion. Wind erosion is a problem on some dry cropland.

In addition to man-caused accelerated erosion, there is considerable geologic erosion, for which there is no economically feasible solution, on both private and public lands. Overgrazing and misuse of steep rangeland can accelerate rilling and gully erosion. Some badland areas in the U. S. may well have started from overgrazing and trampling by migrating buffalo. Heavy rains following cover destruction start accelerated erosion--particularly in arid and semiarid areas similar to parts of the Basin. Other causes of accelerated erosion include indiscriminate use of wheeled vehicles, poorly designed roads and trails, farming too close to streambanks, channel straightening, poor reclamation of petroleum and mineral exploration areas and timber harvest areas, and poor irrigation and tillage practices. There are local areas of severe streambank and channel erosion in natural drainages being used to transport irrigation and waste water. Examples are Sand Coulee, Silvertip, Dry, Elbow, and Rushwater Creeks. Failure to recognize fragile vegetation and erodible soils has resulted in widespread cases of accelerated erosion.1/

Streambank erosion is moderate to severe on 71 miles of the Clarks Fork and its tributaries and 90 miles of the Bighorn and its tributaries. There are 40 miles of bank erosion along Pryor Creek and other direct tributary drainages into the Yellowstone River. Bank stabilization may be needed in some cases.

SEDIMENT DAMAGE

Sediment is a by-product of erosion. Where one can control the latter, he can control the former. In some isolated cases, cropland along streams and on alluvial fans receives deposits of infertile sediments. These deposits generally produce a short-term reduction in crop yields. The soils in these alluvial areas originated from just such deposits. Over time, the new deposits are mixed with the soil and organic matter and production is restored or, in some cases, enhanced.

In some areas, irrigation canals trap sediment from overland flooding to such an extent that their transport capacity is reduced. The cost of periodic cleaning and repair of these canals increases crop production costs.2/ Sediments originating from marine shales often carry undesirable salts into streams, stock water reservoirs, and onto cropland. Sediments

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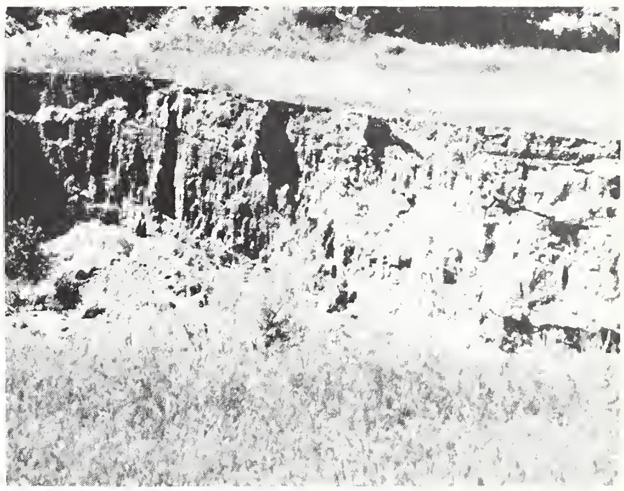
1/ For information on localized erosion and sediment problems, see "A Study of Erosion and Sedimentation, Montana Portion, Clarks Fork of the Yellowstone River Basin," January 1973, prepared for Montana Legislative Assembly.

2/ About 20 percent of canals and laterals have to be cleaned each year.

Sediment accumulation of 36 years has reduced the storage capacity and attractiveness of Cooney Reservoir in Carbon County. SCS PHOTO 11-P830-7

Overuse of stream bottom has destroyed browse and game habitat.
USDA - FOREST SERVICE PHOTO



Streambank erosion of sandy soils along Elbow Creek. SCS PHOTO 11-P870-7

Permeable log jetties constructed on the Bighorn River in an attempt to control bank erosion. SCS PHOTO 11-4954-3

PLATE 16

SCS PHOTO 11-P966-4

In order for open drainage ditches to function properly, they must receive annual maintenance to remove debris and sloughed-in banks and to be kept free from excessive vegetative growth. Two Leggins Irrigation Unit.

SCS PHOTO 11-P966-

PLATE 17

shorten the life of reservoirs. See table IV-1. Trout reproduction is severely limited by sediment in the Clarks Fork and some of its tributaries.

TABLE IV-1--SEDIMENT YIELDS ON SELECTED RESERVOIRS BASED ON SUSPENDED LOAD AND/OR RESERVOIR SURVEYS WIND-BIGHORN-CLARKS FORK RIVER BASIN

Reservoir Name & Subbasin	Drainage Area Above Reservoir	Sediment Yield Average Annual	
		Total Acre-Feet	Acre-Feet per Square Mile
	(square miles)		
Boysen Reservoir	7,767	1,398	0.18
Bighorn Reservoir			
Bighorn River	8,598	3,525	0.41
Shoshone River	1,492	746	0.50
Buffalo Bill Reservoir	2,023	708	0.35

Source: River Basin Planning Staff

Sediment Yields

Sediment yields depend on a combination of the erodibility of the soils and parent materials, vegetative cover is affected by climate and soil conditions, steepness of slope, and the pattern of precipitation. For example, 10 percent of the Basin is underlain by Precambrian igneous and metamorphic rock. This area is located at high elevation and has high rainfall and good vegetative ground cover. The area produces 37 percent of the Basin water runoff, but only 4 percent of the Basin sediment yield. In contrast, 13 percent of the area is underlain with tertiary sedimentary rock. This latter area produces only 9 percent of the runoff, but produces 22 percent of the sediment yield. The highest sediment yield is found in the arid breaks of exposed marine shales where salt concentrations and low rainfall inhibit vegetative growth. Procedures used in preparing the sediment yield map do not involve the delineation of areas based on particular-sized watersheds. Each delineation provides a range of rates that in general encompass sediment yield possibilities. The mapping procedure used leads to a general portrayal of conditions and not for specific projects. See table IV-2 and map IV-1. In addition, cloudbursts are the typical summer rainfall pattern.

Sediment yields in the lower Wind-Bighorn-Clarks Fork River Basin are estimated to range from less than .05 to a maximum of 1.0 acre-feet per square mile per year (map IV-1 and table IV-2).

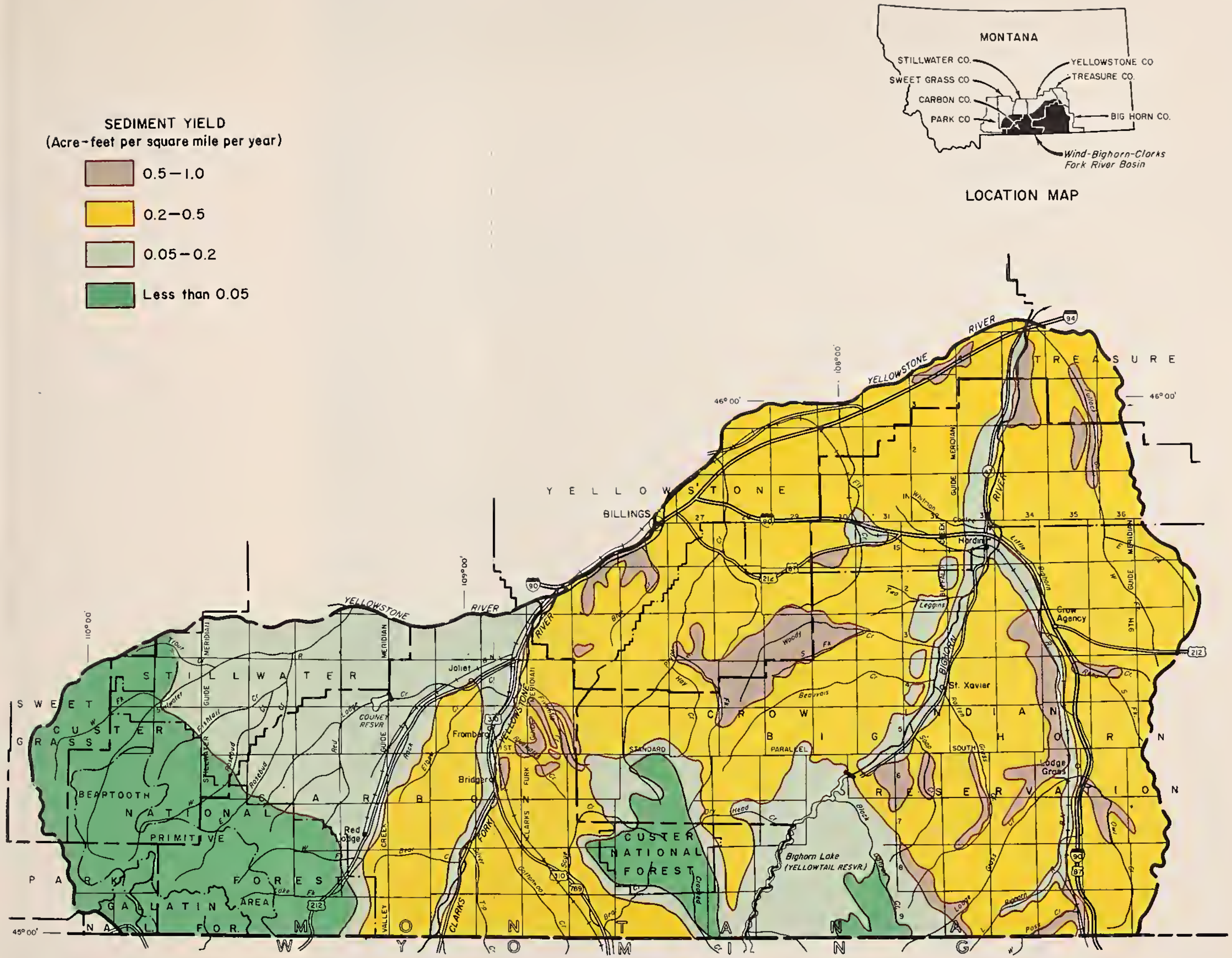
TABLE IV-2--RELATIONSHIP OF GEOLOGIC FORMATIONS
TO WATER AND SEDIMENT YIELDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Type of Rock	Percentage of Basin Area	Estimated Yields: Water Percentage of Basin Yield	Estimated Yields: Sediment Percentage of Basin Yield
	- - - - - - - -	Percent	- - - - - - - -
Precambrian Igneous and Metamorphic	10	37	4
Paleozoic and Mesozoic Sedimentary	64	42	49
Cretaceous-Tertiary Pyroclastics & Volcanic Extrusives	1	2	1
Tertiary Sedimentary	13	9	22
Quaternary Alluvium and Terraces	12	10	24
TOTALS	100	100	100

Source: River Basin Planning Staff

The highest sediment yield areas include the drainages tributary to the Bighorn and Little Bighorn Rivers and basins tributary to the upper part of the Clarks Fork River in Montana. These areas, which are composed largely of moderately steep, generally rough, broken topography underlain by soft, erosive shale and sandstone strata, are predominantly affected by geologic erosion. However, the area does include some cultivated lands with fine-grained erodible soils.

Mountainous areas composed of the Beartooth Range and the Bighorn and Pryor Mountains have sediment yield rates estimated to be less than .05 acre-feet per square mile per year. These areas are characterized chiefly by hard, erosion-resistant crystalline and sedimentary rocks, relatively free-draining stable soils, and good vegetative cover locally. However, localized problem areas occur in the form of eroding trails caused by over-use by livestock and four-wheel drive vehicles on high mountain meadows and steep slopes. These tracks often become small gullies contributing sediment to tributary streams. Surface disturbance



MAP IV-1

SEDIMENT YIELD MAP

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914K

caused by bulldozers during exploration for minerals has caused considerable damage to mountainous areas and contributes significantly to localized sediment problems. Overgrazing has also bared slopes in some forested areas which continue to contribute sediment to stream courses.

Associated with the steep, mountainous terrain are rolling uplands and high plains characterized predominantly by soft sedimentary strata and poor-to-fair vegetative cover with an estimated yield rate of .05-.2 acre-feet per square mile per year. These areas include some moderately steep mountainous lands underlain by fairly hard, resistant sedimentary rocks flanking the Pryor and Bighorn Mountains.

Broadly terraced river valleys and gentle-to-moderately rolling interstream uplands, characteristic of the Great Plains which comprise much of the Basin area, have sediment yield rates of .2-.5 acre-feet per square mile per year. The chief factors in sediment production in these areas include soft, erodible shale, siltstone, and sandstone strata which underlie a large part of the area, silty to silty sandy dispersed soils, and high intensity cloudburst-type storm activity. Long slopes characteristic of the uplands are particularly susceptible to accelerated erosion where the grass cover is sparse.

Previous investigations made in connection with the Missouri River Basin Framework Study (1968) indicate that variations in sediment yields are generally fairly closely associated with the surface geology. An inverse relationship generally exists between rainfall and soil erodibility with the more erosive, more easily dispersed soils occurring in the lower rainfall areas.

The sediment yield map prepared for this report represents to a limited extent a refinement of the sediment yield map prepared previously by the Task Force on Sedimentation (1968) for the Missouri River Basin Framework Study. This refinement is based to a large degree on known areas of geologic and cropland erosion, combined with a fairly detailed knowledge of local watershed characteristics as related to sediment production. The sediment yield map prepared for the Missouri River Basin Framework Study (1968) was based primarily on suspended sediment discharge records and reservoir sediment data.

FLOODWATER DAMAGES

In general, historical data from newspaper morgues do not show sufficient economic damage on most of the small watersheds in the Basin to justify single-purpose flood prevention projects. Flood damages are generally confined to sparsely inhabited cropland areas. Some roads, bridges, farm outbuildings, machinery, and livestock have been lost and some crops have been destroyed, but not with a high degree of frequency.

Damages to fences and crops are seldom reported in newspapers. Table IV-3 shows a brief resume of newspaper records of flood damages by watershed area. Table IV-4 shows estimated average annual damages by subbasins. Table IV-5 shows projected damages by subbasins. Residential flood damages have occurred in Red Lodge, Lodge Grass, and along Blue Creek.

TABLE IV-3--YEARS OF MAJOR FLOODS ON SELECTED WATERSHEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Name	Years of Record										
	'60	'61	'62	'63	'64	'65	'66	'67	'68	'69	'70
14b-2 Fishtail to Butcher Creek				M				S	S		
14-27 Blue-Duck Creek				S	S	S				S	
14d-1 and 2 Pryor Creek				S	S	S					
14c-7 Clarks Fork-Ruby Creek					S						
14c-9 Red Lodge-Rock Creek			S	M				S	S		
14e-37a Two Leggins				S				S			
14e7-3 Lodge Grass Creek						S				S	

Source: River Basin Planning Staff and Newspaper Morgues
S = Serious Flooding
M = Moderate Flooding

The water wells for the town of Joliet were flooded in 1964; as a partial result, the residents of Joliet passed a bond issue and drilled new wells outside the flooded area. The town of Fishtail often receives winter flooding caused by ice building up in the West Rosebud Creek channel during fluctuating operation of the Mystic Lake power plant by Montana Power Company.

TABLE IV-4--ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE ON SELECTED DRAINAGE

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Major Drainage	Flood Plain Area	Current Average Annual Damage 1/ Crop and Pasture	Other Rural	Urban	Indirect	Total
	(Acres)	- - - - - - - - - - - - - -	- - - - - - Dollars	- - - - - -	- - - - - -	- - - - - -
Stillwater River Subbasin	3,400	2,400	6,100	5,000	NA	13,500
Clarks Fork Subbasin	15,200	20,400	33,500	16,000	NA	69,900
Bighorn Subbasin (including Little Bighorn)	32,500	30,100	42,900	58,400	NA	131,400
Yellowstone Minor Tribs.	29,800	53,600	80,300	104,600	NA	238,500
TOTAL	80,900	106,500	162,800	184,000	NA	453,300

Source: Missouri River Basin Comprehensive Framework Study and River Basin Planning Staff

1/ Price base: Urban and Other Rural = 1960; Crop and Pasture = 1964.

TABLE IV-5--SUMMARY OF CURRENT AND PROJECTED FLOOD DAMAGES
in the
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Subbasin	Area Subject to Flooding	Average Annual Flood Damages[1/]: Under Current Economic Development	Under Projected Economic Development[2/]: 1980	2000	2020
	(1000s Acres)	(1000s Dollars)			
Stillwater:					
Main Stem	2.0	8.5	10.7	18.2	31.2
Tributaries	1.4	5.0	6.7	11.9	21.4
Clarks Fork:					
Main Stem	10.5	30.2	39.0	66.9	116.7
Tributaries	4.7	39.7	49.7	82.3	139.3
Bighorn:					
Main Stem	15.1	59.6	74.9	130.4	227.9
Tributaries (including Little Bighorn)	17.4	71.8	90.7	158.4	277.7
Yellowstone Minor Tributaries:					
Main Stem	20.0	111.1	139.4	232.6	394.9
Tributaries	9.8	127.4	166.6	289.8	511.7
Montana TOTALS	80.9	453.3	577.7	990.5	1,720.8

Source: Missouri River Basin Comprehensive Framework Study and River Basin Planning Staff.

1/ Price base: Urban and Other Rural = 1960; Crop and Pasture = 1964.
2/ Projection coefficients from Missouri River Basin Comprehensive Framework Study.

IMPAIRED DRAINAGE

About 50,000 acres in Montana's part of the Basin have impaired drainage problems. There are wet areas along the flood plains of the Clarks Fork, Bighorn, Little Bighorn, and Yellowstone Rivers and some of their tributaries. Most of the wet areas in the Basin exist because of impaired drainage and, in some areas, artesian ground water. Impaired drainage is related to restricted movement of water away from the wet area to the local drainage system. A natural high water table, over-application of irrigation water, insufficient outlets for irrigation waste water, and seepage from irrigated upper benches and canals can aggravate the situation. Artesian pressure in the underlying alluvium or bedrock aquifers can raise the water table abnormally high. Depth of water table is governed by configuration of the impermeable floor under water-bearing material, rate of recharge, transmissibility of the aquifer, and topography.

Drainage studies have been made on some of these wet areas, but financial limitations and lack of local initiative have delayed remedial construction. Huntley project in the Yellowstone River valley has about 11,500 acres where the water table is less than 6.0 feet below the surface or where a salinity problem exists. Potential drainage projects in the Clarks Fork valley total about 6,500 acres. In the Big Horn River valley north of Yellowtail Dam, there are over 45,000 acres under irrigation. Waterlogging has occurred on about 24,000 of these acres. There are approximately 5,900 acres in the Little Big Horn valley that have a high water table. Many of these are found in low areas associated with old meanders of the river.

Floodwater in the valleys of Tullock, Beauvais, and Pryor Creeks causes local waterlogging of soils in isolated areas of low elevations. The effect is particularly detrimental when flooding occurs during the growing season.

Waterlogging and salinity are often caused by capillarity in the problem areas. Texture and hydrological properties of the soil, temperature, and salinity govern the height of capillary rise. Waterlogging usually does not occur when the water table is over six feet deep in clay soils; over four feet with medium-textured soil; or over three feet in sandy soil. Problems will normally appear whenever the water is within four to five feet of the surface. The resulting elevated water tables, soil drowning, and periodic surface ponding decrease crop production, increase operating costs, and increase the mosquito and vector problems of these areas. See Impaired Drainage Map IV-2.

WATER SUPPLIES--IRRIGATION DEMANDS--SHORTAGES

Lands irrigated by diversion or pump-lift out of the Yellowstone and Bighorn Rivers have a full supply of late season water because flows in these rivers hold up well through the summer. Lands that are irrigated out of minor tributaries are often short of water. The Stillwater drainage generally has more water available than there is land to irrigate. There are about 97,900 acres currently irrigated in watersheds in which there are deficits of late season water 50 years out of 100. Temporal surplus spring runoff is sufficient within the study area to provide a full supply to all of those acres if it were stored for later use. See figure IV-1.

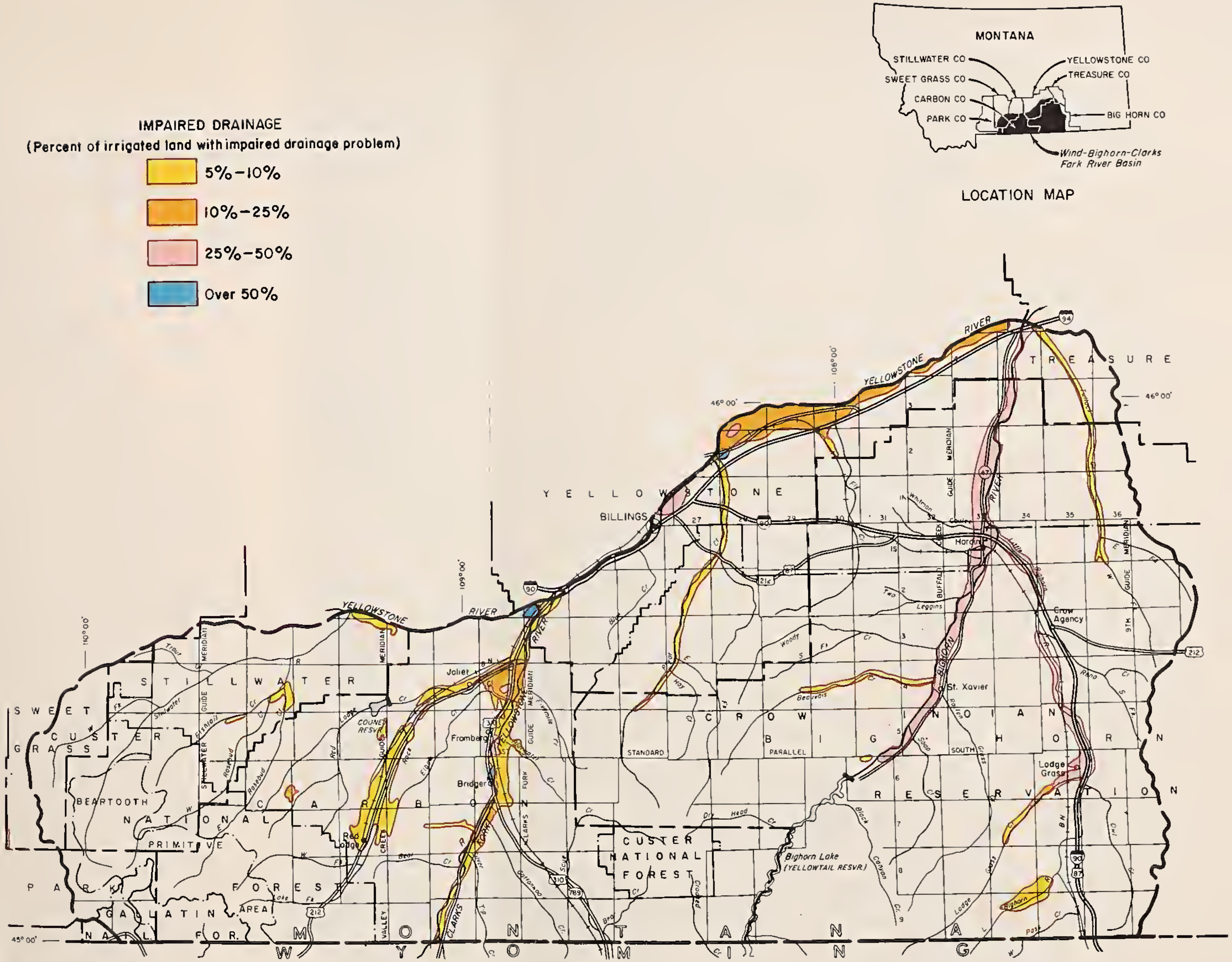
Aside from actual late season shortages of water supply, most of the irrigation development is plagued with low efficiencies in water distribution and on-farm irrigation use. Some recent canal measurements in Carbon County revealed as much as 60 percent loss of water between the point of diversion and the headgate of the first farm on the canal. Much of this water finds its way back to the stream through ground water, but considerable quantities are lost to deeper percolation, phreatophytes[1/], and surface evaporation. As a result of haphazard development and the existing pattern of water rights, there are many duplicating ditches with some ditches crossing over or under one another. Maintenance costs and overall water losses are high. See table IV-6.

