UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

MISSOURI RIVER BASIN

LAND INVENTORY OF THE PUBLIC DOMAIN

A SUMMARY -1972

For Administrative Use Only

Land Resources Inventory
of the public domain in the

MISSOURI RIVER BASIN

A Missouri River Basin Investigation

DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

DENVER, COLORADO

1972

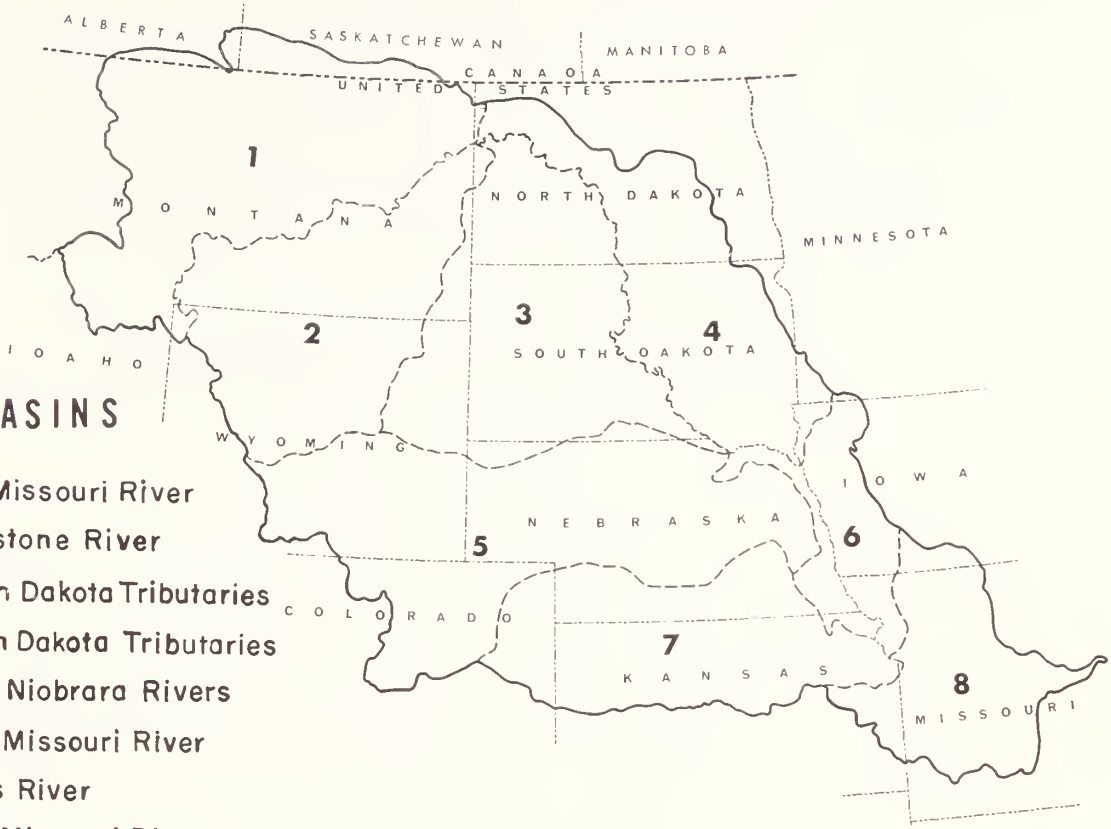
THIS REPORT WAS PREPARED PURSUANT TO THE FLOOD CONTROL ACT OF 1944. PUBLICATIONS OF THE FINDINGS AND RECOMMENDATIONS HEREIN SHOULD NOT BE CONSTRUED AS REPRESENTING EITHER THE APPROVAL OR DISAPPROVAL OF THE SECRETARY OF THE INTERIOR. THE PURPOSE OF THIS REPORT IS TO PROVIDE FURTHER INFORMATION AND ALTERNATIVES FOR FURTHER CONSIDERATION BY THE BUREAU OF LAND MANAGEMENT, THE SECRETARY OF THE INTERIOR, AND OTHER FEDERAL AGENCIES.

PRESENT STATUS OF BUREAU OF LAND MANAGEMENT STUDIES IN THE MISSOURI RIVER BASIN (LAND CLASSIFICATION)

1972

JLK

MAJOR SUBBASINS OF THE MISSOURI RIVER SYSTEM



SUBBASINS

1 Upper Missouri River
2 Yellowstone River
3 Western Dakota Tributaries
4 Eastern Dakota Tributaries
5 Platte-Niobrara Rivers
6 Middle Missouri River
7 Kansas River
8 Lower Missouri River

As the nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources".

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States - now and in the future.

FOREWORD

This report presents a broad natural resources inventory of the 20 million acres of public domain in the Missouri River Basin. It summarizes the findings of resources investigations extending from 1946 to 1972. During those years, Bureau of Land Management employees working as part of the Missouri River Basin Project of the Department of the Interior, examined the land in the field, compiled their data, and published the results in a series of 14 preliminary, and 35 detailed land inventory reports. Each report covered one of the tributary hydrologic areas in the Missouri River system, as shown on the preceding map. Preparation of the Summary Report which follows was approved by the Interior Missouri Basin Field Committee as the best way to assemble all the data into one volume, and to update the earlier information.

The basic authority for this series of reports goes back to the Flood Control Act of 1944, under which Department of the Interior responsibilities have been carried out by its Secretary, through the Bureau of Reclamation as construction agency. The Department, through the latter agency, financed Bureau of Land Management participation in the Missouri River Basin Project by transfer of funds through June 30, 1971; thereafter, funding was by direct Bureau of Land Management appropriation. The name, "Missouri River Basin Project" was changed by Public Law 91-576, approved December 24, 1970, to "Pick-Sloan Missouri Basin Program."

The public lands resource data is presented in a format intended to make it of maximum utility to planners, both inside and outside the Bureau of Land Management. The style of presentation is to show natural resource data as an overlay to land status maps. The broad locations of potential resource availability, feasible prospects for resource development, problem areas, and areas requiring extra management care, immediately stand out. A short narrative describes the significance of data portrayed by each resource overlay map. The overlay maps have been supplemented by statistical tables and graphics, to present large amounts of information in consolidated form.

The only breakdown in land status is public domain vs. lands in non-public ownership. The public lands are those administered by the Bureau of Land Management; they do not include National Forests or other Federally administered areas. The only withdrawn lands inventoried are those so designated under Bureau of Land Management internal programs. The Public Land Inventory on page 103 lists the subbasins with public domain acreages current at the time of the field examination.

Publication of this summary report for public lands in the Missouri Basin occurs close to the time of appearance of the Type I Comprehensive Framework Study Report for the basin. Reliance was placed on the Type I Report for resource data appearing as overlay information on five of the status foldout maps. The maps so constructed include those for Ground Water, Streamflow Depletions, Sedimentation, Land Resource Regions, and Coal Resources. Various other resource data from the Type I Study appears in this report, all of it generated originally by one of the participating agencies in the Type I work.

In the report that follows, major river subbasins were selected as the basic unit for aggregation of data, since that system was indicated by the nationwide Type I Framework Studies as the format of the future for the broadgauge resource planning. Four of the eight major subbasins in the Missouri River Basin contain large acreages of public domain. These are the Upper Missouri, Yellowstone, Western Dakota Tributaries, and Platte-Niobrara Subbasins. Overlay resource maps and detailed public lands data are limited to the four subbasins named, each of the four comprising a major section of the report.

Data portrayed by the resource maps, tables, and narrative in the four major subbasin sections is combined into a statistical summary, wherever possible, and presented in the opening section of the report, entitled "Public Lands Summary." Data which proved to be essentially similar for each subbasin appears in the Summary section only, to avoid repetition.

Four major subbasins of the Missouri Basin do not contain significant amounts of public land; they are the Eastern Dakota Tributaries, the Kansas River, the Middle Missouri River Tributaries, and the Lower Missouri River Tributaries. Throughout the four latter subbasins there are minor public land holdings aggregating less than 5,000 acres. These scattered, isolated tracts are of no outstanding public value in most cases, save a few which may have recreational potential, or some other special attribute. Because of the relative unimportance of these lands in the total resources picture, and the likelihood of their ultimate disposition to other than Federal administration, they are not identified or discussed in this report.

The Great Divide Basin of Wyoming has been discussed as part of the Missouri River Basin in some resources studies, and as part of the Pacific Southwest Basin in others. One reason for differing approaches is the room left for disagreement by two possible locations

of the true Continental Divide. In this report, as well as the earlier North Platte River Land Inventory Report, the Great Divide Basin is discussed as part of the Missouri River system. Inclusion of the Great Divide area adds about 1,680,000 acres to the total river basin, most of it public domain.

The field inventory and analysis of public lands data in this report incorporates the work of more than 100 field men, employed as permanent and seasonal land examiners during the years 1946-1971. The assembling, updating and writing of the report were done during 1971 by Range Conservationists James Chappell, Jr., Owen D. Dutt, Raymond C. Sherfey, and Supervisory Range Conservationist Richard D. Burr. The maps and text graphs were prepared by draftsman John L. Kovacs. Manuscript layout and preparation were the work of secretary Betty E. Easton. Overall direction was the responsibility of Eugene L. Schmidt, Chief, Office of River Basin Studies. Advice and assistance were provided by State and District Offices of the Bureau of Land Management throughout the Missouri River Basin. The cover, depicting the Lewis and Clark expedition on the Missouri River, Montana, all sketches and the map designs were by Richard D. Burr.

TABLE OF CONTENTS

The field inventory and analysis of public domain lands data in this report incorporates the work of more than 100 field men.

INTRODUCTION

The public domain is administered in trust for the people of the United States by the Bureau of Land Management within the framework of broad policies set by Congress through enactment of various public land laws. These laws were written with the general intent, among other things, to stabilize the western livestock industry, conserve soil and other natural resources, encourage fishing, hunting, and other recreation, and to make land available for urban and industrial development as needed. The public lands are managed by a decentralized organization, with major responsibility delegated to the field. Primary management is vested in the respective State Directors. In the Missouri Basin these officials are located in Billings, Montana, Cheyenne, Wyoming, and Denver, Colorado. The Montana State Director is responsible also for public lands in North Dakota, South Dakota, and Minnesota. The State Director at Cheyenne is responsible for Wyoming, Nebraska, and Kansas. The Colorado State Director is responsible for lands only in that State. On-the-ground management is performed by District Managers and their staffs; there are 11 District Offices with management responsibilities in the Missouri Basin. The 20 million acres of public land in the Missouri Basin comprise 6 percent of its total land area.

The traditional concept of the public lands as primarily a grazing resource has been vastly modified in recent years. In the Missouri Basin the public lands are grazed by about 1,200,000 cattle, and twice that number of sheep, during the annual periods of proper use. Over 190,000 big game animals graze the lands, utilizing forage reserved for that purpose. From 10 to 20 million board feet of saw timber are cut annually. There are 1,695,000 Visitor Days of recreational use annually. Included in this are sportsmen who harvest 17,000 antelope, 27,000 deer, 53,000 upland game birds, and substantial numbers of other game and fish.

Mineral production from the public lands is large, particularly oil and gas. The receipts derived from the government's one-eighth royalty on oil and gas production, plus bid bonuses and other fees, are returned 37½ percent to the State of origin, 52½ percent to the Federal Reclamation Fund, and 10 percent to the General Treasury. Payments to the Missouri Basin States average approximately $22 million annually.

The watersheds of the public lands contribute importantly to mainstem flows; these vast acreages are also becoming more and more recognized for their contribution to the "open space" needs of

the Nation. Dollar values per acre have increased rapidly in recent years, making the public domain a resource of great economic significance to the country.

Where important Federal programs such as Reclamation Projects are established on public domain, the government interest is protected by withdrawal of the land from appropriation. Withdrawal is accomplished under authority having its origin in Congressional action, or the implied powers of the President. Through the years, active Federal programs have resulted in sizeable withdrawals, compensated in part by restorations as lands are no longer needed. The balance of withdrawals over restorations for major agency activities in the Missouri River Basin is as follows:

Bureau of Sports Fisheries and Wildlife	800,000 acres
Bureau of Reclamation	630,000 acres
Corps of Engineers	516,000 acres
Power Purposes	135,000 acres

HISTORICAL REVIEW OF THE PUBLIC LAND LAWS

The public lands of the Missouri River Basin were originally acquired by the United States as part of the Louisiana Purchase in 1803. These lands were placed under jurisdiction of the General Land Office when it came into existence on April 25, 1812. Since that time, various public land laws have been a major influence in settlement and development of the river basin.

Among the early land laws was the Homestead Act of 1862, which made it possible for settlers to acquire farms of 160 acres for a nominal fee. To become a full owner, the entryman was required to live on the land and cultivate a specified percentage for 5 years.

As settlement of the Missouri River Basin reached the more arid west, it became evident that a quarter-section of land was not always an adequate farm unit. However, by taking advantage of other related acts, the settlers could increase their holdings, thus creating a more economically effective enterprise.

One such law was the Timber Culture Act of 1873. Until its repeal in 1891, this act granted tracts of public land to settlers who planted and cared for trees on the plains. Another, the Desert Land Act of 1877, authorized disposition of 640-acre tracts of arid public lands at $1.25 per acre to entrymen upon proof of reclamation by irrigation. In 1891 the area was reduced to 320 acres. The Timber and Stone Act of 1878 provided extra land by authorizing the sale of public lands especially vaulable for either timber or stone, and otherwise unfit for cultivation.

At the turn of the century, Congress continued to stimulate settlement and development in the west by passage of legislation rewarding persons willing to reclaim the land.

The Reclamation Act of 1902 authorized homesteading on as much as 160 acres of arid public lands, provided these lands were reclaimed through irrigation, and each homesteader paid the cost of water. The Forest Homestead Act of 1906 permitted homesteading of 160-acre tracts in National Forests. In 1909, the Enlarged Homestead Act was passed, making it possible to file on a 320-acre dry land homestead. In 1912, the residence requirement on homesteads was shortened to 3 years, making it easier to prove up. In 1916, the Stock Raising Homestead Act was passed, providing for 640-acre homesteads on land that had been classified for stock raising.

The railroads carried settlers westward, with their windmills, barbed wire, and farm machinery, and on the return trip transported the farmers' meat and grain to eastern markets. Railroad companies actively promoted settlement along their routes, offering greatly reduced transportation fares, easy terms on railroad land, free seed, and free temporary housing for the settler at his destination.

Beginning in 1862, Congress passed legislation granting public lands to railroad companies for the purpose of rights-of-way, alternate sections to a normal depth of 20 miles on each side of the line, plus additional lands for stations, shops, and other property. The railroad companies sold some of these lands to settlers as a means of financing construction, and developing future railroad business. Other settlers, following the lifeline of the railroad, migrated to alternate sections of public land along the rights-of-way, purchasing tracts up to 80 acres under a special law designed for the purpose.

The farmers later struggled against the economic power of the railroads, but the fact remained that rails were essential to development of the land and utilization of its resources.

During the 1930's, the hopes of settlers dwindled as drought mounted and homesteading opportunities diminished. The Nation was running out of public lands suitable for homesteading and capable of supporting a family.

In an effort to conserve the remaining public lands, which by then were badly abused, Congress passed the Taylor Grazing Act of 1934. This act was among the most comprehensive of the conservation programs ever attempted for the resources of the Nation. Its primary purpose was to reduce injury to the public rangelands resulting from overgrazing, soil deterioration, and other misuse of the natural resources of vast western areas. Under Executive Orders of Withdrawal, unreserved and unappropriated public lands, chiefly in ten western States, were closed to unrestricted settlement and use. Certain restrictions were placed on these lands before they could be transferred to private ownership, but they remained open for location of mining claims and for public hunting, fishing, camping, and other outdoor uses. This act also authorized the organization of Grazing Districts, under a newly established Division of Grazing, for regulation of use. Grazing permits were issued within each District, and isolated tracts not within Districts were also leasable under the Taylor Grazing Act.

The Bankhead-Jones Farm Tenancy Act of 1937 authorized Federal purchase of privately owned farmlands. Known as Land Utilization (L.U.) projects, these marginal lands produced insufficient income to support

the farm families trying to live there. Owner and family were re-located elsewhere, and the marginal lands were retired from cultivation. Laws which govern the use and disposition of the Bankhead-Jones lands differ from those applicable to the other public lands.

In 1946, the Bureau of Land Management was created within the Department of the Interior. The administration and responsibilities of the General Land Office (founded in 1812) and the Grazing Service (founded in 1934) are now under its jurisdiction.

Since 1964, the public lands have come within the scope of a Classification Program on a national scale for designation to their best form of management under a multiple-use concept. Following public hearings and other fact-finding actions, most of the public lands have now received a form-of-use designation under the Multiple Use Act of 1964.

In addition to laws authorizing surface use, there were also mineral exploration laws which played an essential role in the development of the Missouri Basin. The Mining Act of 1866 declared all mineral lands of the public domain free and open to exploration and occupation. The General Mining Law of 1872 identified mineral lands as a distinct class of public lands, subject to exploration, occupation, and purchase under stipulated conditions. The act protected private interests in mining claims, and provided for issuance of title.

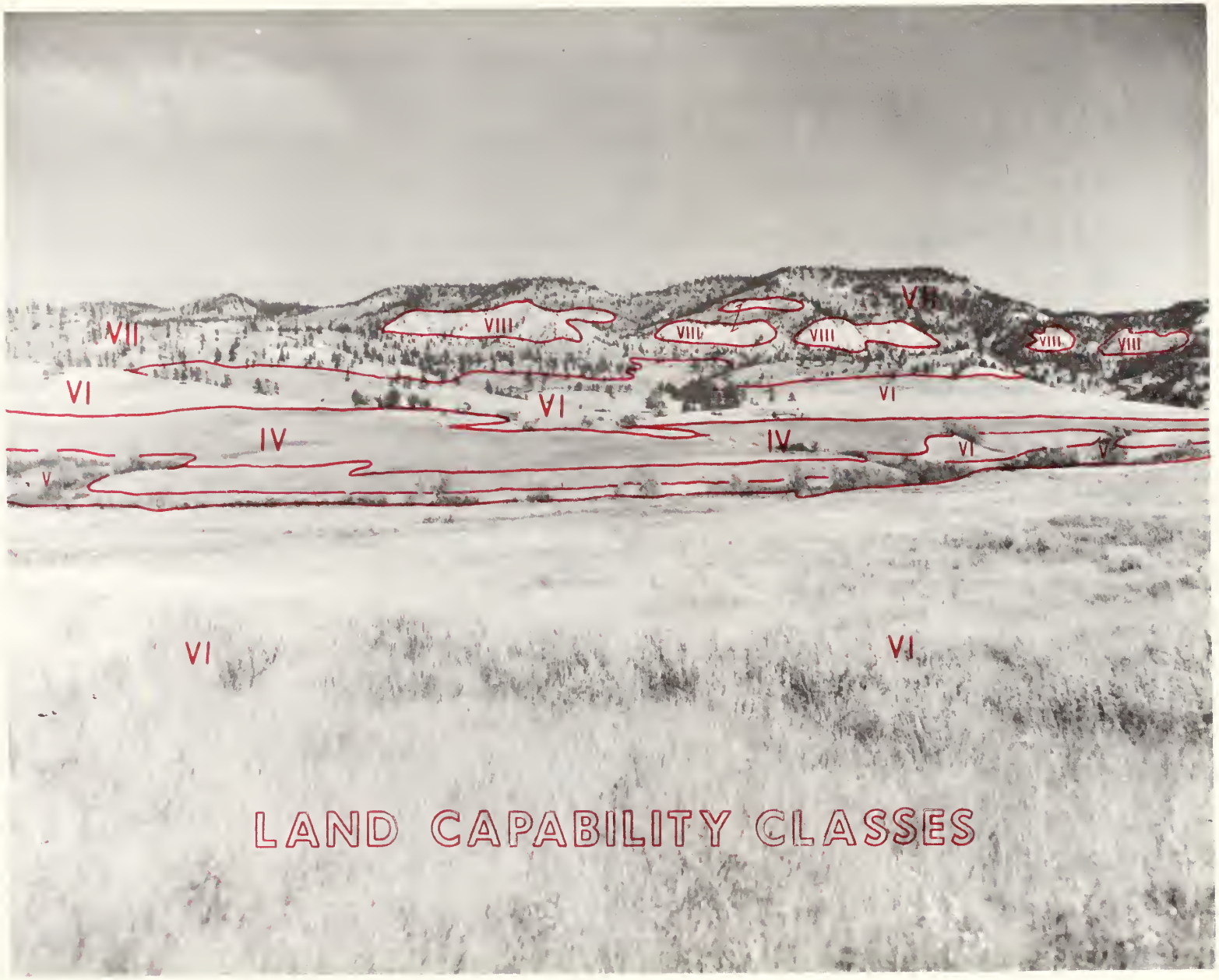
Another law of great impact was the Mineral Leasing Act of 1920, authorizing leasing of public domain for private extraction of oil, gas, coal, phosphate, sodium, and other minerals. The act assured orderly prospecting and exploration, and opportunity for resource conservation. These and other mineral development laws aided in establishment of the natural resources base which accounts for much of the industrial leadership of the Nation.

CHARACTERISTICS OF THE PUBLIC DOMAIN SUMMARIZED

Land Capabilities and Classes

Land capabilities express the limits for long-range, safe, economic land use. Government agencies commonly group capabilities into eight broad classes determined by the soil factors of depth, texture, fertility, slope and susceptibility to erosion. These factors are balanced against long-term production without soil damage.

Classes I - IV	All lands can be cultivated. Soils deep to fairly deep, level, and fertile. Class I soils produce any crop within limits of local climate; Class II require moderate precaution to guard against soil erosion, and maintain fertility. The higher the class number, the greater the management problems and degree of precaution needed.
Class V	This class falls between major groups that can be cultivated, and those which must remain in permanent plant cover. These soils may be deep and nearly level, but cannot be cultivated due to flooding, rockiness, etc.
Class VI	Restricted to permanent, native plant cover. Finds its highest form of use in production of livestock forage and forage for wildlife, and watershed protection. For these uses, no restrictions other than good range management practices are needed.
Class VII	Includes soils with increasing use hazards resulting from such factors as increased slope, shallow profile and unstable texture. Restricted to lighter grazing, and greater care in management than Class VI is needed.
Class VIII	At the extreme of land capability. Includes marshes, steep rugged mountains, and barren badlands. Values for wildlife are often high, as are watershed protection and recreational use.


VII
VIII
VIII
VIII
VII
VIII
VI
VI
VI
IV
IV
V
VI
V
VI
VI
LAND CAPABILITY CLASSES

In the Missouri River Basin, 61 percent of the public domain lands have a Class VII land capability. This land is principally suited for grazing by livestock, with care taken in management to guard against soil erosion and range deterioration. Thirty-one percent of the public land is in land Class VI, which is sufficiently stable to support livestock grazing or timber production without serious restriction. However, this land class should remain in permanent native plant cover. Four percent of the public domain is Class VIII, where use is restricted to carefully managed grazing, wildlife habitat, recreation, and watershed protection; the native plant cover must remain intact. The remaining 4 percent of the area is predominantly Class V, which cannot be cultivated. Land capability Classes I-IV are negligible.

Land Capability designations by acreage and percent are given in the accompanying spread sheet for each of the four subbasins containing major amounts of public domain.

Range Condition

A combination of climate and range management practices largely determine range condition; the two work together to produce the generally favorable range condition on public lands in the Missouri River Basin.

The most sensitive and accurate indicator of range condition is total plant cover. The original vegetative covering for each range site is first determined by studying protected or well-managed range lands. Current condition is then evaluated by comparing present vegetation with that originally occupying the site. Range condition is expressed as follows:

Excellent	75 to 100% of the original plant cover
Good	50 to 75% of the original plant cover
Fair	25 to 50% of the original plant cover
Poor	0 to 25% of the original plant cover.

A range site in "Excellent" condition has, essentially, its original plant cover. The next lower class, "Good," represents small changes in which some percentage of the original plants have been replaced. Lower condition groups, "Fair" and "Poor," represent greater departures from the original plant cover.

Typical "Excellent" and "Good" rangelands have more of the desirable grasses and forbs, greater forage production, and more soil cover of mulch and litter. These factors, however, vary with climate and range type. Rangeland in "Fair" and "Poor" condition has less forage production, and many of the plants are unpalatable. It is important to note that condition is not directly related to forage production. Badlands can be in "Excellent" condition, but the total forage production is low.

On "Fair" rangeland, the plants may be inferior to those of the original plant cover, but still furnish forage at a season of critical need. Therefore, areas in "Fair" condition may be highly useful in management of the range.

"Poor" condition is the lowest class. The original plant cover may be partly or completely replaced by other, often undesirable, vegetation.

Field examination, as summarized below, disclosed that 86 percent of the public domain in the Missouri River Basin is in "Good" or "Excellent" condition. Only 14 percent has changed substantially from the original plant cover species.

Excellent Condition	28 percent	5,706,000 acres
Good Condition	58 percent	11,682,000 acres
Fair Condition	11 percent	2,286,000 acres
Poor Condition	3 percent	521,000 acres

A complete summary of Range Conditions in the four subbasins containing major amounts of public domain is present in the accompanying spread sheet.

Range Vegetation

The Bureau of Land Management maps rangelands according to general vegetative aspect, as seen by a ground level observer at middle visual distance. There are 18 standard range types, based on dominant plants. Range types are identified by a number and general name, such as 1-Grassland, 2-Meadow, 3-Perennial Forbs, 4-Sagebrush, etc. A variety of terminology combinations may be used, such as grassland with conspicuous sagebrush, coniferous timber with mountain shrub understory, etc.

Brushlands and perennial grasslands dominate the vegetative aspect of public lands in the Missouri River Basin. The brush species, mostly big sagebrush and saltbush, dominate 43 percent of the public range; perennial grasses dominate 42 percent. The timber aspect predominates on 12 percent of the land. The term Waste or Barren is applied to 3 percent.

The brush species are moderately palatable, and form an important source of winter livestock feed. They are a major, year-long grazing mainstay for wildlife, especially antelope. The brushy plants also afford highly important cover for the wild animal and bird populations.

The most common perennial grasses are western wheatgrass (bluestem wheatgrass), bearded bluebunch wheatgrass, blue grama, needleandthread, and Idaho fescue. All of these perennial grasses are palatable to livestock, and have root systems which are effective in soil retention.

The perennial and annual weed species are widely distributed, but the plants seldom form the dominant vegetative aspect. Many of the weeds are palatable; they often form the major forage source, especially on sheep ranges.

Wastelands usually receive that classification because they have only slight value, or no value at all for grazing by domestic livestock. They may be so heavily vegetated by timber or brush that stock cannot use them, or they may be inaccessible. Barren lands are those supporting no natural vegetation, such as sand dunes and lava flows. Objection has been raised by some writers to the terms Waste, and Barren, because of the semantic connotation that lands so described have no value. These lands have, in fact, definite and important values such as for wildlife cover and feeding grounds, watersheds, recreation, and open space. In certain classifications the questionable terms have been replaced by the word Wildland, and readers who wish to do so may regard them as interchangeable in this report. The accompanying spread sheet and bar graph summarize the vegetative characteristics of public lands in the Missouri River Basin.

Soil Erosion

Most of the erosion taking place on public lands of the Missouri River Basin is a natural geologic process. While continuing geologic erosion is normal, it can still create serious problems in land management and water quality considerations.

Distinct from geological erosion is a process called "accelerated" erosion. Accelerated erosion results in loss of soil at a more rapid rate than the normal geological variety; among the causes are fire, logging, road construction, overgrazing, or other activity which removes plant cover, permitting water and wind to carry away the soil.

The relative severity of accelerated erosion is described by class numbers as follows:

Class 1 None to slight. Almost undetectable.

Class 2 Slight to moderate. In mature soils, 3/4 of the "A" horizon gone; in structureless soils, top 3 to 4 inches gone; rills wide-spread; small gullies common.

Class 3 Moderate to severe. In mature soils, the entire "A" horizon gone; in structureless soils, top 5 inches gone; gullies large and deep.

Class 4 Severe. So severe as to change the landscape; many large, deep gullies.

Field examination disclosed that damage to Missouri Basin public lands from accelerated erosion has been nominal. Sixty-four percent of the lands were evaluated in Class 1 for water erosion. This means that damage was none to slight on 2 out of every 3 acres. Water erosion produced Class 2, slight to moderate damage, on 29 percent of the land. Class 3 water erosion, moderate to severe, occurred on 7 percent of the land.

Wind erosion was found to be negligible when averaged basinwide, although localized areas of damage can and do occur.

The relative freedom of public lands from accelerated erosion is attributed mainly to 1) the predominantly permanent vegetative cover, and 2) management which assures that use of the land will be limited to its capability class.

The accompanying spread sheet figures reflect sheet and gully erosion caused by water only; wind erosion was not included because the losses become so statistically small in a basinwide tabulation.

CHARACTERISTICS OF PUBLIC DOMAIN SUMMARIZED,
MISSOURI RIVER BASIN

Soil Erosion

Most of the erosion taking place on public lands of the Missouri River Basin is a natural geologic process. While continuing geologic erosion is normal, it can still create serious problems in land management and water quality considerations.

Distinct from geological erosion is a process called "accelerated" erosion. Accelerated erosion results in loss of soil at a more rapid rate than the normal geological variety; among the causes are fire, logging, road construction, overgrazing, or other activity which removes plant cover, permitting water and wind to carry away the soil.

The relative severity of accelerated erosion is described by class numbers as follows:

Class 1 None to slight. Almost undetectable.

Class 2 Slight to moderate. In mature soils, 3/4 of the "A" horizon gone; in structureless soils, top 3 to 4 inches gone; rills wide-spread; small gullies common.

Class 3 Moderate to severe. In mature soils, the entire "A" horizon gone; in structureless soils, top 5 inches gone; gullies large and deep.

Class 4 Severe. So severe as to change the landscape; many large, deep gullies.

Field examination disclosed that damage to Missouri Basin public lands from accelerated erosion has been nominal. Sixty-four percent of the lands were evaluated in Class 1 for water erosion. This means that damage was none to slight on 2 out of every 3 acres. Water erosion produced Class 2, slight to moderate damage, on 29 percent of the land. Class 3 water erosion, moderate to severe, occurred on 7 percent of the land.

Wind erosion was found to be negligible when averaged basinwide, although localized areas of damage can and do occur.

The relative freedom of public lands from accelerated erosion is attributed mainly to 1) the predominantly permanent vegetative cover, and 2) management which assures that use of the land will be limited to its capability class.

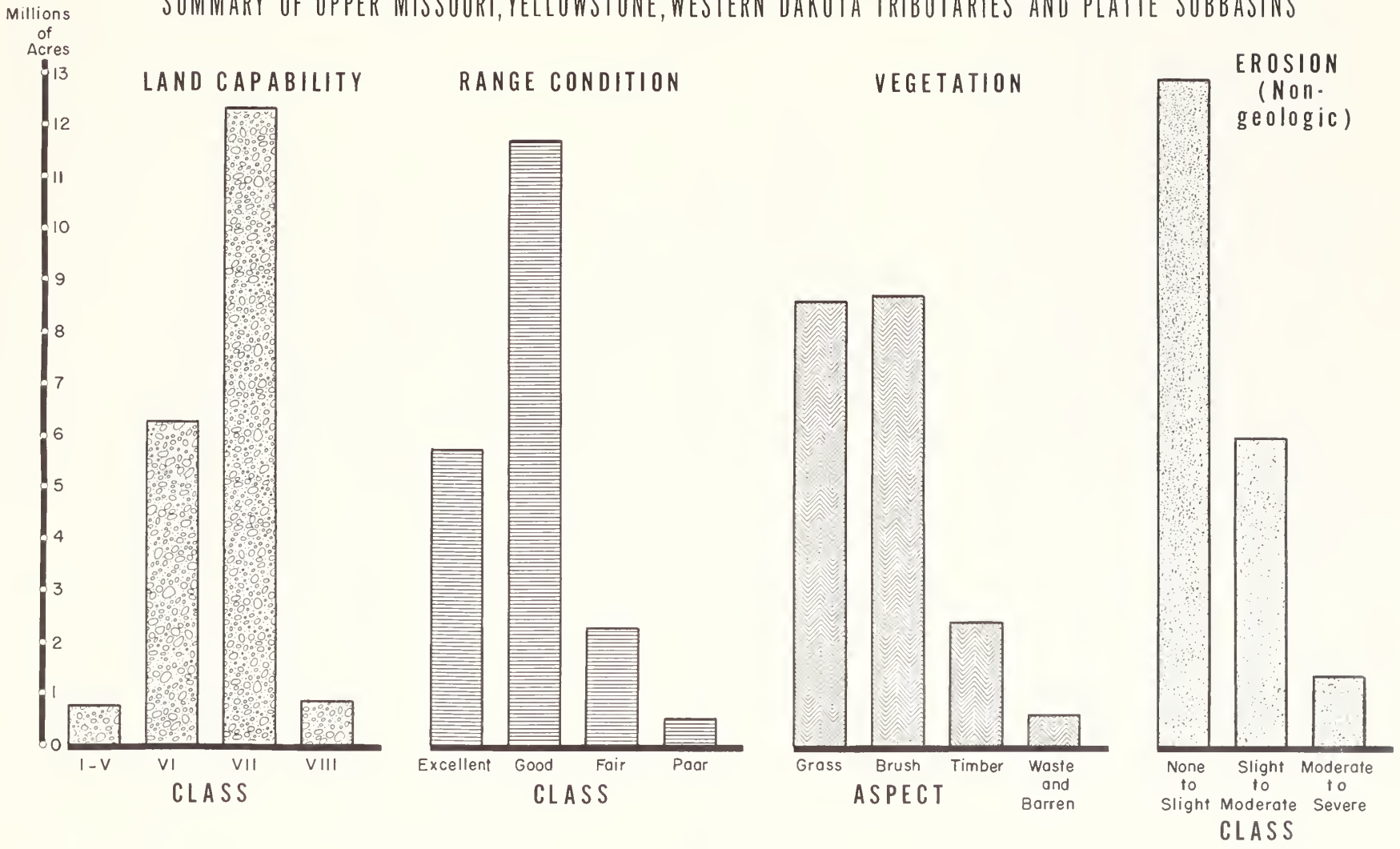
The accompanying spread sheet figures reflect sheet and gully erosion caused by water only; wind erosion was not included because the losses become so statistically small in a basinwide tabulation.