Water supply shortages on presently irrigated lands have been estimated using present irrigation efficiencies and are shown by hydrologic subareas and subbasins in table IV-6. The present water diversions shown in columns 5 and 8 have been reduced in many subareas so the amount shown will not exceed the computed diversion requirements shown in column 4. This was necessary so that the correct supply needed for storage or transfer could be shown in columns 6, 7, 9, and 10. Many irrigators are diverting more water than is necessary for a full irrigation supply. Data are shown for both the 50 and 80 percent chance year. Surface water resources data of native water supply, flows from upstream sources, depletion by phreatophytes, reservoir evaporation, irrigation depletions, and water supply remaining at the outlet of the subarea for the 50 and 80 percent chance year are shown in table II-8. Data for table IV-6 were developed using the data assembled for table II-8.

The actual water available for storage or remaining needs for a given watershed will depend on downstream water rights and demands and will vary from the values shown in table IV-6. These latter values are based on annual water budget studies and indicate where annual rather than temporal water shortages and surpluses exist.

Flows in smaller streams are often too low for good trout production in late summer and are further aggravated by irrigation diversion.

1/ Phreatophyte plant classification describes a distinct group of plants which survives by drawing water directly from the zone of saturation.



MAP IV-2

IMPAIRED DRAINAGE

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

USDA-SCS-PORTLAND, OREG. 1973

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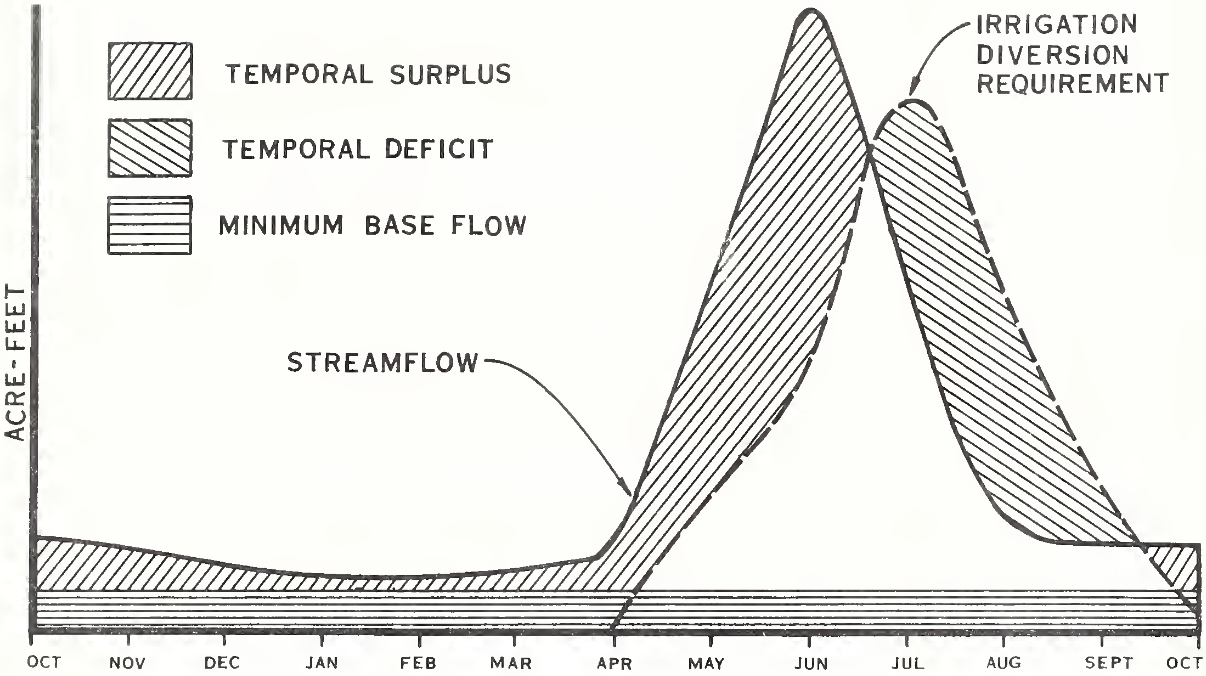

FIGURE IV-1 -- TYPICAL STREAMFLOW AND IRRIGATION DIVERSION REQUIREMENT CURVES

Livestock water shortage is a problem on about 1,450 dry range sites involving about 925,000 acres. Some areas have poor materials for dams or too pervious basins for stock water reservoirs.

Potable water for human consumption is plentiful except for some areas around Fromberg and on the heavier soils and shale areas along the Bighorn valley from Bighorn Lake (Yellowtail Reservoir) to Hardin.

PHREATOPHYTES

Phreatophytes in the Basin consist of cottonwoods, willows, water birch, alder, cattails, rushes, and sedges. Most of these serve some beneficial use as habitat for wildlife even though they are heavy users of water. It is estimated that 224,540 acre-feet of water are used each year by 43,199 acres of phreatophytes. This volume of water is

TABLE IV-6--WATER SUPPLY SHORTAGES ON PRESENTLY IRRIGATED LANDS WITH PRESENT EFFICIENCIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Numbers	Hydrologic Subareas	Present Area of Irrigated Land (Acres)	Irrigation Diversion Requirement 1/ (Acre-Feet)	50 PERCENT CHANCE: Present Water Diversions 2/	50 PERCENT CHANCE: Need For Storage or Transferred Water 3/	50 PERCENT CHANCE: Transfer Needs	80 PERCENT CHANCE: Present Water Diversions 2/	80 PERCENT CHANCE: Need For Storage or Transferred Water 3/	80 PERCENT CHANCE: Transfer Needs
				- - - - - - Acre-Feet - - - - - -			- - - - - - Acre-Feet - - - - - -		
	Stillwater Subbasin								
14b-1	Upper Stillwater River	768	5,000	5,000	0	0	5,000	0	0
14b-2	Fishtail to Butcher Cr.	18,843	117,750	117,750	0	0	117,750	0	0
14b-3	Lower Stillwater River	5,490	27,440	27,440	0	0	27,440	0	0
14b-4	Shane-Beaver Creek	4,151	24,920	24,920	0	0	24,920	0	0
	Subbasin Total	29,252	175,110	175,110	0	0	175,110	0	0
	Yellowstone Minor Drainages								
14-22	Cow-Bellion Creek	1,610	12,050	12,050	0	0	12,050	0	0
14-27	Blue-Duck Creek	3,124	23,450	23,450	0	0	23,450	0	0
14-31	Arrow Creek	27,990	170,080	170,080	0	0	170,080	0	0
14-32	Fly Creek	1,250	7,620	7,620	0	0	7,620	0	0
14-36	Lost Boy Creek	1,058	7,480	7,390	90	0	7,390	90	0
14-37	Custer Drainage	2,200	15,960	15,300	660	0	15,300	660	0
14d-1	Upper Pryor Creek	1,371	10,300	10,300	0	0	10,300	0	0
14d-2	Lower Pryor Creek	1,348	6,730	6,730	0	0	6,730	0	0
	Subbasin Total	39,951	253,670	252,920	750	0	252,920	750	0
	Clarks Fork Subbasin								
14c-3	Clarks Fork-Zimmer Creek	0	0	0	0	0	0	0	0
14c-4	Pat O'Hara Creek	112	950	900	50	0	900	50	0
14c-4a	Big Sand Coulee	968	8,100	7,750	350	0	7,750	350	0
14c-6	N.F. Cherry-Silvertip Creek	10,633	69,320	68,040	1,280	0	68,040	1,280	0
14c-7	Clarks Fork-Ruby Creek	11,385	74,240	72,880	1,360	0	72,880	1,360	0
14c-8	Upper Rock Creek	40	400	400	0	0	400	0	0
14c-9	Red Lodge-Rock Creek	39,308	265,310	265,310	0	0	213,200	52,110	52,110
14c-10	Elbow-Lower Rock Creek	19,100	119,730	44,340	75,390	75,390	13,860	105,870	105,870
14c-11	Lower Clarks Fork-E. Side	7,082	44,380	43,580	800	0	43,580	800	0
	Subbasin Total	88,628	582,430	503,200	79,230	75,390	420,610	161,820	157,980

See footnotes on following page.

TABLE IV-6--WATER SUPPLY SHORTAGES ON PRESENTLY IRRIGATED LANDS WITH PRESENT EFFICIENCIES (Continued)

Watershed Numbers	Hydrologic Subareas	Present Area of Irrigated Land (Acres)	Irrigation Diversion Requirement 1/ (Acre-Feet)	50 PERCENT CHANCE: Present Water Diversions 2/ (Acre-Feet)	50 PERCENT CHANCE: Need For Storage or Transferred Water 3/ (Acre-Feet)	50 PERCENT CHANCE: Transfer Needs (Acre-Feet)	80 PERCENT CHANCE: Present Water Diversions 2/ (Acre-Feet)	80 PERCENT CHANCE: Need For Storage or Transferred Water 3/ (Acre-Feet)	80 PERCENT CHANCE: Transfer Needs (Acre-Feet)
	Bighorn Subbasin								
14e6-8	Sage Creek	1,449	9,160	9,160	0	0	9,160	0	0
14e-27	Crooked Creek	332	2,080	2,080	0	0	2,080	0	0
14e-28	Porcupine Creek	0	0	0	0	0	0	0	0
14e-30	Dryhead Creek to Wyoming	134	840	840	0	0	840	0	0
14e-32	Soap Creek	4,507	29,400	28,840	560	0	24,230	5,170	5,170
14e-33	Beauvais Creek	1,122	9,200	9,000	200	0	9,000	200	0
14e-34	Rotten Grass Creek	17,088	80,540	78,110	2,430	0	78,110	2,430	0
14e-35	Two Leggins-Woody Creek	15	100	100	0	0	100	0	0
14e-37	West Side Bighorn River	3,606	17,200	16,490	710	0	16,490	710	0
14e-37a	Two Leggins Irrigation Unit	27,085	113,090	108,350	4,740	4,740	108,350	4,740	4,740
14e-38	East Side Bighorn River	321	2,160	1,460	700	700	1,460	700	700
14e-40	Lower Tullock Creek	795	6,650	5,850	800	0	5,850	800	0
	Subbasin Total	56,454	270,420	260,280	10,140	5,440	255,670	14,750	10,610
	Little Bighorn Subbasin								
14e7-1	Little Bighorn River	6,773	50,800	50,800	0	0	50,800	0	0
14e7-2	Pass Creek	696	5,220	5,220	0	0	5,220	0	0
14e7-3	Lodge Grass Creek	2,234	11,470	11,470	0	0	11,470	0	0
14e7-4	Owl Creek	1,042	6,440	6,440	0	0	6,100	340	340
14e7-5	Little Bighorn-East Side	250	1,520	1,520	0	0	1,520	0	0
14e7-6	Little Bighorn-West Side	6,139	24,250	24,250	0	0	24,250	0	0
	Subbasin Total	17,134	99,700	99,700	0	0	99,360	340	340
Summary									
Stillwater Subbasin		29,252	175,110	175,110	0	0	175,110	0	0
Yellowstone Minor Drainages		39,951	253,670	252,920	750	0	252,920	750	0
Clarks Fork Subbasin		88,628	582,430	503,200	79,230	75,390	420,610	161,820	157,980
Bighorn Subbasin		56,454	270,420	260,280	10,140	5,440	255,670	14,750	10,610
Little Bighorn Subbasin		17,134	99,700	99,700	0	0	99,360	340	340
TOTAL		231,419	1,381,330	1,291,210	90,120	80,830	1,203,670	177,660	168,930

Source: River Basin Planning Staff

1/ Based on average annual consumptive uses. 2/ Diversions shown here do not exceed estimated diversion requirements. Actual diversions may exceed these amounts in dry years on streams where water supply is not limited. 3/ The exercise of water rights may create additional storage needs in some locations.

about 64 percent as much as that consumed by irrigated crops. Because of practical, political, and environmental limitations, overall phreatophyte control may not appreciably increase the water supply available for irrigation. Some of the lands they occupy may be capable of producing more valuable pasture, hay, or other crops than are produced by the phreatophytes. Areas of the phreatophytes are shown in table II-8.

FORESTED LAND PROBLEMS

Wood from forested lands makes only a small contribution to the local economy of the area. Scattered stands of low quality timber, inaccessibility, slow growth due to overcrowding, inadequate skilled woods workers, and lack of a processing plant for small material are all problems even though a market does exist in Billings and vicinity for finished wood products.

Many of the forested lands have been overgrazed in the past and some are still utilized beyond their safe carrying capacity. Overgrazing contributes to increased erosion, higher sediment yields, accelerated runoff causing higher peak flows in localized streams and generally poor watershed conditions.

Most of the problems on forested lands are related to recreation use or mineral exploration. Recreation-related problems include degraded water quality from increased sediment production and inadequate treatment of garbage, sewage, and waste water. Peak period demands for recreational facilities bring about some overuse of campsites, both developed and undeveloped. Recreational summer homes without adequate sewer systems are the greatest threat to water quality in the forested area. Subdivision of privately owned recreational lands is occurring on an unplanned, uncoordinated basis and is contributing to inflated land values. It is also causing heavy use on roads and trails and an increase in requests for special use permits on public lands for water systems, recreation, stock grazing, and rights-of-ways for roads and transmission lines. Increased recreational use greatly increases man-caused fire risks, pressures on fish and wildlife populations, littering, and trespass. Some mineral prospecting and mining operations have created large scars on the landscape, increased erosion and sediment yields, and left lands unproductive. Roads have been built into previously inaccessible country. Off-road vehicles entering this newly opened land often contribute to damage of fragile alpine soils and sparsely vegetated slopes by creating ruts which can channel water and become erosion gullies.

While there is access across some private lands to public lands, in many areas landowners refuse to sell or grant crossings or rights-of-way to public lands. This results in overuse of public lands in some areas with presently available public access.

Range and Forest Fires

Fire control within the national forest boundary is the responsibility of the Forest Service. Forest fire control on private and state timber lands is the responsibility of local fire districts in cooperation with the Office of the State Forester. Range fires on public domain lands are controlled by the Bureau of Land Management. Range fires on private land are generally fought by local residents, fire district members, and by Bureau of Land Management personnel if public domain is endangered. Forest fires in the region mostly start from lightning and the small acreage burned annually has not produced problems of any magnitude. Range fires usually cover large acreages and are more frequent because of the greater opportunities for man-caused fires. Uncontrolled range fires in semiarid areas destroy valuable forage and wildlife cover, increase runoff and subsequent erosion. A lack of recognition of fire as a tool in proper range and forest management has resulted in many acres of subclimax ecosystems. In turn, reduced forage production and increased erosion and sedimentation occur locally. On the average, 17 fires per year burn 95 acres of federal forested lands while six fires on Indian lands damage 644 acres each year. One hundred and sixty fires per year on state and other private forested lands burn an undetermined acreage.

POLLUTION

Water pollution in the Basin is not a serious problem at present except in localized instances. The larger towns have sewage lagoons while the smaller towns depend on private septic tanks. There is some danger of ground-water contamination and occasional stream pollution from improperly treated sewage. A common complaint is infiltration of ground water into the sanitary sewers in Absarokee, Red Lodge, Roberts, and Joliet. Sewage lagoon improvements are needed at Hardin, Lodge Grass, and Crow Agency. Most of the other towns have adequate systems. Feedlots along streambanks are an increasing potential source of pollution. Some fertilizer and agricultural chemicals are carried into the streams by sediment from overland flooding and by irrigation waste water. Past attempts to measure the intensity or change in agricultural chemical pollution have been inconclusive. Sediment is the greatest measurable pollutant. Silvertip Creek in Carbon County is being polluted with chemicals from the Elk Basin oil field to the extent that the Montana Animal Health Director recommends that cattle be kept from drinking it. Mine acid pollution has been identified by the Forest Service in the headwaters of the Stillwater River and in the Fisher Creek headwaters of the Clarks Fork River near Cooke City. Mine workings and tailings near Nye are a source of sediment and metals during periods of high runoff. Some communities discharge treated waste waters into streams, thereby increasing the organic load. Algae are abundant in the Bighorn River below Yellowtail Dam. This creates variations in oxygen balances and increases in turbidity.

FISH AND WILDLIFE PROBLEMS

Except for isolated areas in the higher mountains, nearly all habitat on both public and private land has been adversely affected to some degree by overgrazing and improper land use during the last 50 years. Big game are often in direct competition for forage with sheep, cattle, and horses, particularly for critical winter range. Overgrazing by both game and livestock has decreased the quality and quantity of forage and has accelerated erosion and sediment production. Sagebrush and weed control spraying may have had adverse effects on deer, antelope, sage grouse, and pheasant habitat. Deer population on the Indian reservation has been reduced beyond the optimum by overhunting to the extent that deer forage is going unused. There has been a decline in antelope numbers due to a combination of change in habitat and overharvest of game. In some areas predator control has brought an imbalance in natural wildlife populations with an overpopulation of rodents.

RELATIONSHIP OF WATER PROBLEMS TO IMPAIRMENT OF NATURAL BEAUTY

Problems related to the visual resource of the area's environment are not unique, but do exist and are the subject of increased concern by the public. Litter, junked cars, and cars used for riprap are examples of visual discord. Esthetic values are often damaged by alteration of the natural landscape. This problem is related to timber harvest, mining, and land clearing for pasture, cropland, transmission lines, and roads. Some water resource developments are unsightly unless provisions for esthetics are included in such items as vegetative plantings, road and overlook location, and careful recreational facility layout.

ECONOMIC PROBLEMS

Among the most pressing of the economic problems in the Basin is the human degradation resulting from poverty, unemployment, and underemployment of the Indians. About 32 percent of the land within the Crow Reservation boundary is no longer owned by the Indians. Some land went into roads and railroads and Bighorn Lake, but most was bought by white ranchers and farmers. The best cropland and ranchland is now in non-Indian ownership, leaving more marginal land to the Indians.

A higher percentage of the total potentially irrigable land has been developed off the reservation than has been developed on the reservation. This is partially explained by the difficulties in administration of multiple ownership of small tracts of land, limited Indian development capital, early sale of good lands to whites, and differences in economic pressures confronting Indians and non-Indians. For example, division of property rights among the heirs has progressed to the point that many tracts of land now have over 100 fractional owners. Administration or legal clearance for the development of such lands is almost impossible under present statutes. Even with maximum economic development of agricultural resources on Indian lands, the poverty would not be solved because there is not enough economic base on those lands to support the 3,800 Indians living there. Other solutions must be found. There is a program with funds administered by FmHA called the Indian Lands Acquisition Loan Program. Under this program, tribal agencies can borrow funds to acquire ownership of multiple-owner tracts or of non-Indian tracts. Loans are for 40 years at 5 percent interest with repayment by first assignment of income from purchased lands and from assignment of other tribal incomes. At present, only one such loan has been made on the Crow Indian Reservation.

The Indian factors present some institutional barriers to development and social problems beyond the scope or intent of this investigation. Cultural attitudes concerning preparation for the future, incentives to save, concepts of time orientation, and the work ethic that are common to the non-Indian are alien to the older Indian culture. Indians who have adopted these white attitudes present fewer problems in adjustment than those retaining the Indian cultural attitudes.[1/] Paternalism of charitable organizations and the reservation system itself appear to hinder adjustment and assimilation of this minority group into the mainstream flow of our economic society.

Under the present system of small school districts, nearly all small towns have their own high schools. Local people complain that this causes higher property taxes than might otherwise occur, higher costs per student, and disadvantages to students in lower quality education than is available in larger high schools.

1/ Reifel, Ben; Indians of the Missouri Basin--Cultural Factors in Their Social and Economic Adjustment. Paper presented at MBIAC meeting at Aberdeen, South Dakota. May 14-15, 1958.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

This chapter describes the need for land and water resource development as related to problems, projected economic activity, and needs for environmental and social improvement. Project-type developments are needed to reduce flood damages in the town of Lodge Grass and the residential area along Blue Creek to the one percent chance level. Irrigation and drainage developments are needed to provide more efficient use of agricultural resources and provide for continued expansion of crop and livestock production which is projected to double by 2020. Both project and land treatment measures are needed to reduce erosion and sediment production to the lowest practical level to enhance water quality and preserve environmental resources. The increased production of crops and livestock is needed to improve the economic and employment base. This would improve the income per person (which is about 72 percent that of the national average) and decrease the 25 percent rate of chronic underemployment.

WATERSHED PROTECTION AND MANAGEMENT TO REDUCE EROSION AND SEDIMENT PRODUCTION

The high proportion of Basin lands with moderate and severe erosion hazards necessitates continued effort in watershed protection and management. On land inventoried in the 1970 Conservation Needs Inventory (CNI), 59 percent of the cropland and 74 percent of the rangelands have moderate to severe water or wind erosion hazards. Rangeland in particular is susceptible to severe water erosion hazard. Most public domain lands and large acreages of national forest lands are classified as range. By applying the CNI percentages of erosion hazards over all Basin lands, it is estimated that about 246,700 acres of cropland have moderate erosion hazards and 91,800 acres of cropland have severe erosion hazards. For rangeland, 677,600 acres have moderate hazards and 1,961,400 acres have severe hazards. It should be emphasized that erosion hazard classification does not indicate that moderate or severe erosion is occurring, but rather that such erosion would occur without careful management. On the basis of erosion hazards and land treatment needs, increased awareness and intensified vigilance in watershed protection and management are essential to prevent loss or deterioration of the land resource and to hold sediment production to the lowest practical minimum. See tables V-1 and V-2.

As recreation use increases, there will be a need to increase fire prevention and protection measures, improve roads and trails, provide adequate sewage treatment facilities, prevent overuse of recreational sites, and control off-road vehicular travel to maintain the environmental quality. More adequate laws are needed to control mineral exploration and extraction, to reduce damage to watershed cover and prevent erosion. Grazing lands should be managed for optimum use, but

TABLE V-1--CONSERVATION TREATMENT NEEDS ON STATE AND PRIVATE LANDS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Treatment Category	Cropland Irrigated	Cropland Dryland	Range	Forest	Other Land 1/	Total 1/
	acres					
Treatment Adequate	10,692	138,376	968,570	238,550	18,543	1,374,731
Treatment Infeasible	0		94,158			94,158
Cropland Practices						
Cultural or Management Measures	23,933	206,180				230,113
Improved Irrigation Systems and Management	132,180					132,180
Irrigation Water Management Only	14,614					14,614
On-Farm Drainage Only	50,000					50,000
Pasture and Range Practices						
Needs Protection Only			1,558,602			1,558,602
Needs Improvement Only			79,226			79,226
Brush Control & Improvement			417,805			417,805
Reestablishment of Vegetative Cover			22,533			22,533
Reestablishment with Brush Control			1,085			1,085
Forest						
Establishment & Reenforcement of Timber Stands				9,060		9,060
Timber Stand Improvement				54,355		54,355
Other Land						
Needing Treatment					22,548	22,548
MONTANA TOTALS	231,419	344,556	3,141,979	301,965	41,091	4,061,010

Source: Conservation Needs Inventory 1970

1/ Water areas are excluded.

TABLE V-2--STATUS OF LAND TREATMENT NEEDS ON STATE AND PRIVATE LANDS 1/

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Land Use	Treatment Adequate	No Treatment Feasible	Treatment Needed	Total
	- - - - - - - - - -	- - - - - - acres	- - - - - - - - - -	- - - - - - -
Big Horn County				
Irr. & Dry Cropland	34,786		199,678	234,464
Pasture & Rangeland	347,524	54,580	1,466,924	1,869,028
Forested Land	147,785	--	14,920	162,705
Carbon County				
Irr. & Dry Cropland	61,015	--	117,939	178,954
Pasture & Rangeland	201,073	24,180	333,525	558,778
Forested Land	28,594	--	14,000	42,594
Stillwater County				
Irr. & Dry Cropland	11,303	--	32,034	43,337
Pasture & Rangeland	61,187	--	101,671	162,858
Forested Land	29,318	--	21,618	50,936
Treasure County				
Irr. & Dry Cropland	2,188	--	2,166	4,354
Pasture & Rangeland	37,498	2,453	35,645	75,596
Forested Land	3,730	--	9	3,739
Yellowstone County				
Irr. & Dry Cropland	39,776	--	75,090	114,866
Pasture & Rangeland	321,288	12,945	141,486	475,719
Forested Land	29,123	--	12,868	41,991
BASIN TOTALS				
Irr. & Dry Cropland	149,068	--	426,907	575,975
	(28%)	--	(72%)	(100%)
Pasture & Rangeland	968,570	94,158	2,079,251	3,141,979
	(31%)	(3%)	(66%)	(100%)
Forested Land	238,550	--	63,415	301,965
	(78%)	--	(22%)	(100%)

Source: River Basin Planning Staff

1/ Ratios of treatment needs to land use in County CNI data 1967 were applied to acreages of land used in private cropland, forested land, and grassland in the Basin.

there is a need to restore overgrazed lands and limit the number of grazing animals to the carrying capacity of the range. The meeting of the above needs will provide watershed protection by reducing damaging effects of fire, preventing overuse and misuse of the land and reducing erosion and sediment production on forest and rangelands.