CHARACTERISTICS OF PUBLIC DOMAIN SUMMARIZED,
MISSOURI RIVER BASIN

SUBBASIN	Total Public Land	LAND CAPABILITY				RANGE CONDITION				VEGETATION				EROSION		
		Class I-V	Class VI	Class VII	Class VIII	Excellent	Good	Fair	Poor	Grass	Brush	Timber	Waste & Barren	Class 1	Class 2	Class 3
	--Thousand Acres--	-------Thousand Acres--------				--------Thousand Acres--------				---------Thousand Acres---------				----Thousand Acres---		
Upper Missouri River	5,608	56 (1%)	1,458 (26%)	3,758 (67%)	336 (6%)	1,178 (21%)	3,757 (67%)	617 (11%)	56 (1%)	3,757 (67%)	1,178 (21%)	505 (9%)	168 (3%)	4,487 (80%)	1,009 (18%)	112 (2%)
Yellowstone River	8,043	161 (2%)	1,528 (19%)	6,032 (75%)	322 (4%)	3,056 (38%)	3,620 (45%)	1,126 (14%)	241 (3%)	3,137 (39%)	4,504 (56%)	241 (3%)	161 (2%)	5,711 (71%)	1,850 (23%)	482 (6%)
Western Dakota Tributaries	1,275	38 (3%)	586 (46%)	638 (50%)	13 (1%)	102 (8%)	880 (69%)	280 (22%)	13 (1%)	599 (47%)	599 (47%)	64 (5%)	13 (1%)	803 (63%)	357 (28%)	115 (9%)
Platte-Niobrara	5,269	527 (10%)	2,687 (51%)	1,897 (36%)	158 (3%)	1,370 (26%)	3,425 (65%)	263 (5%)	211 (4%)	1,054 (20%)	2,371 (45%)	1,581 (30%)	263 (5%)	1,897 (36%)	2,740 (52%)	632 (12%)
TOTAL	20,195	782 (4%)	6,259 (31%)	12,325 (61%)	829 (4%)	5,706 (28%)	11,682 (58%)	2,286 (11%)	521 (3%)	8,547 (42%)	8,652 (43%)	2,391 (12%)	605 (3%)	12,898 (64%)	5,956 (29%)	1,341 (7%)

CHARACTERISTICS OF PUBLIC DOMAIN

SUMMARY OF UPPER MISSOURI, YELLOWSTONE, WESTERN DAKOTA TRIBUTARIES AND PLATTE SUBBASINS



Watershed Relationships

Public lands in the Missouri Basin are generally associated with low precipitation and low runoff. Almost 13 million acres, or 65 percent of the land, is in the 0 to 1 inch runoff zone. Total contribution to mainstem streamflow is still important, however, due to the vast acreages. To conserve and make best use of the available water supply, impoundments and land treatment measures are utilized. These practices produce a modest depletion of 45,030 acre feet annually in the Basin, but the net result is beneficial through better livestock watering facilities, improved ability to achieve desired range management goals, and reduction in soil erosion. The following tables provide a Basinwide summary of watershed zones, streamflow depletions, and the status of land treatment and management practices on the public domain.

SURFACE RUNOFF

Subbasin	Acres of Public Domain by Zone		
	0 - 1 inch	1.1 - 4 inches	4.1 - 20 inches
Upper Missouri	4,823,000	729,000	56,000
Yellowstone	3,378,000	2,654,000	2,011,000
Western Dakota Tributaries	616,000	659,000	--
Platte-Niobrara	4,177,000	672,000	420,000
TOTAL	12,994,000	4,714,000	2,487,000

ANNUAL STREAMFLOW DEPLETIONS

Subbasin	BLM Depletion (acre ft)	BLM Relative Depletion In Subbasin (%)	All Depletions In Subbasin (acre ft)
Upper Missouri	20,520	4.0	567,400
Yellowstone	16,345	5.0	344,800
Western Dakota Tributaries	3,425	1.3	264,000
Platte-Niobrara	4,740	2.8	168,600
TOTAL	45,030	3.3 (average over entire basin)	1,344,800

LAND TREATMENT AND MANAGEMENT PRACTICES

Subbasin	BLM Total Only (acres)	Land Adequately Managed Or Treated (acres)	Needs Management Only (acres)	Needs Vegetative Or Mechanical Treatment (acres)
Upper Missouri				
Acres	5,608,000	2,564,000	1,971,000	1,073,000
%		(46%)	(35%)	(19%)
Yellowstone				
Acres	8,043,000	4,507,000	2,478,000	1,058,000
%		(56%)	(31%)	(13%)
Western Dakota Tributaries				
Acres	1,275,000	629,000	409,000	237,000
%		(49%)	(32%)	(19%)
Platte-Niobrara				
Acres	5,269,000	2,000,000	1,000,000	2,269,000
		(38%)	(19%)	(43%)
TOTAL	20,195,000	9,700,000	5,858,000	4,637,000
		(48%)	(29%)	(23%)

Livestock and Grazing

Ninety-five percent of the public domain in the Missouri Basin is grazed by livestock. The remaining 5 percent, classed as Waste and Barren, contributes little to livestock, but provides important wildlife habitat and watershed values. The useable lands are grazed during the proper season by 1,197,000 cattle and 2,427,000 sheep. The stock do not depend exclusively on public domain during the authorized season, however, because lands in other ownership are also utilized. Daily consumptive use of water by livestock is 18,005,000 gallons. According to standard criteria for estimating adequacy of range livestock water, 57 percent of the public lands are adequately supplied to achieve proper forage utilization. Water quality is well within acceptable limits. Fees paid for public domain grazing are based on carrying capabity, measured in animal unit months. A formula accepted by the industry relates the fee to market prices for beef and lamb in the western States. Periodic increases have raised the charge to ranchers from an initial 5¢ per animal unit month in 1936, to 44¢ currently.

PUBLIC DOMAIN CONTRIBUTION TO LIVESTOCK PRODUCTION

Subbasin	Usable Range	Numbers of Permittees	Numbers of Cattle*	Numbers of Sheep*	Grazing Use
	(acres)				(AUM's)
Upper Missouri	5,272,000	3,000	421,000	495,000	1,052,000
Yellowstone	7,721,000	2,240	440,000	1,070,000	1,155,000
Western Dakota Tributaries	1,110,000	935	107,000	268,000	265,000
Platte-Niobrara	5,111,000	950	229,000	594,000	470,000
TOTAL	19,214,000	7,125	1,197,000	2,427,000	2,942,000

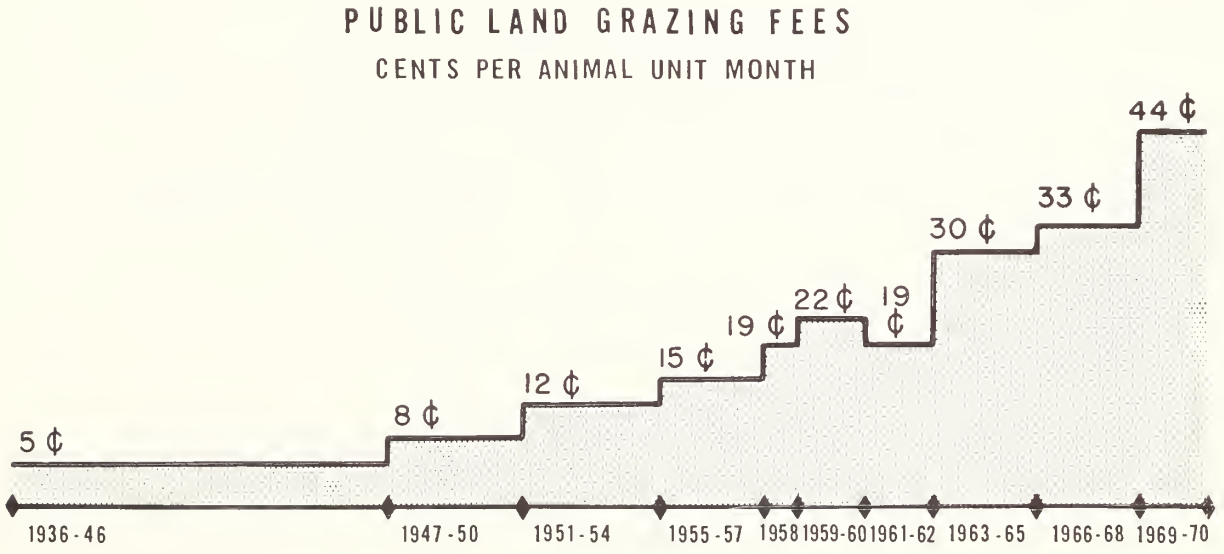
*These livestock also utilize non-Federal rangelands.

PUBLIC DOMAIN LIVESTOCK WATER

Subbasin	Source			Number of Ponds	Daily Consumptive use by livestock	Grazing Area * adequately supplied with water	Water Quality** (dissolved solids)	
	Surface	Wells	Stock Ponds				Surface Water	Ground Water
	---(%)---				(gallons)	---(%)---	-----(ppm)------	
Upper Missouri	80	5	15	2,600	5,795,000	60	200-1,000	200-4,000
Yellowstone	60	5	35	2,000	6,885,000	55	200-1,000	250-2,000
Western Dakota Tributaries	73	2	25	300	1,686,000	40	250-4,000	200-4,000
Platte-Niobrara	65	5	30	600	3,639,000	60	250-500	200-1,000
TOTAL				5,500	18,005,000	53.7 (average over 4 subbasins)		

*Based on criteria recommending 1/4 to 1/2 mile travel to water over rough topography, 3/8 to 3/4 mile in rolling terrain, and 3/4 to 1 mile on level ground.

**Recommended maximum dissolved solids tolerance levels are approximately 10,000 parts per million for beef cattle; 1,750 parts for field crop irrigation, and 500 parts for human consumption. Ground water quality data applies only to those areas shown on individual subbasin resource maps as being favorable to ground water recovery.



Timber

There are 1,039,000 acres of public domain in the Missouri River Basin which support forests and woodlands. Most of the forest lands are at moderate elevations, generally below 8,000 feet. This is true because public domain gives way to National Forests at the middle and upper elevations. The pinyon-juniper is the most commonly found type on the public lands, grading into ponderosa pine, and at higher elevations, Douglas fir, Engelmann spruce, and lodgepole pine.

Poles and posts are cut from the public lands in large numbers for local use on farms and ranches. Saw timber sales are common, with 8,240,000 board feet of lumber sold during the year ended June 30, 1971. Sales are quite variable from year to year. The Western Dakota Tributaries Subbasin, with only 4 percent of the forested area, contributed 26 percent of the saw timber during the year. This was the result of ponderosa pine sales in the Black Hills region. The Upper Missouri and Yellowstone River Subbasins, with 45 percent and 38 percent of the timber acreage, each sold 36 percent of the saw timber.

PUBLIC DOMAIN FOREST AND WOODLAND

Subbasin	Public Domain Forest and Woodland			Timber Sales FY 1971
	Total	Commercial	Non-Commercial	
	acres			board feet
Upper Missouri	461,000 (45%)	337,000	124,000	2,930,000 (36%)
Yellowstone River	395,000 (38%)	155,000	240,000	2,970,000 (36%)
Western Dakota Tributaries	37,000 (4%)	19,000	18,000	2,150,000 (26%)
Platte-Niobrara	146,000 (13%)	127,000	19,000	190,000 (2%)
TOTAL	1,039,000 (100%)	638,000	401,000	8,240,000 (100%)

Minerals

Minerals of the public lands are administered by the Bureau of Land Management, which encourages their development in accordance with provisions of law and the principles of conservation.

Authority for disposition of mineral lands and resources is contained in the General Mining Laws of 1872, the Mineral Leasing Act of 1920, various special leasing acts, and the Materials Disposal Act of 1947. The General Mining Laws apply within the Missouri Basin States, with the exceptions of Iowa, Kansas, Minnesota, and Missouri.

Lands in which both surface and mineral rights are held by the Federal government in the Missouri Basin amount to over 20 million acres. The government also owns and administers mineral rights to about 30 million additional acres in the basin, the surface of which has been patented. In some land titles the government has retained rights to oil and gas only; in others, coal or fissionable materials, some of them reserve a combination of several minerals, and others reserve all mineral content to the government.

While the Bureau of Land Management has sole responsibility for administration of the General Mining Laws and the Material Sales Statute, it shares responsibility with the Geological Survey under the Mineral Leasing Acts. Mineral leasing applications are received and adjudicated by the Bureau of Land Management, the permits, licenses and leases are issued, and rentals collected on non-producing leaseholds. The Geological Survey supervises operations on producing leases, and collects the rents and royalties.

The following tabulations summarize mineral leasing and materials disposal activities on public lands within the borders of the Missouri Basin States, excepting Colorado. Colorado is not included because such a small percentage of its public domain is within the Missouri Basin drainage, and a correspondingly small part of its mineral products come from there. Wyoming and Montana account by far for the bulk of disposals under the Mineral Leasing and Materials Sales Acts within the Missouri Basin.

MINERAL LEASES IN EFFECT, JUNE 30, 1970

Oil & Gas		Coal		Sodium, Phosphate & Other	
No.	Acreage	No.	Acreage	No.	Acreage
49,300	30,000,000	126	230,000	84	117,000

PRODUCTION FROM MINERAL LEASES, FISCAL YEAR ENDING JUNE 30, 1970

Oil	Natural Gas	Gasoline & LPG	Coal
(barrels)	(000 cu. ft.)	(gallons)	(tons)
104,136,000	162,148,000	126,505,000	2,641,000

MATERIALS DISPOSALS BY SALE AND FREE USE PERMIT
FISCAL YEAR ENDING JUNE 30, 1970

Sand & Gravel	Road Base	Lightweight Aggregate	Surfacing Material	Stone
----------cubic yards----------				----tons---
1,408,000	800,000	423,000	52,000	68,000

Production figures for hard rock and other minerals extracted from unpatented lode and placer mining claims held under the General Mining Laws are not reported to the Bureau of Land Management. These figures are gathered by the compiling agency, together with minerals statistics for all lands; thus, the data applicable to public domain cannot be identified separately.

The government received a one-eighth royalty on minerals produced under the Mineral Leasing Act. This amount, plus bid bonuses and other fees are distributed 37½ percent to the State where production occurred, 52½ percent to the Federal Reclamation Fund, and 10 percent to the General Treasury. The State governments in the Missouri River Basin currently receive approximately $22 million annually as their 37½ percent share.

The land surface area utilized for mineral production and processing is minor, amounting to only 33,500 acres for all lands, public and private, in the entire Missouri Basin. Of that amount, 9,500 acres are utilized for oil and natural gas, and 24,000 acres for all other minerals. The output value per acre is $79,500 for oil and gas, and $13,300 for other minerals. The oil and gas producing fields on public domain are so nominal in size that they become indiscernible when superimposed on a river subbasin map; for that reason they were omitted from the series of resource overlay maps appearing in this report.

The public lands have long been an important source of the minerals coal and bentonite, coal being extracted under authority of the mineral leasing laws, and bentonite under the General Mining Laws. The following table summarizes acreages of public domain overlying the respective minerals, as indicated by geologic mapping; the basic data is portrayed in map overlay format in the river subbasin sections of this report. The tabulated acreage includes only those areas where both surface and mineral rights are the property of the United States.

PUBLIC DOMAIN COAL AND BENTONITE ACREAGE

Subbasin	Coal	Bentonite
	(acres)	(acres)
Upper Missouri	943,000	4,767,000
Yellowstone	4,000,000	2,413,000
Western Dakota Tributaries	277,000	223,000
Platte-Niobrara	950,000	53,000
TOTAL	6,170,000	7,456,000

Recreation

Outdoor recreation is increasingly recognized as an important use of the public domain, and with it, the potential that the public lands have for contributing to the emerging "Open Space" concept of contemporary land use. The public lands are open to all forms of recreational use, so long as the user does not violate specific provisions of law such as the prohibition against removal of antiquities, or local fishing and hunting regulations.

Although all lands are open to recreation, certain primary use areas receive more activity for reasons such as ease of access, proximity to population centers, and productivity of big game animals. Land area figures in the following table are for the more heavily used areas, which absorb the bulk of recreational use in each subbasin. The figures giving visitor days of use, however, account for all recreation which the respective subbasins are known to support. The term "Visitor Day" is used to mean an aggregation of 12 Visitor Hours, where a Visitor Hour is 60 full minutes of activity.

PUBLIC DOMAIN RECREATION AREA AND USE

Subbasin	Primary Recreation Use Land	Amount of Use	Amount of Primary Use Land	Relative Amount of Use	Developed Recreational Sites
	(acres)	(Visitor Days)	(%)	(%)	(number)
Upper Missouri	2,500,000	100,000	22	6	4
Yellowstone	4,677,000	575,000	40	34	3
Western Dakota Tributaries	800,000	150,000	7	9	4
Platte-Niobrara	3,582,000	870,000	31	51	7
TOTAL	11,559,000	1,695,000	100	100	18

The Platte-Niobrara Subbasin, with its heavy demand from Denver residents, accounts for 51 percent of the public domain recreational use in the Missouri Basin, while containing 31 percent of the high-impact recreational land. The entire Platte-Niobrara Subbasin in Colorado and Wyoming is credited with being a high-impact area, with the exception of the Great Divide Basin of Wyoming. The other three subbasins are areas of surplus recreational opportunity. Even where a surplus exists, however, there are still specific locations of over-use.

Eighteen developed recreational sites are available on the public lands, consisting of picnic grounds and overnight camping facilities; more are planned, especially at locations where intensive recreational use takes place despite a lack of facilities.

Public domain recreational opportunities are heavily land oriented. By the nature of the land, recreational uses predominantly take the form of extensive rather than intensive activity. Those uses which occur because open space is available, and to which large land areas are essential, are the dominant ones. The following table summarizes the most frequently occurring forms of recreational use.

MAJOR RECREATIONAL ACTIVITIES BY RANK

Subbasin	Driving and Sightseeing	Hunting	Fishing	Picnicking	Camping
Upper Missouri	3	1	2	4	5
Yellowstone	2	1	3	4	5
Western Dakota Tributaries	1	2	5	3	4
Platte-Niobrara	1	3	4	2	5

Fish and Wildlife

The Missouri Basin supports a variety of fish and wildlife, often in a pristine environment, and of national importance. Because of its central location, and the quality and variety of its fish and wildlife, the basin affords some of the prime fishing and hunting areas of the country.

The Upper Missouri and Yellowstone Subbasins, both containing major concentrations of public land, were termed in the Missouri Basin Comprehensive Framework Studies as areas of surplus fish and wildlife opportunity. Even where a surplus exists, however, there are still specific locations of over-use.

The primary concern of the Bureau of Land Management in its fish and wildlife activity is for development and management of a favorable habitat. Central to the program is cooperation with State and Federal agencies whose primary mission is management and conservation of the species themselves. Nearly all public land is important to fish and wildlife in some way, with certain areas much more so, because they are so vital in providing critical habitat. The key habitat areas are depicted in map form in the River Subbasin sections of this report. The following table provides a basinwide acreage summary. The amount of forage set aside for wildlife, as shown in the table, is distributed throughout the respective subbasins, not limited to the key habitat areas.

KEY FISH AND WILDLIFE HABITAT ON THE PUBLIC DOMAIN

Subbasin	Land Habitat Area	Water Habitat Area	Forage Designated for Wildlife Use
	(acres)	(acres)	(AUM's)
Upper Missouri	1,635,000	25,000	80,000
Yellowstone	1,015,250	7,500	117,000
Western Dakota Tributaries	35,000	1,200	10,500
Platte-Niobrara	533,000	2,800	57,000
TOTAL	3,218,250	36,500	264,500

CLASSIFICATION AND MULTIPLE USE ACT

By the Classification and Multiple Use Act of September 19, 1964, (Public Law 88-607) Congress directed the Department of the Interior, among other things, to determine which of the public domain lands were suitable for disposal, and which contained values making them suitable for retention in federal ownership and management under principles of multiple use stated in the act.

The act expired 6 months after the final report of the Public Land Law Review Commission to Congress on June 23, 1970. All proposals to classify public lands under authority of the act were thus required to be published in the Federal Register not later than December 23, 1970. Every proposed classification under the act during its 6 effective years was preceded by a widely published Notice of Intent, local publicity, meetings of interested persons and organizations, and public hearings were held to insure expression of opinions on all aspects of the action.

Even though the period for making classifications has expired, the actions taken remain in effect unless modified by a suitable order. Expiration of the act did not affect other long-term authorities, such as provisions of the Taylor Grazing Act, for classification of the public lands. Neither did it change the petition-application system by which individual requests for land classification are initiated.

Among the maps in each of the subbasin sections of this report is one which shows actions completed under the Classification and Multiple Use Act. Solid lines designate the boundaries of Planning Units. The Planning Units identify major concentrations of public land for general planning purposes. They are a standard data source for internal agency planning, and for Inter-agency work, such as river basin planning and economic development planning.

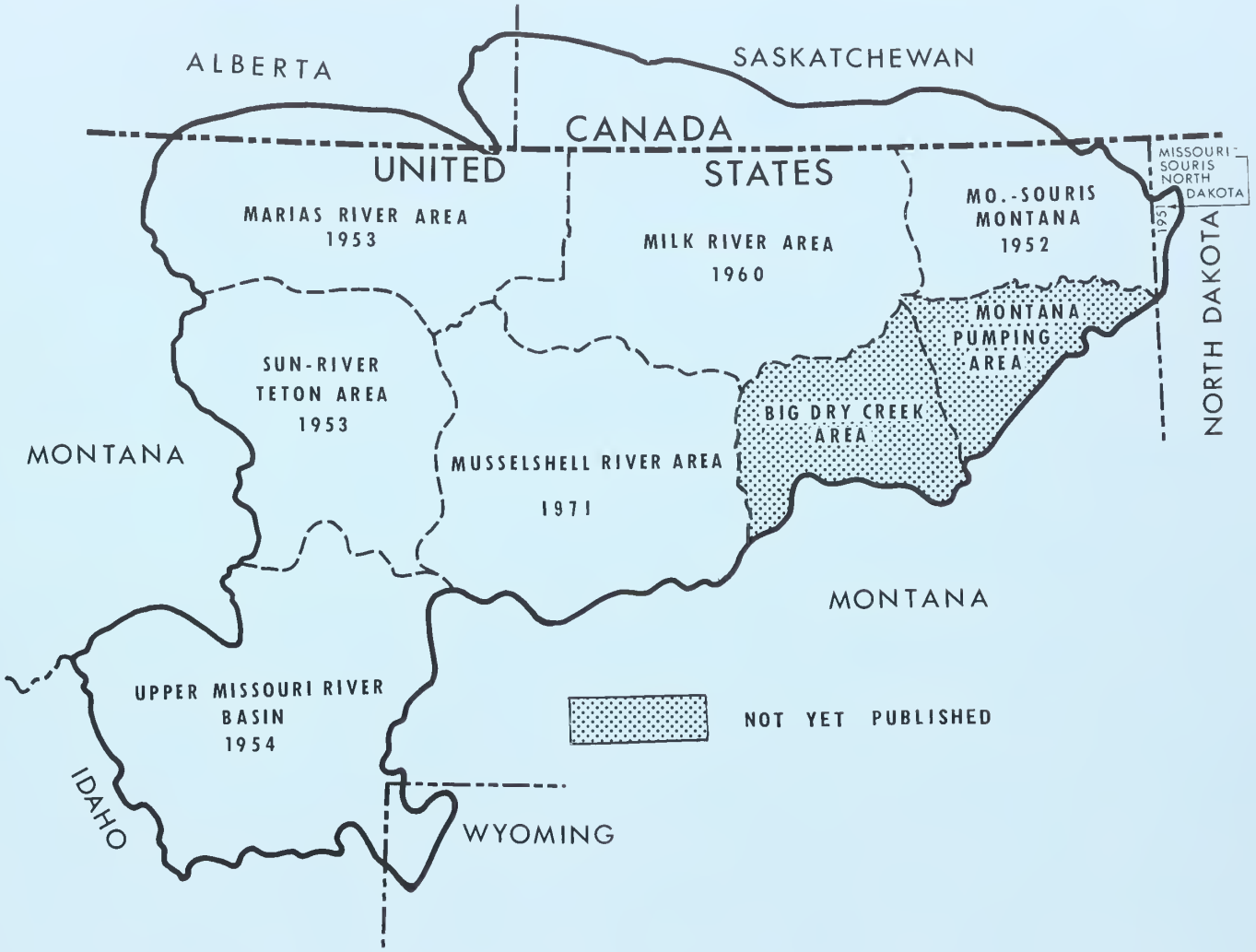
Lands designated for retention under authority of the Classification and Multiple Use Act are identified by a color overprint superimposed on Bureau of Land Management status. A narrative accompanying the maps points out significant factors in the classification of each subbasin. Private as well as public lands were included in the color overprint, but the public land retention designation in no way affects the status of private holdings.

Among major factors considered in establishing retention designations was the density of the public land pattern. In most cases the public lands identified for retention have fallen into either of two density patterns: from 30 percent to 50 percent government administered land in the unit, or 50 percent and upward of Federal land. Areas with these amounts of public domain are regarded as well blocked, and suited to efficient administration in Federal ownership. There are additional reasons for retention classification, even though the land pattern may not be well blocked, such as key wildlife habitat, or important recreational sites. Areas jointly administered by the Bureau of Land Management and another Federal agency for a specific purpose such as a game refuge, are classified for retention. Areas of scattered, isolated tracts, where Bureau of Land Management administrative responsibility is nominal, are normally considered as prospective disposal areas.

UPPER MISSOURI SUBBASIN

UPPER MISSOURI RIVER SUBBASIN

Published Bureau of Land Management Land Inventory Reports



UPPER MISSOURI SUBBASIN

General Description

The Upper Missouri Subbasin occupies the northern sector of the Missouri Basin. It measures 580 miles long by 270 miles wide and contains 53 million acres. Ninety-nine percent of the subbasin is in Montana, the remainder being equally divided between Wyoming and North Dakota. The Bureau of Land Management administers 5.6 million acres, about 11 percent of the area.

LAND AREA

	Subbasin		Public Domain	
	(acres)	(% of subbasin)	(acres)	(% of subbasin)
Montana	52,207,000	99.0	5,608,000	11
North Dakota	378,000	.5	0	0
Wyoming	377,000	.5	0	0
TOTAL	52,962,000	100%	5,608,000	11%

Topographic divisions include the Northern Great Plains' gently sloping benches and broad valley bottoms, rolling to rough foothills, and the rugged, steep mountains culminating in the Continental Divide. Elevations vary from 11,000 feet in the west to 1,500 feet in North Dakota.

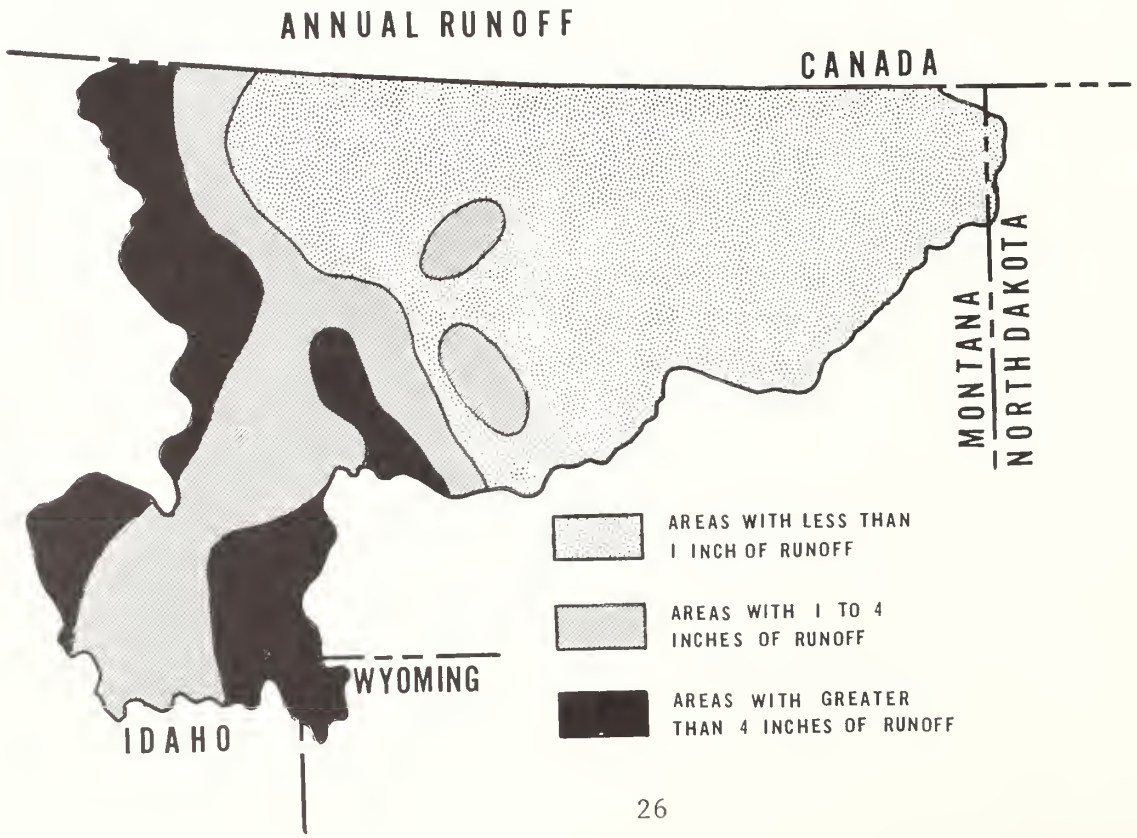
The subbasin has a rigorous climate with a relatively short growing season. Summers are hot, and winters have subzero temperatures and blizzards. Average annual precipitation ranges from 12 to 48 inches, depending on location, with high mountain areas receiving up to 60 inches. About half of the precipitation falls during the growing season. Summer storms, of short duration, are often severe and occasionally accompanied by hail.

The subbasin has 294,000 people, about four per square mile. Urban areas are located at Great Falls, population 60,100, Helena, 22,700, and Bozeman, 18,700.

The major land use is pasture and range, with about 32.2 million acres, or 61 percent, used for grazing. Cropland occupies 10.7 million acres, or 20 percent of the subbasin. Forests and woodlands cover 7.2 million acres, or 14 percent. The remaining 2.8 million acres are classed as miscellaneous.

SUBBASIN LAND USE

	Acres	% of Subbasin
Pasture and Range	32,252,000	61
Cropland	10,700,000	20
Forest and Woodland	7,200,000	14
Transportation and Urban	1,200,000	2
Water	700,000	1
Recreation	500,000	1
Other Agriculture	300,000	
Fish and Wildlife	100,000	1
Military	7,000	
Mineral Industry	3,000	
TOTAL	52,962,000	100%



Surface Runoff

The accompanying map illustrates in simplified form the location of high and low runoff watersheds in relation to the position of public lands in the Upper Missouri Subbasin. Although the map expresses runoff rates in terms of "less than 1 inch" to "more than 4 inches," the measured extremes vary from a low of one-half inch to as much as 20 inches.

The highest runoff zone, ranging from 4 inches to 20 inches annually, coincides with the higher mountain elevations from the Canadian border on the north, ranging southward to the western boundaries of Yellowstone Park. These high watersheds supply the headwaters streams of the Missouri River system, including the Milk, Marias, Teton, Madison, Jefferson, and Gallatin. Public domain is limited, consisting of isolated tracts of relatively small acreage near the upper reaches of the Sun, Teton, and Big Hole Rivers, the latter a tributary to the Jefferson in the southwest sector of the subbasin.

The 1 inch to 4 inches runoff zone occupies mid-elevations through foothill and high valley country from the Red Rock drainage of Montana on the south, to the Canadian border. For many miles, from Three Forks, Montana to Fort Benton, this zone follows the Missouri River mainstem. It contains about 13 percent of the public domain in the subbasin, most of which occurs in the southwestern sector, centered about Dillon, Montana.

The runoff zone of 1 inch or less occupies the plains of Montana, extending eastward from the vicinity of Great Falls to the North Dakota border. About 87 percent of the public land in the subbasin is located in this zone, in a compact, easily managed land pattern. The nature of this land, in a low precipitation belt, dictates that its use be extensive rather than intensive, to avoid damage to the resource. The principal value of these public lands is for the grazing of range livestock, plus the contribution of surface flow to the mainstem rivers. Even though the rate of runoff per acre is low, the total increment is important as a contribution to the irrigation, domestic and navigation supply downstream.

Ground Water

Areas with ground water potential include (1) the western mountainous regions, (2) along the bottomlands of the Missouri, Milk, and Musselshell Rivers, and (3) the mountains of the subbasin's central portion. The accompanying map shows areas where properly located and constructed wells less than 1,000 feet deep can produce at least 300 gallons per minute.

In the subbasin's western portion, water-bearing formations underlie an estimated 200,000 acres of public domain. This public domain is generally too rough, rocky and steep for cultivation, even though water quality is good or excellent. In the subbasin's northwestern portion, ground water is often below standards for human use but can still be used to water livestock and to irrigate. Recommended maximum dissolved solids tolerance levels are approximately 500 parts per million for human consumption, 10,000 parts per million for beef cattle, and 1,750 parts per million for irrigation of field crops.

About 250,000 acres of public domain overlie water-bearing formations along the subbasin's larger rivers. This land is generally scattered, but when larger blocks of public domain do occur, the land is too rough, broken and rocky for cultivation. Water quality progressively declines downstream, finally reaching a point where it can be tolerated only by livestock.

The large aquifer in the subbasin's central portion is of excellent quality. About 100,000 acres of public domain lie in a scattered pattern throughout the aquifer's eastern half.

For the most part, the subbasin's public domain is too rough and broken for cultivation. Application of ground water is generally limited to livestock and recreational uses. In local areas, water for domestic use can be developed.

GROUND WATER MAP - Upper Missouri
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN

MONTANA

CANADA

HAVRE

MALTA

WOLF POINT

MONTANA
NORTH DAKOTA

GREAT FALLS

JORDAN

LEWISTOWN

HELENA

DILLON

IDAHO
WYOMING

AREA FAVORABLE TO GROUND WATER RECOVERY

GROUND WATER MAP - Upper Missouri Subbasin

Streamflow Depletions

Streamflow depletions are anything, whatever the reason, that prevent water after once entering an area, from leaving that area by the master drainage. The streamflow reduction can result from natural or man-made influences, such as transpiration by deep-rooted plants along stream banks or consumptive use by cultivated crops. Depletions occurring on the public lands account for only 4 percent of the Upper Missouri Subbasin's total depletions.

Public domain depletions result from two general practices:

1) Impoundments
2) Land treatment measures.

The impoundments are principally stock watering reservoirs averaging about 3 surface acres in size. The earth-fill dams provide a reservoir at least 12 feet deep to insure that water will be available during drought. A few, moderately larger, flood control structures have also been built. Key installations have a 100-year design life; less important structures have a 25-year life. Most reservoirs are expected to ultimately fill with silt. Experiments have shown that 1 cubic yard of structural material will intercept 5 cubic yards of sediment. The subbasin has about 2,600 impoundments; depletions result from livestock use and surface evaporation.

The second form of depletion results from land treatment measures, such as contour furrowing, rangeland pitting, water spreading, dikes, and water diversions. Although a certain amount of depletion results from land treatment practices through surface evaporation or ground water contribution, the net result is beneficial. These treatment practices hold more water on the land than they dissipate, they reduce soil erosion, and they contribute to improved range management practices. In the subbasin, about 8,000 acres of public lands have been treated.

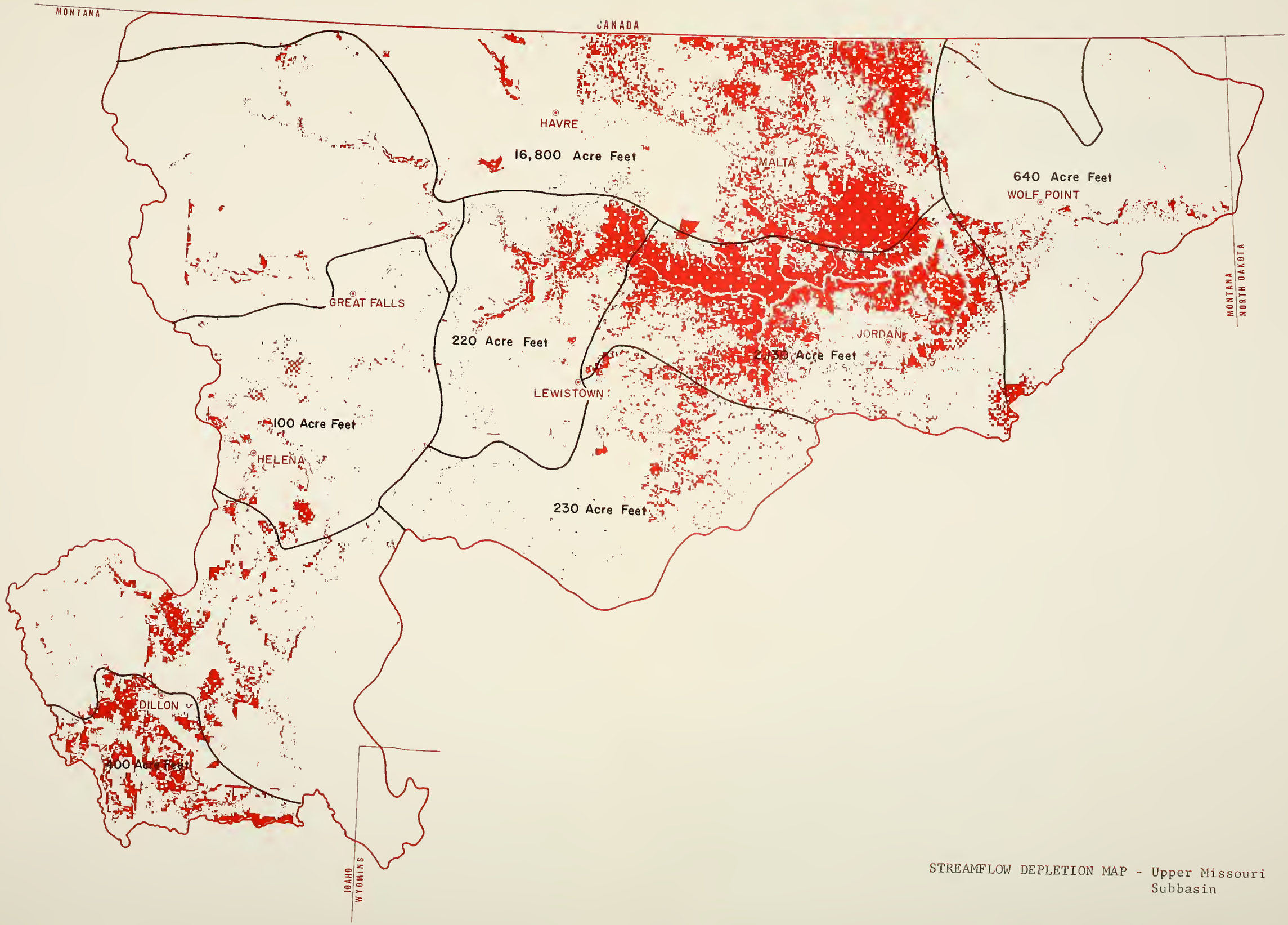
The following table summarizes the streamflow depletions in the Upper Missouri River Subbasin.

ANNUAL STREAMFLOW DEPLETIONS

Tributary Basin	BLM Depletion (acre ft)	BLM Relative Depletion In Tributary Basin (%)	All Depletions In Tributary Basin (acre ft)
Milk River	16,800	22.0	77,800
Missouri River Valley & Ft. Peck	2,130	1.0	154,200
Missouri River Valley to Williston	640	3.0	24,200
Beaverhead River	400	.5	77,200
Musselshell River	230	1.0	26,100
Arrow and Judith Rivers	220	2.0	11,300
Smith and Dearborn Rivers	100	.2	34,400
All Other Areas, Upper Missouri System	--	--	162,200
	20,520	4% (average over entire subbasin)	567,400

STREAMFLOW DEPLETION MAP - Upper Missouri
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



STREAMFLOW DEPLETION MAP - Upper Missouri Subbasin

Sedimentation

Erosion and sedimentation of the land depends to a large extent on the amount of surface runoff. The amount, intensity, duration, and season of precipitation all have an important effect on runoff. The effect of precipitation in turn is influenced by vegetation, soils and topography.

All else being equal, it is evident that higher precipitation will produce higher runoff. Steep slopes will erode more rapidly than level areas. Soils that inhibit infiltration contribute to higher runoff rates. In ascending order of their ability to retain water and reduce runoff, vegetative cover ranks as follows:

1) bare soil
2) cultivated crop land
3) shrubs
4) open grassland
5) grass sod
6) mature forest

In the Upper Missouri Subbasin the factors contributing to high sediment yield are all combined in the badlands area north of Fort Peck Reservoir, and in the Milk River tributaries identified as Willow, Timber, and Telegraph Creeks. High intensity summer storms fall on nearly barren, steep, heavy clay soils with impervious shale parent material. The resulting sediment displacement is high, ranging from 400 to 2,000 tons per square mile per year. In the western parts of the subbasin, high amounts of precipitation are received as snowfall, but the forest vegetation and permeable soils reduce both runoff and sediment yield.

Erosion and sediment can be controlled. For sheet erosion, the best control measures are proper rates of livestock utilization, proper distribution and control of livestock, plus control of rangeland fires, and re-seeding depleted areas. For gully erosion, structural measures such as dams and water spreaders are more effective for control. It has been found by experiment that each cubic yard of structural material in place in a flood control dam will intercept an average of 5 cubic yards of sediment during the lifetime of the structure. These structures as built on the public lands, have a design life of 100 years for key installations, and 25 years for the smaller types. With structural control measures the off-site benefits nearly always exceed those which accrue on-site.

The following table provides sediment loss figures for public and non-public lands in the Upper Missouri Subbasin.

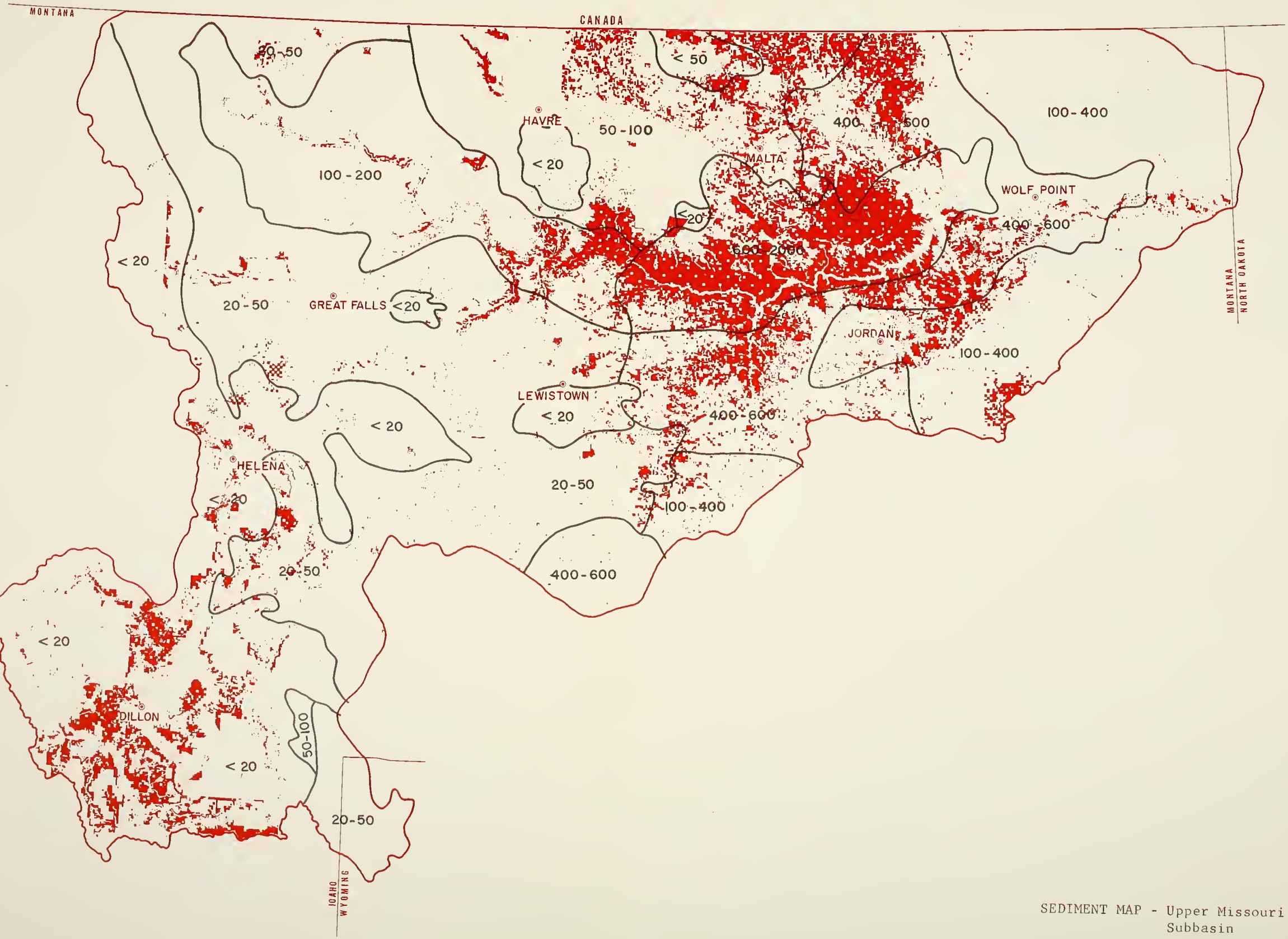
SEDIMENT MEASUREMENT

Hydrologic Subarea	Land Area		Loss Factor	Average Annual Sediment Loss	
	Public Land	All Land		Public Land	All Lands In Hydrologic Subarea
	--(sq. mi.)--		tons per sq. mi.	-------(acre ft.)-------	
Jefferson River near Twin Bridges	1,033	7,632	12	9	65
Missouri River at Toston	1,707	14,669	27	32	280
Missouri River near Zortman	2,363	13,000 (est.)	448	750	4,100
Musselshell River at Mosby	1,391	5,941	73	72	305
Milk River at Nashua	4,597	18,300	448	1,450	5,800
Missouri River at Culbertson	47	34,000	207	7	5,000

Watershed protection measures such as re-seeding, water spreading, and proper rates of grazing are effective in reducing peak waterflow, and sediment resulting from high runoff. Intensive vegetative or mechanical rehabilitation practices, or both, as well as proper management are needed to stabilize high sediment producing ranges. It was estimated in 1966 that 30 percent of private rangelands, and 46 percent, or 2,564,000 acres of Bureau of Land Management ranges, were adequately managed or treated. It was also estimated that 1,971,000 acres of public domain were in need of augmented management practices, and that an additional 1,073,000 acres needed further management attention, plus vegetative or mechanical treatment.

SEDIMENT MAP - Upper Missouri
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
LOSSES IN TONS PER ACRE PER YEAR



SEDIMENT MAP - Upper Missouri Subbasin

Land Resource Regions

In broad terms of land use, there are three major Land Resource Regions in the Upper Missouri Subbasin, as follows:

1) Western Great Plains Range and Irrigated Region;
2) Northern Great Plains Spring Wheat Region;
3) Rocky Mountain Range and Forest Region.

Each Region is comprised of several Land Resource Areas, which are identified according to principal features of soil or topography. Only the Regions are shown on the accompanying map, however, partly because they are descriptive of major land use, and partly due to complexities resulting from introduction of numerous boundary lines into such reduced space.

Major uses of the public lands are summarized in the following table. Besides the uses of Pasture and Range, and Forest and Woodland identified in the table, there is a third major designation, Cropland. Since none of the public land is used for cultivated crops, however, that heading is omitted.

PUBLIC LAND USE

Region	BLM			Regional Total All Lands
	Pasture & Range	Forest & Woodland	Total	
	(acres)			
Western Great Plains Range & Irrigated Region	2,467,500	--	2,467,500	13,600,000
Northern Great Plains Spring Wheat Region	1,962,800	--	1,962,800	17,966,000
Rocky Mountain Range & Forest Region	716,700	461,000	1,177,700	21,397,000
	5,147,000	461,000	5,608,000	52,963,000

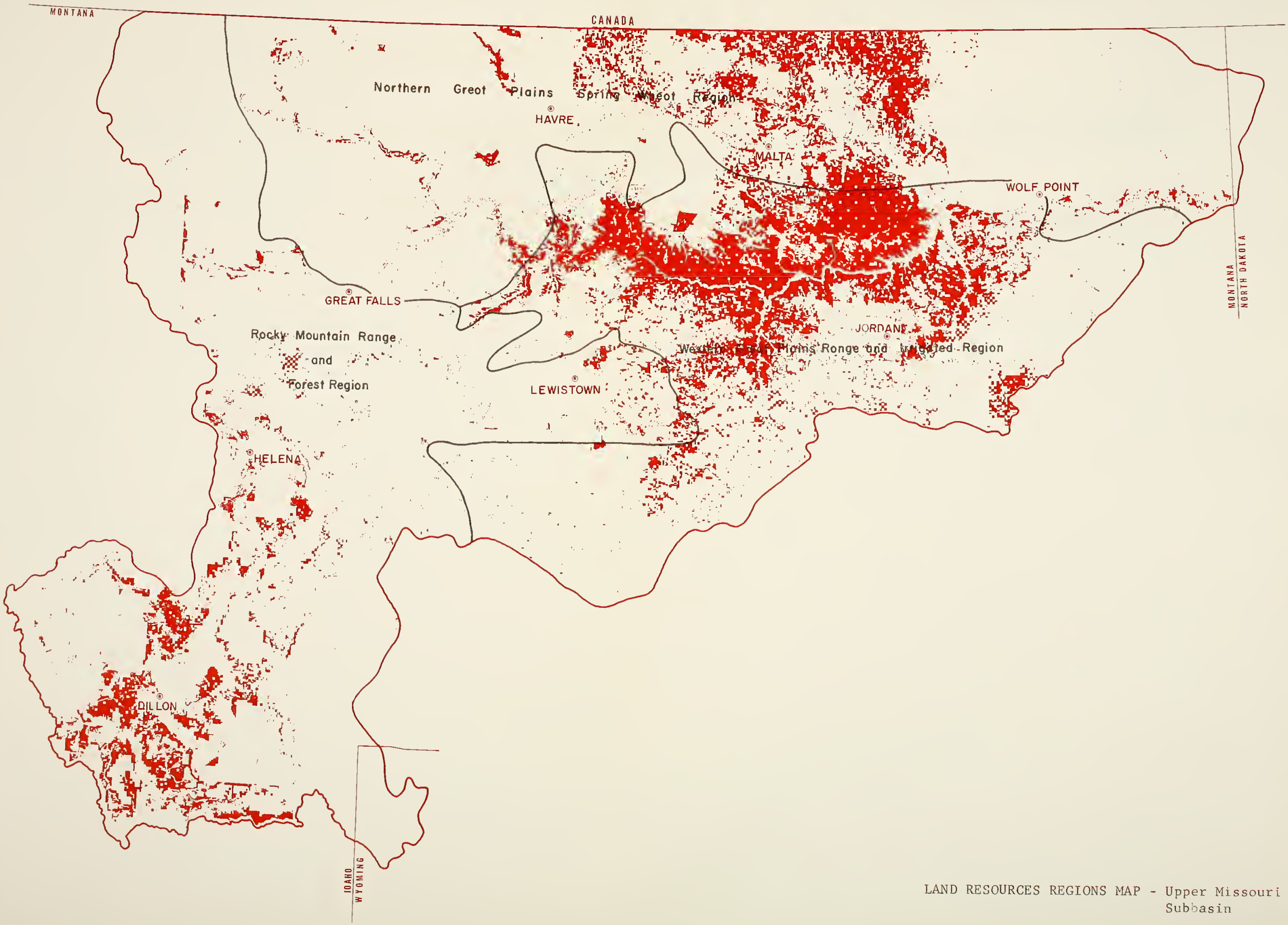
Of 5,608,000 acres of public domain in the Upper Missouri Subbasin, 44 percent, or 2,467,500 acres, is found in the Western Great Plains Range and Irrigated Region. Public lands comprise 18 percent of the surface area of the Region. The Region is characterized by low rainfall, unfavorable soils, steeply sloping topography, and a severe climate. These disadvantages made the Region relatively undesirable to early settlers, and probably accounted for the large acreages remaining in public ownership. Over 85 percent of the Western Great Plains Range and Irrigated Region is devoted to grazing use. It is well suited to that purpose due to its hardy and palatable perennial forage grasses. Virtually all of the public domain is in rangeland or pasture. The land pattern is well blocked, contributing to effective management.

The Northern Great Plains Spring Wheat Region extends across northern Montana, below the Canadian border. The Region has fertile soils and relatively smooth topography resulting from glaciation. It is adapted to quick maturing crops such as spring wheat and flax, which can be productive despite the short growing season and low rainfall. About 43 percent of the Region is devoted to cultivated crops; 56 percent, or 10,008,000 acres, is in pasture and range. About 20 percent of the rangeland, or 1,962,800 acres, is comprised of public lands. This acreage is found in a relatively concentrated land pattern, lending itself to efficient administration for grazing purposes.

The Rocky Mountain Range and Forest Region includes Montana's mountains and intervening rangelands, extending westward to the Continental Divide. The mountains are rugged, the basins are broad, and there are remnants of high plateaus. Grazing is the leading land use, with 12,800,000 acres, or 60 percent of the land, serving that purpose. Approximately 6 percent, or 716,700 acres, of the grazing land consists of public domain. There are also 461,000 acres of public domain forest and woodland. The public lands are found principally among the rugged mountains and valleys in the southwestern portion of the Region, at relatively high elevations. The land pattern is less concentrated than in the eastern part of the Region, but it is still sufficiently compact to permit efficient administration, especially in the Dillon, Montana area.

LAND RESOURCES REGIONS MAP - Upper Missouri
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



LAND RESOURCES REGIONS MAP - Upper Missouri Subbasin

Livestock

The total area in the Upper Missouri Subbasin is 52,962,000 acres. Of that amount, 5,608,000 acres are public domain administered by the Bureau of Land Management. Vegetation produced on 94 percent of these lands makes an important contribution to the growth and maintenance of range cattle and sheep. The remaining 6 percent of public domain has a land capability of Class VIII, Waste or Barren, which contributes little to the livestock industry, but provides wildlife habitat and watershed values.

PUBLIC DOMAIN CONTRIBUTION TO LIVESTOCK PRODUCTION

Usable Range **	Number of Permittees	Number of Cattle *	Number of Sheep *	Grazing Use
(acres)				(AUM's)
5,600,000	3,000	421,000	495,000	1,052,000

Of the Bureau of Land Management lands in the Upper Missouri Subbasin, 3,603,000 acres are concentrated in the east half. Another area of concentration includes 1,062,000 acres in the southwestern part, in the Dillon area, while 943,000 acres are scattered throughout the subbasin with no particular pattern.

Nearly 69 percent of the subbasin is used as range for the production of cattle and sheep. Cattle in total numbers are increasing, while sheep numbers are expected to decrease, or increase only slightly. Grazing capacity on public lands is computed in animal unit months (AUM's). One AUM represents the amount of forage sufficient to support a mature cow, or its equivalent, generally considered to be five sheep, for one month. Grazing fees, based on the animal unit month, are established by the Secretary of the Interior at a rate equal to a specified percentage of the average market price per pound of beef and lamb in the 11 western states during the preceding calendar year. During 1971 the fee was 44¢ per animal unit month.

The livestock industry of Montana was founded in the headwaters region of the Upper Missouri Subbasin during the summer of 1862. The main incentive for establishment of livestock herds was to supply beef to the mining camps. In October 1868, the first Montana trail drive was made from the ranching area to markets at Salt Lake City, Utah -- more than 300 miles. Subsequent drives were made until the

*These livestock also utilize non-Federal rangelands.
**Includes Charles M. Russell Wildlife Range.

Northern Pacific Railway reached the upper end of the subbasin in 1883. It was estimated that a 4-year-old steer could be raised at a cost of $3.80, and the market value was between $18 and $30 delivered to the railroad. Profits realized from beef production during this era were from 350 to 450 percent. The ranching enterprises prospered, and by the end of 1884 there were 140,000 cattle valued at more than $5 million in the upper part of the Missouri Subbasin. Sheep production began prior to 1883, but made little progress until it was possible to ship by rail to central markets in other states.

In 1964, total receipts from crops and livestock in the Upper Missouri Subbasin amounted to more than $237 million. About $113 million, or 48 percent, was derived from livestock or livestock products. By 1969 there were 486 million pounds of cattle and calves in the subbasin; this figure is expected to increase 43 percent, to 695 million pounds by 1980. By 1969 there were also 48 million pounds of sheep and lambs, and by 1980 this class of livestock is expected to increase 6 percent, to 51 million pounds.

Approximately 80 percent of the public domain in the Upper Missouri Subbasin is within the boundaries of Bureau of Land Management Districts. The Malta District has the greatest concentration of public lands; other Districts with responsibilities in the subbasin include Dillon, Lewistown, and Miles City. The Missoula District extends a short distance into the Helena area. The remaining 20 percent of lands administered by the Bureau of Land Management are managed under a leasing system which is applicable to public lands not within a District.

Notable in grazing and livestock management in the State of Montana are the cooperative grazing associations which were authorized under Chapter 208 of the 1939 Montana Session laws. This authority was enacted particularly for localities where ranching units were difficult to manage because of scattered, intermingled tracts of Federal, State, railroad, and private land. It enabled livestock operators and their authorized associations to cooperatively manage their lands to mutual advantage, and to provide for long-term conservation needs. Most of the associations are in north-central and northeastern Montana, in the Upper Missouri and Yellowstone Subbasins. The Department of the Interior, as part of its Grazing Regulations for Public Lands, recognizes local organized grazing districts authorized by State law, as in the case of Montana.

Stockwater

Surface runoff, impounded in earth structures, is the main source of stockwater in the Upper Missouri River Subbasin. Projects of this type provide 80 percent of the water consumed by livestock. Wells produce 5 percent while perennial streams, intermittent drainages, springs, and other sources furnish 15 percent.

The subbasin is characterized by high mountains in the western part, to rolling plains and badlands in the east. Elevations vary from 11,000 feet to 2,000 feet above sea level, with much of the plains area in a semiarid region. In the western part, water bearing formations underlie an estimated 200,000 acres of public domain, and water quality is good to excellent. On the eastern plains, ground water is generally of low quality, but its use for livestock is important because surface water sources are not dependable during drought. In extremely dry periods even ground water levels may decline, causing wells to fail. The Dillon, Helena, Great Falls, and Lewistown areas are favorable for ground water development. This is also true for the Milk River flood plain from Havre, Montana to the vicinity of Fort Peck. Development opportunities also occur along the Missouri River mainstem from Fort Peck Reservoir to the Montana-North Dakota boundary.

Stockwater ponds on public domain number approximately 2,600, with a combined surface area of about 8,000 acres. The 421,000 cattle and 495,000 sheep grazing the public lands consume an estimated 5,795,000 gallons of water daily. Sixty percent of the 5,272,000 acres of public domain used for grazing is adequately supplied with stockwater under the standard formula. This formula recommends 3/8 to 3/4 of a mile travel distance to water for rolling terrain, and 3/4 to 1 mile on level ground.

As subbasin runoff moves downstream, water quality progressively declines until dissolved solids may amount to 4,000 parts per million. Such water is acceptable to range cattle, however, which can tolerate up to 10,000 parts per million. That section of the subbasin with the greatest concentration of public domain does not coincide with important ground water aquifers. The condition is especially evident to the west, north, and northeast of Jordan, Montana, an area highly dependent upon surface impoundments for stockwater, and relying on a 10 inch average annual rainfall to fill them.

Coal Resources

Recoverable coal reserves in the Missouri River Basin are estimated at 450 billion tons, or 55 percent of the Nation's total. Montana has 220 billion tons, or 48 percent of this supply. If these deposits are developed, they will be able to meet much of the Nation's future needs for electric power, synthetic gas, liquid fuels, fertilizers, and other consumer products.

The lowest quality coal, lignite, underlies much of the subbasin's eastern portion. Because it will burn by spontaneous combustion, lignite cannot be stored for long, or moved great distances. Despite this drawback, lignite is in great demand for steam-electric power plants such as the one at Sidney, Montana. In the eastern part of the Upper Missouri Subbasin, 535,000 acres of public domain, mostly northeast of Jordan, Montana 1/, overlie lignite beds. Opportunities for use of these lignite beds in power generation appear good. Besides the fuel, abundant cooling water is needed to generate power at competitive rates, thus restricting potential plant sites.

The north-central subbasin is underlain by sub-bituminous coal beds. Prospects are favorable for steam-electric power generation, or coal conversion to gasoline and other energy and chemical products. Large water supplies are needed for the latter use. About 350,000 acres of public domain occur in the sub-bituminous coal area. Most of the land is in large blocks to the north of Lewistown, and northeast of Havre, Montana.

The best quality coal in the subbasin is bituminous, which occurs in the west and central parts. There are 58,000 acres of public domain overlying the bituminous coal beds. This coal can be used for power generation, chemical conversion, or for export out of the basin by unit train to areas needing a low sulphur fuel in steam generating plants.

1/ The United States also owns coal rights in many places where surface title has passed to private owners, but minerals were reserved. That acreage has not been determined for purposes of this report, however.

COAL RESOURCES MAP - Upper Missouri
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN

MONTANA

CANADA

HAVRE

MALTA

WOLF POINT

MONTANA
NORTH DAKOTA

GREAT FALLS

JORDAN

LEWISTOWN

HELENA

DILLON

IDAHO
WYOMING

COAL DEPOSITS

COAL RESOURCES MAP - Upper Missouri Subbasin

Recoverable coal reserves in the Missouri River Basin are estimated at 450 billion tons, or 55 percent of the Nation's total.

Bentonite Deposits

Deposits of bentonite are widespread, with the accompanying map showing their location in relation to the 5,608,000 acres of public domain in the subbasin. About 85 percent, or 4,767,000 acres of public domain, overlies geological formations containing some form of bentonite. The gross area of bentonite bearing formations approaches 19 million acres, or 36 percent of the subbasin.

BENTONITE BEARING ACREAGE

	Within Bentonite Formations
	(acres)
Public Domain	4,767,000
Other Land	14,206,000
TOTAL	18,973,000

Although the subbasin's bentonite deposits are extensive, they remain relatively undeveloped primarily because of the large amount of high quality bentonite produced in Wyoming. As of 1966, only six companies were producing bentonite in the Upper Missouri River Subbasin. Production was limited mainly to local demands for bentonite in oil well drilling mud, and canal lining for irrigation projects.

The bentonite deposits in this subbasin will continue to remain in somewhat of a "reserve" status as long as the demand is being met by established producing areas. Deposits in Wyoming are presently sufficient to expand production as demand requires. With the inevitable decline of production from current sources as reserves diminish, the Upper Missouri River Subbasin could become important as a bentonite producer.

BENTONITE DEPOSITS MAP - Upper Missouri
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN

MONTANA

CANADA

HAVRE

MALTA

WOLF POINT

MONTANA
NORTH DAKOTA

GREAT FALLS

JORDAN

LEWISTOWN

HELENA

DILLON

IDAHO
WYOMING

BENTONITE-BEARING FORMATIONS

BENTONITE PROCESSING PLANT

BENTONITE DEPOSITS MAP - Upper Missouri Subbasin

Fish and Wildlife

Thirty percent, or 1,660,000 acres of public domain in the Upper Missouri Subbasin is important fish and wildlife habitat. Most of this habitat is in the subbasin's center section, but large tracts also occur in the southwestern corner, as shown on the accompanying map. The areas delineated on the map are essentially public domain with interspersed private holdings.

KEY FISH AND WILDLIFE HABITAT ON PUBLIC DOMAIN

	Land	Water	Total
	(acre)	(acre)	(acre)
Key Wildlife Areas	1,635,000	16,000	1,651,000
Key Fishing Areas	--	1,000	1,000
Stock Ponds	--	8,000	8,000
	1,635,000	25,000	1,660,000

Big game, mostly deer and antelope, with moderate numbers of elk and bighorn sheep, use more than 1 million acres of the public domain. Eighty-nine percent of this land is pasture and range; the remainder is forest and woodland. The Bureau of Land Management reserves 80,000 AUM's of forage for big game use.