In order to manipulate and manage grazing animals, adequate land treatment measures such as cross fences and stock water developments need to be established. This is essential in developing grazing management systems designed to improve range conditions and minimize erosion.

Establishment of management practices in the Basin should correspond with goals of the Montana Rangeland Resource Plan: (1) 80 percent of the range will be operated under some form of intensive management planning by 1980; (2) 80 percent of the range will be in good-to-excellent condition by 1980; and (3) 80 percent of the stock water developments will be installed by 1980.

Stock water developments and fencing needs on state and private rangeland, including Indian Trust lands, will be determined as individual management plans are developed.

Treatment needs on national forest rangeland are estimated at 5 stock water site developments and two miles of drift fence. Treatment needs on federal forested lands call for construction of 10 miles of multiple-use roads and 20 miles of recreational trails. No information of this type is available on state and private forested lands. There is a need to reduce the erosion from substandard forest roads, mining access roads, mineral exploration pits, inadequate trails, and from abandoned roads and trails. There is also a general need to rehabilitate abandoned mineral exploration and extraction areas. Quantification of land treatment needs to control erosion is shown in table VIII-3.

Locally, on BLM administered lands some roads will be taken out of general use and designated for fire control and other emergency uses.

On irrigated lands, improved irrigation systems with better waste water outlets are needed to reduce erosion and sediment production. On dry cropland, increases in stripcropping, stubble-mulching, grassed waterways, and regrassing of steep fields are needed to reduce erosion and sediment production. In some areas, there is a need to exclude cattle from erosive streambanks--both on private and public lands.

Land treatment measures can reduce sediment production. However, it must be realized that a large portion of the land area in the Basin is subject to erosion that is not caused by man's activities. High sediment concentrations are to be expected in some drainages. For example, on July 14, 1860, Lt. Maynadier observed the Clarks Fork River and wrote, ". . .its waters being turbid, produces a slight discoloration in that of the Yellowstone." An excerpt from the Lewis and Clark journal:

> "July 24, 1806: The name of Clarks Fork was given to this stream. It is a bold river 150 yards wide at its entrance, but a short distance above is contracted to 100 yards. The water is of a light, muddy color and much colder than that of the Yellowstone."

Treatment measures in these areas could reduce total sediment production only by an insignificant amount.

FLOOD PREVENTION

Flood damage in the Basin has not been a major problem largely due to sparse population and intelligent location of most residences out of the flood plains. There is some urban flood damage along Rock Creek in Red Lodge that can be corrected with channel enlargement and flood diking or removal of residences from the damage area. The average annual value of these damages is not sufficient to justify the amount of single purpose storage above Red Lodge that would be required to rectify the problem. There is some flood damage to cabins and summer homes along the Stillwater River caused basically from encroachment on the flood plain. A similar situation exists along the Little Bighorn River and along Blue Creek and Pryor Creek except that these are year-round residences--mostly Indian residences on the Little Bighorn and Pryor Creek. There is need for flood prevention measures on Lodge Grass Creek and Blue Creek in order to prevent potential tragedy.

Land treatment in this part of the Basin would have very little effect on the total volume of runoff generated from high intensity storms and probably only minor effect on timing of the associated flood peaks. Floodproofing of some existing structures may have short-time local benefits. Riprap protection of bridges and critical highway areas is needed in conjunction with increased capacities in overflow channels and bridges in some areas. Flood plain zoning with strict enforcement to prevent further encroachment on flood plains and stream channels is needed to prevent damages to summer homes and residences. In conjunction with zoning, some existing buildings need to be removed from the flood plains of Blue Creek, Pryor Creek, Little Bighorn River, Rock Creek, and Stillwater River and its tributaries. These buildings and corrals not only receive damages, but endanger other properties by reducing channel capacities and contributing to debris dams.

DRAINAGE IMPROVEMENT

Drainage improvement is needed on 12,000 acres on Yellowstone Minor Drainages; 8,100 acres on the Clarks Fork Subbasin; 24,000 acres on the Bighorn Subbasin; and 5,900 acres on the Little Bighorn Subbasin to correct high water table conditions caused by insufficient outlet for irrigation waste waters and seepage from canals and irrigated upper benches. Group action or project development will be needed for 33,000 acres where natural outlets to the rivers are either non-existent or are impaired by other developments such as highways and railroads. Alleviation of these high water table conditions is needed to accomplish the production efficiencies of resources committed to irrigated agriculture in these areas.

IRRIGATION

Based on water resource surveys by the Montana Department of Natural Resources and Conservation and updating by local technicians, there are 231,419 acres now irrigated in the Basin with an additional 41,750 acres potentially irrigable from existing irrigation canals. In addition to these potential acreages, the Bureau of Reclamation's Hardin Unit proposal contains 42,600 acres of irrigable land.[1/] The primary need in the irrigated sector is for improvement of irrigation delivery systems and on-farm irrigation systems and practices. Some areas need storage of spring runoff for late season use. Adequate water supplies and reasonable water use efficiencies are needed to achieve a profitable return to resources used in irrigation. Ditch consolidation and/or reorganization are needed to serve 77,000 acres in Carbon County; 20,000 acres in Stillwater County; 10,000 acres in Yellowstone County; and 44,000 acres in Big Horn County. The need for consolidation and reorganization in Big Horn and Yellowstone Counties is lower due to more irrigation development under larger projects than under small private diversions. Development in Carbon and Stillwater Counties was predominantly by individual or small group appropriation which resulted in multiple diversions and parallel ditch construction.

Stream gage records and simulation studies show that adequate full season water is available for irrigation systems under direct diversion from the Bighorn and Yellowstone Rivers. On the Little Bighorn, a full season supply is available more than eight years out of ten for currently irrigated acres and current irrigation efficiencies. On the Clarks Fork, a full season supply is available 50 percent of the years for current irrigated acres and efficiencies. Supply would be even more deficient if all irrigable acres are added. An irrigation study is needed on Rock Creek and the Clarks Fork River to determine present uses and needs. There are insufficient data on water diversions and uses to determine the extent and causes of reported shortages. Lands on the Stillwater drainage generally have sufficient water supply, especially if their irrigation efficiencies were improved.

1/ Total potentially irrigable land in the Basin is estimated at 485,150 acres as based on physical characteristics of the land. However, only a small portion of these acres is economically feasible to irrigate under current crop prices and development costs.

All of these water deficits could be corrected with storage of excess spring runoff. Storage sites need to be developed whenever economically feasible. Some of the deficits can be corrected with improved irrigation distribution and use efficiencies. The least costly approach may well be a combination of storage and improvement of distribution and on-farm efficiencies. On lower elevation tributaries where runoff yield is lower and less dependable, neither storage nor improved efficiencies will solve the deficits for very large acreages. Such areas will have to depend on pump lifts out of larger rivers or on water transported from adjacent drainages.

RURAL, DOMESTIC, AND LIVESTOCK WATER SUPPLY

Potable water for human consumption on farms and ranches is supplied largely by wells. In some areas on the heavier soils that were developed from marine shales, the ground water is too high in salts content for human use. Residents in an area from Yellowtail Dam to near Hardin have been exploring the feasibility of a water treatment plant and pipeline system to serve their farms. Another area with domestic water problems exists near Fromberg.

Livestock water development, including wells, spring developments, plastic pipelines, and possibly livestock pond lining, is needed to improve the livestock distribution on private and public range. These water developments, coupled with additional drift fences, can result in better utilization of the existing vegetation. Good range management is also needed to reduce erosion and sediment damages.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

At present, there is ample water for the towns in the Basin and for existing industry. The potential for new industry will largely depend on the pattern of steam-electric power generation in the eastern Montana-northern Wyoming coal region. Earliest development is expected to occur just east of the Basin. Water for this development may be transported from Bighorn Lake by a conduit now being planned. As steam-electric generation and associated development moves into the Basin, additional industrial water may need to be developed, but such needs are not expected before 1985-1990. Spin-off industrial development from low-cost at-site electricity could develop before that period.

Following an extended period of static production levels (ten year average annual production, 1958-67 was 354,102 tons/year), Montana coal production began to increase rapidly in 1968. By 1971 the production was 7,097,126 tons, 20 times the earlier annual average. All indications are that annual figures will show continued rapid increase. Neither state nor industry officials can predict when or at what level production will stabilize.

Year	Production (tons)	Year	Production (tons)
1958 1/	338,836	1966	415,410
1959	337,866	1967	364,509
1960	301,273	1968	555,271
1961	358,848	1969	1,024,885
1962	365,850	1970	3,517,158
1963	336,548	1971	7,097,126
1964	344,636	1972	8,044,815
1965	377,248		

1/ 1958-1971 figures from Biennial Reports of the Montana Board of Equalization/Department of Revenue
2/ 1972 preliminary estimate from Montana Department of State Lands

FORESTED LAND MANAGEMENT

There is a need to inventory the timber resources of commercial forest lands that are not within specially designated areas such as wilderness. The potential of these lands needs to be assessed on the basis of realistic and continuing silvicultural practices such as commercial thinning and reforestation. There is a need for a year-round wood processing plant in the Basin that could supply a portion of the Billings wood market and other local demands. A skilled force of woods workers and plant operators needs to be trained as part of any forest management program. A multiple use land management concept, including grazing, timber, water, fish and wildlife, and recreational uses, is needed for a successful forestry program.

RECREATION

Recreational needs within the Basin are more a function of forces outside the area than a function of local population and income factors. As the interstate highway system is completed, population increases, and vacation time and income per worker increase, there will be associated increases in recreational pressures. The western expanses of the United States such as the Basin with large areas of public land will have to absorb much of this national pressure. Local pressures will increase along with moderate increases in population, but are expected to be minor in comparison with national pressures on the area. Levels of recreational activity for the Basin are estimated in table V-3. Total use is projected to increase from 1,641,800 visitor days in 1970 to 2,068,700 visitor days in 2020, an increase of 26 percent. Recreation increase is taken to be a function of the increase in population within the area of influence, as projected by the OBERS report, and ignores changing influences outside the area of influence. It is assumed that participation rates will not increase and that the distribution of recreational demand

TABLE V-3--PRESENT AND PROJECTED RECREATIONAL NEEDS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Activity	Current	1985	2000	2020
	Visitor Days			
Boating				
Use	89,500	95,800	102,900	112,800
Supply	151,200	151,200	151,200	151,200
Needs	---	---	---	---
Swimming				
Use	71,500	76,500	82,200	90,100
Supply	94,500	94,500	94,500	94,500
Needs	---	---	---	---
Camping				
Use	853,900	913,700	982,000	1,075,900
Supply	345,700	513,700	513,700	513,700
Needs	508,200	400,000	468,300	562,200
Sight-Seeing				
Use	186,200	198,900	214,500	234,600
Supply	NA	NA	NA	NA
Needs	NA	NA	NA	NA
Winter Sports				
Use	65,600	70,100	75,600	82,700
Supply	105,000	105,000	105,000	105,000
Needs	---	---	---	---
Hiking				
Use	18,600	19,900	21,400	23,400
Supply	NA	NA	NA	NA
Needs	NA	NA	NA	NA
Fishing				
Use	172,200	184,300	198,000	217,000
Supply	210,000	210,000	210,000	210,000
Needs	---	---	---	7,000
Hunting				
Use	32,000	34,200	36,900	40,300
Supply	NA	NA	NA	NA
Needs	NA	NA	NA	NA
Picnicking				
Use	152,300	163,000	175,100	191,900
Supply	277,600	277,600	277,600	277,600
Needs	---	---	---	---
Total Demand	1,641,800	1,756,400	1,888,600	2,068,700

Source: River Basin Planning Staff NA = Not available between Montana residents and nonresidents will not change, either. Demand figures may be low because of these assumptions and because the impact of coal strip-mining east of the Basin was not considered.

There is a need to recognize the fact that, for some people, the quality evaluation of the recreational experience will decline with increased development and subsequent increased recreational participation in what previously had been relatively unique activities. However, the sum value to all recreational participants may be greater after development than before development, depending on the degree of public saturation and destruction of the recreational resource.

Recreational supply in the Basin is also affected significantly by factors outside the area, specifically state and federal government attitudes toward recreational development. Historically, governmental funding for recreational facilities has not been adequate to meet the demands.

Recreational use in visitor days (12 hours of recreational activity) does not necessarily indicate the number of times that a particular activity was enjoyed; for example, one visitor day of picnicking may represent six people having one two-hour picnic, or one person having six two-hour picnics. One picnic unit could be occupied for each picnic.

Also, development of supply in visitor days assumes that a particular recreational unit is available for use during 12 hours each day. But a picnic table might be used only once (two-hour period) during a day.

Consequently, the recreational demand-supply situation as presented in tables V-3 and V-4 does not give an adequate description of recreational needs. Each visitor day may represent more than one recreational experience. As much as 80 percent of total use may occur during weekends. Additional water-based recreational facilities close to Billings would receive heavy evening and weekend use.

Striving to meet peak demands is economically inefficient due to the large percentage of idle capacity during the remaining periods. This factor, along with the lack of generation of revenue to government agencies and high maintenance costs, has limited public development of recreational facilities. Consequently, the actual demands for recreational facilities, particularly for swimming and camping, are in excess of supply; and increases in demand will greatly overtax existing recreational facilities on both public and private land to the point of damaging some facilities. Particular needs include increases in camping and trailer spaces, fishing and boating access areas and marinas, improved land access, and more swimming areas (tables V-3 and V-4).

TABLE V-4--EXISTING AND PLANNED RECREATIONAL FACILITIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Facility	Existing	Planned	Total	Total Additional Units Needed
Camping				
Federal (No. units)	475	400	875	1,210--1970
State "	53	NA	53	952--1985
Municipal "	6	NA	6	1,115--2000
Private "	289	NA	289	1,339--2020
	823	400	1,223	
Picnicking				
Federal (No. units)	245	200	445	NA
State "	222	NA	222	NA
Private "	138	NA	138	NA
Local "	56	NA	56	NA
	661	200	861	
Hiking - Unclassified				
Federal (Miles of trails)	54	NA	54	NA
State " "	NA	NA	NA	NA
Private " "	NA	NA	NA	NA
	54	NA	54	NA
Hiking - Classified				
Federal (Miles of trails)	135	NA	135	NA
State " "	NA	NA	NA	NA
Private " "	NA	NA	NA	NA
	135	NA	135	NA
Boat Launching				
Federal (No. sites)	4	NA	4	NA
State "	2	NA	2	NA
Private "	NA	NA	NA	NA
	6	NA	6	NA
Marinas				
Federal (No. sites)	0	1	1	NA
State "	0	NA	NA	NA
Private "	1	NA	1	NA
	1	1	2	NA
Observation Sites				
Federal (No. sites)	4	NA	4	NA
State "	NA	NA	NA	NA
Private "	NA	NA	NA	NA
	4	NA	4	NA

NA - Not Available

TABLE V-4--EXISTING AND PLANNED RECREATIONAL FACILITIES (Cont'd)
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Facility	Existing	Planned	Total	Total Additional Units Needed
Winter Sports				
Federal (No. sites)	1	NA	1	NA
State "	0	NA	NA	NA
Private "	1	NA	1	NA
	2	NA	2	NA
Swimming				
Federal (No. sites)	1	NA	1	NA
State "	NA	NA	NA	NA
Private "	1	NA	1	NA
Local "	4	NA	4	NA
	6	NA	6	NA
Fishing Access				
Federal (No. sites)	20	NA	20	NA
State "	20	NA	20	NA
Private "	NA	NA	NA	NA
	40	NA	40	NA

Source: River Basin Planning Staff
NA = Not available

It should be pointed out, however, that 1970 excess recreational demands were met in some way and new facilities will have to compete with unorganized recreational supplies.

Increasing recreational pressure will require many new facilities, primarily on private lands. Private lands near public lands provide the best opportunities to develop these facilities as private business is then permitted to judge the economic feasibility of development. This is likely to be the only way in which recreational demands would be met due to the lack of public recreational construction funds. Public monies might be put to better use providing better access to public lands through more and better roads as well as improved public information. Privately developed facilities may better match demands than public development because private entrepreneurs tend to develop resources only to the extent that the recreating public will tend to pay for their use. In addition, emphasizing facility development on private lands while using public recreational funds to provide other types of recreational services will minimize the degree of economic competition between these two sectors. This factor should encourage private industry to meet the increasing recreational demands. New unevaluated factors affecting recreational pressures on private lands include National Park policies of reducing and eventually eliminating camping facilities and the increased restriction of vehicular travel to designated roads and trails on public domain and National Forest lands.

Along with increased recreational use and development will come a greater need to control the location and distribution of use. This may require city and county zoning laws, better information of current use density and better recreational facility design and maintenance.

FISH AND WILDLIFE

Projected needs for recreational development point up the growing demand for fishing on streams and lakes. A large growth in fishing is also expected on Bighorn Lake and the afterbay below the dam. Storage of water in multipurpose reservoirs to maintain or augment live flows in trout streams or to provide permanent fish and wildlife pools should be considered wherever financial sponsors can be found to pay for the nonfederal share of installation and O&M costs for that purpose. Further benefits to fish and wildlife from sediment and erosion reduction by land treatment practices need to be publicized and encouraged.

Structural and vegetative works of improvement should include provisions for increased habitat for fish and wildlife as well as maintenance of existing habitat, particularly the preservation and enhancement of game winter range. Care should be taken so that the environmental quality of habitats located away from the project site, but influenced by the project, is not degraded by works of improvement. Interagency cooperation leads to better use of available fish and wildlife resources and provides for increased benefits. Special emphasis should be placed on fish and wildlife developments around dense population centers and heavily traveled tourist routes. Maintenance of existing fish and wildlife resources should have the same priority as expansion of new potentials.

Benefits from many fish and wildlife and recreational structural measures accrue more to people from outside the watershed than to people residing in the watershed in that waterfowl migrate to other areas and much of the fishing and camping is enjoyed by people from outside the watersheds. On this basis, there may be a good argument for amending existing legislation to provide greater cost-sharing for such construction and permission for fish and wildlife or recreation to be primary purposes in watershed projects. In many areas, extreme needs for water-based recreation can be found, particularly around population concentrations and in areas along the interstate highway system.

WATER QUALITY CONTROL

Present needs for the maintenance and improvement of water quality include the protection of high quality water for domestic, agricultural, and recreational use and the improvement of lower quality water through sediment reduction and improved sewage treatment. The protection of streams includes prevention of pollution from human, agricultural, oil field, and mining sources. Human pollution occurs from incomplete treatment of sewage and encroachment of summer homes and septic tank drainfields on the narrow flood plains of mountain streams. Increased recreational use will require more and better designed facilities and management on both public and private lands to control pollution from human and animal wastes. Agricultural pollution consists of sediment from range and cropland, agricultural chemicals, and runoff and manure from feedlots. Continued vigilance and increased land treatment is needed to decrease erosion and sediment production. The higher use of fertilizer and pesticides presents a further need to reduce runoff and sediment that carry pollution into streams. Larger feedlots with less farm use of manure require sewage disposal systems or other measures to prevent pollution by livestock.

State water quality standards are established and implemented by the Montana Department of Health and Environmental Sciences with direction from the Montana Water Pollution Advisory Council. Under this authority, water quality standards have been developed and published along with policy statements adopted by the Council. These standards establish stream use classification, maximum allowable additives, minimum waste water treatment requirements, and reasonable measures to minimize sedimentation from man's activities. Thus, adequate laws and standards appear to exist. Enforcement may be quite another matter, especially where diffused sources are concerned. Funding for technical and enforcement personnel and funding for assistance in remedying existing violations of these standards may be a primary need in order to accomplish the goals of the legislation and the quality standards.

PROTECTION OF NATURAL BEAUTY

There is a growing need to provide for the esthetic as well as the economic and utility needs of water and land resource development projects. These needs include reclamation of strip mine and timber harvest areas, roadside plantings, and design of water storage and diversion structures to complement the natural surroundings. The need is not only to develop an awareness for the quality of visual resource, but to also utilize the skills of landscape architects and ecologists together with engineers in designing projects, related structures, and other land resource development projects to optimize the combination of outputs.

RURAL POWER SUPPLY

Adequate rural electric power is supplied by the Montana Power Company and various REA cooperatives within the Basin. Very little further expansion of electrical distribution is anticipated, although total energy demand per person is expected to continue to increase . New hookups will consist largely of rural nonfarm residences, summer homes, and small industries. There may be some more disconnects as farms consolidate. Natural gas is supplied by the Montana Power Company and Montana Dakota Utilities Company to the towns and some farms lying along the gas line rights-of-way.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Many state and federal programs and projects supply technical services and financial assistance to meet resource management and development needs in the Basin. The public needs to be more aware of the services and assistance available and the degree to which these programs can be used to meet their needs. The present level of operation and funding of some of these programs is below that needed to meet present and early action resource development needs. A discussion of state and federal programs follows.

USDA PROGRAMS

Economic Research Service Programs

The Economic Research Service conducts national and regional programs of research, planning and technical consultation, and services pertaining to economic and institutional factors and policy which relate to the use, conservation, development, management, and control of natural resources. This includes their extent, geographic distribution, productivity, quality, and the contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials and resource investment economics; impact of technological and economic change on the utilization of natural resources; resource income distribution and valuation; and the recreational use of resources. The agency also participates in departmental and interagency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

SOIL CONSERVATION SERVICE PROGRAMS

PL-566 Projects and Programs

Applications for assistance under Public Law 566 have been received on four watersheds. Three of these are joint watersheds with Wyoming that are inactive at the present time--Sage Creek-Pryor Mountain (14e6-8), Crooked Creek (14e-27), and Cyclone Bar (14c-5). The application on Two-Leggins Canal (14e-37a) is still active and awaiting preliminary investigation. No other watersheds have been planned or constructed in the Montana part of the Basin. A flood hazard analysis is under way on the Stillwater River. This information will help prevent real estate speculation and retard residential development of the flood plain.

Resource Conservation and Development Projects

The Beartooth Resource Conservation and Development Project serves all of Carbon and Stillwater Counties in the Basin, a total of 1,786,824 acres or about 36 percent of the Montana Basin area. A resource conservation and development project is defined as a locally initiated and sponsored activity to expand the economic opportunities for the people of an area by developing and carrying out a plan of action for the coordinated orderly conservation improvement, development, and wise use of their natural resources. The Resource Conservation and Development project is the local people's program--sponsored, developed, and carried out by the local people with assistance from all agencies of the local, state, and federal governments. Many of the subprojects under the RC&D are directly involved with water and land resource improvement and will benefit from investigation and analysis of this river basin study.

Assistance to Conservation Districts

Under authority of PL-46, the Soil Conservation Service provides a broad program of technical service to farmers and ranchers through the direction of Conservation Districts. These services include assistance in farm and ranch planning, installation of conservation practices, soil surveys, plant materials improvements, snow surveys, technical assistance to other USDA activities, and aid to other agencies responsible for administering conservation programs on private lands.

Under the Great Plains Conservation Program, the SCS provides technical assistance and cost sharing for water and land resource conservation measures with cooperating farmers under a Great Plains contractural arrangement. Part of the Great Plains agreement includes long-range continuing planning for the whole farm resources.