KEY PUBLIC DOMAIN FISH AND WILDLIFE HABITAT BY TYPE

	Forest and Woodland	Pasture and Range	Total Land*	Natural Water		Artificial Water
				Open	Stream	
	-----(acres)-----		(acres)	(acres)	(miles)	(acres)
Big Game	125,000	977,000	1,102,000	--	--	--
Upland Game	55,000	658,000	713,000	--	--	--
Waterfowl	--	--	--	2,000	167	14,000
Fishing Areas	--	--	--	--	68	1,000

*Area total exceeds the 1,635,000 acres of preceding table due to overlapping species habitat.

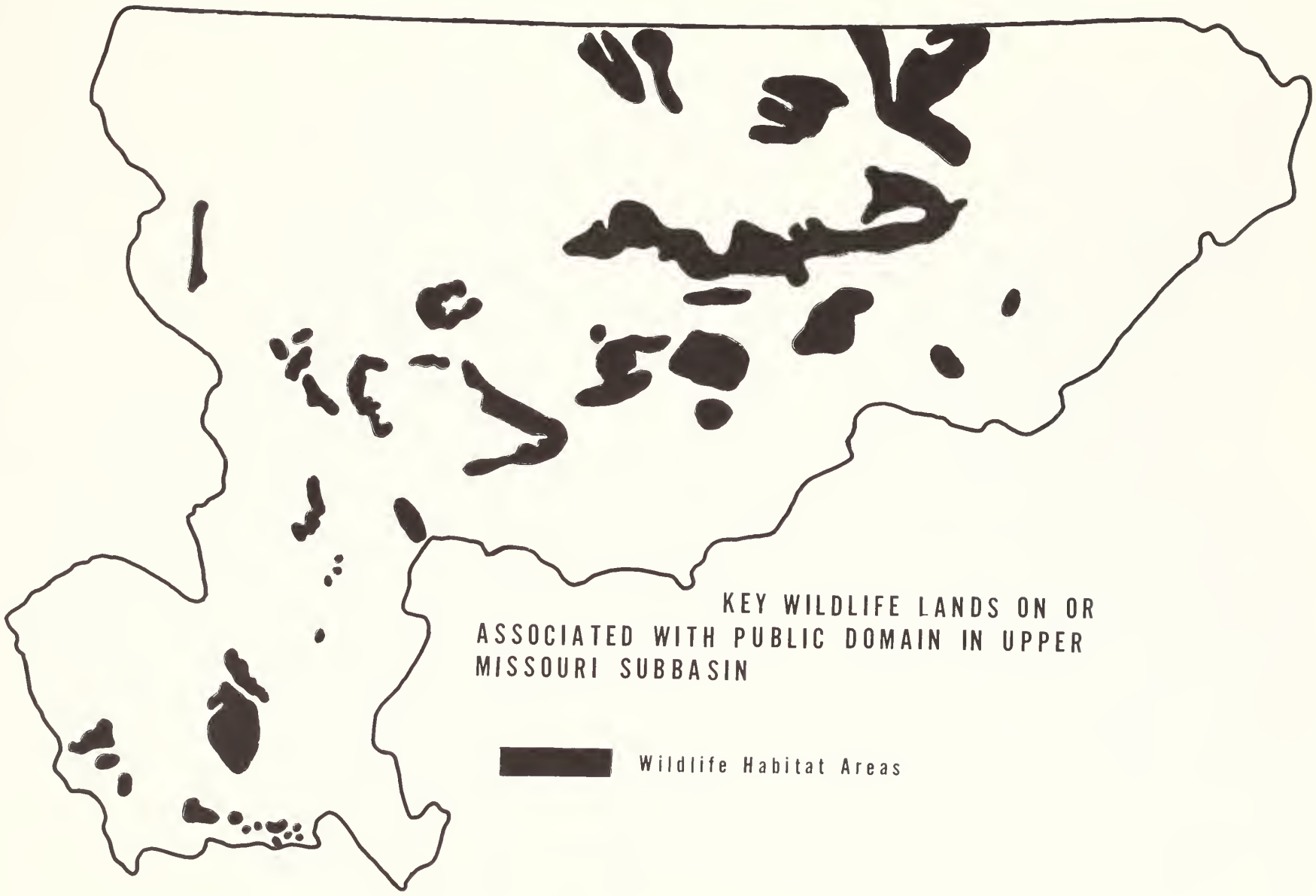
Public domain provides access and fishing areas for 68 miles of streams and 1,000 surface acres of water other than stock ponds. In the west, cold water fish such as rainbow, brook, and cutthroat trout are found at high elevations; brown trout are found at slightly lower elevations. Warm water fish such as walleye, pike, sauger, catfish, bass, perch, and crappie live in the streams and lakes of the eastern portion. Land management influences the streamflow, siltation, and other factors that affect a fishery. Good management of the public domain in the subbasin's southwest portion will help maintain and improve important streams such as the Madison and Big Hole Rivers. This is also true of Fort Peck Reservoir in the subbasin's central portion.

WATERFOWL NUMBERS, ALL LANDS, UPPER MISSOURI SUBBASIN

	Wintering	Breeding
Canada Goose	1,200	10,000
Mallard	84,900	265,200
Pintail	0	145,000
Teal:		
blue-winged	0	27,900
green-winged	200	7,900
Shoveler	0	24,100
Gadwall	10	49,900
Widgeon	100	24,200
Other ducks	1,200	19,000
Trumpeter swan	265	0
TOTAL	87,875	573,200

Waterfowl habitat includes 16,000 acres of open water and 167 miles of streams on the public domain. Over half a million waterfowl breed in the entire subbasin, and approximately 87,000 are winter residents. There are opportunities to increase their numbers, such as by fencing stockponds and building waterspreaders which will add nesting sites and food. Improvements would also benefit other wildlife, and prevent erosion and stream and reservoir siltation.

Upland gamebirds use more than 700,000 acres of public domain, 92 percent of which is pasture and range, and the remainder forest and woodland. Primarily, sportsmen hunt pheasant, sage grouse and sharp-tailed grouse, but Hungarian partridge, chukar partridge, mountain grouse, and turkey also live in the subbasin.


KEY WILDLIFE LANDS ON OR ASSOCIATED WITH PUBLIC DOMAIN IN UPPER MISSOURI SUBBASIN
Wildlife Habitat Areas

Classification and Multiple Use Act

The public lands of the Upper Missouri Subbasin are found in two major areas of concentration. Consideration of land pattern and physical and economic environment directed the designation of these areas pursuant to policies of the Classification and Multiple Use Act. The heaviest public land concentration occurs in the east and north sectors of the subbasin, where 2.7 million acres carry retention designations. The concentrations coincide with broken and rough topography along the Missouri, Milk, Musselshell, Judith, and Marias Rivers, and the Armells, Arrow, and Big Dry Creeks. Away from the waterways, the public land incidence is augmented by properties acquired by the Federal government under the Bankhead-Jones Farm Tenancy Act, and known as Land Utilization (LU) lands.

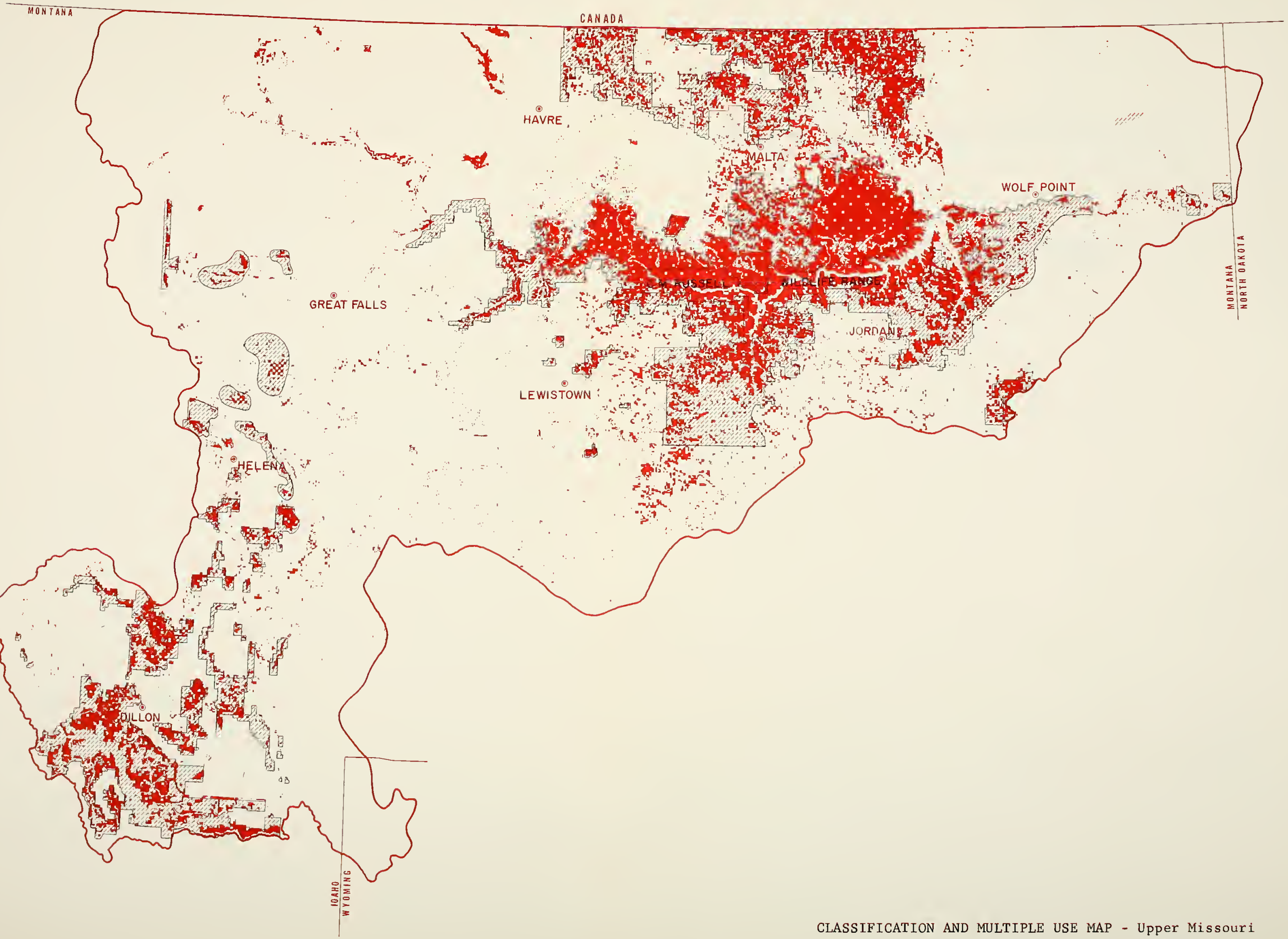
Extending 120 miles east and west along the Missouri River is the 776,000 acre Charles M. Russell Wildlife Range, also designated for retention. Management responsibilities on the Wildlife Range are shared by the Bureau of Sports Fisheries and Wildlife, and the Bureau of Land Management.

In the southwestern part of the subbasin, 1.3 million acres concentrated in the headwaters country of the Missouri River have been classified for retention. The classification determination was based on important land use factors, in addition to the favorable land status pattern. Soils and elevations are unfavorable to cultivation, so extensive forms of use such as grazing and logging are indicated. Recreation opportunities are outstanding, and there is much wildlife. Watershed values are high on the upper tributaries of the Missouri.

Approximately 1.6 million acres of public land, widely scattered throughout the gross area of the Upper Missouri Subbasin, have not been classified under the Classification and Multiple Use Act. In most cases these lands are isolated tracts, where resource values leading to a retention classification are nominal. Exceptions to the isolated character of the public domain may be noted, however, along the Marias River from its mouth to the Blackfoot Indian Reservation, around Fresno Reservoir and along the Milk River, surrounding Lonesome and Wild Horse Lakes, and in the Sweetgrass Hills country close to Canada. The land values in these concentrations can be effectively managed pursuant to authority other than that accompanying a Classification and Multiple Use Act retention designation.

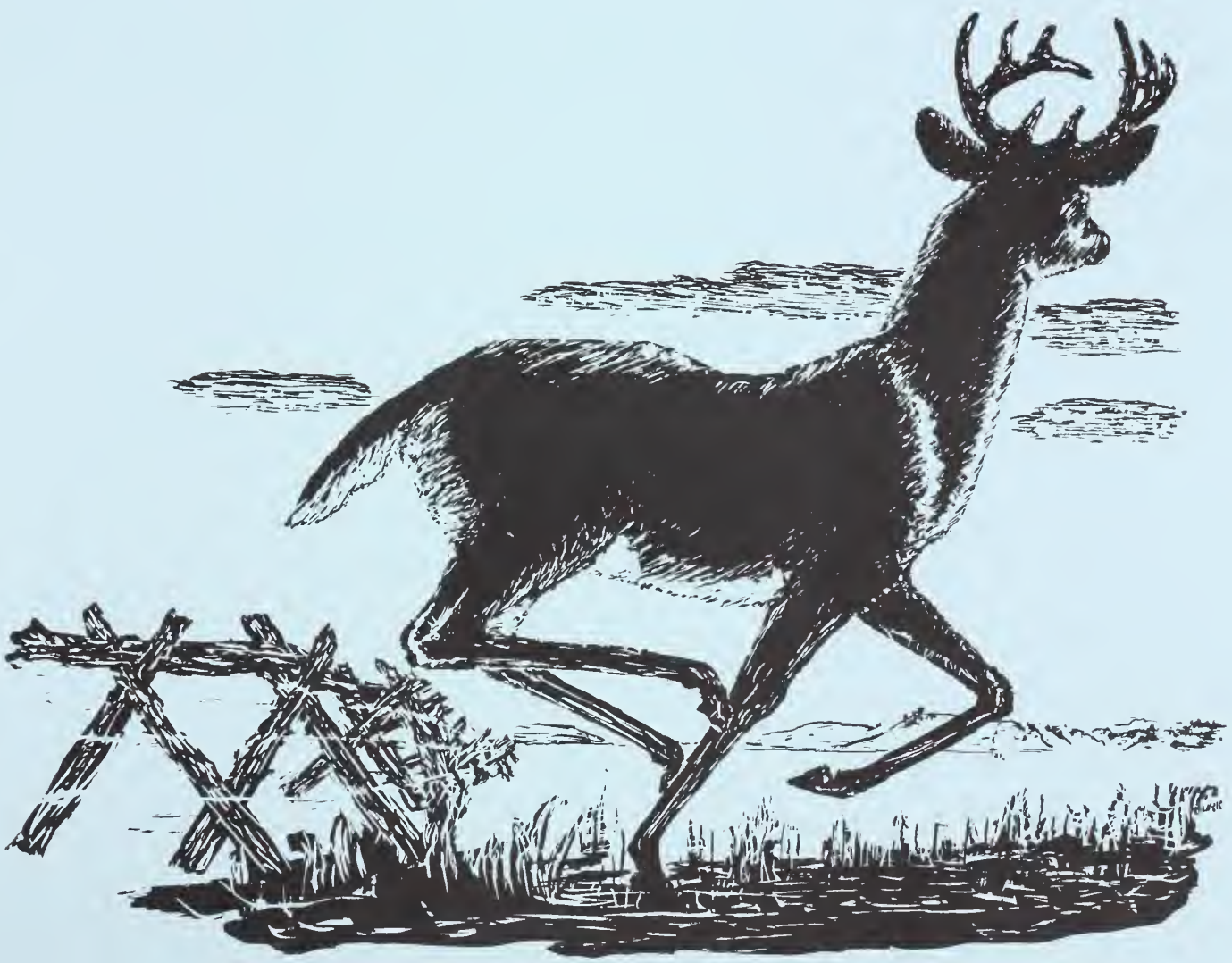
CLASSIFICATION AND MULTIPLE USE MAP - Upper Missouri Subbasin

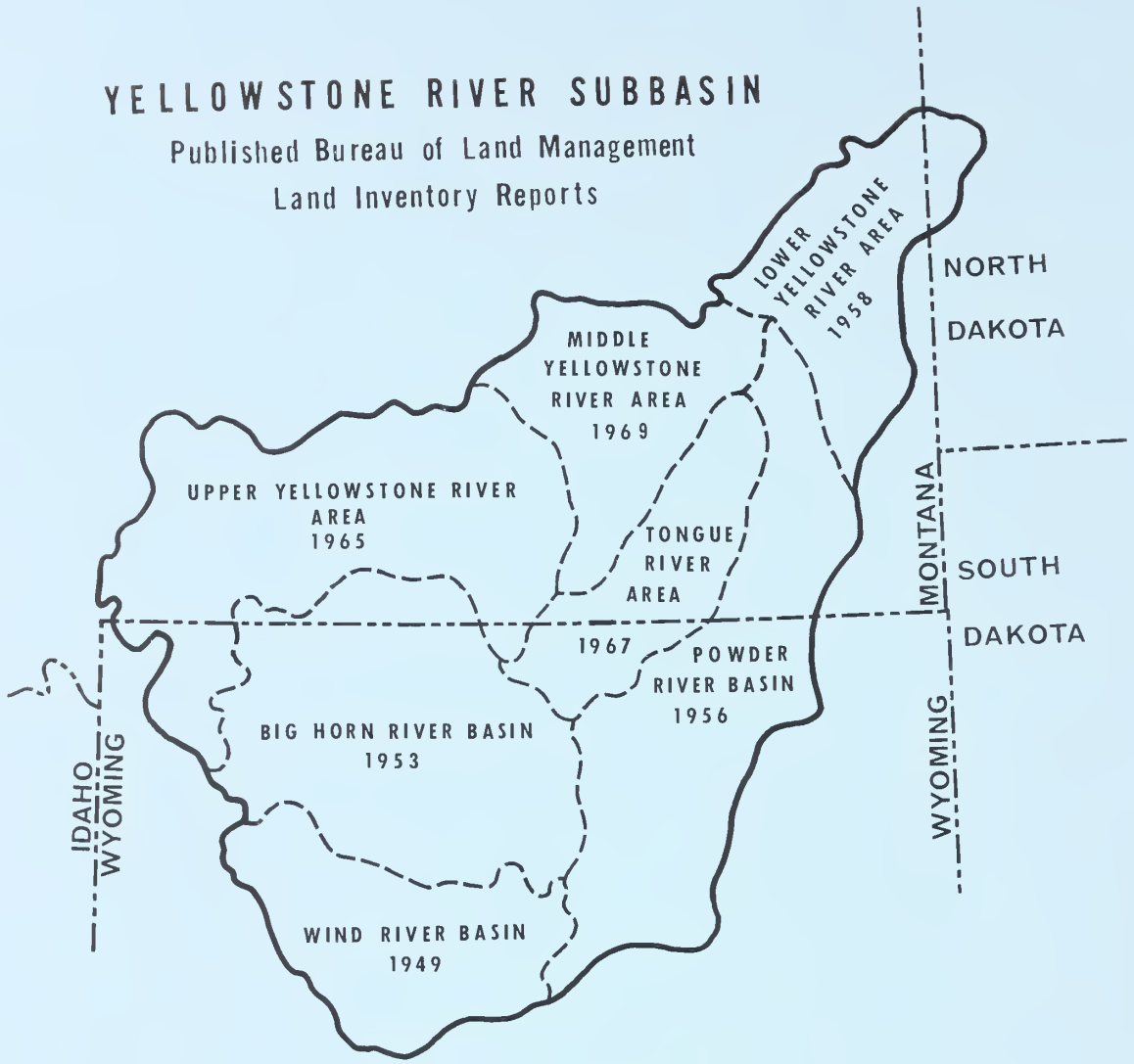
RED PATTERN INDICATES PUBLIC DOMAIN
CROSSHATCH INDICATES RETENTION AREA



CLASSIFICATION AND MULTIPLE USE MAP - Upper Missouri Subbasin

YELLOWSTONE RIVER SUBBASIN




YELLOWSTONE RIVER SUBBASIN
Published Bureau of Land Management
Land Inventory Reports
LOWER YELLOWSTONE RIVER AREA 1958
MIDDLE YELLOWSTONE RIVER AREA 1969
UPPER YELLOWSTONE RIVER AREA 1965
TONGUE RIVER AREA 1967
POWDER RIVER BASIN 1956
BIG HORN RIVER BASIN 1953
WIND RIVER BASIN 1949
NORTH DAKOTA
SOUTH DAKOTA
MONTANA
WYOMING
IDAHO
WYOMING

YELLOWSTONE RIVER SUBBASIN

General Description

The pear-shaped Yellowstone Subbasin lies in north-central Wyoming and eastern Montana. It measures 450 miles long by 320 miles wide and contains 45.1 million acres. Wyoming has 22.7 million acres, or 50 percent, Montana has 21.9 million acres, or 49 percent, and North Dakota has 0.5 million acres, or 1 percent. The Bureau of Land Management administers over 8 million acres, approximately 18 percent of the land area.

LAND AREA

	Subbasin		Public Domain	
	(acres)	(% of subbasin)	(acres)	(% of subbasin)
Montana	22,740,000	50	1,910,000	4
Wyoming	21,947,000	49	6,133,000	14
North Dakota	511,000	1	--	-
TOTAL	45,198,000	100%	8,043,000	18%

Topography varies from the high, steep, rough Rocky Mountains on the west, to the smooth, rolling Northern Great Plains on the east. There are arid basins, badlands, and abruptly-rising mountain ranges. Elevations vary from over 13,000 feet along the Continental Divide to 1,500 feet at the confluence of the Yellowstone and Missouri Rivers.

The climate varies with elevation. Average annual rainfall ranges from 6 inches in the arid basins such as the Bighorn, to 13 inches in the foothills, and over 45 inches in the mountains. About 50 percent of the precipitation falls during the growing season. Average annual temperatures vary by as much as 48° in various locations, with extremes ranging from 100° above zero to 40° below.

More than 276,000 people live in the subbasin. The average density is four persons per square mile; Wyoming has three, and Montana has five people per square mile. Billings, Montana, population 60,500, is the only urban area.

The subbasin's largest land use is for pasture and range, with 33.6 million acres, or 74 percent being grazed. Forests and woodlands cover 6.1 million acres, or 14 percent, croplands cover 3.4 million acres, or 8 percent, and recreation areas cover 1.4 million acres, or 3 percent. The remaining 0.7 million acres is classed as miscellaneous.

SUBBASIN LAND USE

	Acres	% of Subbasin
Pasture and Range	33,628,000	74
Forest and Woodland	6,100,000	14
Cropland	3,400,000	8
Recreation	1,400,000	3
Water	300,000	1
Urban and Transportation	200,000	
Other Agriculture	100,000	
Fish and Wildlife	50,000	
Mineral Industry	10,000	
Military	10,000	
TOTAL	45,198,000	100%

Surface Runoff

Surface runoff contributed by the watersheds of the Yellowstone Subbasin is an important part of the total water economy of the Missouri River Basin. The Yellowstone system contributes an average of 9.3 million acre feet annually, which is 2 million acre feet more than the Missouri River mainstem flow at their confluence in western North Dakota. The Yellowstone produces 16 percent of the Missouri River's total discharge at its mouth, which averages about 57 million acre feet annually.

The Yellowstone has a larger area in the high runoff zone of 4 inches or more annually than any other headwaters subbasin in the Missouri River system. This high runoff zone consists essentially of the Wind River and Absaroka mountain ranges, extending eastward from the Continental Divide. The upper elevations of the Bighorn range in north-central Wyoming also provide a high-yielding watershed. Public domain is scarce in the high-yield zones, consisting of scattered tracts in the vicinity of Livingston, Montana, plus small concentrations near Dubois and Lander, Wyoming on the eastern flanks of the Wind River range.

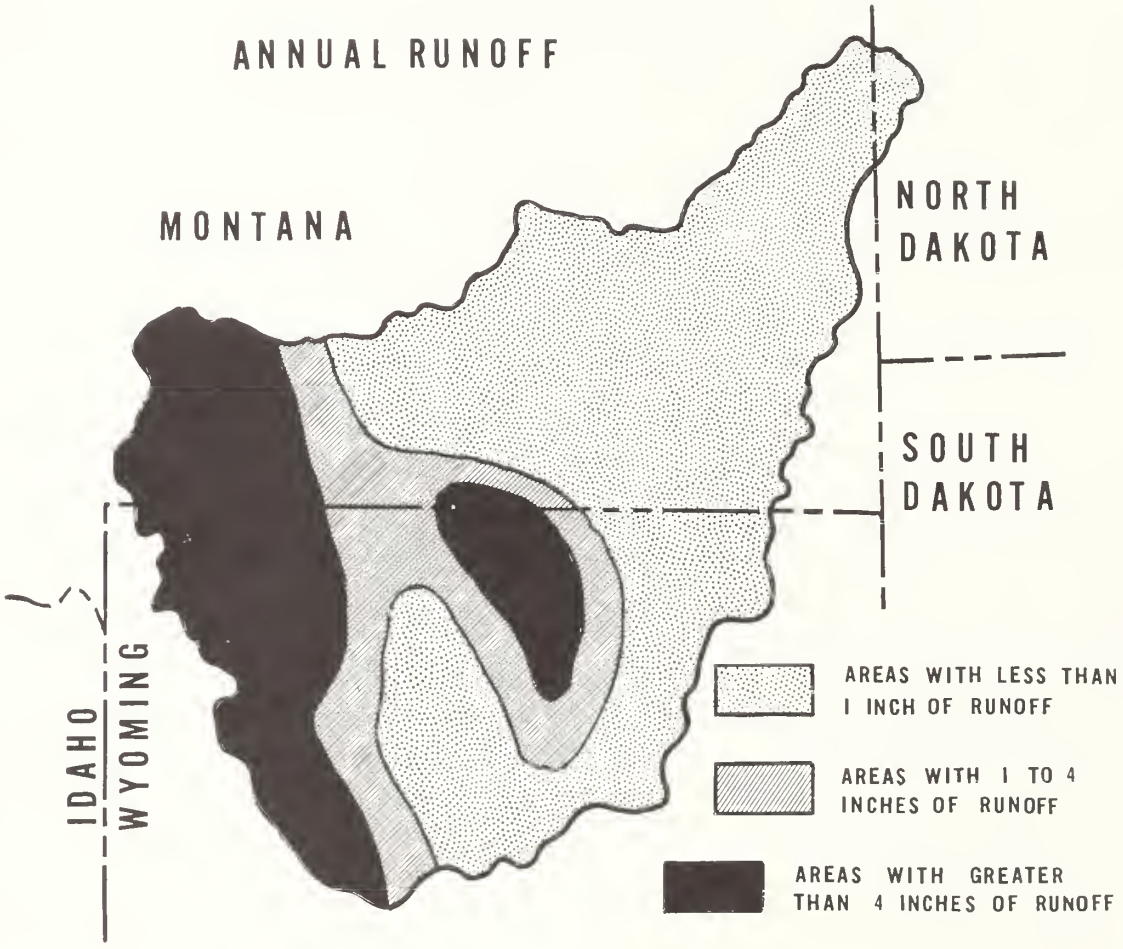
The 1 inch to 4 inches medium runoff zone occupies mid-elevations, in a band extending eastward from the mountain ranges onto the high plains. Public domain is abundant in this zone, especially south from Cody, Wyoming, past Meeteetse, and bordering the Wind River Indian Reservation. The zone also surrounds the Bighorn range in a concentric band on a contour level, with public domain abundant west of the mountain range, but nearly absent on the east.

The low runoff zone of 1 inch or less occupies the plains and lower elevations of Wyoming and Montana. It includes the drainages of the lower Bighorn River, the Tongue, the Powder, and the lower mainstem of the Yellowstone River. The largest concentrations of public domain in the Missouri River system are found in the lowest runoff zone of the Bighorn and Wind River Basins. In this area the land pattern is virtually solid, and well adapted to public administration. East of Buffalo and Kaycee, Wyoming, public lands are abundant, extending northeastward through Broadus, Montana in the drainage of the Powder River. Another area of concentration surrounds Miles City, Montana, extending eastward to the subbasin boundary along the North Dakota State line, and westward 80 miles or more.

Although the high and low runoff is expressed in this section in terms of "less than 1 inch" to more than 4 inches," the measured

extremes range from one-fourth inch to 20 inches. The accompanying map has been reproduced in simplified form to show the location of high and low runoff zones within the subbasin.

In general, the concentrations of public land correspond to areas of low surface runoff, reflecting in large measure the relatively low average annual precipitation. The fragile nature of much of the public land requires that it be used with care to avoid environmental damage. Thus, the most suitable forms of use have been found to be grazing, wildlife habitat, recreation, and watershed values. Although the unit increment of runoff is low, the total watershed value of the public land is still great in view of the vast acreages contributing to streamflow.



Surface runoff is the subbasin's main source of stockwater.

Ground Water

Favorable ground water recovery areas designated on the accompanying map are those where properly constructed and located wells less than 1,000 feet deep are capable of yielding more than 300 gallons per minute.

Three basic ground water areas have been identified in the Yellowstone River Subbasin. The largest encompasses the entire length of the Yellowstone River, including the major portion of six of its tributaries; another area is found in a contiguous band along the northeastern, northern, and western slopes of the Bighorn Mountains, and a smaller area lies along the Wind River, upstream from Boysen Reservoir in Wyoming.

Approximately 182,000 acres of public land overlie the Yellowstone River aquifer. This land is scattered unevenly, the major concentration being in the Powder River and O'Fallon Creek areas. Water quality varies, with total dissolved solids ranging from 250 to 4,000 parts per million. Recommended maximum tolerance levels are approximately 500 parts per million for human consumption, 10,000 parts per million for beef cattle, and 1,750 parts per million for irrigation of field crops.

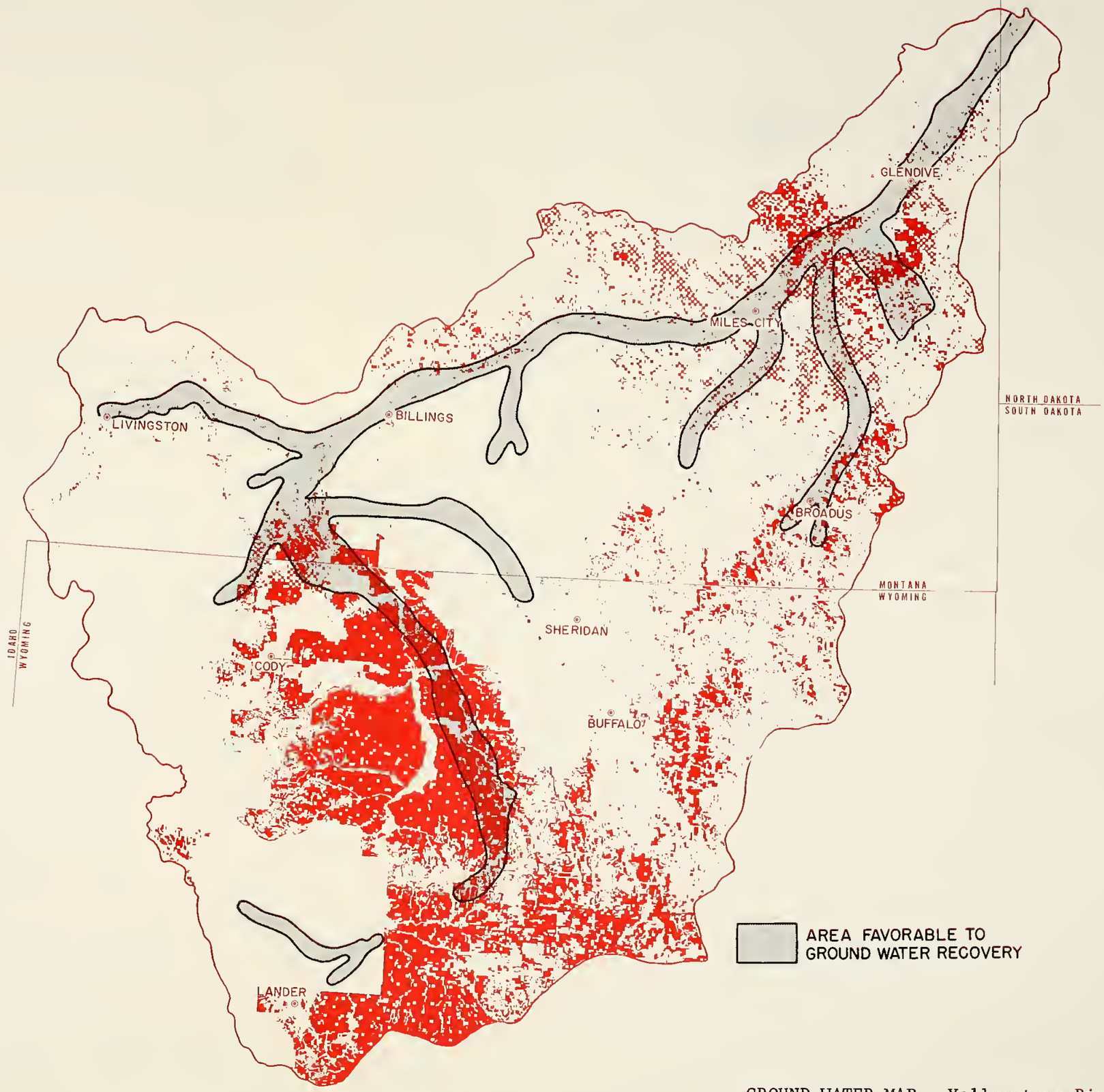
The Bighorn aquifer lies principally along the western slopes of the Bighorn mountain range at the approximate elevation of Hyattville and Tensleep, Wyoming. It continues northwest toward the Pryor Mountains, thence to the southeast, following the contour of the Bighorn range to the approximate latitude of Sheridan, Wyoming.

About 600,000 acres of public land overlie the aquifer, all in the western sector. The water quality is reasonably good, containing from 250 to 2,000 parts per million of dissolved solids. There has been relatively little development of this ground water, probably due to the availability of surface irrigation supplies in the agricultural sections of the Bighorn Basin. Another reason could be the relatively unfavorable topography of the area in which the aquifer is located.

The Wind River aquifer is located on the Wind River Indian Reservation and no vacant public land is associated with it. This well developed aquifer is of good quality water with total dissolved solids ranging from 250 to 500 parts per million.

GROUND WATER MAP - Yellowstone River
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



GROUND WATER MAP - Yellowstone River Subbasin

Streamflow Depletions

Streamflow depletion is anything, whatever its reason, that prevents water after entering an area, from leaving that area by way of the master drainage. The reduction in flow can result from natural or man-made influences, such as transpiration by water-loving plants along stream banks, or consumptive use by cultivated crops.

Total streamflow depletion in the Yellowstone River Subbasin is 344,800 acre feet annually. Sixty-two percent of the depletions result from irrigated farming, and 24 percent from reservoir surface evaporation. Watershed treatment practices and stock watering ponds account for 19 percent. Forest management practices add 5 percent to the streamflow; within certain limits, streamflow is augmented when forests are cut, and diminished as the forest cover increases.

Streamflow depletions caused by Bureau of Land Management projects on public lands reduce streamflow by 16,345 acre feet annually, or 5 percent of the total depletion. Public domain depletions result from two general practices:

1) Impoundments
2) Land treatment measures.

The impoundments are stock watering reservoirs and flood control structures on secondary drainages, with an average size of 3 surface acres. Approximately 2,000 such ponds have been constructed.

The second major source of depletion is land treatment practices, such as contour furrowing, rangeland pitting, water spreading, dikes, and water diversions. These practices deplete streamflow through evaporation to the air and infiltration to the ground. The net result is beneficial, since surface runoff reaches the stream channels in a more even flow, soil erosion is reduced, and range management is enhanced. In the subbasin, approximately 18,000 acres of public land have been treated.

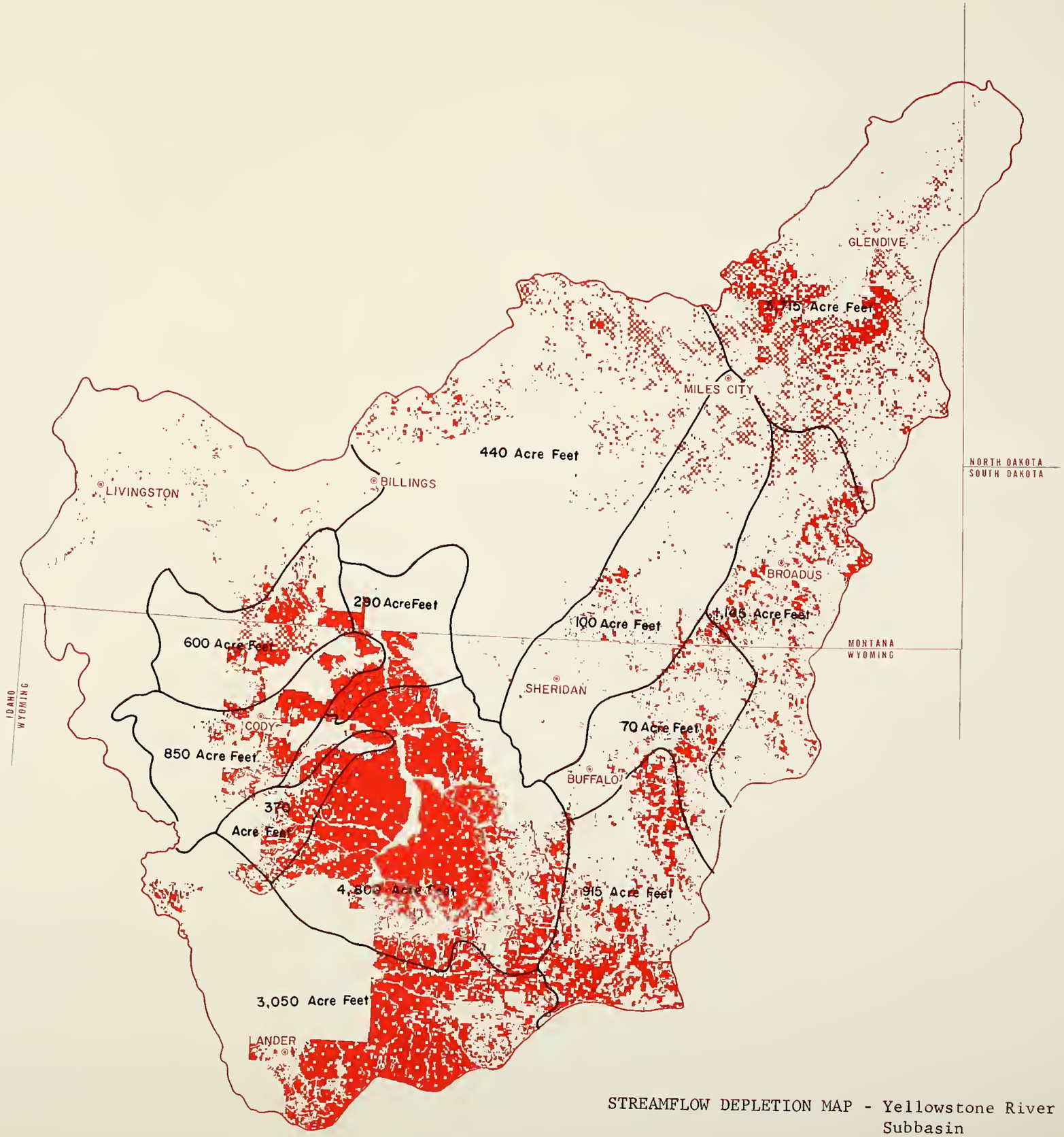
The accompanying table summarizes watershed depletions from impoundments and land treatment practices on public lands in the Yellowstone River Subbasin. Tributary basins are listed in descending order of depletion, rather than by geographical association.

ANNUAL STREAMFLOW DEPLETIONS

Tributary Basin	BLM Depletion (acre ft)	BLM Relative Depletion In Tributary Basin (%)	All Depletions In Tributary Basin (acre ft)
Big Horn Basin, Boysen Dam to Kane, Wyoming	4,800	17	27,800
Lower Yellowstone to Sidney Montana	3,715	15	24,800
Wind River Basin, Wyoming	3,050	3	89,600
Lower Powder River	1,145	10	11,300
Upper Powder River	915	10	9,900
Shoshone River	850	1	76,700
Clarks Fork River	600	14	4,300
Yellowstone Valley, Billings to Miles City, Montana	440	12	23,500
Greybull River	370	53	700
Bighorn Basin, Kane to St. Xavier, Montana	290	1	26,400
Tongue River	100	1	11,700
Middle Powder River	70	2	3,100
All Other Areas, Yellowstone River Subbasin	--	--	35,000
	16,345	5% (average over entire subbasin)	344,800

STREAMFLOW DEPLETION MAP - Yellowstone River Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



STREAMFLOW DEPLETION MAP - Yellowstone River Subbasin

Sedimentation

The Yellowstone River Subbasin has a watershed area of 45,198,000 acres. About 18 percent, or 8,043,000 acres is public land administered by the Bureau of Land Management. An additional 8,052,000 acres are under jurisdiction of other Federal agencies.

Throughout this watershed, rainfall is erratic; frequent high intensity storms subject the area to rapid runoff and flooding. The heaviest runoff to surface streams occurs during the spring as the result of snowmelt and early rains. These periods of high runoff produce substantial amounts of sediment.

The accompanying map and chart illustrate variations in sediment production resulting from different soils, topography, vegetative cover, etc.

The principal damages caused by sediment are:

1) damage to agricultural land and crops from deposition of sediment;
2) silting of irrigation supply canals;
3) silting of drainage ditches, resulting in excessive maintenance costs;
4) the impairment of surface or internal drainage;
5) loss of storage capacity in reservoir;
6) maintenance of roads and highways necessitated by silting of road ditches and blocking of culvert heads, causing overflow;
7) excessive water purification costs in removing sediment from urban and industrial water supply;
8) silting associated with flood damage to homes, industrial, and other properties.

Within the Yellowstone subbasin, 65 percent of the 8,043,000 acres of public domain is located in the Bighorn and the Wind River Basins of Wyoming. These basins account for 4,750,000 acres of public land; most of the sediment they produce settles in the Boysen and Yellowtail Reservoirs.

Public domain in Montana makes up 25 percent, or 1,900,000 acres, of the subbasin's total. The largest concentrations are in Carbon, Custer, Powder, Prairie, and Rosebud Counties. These lands contribute significant amounts of sediment to the Yellowstone River system, with no major impoundments to intercept it.

The highest sediment loss factor occurs in the Powder River, with a watershed of 8,440,000 acres in Wyoming and Montana. About 1,856,000 acres are public domain. The Powder River watershed is the largest contributor of sediment to the Yellowstone River. The flow of the Powder River is not regulated by reservoirs, so sediment goes directly to the Yellowstone and to the Missouri River mainstem.

The Yellowstone contributes the subbasin's collective suspended sediment to the Missouri River in North Dakota, 3 miles east of the Montana line. This sediment load has an annual volume approaching 15,000 acre feet, and diminishes the useful life of the Missouri River reservoir system.

Watershed protection measures such as re-seeding, water-spreading, and proper rates of grazing, can reduce peak flows and sediment production caused by runoff. However, the identifiable effect diminishes as distance from the treatment area increases. Intensive management practices are needed to stabilize high sediment producing areas. In 1966, it was estimated that 37 percent of privately owned land, and 56 percent, or 4,507,000 acres of Bureau of Land Management land, were adequately managed or treated. It was also estimated that 2,478,000 acres of public domain were in need of augmented management practices, and 1,058,000 acres needed supplemental management plus vegetative or mechanical treatment.

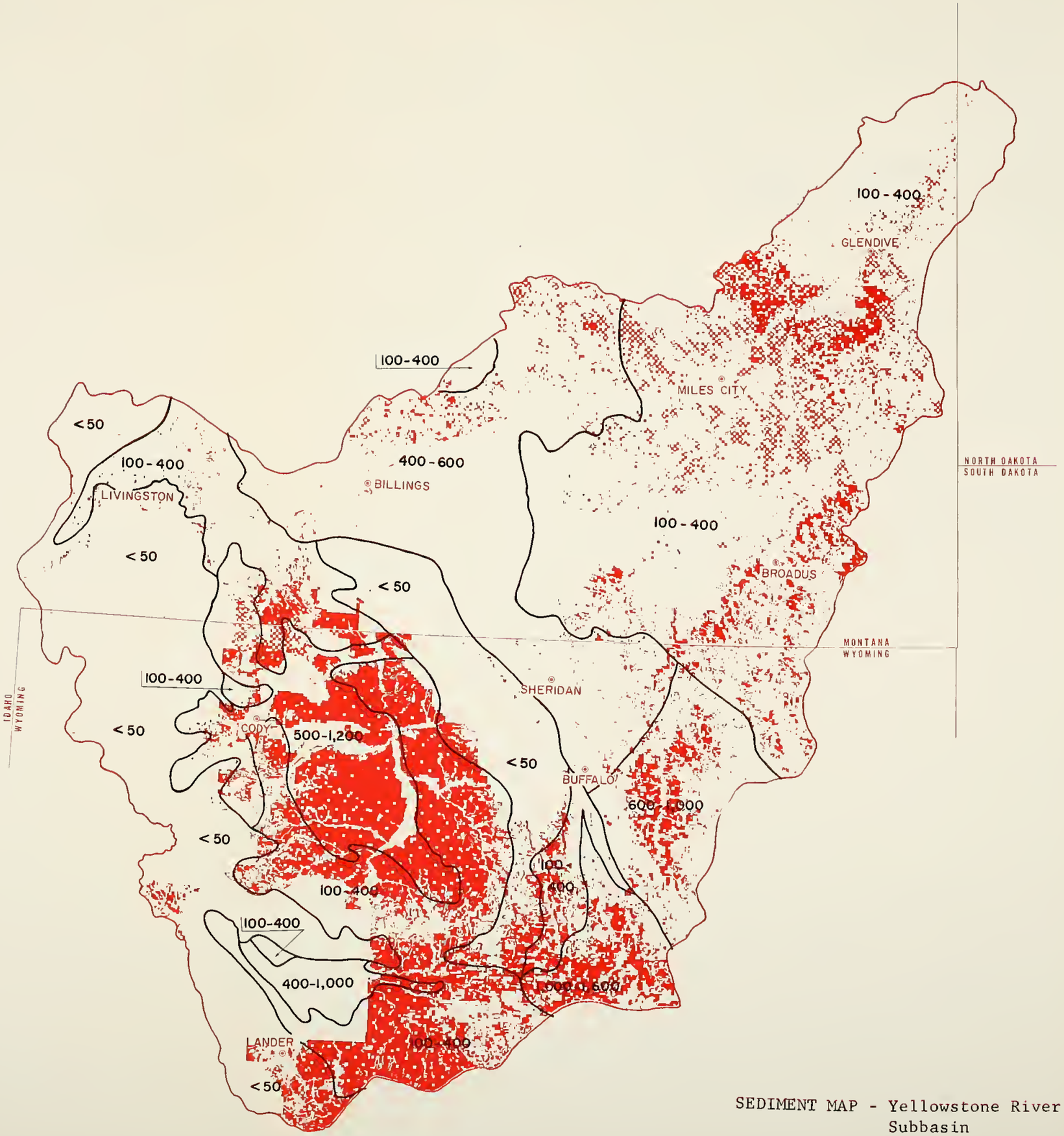
In the following table, gross sediment loss for several hydrologic subareas in the Yellowstone system is given. These figures appear in the Hydrologic Appendix of the Type I Comprehensive Framework Study Report. Sediment loss factors obtained from the same source, applied to the amount of public domain, and divided by the conversion value of 1,416, provide an acre-foot estimate of sediment derived from the public lands. This figure is only an average over an extensive area, since unit sediment yields vary so widely between individual watersheds.

SEDIMENT MEASUREMENT

Hydrologic Subarea	Land Area		Loss Factor	Average Annual Sediment Loss	
	Public Land	All Land		Public Land	All Lands In Hydrologic Subarea
	--(sq mi)--		tons/sq mi	------(acre ft)-----	
Yellowstone R. at Sidney, Mont.	12,570	69,100	304	2,700	14,800
Tongue R. at Miles City, Mont.	280	5,400	78	15	295
Powder R. at Locate, Mont.	2,840	13,190	530	1,050	4,950

SEDIMENT MAP - Yellowstone River
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
LOSSES IN TONS PER ACRE PER YEAR



SEDIMENT MAP - Yellowstone River Subbasin

Land Resource Regions

The Yellowstone River Subbasin contains three major Land Resource Regions, as follows:

1) Western Range and Irrigated Region
2) Rocky Mountain Range and Forest Region
3) Western Great Plains Range and Irrigated Region.

Each Region consists of several geographically associated Land Resource Areas, each of which is identified according to its principal features of soil or topography. Only the Regions are designated on the accompanying map, however, partly because their names are descriptive of major land use, and partly to avoid the use of numerous sub-area boundary lines in the limited map space.

As shown by the following table, rangeland is dominant as the form of public land use in the Yellowstone Subbasin. The forests and woodlands include areas of sawtimber, stands utilized for posts and poles, and broadleaf trees along stream bottoms. A third major designation, "Cropland," found in most broad-scale land classification charts, is omitted because none of the public domain is used for cultivated crops.

PUBLIC LAND USE

Region	BLM			Regional Total All Lands
	Pasture & Range	Forest & Woodland	Total	
	---------(acres)----------			
Western Range & Irrigated Region	3,571,000	129,000	3,700,000	8,588,000
Rocky Mountain Range & Forest Region	1,266,000	182,000	1,448,000	12,655,000
Western Great Plains Range & Irrigated Region	2,811,000	84,000	2,895,000	23,955,000
	7,648,000	395,000	8,043,000	45,198,000

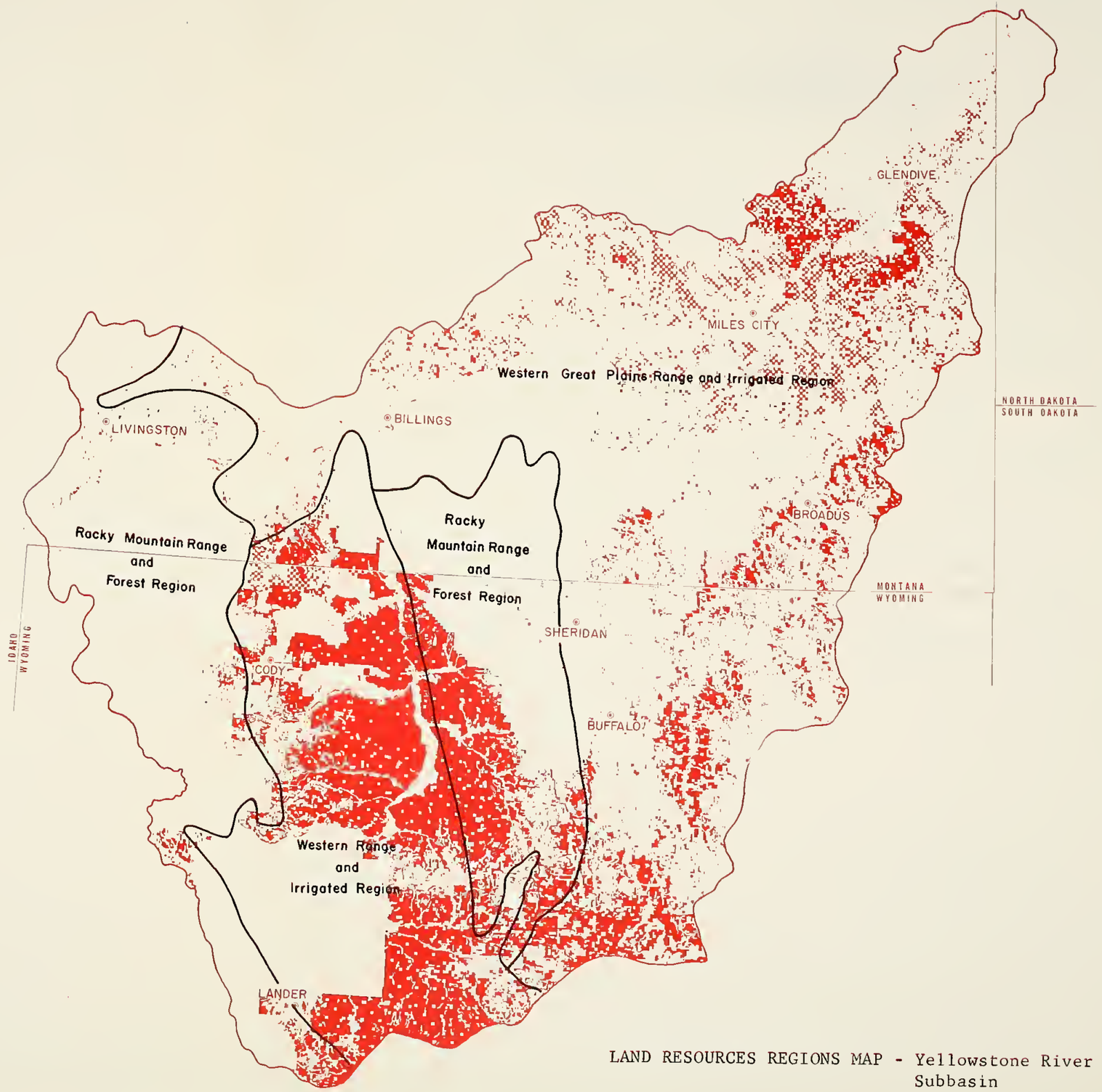
The most striking feature of the accompanying map is the concentration of public land in the Western Range and Irrigated Region. Of the 8,043,000 acres of public domain in the Yellowstone Subbasin, 46 percent, or 3,700,000 acres, is found in the Western Range and Irrigated Region. Public lands comprise 43 percent of the Region, which is the highest for any Land Use Region in the Missouri Basin. This Land Use Region is centered on the Bighorn and Wind River Basins, where the climate is semiarid to arid; the average annual precipitation ranges from 6 inches to 10 inches over a large part of both basins. The plateaus, plains, and alluvial slopes are badly eroded over much of the Region. The native plant cover is sparse and easily damaged. Grazing management must make allowance for the frail nature of these lands. Seasons of use, proper rates of stocking, and range improvements through mechanical treatment are utilized to make best use of the resources, while affording maximum protection. Approximately 85 percent of the Western Range and Irrigated Region is used for grazing. The public lands form large, well blocked management areas, which can be efficiently administered for grazing purposes.

The Rocky Mountain Range and Forest Region occupies two distinct mountainous areas, the Bighorn range on the east, and the Wind River and Absaroka ranges on the west. The public lands are concentrated on the middle and lower slopes of the west side of the Bighorn Mountains, where they form a contiguous pattern. Most of the 1,448,000 acres of public domain in the Region are concentrated in this band. The lands also extend to the south end, and around the southeastern quarter of the Bighorn Mountains in moderate concentration. The forest and woodland type is reasonably well represented in this Region with about 82,000 acres in the Bighorn Mountains and 100,000 acres in the Wind River range. Approximately 11 percent of the Rocky Mountain Range and Forest Region consists of public land. The Region is important for forest products as well as grazing. Growth conditions for native forage are favorable. The principal problem is one of determining and maintaining proper management practices. In addition to seasons of use and rates of stocking, livestock trailing is an important management consideration.

The Western Great Plains Range and Irrigated Region extends northeastward from the Bighorn Mountain foothills to the eastern limit of the Yellowstone Subbasin. There are 2,895,000 acres of public domain, which form 12 percent of the total land surface. The land pattern is noticeably more scattered than in the two western Regions of the subbasin. About 60 percent of this Region is grazing land. Native vegetation is a mixture of short and mid-grass prairie species. The grasses are quite productive, but must be supplemented by feeding during the winter. The native plant cover furnishes good soil protection if properly used and managed. Forage production can fluctuate widely due to seasonal variations in precipitation. Adjustment of grazing use to match forage supply is the basic management problem on public grazing land in the Western Great Plains Range and Irrigated Region.

LAND RESOURCES REGIONS MAP - Yellowstone River
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



LAND RESOURCES REGIONS MAP - Yellowstone River Subbasin

Livestock

The total area in the Yellowstone River Subbasin is 45,198,000 acres, of which 8,043,000 acres are public domain administered by the Bureau of Land Management. Vegetation produced on 96 percent of the public lands makes an important contribution to the growth and maintenance of range livestock, both cattle and sheep. The remaining 4 percent of public domain has a land capability classification of VIII, Waste or Barren, which contributes little to the livestock industry, but does provide wildlife habitat and watershed values.

PUBLIC DOMAIN CONTRIBUTION TO LIVESTOCK PRODUCTION

Usable Range	Number of Permittees	Number of Cattle*	Number of Sheep*	Grazing Use
(acres)				(AUM's)
7,721,000	2,240	440,000	1,070,000	1,155,000

*These livestock also utilize non-Federal rangelands.

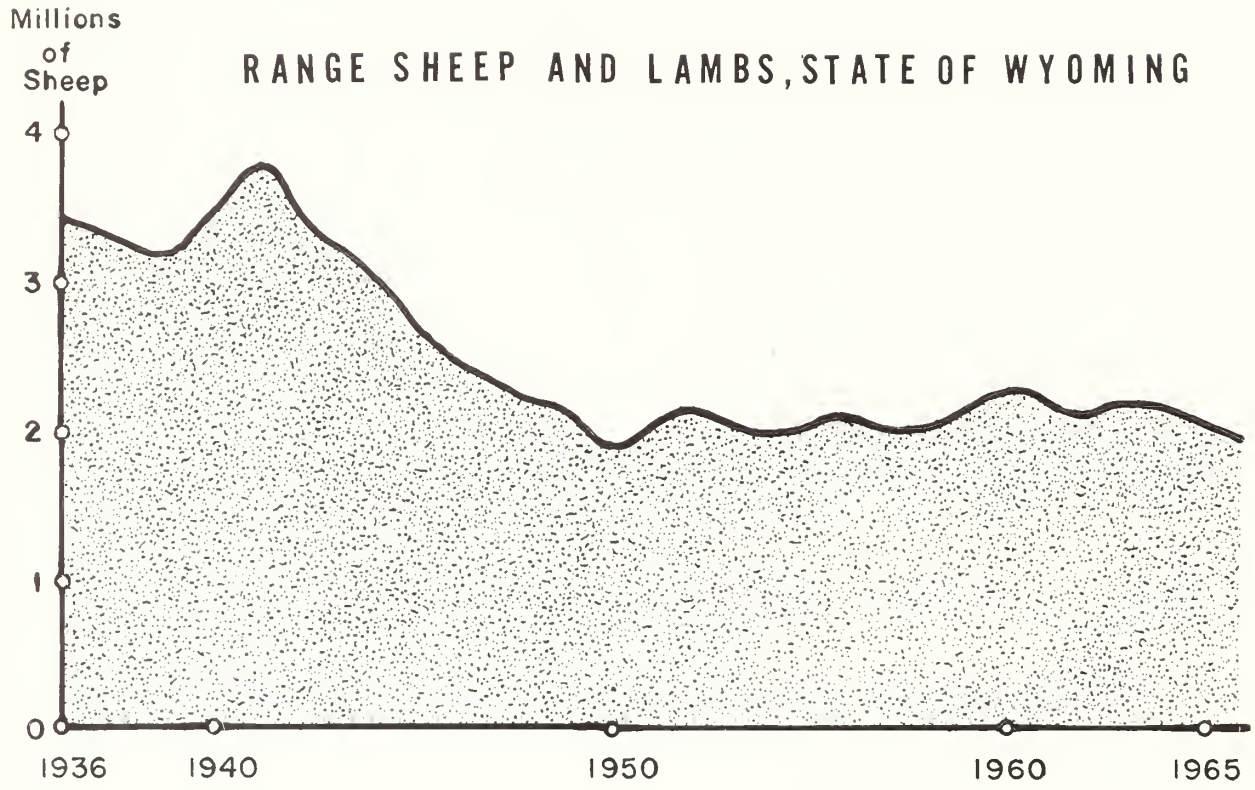
Of the public lands in the Yellowstone drainage, 6,133,000 acres are in Wyoming, with the greatest concentration of the entire Missouri River system in the Bighorn and Wind River Basins.

There are 1,910,000 acres of public domain in the Montana section of the subbasin, concentrated mainly in the Miles City, Glendive, and Broadus areas, and southwest of Billings near the Montana-Wyoming State line. Bureau of Land Management Districts in the Yellowstone Subbasin include all, or parts of, the Worland, Lander, and Casper Districts, Wyoming and the Billings and Miles City Districts, Montana.

Eighty-one percent of the subbasin is used as range for the production of cattle and sheep. Cattle are raised in all parts of the subbasin, and management practices are oriented toward a cow-calf or a cow-calf-yearling production program. There are exceptions, however, such as on the eastern slopes of the Absaroka Mountains, where some cattle ranching is based on steer production.

Although less significant now than formerly, the range sheep industry is an important segment of the subbasin's economy. This is especially true of the north-central part of Wyoming, sometimes

referred to as the Bighorn Basin and Contiguous Area[1/], where about 29 percent of the sheep raised in the State of Wyoming are produced. The following graph illustrates the declining sheep and lamb numbers of Wyoming on a statewide basis. That part of Wyoming in the Yellowstone Subbasin follows the statewide trend.



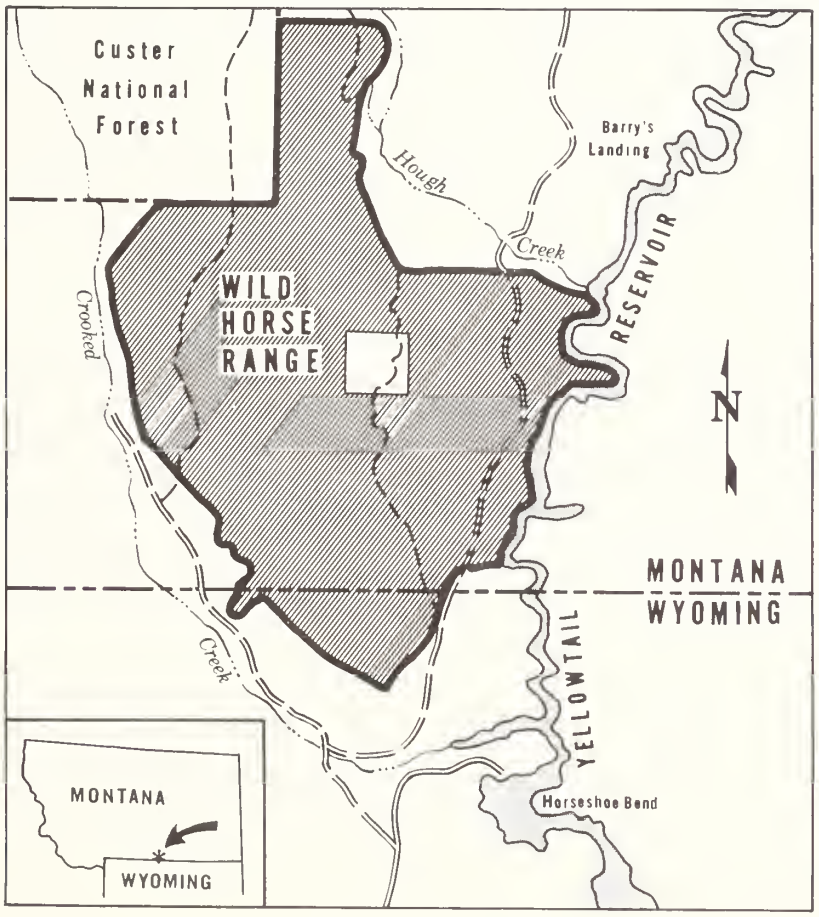
Grazing capacity on public lands is computed in animal unit months (AUM's), which represent the amount of forage sufficient to support a mature cow, or the equivalent, generally considered to be five sheep, for 1 month. Grazing fees, based on the animal unit month, are established by the Secretary of the Interior at a rate equal to a specified percentage of the average market price per pound of beef and lamb in the 11 western States during the preceding calendar year. During 1971, the fee was 44¢ per animal unit month.

1/ Four counties in the Bighorn Basin, western half of Sheridan and Johnson Counties and the Wind River Basin in Fremont County.

In 1964, total receipts from crops and livestock in the Yellowstone Subbasin amounted to $169 million. More than $118 million, or 70 percent, was derived from livestock or their products. In the year 1969, there were 405 million pounds of cattle and calves in the subbasin. This figure is expected to increase 42 percent, to 579 million pounds, by 1980. By 1969, there were also 74 million pounds of sheep and lambs; a 3 percent increase, to 75 million pounds, is anticipated by 1980.

On September 12, 1968, the Secretary of the Interior set aside a 31,000 acre wild horse and wildlife range to be designated the Pryor Mountain Wild Horse Range. This area, shown on the map, consists of 30,000 acres of public land and 1,000 acres with other status. The Bureau of Land Management treats wild horses as members of the ecological rangeland community. Policies have been adopted for preservation of the animals, and protection of their habitat resources in an area suited to their life habits.

PRYOR MOUNTAIN WILD HORSE RANGE



Stockwater

Surface runoff, impounded in earth structures, is the main source of stockwater in the Yellowstone River Subbasin. Projects of this type provide 60 percent of the water consumed by livestock. Wells produce 5 percent, while perennial streams, intermittent drainages, springs, and other sources furnish 35 percent.

Half of the 4,750,000 acres of public land in the Wind River and Bighorn Basins occurs in the zone where annual rainfall averages about 6 inches. Surface water is not dependable yearlong as a livestock source due to erratic precipitation. Stockwater impoundments are unfavorably affected by deficient runoff and unstable soils. These factors contribute to use of the range for winter grazing by sheep, with snow utilized directly by the animals as their major source of water. Yearlong grazing in the downstream reaches of the Yellowstone Subbasin in Montana, with more uniform precipitation, is largely dependent on impounded surface runoff for stockwater.