Conservation practices installed in the Basin with SCS assistance include: 54 miles of irrigation ditch improvements; 33,900 acres of land leveling; 35,513 acres of irrigation management systems; 154,000 acres of stubble mulching; 110,000 acres of stripcropping; 6,800 acres chiseling and subsoiling; 1,109 farm ponds; 1,912 spring and well developments; 57,200 acres of grazing management systems; 1,375 miles of fencing; 12,300 acres of brush control; and 12,000 acres of wildlife cover plantings. Advice is provided for erosion control connected with new construction of homes and highways. Technical assistance is provided for rural sewage disposal and pollution prevention measures for homes, rural towns, and feedlots.

Snow Surveys

Snow surveys provide an additional tool in water supply forecasting and more efficient water use and storage reservoir management.

The Montana and Wyoming Conservation Districts Plant Materials Center at Bridger, Montana, has developed several new plant varieties for general use over the years. Recently, the Center has been involved in selection of plant varieties for use in strip-mine reclamation and in development of a nonbloating milkvetch for pastures and a wheatgrass for roadside plantings and other critical erosion areas.

OTHER USDA PROGRAMS

Agricultural Stabilization and Conservation Service

The Agricultural Stabilization and Conservation Service administers the various farm programs for wheat and feed grains, cropland adjustment, and price supports. The SCS provides the technical assistance needed for planning and installation of a number of conservation practices.

Farmers Home Administration

The Farmers Home Administration serves as the lending agency for a wide variety of loan programs ranging from annual production loans through farm purchase loans to watershed project loans. SCS cooperates with FmHA by providing the technical planning information to support loan applications for developments that deal with soil and water conservation measures.

Cooperative Extension Service

The Cooperative Extension Service disseminates educational and management information from research agencies, educational institutions, federal, state, and local agencies to landowners and other individuals. They provide leadership in 4-H youth programs, crop variety demonstration plots, and county fairs. Extension Service has the organizational leadership in the Community Rural Development (CRD) program, which assists rural people in identifying the services they need for economic, social, and cultural growth and helps them secure those services. Their basic service, in liaison with the experiment station laboratories and coordination of educational meetings, brings closer contact between rural people and their university system. The end result is faster distribution and demonstration of new technology than would otherwise occur.

Rural Electrification Administration

The Rural Electrification Administration provided loans for construction of rural electric association cooperative facilities and transmission lines and rural telephone systems throughout the Basin where such utilities were not available. Additional loans were available for farm electrification and household appliances. The Montana part of the Basin is served by the Beartooth, the Yellowstone, and the Big Horn Electric Cooperatives. For further relationship of USDA agencies and programs, see table VI-1.

Forest Service Programs

The West Fork of Rock Creek, which supplies water for the city of Red Lodge, is on National Forest land designated as a special "municipal watershed" administered by the Forest Service. In order to protect this

TABLE VI-1--USDA AGENCY PROGRAMS RELATED TO RESOURCE CONSERVATION NEEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Conservation Need	PROGRAMS OF AGRICULTURAL AGENCIES					
	Soil Conservation Service	Forest Service	Agricultural Stabilization & Conservation Service	Farmers Home Administration	Extension Service	Rural Electrification Service
Watershed Protection Management	PL-566,PL-46 PL-84-1021 RC&D PL-92-419	Clarke-McNary Act PL-91-224,PL-566 Coop. Forest Mgt. Act	RECP	PL-566,PL-87-128 FHA Act 1961	Smith-Lever Act Ag. Mkt. Act 1946	
Flood Prevention	do	do	RECP	do		
Land Stabilization	do	do	RECP	do		
Sediment Control	do	do	RECP	do	do	
Drainage Improvement	do	----	RECP	FHA Act 1961 PL-566; RC&D	do	
Irrigation	do	----	RECP	do	do	
Rural Domestic and Livestock Water Supply	PL-46 PL-84-1021 RC&D	do		FHA Act 1961 PL-46 PL-84-1021;RC&D	do	
Municipal & Industrial Water Supply	PL-566 RC&D PL-92-419	do		FHA Act 1961 PL-566 PL-92-419		
Waste Disposal	do	----	RECP	FHA Act 1961 PL-92-419	do	
Recreation	PL-566;PL-46 RC&D;PL-92-419 PL-84-1021	PL-90-542; RC&D PL-566; PL-91-606 N.F. Rec. Mgt.		PL-566 PL-92-419 RC&D	do	
Fish and Wildlife	do PL-91-559	N.F. Wildlife Mgt. PL-566;F.A.A. 1962	RECP PL-91-559	do	do	

TABLE VI-1--USDA AGENCY PROGRAMS RELATED TO RESOURCE CONSERVATION NEEDS (Continued)
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Conservation Need	PROGRAMS OF AGRICULTURAL AGENCIES					
	Soil Conservation Service	Forest Service	Agricultural Stabilization & Conservation Service	Farmers Home Administration	Extension Service	Rural Electrification Service
Water Quality Control	PL-46;PL-566 RC&D PL-92-419	PL-91-224;PL-566;PL-91-606 Coop. Forest Mgmt. Act Clarke-McNary Act		FHA Act 1961 RC&D PL-92-419	Smith-Lever Act Ag.Mkt. Act 1946	
Rural Power Supply	----	----	----	----	----	REA
Forage Prod. and Range Mgmt.	PL-46 PL-84-1021 PL-566-RECP	PL-566 N. F. Range Mgt. Coop. Forest Mgt.	RECP		do	
Timber Production	RECP	Clarke-McNary Act N.F. Timber Mgt.;Coop. Forest Mgt.;Pest Cont. Act	RECP		do	
Fire Control		N.F.Timber Mgt; Coop. Forest Mgt.;PL-92-419				
Land Inventory & Monitoring	PL-46 PL-89-560 PL-92-419	PL-92-419				
Rural Development	RC&D PL-92-419	RC&D Coop. Forest Mgt.		PL-92-419 FHA Act 1961	do	

Source: Catalog of Federal Domestic Assistance water supply, the watershed is managed under more rigid guidelines than are required on other adjacent National Forest lands. Continued special emphasis and management are needed to provide the degree of protection necessary for this high value watershed. The Forest Service manages much of the recreational resource adjacent to Yellowstone National Park and is responsible for management of the 230,000-acre Beartooth Primitive Area now under study for wilderness classification. These recreational resources have national significance because of their uniqueness and their proximity to Yellowstone National Park. In addition, the Division of State and Private Forestry of the Forest Service provides assistance to the Montana Department of Natural Resources and Conservation, Division of Forestry, in cooperative forest management, cooperative insect and disease control, and cooperative fire protection programs. They also provide assistance to CRD groups, other rural development programs, and PL-566 projects.

The Forest Service manages the National Forests under the Multiple-Use Sustained Yield Act and the Environmental Protection Act which provide for optimum and continued compatible uses of these public lands without degradation of the environment. One of the key roles of the Forest Service programs is to protect the upstream watersheds. This is accomplished through multiple-use plans, fire prevention, protection and suppression programs, watershed restoration projects, fire and flood rehabilitation projects, and reforestation programs. In addition, interdisciplinary planning and specialist skills are now employed to protect watershed and environmental values during road and trail construction, timber harvest, insect and disease control programs, recreational facility development, wildlife habitat rehabilitation projects, wilderness management, timber stand improvement programs and range management.

PROGRAMS OF OTHER AGENCIES

Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA), of the U. S. Department of the Interior, administers Indian Trust lands and provides technical assistance and social services to Indians on the Crow Reservation. Indian Trust lands total 1,464,802 acres or 29.4 percent of the Basin in Montana.

The federal government's special programs for its Indian citizens, stemming from the trust relationship and the tax-exempt status of Indian Trust lands, are administered for the most part by the Bureau of Indian Affairs--an agency of the Department of the Interior. The one major program outside the Indian Bureau is the health and medical program for reservation Indians, which is under the direction of the Division of Indian Health, U. S. Public Health Service. The Division of Indian Health operates hospitals and clinics, provides sanitation services, and otherwise assists Indians with health and medical problems.

The programs of the Bureau of Indian Affairs include activities in education, social welfare, law and order, credit, housing, employment assistance, real property management, road construction and maintenance, soil and moisture conservation, range management, forest management, irrigation development and management, and other phases of economic development, including industrial development.

It should be emphasized that in nearly all these activities, the Bureau works closely with the tribal governments. Federal and tribal governments have a joint responsibility, and it is recognized that cooperation is essential to the effectiveness of any program. The Bureau's role in large degree is that of supplying to the Indian people the technical services provided elsewhere by other agencies.

The overall objectives of the Bureau of Indian Affairs are:

1. Maximum Indian economic self-sufficiency.
2. Full participation of Indians in American life.
3. Equal citizenship privileges and responsibilities for Indians.

The Bureau of Indian Affairs has conducted an intensive study of potential irrigation and recreation development on the reservation. Considerable work on range utilization improvement is under way with development of springs, wells, and pipelines for stockwater supplies and grazing dispersal. A recreational complex and a carpet factory have been developed at Crow Agency to improve employment opportunities. The Pretty Eagle recreational development near the north end of the Bighorn Recreational Area is nearing completion and will add to employment opportunities.

Irrigation development by the BIA started with the Reno Unit in 1885. This was followed by the Soap Creek Unit in 1894 and other units in later years for a total of eleven units under the Crow Irrigation Project. The largest of these units is the Bighorn Canal Unit with 21,800 acres irrigated. Total land irrigated in Big Horn County amounts to 63,058 acres, including the private development of 14,100 acres under the Two-Leggins Canal. All development is from direct diversion except for offstream storage in the Willow Creek reservoir near Lodge Grass.

<u>Bureau of Reclamation</u>

The Bureau of Reclamation's Yellowtail Dam and reservoir and the proposed Hardin Unit irrigation project dominate the current water development scene in Big Horn County. The dam was completed in 1967 and provides storage capacities of: 259,000 acre-feet for flood control; 250,000 acre-feet for joint use flood control and conservation; 364,000 acre-feet of conservation storage; 483,000 acre-feet of inactive storage; and 19,000 acre-feet of dead storage for a total capacity of 1,375,000 acre-feet. Historical average annual streamflow at the dam site is 2,531,000 acre-feet.

The 42,600 acres of irrigation on the Hardin Unit are expected to use 131,700 acre-feet of diverted water with a net depletion of about 68,500 acre-feet with 63,200 acre-feet of return flows.

The largest subscribed nondepleting water use is hydro-electric power generation. An additional 623,000 annual acre-feet are contracted for coal gasification and steam electric generating companies for use in northeastern Wyoming and southeastern Montana. In addition, further requests are pending for 967,000 acre-feet for industrial use.

The Huntley Irrigation Project was started in 1905 in Yellowstone County. Water is diverted from the Yellowstone River about 15 miles east of Billings. About 29,240 acres are irrigated by this project.

Bureau of Land Management

The Bureau of Land Management (BLM) of the Department of the Interior has the responsibility for administering the use of public domain lands and for conservation measures and land treatment on lands in the Bighorn Canyon National Recreational area. The BLM administers 215,033 acres in the Montana part of the Basin. They have conducted an intensive study of these lands and prepared a Land Planning and Classification report in 1953. More recently they have applied land treatment practices toward erosion reduction and better range use. The BLM is employing the multiple use concept of public lands and is developing some recreational facilities. Preservation of the fragile desert ecology will be an increasing problem as recreational use increases. Some effort is under way to identify and preserve archeological sites in the Pryor Mountain area. A study funded jointly by the BLM, National Park Service (NPS), and Forest Service has begun inventorying the archeological resources of the Basin. Preliminary findings show that the resource is extensively distributed throughout the Basin and that there has been prolonged human habitation. Much of the resource is found in remote areas and remains in good condition. Efforts to control the use of this resource should be made to prevent destruction of this historical component of the Basin.

National Park Service

The National Park Service has prepared plans for and is proceeding with development of the Bighorn Canyon National Recreational Area. Part of the road system and boat launching facilities are completed. Campground facilities will probably be kept at a minimum and restricted mostly to the fringes of the area. Recreational developments on Indian Trust lands are the responsibility of the Tribal Council with assistance from the Bureau of Indian Affairs. Similar developments on Public Domain lands near the canyon area are the responsibility of the Bureau of Land Management. These are largely limited to overlooks on the wild horse range, road designation, and land use control measures.

Bureau of Outdoor Recreation

The Westwide Report on the Critical Water Problems of the Eleven Western States (Review Draft May 1974) indicates that the Secretaries of Agriculture and Interior recommend 5(a) study status under the Wild and Scenic Rivers Act for the Yellowstone River from Yellowstone Lake to Pompeys Pillar, including its Clarks Fork tributary.

A recent 5(d) study conducted by the Bureau of Outdoor Recreation in cooperation with other federal and state agencies concluded that most of this reach of the Yellowstone River met the criteria for designation under scenic or recreational rivers. Further study with extensive public involvement would be required before a recommendation for designation in the National Wild and Scenic River System could be made.

A bill to establish a State system of wild and scenic rivers was defeated in the 1975 session of the Montana Legislature. Most of the opposition came from farmers and ranchers concerned about access to the rivers for maintenance of existing diversions as well as construction of future diversions. Because of opposition to a State system which would have included this reach of the Yellowstone, Montana is withholding support of the 5(a) classification pending an indication of local public support. This is particularly necessary in the Yellowstone case where over 90 percent of the lands bordering the river are in private ownership.

The local position will be determined through a series of public meetings in the Basin.

Other streams in the Basin that might also be studied for designation as a part of the wild river system include:

Lake Fork Rock Cr. above national forest boundary,
West Fork Rock Cr. above national forest boundary,
East Rosebud Creek above Alpine,
West Rosebud Creek above Mystic Lake, and
Forks of Stillwater River above national forest boundary.

Several locations for dam sites have been identified on the streams listed above. The value of these sites must be evaluated before these streams are designated as part of the national system.

Few of the streams listed above are well suited to recreational use for floating. Use of the Clarks Fork, Bighorn, and Yellowstone Rivers for this purpose might be enhanced more through a formal legislated declaration that the water surface, bed, and banks of these rivers below the normal annual high water line constitute navigable and public streams than by including them in the National Wild and Scenic River System.

STATE PROJECTS AND PROGRAMS

The Montana Department of Natural Resources and Conservation operates Cooney Reservoir for irrigation and recreation. Total storage at Cooney is 27,515 acre-feet, of which 24,200 acre-feet are used for supplemental irrigation further down Red Lodge and Rock Creeks. This was the first "Water Board" project in Montana and was financed in part by a grant from Public Works Administration.

The Montana Department of Fish and Game has developed recreational facilities at Cooney Reservoir and at fishing access sites along Rock Creek, Stillwater River, and Bighorn River. They have developed a state fish hatchery on Bluewater Creek, using high quality spring water for the hatchery and rearing ponds. Additional lands were acquired along Bluewater Creek and developed as a fishing access.

All rangeland conservation practices planned for the Basin comply with implementation plans and goals of the Montana Rangeland Resource Plan. That program is a coordinated effort to emphasize the importance of rangeland to all people and the effect of rangeland management on economic activity, watershed protection, and environmental enhancement. For more orientation on state programs, see table VI-2.

The Conservation District programs are available for the entire Basin in Montana. Districts involved include Big Horn Conservation District, Carbon Conservation District, Stillwater Conservation District, Treasure County Conservation District, and Yellowstone Conservation District.

PRIVATE DEVELOPMENTS

There are numerous private water developments under organized ditch companies and by individual diversions. Part of the water use problems stems from too many small diversions and small ditches with high transmission losses, particularly on the Rock Creek and Stillwater River drainages. In Stillwater County, ten ditch companies and 46 private ranches divert water from the Stillwater River and its tributaries. In Carbon County there are 37 ditch companies and a total of 2,101 water rights filings. Nearly all the ditch companies have their own diversions and headworks. Many of the small private appropriators have diversion ditches with or without diversion dams. Rough topography, small acreages served, differences in appropriation priority dates, and personal prides tend to hinder further ditch consolidation or improvements in structural measures and transmission efficiencies. Most of the water lost from ditch seepage returns to the stream system and is rediverted farther on downstream. Thus, the overall stream system efficiency is not as low as it first appears, even though dewatering occurs in short reaches of many smaller streams.

TABLE VI-2--STATE AND LOCAL AGENCY PROGRAMS RELATED TO RESOURCE PROBLEMS AND NEEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Conservation Need	State of Montana and Political Subdivisions
Watershed Protection and Management	Department of Natural Resources and Conservation - Title 89, Chapters 1 and 35, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947 Cities, Towns, & Counties--Title 89, Chapter 33, R.C.M. 1947
Flood Prevention	Department of Natural Resources & Conservation--Title 89, Chapters 1 and 35, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947 Cities, Towns, & Counties--Title 89, Chapter 33, R.C.M. 1947
Land Stabilization	Department of Natural Resources & Conservation--Title 28, Chapter 1, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947
Sediment Control	Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947
Drainage Improvement	Conservation Districts--Title 89, Chapter 34, R.C.M. 1947 Drainage Districts--Title 89, Chapters 22 through 28, R.C.M. 1947 Department of Natural Resources and Conservation--Title 89, Chapter 1, R.C.M. 1947
Irrigation	Department of Natural Resources & Conservation--Title 89, Chapter 1, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Irrigation Districts--Title 89, Chapters 12 through 21, R.C.M. 1947
Rural, Domestic, and Livestock Water Supply	Department of Natural Resources & Conservation--Title 89, Chapter 1, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947

TABLE VI-2--STATE AND LOCAL AGENCY PROGRAMS RELATED TO RESOURCE PROBLEMS AND NEEDS (Continued)

Conservation Need	State of Montana and Political Subdivisions
Municipal and Industrial Water Supply	Department of Natural Resources & Conservation--Title 89, Chapter 1, R.C.M. 1947 Cities and Towns--Title 11, Chapter 9, R.C.M. 1947 Dept. of Health & Environmental Sciences--Title 69, Chapter 49, R.C.M. 1947
Waste Disposal	Cities and Towns--Title 11, Chapters 9 and 22, R.C.M. 1947 Department of Health & Environmental Sciences--Title 69, Chapters 48 through 50, R.C.M. 1947
Recreation	Department of Natural Resources and Conservation--Title 89, Chapter 1, R.C.M. 1947 Department of Fish and Game--Title 26, R.C.M. 1947 Conservancy District--Title 89, Chapter 34, R.C.M. 1947
Fish and Wildlife	Department of Fish and Game--Title 26, R.C.M. 1947
Water Quality Control	Department of Health and Environmental Sciences--Title 69, Chapter 48, R.C.M. 1947 Department of Natural Resources and Conservation--Title 69, Chapter 29, R.C.M. 1947
Rural Power Supply	None--all private
Forage Production and Range Management	Department of Natural Resources and Conservation--Title 46, Chapter 23, R.C.M. 1947 Grazing Districts--Title 46, Chapter 23, R.C.M. 1947
Timber Production	Department of Natural Resources & Conservation--Title 28, Chapter 1; Title 81, Chapter 14, R.C.M. 1947
Fire Control	Department of Natural Resources & Conservation--Title 28, Chapter 1; Title 81, Chapter 14, R.C.M. 1947
Land Inventory and Monitoring	Department of Natural Resources and Conservation--Title 28, Chapter 1; Title 89, Chapter 1, R.C.M. 1947 Counties--Title 11, Chapter 6, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947
Rural Development	Rural Improvement Districts--Title 16, Chapter 16, R.C.M. 1947

Source: Montana Department of Natural Resources and Conservation.

Related land resource developments are rapidly increasing in the Basin, especially in the areas of recreation and minerals. Because of the attractiveness of the area, subdivisions for year-round and part time occupancy homes are increasing in number. The proximity of private lands to the more esthetic recreational resources provides opportunity for development of high quality private recreational facilities at reasonable costs. In addition, these developments lessen the pressure of recreationists on public facilities. Also, it broadens the area absorbing the recreational burden. Expanded mineral exploration is under way by the mining industry, and extraction may increase if market conditions continue to make it economically feasible. The recent interest in this area has stemmed from increased mineral prices and improved mineral retrieval technology.

Recreational and mineral developments impose related environmental and service costs on area users. If these effects are not minimized, many of the Basin's desirable attributes may be jeopardized.

VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

This chapter describes the capability of the Basin to supply water and land resources in terms of physical development potential for meeting identifiable needs. These potentials are not aligned with specific projects and programs, but are identified with particular problems and needs.

AVAILABILITY OF LAND FOR POTENTIAL DEVELOPMENT

In Montana's part of the Basin, about 485,150 acres of irrigable land have been identified.[1/] This acreage includes 12,833 acres in the Stillwater Subbasin; 159,556 acres in the Yellowstone Minor Drainages; 56,523 acres in the Clarks Fork Subbasin; 187,886 acres in the Bighorn Subbasin; and 68,352 acres in the Little Bighorn Subbasin. This acreage includes 41,750 acres that can be irrigated from existing canals and 42,600 acres of dry cropland and range that could be brought under irrigation by development of the Bureau of Reclamation's Hardin Unit. Considerable additional acres can be brought into irrigation with extension of existing canals or development of some pump-lift units. Big Horn County leads in potential irrigable acres--both under existing ditches and under new project units. The Bureau of Indian Affairs reports a total potential in Big Horn County of 89,776 acres, including the Hardin Unit. Many of the irrigable acres can be irrigated from pump-lifts, new diversions, and ditch extensions. The gradual shift to sprinkler irrigation, that is partly caused by lack of skilled irrigators, will tend to bring more lands into irrigation that were previously considered too steep or too uneven to be classed as irrigable. See table VII-1 and map II-7.

There is some potential for irrigation development from either storage or ground-water development near Sage Creek. Recent investigation in this area shows 14,576 acres irrigable with an 80 percent chance supply of 13,240 acre-feet from surface water and an unknown supply of ground water. Distribution of land ownership in the Sage Creek area and program restrictions may preclude project-type development, but may not restrict independent private development.

1/ Potentially irrigable acres as identified here include areas of soils with physical characteristics of texture, structure, slope, and chemical and climatic make-up that would produce satisfactory sustained yields if placed under irrigation. The economic analysis of providing the water storage or delivering it to these acres is completed for only the most practical developments.