Stockwater ponds on public domain number approximately 2,000, with a combined surface area of about 6,000 acres. The 440,000 cattle and 1,070,000 sheep grazing the public lands consume an estimated 6,885,000 gallons of water daily. Fifty-five percent of the 7,721,000 acres of public land used for grazing is adequately supplied with stockwater under the standard formula recommending 3/8 to 3/4 of a mile travel distance to water for rolling terrain, and 3/4 to 1 mile on level ground. As surface runoff moves downstream, water quality declines to where it may contain dissolved solids amounting to 4,000 parts per million. The maximum dissolved solids tolerance by range cattle is considered to be 10,000 parts per million.

Ground water formations have been identified along the length of the Yellowstone River including major portions of six tributaries. Another ground water source is found along the northeastern, northern, and western slopes of the Bighorn Mountains at the approximate elevation of Hyattville and Tensleep, Wyoming. About 600,000 acres of public land overlie this aquifer. Water quality is reasonably good, with total dissolved solids ranging from 250 to 2,000 parts per million. A more limited ground water source parallels the Wind River, upstream from Boysen Reservoir.

Coal Resources

The largest coal deposits in the United States lie within the Missouri River Basin in southeastern Montana, northeastern Wyoming, and the western Dakotas. This coal represents one of the most important energy reserves in the country. Recoverable reserves in the Missouri River Basin are estimated at 450 billion tons or 55 percent of the Nation's total. The States of North Dakota, Montana, and Wyoming have about 80 percent of the supply held by the Missouri River Basin. These reserves are very important in their potential to aid in meeting future national needs for electric power, liquid fuels, synthetic gas, and other energy products.

This area of abundant reserves encompasses much of the Yellowstone River Subbasin, which has at least 50 percent, or 4 million acres, of its public domain in coal bearing strata. A large part of the Montana and Wyoming coals are sub-bituminous, grading into lignites in the eastern portions.

In Montana, most of the land in the Yellowstone River Subbasin is underlain by the Tongue River Formation, which is 1,500 to 1,700 feet thick. In places, this formation contains as many as 20 coal beds, some of them 40 feet thick. Best known is the Rosebud coal bed, mined at Colstrip, where it is 28 feet thick. Approximately 56 percent of the coal in Montana is in this locality, in Rosebud, Bighorn, and Powder River Counties. Coal production from the public lands of Montana amounted to 145,000 tons in 1969, almost double what it had been in 1964. Much of the production came from the Yellowstone subbasin.

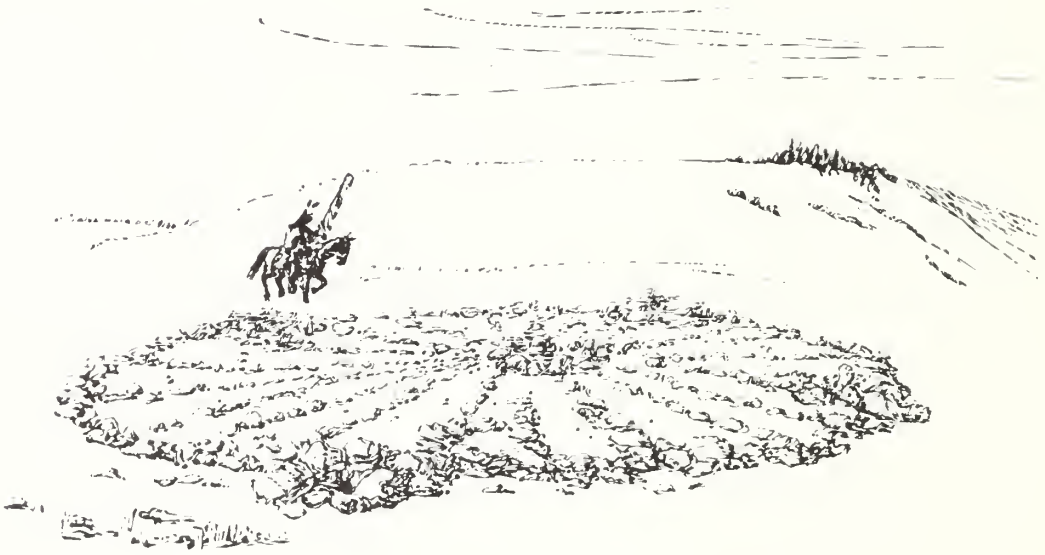
In Wyoming, most of the coal bearing land in the Yellowstone River Subbasin is located in the Powder River and Bighorn Basins. Most of the mining to date has been concentrated near the town of Sheridan, and at Wyodak, near Gillette. Wyoming's public land coal production was 1,641,000 tons in 1969, compared to 1,237,000 tons in 1964. Wyoming has important coal producing areas, however, on public lands outside of the Yellowstone Subbasin, and beyond the boundaries of the Missouri River Basin. In both Wyoming and Montana there are large acreages where coal is reserved to the United States beneath private surface ownership.

Strip mining has proven to be the most economical means of reaching the Montana and Wyoming coal deposits. Although much coal is readily available, the subbasin's geographic location, its comparatively light industrial development, and the availability of competing coal in adjoining subbasins may slow development in the Yellowstone area.

Energy companies are studying the feasibility of constructing, within the Yellowstone River Subbasin, thermo-electric generating plants, and plants for converting coal to petroleum and related products. In anticipation of future development, these companies are beginning to acquire ownership of land and to enter into contracts for water.

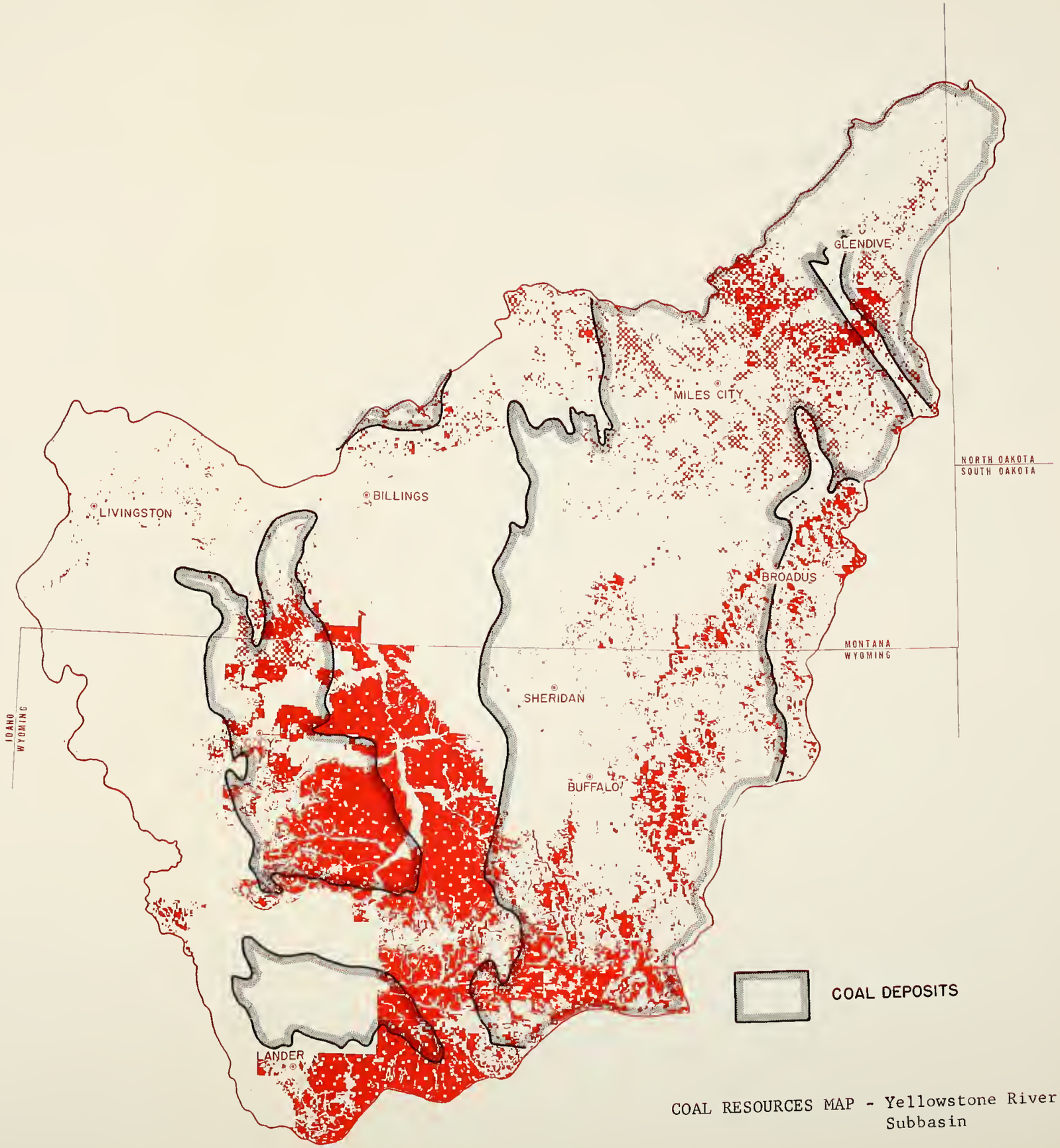
Currently the total output and value of coal remains relatively minor; value of coal production between 1957-63 represented less than 1 percent of oil and gas production during those years. It has been calculated that coal production could represent about 8 percent of the value of oil and gas by the year 2020.

MEDICINE WHEEL IN WYOMING'S BIGHORN MOUNTAINS



COAL RESOURCES MAP - Yellowstone River
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



COAL RESOURCES MAP - Yellowstone River Subbasin

The range sheep industry is an important segment of the subbasin's economy.

Bentonite Deposits

The accompanying map shows the approximate location of bentonitic geological formations and known outcrops of bentonite. Processing plants are also designated.

The accompanying map shows the approximate location of the bentonitic geological formations and known outcrops of bentonite where they occur. Processing plants are also designated.

About 30 percent, or 2,413,000 acres of the public domain in this subbasin, overlies bentonite formations. This public land is in a heavy contiguous pattern over much of the area.

BENTONITE BEARING ACREAGE

	Within Bentonite Formations
	(acres)
Public Domain	2,413,000
Other Land	1,860,000
TOTAL	4,273,000

It has been reported that 15 to 20 million tons of bentonite exist in the Bighorn Basin, Wyoming. Many of the deposits are in the western part of the basin, near Cody. These deposits contain much chert and grit, which has limited their use to local applications.

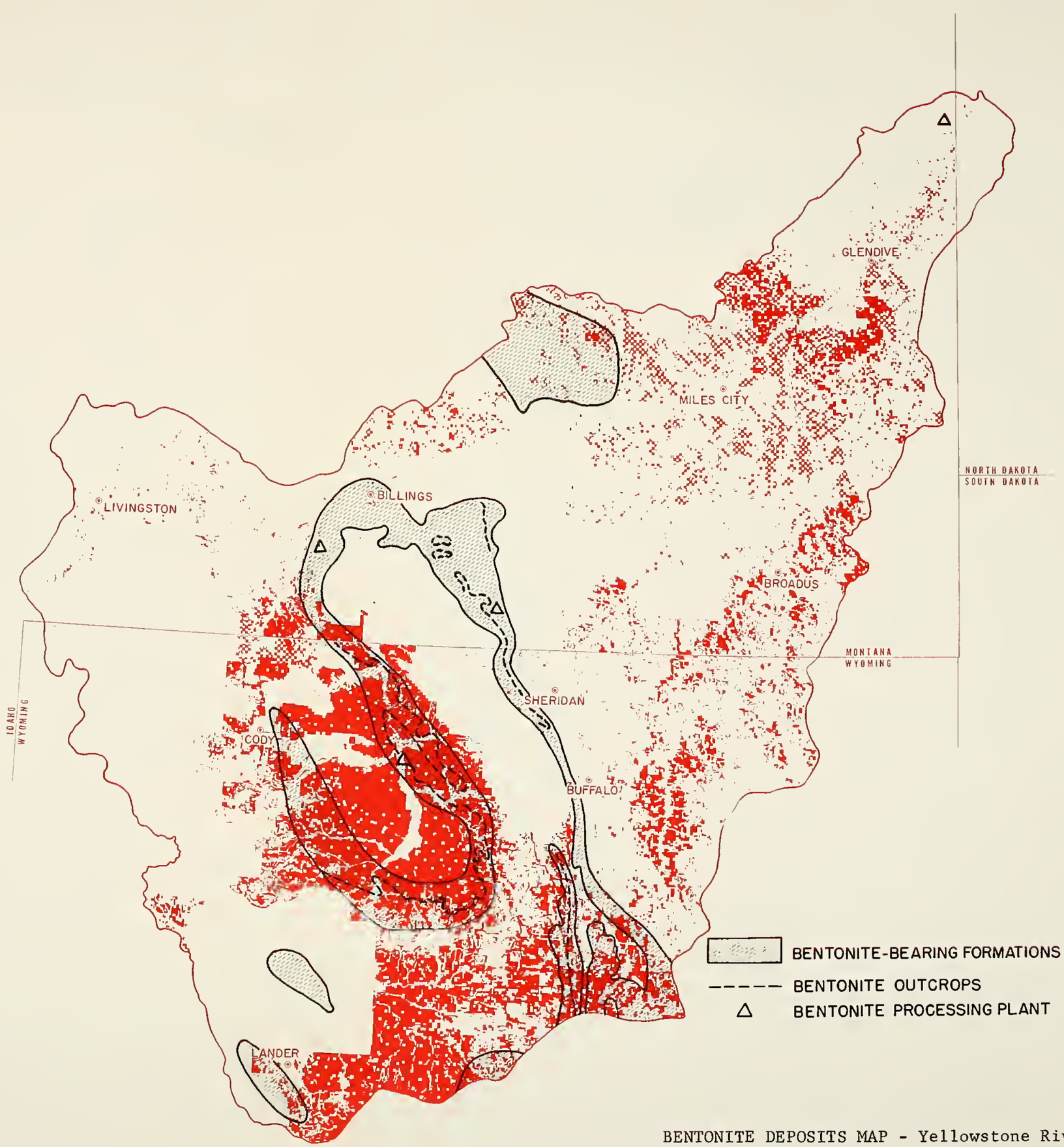
North of Greybull, Wyoming, extensive exploratory drilling has indicated 4 to 5 million tons of all-purpose bentonite, which can be mined economically.

Many deposits of bentonite occur along the east side of the Bighorn Mountains. They are reported to be of good quality, but suffer the economic drawback of a long truck haul to a railroad.

The vast bentonite deposits within the Yellowstone River Subbasin represent a dependable reserve, which will have further development on increased demand, and depletion of present sources.

BENTONITE DEPOSITS MAP - Yellowstone River
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



BENTONITE DEPOSITS MAP - Yellowstone River Subbasin

Fish and Wildlife

Thirteen percent, or 1,022,750 acres of the public domain in the Yellowstone River Subbasin, is important fish and wildlife habitat. These lands are scattered in tracts of varying sizes from the south edge of the subbasin, nearly to its northeastern extremity, as shown on the accompanying map. The areas delineated on the map are essentially public domain with interspersed private holdings.

KEY FISH AND WILDLIFE HABITAT ON PUBLIC DOMAIN

	Land	Water		Total
		Open	Stream	
	(acre)	(acre)	(miles)	(acre)
Key Wildlife Areas	1,015,000	1,500	--	1,016,500
Key Fishing Areas	250	--	214	250
Stock Ponds	--	6,000	--	6,000
	1,015,250	7,500	214	1,022,750

Big game, mostly deer and antelope, with moderate numbers of elk, bighorn sheep, and black bear use more than 1 million acres. The Bureau of Land Management reserves 117,000 AUM's for big game use.

KEY PUBLIC DOMAIN FISH AND WILDLIFE HABITAT BY TYPE

	Pasture and Range	Total Land	Natural Water Stream	Artificial Water Open
	(acre)	(acre)	(miles)	(acre)
Big Game	905,000	905,000	--	--
Upland Game	110,000	110,000	--	--
Waterfowl	--	--	--	1,500
Fishing Areas	--	--	214	250

Public domain provides access and fishing areas for 214 miles of stream. Cold water fish such as cutthroat, brook and rainbow trout are found at high elevations; brown trout and whitefish are found at lower elevations. Mackinaw or lake trout live in some of the deeper lakes, and golden trout and grayling live in a few of the alpine lakes. Warm water fish such as walleye, pike, catfish, burbot, bass, and sauger live in the streams and lakes of the eastern portion. In the lower portion of the Yellowstone River, paddlefish have established themselves. Land management influences the streamflow, siltation, and other factors that affect a fishery. Good management of the public domain will help maintain and improve important streams such as the Bighorn and Wind Rivers.

WATERFOWL NUMBERS, ALL LANDS, YELLOWSTONE RIVER SUBBASIN

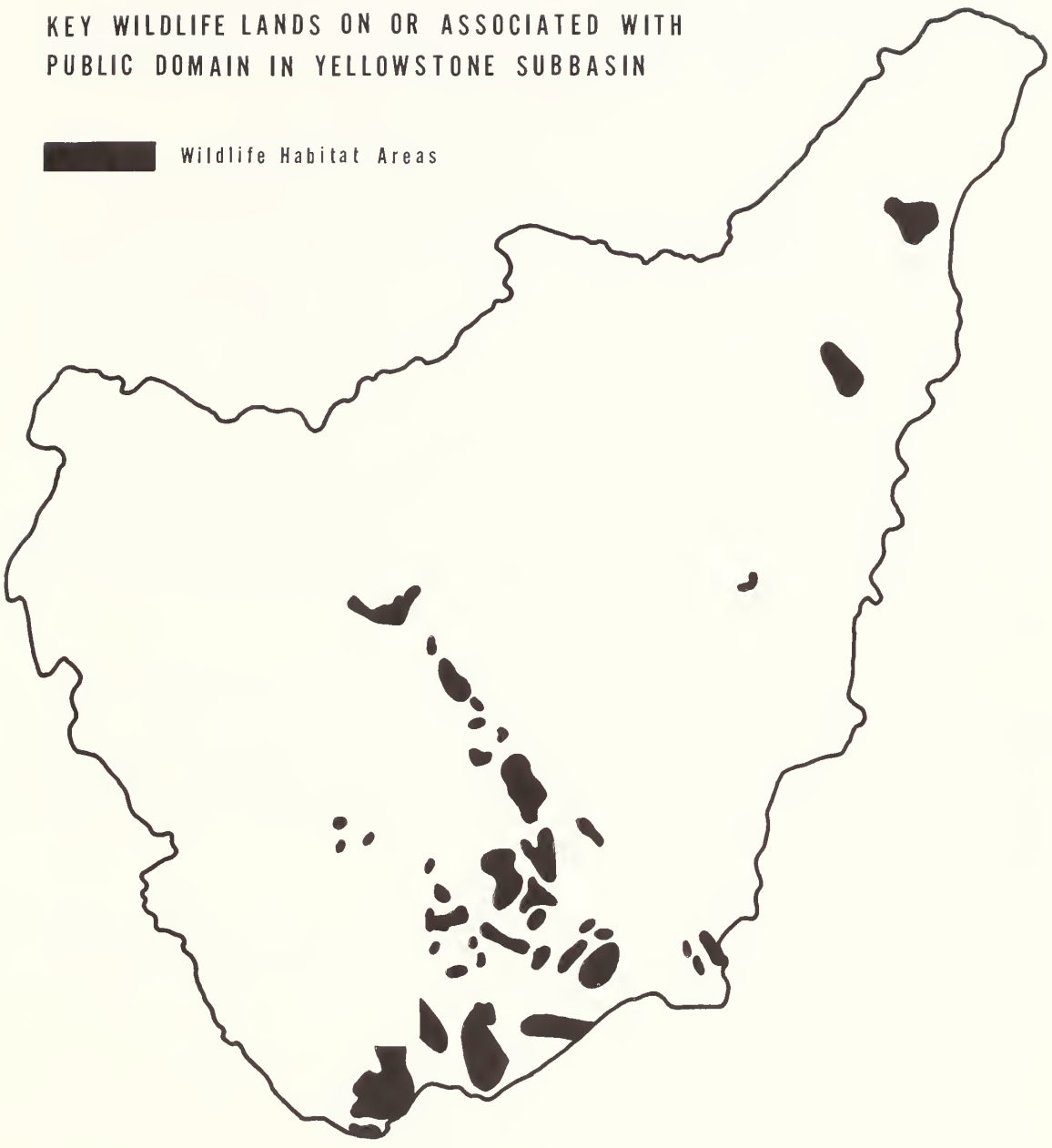
	Wintering	Breeding
Canada Goose	1,600	1,200
Mallard	56,300	160,000
Pintail	1,000	29,000
Teal	4,000	26,000
Shoveler	1,000	10,100
Gadwall	1,000	22,400
Widgeon	3,000	10,200
Other ducks	500	8,100
TOTAL	68,400	267,000

Public domain waterfowl habitat includes 1,500 acres of open water. Over 265,000 waterfowl breed in the entire subbasin, and approximately 68,000 are winter residents. There are opportunities to increase these numbers; for example, stockponds and waterspreaders add nesting sites and food. Improvements would also benefit other wildlife, and prevent erosion, and stream and reservoir siltation.

Upland game birds use 110,000 acres of the public domain. Pheasant, sage grouse, sharp-tailed grouse, Mountain grouse, Hungarian partridge, chukar partridge, and turkey live in the subbasin.

KEY WILDLIFE LANDS ON OR ASSOCIATED WITH PUBLIC DOMAIN IN YELLOWSTONE SUBBASIN

Wildlife Habitat Areas



Classification and Multiple Use Act

Public domain amounts to 28 percent, or 6.1 million acres, of the land surface in the Yellowstone River Subbasin in Wyoming. In Montana it accounts for 8 percent, or 1.9 million acres. The Bighorn and Wind River Basins of Wyoming contain exceptionally heavy public land concentrations. There are also moderately heavy concentrations at the south end of the Bighorn Mountain range, in the Powder River country of Wyoming, and northeast from Miles City, extending towards Glendive, Montana.

The heavy land patterns, with nearly solid public domain, occur in the semiarid rain shadows of the Wind River and Absaroka mountain ranges of Wyoming. The low precipitation and poor soils made these areas unattractive to settlers for farming and ranching, with the result that most of the land remained in public ownership. The rain shadow effect is also evident in the area south and southeast of the Bighorn range, where heavy public land concentrations are located.

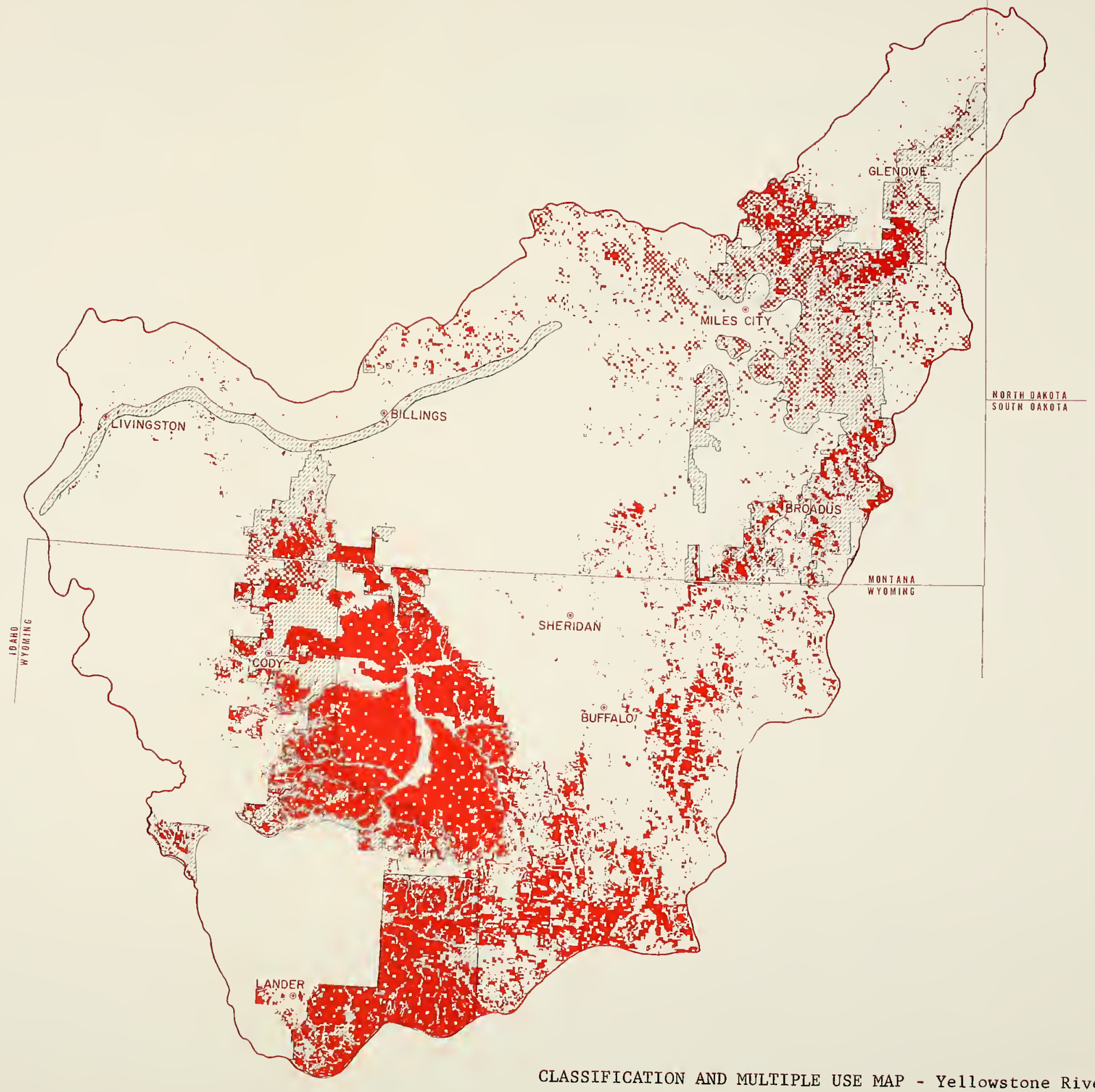
Retention classifications in Wyoming cover the dense public land pattern of the Wind River Basin, the Owl Creek Mountains south of the Bighorn Basin, limited areas of the Bighorn Basin north and east of Cody, and the approaches to the Bighorn National Recreation Area. In Montana, a retention classification covers the Pryor Mountain range of the wild horse herd, access to the Bighorn National Recreation Area, and public land along the 250 miles of the Yellowstone River with its outstanding sports fishery.

The absence of a designation under the Classification and Multiple Use Act for the majority of the Bighorn Basin, Wyoming, with its dense public land pattern, stands out on the accompanying map. This omission was intentional on the part of the classifying officials and participating members of the public, who considered that the very density of the land holdings provided sufficient reservation in itself without legal encumbrance.

Retention classifications were made along the higher reaches of the Wind River in the vicinity east of Dubois, Wyoming, and in the major area of public land which lies north, east, and southeast of Miles City, Montana.

CLASSIFICATION AND MULTIPLE USE MAP - Yellowstone River
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
CROSSHATCH INDICATES RETENTION AREA



CLASSIFICATION AND MULTIPLE USE MAP - Yellowstone River Subbasin

WESTERN DAKOTA TRIBUTARIES SUBBASIN

WESTERN DAKOTA TRIBUTARIES SUBBASIN

Published Bureau of Land Management Land Inventory Reports

WESTERN DAKOTA TRIBUTARIES SUBBASIN

General Description

The Western Dakota Tributaries Subbasin is located in western North and South Dakota, and in eastern Montana and Wyoming. It includes all tributaries entering the mainstem Missouri from the west, between the Yellowstone confluence and as far south as the White River. It measures about 400 miles in both length and width, and contains 49.4 million acres. The Bureau of Land Management administers 1,275,000 acres, about 2.5 percent of the land area.

LAND AREA

	Subbasin		Public Domain	
	(acres)	(% of subbasin)	(acres)	(% of subbasin)
South Dakota	25,739,000	52	269,000	.5
North Dakota	11,972,000	24	54,000	0
Wyoming	7,472,000	15	471,000	1.0
Montana	2,499,000	5	481,000	1.0
Nebraska	1,674,000	4	0	0
TOTAL	49,356,000	100%	1,275,000	2.5%

Topography varies from smooth plains to high buttes, rough canyons, level tablelands, and steep badlands. The Black Hills, an isolated mountain range rising from the plains, are located in the southwest. Elevations vary from 7,200 feet in the Black Hills to about 1,400 feet in the southeast.

The climate is typically continental, with extremes of temperature and precipitation. Temperatures average 20° in January and 70° in July. The average annual temperature is 50°. During the winter extreme blizzards often occur. Average annual rainfall varies from 12 inches in the western portion to 19 inches in the southeast.

About 288,000 people live in the subbasin. Average density is four people per square mile. North and South Dakota have five people per square mile, Montana has two, and Wyoming has one person per

square mile. Urban areas are located at Rapid City, population 43,800 and Pierre, 9,700, in South Dakota, and Dickerson, 12,400, and Mandan, 11,100, in North Dakota.

The major land use is for pasture and range with 35.3 million acres, or 71 percent, used for grazing. Cropland occupies 9.3 million acres, or 19 percent. Urban areas and highways cover 0.9 million acres, or 2 percent, and water covers 0.5 million acres, or 1 percent.

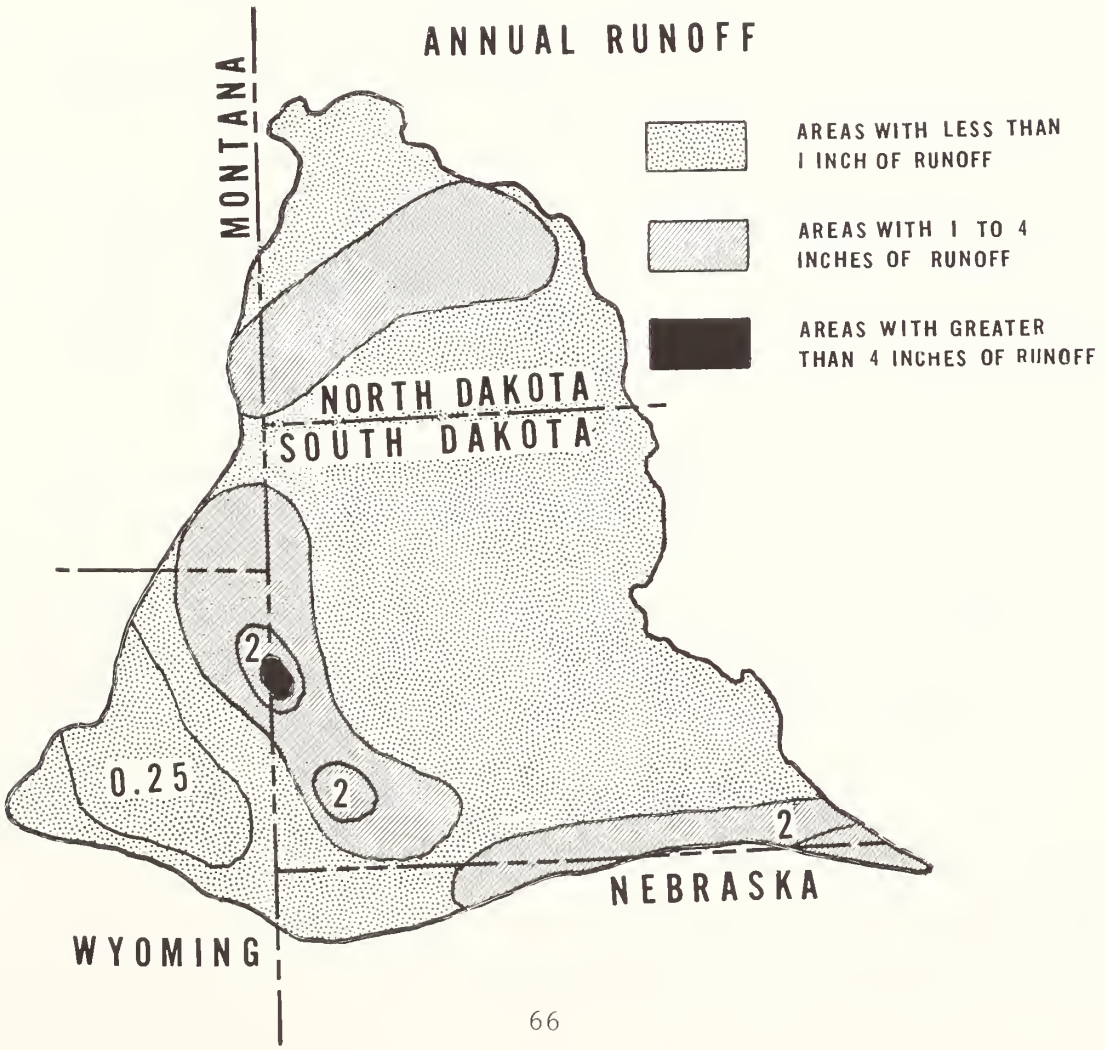
SUBBASIN LAND USE

	Acres	% of Subbasin
Pasture and Range	35,253,000	71
Cropland	9,300,000	19
Forests and Woodlands	2,500,000	5
Transportation and Urban	900,000	2
Water	500,000	1
Recreation	300,000	
Military	300,000	
Other Agriculture	200,000	2
Fish and Wildlife	100,000	
Mineral Industry	3,000	
TOTAL	49,356,000	100%

Surface Runoff

Public lands in the Western Dakota Tributaries Subbasin occur principally in the zone of intermediate surface runoff, from 1 inch to 4 inches annually. The northern third of the southwesterly 1 inch zone shown on the accompanying plat covers the heavy public land concentrations lying south of Ekalaka, Montana, and extending toward Belle Fourche, South Dakota. The public land concentration in Bowman County, North Dakota is also in the intermediate runoff zone. Southwest of Newcastle, Wyoming, the public lands at the headwaters of the Little Missouri, Belle Fourche, and Cheyenne Rivers fall within the runoff zone of less than 1 inch. On a more detailed map, these scattered tracts are seen to be within a zone of one-quarter inch annual runoff.