TABLE VII-1--POTENTIAL IRRIGABLE LANDS AND WATER REQUIREMENTS BY SUBBASINS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Irrigable Land 1/ (Acres)	Estimated 2/ Net Irrigation Needs Per Composite Acre (Acre-Inches)	Estimated 3/ Irrigation Depletion (Acre-Feet)	Estimated 4/ Diversion Requirements (Acre-Feet)
	Stillwater Subbasin				
14b-1	Upper Stillwater River	199	11.70	194	970
14b-2	Fishtail to Butcher Cr.	7,825	15.00	9,781	39,124
14b-3	Lower Stillwater River	3,383	15.00	4,229	14,097
14b-4	Shane-Beaver Creek	1,426	18.00	2,139	7,130
	Subbasin Total	12,833	15.28	16,343	46,694
	Yellowstone Minor Drainages				
14-22	Cow-Bellion Cr.	3,187	18.00	4,781	15,937
14-27	Blue-Duck Cr.	22,845	18.00	34,268	97,909
14-31	Arrow Cr.	10,839	18.96	17,126	48,931
14-33	Fly Creek	26,427	18.96	41,755	119,300
14-36	Lost Boy Creek	7,668	19.56	12,499	35,711
14-37	Custer Drainage	2,481	20.04	4,143	11,837
14d-1	Upper Pryor Creek	51,185	18.00	76,778	219,366
14d-2	Lower Pryor Creek	34,924	18.00	52,386	130,965
	Subbasin Total	159,556	18.33	243,736	609,340
	Clarks Fork Subbasin				
14c-3	Clarks Fork-Zimmer Creek	---	---	---	---
14c-4	Pat O'Hara Creek	---	---	---	---
14c-4a	Big Sand Coulee	1,353	20.0[illegible]	2,260	9,040
14c-5	Line Creek	---	---	---	---
14c-6	N.F. Cherry-Silvertip Creek	12,056	19.56	19,651	65,503
14c-7	Clarks Fork-Ruby Creek	10,449	19.56	17,032	48,663
14c-8	Upper Rock Creek	590	11.64	572	2,860
14c-9	Red Lodge-Rock Creek	13,089	12.96	14,130	56,544
14c-10	Elbow-Lower Rock Creek	5,699	19.56	9,289	26,540
14c-11	Lower Clarks Fork E. Side	13,287	19.56	21,658	61,880
	Subbasin Total	56,523	17.96	84,596	211,490

TABLE VII-1--POTENTIAL IRRIGABLE LANDS AND WATER REQUIREMENTS BY SUBBASINS (Continued)

Watershed Number	Watershed Name	Irrigable Land (Acres) [1]	Estimated Net Irrigation Needs Per Composite Acre (Acre-Inches) [2]	Estimated Irrigation Depletion (Acre-Feet) [3]	Estimated Diversion Requirements (Acre-Feet) [4]
	Bighorn Subbasin				
14e6-8	Sage Creek	14,576	18.96	23,030	65,800
14e6-8a	Dry Creek	---	---	---	---
14e-27	Crooked Creek	125	18.96	198	660
14e-28	Porcupine Creek	---	---	---	---
14e-30	Dryhead Creek to Wyoming	9,603	18.96	15,172	50,573
14e-31	Black Canyon Cr.	---	---	---	---
14e-32	Soap Creek	8,509	19.56	13,870	39,629
14e-33	Beauvais Creek	39,706	19.68	65,118	217,060
14e-34	Rotten Grass Creek	15,656	19.80	25,832	73,806
14e-35	Two Leggins-Woody Cr.	22,925	19.92	38,055	126,850
14e-36	Warren Bench	2,265	20.04	3,782	10,806
14e-37	West Side Bighorn River	31,679	20.04	52,904	132,260
14e-37a	Two Leggins Irr. Unit	2,719	20.04	4,540	11,350
14e-38	E. Side Bighorn River	10,256	20.04	17,128	42,820
14e-39	Upper Tullock Creek	13,752	20.04	22,966	91,864
14e-40	Lower Tullock Creek	16,115	20.04	26,912	89,707
	Subbasin Total	187,886	19.77	309,507	687,793
	Little Bighorn Subbasin				
14e7-1	Little Bighorn River	7,277	18.00	10,916	36,387
14e7-2	Pass Creek	---	---	---	---
14e7-3	Lodge Grass Creek	13,079	18.48	20,142	57,549
14e7-4	Owl Creek	8,600	18.48	13,244	37,840
14e7-5	Little Bighorn E. Side	11,144	18.96	17,608	50,309
14e7-6	Little Bighorn W. Side	28,252	18.96	44,638	111,595
	Subbasin Total	68,352	18.71	106,572	236,827

TABLE VII-1--POTENTIAL IRRIGABLE LANDS AND WATER REQUIREMENTS BY SUBBASINS (Continued)

Watershed Number	Watershed Name	Irrigable Land (Acres) 1/	Estimated 2/ Net Irrigation Needs Per Composite Acre (Acre-Inches)	Estimated 3/ Irrigation Depletion (Acre-Feet)	Estimated 4/ Diversion Requirements (Acre-Feet)
	Summary				
Stillwater Subbasin		12,833	15.28	16,341	46,689
Yellowstone Minor Drainages		159,556	18.33	243,722	609,305
Clarks Fork Subbasin		56,523	17.96	84,596	211,490
Bighorn Subbasin		187,886	19.77	309,542	687,871
Little Bighorn Subbasin		68,352	18.71	106,572	236,827
TOTAL		485,150	18.82	760,773	1,792,182

Source: River Basin Planning Staff

1/ Irrigable land is identified only by slope and physical soil characteristics that would sustain irrigated cropping--not by economic feasibility.

2/ See Table VII-2.

3/ Total depletion is estimated to be from 120% to 130% of the irrigation depletion.

4/ Diversion requirements were determined from estimated project efficiencies adjusted with consideration of waste water reuse.

In some areas there is still potential for conversion of range to dry cropland as evidenced by changes noted between the last two aerial photo coverages. On cropable sites with adequate moisture and soils, the economic margin between returns from fallow-dryland cropping and dry range is heavily in favor of cropping. Most of these convertible lands are in Big Horn and Yellowstone Counties. Based on class II and III land in the changing area now used in range, there may be as many as 100,000 acres that can be profitably converted from range to dry cropland.

Availability of lands for residential, industrial, or recreational purposes may be in competition with agriculture. Because of economies in simplicity of street and utility installation, the most nearly level lands with good internal drainage are most desirable for urban and industrial tract development. These same general conditions are desirable for irrigation development. Returns in income and personal satisfaction are consistently higher for land used in urban and industrial development than for land in agricultural production. Even though conflicts in land use may occur, there is ample land to satisfy both agricultural and nonagricultural purposes in the Basin. Recreational uses of land are more apt to compete with range and timber production. Recreational uses of water tend to compete with irrigation diversions and storage drawdowns in multiple use reservoirs.

AVAILABILITY OF WATER FOR POTENTIAL DEVELOPMENT

In general, there is sufficient water yield in the Basin and subbasins to provide a full water supply to the economically irrigable acres.1/ However, there is a seasonal and a locational maldistribution of this water in relation to its time and area of need. Surplus spring runoff flows into the Yellowstone unused. More of this early flow could be stored for late summer use. Some canals can be enlarged and extended to serve more acres. Nearly all canals can be improved to decrease the heavy transmission losses now occurring. Some inter-subbasin transfers may be desirable. Irrigation of most of the potentially irrigable acres would require some combination of early flow storage, building of long canals, and construction of expensive pump lifts. The high cost of storage reservoirs and water conveyance systems in comparison with increased returns from irrigation is the most limiting factor in further irrigation expansion. Irrigable lands lying under existing canals or that can be served by extending existing canals offer the best potentials for added irrigation development. Most of the lands being irrigated need land treatment to improve on-farm irrigation efficiencies. There may be some potential for snowpack management and weather modification

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1/ Economically irrigable land is that which can be brought under irrigation at an average annual total cost lower than the average annual value of increased production that is directly attributable to that irrigation.

TABLE VII-2--NET INCHES OF IRRIGATION WATER NEEDED BY CROPS IN A NORMAL YEAR TO PROVIDE FOR THEIR CONSUMPTIVE USE OF MOISTURE 1/

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

CROP	AREA						
	HARDIN	BRIDGER	HUNTLEY	BILLINGS	COLUMBUS	WYOLA	RED LODGE
	inches						
Alfalfa	22.2	22.1	21.9	21.4	20.2	19.8	12.8
Dry Beans	13.1	13.6	12.9	12.3	12.7	12.9	11.7
Sugar Beets	19.6	20.0	19.4	19.1	17.5	17.2	8.1
Silage Corn	15.6	15.4	15.2	14.9	13.9	13.6	8.6
Sweet Corn	13.7	14.1	13.3	12.8			
Small Grain	12.6	13.1	13.0	11.4	11.6	11.9	10.1
Grass	19.2	19.3	18.8	18.3	17.6	17.1	10.5
Peas		11.7	11.0	10.5			7.8
Potatoes	18.8	18.8	18.6	18.2	17.8		11.8

Source: River Basin Planning Staff

1/ Effective rainfall has been subtracted from gross crop water requirements.

to increase winter precipitation on selected drainages to help augment late season water supplies. Through a combination of storage of excess early runoff, canal combination and improvement, and improved on-farm irrigation systems and management to improve overall irrigation efficiencies, it appears physically possible to provide a full supply of irrigation water to all economically irrigable acres in the Basin. Quantities of water available in streams are shown in table IV-6 and figure VII-1.

There is a power reservation site on East Rosebud Creek above the Weast Canal diversion. No data are readily available on its kilowatt potential, but the estimated cost per acre-foot of storage is quite low ($25/acre-foot) and the 80 percent chance water yield is estimated at 116,000 acre-feet. As a nonconsumptive use, hydroelectric generation makes multiple-use storage of early season runoff that much more economical. After it passes through the turbines, this water can be used for irrigation or other purposes.

There is potential demand for a peaking-power hydroelectric dam in the Clarks Fork Canyon in Wyoming. The Bureau of Reclamation has estimated that this site has 177,500 kilowatts potential. Such a dam would also have recreational and irrigation water stabilization benefits. Economic and ecological arguments favor harnessing flow resources for hydrogeneration over using available stock resources of fossil and fission fuels. It is worth noting, however, that hydropower will fall far short of meeting the ultimate power needs of the whole region and would constitute only a fraction of the needs of the nation. A combination of hydro- and steam-electric power, water for industrial use, attractive climatic conditions, and recreational potential may encourage further light industrial development in the Basin.

There is ample high quality water that can be developed for municipal or industrial use in most of the Basin. In some parts of the Bighorn and Clarks Fork valleys, the ground water contains an excessive amount of dissolved salts and cannot be used for human consumption. Rural domestic supplies might be developed in those areas where population densities are high enough to keep the cost per family from being prohibitive. Unsubscribed water that could be used for industrial development is still available in Yellowtail Reservoir.

Storage of water for use outside the Basin is an important consideration. Coal-energy development in southeastern Montana will create high value usage of much water available in the overall Yellowstone drainage. Stored water from a dam in Clarks Fork Canyon might well be put to use in energy plants farther down the Yellowstone. The cost and value of water would seem to be the ultimate determining factor in the case of local use versus distant use. The federal government might well have to consider an ordering of priorities related to the highest use and need. Little, if any, water would be utilized for coal energy development inside the Basin.

IMPOUNDMENTS

Potential impoundments in the Montana part of the Basin or potential changes in existing impoundments are shown in the following table. The watershed location, principal purposes, capacity in acre-feet, annual water yield, and estimated cubic yards of fill are shown for individual structure sites. Several high mountain lakes in the Beartooth Primitive Area were identified for potential storage of spring runoff for late summer use. These sites were first located on topographic maps and aerial photos and then viewed from helicopter by a team of planners. No detailed investigations have been made of these sites. The potential for their development would be to provide late summer water for irrigation, municipal water, and streamflow augmentation. At present there are no known sponsors for their development. Construction and operation would present special problems in costs and environmental protection, but in several areas of the west these high mountain reservoirs are very beneficial. Presidential or Congressional action would be required to develop these sites. These sites can be identified on table VII-3 and map VII-1.

CHANNEL IMPROVEMENTS AND LEVEES

The only channel improvements identified in watershed investigations for flood prevention are the short reach of Rock Creek as it passes through Red Lodge, the short reach of West Rosebud Creek as it passes through Fishtail, Blue Creek near Billings, and Lodge Grass Creek as it passes through the town of Lodge Grass. In these cases there is either a lack of feasible storage sites to provide sufficient control close enough to the damage area or insufficient average annual damages to justify high storage costs. In each case, diking is needed to provide the one percent chance level of protection for urban areas required by PL-566 guidelines.

Some stream reaches along the Little Bighorn need stabilization to stop bank erosion that now endangers Indian homes. Some of these houses might be relocated out of the flood plain.

WATER TABLE CONTROL

Drain outlets and on-farm drainage, combined with more efficient irrigation management and distribution, have a potential to reduce high water tables in irrigated areas. Most of the areas needing drainage have soils suitable for irrigation that can be treated with individual or small group action. A few areas may be served by project action similar to that requested by the Two Leggins Canal irrigators (14e-37a). Much canal consolidation and lining can be done on a project basis to reduce water losses and seeped areas.

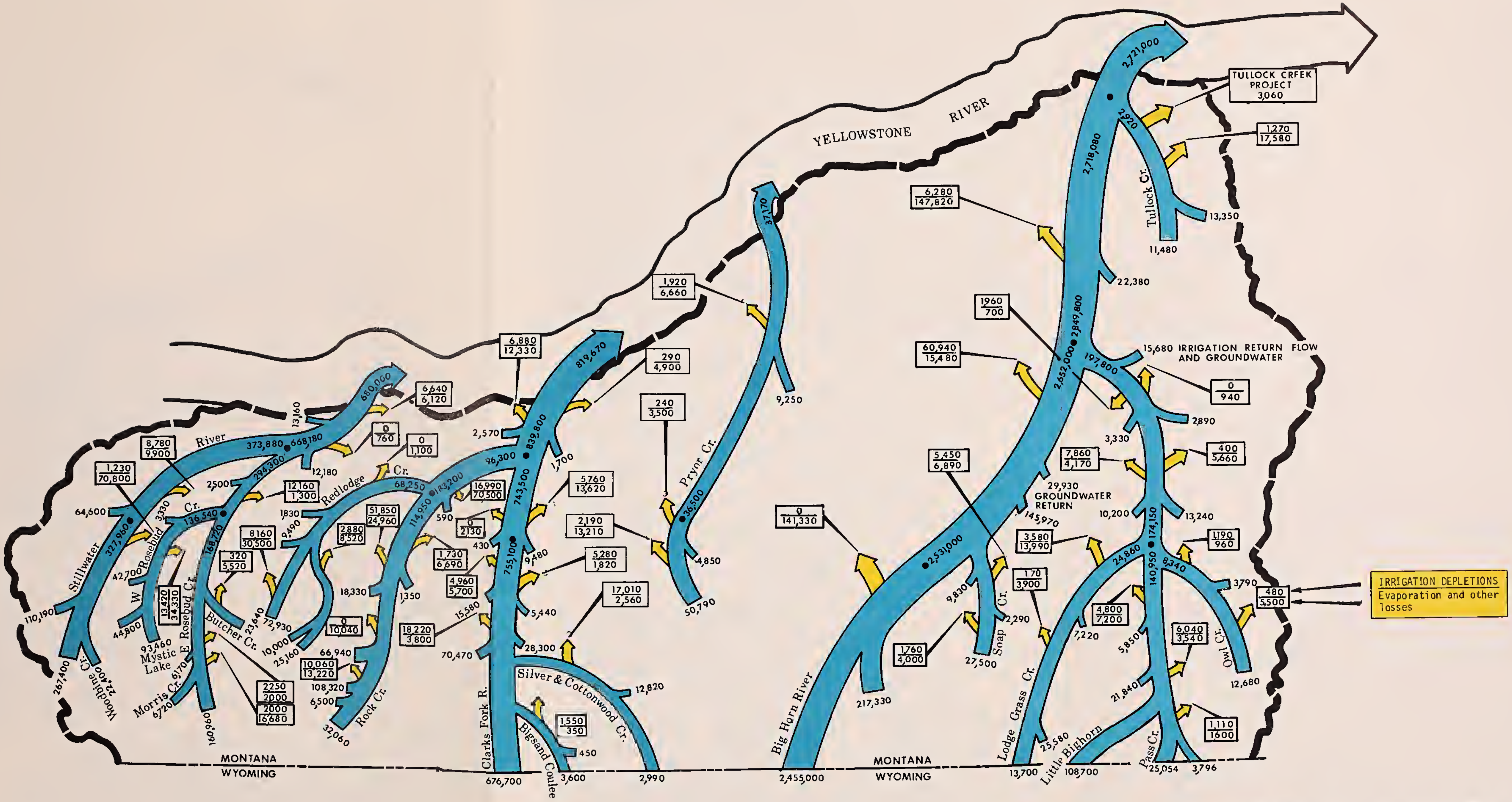
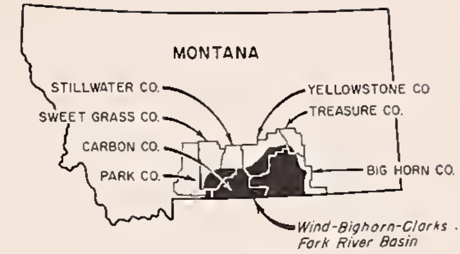


FIGURE VII-1 WATER BUDGET FLOW CHART

WATER YIELD AND DEPLETIONS

(ACRE FEET — ANNUAL YIELD)

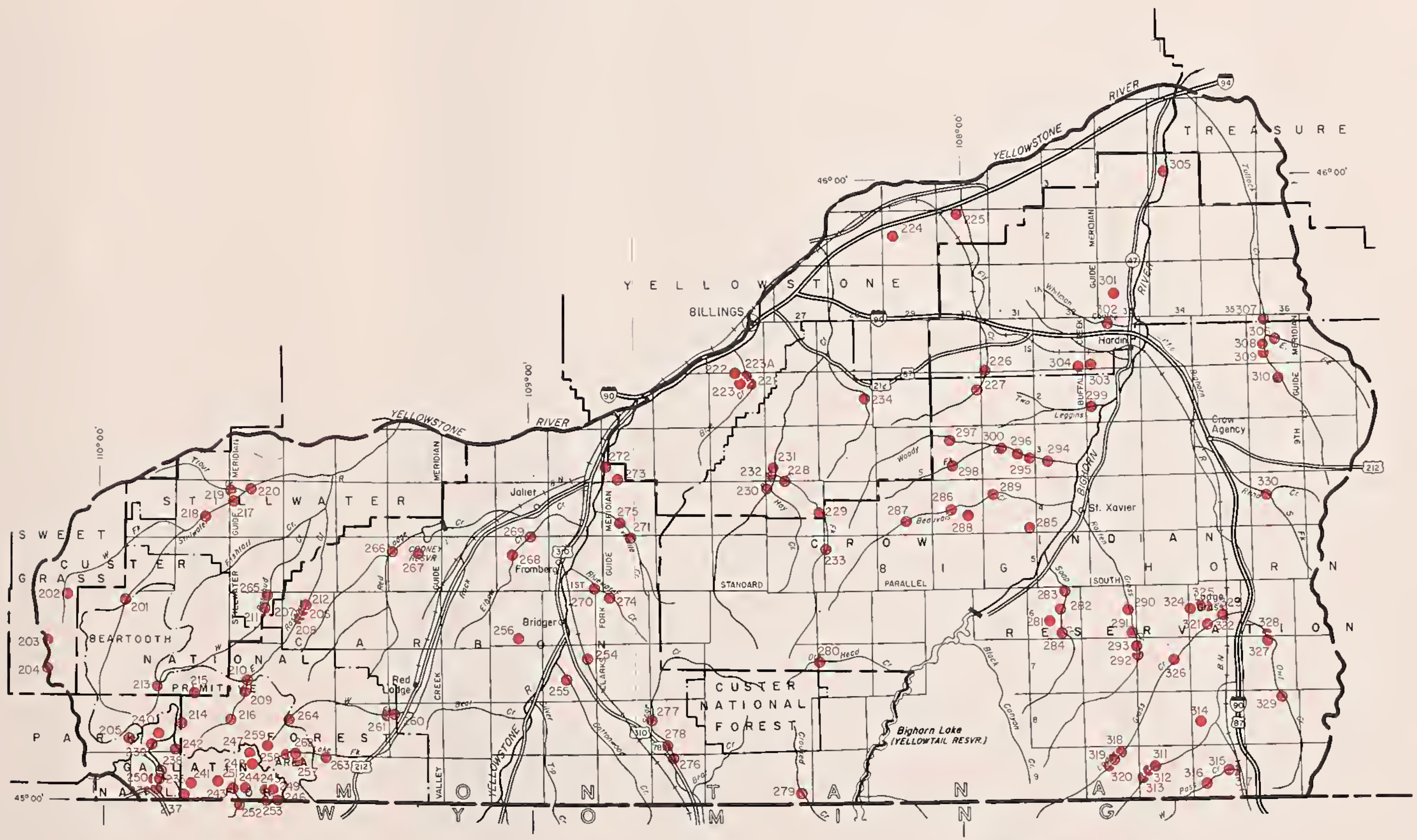
USDA-SCS-PORTLAND, OREG. 1973



LOCATION MAP

300 ● KNOWN RESERVOIR SITES

SEE TEXT FOR LISTING OF INDIVIDUAL RESERVOIR SITES



MAP VII-1

KNOWN RESERVOIR SITES

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914N-N

TABLE VII-3--PROBABLE RESERVOIR SITES

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed No.	Watershed Name	Site Name	Reservoir Map Index Number	Location: Township	Location: Range	Location: Section	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft) 1/	Reservoir Water Depth (Feet) 2/	Top Length of Embankment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embankment to Storage Ratio (Cu.Yd./Ac-Ft) 3/	Project Purpose Use 4/	Data Source Number 5/	Additional Storage Capacity Available (Ac-Ft)
Stillwater Subbasin																
14b-1	U. Stillwater R.	Sioux Charley L.	201	6S	15E	7	98,560	205,000	24,500	115	1,580	1,380,000	56	R,I,F	1,5,2	
		Lightning Cr. 6/	202	6S	13E	2	820	2,600	1,675	25	80	4,400	2.6	I	1,6	
		Wounded Man L. 6/	203	6S	13E	34,35	1,984	6,609	1,560	30	100	7,238	4.6	I	1,6	
		Pentad L. 6/	204	7S	13E	15	576	1,990	1,140	30	120	9,212	8.1	I	1,6	
		Goose L. 6/	205	8S	15E	19	1,728	6,476	2,370	20	100	4,140	1.7	I	1,6	
14b-2	Fishtail to Butcher Cr.	Sand Ford	206	6S	18E	9	71,070	142,000	37,420	70	1,500	420,000	11	P,R	2	
		E. Rosebud Cr. #1	207	6S	18E	16,9	71,070	142,000	25,000	52	1,100	144,000	6	I	1	25,000+
		E. Rosebud Cr. #2	208	6S	18E	16,17	71,070	142,000	25,000	56	1,590	318,000	13	I	1	
		E. Rosebud L.	209	7S	17E	29	47,380	118,000	25,000	90	2,460	1,300,000	52	R,I	1,2	5,000+
		E. Rosebud L.	210	7S	17E	21			1,200					P	5	
		W. Rosebud Cr. #1	211	6S	17E	2	58,880	128,000	25,000	149	2,250	3,460,000	138	R,I	1	10,000+
		Roscoe	212	6S	18E	9			6,800					I	5	
		Silver L. 6/	213	7S	15E	22	11,008	29,336	2,320	40	310	28,202	12.1	I	1,6	
		Cairn L. 6/	214	8S	16E	18	832	3,325	1,195	10	80	1,187	0.9	I	1,6	
		Turgulse L. 6/	215	7S	16E	33	1,792	6,865	3,015	30	140	12,017	4.0	I	1,6	
		Rainbow L. 6/	216	8S	16E	13	22,016	73,340	1,640	20	80	3,450	2.1	I	1,6	
14b-3	L. Stillwater River	Beehive #1	217	4S	17E	17,18	258,600	323,000	292,710	320	1,150	11,000,000	38	I,P	2	
		Beehive #2	218	4S	16E	22	236,610	315,000	301,061	233	2,410	7,900,000	26	I,P	2	
		Trout Cr.	219	4S	17E	6	16,960		7,800	130	620			I	5	
		Upper Stillwater	220	4S	17E	4	277,120		9,000	80	830			I	5	
Yellowstone Minor Drainages																
14-27	Blue-Duck Cr.	Blue Cr. #2	221	2S	26E	2,11	37,360	3,870	7,920	97	2,200	850,000	107	R,I,F	1	
		Basin Cr. #1	222	1S	26E	33	3,293	300	710	69	539	279,639	394	R,F	1	3,000+
		L. Basin Cr.	223	2S	26E	3,10	1,996	200	380	45	657	127,838	336	F	1	1,200
		Big Coulee	223A	2S	26E	2	2,450	240	580	41	470	25,800	45	F		
14-31	Arrow Cr.	Arrow Cr. #1	224	2N	29E	17	18,140	1,500	4,680	59	1,800	590,000	126	R,I,F	1	
14-32	Fly Cr.	Fly Cr. #1	225	2N	30E	4	162,140	13,500	25,000	55	1,770	1,039,900	42	R,I,F	1	35,000
		Fly Cr. #2	226	1S	31E	31	47,880	4,000	11,700	34	2,505	347,845	30	R,I,F	1	40,000+
		Fly Cr.	227	2S	30E	12									4	
14d-1	Upper Pryor Cr.	E.F. Pryor #1	228	4S	27E	5	51,670	8,600	17,100	75	2,650	1,180,000	69	R,I,F	1	40,000
		E.F. Pryor #2	229	4S	27E	24	38,700	6,500	13,100	84	2,210	1,400,000	107	R,I,F	1	23,000
		Hay Cr.	230	4S	27E	6	20,580	3,430	6,930	83	1,680	820,000	118	R,I,F	1	7,000
		Pryor Cr. #1	231	3S	27E	30,31,32	212,888	23,000	21,500	77	3,665	1,000,000	47	R,I,F	1	30,000
		Pryor Cr.	232	3S	27E	29,30	205,440	34,600	21,500	75					4	
		E.F. Pryor Cr. #1	233	5S	28E	7									4	
14d-2	Lower Pryor Cr.	E.Fork Cr. #1	234	2S	28E	13									4	
Clarks Fork Subbasin																
14c-3	Clarks Fk.-Zimmer Cr.	Broadwater Curl L.	235	9S	15E	15			9,300	50	1,000			I	5	
		Kersey L. 6/	236	9S	15E	27	1,984	4,131	2,710	20	100	3,822	1.4	I	1,6	
		Fox L. 6/	237	9S	16E	30	16,000	55,965	9,895	65	450	103,662	10.5	I	1,6	

TABLE VII-3--PROBABLE RESERVOIR SITES (Continued)

Watershed No.	Watershed Name	Site Name	Reservoir Map Index Number	Location: Township	Location: Range	Location: Section	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft)1/	Reservoir Water Depth (Feet) 2/	Top Length of Embankment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embankment to Storage Ratio (Cu.Yd./Ac-Ft)3/	Project Purpose Use 4/	Data Source Number 5/	Additional Storage Capacity Available (Ac-Ft)
14c-3	Clarks Fk.-Zimmer Cr.	Broadwater L. 6/	238	9S	15E	10,15	11,776	46,093	4,260	30	110	12,702	3.0	I	1,6	
		Lower Aero L. 6/	239	8S	15E	28	2,880	11,992	6,400	25	150	9,770	1.5	I	1,6	
		Upper Aero L. 6/	240	8S	15E	22	1,472	6,129	4,950	20	300	13,792	2.8	I	1,6	
		Canyon L. 6/	241	9S	16E	19,20	4,672	17,509	1,513	25	110	6,357	4.2	I	1,6	
		Upper Russell Cr. L. 6/	242	8S	15E	36	1,216	5,063	1,416	40	140	19,273	13.6	I	1,6	
		Lake Elaine 6/	243	9S	17E	18,19	1,728	6,476	5,420	40	450	31,783	5.9	I	1,6	
		Green L. 6/	244	9S	17E	20	8,512	34,026	1,675	25	500	30,166	18.0	I	1,6	
		Golden L. 6/	245	9S	17E	23,26	2,240	7,835	1,410	20	100	4,830	3.4	I	1,6	
		Albino L. 6/	246	9S	17E	25	576		3,150	30	320	36,187	11.5	I	1,6	
		above Flat Rock L. 6/	247	8S	17E	33	832	3,465	1,640	40	100	12,840	7.8	I	1,6	
		Flat Rock L. 6/	248	9S	17E	4	3,328	13,858	1,740	30	100	9,869	5.6	I	1,6	
		Jasper L. 6/	249	9S	17E	23	1,792	6,268	1,680	20	200	10,699	6.3	I	1,6	
		Curl L. 6/	250	9S	15E	15	16,000	60,000	7,950	40	110	19,005	2.4	I	1,6	
		Jorden L. 6/	251	9S	16E	14	3,008	12,525	1,560	30	100	9,208	5.9	I	1,6	
		Granite L. 6/	252	58N	106W	21,22 7/	20,992	28,670	5,440	20	120	6,550	1.2	I	1,6	
		Lonesome L. 6/	253	9S	17E	35	576	1,967	1,230	30	80	5,918	4.8	I	1,6	
14c-6	N.F. Cherry-Silvertip Cr.	Bridger Cr. #1	254	7S	23E	12	19,390	2,700	6,160	74	1,100	632,836	103	R,I,F	1	25,000
		Cottonwood Cr. #1	255	7S	23E	21	73,670	3,100	15,900	88	1,400	842,423	53	R,I,F	1	30,000+
14c-7	Clarks Fk.-Ruby Cr.	Sand Cr. #1	256	6S	22E	34	6,100	500	1,740	48	783	167,226	96	R,I,F	1	25,000+
14c-8	Upper Rock Cr.	Black Canyon 6/	257	9S	18E	5	2,800		5,100	400	800			I	5	
		Second Rock Cr. 6/	258	8S	18E	31	3,950		740	25	450			I	5,6	
		Third L. 6/	259	8S	17E	35	700		2,100	40	370			I	5	
		W.F. Rock Cr. #3	260	8S	20E	6			3,000					I	5	
		W.F. Rock Cr. #4	261	8S	20E	6			6,900					I	5	
		Keyser Brown L. 6/	262	8S	18E	32	7,500		500	35	340			I	5	
		Lake Cr. #5 6/	263	9S	18E		550		1,600	150				I	5	
		Quinnebaugh Meadows 6/	264	8S	18E	7	9,800		3,000	95				I	5	
14c-9	Red Lodge-Rock Cr.	W. Red Lodge Cr.	265	6S	17E	12	29,990	12,500	16,400	103	2,200	2,500,000	153	R,I,F	1	20,000-
		Red Lodge Cr.	266	5S	20E	6,7	83,470	19,500	25,000	102	2,480	2,500,000	100	R,I,F	1	14,000+
		Willow Cr. #2	267	5S	20E	10,11	31,490	13,800	17,820	98	1,730	1,500,000	84	R,I,F	1	
14c-10	Elbow-Lower Rock Cr.	Elbow Cr. #1	268	4S,5S	22E,22E	35,2	24,320	4,900	11,700	91	2,300	884,700	76	I	1,5	30,000+
		Elbow Cr. #2	269	5S	22E	9,16	22,890	3,800	7,620	81	1,730	596,726	78	R,I,F	1	3,000
14c-11	Lower Clarks Fk. E. Side	Bluewater Cr.	270	5S	23E	35	29,060	23,300	11,955	105	1,500	1,250,000	104	R,I,F	1	8,045
		Five Mile Cr.	271	5S	24E	4	22,840	5,300							1	
		Cottonwood Cr. #1	272	3S	24E	19,30	29,390	2,000	7,300	82	1,155	600,000	82	R,I,F	1	
		Cottonwood Cr. #2	273	3S	24E	33	24,090	2,000	6,250	62	1,395	412,626	66	R,I,F	1	15,000+
		Bluewater Cr.	274	6S	24E	5			3,250	100				I	5	
		Five Mile Cr.	275	4S	24E	29	9,600		1,500	60	800			I	5	
Big Horn Subbasin																
14e6-8	Sage Creek	Sage Creek #1	276	9S	25E	4	101,760	10,200	25,000	82	2,050	1,300,000	52	R,I,F	1	20,000
		Sage Cr. #2	277	8S	25E	18	76,570	9,500	21,000	51	4,390	1,050,000	50	R,I,F	1	
		Sage Cr. #3	278	8S	25E	28,32,33	84,570	17,000	25,000	75	2,310	695,616	28	R,I,F	1	10,000+
14e-27	Crooked Creek	Crooked Cr. #1	279	9S	27E	26	27,590	4,600	8,010	91	2,407	1,606,019	200	R,I,F	1	10,000
14e-30	Dry Head Cr. to Wyo.	Dry Head Cr.#1	280	7S	28E	7	13,900	4,100	5,810	132	718	1,096,491	189	R,I,F	1	40,000+

TABLE VII-3--PROBABLE RESERVOIR SITES (Continued)

Water-shed No.	Watershed Name	Site Name	Reser-voir Map Index Number	Location Town-ship	Location Range	Location Sec-tion	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft)1/	Reservoir Water Depth (Feet) 2/	Top Length of Embank-ment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embank-ment to Storage Ratio (Cu.Yd./Ac-Ft)3/	Project Purpose Use 4/	Data Source Num-ber 5/	Additional Storage Capacity Available (Ac-Ft)
14e-32	Soap Creek	W.F. Soap Cr. #1	281	6S	32E	21	10,700	3,100	4,980	81	1,263	666,652	134	R,I,F	1	5,000
		Soap Cr. #1	282	6S	32E	15	59,180	20,400	25,000	82	3,270	2,054,290	82	R,I,F	1	10,000
		Soap Cr. #2	283	7S	32E	2	36,090	12,900	19,000	91	2,220	1,871,000	99	R,I,F	1	
		Soap Cr.	284	6S	32E	34									4	
14e-33	Beauvais Cr.	Hay Coulee	285	4S	31E	36	11,100	3,000	5,140	67	2,130	529,577	103	R,I,F	1	5,000+
		Beauvais Cr. #3	286	4S	30E	21	76,870	24,000	25,000	76	2,720	1,112,957	45	R,I,F	1	15,000+
		Beauvais Cr. #4	287	4S	29E	21,27	49,280	16,400	25,000	84	2,715	2,221,944	89	R,I,F	1	10,000
		Muddy Cr. #1	288	4S	30E	23	19,190	5,600	9,080	54	1,497	455,782	50	R,I,F	1	10,000
		Beauvais Cr.	289	4S	31E	8									4	
14e-34	Rotten Grass Cr.	Rotten Grass #1	290	6S	33E	13	58,580	24,900	25,000	87	3,350	2,499,560	100	R,I,F	1	
		Rotten Grass #3	291	6S	33E	36	45,780	20,000	25,000	99	4,000	3,100,000	124	R,I,F	1,4	
		Rotten Grass #4	292	7S	34E	7	42,780	19,300	25,000	91	3,600	2,017,352	81	R,I,F	1	
		Rotten Grass	293	7S	34E	6,7	49,920	12,600	14,000	77	2,800				4	
14e-35	Two Leggins-Woody Cr.	Woody Cr. #1	294	3S	32E	29	97,060	15,400	25,000	72	2,000	1,136,384	46	R,I,F	1	2,500
		Woody Cr. #2	295	3S	31E	24	90,560	14,300	25,000	74	2,395	1,356,856	55	R,I,F	1	25,000
		Woody Cr. #3	296	3S	31E	14	85,370	13,500	25,000	62	2,340	837,744	34	R,I,F	1	25,000
		Big Woody Cr. #1	297	3S	30E	9	33,490	6,100	14,500	49	2,040	462,416	32	R,I,F	1	20,000+
		Little Woody Cr. #1	298	3S	30E	21,27	21,290	4,000	9,000	49	2,035	303,829	34	R,I,F	1	21,000
		Two Leggins Cr. #1	299	2S	33E	19,20	34,490	4,300	10,650	74	1,731	909,165	85	R,I,F	1	7,000
		Woody Cr.	300	3S	31E	16									4	
14e-37	West Side Bighorn R.	Lone Tree Coulee	301	1N	33E	20	11,520	960	3,340	48	2,170	340,000	102	R,I,F	1	
		Whitman Coulee	302	1S	33E	9	20,460	1,700	5,600	54	1,520	436,000	78	R,I,F	1	1,700
		Williams Coulee #1	303	1S	33E	31,32	26,190	2,200	6,900	50	1,910	554,671	80	R,I,F	1	10,000
		Williams Coulee #2	304	1S	32E	36	23,690	2,000	6,500	44	1,435	352,532	54	R,I,F	1	
14e-38	East Side Bighorn R.	Custer	305	3N	34E	8	14,304,000		501,000	115	3,650			F,P	5	
14e-39	Upper Tullock Cr.	E.F. Tullock Cr. #1	306	1S	36E	15,22	32,890	4,100	9,800	63	2,320	524,987	54	R,I,F	1	15,000
		Tullock Cr. #1	307	1S	36E	5	142,087	6,963	19,358	60	3,300	680,000	35	I	1	
		W.F. Tullock Cr. #1	308	1S	36E	20	99,260	12,400	25,000	67	2,695	877,559	35	R,I,F	1	15,000+
		Tullock Cr.	309	1S	36E	29	86,400	4,135	34,000	65	3,800				4	
		W. F. Tullock Cr. #2	310	2S	36E	10	75,070	9,400	22,500	67	2,735	1,105,880	49	R,I,F	1	20,000+
Little Bighorn Subbasin																
14e7-1	Little Bighorn R.	Little Bighorn	311	9S	34E	17	129,280	106,000	70,000	138	3,000				4	
		Little Bighorn #1	312	9S	34E	17	134,450	115,400	25,000	110	1,900	1,684,870	67	R,I,F	1	100,000+
		Little Bighorn #2	313	9S	34E	19,20	133,450	115,000	25,000	98	2,520	2,150,000	86	R,I,F	1	100,000+
		Crazy Head Cr. #1	314	8S	35E	20	8,000	1,300	2,916	72	1,510	535,000	184	R,I,F	1	15,000+
14e7-2	Pass Creek	Pass Cr. #1	315	9S	35E	14	42,680	16,900	24,600	97	2,455	2,500,000	101	R,I,F	1	
		W. Pass Cr. #1	316	9S	35E	28,29	21,990	9,200	12,730	98	1,465	1,060,000	83	R,I,F	1	10,000+
		Pass Cr.	317	9S	35E	14	44,800	26,231	13,600	76	2,625				4	

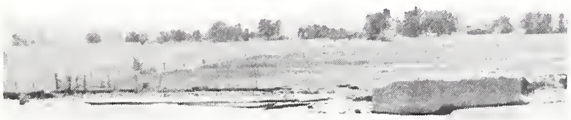
TABLE VII-3--PROBABLE RESERVOIR SITES (Continued)

Watershed No.	Watershed Name	Site Name	Reservoir Map Index Number	Location: Township	Location: Range	Location: Section	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft)1/	Reservoir Water Depth (Feet) 2/	Top Length of Embankment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embankment to Storage Ratio (Cu.Yd./Ac-Ft)3/	Project Purpose Use 4/	Data Source Number 5/	Additional Storage Capacity Available (Ac-Ft)
14e7-3	Lodge Crass Cr.	Lodge Crass Cr. #1	318	9S	33E	2,3	41,780	31,000	25,000	157	1,290	1,720,000	69	R,I,F	1	
		Lodge Crass Cr. #2	319	9S	33E	10	40,180	30,500	25,000	153	2,800	2,800,000	112	R,I,F	1	10,000+
		Lodge Crass Cr. #3	320	9S	33E	9	38,290	29,800	25,000	155	2,700	3,700,000	148	R,I,F	1	10,000+
		Lodge Crass Cr. #4	321	6S	35E	28,29	96,160	39,800	25,000	80	3,830	1,850,000	74	R,I,F	1	7,000+
		Lodge Crass Cr. #5	322	6S	35E	15,22	108,780	40,800	25,000	75	3,300	1,809,330	72	R,I,F	1	8,000+
		Cood Luck Cr. #1	323	6S	35E	16,17	9,560	800	3,000	50	1,390	370,000	123	R,I,F	1	10,000+
		Good Luck Cr. #2	324	6S	35E	18	7,580	650	2,158	52	1,315	368,000	171	R,I,F	1	2,800+
		Cood Luck Cr. #3	325	6S	35E	17	8,596	725	1,440	38	1,350	290,000	201	F	1	4,600
		Lodge Grass Cr.	326	7S	34E	14									4	
14e7-4	Owl Cr.	Owl Cr.	327	7S	36E	4	100,000	10,000	37,500	95	3,000				4	
		Owl Cr. #1A	328	7S	36E	4	102,760	6,700	25,000	80	2,400	1,507,420	60	R,I,F	1	30,000+
		Owl Cr. #2	329	8S	36E	2	50,580	4,000	12,750	65	1,360	531,895	42	R,I,F	1	20,000+
14e7-5	Little Bighorn E. Side	Reno Cr. #1	330	4S	36E	17	37,890	1,800	8,500	72	2,810	630,000	74	R,I,F	1	12,000+

1/ Represents increased storage on wilderness study area sites.
2/ Represents increased water depth on wilderness study area sites.
3/ A comparative figure derived from dividing the estimated earth fill in cubic yards by the estimated water storage capacity in acre-feet.
4/ I--irrigation; F--flood protection; R--recreation (fishing, hunting, and boating); S--water supply (industrial, municipal, and domestic); P--power.
5/ Source: 1--Soil Conservation Service, 2--Bureau of Reclamation, 3--Corps of Engineers, 4--Bureau of Indian Affairs. 5--Montana Department of Natural Resources and Conservation, 6--Forest Service.
6/ Sites in wilderness study area.
7/ In Wyoming.

Irrigation diversion on Rock Creek above Red Lodge needs to be replaced. SCS PHOTO 11-P869-S

Golden Ditch diversion out of Clarks Fork River before reconstruction, 1959. SCS PHOTO 11-6115-1



Golden Ditch diversion after reconstruction, 1961, eliminating annual diking and pollution of the river. SCS PHOTO

IRRIGATION SYSTEMS

Improvement of distribution systems and consolidation of canals offer the best potential for more efficient water use. Present conveyance efficiencies as low as 40 percent were measured at the first farm turnout. In other words, 60 percent of the water diverted from the stream is lost from the canal before it reaches the first farm. Additional losses occur on down the canal, making the distribution efficiency even lower. Significant water savings could be realized on individual units from improvements in conveyance or farm application. Much of this "lost" water finds its way back into the stream through ground-water recharge and is diverted again and again until the stream leaves the Basin. Under present economic conditions extensive canal lining or piping of irrigation water is not feasible. Part of the diverted water is lost from the Basin through deep percolation and nonproductive phreatophytic transpiration. It is estimated that actual savings of water from canal lining in the Basin would amount to 12,600 acre-feet and another 21,000 acre-feet would be saved from improvement of on-farm efficiencies.

On-farm efficiencies range from 15 to 60 percent for flood and row-crop irrigation with the typical efficiency of about 30 percent. On-farm efficiencies depend on irrigation management practices dealing with soil permeability and water-holding capacity, slope of field, degree of uniformity, length of irrigation run, and skill of the irrigator. Only the last three of these factors have much potential for change and the last factor appears to be deteriorating.

As time goes on, more and more sprinkler irrigation is being used to offset the shortage of skilled irrigators. Investment per acre in conventional sprinkler systems tends to approximate the cost of land leveling and ditch preparation. Further investment in automated central pivotal systems greatly exceeds conventional sprinkler systems. Labor, power, and maintenance costs per acre on conventional sprinkler systems tends to exceed the variable costs of conventional flood or row-crop irrigation. The added amortization and maintenance costs on the large automated systems more than offset the savings in labor costs over conventional sprinklers at the present time. In addition, the rates of water application at the outer end of the pivotal boom are higher than the intake rates of the soil, resulting in runoff and inefficiency. On the basis of these comparisons, it appears that more conventional wheel move laterals or hand move sprinkler systems should come into use. With adoption of sprinklers, there comes a degree of built-in water management, less need for land preparation, and some increase in land areas irrigated that were in ditches before or too uneven for flood and row-crop irrigation. On-farm irrigation efficiency will increase as the number of sprinkler irrigation systems increases. Other increases in irrigation efficiency may be achieved through farm ditch lining and improved irrigation management education.

DEVELOPMENTS FOR RECREATION--FISH AND WILDLIFE

Development potentials in recreation can be broken into two categories. The first would consist of improving use of existing resources and the second would consist of new development. Improved accessibility to public lands and fishing waters is needed and can be accomplished by providing for walking access along banks of prime trout streams, lakes, and reservoirs and acquiring access across private land. This approach would entail more legal and legislative participation along with purchase of rights-of-way. Total investment in physical and depreciable structures would be low.

New development potentials would consist of new reservoirs, new roads and trails, new dude ranch type developments, and new campground facilities. Most of these items will require considerable capital investment and will have relatively high operating, maintenance, and replacement costs. Much of the success of this second category investment will depend on the accomplishments under the first category.

Grazing rights often have been interpreted by ranchers as rights to exclude all other users from the multiple use of federal and state lands. In many places the only practical entry to public land is across private ownership land. If the multiple use of public lands concept is to be realized, then access needs to be acquired through either negotiations or court action. There is a potential for providing much additional recreational opportunity at a relatively small annual cost.

Except for licensed fish ponds, trout water and the fish therein are generally considered state-owned property. Yet a very high proportion of the bank miles is posted private lands. There is a good potential for developing fisherman access paths along these streambanks and lakeshores with only minimum competition with agricultural uses. Such access logically should be governed and policed by the Montana Department of Fish and Game. Costs for acquiring the rights-of-way easements and building fence stiles and parking areas might be shared between federal and state funds. Some other states have acquired fisherman walkway easements. See table VII-4.

New developments should include consideration of recreational and fish and wildlife water storage with financial support from state and local agencies. There are good potential sites for either public or private campground development on or near public lands. Because of the problems associated with attempting to meet outdoor recreation demands as discussed in chapter five, the best opportunities to meet expanding demands will be through improvement of access to public lands and provision of developed facilities by the private sector. By doing this, the recreationists will pay the relatively high costs of providing the facilities they desire while maximizing opportunities to recreate for all persons through the public funds expenditure on access. If the water resource user has to pay the full cost of his using that resource, he may find his preferences changing away from that use.

TABLE VII-4--STREAMS, LAKES, AND IMPOUNDMENTS WITH OPPORTUNITIES FOR FISHERY IMPROVEMENT--LAND AND WATER REQUIRED AND BENEFITS ESTIMATED

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Fishery Opportunity No.	Subarea Stream of Impoundment	Location State or County	Present Fishery Class	Class Change	Acres or Miles	Limiting Factors	Needs (Improvement Opportunities)	Resources Needed: Land	Resources Needed: Water	Annual Fisherman-Day Benefits: Use	Annual Fisherman-Day Benefits: Capacity
4a	Bighorn River, Yellowtail Dam to St. Xavier	Big Horn, Montana	3	3 to 1	15	(1) Access (2) Lack of spawning Area (3) Siltation (4) Goldeye	(1) Roads, parking, sanitary facilities on both sides of river at 2-mile intervals (5 acres each) (3) Stop silt in Beauvais, Soap, & Rottengrass Creeks	75 0	0 0		35,000
b	Bighorn River, St. Xavier to Hardin, Montana	Big Horn, Montana	3	3 to 2	25	(1) Access (2) Lack of spawning Area (3) Siltation (4) Gold eye	(1) Roads, parking, sanitary facilities on both sides of river at 2-mile intervals (5 acres each) (2) Intensive stocking (4) Goldeye barrier	125	0		33,000
8	Lakes & Streams on Beartooth Plateau	Carbon, Park, Stillwater, Sweetgrass, Montana				(1) Lack of information resulting in unused resources (2) Lack access (3) Empty habitats (4) Stunted fish populations (5) Winter kill	(1) Roads, trails, campgrounds, signs (2) Maps, Information & access acquisition	0			
10d	Rock Creek, Bluewater Creek, Red Lodge Creek,	Carbon, Montana	4 4 4	4 to 3 4 to 3 4 to 3	20 5 10	(1) Dewatering (2) Sediment (3) Channel Disturbence (4) Access	(1) Supplement or restore more desirable flows below many diversions during irrigation season (2) Better water use, streambank, fencing, etc. (3) Return to channel, revegetation & protect bank vegetation	0	60 cfs 60 cfs 60 cfs	not consumed	10,000

TABLE VII-4--STREAMS, LAKES, AND IMPOUNDMENTS WITH OPPORTUNITIES FOR FISHERY IMPROVEMENT--LAND AND WATER REQUIRED AND BENEFITS ESTIMATED (Cont'd)

WIND-BIGHORN-CLARKS FORK RIVER BASIN

(Montana)

Fishery Opportunity No.	Subarea Stream of Impoundment	Location State or County	Present Fishery Class	Class Change	Acres or Miles	Limiting Factors	Needs (Improvement Opportunities)	Resources Needed: Land	Resources Needed: Water	Annual Fisherman-Day Benefits: Use	Annual Fisherman-Day Benefits: Capacity
f	Lodgegrass Creek	Bighorn,	3	None	5	(1) Dewatering	(1) Supplement or restore more desirable flows below many diversions during irrigation season	0	16 cfs (not consumed)		9,900
	Rottengrass Creek	Bighorn,	0	0 to 3	5	(2) Sediment		0	16 cfs		
	Sage Creek	Bighorn,	0	0 to 3	8	(3) Access		0	16 cfs		
	Willow Creek	Carbon,	4	None	5			0	16 cfs		
	Dry Creek	Carbon, Montana	0	0 to 3	4		(2) Clean up return flows, streambank fence, better grazing, etc.	0	16 cfs		
g	Pryor Creek	Carbon, Montana	4	4 to 3	15	(1) Dewatering (2) Sediment (3) Access	(1) Supplement or restore flows below irrigation diversions (2) Clean up return flows, streambank fence, better grazing, etc.	0	135 cfs (not consumed)		3,750
h	Clarks Fork River	Carbon, Montana	4	4 to 3	30	(1) Dewatering (2) Sediment, Oil and other pollution	(1) Supplement flows below irrigation diversions (2) Clean up return flows, streambank fences, better grazing, etc.	0	333 cfs (not consumed)		6,750
14	Bighorn (Yellowtail) Reservoir	Montana - Wyoming		None	12,685	(1) Legislative & administrative restrictions, marketing, distribution, and technological difficulties (2) Fish eggs destroyed by drying	(1) Commercial fishing for food and manufactured fish products and to enhance management of sport fishing resources (2) Spring drawdown before May 1 and stable or rising till June 1	0	0		(1) 60,000 lb. per year (2) 60,000 lb. f-men day

TABLE VII-4--STREAMS, LAKES, AND IMPOUNDMENTS WITH OPPORTUNITIES FOR FISHERY IMPROVEMENT--LAND AND WATER REQUIRED AND BENEFITS ESTIMATED (Cont'd)
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Fishery Opportunity No.	Subarea Stream of Impoundment	Location State or County	Present Fishery Class	Class Change	Acres or Miles	Limiting Factors	Needs (Improvement Opportunities)	Resources Needed: Land	Resources Needed: Water	Annual Fisherman-Day Benefits: Use	Annual Fisherman-Day Benefits: Capacity
15	Small Mountain Streams Beartooth Mountains	Carbon, Stillwater, Sweetgrass, Montana		0 to 4		(1) Dewatering (2) Sediment (3) Access	(1) Provide sustained flows (2) Clean up returned flows, streambank fence, better grazing, etc.	100	? (not consumed)		(1) Natural survival (2) Re-production naturally

Source: Montana Fish and Game Department

Potentials for fish and wildlife developments are largely limited to associated developments of water and land for other purposes. There is a good potential for wildlife habitat preservation and development and it should ben encouraged as part of the overall land treatment programs.