The higher precipitation zones, those ranging from 2 inches to 4 inches and above, coincide with increasing elevations of the Black Hills, where public domain is generally limited to the "Black Hills Exemption Area" near Deadwood, South Dakota.



Ground Water

There are four principal areas of ground water in the Western Dakota Tributaries Subbasin. Three are on the periphery of the Black Hills; a large area is centered on the Cheyenne River arm of Oahe Reservoir in South Dakota, and lesser areas lie along the Missouri River in North Dakota. Favorable ground water recovery areas on the accompanying map are where properly constructed wells less than 1,000 feet deep yield more than 300 gallons per minute.

Major concentrations of public land in the subbasin do not coincide with important ground water aquifers. Some 16,000 acres of public land overlie the Belle Fourche-Rapid City aquifer, most of it north of Redwater Creek. Ground water quality is good to fair in the vicinity of the creek, diminishing to the north with increasing distance from the Black Hills. South of Redwater Creek, water quality is high, but public lands are isolated tracts, seldom larger than 40 acres. About 5,500 acres overlie the Fall River County aquifer, with water quality rated as good. Approximately 7,000 acres overlie the aquifer in Crook County, Wyoming, with water quality rated good. In the two latter areas the public lands are scattered, in tracts of 160 acres or less.

Ground water located under public lands appears to be best suited for livestock water, or for domestic use at recreational sites.

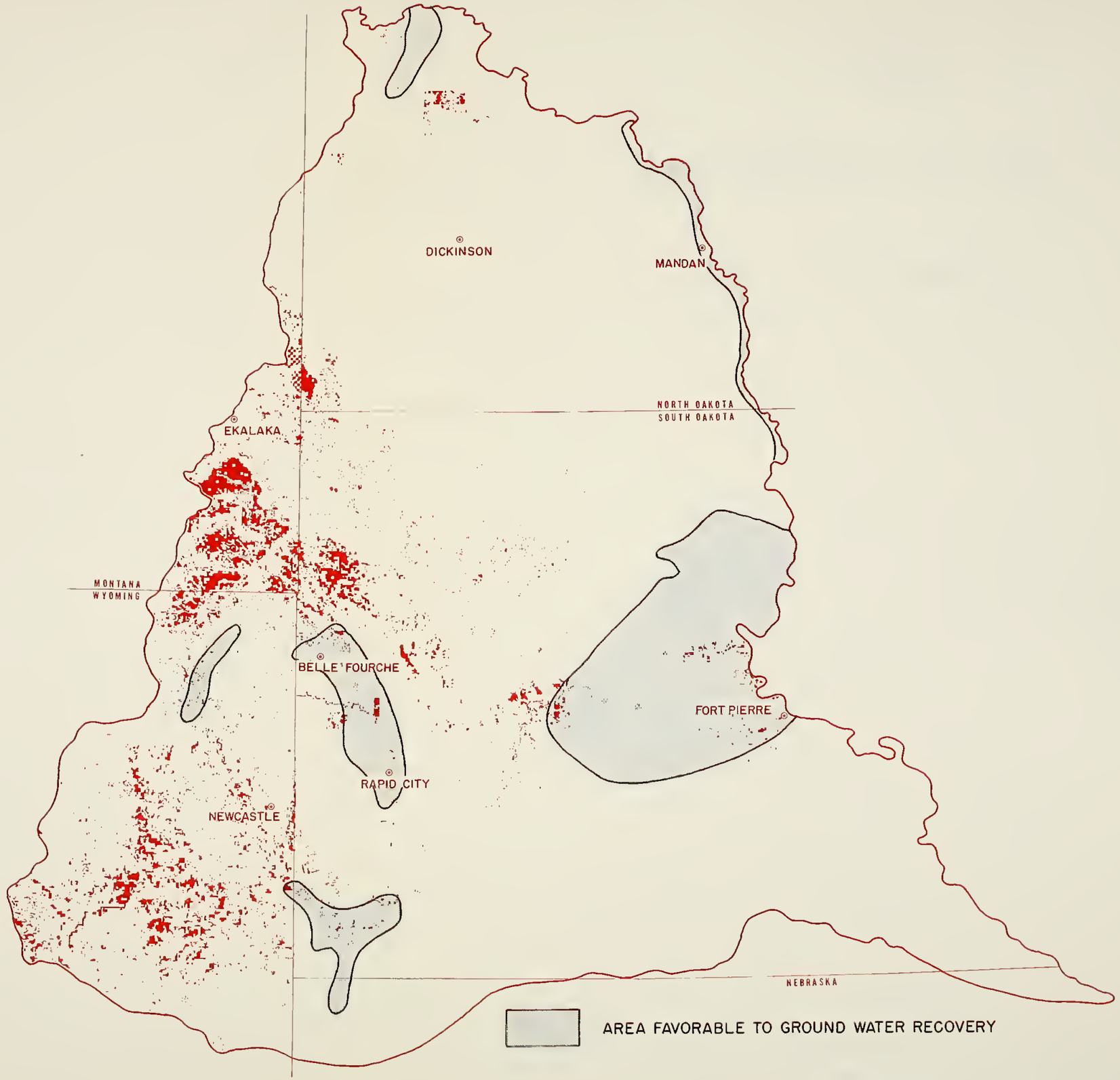
Within the extensive, high-yielding aquifer area on the Cheyenne River west of Oahe Reservoir, public lands are scattered in tracts of 160 acres or less; they total less than 13,000 acres. Ground water quality grades from fair to poor, with dissolved solids of 1,000 to 4,000 parts per million. In comparison, the maximum dissolved solids for desirable drinking water is approximately 500 parts per million; for range cattle, 10,000 parts per million, and for irrigation, 1,750 parts per million.

Artesian flows are common from the confined aquifers of the Cheyenne River area. In many cases the water emerges from the ground at elevated temperatures.

Ground water utilization on public land within the Cheyenne River aquifer will probably be limited to livestock water, because the land is generally unsuited for cultivation. Completion of the westside road bordering Oahe Reservoir will result in recreational use of some tracts.

GROUND WATER MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



GROUND WATER MAP - Western Dakota
Tributaries Subbas

Streamflow Depletions

Streamflow depletion occurs whenever anything, whatever the reason, prevents water once having entered an area, from leaving that area by the master drainage. The reduction in flow can result from natural causes such as transpiration by phreatophytes, or a man-made influence as illustrated by evaporation losses from reservoirs.

In the Western Dakota Tributaries Subbasin, depletions amount to 264,000 acre feet annually. Depletions from the public lands account for 3,425 acre feet annually, or 1.3 percent of the total. Nearly all of the public land depletions take place in the tributary drainage of the Little Missouri River, with 3,300 acre feet. This is the result of extensive land treatment practices designed to control erosion on the frail lands in the Alzada vicinity of southeastern Montana.

Besides the Little Missouri drainage, depletions from public lands occur in the upper reaches of the Cheyenne and Belle Fourche tributary basins. These depletions result from two practices:

1) Impoundments
2) Land treatment measures.

The impoundments on public land are principally stock watering reservoirs which average about 3 surface acres in size. These reservoirs are constructed to a minimum depth of 12 feet to insure availability of water during dry seasons. Depletions result from consumptive use by livestock and from surface evaporation. In the Western Dakota Tributaries Subbasin there are 400 such impoundments on the public lands.

Land treatment measures such as contour furrowing, rangeland pitting, water spreading, dikes, and diversions result in depletion of surface flow through evaporation to the air and infiltration to the ground. The three tributary basins discussed in this section have the lowest ground infiltration rate within the Western Dakota Tributaries Subbasin, ranging from .05 inches to .20 inches per hour of saturation. The low rate of infiltration contributes to a higher rate of surface runoff. Eighteen thousand acres of public land have been treated, mostly in the upper reaches of the Little Missouri River.

The following table summarizes watershed depletions from impoundments and land treatment practices on the public domain of the Western Dakota Tributaries Subbasin.

ANNUAL STREAMFLOW DEPLETIONS

Tributary Basin	BLM Depletion (acre ft)	BLM Relative Depletion In Tributary Basin (%)	All Depletions In Tributary Basin (acre ft)
Little Missouri River	3,300	15.0	21,800
Cheyenne River above Angostura Reservoir	75	.2	51,300
Belle Fourche River, Wyoming	50	2.5	2,000
All Other Areas, Western Dakota Tributaries Subbasin	--	--	188,900
	3,425	1.3 (average over entire subbasin)	264,000

STREAMFLOW DEPLETION MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN

STREAMFLOW DEPLETION MAP - Western Dakota
Tributaries Subbasin

Sedimentation

Within the Western Dakota Tributaries Subbasin there are ten rivers directly tributary to the Missouri River from the west. All of them contribute to the sediment load carried downstream to the mainstem reservoirs. Average sediment concentrations range from 300 parts per million in some of the Black Hills' streams to over 8,000 parts in some of the plains' drainages. These sediments have a volume of many thousand acre feet annually, and constitute the greatest hazard to continued useful life of the Missouri River reservoir system.

Runoff characteristics of the subbasin are typical of most streams in the northern Great Plains. Streamflow is erratic and unpredictable, with widely varying amounts of water from year to year. Sheet erosion is considered to be the major cause of sediment, resulting in heavy loading of the surface streams. It is estimated that suspended sediment solids reaching the main drainageways are at least 700 times the amount from sewage disposal.

The heaviest runoff to surface streams occurs during the spring as the result of snowmelt and spring rains. Occasional high flows during the summer result from local storms of cloudburst intensity. Streams draining the Black Hills have longer periods of sustained high flow during spring and early summer because of snow accumulation at higher elevations.

Most Bureau of Land Management administered lands within the subbasin are located in southeastern Montana and northeastern Wyoming, near the upper reaches of the drainages. Sediment loads are less of a problem in upstream watersheds than in downstream sections closer to the Missouri River mainstem. The accompanying chart and map illustrate differences in upstream and downstream sediment loads.

Installation of water spreading structures, especially in the Alzada, Montana area, has been beneficial in limiting the movement of soil solids during heavy runoff. In some instances this type of range improvement has also tripled the carrying capacity of native ranges.

Among the problem drainages of the Western Dakota Tributaries is Lance Creek in Wyoming, with a drainage area of 2,000 square miles. The Lance Creek watershed is the major contributor of sediment carried into Angostura Reservoir, and is an exception to the generally observed principal of better conditions upstream.

About 288,000 people live in the subbasin. Average density is four persons per square mile.

Watersheds of the White River at the southern edge of the subbasin are the heaviest sediment producers of all the hydrologic subareas in the subbasin. For example, near Kadoka, South Dakota, the amount of sediment carried has been recorded at 1,500 tons per square mile of drainage area per year. In contrast, the upstream sediment load near Oglala, South Dakota, 80 miles southwest, is 86 tons per square mile per year.

The Bad River drainage, tributary to the Missouri at Fort Pierre, South Dakota, has the second highest sediment rate, with 1,350 tons per square mile annually. Both the Bad and the White River systems have minimum amounts of public land.

Among the subdrainages containing larger amounts of public land, the Little Missouri, near Watford City, North Dakota has by far the highest sediment loss. With a loss factor of 689 tons per square mile per year, the total attributed to public land is 500,000 tons annually. Field examinations in the past have indicated that about 40 percent of the drainage area suffers from moderate to severe erosion.

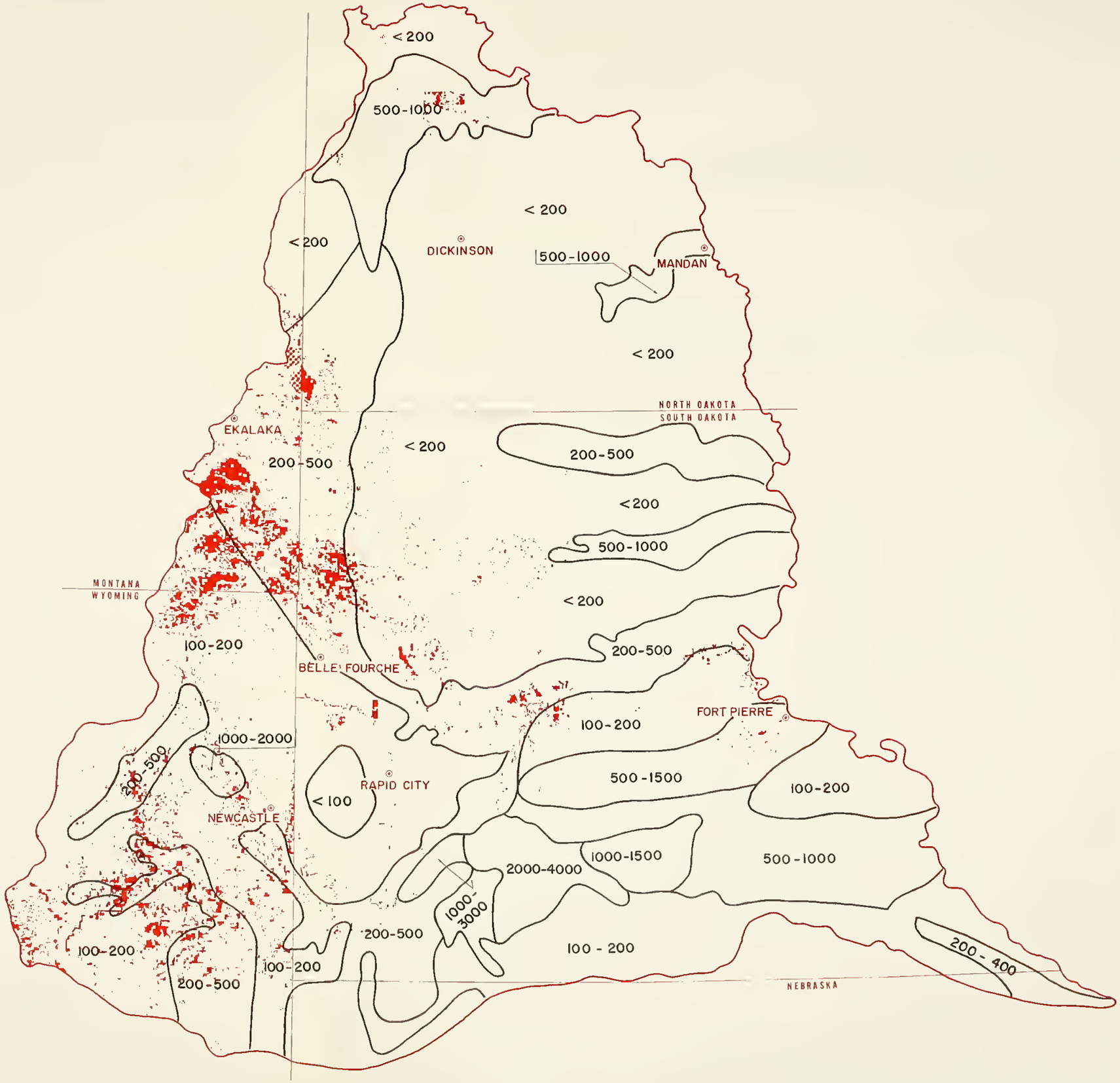
In the following table, gross sediment loss for several hydrologic subareas in the Western Dakota Tributaries system is given. These figures appear in the Hydrologic Appendix of the Type I Comprehensive Framework Study Report. Sediment loss factors, obtained from the same source, applied to the amount of public domain, and divided by the conversion value of 1,416, provide an acre-foot estimate of sediment derived from the public lands. This figure is only an average over an extensive area, since unit sediment yields vary so widely between individual watersheds.

Sediment can be reduced by such measures as re-seeding, water spreading, and proper rates of grazing. These practices retard peak waterflows and the erosion accompanying excessive runoff. Intensive vegetative or mechanical practices, or both, plus proper management are still needed in many places, in addition to locations where they have already been applied. It was estimated in 1966 that 50 percent, or 629,000 acres, of public domain rangelands was adequately managed or treated; privately owned ranges were also estimated at 50 percent. There were 409,000 acres of public range in need of augmented management practices only, and an additional 237,000 acres which needed further management attention plus mechanical or vegetative treatment.

Hydrologic Subarea	Land Area		Loss Factor	Average Annual Sediment Loss	
	Public Land	All Land		Public Land	All Lands In Hydrologic Subarea
	--(sq. mi.)--		tons per sq. mi.	-------(acre ft)------	
Bad River, Fort Pierre, S.D.	7	3,107	1,350	7	3,000
Belle Fourche River, near Sturgis, S.D.	130	5,870	200 (est.)	18	460
Cheyenne River, near Hot Springs, S.D.	400	8,710	191	54	1,200
Cheyenne River, near Eagle Butte, S.D.	105	24,500	317	23	5,600
Lance Creek, near Spencer, Wyoming	33	2,070	385 (est.)	9	585
Little Missouri River, near Alzada, Mont.	95	904	165 (est.)	11	920
Little Missouri River, near Watford City, N.D.	725	8,490	689	350	4,150
Moreau River, near Faith, S.D.	134	2,660	200 (est.)	19	460

SEDIMENT MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
LOSSES IN TONS PER ACRE PER YEAR



SEDIMENT MAP - Western Dakota
Tributaries Subbasin

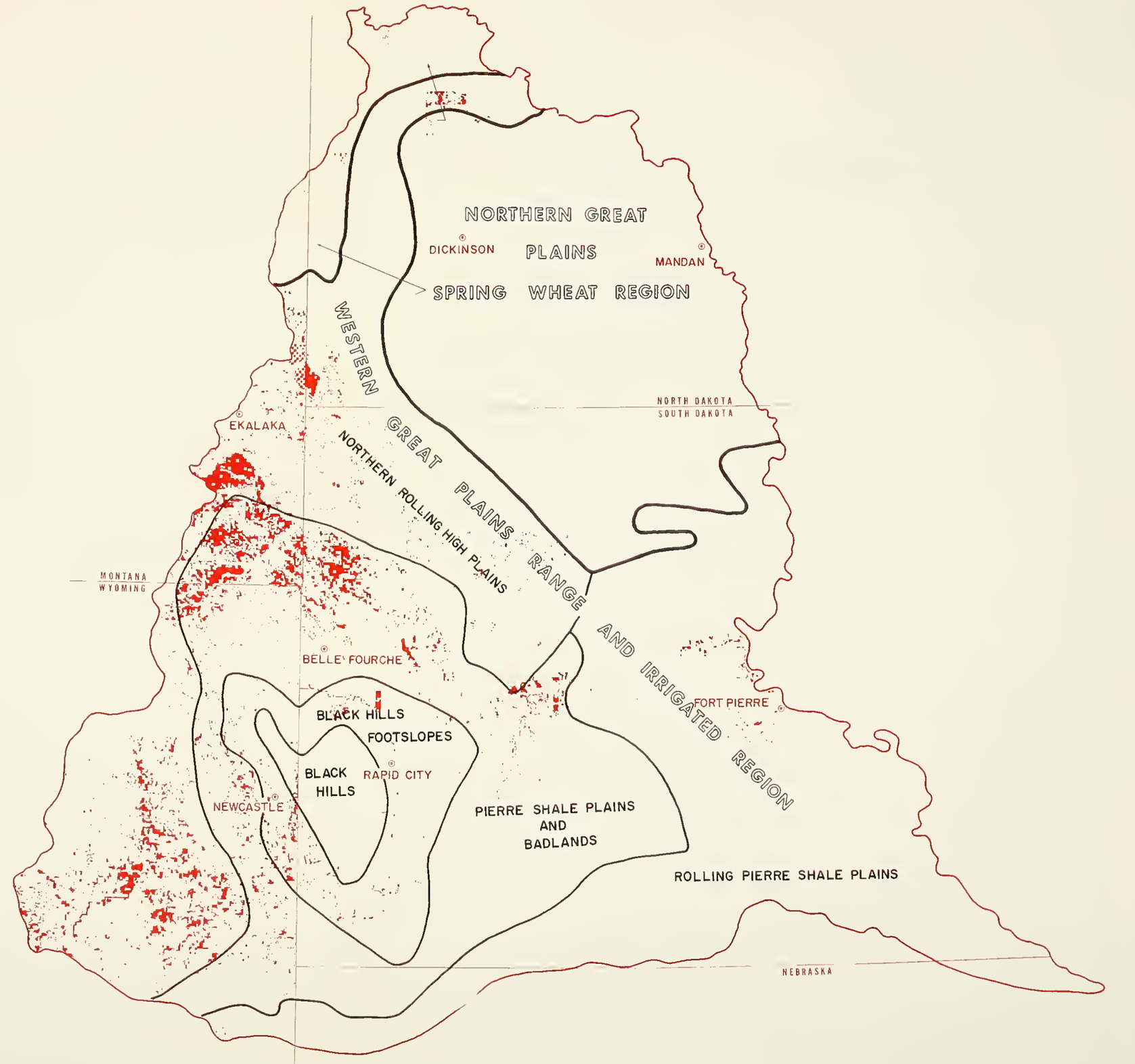
Almost all of the public domain is found in the Western Great Plains Range and Irrigated Region. Of the 1,275,000 acres in the subbasin, 905,000 acres, or 71 percent, are in Montana and Wyoming, west and northwest of the Black Hills. There are 153,000 acres concentrated north of Belle Fourche, South Dakota, and 33,000 acres between Belle Fourche and Fort Pierre. In the vicinity of Bowman and Watford City, North Dakota, there are concentrations of 36,000 acres and 19,000 acres respectively. On the subbasin's eastern side there are 16,000 acres near Fort Pierre, South Dakota. The Western Great Plains Range and Irrigated Region is important in production of native forage; almost 75 percent of the Region is rangeland. Perennial grasses and shrub species predominate. Because of natural characteristics of the country, grazing is the most important single land use. The carrying capacity averages about 6 acres per animal unit month on the public lands of Montana, 4.5 acres in Wyoming, and 3 acres in the Dakotas and Nebraska; it ranges from a low of 3 to a high of 10 acres.

The Black Hills Footslopes, and the Black Hills proper, form a contrast to the surrounding Great Plains Range and Irrigated Region. Public domain in these two areas includes 5,000 acres in the "Black Hills Exemption Area," south and west of Deadwood, South Dakota. These fragmented lands were "exempted" from the Black Hills National Forest because of intermingled mining claims, and have potential for recreation providing boundaries and possessory claims can be resolved. A 6,400 acre block immediately east of Sturgis, where the Bureau of Land Management has constructed a 20-unit campground, has potential for additional recreational development.

The Northern Great Plains Spring Wheat Region has a uniform aspect from the standpoint of elevation, topography, climate, soils, and vegetation; due to its uniformity it is not divided into Land Use Areas in the Western Dakota Tributaries Subbasin. The Region has 60 percent of the cropland in the subbasin. The dominant crop is spring wheat grown by dry farming methods; other principal crops include feedgrains and hay. The remaining land surface retains its original vegetative cover of native grasses and shrubs. Public lands are unimportant in the Region, occurring in small scattered tracts. There is no public land concentration sufficient to provide notable management opportunities. Individual tracts of public domain seldom exceed 80 acres in size.

LAND RESOURCES REGIONS MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



LAND RESOURCES REGIONS MAP - Western Dakota
Tributaries Subbasin

Livestock

The total area of pasture and range in the Western Dakota Tributaries Subbasin exceeds 35 million acres, and livestock production is the predominant agricultural activity. Vegetation produced on 87 percent of the 1,275,000 acres of land administered by the Bureau of Land Management contributes importantly, as shown on the chart, to the growth and maintenance of cattle and sheep raised on farms and ranches. The remaining 13 percent of public domain has a land capability classification of VIII, Waste and Barren, and contributes little to the livestock industry, but does provide wildlife habitat as described in the Wildlife section of this report.

PUBLIC DOMAIN CONTRIBUTION TO LIVESTOCK PRODUCTION

Usable Range	Number of Permittees	Number of Cattle*	Number of Sheep*	Grazing Use
(acres)				(AUM's)
1,110,000	935	107,000	268,000	265,000

Of the Bureau of Land Management grazing lands in the Western Dakota Tributaries, 1,113,000 acres are concentrated in the western part, with 905,000 acres in the Montana-Wyoming portion. There are moderate concentrations of public domain in South Dakota, north of Belle Fourche, northeast of Rapid City, and northwest of Fort Pierre, aggregating 194,000 acres. Other concentrations total 48,000 acres in Bowman and Dunn Counties, North Dakota. Another 128,000 acres are scattered throughout the subbasin, with no particular pattern.

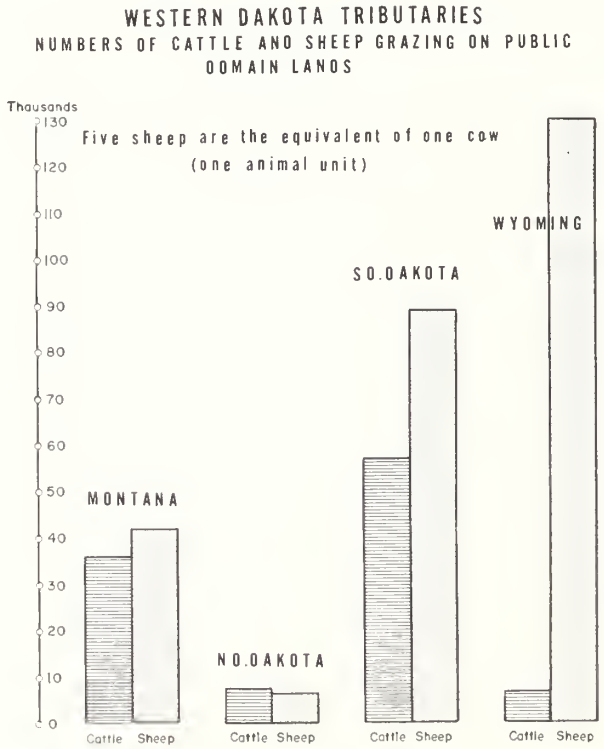
Nearly 75 percent of the subbasin is in pasture and range. Cattle are raised on almost all farms and ranches, and management practices are oriented toward a cow-calf, or a cow-calf-yearling, production program. Grazing capacity on public lands is computed in animal unit months (AUM's), which represent the amount of forage sufficient to support a mature cow, or the equivalent, generally considered to be five sheep, for a period of 1 month. Grazing fees, based on the animal unit month, are established by the Secretary of the Interior at a rate equal to a specified percentage of the average market price per pound of beef and lamb in the 11 western States during the preceding calendar year.

*These livestock also utilize non-Federal rangelands.

In 1964, total receipts from agriculture in the Western Dakota Tributaries Subbasin amounted to $238 million. Almost 70 percent, or $163 million, was derived from livestock or livestock products. In the year 1969, there were 770 million pounds of cattle and calves in the subbasin. This figure is expected to increase more than 45 percent, to 1,100 million, by 1980. By 1969, there were also 68 million pounds of sheep and lambs. The projection is for a 4 percent increase in this class of livestock to 71 million pounds by 1980.

The Taylor Grazing Act of June 1934, with its amendments, provides for issuance of permits or licenses with organized Districts to qualified applicants for grazing privileges on public lands. Class and numbers of livestock, and the season or period of use are specified in the permit. Permits are usually for a term of 10 years, but may be amended, reduced, or even cancelled, under certain conditions. The public lands in the Montana portion of the subbasin are part of a District.

The Taylor Grazing Act also provides for a leasing system applicable to public lands so situated as not to justify their inclusion in a District. A lease is usually for 10 years, and each renewal cannot exceed 10 years. The leased public domain is used in conjunction with privately owned or controlled lands in supplying feed for a stipulated number of livestock for a definite period of the year. Except for Montana, public domain in the subbasin is administered under the lease system.



Stockwater

Surface runoff impounded in earth structures is the main source of stockwater in the Western Dakota Tributaries Subbasin. Projects of this type provide 73 percent of the water consumed by livestock. Wells produce 2 percent, while perennial streams, intermittent drainages, springs, and other sources furnish 25 percent. Ground water development is limited in the subbasin because of high mineral content, too great a depth for economical pumping, or because it is not available. The maximum dissolved solids content for tolerance by range cattle is 10,000 parts per million, and some ground water exceeds this figure to the extent that livestock will not drink it.

Major concentrations of public land in the subbasin generally do not coincide with important ground water aquifers. An exception is Stanley County, South Dakota, which includes almost 16,000 acres of public domain in scattered tracts of 160 acres or less. Artesian wells, some of them flowing, have been developed in parts of the county. Even so, the area is highly dependent on surface water impoundments. It has more than 200 miles of frontage on the Cheyenne River and mainstem of the Missouri, plus an average of one earth structure, to store runoff, for every 5 sections of land in the county. Compared with any area of equal size, except the Black Hills, Stanley County has the greatest amount of water available, with the best distribution, for livestock and wildlife in the Western Dakota Tributaries Subbasin.

There are approximately 300 stockwatering ponds on public domain in the subbasin, with combined surface area of about 1,000 acres. The 107,000 cattle and 268,000 sheep grazing the public lands consume an estimated 1,686,000 gallons of water daily. Forty percent of the 1,110,000 acres of public domain used for grazing is adequately supplied with stockwater under the standard formula recommeding 3/8 to 3/4 of a mile travel distance to water over rolling terrain, and 3/4 to 1 mile on level ground.

Coal Resources

Recoverable coal reserves in the Missouri Basin are estimated at 450 billion tons, or 55 percent of the Nation's total. The States of North Dakota, Montana, and Wyoming have about 80 percent of the supply held by the Missouri Basin. These abundant reserves are centered on the Western Dakota Tributaries Subbasin. If developed, they will be able to meet much of the Nation's needs in future years for electric power, synthetic gas, liquid fuels, fertilizer, and other consumer products. In North and South Dakota the deposits are principally lignite; elsewhere, they are of bituminous and sub-bituminous grade.

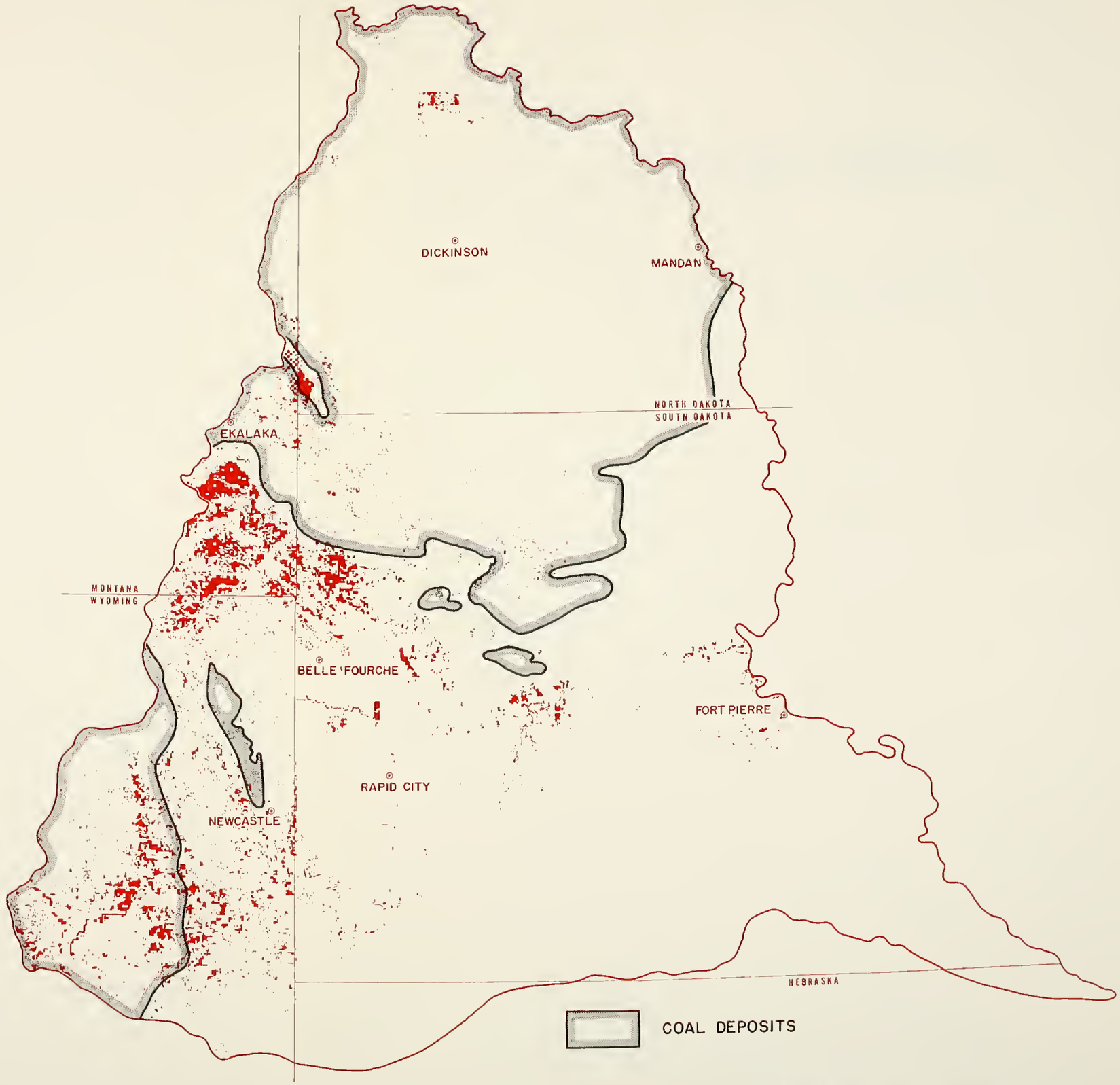
Large steam-electric generating plants, major users of coal, have already been built in the North Dakota portion of the subbasin. The locations selected, immediately west of the Missouri River, near Stanton, have the advantage of continuity of coal seams, reasonable depth of overburden, and access to abundant cooling water.