WATER QUALITY

Water quality as affected by human activity is not yet a serious problem in the Montana part of the Basin. There is some increase in temperature of return flows from irrigation that is not expected to change much except as sprinkler irrigation increases and total return flows increase. Sediment and nutrient content of return flows are not overly serious at present. Future problems may exist in pollution from feedlots and encroachment by summer home development on mountain stream flood plains. Strict enforcement of state laws and regulations might prevent this problem from becoming more serious as livestock feeding and population pressures increase. Although sediment is considered a serious problem on the Clarks Fork River, that part of the total sediment load originating from geologic erosion is so great that sediment from return irrigation flows is relatively insignificant. Elimination of man-caused sediment will have little effect on the overall sediment load of the river. However, there is a good potential for reducing erosion and sediment transport in irrigation wasteways and other selected sites.

MUNICIPAL WASTES

Municipal and industrial waste disposal for the Basin is summarized in table VII-5. Population and waste projections for communities are included in the FmHA county reports within the Basin.

Community sewer system improvements or new community sewer systems are needed in Hardin, Lodge Grass, Crow Agency, Red Lodge, Joliet, Belfry, Absarokee, and Fishtail to provide an opportunity for improving the water quality of streams near those communities. A community sewer system is considered necessary and feasible at Pryor and Silesia. A community sewer system is feasible in Rockvale, Bearcreek, and Boyd. The present subsurface systems are adequate unless problems develop in Grizzly Peak Mountain Homes Subdivision of Carbon County, East Rosebud Lake Association Development of Carbon County, Pompeys Pillar, and Huntley.

Waste discharge permits are issued to the communities having surface water discharges. Infiltration water, lack of secondary treatment, storm water entering sewage systems, operation problems, overloading, overflow and seepage, and possible health hazards created by individual subsurface systems are identified as problems of the existing sewage treatment systems.

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Municipality or Industry	Estimated Load (p.e.) Untreated	Estimated Load (p.e.) Treated	Estimated Flow Discharged Million Gallons per Day	Status
STILLWATER RIVER				
Community of Absarokee	600	200	0.3	Considerable groundwater enters sewerage system which affects treatment in sewage lagoons. Need sealing of sewers to eliminate infiltration water.
CLARKS FORK RIVER				
Community of Belfry	200	0	0	Sewage lagoon system has no overflow.
Town of Bridger	700	100	0.2	Sewage lagoon system to be tested for adequacy by Dept. of Health during coming year.
Town of Fromberg	350	60	0.03	An additional lagoon cell is being planned to provide improved treatment.
Community of Edgar	200	0	0	No overflow from sewage lagoon system.
ROCK CREEK				
City of Red Lodge	1,800	0	0	No overflow from new sewage lagoon system. Considerable infiltration in sewer system

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS (Continued)

Municipality or Industry	Estimated Load (p.e.) Untreated	Treated	Estimated Flow Discharged Million Gallons per Day	Status
City of Red Lodge (Continued)				and survey needs to be made to determine construction work needed to eliminate excess water. Heavy loading placed on treatment system by cannery.
Community of Roberts	200	50	0.1	Considerable infiltration of groundwater occurs in sewerage system. Sealing of sewers or additional lagoons are needed.
Town of Joliet	400	100	0.1	Considerable groundwater enters sewerage system. Improvements have been recently made to existing primary treatment facilities to upgrade treatment. Dept. of Health to test treated discharge during coming year to determine adequacy of treatment.
YELLOWSTONE RIVER				
Communities of Worden and Ballantine	600	0	0.0	Lagoon system presently does not have overflow.
Community of Custer	200	0	0.0	Lagoon system presently does not have overflow.
BIGHORN RIVER				
Yellowtail Dam Visitor Center	30	5	0.003	Activated sludge secondary treatment facilities treat wastewater.

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS (Cont'd)

Municipality or Industry	Estimated Load (p.e.)		Estimated Flow Discharged Million Gallons per Day	Status
	Untreated	Treated		
BIGHORN RIVER (Continued)				
Ft. Smith Federal	300	30	0.01	Sewage lagoons serve as treatment facility.
City of Hardin	3,000	600	0.1	Sewage lagoon improvements are planned when grant funds become available.
LITTLE BIGHORN RIVER				
Town of Lodge Grass	600	200	0.03	Lagoon improvements are planned by the U. S. Public Health Service
Community of Crow Agency	2,000	0	0.0	Lagoon system presently overloaded. Treatment system preceding lagoons planned for 1973. Major contribution of wastewater by carpet mill.

Source: Montana Department of Health and Environmental Sciences

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS (Continued)

Municipality or Industry	Estimated Load (p.e.) Untreated	Treated	Estimated Flow Discharged Million Gallons per Day	Status
City of Red Lodge (Continued)				and survey needs to be made to determine construction work needed to eliminate excess water. Heavy loading placed on treatment system by cannery.
Community of Roberts	200	50	0.1	Considerable infiltration of groundwater occurs in sewerage system. Sealing of sewers or additional lagoons are needed.
Town of Joliet	400	100	0.1	Considerable groundwater enters sewerage system. Improvements have been recently made to existing primary treatment facilities to upgrade treatment. Dept. of Health to test treated discharge during coming year to determine adequacy of treatment.
YELLOWSTONE RIVER				
Communities of Worden and Ballantine	600	0	0.0	Lagoon system presently does not have overflow.
Community of Custer	200	0	0.0	Lagoon system presently does not have overflow.
BIGHORN RIVER				
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TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS (Cont'd)

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Community of Crow Agency	2,000	0	0.0	Lagoon system presently overloaded. Treatment system preceding lagoons planned for 1973. Major contribution of wastewater by carpet mill.

Source: Montana Department of Health and Environmental Sciences

OTHER URBAN WASTES

These wastes primarily include runoff from developed areas, storm water, and drainage from solid waste disposal sites. These problems are noted under remarks in table VII-5.

INDUSTRIAL WASTES

The major industries in this Basin are primarily related to agriculture, petroleum, mining, and forest products. Other types of industry exist, but generally they have less impact on the Basin water quality. Industries which discharge waste waters to surface streams are required to have a waste discharge permit.

MINING ACTIVITY

Increasing demands for power and the development of extra-high voltage power transmission enhances the potential economic feasibility of mine-mouth thermal-electric power generation from eastern Montana coal fields. Nearly 1.5 million acre-feet of water per year will be required by the coal industry according to studies made on coal development potentials east of this Basin by the Bureau of Reclamation. The Montana Department of Natural Resources and Conservation has been instructed by the 41st Legislative Assembly by Legislative Joint Resolution #18 to keep the Legislative Council informed of progress on the development of Montana's coal resources and of any agreements contemplated which might affect water to be used from the drainage areas of the Bighorn and Little Bighorn Rivers.

AGRICULTURAL WASTES

The most common water quality degrading characteristics of irrigation return flows are total dissolved solids, sediment, and chemicals. The main factors influencing the impact of irrigation return flow on water quality are soils and geology, type of irrigation used, and farming practices (use of chemicals, etc.). There is a potential for improving water quality and protecting the environment through education and land treatment measures to reduce agricultural pollution of streams.

FEEDLOT WASTES

Cattle feeding within the Basin can be expected to increase substantially in the future. Currently, the larger feedlots in the Basin are located in Yellowstone County.

With all new feedlots, proper location and waste treatment facilities can be expected so little additional waste contribution to streams is anticipated from these sources. The actual effects upon streams from existing feedlots within the Basin have not been determined, but are believed to be minor. The Montana Department of Health and Environmental Sciences has held hearings on a feedlot waste discharge permit regulation and a regulation was adopted on June 24, 1972. However, there is potential for protecting the environment through education and enforcement of health regulations.

RECREATIONAL WASTES

Outdoor recreation will continue to be an important factor in future development of this Basin. Wastes from recreation may be minor in volume, but costly to control because of dispersion over large areas. Again the potential for environmental protection lies in education and enforcement of regulations.

LAND TREATMENT

The updated Conservation Needs Inventory points up the large amount of land treatment that is still needed. There is a potential for much of this treatment on irrigated land to improve irrigation efficiency and on rangeland to improve grazing distribution and prevent erosion.

The greatest potential for beneficial land treatment on cropland consists of improving irrigation management and irrigation systems on about 130,000 acres and on-farm drainage on about 50,000 acres. The greatest potential on rangeland consists of rangeland protection on about 1,560,000 acres and brush management and range improvement on about 500,000 acres. The large potential for land treatment indicates a need for accelerated investment in this area and continuing activity over time.

Land treatment needs on forested lands are related to: (1) correction of previous poor management practices such as overgrazing, poor road location, abandoned roads and trails and mineral exploration disturbances; and (2) control of existing or potential problems such as control of mineral exploration practices, off-road vehicular travel and recreation overuse. While continued enforcement of existing laws and better land management planning will greatly reduce future problems, there is a potential for correcting past problems through structural measures such as streambank stabilization, installation of physical erosion control structures on abandoned roads and trails, rehabilitation of old mining disturbances, or vegetative measures such as reforestation of denuded forest lands and reseeding of overgrazed and eroding rangelands. Due to the dramatic climatic conditions in the high mountainous areas and the semiarid regions, it is not practical from a watershed management viewpoint to wait until nature heals wounds such as abandoned roads which generally continue to erode. There is a potential for development of structural land treatment measures along with improved management techniques.

POTENTIAL FOREST INDUSTRY DEVELOPMENT

The characteristics of the Basin forest industry discussed in chapter three indicate that no significant increase in this activity may be expected. In fact, the probable level of development will decline.

NATURAL BEAUTY

There is a real opportunity to develop positive programs to protect the visual resource through repair or altering past scars. It is no longer practical or sound to plan for development potential without providing for esthetics of these projects. The potential lies in designing water and land resource projects to fit the landscape of which they become a part. Projects need to be designed to meet people's needs, including visual quality.

VIII. OPPORTUNITIES FOR DEVELOPMENT AND IMPACT OF USDA PROGRAMS

The U. S. Department of Agriculture and agencies of the State of Montana participated in this river basin study to identify opportunities to solve water and related land resource problems and improve the economic situation of the area. Through the identification of these opportunities and the realization of their interrelationships in water use and impacts, it is hoped that a coordinated, priority-oriented development can be accomplished.

PUBLIC LAW 566

All of the 44 hydrologic watersheds or parts of watersheds in Montana's share of the Basin were investigated as to their potential for PL-566 project development. During the early process of investigation, 20 watersheds were found to have no project potential in that they had insufficient flooding damages, irrigation shortages, or drainage needs to warrant project action. The remaining 24 watersheds under more intensive study were found to have nine potential feasible projects; 12 economically infeasible, but physically potential projects; and three questionably feasible projects. The nine potential projects and two questionable projects are described below. (See map VIII-1.)

14-32 Fly Creek

In the Fly Creek fan area of the Huntley Irrigation Project, there is a project opportunity to provide drainage outlets to the Yellowstone River. About 11,500 acres are now damaged by high water table caused by irrigation development without sufficient drainage. It is estimated that 130 farms can be made more productive. Along with the drainage outlets, 20,000 acres need land treatment in the form of field drainage, water control structures, and improved irrigation management.

14-27 Blue Creek

The drainage of Blue Creek, across the Yellowstone River from Billings, is being built up very rapidly with rural residences. At present there are 25 homes and a grade school that have been damaged by summer floods. Seven years ago there were only nine homes on the flood plain. Nearly all the flood plain is platted subdivision. Without flood prevention measures, it appears that a tragedy is in the making. There is a good dam site that will control 60 percent of the drainage area and could provide an excellent recreational pool and municipal and fire protection water for the many new homes in the area.

14d-1 and 14d-2 Pryor Creek

Pryor Creek has an excellent multipurpose development potential that can be of high economic development benefit to Indian Trust lands. About 55 percent of the land in the two watersheds is Indian Trust land. The watershed provides ample water yield to develop all the high quality irrigable bottom lands of the Pryor Creek valley. A dam site has been identified on the main stem of Pryor Creek just below where the East Fork of Pryor Creek joins the main stem. At this location, about 25 miles from Billings, the recreational pool would receive a lot of use. Below the reservoir, 1,607 acres now irrigated would receive supplemental water and 2,632 acres now in dryland and pasture would receive a full supply of irrigation water. This new irrigation would logically shift into production of corn and corn silage because it is the closest haul (10-20 miles) to one of Montana's largest new feedlots. Migratory waterfowl would benefit from the resting area near large wheat fields.

14c-9 Red Lodge-Rock Creek

This watershed needs improvement in irrigation efficiency and cooperation in exchange of stored water for direct diversion water. Some ditch consolidation may be warranted. Some increase in import of water from East Rosebud Creek may be desirable. Water use and diversion measurements are inadequate to base plan formulation. A history of unused storage capacity in Cooney Reservoir indicates an unwillingness of irrigators in the upper watershed to pay one dollar per acre-foot for irrigation water. Feasibility of further project action is very questionable under such circumstances.

14c-10 Elbow Creek

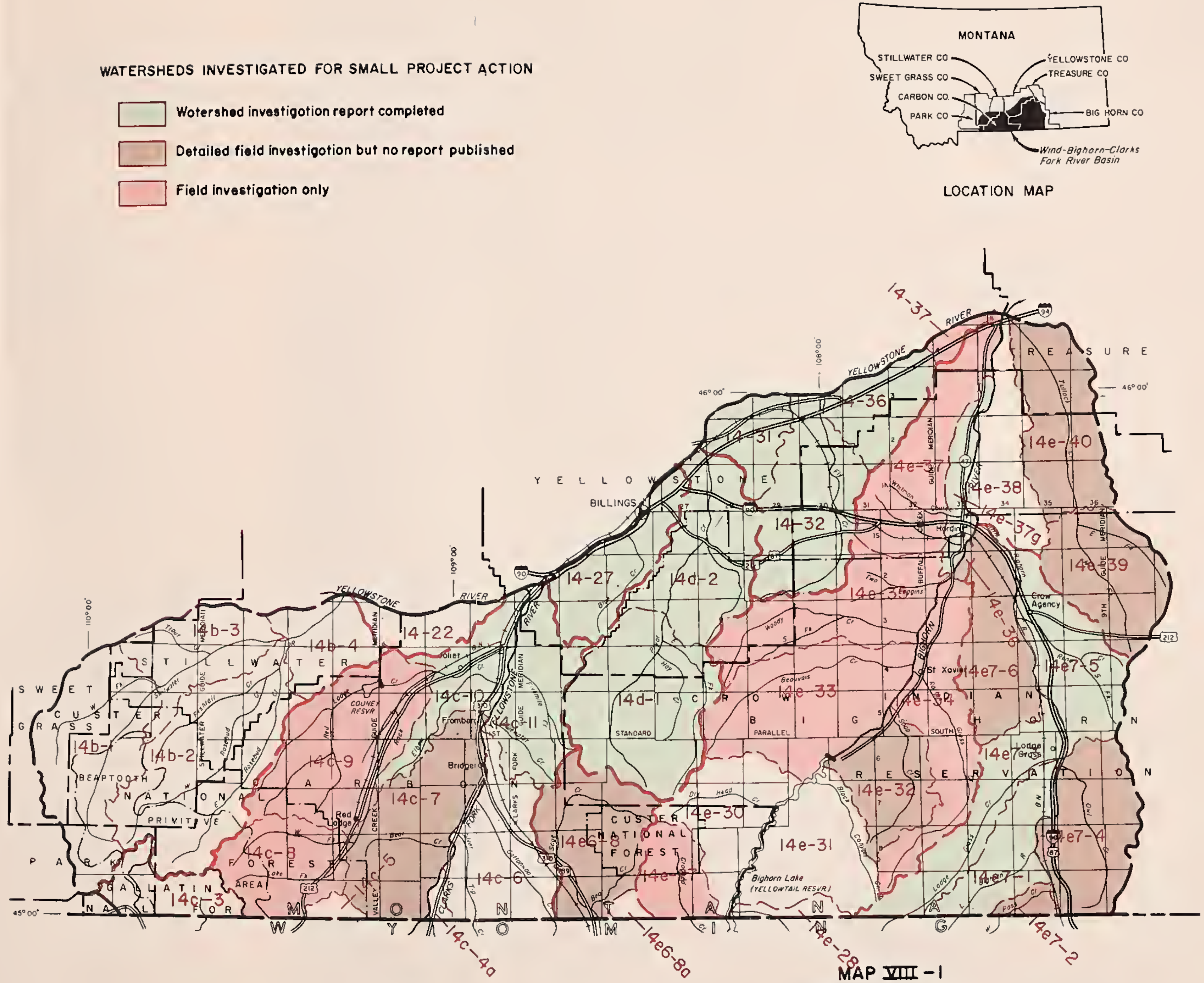
This watershed would provide offstream storage for supplemental water and conversion of some additional dryland to irrigation. Water-based recreation would help alleviate heavy weekend pressure on Cooney Reservoir. About 5,300 acres now irrigated would be assured of a supplemental supply and 1,400 acres now in dryland would be provided a full supply of water. An existing canal would be enlarged and extended to bring unused off-season water to the Elbow Creek reservoir site.

14c-11 Lower Clarks Fork East Side

Lands now irrigated in this watershed are short of water during the peak irrigation demand period, thus limiting their production. Bluewater Creek has about 5,000 acre-feet of unused off-season water that could be stored and released into the Orchard and Edgar Canals to provide that full season use. Recreational and fish and wildlife water can provide additional benefits during summer months.

14e-37a Two Leggins Irrigation Unit

This watershed is badly in need of a coordinated reorganization, canal consolidation, and drainage project to alleviate high water table conditions on potentially good irrigated lands. These changes are needed to improve the economic efficiencies of agriculture in a disadvantaged area. Over half the county is in the Crow Indian Reservation,



MAP VIII - I

WATERSHEDS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914P

and the sugar factory in Hardin has gone out of business. It is estimated that the project would benefit 14,000 acres now damaged by high water tables and improve the economy on 70 farms. An application for Public Law 566 assistance has been filed, but authority for planning has not yet been granted.

14e-39 and 14e-40 Tullock Creek

Tullock Creek has many acres of bottom lands that get mainly waterspreading irrigation during flood periods. Much of the spring runoff goes down the creek with little use. By storing runoff for more timely use to supplement the present irrigation, yields can be improved to augment the forage base and alleviate the pressure on range lands. Only incidental recreational and fish and wildlife benefits would be realized.

14e7-1 Upper Little Bighorn River

There is an opportunity to develop a new diversion just below Wyola to carry presently unused streamflow to about 2,900 acres of good dryland on the Crow Indian Reservation. The proposal would help 20 farms and provide an increase in employment opportunities in irrigation, harvest, and feeding of hay and corn silage. The proposal is both engineeringly and economically feasible.

14e7-3 Lodge Grass Creek

Lodge Grass Creek has a history of flooding the town of Lodge Grass and interrupting traffic on U. S. Highway 87. The damages can be prevented with a combination of upstream diversion into Lodge Grass Reservoir, flood storage on Good Luck Creek drainage, and a flood training dike around the town of Lodge Grass to handle flows from the uncontrolled area. Only incidental recreational benefits are expected from the storage site on Good Luck Creek.

14e7-5 Little Bighorn East Side

There is an opportunity to develop two small pump-lift irrigation units in this watershed. In one unit, the water would be lifted 55 feet to a canal to irrigate 1,100 acres about eight miles south of Crow Agency. In the other unit, water would be lifted 65 feet to canals to irrigate 1,170 acres just three miles south of the confluence of the Little Bighorn and Bighorn Rivers. Both units are on the Reservation. Ample unused water is available for this development.

The overall environmental impact of potential PL-566 projects and land treatment under various USDA programs would be definitely beneficial. Probably the greatest impact would consist of reduction of erosion and sediment production. Next would be a substantial increase in resting and nesting area for waterfowl and water supplies for big game and upland game birds in farm ponds and multipurpose watershed reservoirs. Breaking up of single-type habitat by irrigation development would provide edge and fringe habitat and water supplies not now available for wildlife. In potential projects, an increase of about ten miles of live streamflow can replace intermittent flow. Also, loss of about two miles of low value live streamflow and 40 acres of streambank habitat would be offset by 1,000 new acres of recreational water surface and its related shoreline. These same projects would trap about 61 acre-feet of sediment per year that are presently polluting streams and rivers. A summary of PL-566 projects and their impacts is shown in table VIII-1.

ECONOMIC IMPACT

Installation of works of improvement can provide a stimulus toward economic growth and development. The complexity of relationships that exist between various sectors of the local economy and how they relate to the region and the nation make it an intricate task, if not impossible, to quantify all effects likely to occur. The Basin's economy is made up of the aggregate economic activity of all its people. An initial change in one of its basic sectors will signal adjustments to take place in other sectors which will induce further changes and so on. The result of these changes can be quantified in terms of employment and income.

Employment will be generated as the works of improvement become operative. An employment multiplier can be used to estimate this impact. This approach involves a breakdown of total employment into two major occupational groups: (1) the basic group which includes agriculture, forestry, manufacturing and mining which produce goods and services locally for consumption mainly outside the Basin; and (2) the derivative or service-oriented group which includes those industries whose goods and services are mainly consumed locally. Total employment and incomes rise and fall with the basic group. A change in the basic activities sets a sort of chain reaction in motion that is reflected through all sectors of the economy.

A ratio of basic activity to derivative activity is computed from employment data as reported in U. S. Census of Population. This ratio is not static. The number of employees in the derivative group becomes larger relative to the basic group over long periods of time. Employment data from tables III-6 and III-9 are combined to show the following:

	Employment			
Year	Total	Basic	Derivative	B/D Ratio
1940	8,512	5,476	3,036	1: .55
1950	8,610	4,798	3,812	1: .79
1960	7,847	3,465	4,382	1:1.26
1970	7,085	2,572	4,513	1:1.75
1980	6,700	2,150	4,550	1:2.12
2000	6,400	1,800	4,600	1:2.55
2020	6,300	1,700	4,600	1:2.70

TABLE VIII-1--SUMMARY OF WATERSHED INVESTIGATION REPORTS AND THEIR IMPACTS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

				PHYSICAL & BIOLOGICAL IMPACTS (Annual Amounts of Change)							ECONOMIC IMPACTS (Annual Benefits)							LAND USE AND AVAILABILITY CHANGE						SOCIAL IMPACTS	
WATERSHED NAME AND NUMBER	Potential State of Montana Involvement	Installation Cost ($)	Annual Cost @5-5/8% ($)	Net Water Consumption (A.F./yr.)	Water Supply Timing Charge (A.F./yr.)	Water Quality (T.D.S.-PPM)	Sediment Reduction (A.F. or tons/yr.)	Fish & Wildlife Habitat (Acres or Miles of Stream)	Vegetative Improvement (Acres)	Erosion Reduction (Acres)	Flood Damage Reduction ($)	Increased Agricult. Production ($)	Increased Per Capita Income ($)	Increased Employment (Man-Yrs)	Total Secondary Benefits ($)	Increased Recreational Use (Visitor-Days)	New Community Water Supplies (Number Persons Served)	Cropland to Grassland (Acres)	Cropland to Wildlife & Recreation (Acres)	Range to Cropland (Acres)	Wetland to Cropland (Ac)	Range to Recreation (Acres)	Land to Water Surface (Av. Ac)	Cropland With Improved Production (Ac.)	Grassland With Improved Production (Acres)
EARLY ACTION:																									
1. Blue Creek, 14-27	Rec. Co-sponsor	3,183,810	206,590	420	2,460	--	9.53 AF/yr	+5 miles	--	--	102,900	--	--	--	--	17,610	400	--	--	--	--	320	168	--	--
2. Pryor Creek, 14d-1, 14d-2	Irr. & Rec. Co-sponsor	2,797,300	188,980	6,265	9,902	--	28 AF/yr	-2 miles	4,207	--	7,500	474,000	NA	27	79,250	57,275	--	--	200	2,285	--	800	335	1,922	2,285
3. Two Leggins Irr. Unit, 14e-37a	---	5,147,370	342,100	--	--	--	--	nil	8,900	--	--	974,000	7,000/45	24	162,770	--	--	--	--	--	8,900	--	--	8,900	--
4. Upper Little Bighorn River, 14e7-1	Irr. Co-sponsor	436,520	26,850	5,800	--	--	--	+	2,900	--	--	273,000	4,000/14	9	46,900	--	--	--	--	--	--	--	--	2,900	--
5. Lodge Grass Creek, 14e7-3	---	580,630	34,900	--	--	--	5.4 AF/yr	-6 acres	--	--	36,000	--	--	--	--	3,375	--	--	--	--	--	27	27	--	--
LATER ACTION: 1/																									
1. Huntley Irrigation Project, 14-31, 14-32,14-36	Drainage Co-sponsors	1,952,600	125,320	--	--	--	--	nil	11,700	--	--	904,440	5,000/55	15	151,000	--	--	--	--	--	11,700	--	--	11,700	--
2. Elbow Creek, 14c-10	Irr. & Rec. Co-sponsors	1,790,600	117,510	5,550	10,450	--	7 AF/yr	-35 acres	1,400	40	--	218,817	6,000/21	9	19,000	41,135	--	--	--	500	--	400	235	6,182	500
3. Bluewater Creek, 14c-11	Irr. & Rec. Co-sponsors	1,900,280	127,050	2,600	5,698	--	11 AF/yr	+5 miles	5,354	--	--	246,000	4,500/26	5	37,500	46,220	--	--	--	--	--	--	235	5,354	--
4. Little Bighorn East Side, 14a7-5	---	355,730	27,520	4,540	--	--	--	--	2,270	--	--	238,000	4,800/11	8	40,400	--	--	--	--	1,135	--	--	--	1,135	1,135

Source: River Basin Planning Staff
1/ Some of these projects may move into Early Action category.

The combined effects of changes in land use and crop yields on the benefited acres are major determinants used in evaluating the economic impact. About 37,000 acres in the watersheds investigated will be affected. Changes in land use are expected on only part of the total; however, nearly all the benefited area will be used more intensively and efficiently. Hay, silage, and feed grain production will be increased while sugar beet, pasture, and range production will decline.

By 2000, with the resource developments in place and operative, the gross value of agricultural production will be increased $3,328,000. Approximately 68 percent of the increase ($2,269,000) will come from lands that are irrigated at the present time and need either additional water or the removal of excess water. Supplemental irrigation water will be provided by the projects. The remaining 32 percent ($1,059,000) will come from land that is currently used for grazing and dryland crops, but will be developed for irrigation as a part of the project.

Projected economic benefits will be realized across the Basin and will contribute to economic development objectives. To the extent that additional agricultural production and associated economic activity merely displace production and activity in other areas or affect market prices, the benefits may not truly be national gains. Therefore, it is assumed that output-increasing effects of the proposed developments are so small on an interregional basis, that any displacement or price effects would be insignificant.

The value of agricultural production per agricultural employee in 2000 is estimated at $43,380.1/ If it is assumed that agricultural labor resources are fully employed without the plan, that additional output will provide for 97 additional basic employees. By applying the employment multiplier for the year 2000, it can be shown that derivative employment can increase by 247. The total impact on employment resulting from the increased agricultural production associated with the programs is estimated to be as much as 344. This is comparable to providing employment for all males between the ages of 30 to 49 in the study area that were reported as nonworkers in 1970. Conversely, if it is assumed that labor resources are underemployed to the extent that the increased production can come about without affecting employment, the basin-wide effect amounts to an average of an additional $620 of net farm income per farm worker.

After deducting the nonfederal share of annual project costs from primary benefits, the remainder (approximately $1.4 million) can be considered as income to the Basin. This increase in income is available for consumption spending. A portion of this increase will be spent in the Basin, and in turn, respent within the area until its

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1/ Gross value of agricultural production from table III-13 ($52,056,000) divided by the number of agricultural employees from table III-9 (1,200).

marginal effects become zero. A summation of these successive rounds of spending is commonly called the income multiplier. This indicator measures the total change in a particular sector. Recent studies in areas similar to the Basin estimate the income multiplier to be about 2.0. If the entire $1.4 million were dispersed in the Basin, the total income effect would be at least $2.7 million annually, which is an average of $123 per resident. No attempt was made to project the income multiplier for 2000. However, as the basic-derivative employment ratio changes, the income multiplier will react in a similar fashion.

Local benefits can also accrue through the investment of nonlocal funds for resource developments. The federal share of installation costs and part of the other costs for watersheds investigated in this study total $9,658,500. If a fifteen-year period is required for project installation and federal funds are provided in equal increments over the period, this is equivalent to $643,000 annually. All of this investment can represent new income to the study area provided a local contractor is employed and he purchases capital, labor, supplies, and machinery within the study area. The local area could be enriched as much as $1,286,000 annually because the added increment of new investment income during the fifteen-year construction period is affected by the income multiplier.

LAND TREATMENT

With accelerated improved rangeland management, the Basin's ranching economy can be increased on private and state land by nearly one million dollars annually. Projections show a potential increase by year 2000 of about 172,500 animal unit months of grazing and $862,500 of annual increased income resulting from proposed range condition improvement.

In addition to, and in line with the Montana Rangeland Resource Plan, ranchers have an opportunity to supplement their regular incomes by taking advantage of additional recreational enterprise opportunities. These enterprises, plus the necessary supporting businesses, would add materially to the annual income of the area. Other benefits will be in the form of money saved from reducing pollution and erosion from rangeland after range condition improvements.

By 2000, accelerated land treatment on cropland will have the potential to increase feed output by the equivalent of about 267,400 animal unit months per year worth about $1,334,000. Potential to increase forage on private and state forested land will amount to about 7,700 AUM's worth $38,500 per year. See table VIII-2.

TABLE VIII-2--PROJECTED CHANGES IN AUM FORAGE EQUIVALENTS OF PRODUCTION BY LAND TREATMENT ALTERNATIVES ON STATE AND PRIVATE LANDS
Wind-Bighorn-Clarks Fork River Basin
(Montana)

Treatment Practice	Area Needing Land Treatment	PROJECTED EXISTING PROGRAMS: Applied by Year 2000	PROJECTED EXISTING PROGRAMS: Installed Cost	PROJECTED EXISTING PROGRAMS: Annual Forage Equivalent Increase 1/	PROPOSED ACCELERATED PROGRAMS: Applied by Year 2000	PROPOSED ACCELERATED PROGRAMS: Installed Cost	PROPOSED ACCELERATED PROGRAMS: Annual Forage Equivalent Increase 1/
	(Acres)	(Acres)	(Dollars)	(AUM's)	(Acres)	(Dollars)	(AUM's)
Irrigated Cropland							
Cultural or Management Measures	23,933	7,600		1,900	16,800		4,200
Improved Irrigation Systems	132,180	27,800		79,200	62,000		176,700
Water Management Only	14,614	3,800		6,600	8,400		14,700
On-farm Drainage Only	50,000	8,000		32,000	17,800		71,200
Subtotal	220,727	47,200	15,100,000	119,700	105,000	33,600,000	266,800
Nonirrigated Cropland							
Cultural or Management Measures	206,180	33,900	1,425,000	300	68,400	2,875,000	600
Pasture and Rangeland							
Needs Protection Only	1,558,602	488,500		48,800	1,252,800		125,300
Needs Improvement Only	79,226	24,800		2,500	63,700		6,400
Brush Control & Improvement	417,805	81,800		12,300	209,900		31,500
Reestablish Vegetative Cover	22,533	7,100		3,600	18,100		9,100
Reestablishment & Brush Control	1,085	200		100	500		200
Subtotal	2,079,251	602,400	3,000,000	67,300	1,545,000	7,725,000	172,500
Forested Land							
Management to Improve Forage	113,370	56,700		5,700	90,700		9,100
Reduction of Grazing	39,300	7,900		-800	13,800		-1,400
Subtotal	152,670	64,600	450,000	4,900	104,500	725,000	7,700
Other Lands							
Vegetative & Structural Measures	22,548	8,200	1,800,000	NA	18,500	4,075,000	NA
TOTALS	2,681,376	756,300	21,775,000	192,200	1,841,400	49,000,000	447,600

Price base 1974. NA = Not applicable

1/ All crop and forage production converted to AUM's of forage equivalents (i.e., 450# corn or 900# hay equals 1 AUM.)

SELECTED FORESTED LAND TREATMENT OPPORTUNITIES

This section of the report relates to forest land treatment needs on 11 potential watersheds within the Wind-Bighorn-Clarks Fork Type 4 River Basin study. The inventory was based on a field, map, and aerial photo reconnaissance survey of the following watersheds:

Watershed Name	Watershed Number	Forest Acres
Upper Little Bighorn River	14e7-1	11,520
Lodge Grass Creek	14e7-3	17,280
Little Bighorn - East Side	14e7-5	6,080
Two Leggins Irrigation Unit	14e-37a	1,100
Tullock Creek - Upper & Lower	14e-39 & 40	20,116
Fly Creek	14-32	26,230
Blue Duck Creek	14-27	250
Pryor Creek - Upper & Lower	14d-1 & 2	35,350
Red Lodge - Rock Creek	14c-9	16,570
Elbow - Lower Rock Creek	14c-10	3,720
Lower Clarks Fork - East Side	14c-11	3,842
	TOTAL	142,108

Nine major categories of forest land treatment opportunities were identified during the survey and briefly described. (See table VIII-3.)

In addition to the 11 watersheds that were investigated, there are 18 other watersheds that contain forested lands. There is only limited information available on these forested lands, most of which are privately owned. General information indicates that land treatment measures on these watersheds will be similar to those displayed in table VIII-3. Additional field investigations are needed to accurately assess the opportunities on these areas.

Stream Channel Clearing

This work consists of removing log debris (primarily cottonwood) from major stream and river channels which are deflecting peak runoff flows toward banks causing scouring, sedimentation, and reduction of channel capacity and water quality.

TABLE VIII-3--SELECTED FORESTED LAND TREATMENT NEEDS FOR WATERSHED INVESTIGATION REPORTS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Name	Watershed Number	Gross Acres	Forested Acres	% Forested Land	River Miles Primary Channel	Stream Channel Log Debris Clearing (Miles)	SUPPLEMENTAL LAND TREATMENT NEEDS						
							Streambank Stabilization (Miles)	Sheet Erosion Control (Acres)	Gully Stabilization (Acres)	Road & Trail Stabilization (Acres)	Afforestation & Reforestation (Acres)	Forest Mgt. Plans (Acres)	Forest Fire Protection (Acres)
Upper Little Bighorn River	14e7-1	88,346	11,520	13.0	32	4.5	2.4	300	57	75	575	11,520	11,520
Lodge Grass Cr.	14e7-3	108,938	17,280	15.8	32	5.0	3.5	400	86	96	860	17,280	17,280
Little Bighorn-East Side	14e7-5	141,321	6,080	4.3	32	4.0	2.2	100	30	48	300	6,080	6,080
Two Leggins Irrigation Unit	14e-37a	32,781	1,100	3.3	16	3.0	1.0	25	5	8	55	1,100	1,100
Tullock Cr. - Upper & Lower	14e-39 & 40	298,119	20,116	6.7	64	7.0	3.0	400	100	80	1,005	20,116	20,116
Fly Creek	14-32	179,151	26,230	14.6	32	2.0	2.4	500	131	109	1,010	26,230	26,230
Blue Duck Cr.	14-27	118,570	250	.2	16	1.0	.5	5	1	2	10	250	250
Pryor Cr. - Upper & Lower	14d-1 & 2	389,422	35,350	9.0	96	8.0	7.2	600	176	180	1,400	35,350	35,350
Red Lodge-Rock Cr.	14c-9	207,780	16,570	7.9	80	11.0	4.5	300	82	132	800	16,570	16,570
Elbow-Lower Rock Cr.	14c-10	91,302	3,770	4.2	32	3.5	6.5	75	18	30	180	3,770	3,770
Lower Clarks Fork-East Side	14c-11	133,184	3,842	2.8	40	2.0	4.0	80	19	30	192	3,842	3,842
TOTAL UNITS		1,788,914	142,108	7.9	472	51	37.2	2,785	705	790	6,387	142,108	142,108

Source: River Basin Planning Staff

Streambank Stabilization

Work involves riprap of channel bank meanders which are scoured and contain fine-textured, eroding soils. Work consists of rock placement, dozer shaping, and revegetation to grass, brush, or trees.

Sheet Erosion Control

Work involves revegetation and fertilization of scattered areas throughout the subwatersheds. In some areas, grading of rilled areas will be required to prepare a stable angle of repose for revegetation.

Gully Stabilization

Work consists of plugging, reshaping, and revegetating major gully formations in fine-textured eroding soils which are actively contributing sediment to streams during peak runoff.

Road and Trail Stabilization

Work involves drainage, revegetation, and abandonment, where practicable, of work access roads and trails in the subwatersheds. In some areas, improved stream crossings are needed such as log bridges, culverts, or hardstanding fords.

Afforestation and Reforestation

Many forest acres require planting to reach full stocking, and, conversely, a few overstocked stands need thinning. Also, some areas of steep, eroding slopes should be converted from range to forest for maximum production.

Forest Management Plans

To insure sound investments, specific forest land treatment needs should comply with objectives jointly agreed to in a forest management plan. For example, there is little value in reforestation if cattle graze uncontrolled.

Forest Fire Protection

Adequate wildfire protection must be assured to protect any land treatment investment. In most cases, these funds could best be used to upgrade local fire department equipment and training.

Technical Support Overhead

This work involves the preparation of detailed project plans, once land treatment funds are available, and provision for the necessary technical supervision during the life of the project installation.

Cost Basis

The following 1972 base unit cost for the major forest land treatment measures were used in the analysis which totals $992,018 for treatment of 142,108 forest acres in the 11 project watersheds:

Treatment	Units	Cost/Unit
Stream channel debris clearing	Miles	$ 500.00
Streambank stabilization	Miles	1000.00
Sheet erosion control	Acres	100.00
Gully stabilization	Acres	200.00
Road and trail stabilization	Acres	100.00
Reforestation, afforestation, thinning	Acres	50.00
Forest management plans	Acres	.10
Forest fire protection	Acres	.05
Technical support overhead	Subwatersheds	10 percent of treatment cost

RESOURCE CONSERVATION AND DEVELOPMENT PROJECTS

Project proposals in the Beartooth RC&D area of the Basin include many opportunities that deal with water and land resources. Several proposals have been made on ditch consolidation and irrigation system reorganization. Many of these can be developed as small group projects and a few would qualify as watershed projects. One of the more serious proposals deals with renovation of the principal spillway of Cooney Reservoir, improving the recreational facilities, and developing a reservoir management plan based on snow surveys. Development of more fishing access along Rock Creek and the Stillwater River is requested. Streambank riprap to stop erosion in critical locations is proposed for Rock Creek, Stillwater River, and Clarks Fork River. Reduction of sediment in the Clarks Fork River is proposed as a potential for enhancing the fishery.

Several areas with high water tables are noted for group drainage. Gravel pits can be renovated into fishing ponds with camping facilities. Several locations were noted for their recreational development potential, including overnight camping, vacation camping, dude ranches, historical trails development, and national parkway development of the Red Lodge to Cooke City highway over Beartooth Pass.

Water and sewer improvements were suggested for Bearcreek, Belfry, and Bridger. Sanitary land fills were suggested for the northern part of Carbon County and Belfry as potentials for improving the environment. Nearly every community suggested school consolidation, including addition of vocational education. Most project proposals deal directly or indirectly with attempts to improve the economic and social well-being of the area.

IX. COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

The implementation of an orderly and comprehensive program for development of the Basin's water and related land resources should be based on coordinated proposals of federal, state, and local agencies which will be accepted by the people in the Basin. The Governor's Office of Budget and Program Planning serves as the clearinghouse for all planning and programs supported by federal funding. The Water Resources Division of the Montana Department of Natural Resources and Conservation has the responsibility to coordinate the various federal, state, and local water development projects and to formulate a comprehensive, coordinated multiple-use state water plan. Within this framework, many of the problems and opportunities identified in this report can be corrected and developed under various on-going programs of USDA and other agencies. Individual project planning will be required in most instances and those project plans need to be coordinated into the overall Basin development instead of using an independent project development approach.

Data compiled in this report will be useful in later planning efforts which may incorporate the new Principles and Standards for water and related land resource planning. Under those standards, public involvement and analysis of alternative plans for resource development are heavily stressed. Beneficial and adverse effects to all segments of society will be evaluated to determine the desirability of resource development proposals.

Under the Montana State Water Plan, the Water Resources Division of the Montana Department of Natural Resources and Conservation is responsible for public involvement and coordination of various agency projects and programs for water development. It is the policy of the Montana Water Plan to bring all interested parties into the planning process early enough for them to have an effect on the results of the study.

ALTERNATIVE APPROACHES

Opportunities for development identified in chapter VIII could be developed by means other than USDA programs. These alternatives include individual and group private development, state-planned or -subsidized projects, small irrigation projects under the Bureau of Reclamation or the Bureau of Indian Affairs, flood prevention under the Corps of Engineers, and flood plain control under the state and local government action. Alternatives for PL-566 project developments include the following:

Fly Creek Watershed drainage could be accomplished by private groups or under Bureau of Reclamation's small project program.

Blue Creek flood prevention could be provided through strict flood plain zoning and relocation of some existing homes.

Pryor Creek irrigation and recreation could be developed under small watershed programs of either Bureau of Reclamation or Bureau of Indian Affairs.

Red Lodge-Rock Creek water exchange and irrigation reorganization might be achieved through Water Use Act procedures under Montana Department of Natural Resources and Conservation.

Two Leggins irrigation and drainage could be improved under the small watershed program of the Bureau of Reclamation.

Tullock Creek irrigation storage might be built through Montana Department of Natural Resources and Conservation or Bureau of Reclamation programs.

Upper Little Bighorn diversion and irrigation could be installed by a private group or under leadership from the Bureau of Indian Affairs.

Lodge Grass flood prevention could be provided by local government or Corps of Engineers construction of a flood training dike.

Lower Little Bighorn pump-lift irrigation could be installed by private individuals or groups.

Conservation land treatment measures on private lands could be applied by landowners without federal technical or financial assistance.

PROJECTS OR MEASURES NEEDED BUT NOT PRESENTLY AVAILABLE THROUGH USDA PROGRAMS

It is difficult to determine what needs should be satisfied first in a Basin. In spite of this, there are some areas which are not covered adequately by USDA programs and which need help. These include: management of nonagricultural land use and land development, flood plain management, better measurement of water use, mineral-related water, fossil-fuel factors, environmental quality, and water rights related to the Yellowstone River Compact.

Bureau of Reclamation project proposals in Montana include the following:

The Hardin Unit would use Big Horn River water to irrigate about 47,500 acres now mostly in dryland crops and mostly within the Crow Indian Reservation.

The Little Bighorn and Dunmore Units would use Little Bighorn River water to irrigate about 18,200 acres--all within the Indian Reservation.

There are several other deferred Bureau project proposals in the Basin. Anyone desiring more detailed information should contact the Regional Director for the Bureau of Reclamation at Billings, Montana.

At present, the local share of the costs are borne by the project sponsors while the greatest share of the recreation and fish and wildlife benefits are enjoyed by people living outside the project area. More of these costs need to be borne by people receiving the benefits. Similar needs apply to water quality enhancement and environmental protection.

There is a need for greater funding of flood plain studies and financing nonstructural flood plain management measures as an alternative to structural control measures.

OTHER AGENCY PROGRAMS AND THEIR IMPACTS

When all interests are brought together in a coordinated water planning effort, in addition to USDA at least the following departments and agencies should be involved: U. S. Department of the Interior, U. S. Geological Survey, Bureau of Indian Affairs, Bureau of Sport Fisheries and Wildlife, Bureau of Land Management, Bureau of Reclamation, Bureau of Outdoor Recreation; Department of the Army, Corps of Engineers; Environmental Protection Agency; Missouri River Basin Commission; Old West Regional Commission; Montana Department of Natural Resources and Conservation; Montana Department of State Lands; Montana Department of Fish and Game; Montana Department of Health and Environmental Sciences; Montana Department of Intergovernmental Relations, Planning Division.

Any program for the public land which affects grazing use will affect agriculture in the Basin. A reduction in forage taken from public land would require either a reduction in animal units in the Basin or an increase in forage produced on private land. An increase in forage taken from the public land might reduce grazing pressure on private rangeland, but would probably encourage an increase of animal units in the Basin. This would also require increased forage production on private land, especially for winter feed.

Conversely, changes in the management and use of private forage-producing land can result in both positive and negative impacts on the public range. The timing as well as the amount of grazing is critical to the management of all rangeland. Therefore, any changes in grazing policies for the public land need to be keyed to programs to improve the management of all forage-producing lands. USDA agencies can, and should, be actively involved in the development and coordination of such programs.

Because the next planning effort in the Basin is expected to use some form of Principles and Standards planning procedures, the number of agencies and p' · grams directly involved in the planning process can be anticipate to be much greater than those considered in this Type 4 study. It is probable that all planned actions with a significant environmenta., social, or economic impact will be planned jointly and coordinated with other agencies.

NEW PROGRAMS OR CRITERIA TO MEET NEEDS

Application of the Principles and Standards planning procedures to this study effort would significantly increase the need for inter-agency and public coordination in planning within the Basin. Application of the Principles and Standards would also have necessitated greater consideration of programs and alternatives outside the general responsibility of USDA. Because of the position of the Basin with respect to the urban center of Billings, the downstream coal fields of the Fort Union region, and the massive recreational complex of Yellowstone Park, this broader consideration may have helped make the study a more useful element in the State Water Plan.

POTENTIAL UTILIZATION BEYOND NEEDS OF BASIN--EXPORT

In the case of the Bighorn and Clarks Fork Rivers in Montana, downstream (and upstream) needs are of critical importance. At this date it appears that there is great likelihood that large-scale development of coal will occur downstream from the study Basin. The likely increased demand for industrial water may negate any plans for large-scale use of water within the Basin. On the other hand, this demand may necessitate planning for storage to satisfy this need. Another consideration, especially for in-stream uses of the water, involves the possible diversion of water from these streams before it enters the borders of Montana. If this should occur, it would probably be as a result of Wyoming's industrial demands.

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