Coal production from public lands in North Dakota amounted to 1,140,000 tons in 1969, a three-fold increase over 1964. This production came from lands where both surface and mineral rights are held by the government, as well as lands where the mineral rights only were retained, following surface disposal. In North Dakota, the public lands fee amounts to 53,000 acres; 32,000 acres are in Bowman County, however, outside the coal field boundaries.

The South Dakota Counties of Harding and Perkins contain about 38,000 acres of public land within the area of known coal reserves. In Montana, the heavy concentrations of public land within the Western Dakota Tributaries are almost entirely outside the coal reserve boundaries. However, public lands with large reserves in Montana lie within the adjacent Yellowstone subbasin. In Wyoming, at least one-half of the Bureau of Land Management administered lands within the Western Dakota Tributaries drainage contain coal, either bituminous or sub-bituminous. Characteristics of these coal beds make them especially adaptable to hydrogenation for production of fuels and industrial products. By-product heat from this process can be used to generate electricity, providing water is available. Preliminary studies have been made by the Bureau of Reclamation to determine the feasibility of bringing water to northeastern Wyoming to serve the needs of potential coalfield industrial development.

COAL RESOURCES MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



COAL RESOURCES MAP - Western Dakota
Tributaries Subbasin

Bentonite Deposits

The principal bentonite-producing area in the United States is located in Montana and Wyoming, west and north of the Black Hills. Practically all the high-swelling type, and 66 percent of all material classified as bentonite, is produced there.

The bentonite formations have a gross area of about 961,000 acres in Montana and Wyoming. Of that amount, approximately 223,000 acres are public domain.

BENTONITE BEARING ACREAGE
(Montana and Wyoming Only*)

	Within Bentonite Formations
	(acres)
Public Domain	223,000
Other Land	738,000
TOTAL	961,000

*South Dakota is omitted from the tabulation because the bentonite that could be economically mined there has been worked out.

Public lands valuable for bentonite can be claimed under the United States Placer Mining Laws by qualified locators. Development and production can take place on an unpatented claim, or the locator may elect to apply for title after fulfilling the requirements of law. Bentonite deposits on private lands are either owned by the processing companies, or controlled through lease and option agreements.

Nine processing plants are currently operating in this area. Due to depletion of bentonite reserves in South Dakota, these plants are now processing deposits located in the Wyoming and Montana sections of the Western Dakota Tributaries Subbasin.

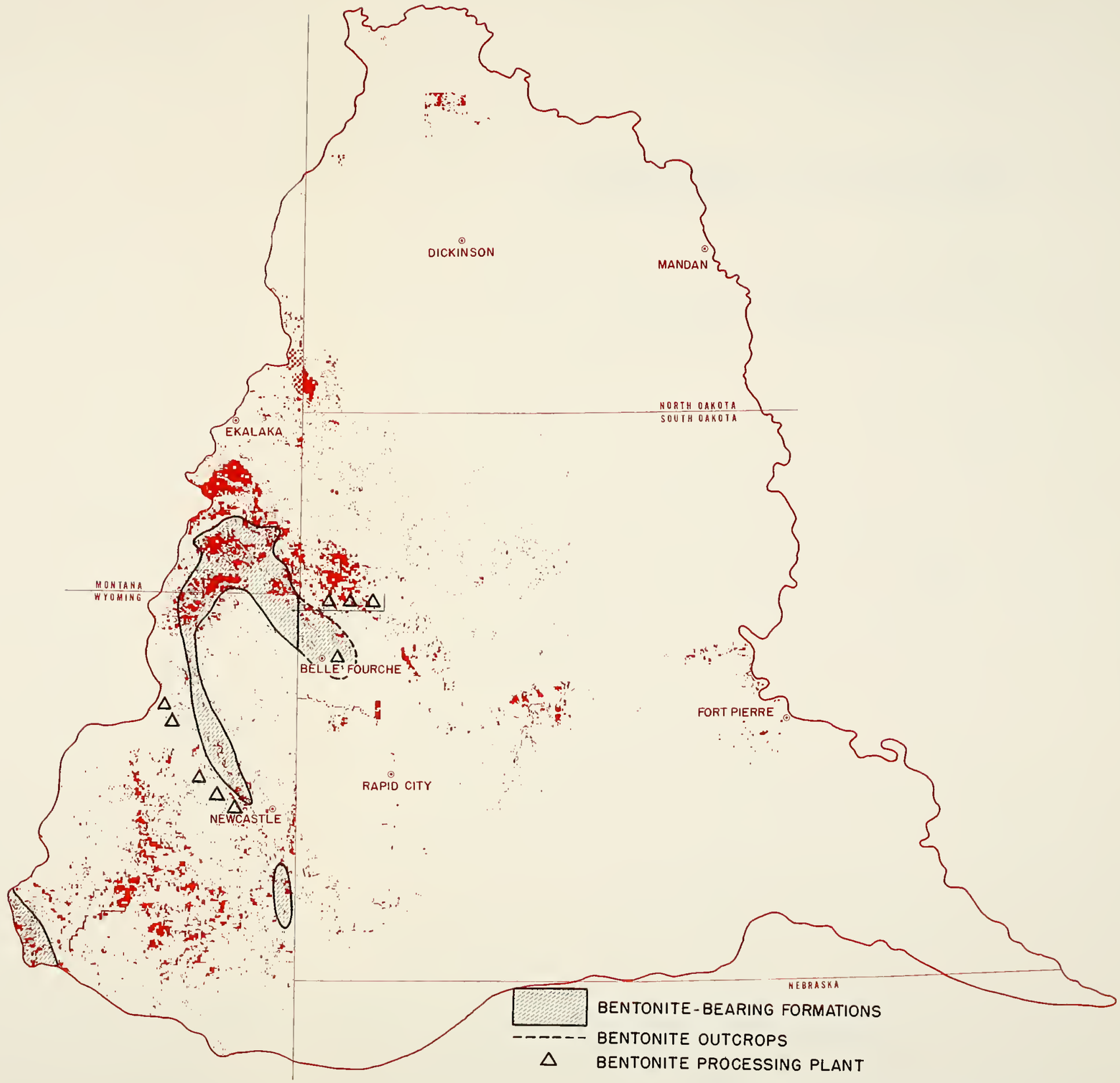
Bentonite is mined by surface methods. Most of the mining is by contract, but some of the claim owners and producing companies

mine their own deposits. Some companies purchase as much bentonite from individual claim holders as possible, to conserve deposits under their control.

The bentonite industry makes a major contribution to the economic stability and general welfare of the subbasin. This industry makes large tax payments, provides local employment, and encourages local business. A railroad spur was extended 25 miles from Belle Fourche, South Dakota, to a processing plant near Colony in northern Crook County, Wyoming, principally to ship bentonite.

BENTONITE DEPOSITS MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



BENTONITE DEPOSITS MAP - Western Dakota
Tributaries Subbasin

Fish and Wildlife

Three percent, or 36,200 acres, of the public domain in the Western Dakota Tributaries Subbasin is important fish and wildlife habitat. This habitat is in the subbasin's western portion as shown on the accompanying map. The areas delineated on the map are essentially public domain with interspersed private holdings.

KEY FISH AND WILDLIFE HABITAT ON PUBLIC DOMAIN

	Land	Water	Total
	(acre)	(acre)	(acre)
Key Wildlife Areas	35,000	200	35,200
Stock Ponds	--	1,000	1,000
	35,000	1,200	36,200

Big game, mostly deer and antelope, use 25,000 acres of the public domain. The Bureau of Land Management reserves 10,500 AUM's of forage for big game use.

KEY PUBLIC DOMAIN FISH AND WILDLIFE HABITAT BY TYPE

	Forest and Woodland	Pasture and Range	Total Land	Natural Water Open
	(acre)	(acre)	(acre)	(acre)
Big Game	--	25,000	25,000	--
Upland Game	3,000	7,000	10,000	--
Waterfowl	--	--	--	200

WATERFOWL NUMBERS, ALL LANDS,
WESTERN DAKOTA TRIBUTARIES SUBBASIN

	Wintering	Breeding
Canada Goose	6,310	60
Mallard	84,200	129,200
Pintail	0	41,800
Teal	0	83,300
Shoveler	0	21,800
Gadwall	0	19,200
Widgeon	0	12,200
Other ducks	1,720	13,450
TOTAL	92,230	321,010

Waterfowl habitat includes 200 acres of open water on the public domain. Over 320,000 waterfowl breed in the entire subbasin, and approximately 92,000 are winter residents. There are opportunities to increase these numbers; for example, stockponds and water spreaders add nesting sites and food. Improvements would also benefit other wildlife, and prevent erosion and stream and reservoir siltation.

Upland gamebirds use 10,000 acres of the public domain. Seventy percent of this land is pasture and range; the remainder is forest and woodland. Primarily, sportsmen hunt pheasant, sharp-tailed grouse and prairie chicken, but sage grouse, Hungarian partridge, turkey, and chukar partridge also live in the subbasin.

KEY WILDLIFE LANDS ON OR ASSOCIATED WITH PUBLIC DOMAIN IN WESTERN DAKOTAS TRIBUTARIES SUBBASIN

Wildlife Habitat Areas

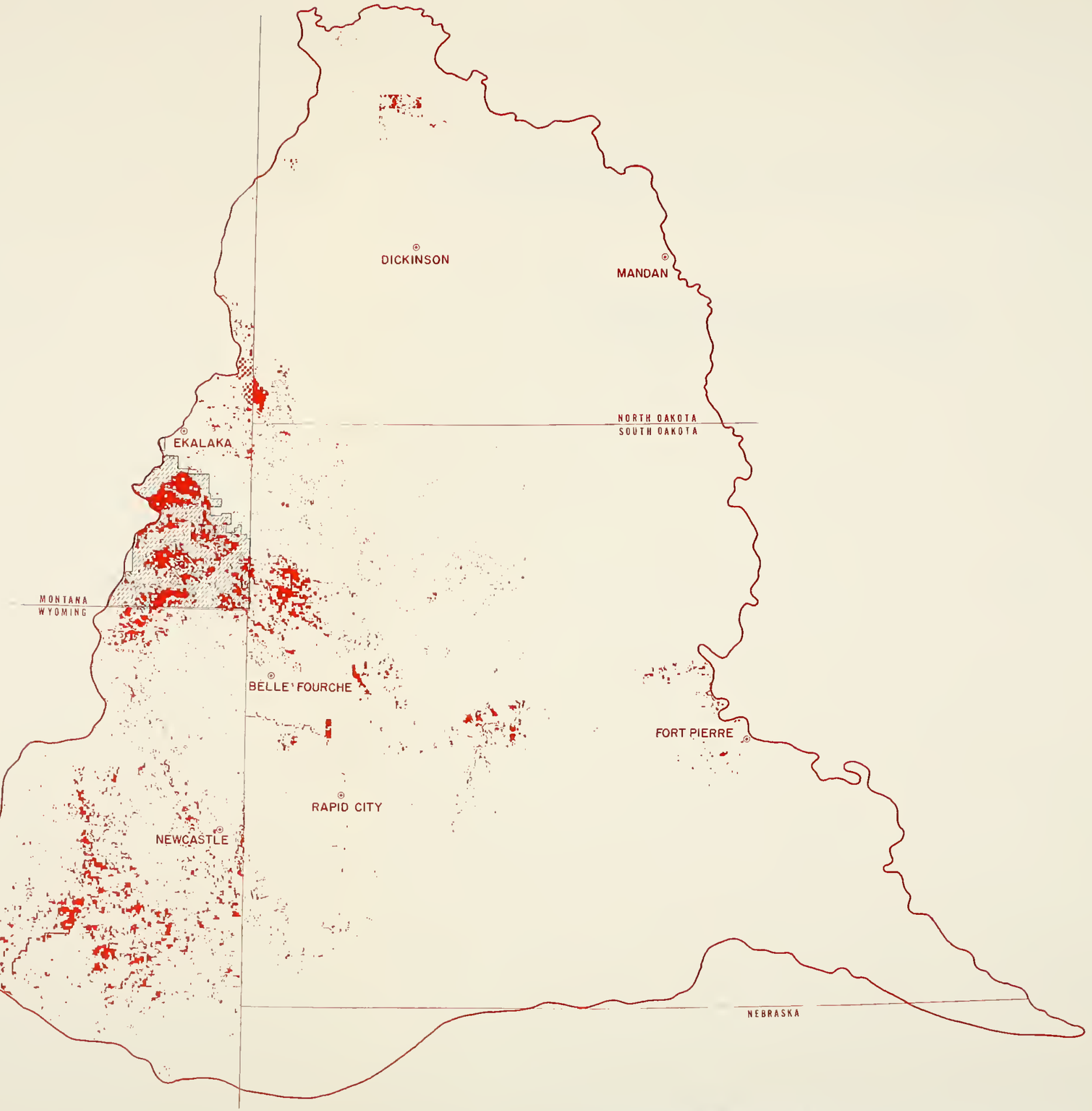
Classification and Multiple Use Act

Public lands in the Western Dakota Tributaries Subbasin, Wyoming and South Dakota, have not received a designation under the Classification and Multiple Use Act. The accompanying map shows the relatively scattered location of the land, and this fact principally accounts for the absence of classification action. As pointed out in the Summary section of this report, however, other classification authorities such as Section 7 of the Taylor Grazing Act, are available to implement any land tenure decisions which might be required. Much of the public land in Wyoming and South Dakota has special value for recreation, timber, as essential parts of livestock operations, and for various natural resources. These considerations will result in continued Federal management of a large part of the land, although formal classification has not been made.

The Montana portion of the subbasin has been included in a Retention Unit designation. Several blocks with a solid public land pattern are present, and public ownership falls within the 30 percent to 50 percent category of gross Federal surface acreage.

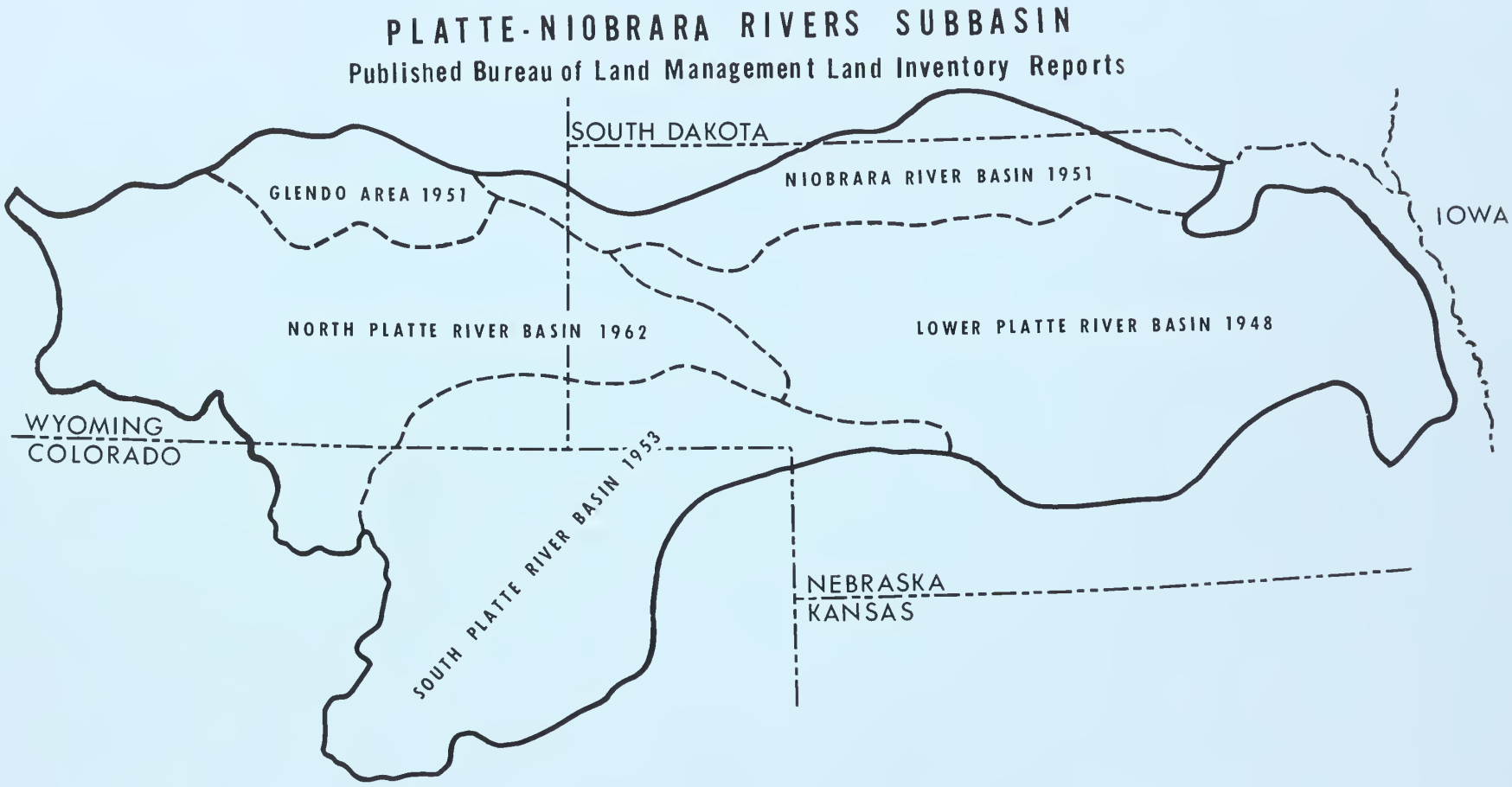
CLASSIFICATION AND MULTIPLE USE MAP - Western Dakota
Tributaries Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
CROSSHATCH INDICATES RETENTION AREA



CLASSIFICATION AND MULTIPLE USE MAP - Western Dakota Tributaries Subbasin

PLATTE-NIOBRARA SUBBASIN


PLATTE-NIOBRARA RIVERS SUBBASIN
Published Bureau of Land Management Land Inventory Reports
SOUTH DAKOTA
GLENDO AREA 1951
NIOBRARA RIVER BASIN 1951
IOWA
NORTH PLATTE RIVER BASIN 1962
LOWER PLATTE RIVER BASIN 1948
WYOMING
COLORADO
SOUTH PLATTE RIVER BASIN 1953
NEBRASKA
KANSAS

PLATTE-NIOBRARA SUBBASIN

General Description

The combined Platte-Niobrara Subbasin occupies 63.7 million acres across the southern third of the Missouri River Basin. It measures 600 miles east to west, by 300 miles north to south, and is the largest, most populous, and highly developed subbasin within the Missouri Basin. The Bureau of Land Management administers 5.3 million acres, or about 9 percent of the area. This figure includes the Great Divide Basin, west of Rawlins, Wyoming. Most of the public lands are in Wyoming, as shown by the following table.

LAND AREA

	Subbasin		Public Domain	
	(acres)	(% of subbasin)	(acres)	(% of subbasin)
Colorado	13,395,000	21	296,000	1
Nebraska	33,338,000	52	3,000	0
South Dakota	921,000	2	0	0
Wyoming	16,020,000	25	4,970,000	8
TOTAL	63,674,000	100%	5,269,000	9%

Topography varies from the steep, rough Rocky Mountains, to rolling plains, and the broad, shallow river valleys of the eastern sector. Elevations range from above 14,000 feet along the Continental Divide in Colorado to about 1,000 feet at the confluence of the Platte and Missouri Rivers in eastern Nebraska.

There are wide variations in the continental type climate. The average annual rainfall varies from 6 inches on the Red Desert of Wyoming to 18 inches at North Platte, Nebraska, and up to 28 inches in the subbasin's eastern portion. Seasonal precipitation is undependable from year to year, ranging from less than one-half of normal to several times the average amount. Frequent, heavy, localized thundershowers occur, often with cloudburst intensity.

Temperatures range from 30^{o} below zero to 110^{o} above; the mean annual temperatures vary from 45^{o} in the west to 55^{o} in the east. The eastern portion's growing season is long, averaging 160 days; in the west, it is 120 days, or less. Humidity is low in the west, and high in the east.

The population is 2.3 million. Most of the people live in Colorado, where the density is 70 per square mile. In contrast, Wyoming has one person per square mile. The average density for the subbasin is 23 people per square mile. Major cities are Denver, Colorado, with an urban area population in excess of 1 million, and Lincoln, Nebraska with 150,000.

Livestock use the major land area, with 39.6 million acres, or 62 percent of the subbasin, in native range. Cropland occupies 15.6 million acres, or 25 percent of the subbasin; forests and woodlands cover 5.2 million acres, or 8 percent; miscellaneous uses account for 3.2 million acres, or 5 percent. Land use is summarized as follows:

SUBBASIN LAND USE

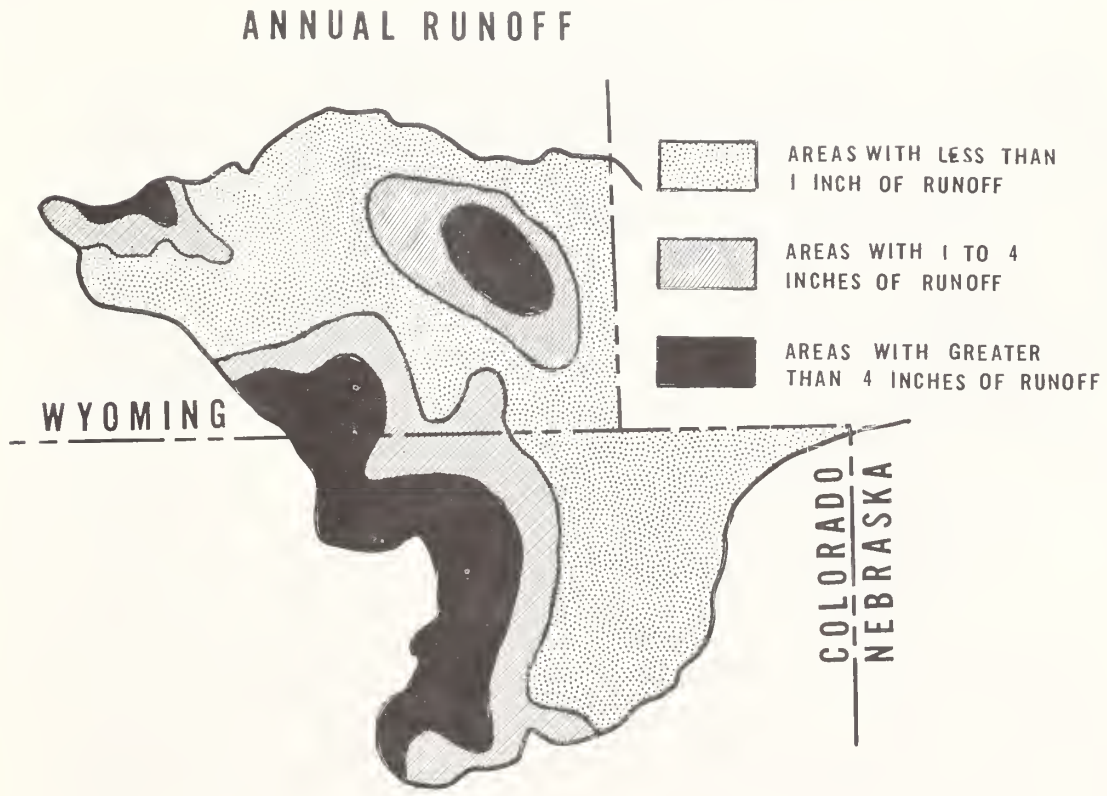
	Acres	% of Subbasin
Pasture and Range	39,671,000	62
Cropland	15,600,000	25
Forest and Woodland	5,200,000	8
Urban and Transportation	1,200,000	2
Water	700,000	1
Other Agriculture	600,000	1
Recreation	400,000	1
Fish and Wildlife	200,000	
Military	100,000	
Mineral Industry	3,000	
TOTAL	63,674,000	100%

In the following natural resource overlay maps and discussions for the subbasin, only the States of Wyoming and Colorado are included. The map scale for these important public land States is greatly improved by omission of the remaining States, Nebraska and South Dakota, with their minimal acreage of public domain. Map illustration of such small holdings as occur in the two latter States would result in scarcely discernable dots on the maps, and be of little value to the viewer. The subbasin's gross land area in Wyoming and Colorado is 29,415,000 acres, of which 5,266,000 acres are administered by the Bureau of Land Management.

Surface Runoff

Watershed runoff entering streams of the Platte-Niobrara Subbasin varies widely from place to place, and year to year, as a result of changing climatic and other influences. Although the accompanying map expresses high and low runoff in terms of "less than 1 inch" to "more than 4 inches," the measured extremes range from one-tenth inch to as much as 20 inches. The map is presented in simplified form to show the location of high and low runoff zones within the subbasin.

The highest runoff, ranging from 4 inches to 20 inches annually, is found along the eastern front of the Rockies, extending from the approximate location of Elk Mountain, Wyoming, to South Park, Colorado. These are the higher elevations, extending to the Continental Divide. Public domain is limited, consisting of scattered tracts in the mountain valleys of Colorado and southern Wyoming.



The 1 inch to 4 inch runoff zone occupies mid-elevations, extending eastward from the foothills onto the high plains bordering the Rocky Mountains. The zone occupies a narrow band extending southward from the head of the Sweetwater drainage, Wyoming, to South Park, and the Black Forest of Colorado. Heavy concentrations of public domain are found in this zone through much of its extent in south-central Wyoming.

The runoff zone of 1 inch or less occurs over the plains of Colorado and Wyoming, and the Red Desert interior drainage of Wyoming. Public domain dominates the land pattern through much of this zone in Wyoming, ranging from a railroad checkerboard to virtually solid holdings interspersed only with State school sections.

In general, the concentrations of public land correspond to areas of low surface runoff, which reflects in large measure the relatively low average annual precipitation. The nature of the land dictates that its use be extensive rather than intensive, to avoid environmental damage. In this perspective, the watershed value of such vast acreages becomes quite important, even though the runoff unit increment to streamflow is relatively low.

In general, the concentrations of public domain correspond to the areas of low surface runoff.

Ground Water

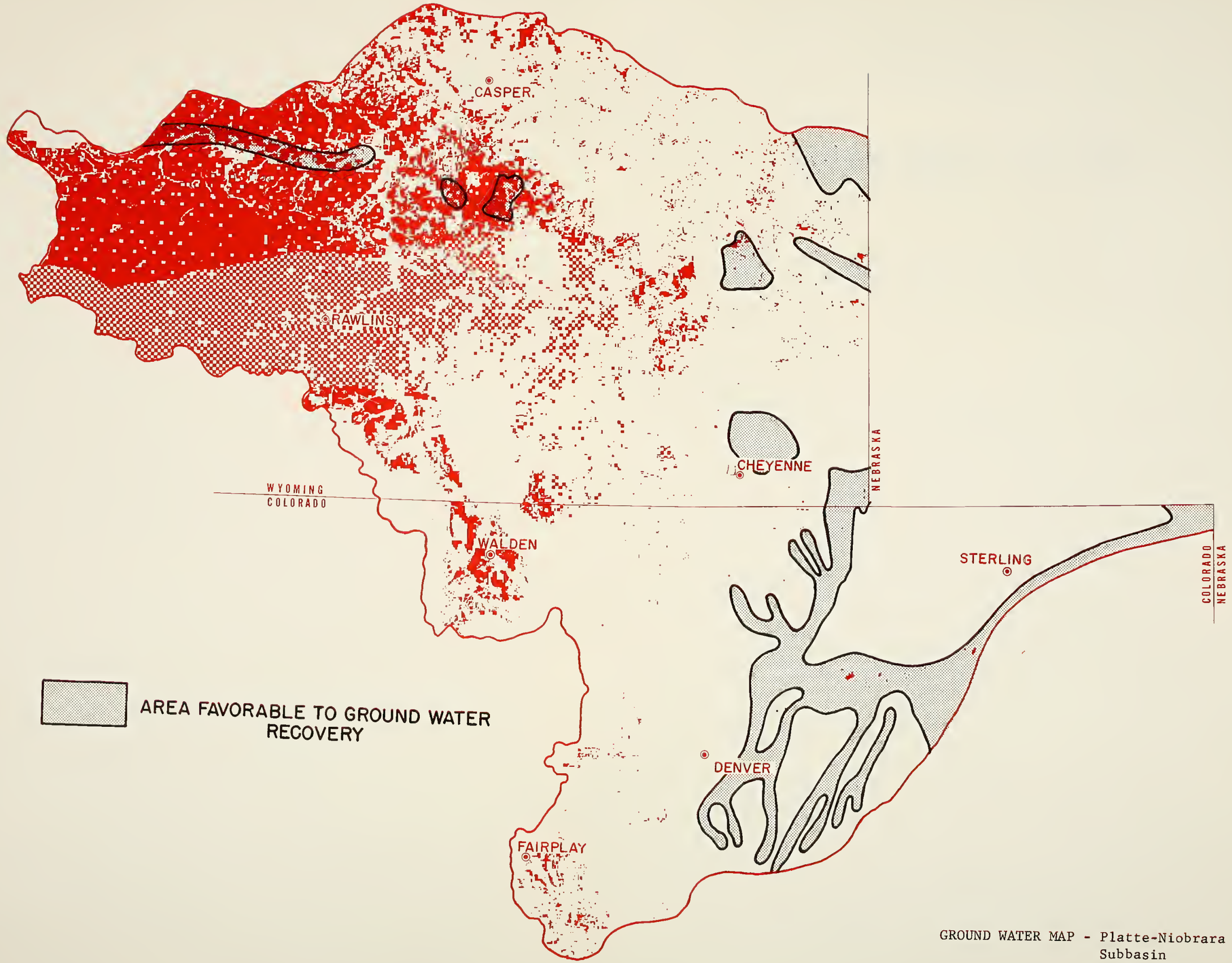
The recoverable ground water of the Platte-Niobrara Subbasin's Nebraska portion is outstanding with vast, proven reserves in the Sand Hills. Land ownership in the region is virtually all private. To the extent that ground water is associated with appreciable amounts of public domain, one significant recovery area and two minor ones have been described, all in Wyoming. Favorable recovery areas designated on the accompanying map are those where properly located and constructed wells less than 1,000 feet deep are capable of yielding more than 300 gallons per minute.

The largest of the aquifers associated with public domain coincides with the Sweetwater River, extending about 60 miles upstream from Pathfinder Reservoir. Approximately 138,000 acres of well blocked, generally contiguous public land overlie the Sweetwater aquifer. Relatively little ground water development has taken place, probably due to the availability of surface water for irrigation of hay meadows, the principal form of agriculture. The water is of excellent quality, with total dissolved solids generally less than 250 parts per million. In comparison, recommended maximum tolerance levels are approximately 500 parts per million for human consumption, 10,000 parts for range cattle, and 1,750 parts for irrigation of field crops.

Of the two smaller areas, the Canyon Creek aquifer contains about 2,500 acres of public land and the Stinking Creek aquifer about 12,000 acres. With total dissolved solids of less than 250 parts per million, these are high quality aquifers; their potential for beneficial use on public lands appears limited to livestock watering in the foreseeable future.

GROUND WATER MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



GROUND WATER MAP - Platte-Niobrara Subbasin

Streamflow Depletions

Streamflow depletion has been defined as anything, whatever the reason, that prevents water, after entering an area, from leaving that area by the master drainage. The reduction in flow can result from natural or man-made influences, such as transpiration by phreatophytes along stream banks or the consumptive use by cultivated crops. Depletions occurring on the public lands account for only 2.8 percent of total depletions in the Platte-Niobrara Subbasin.

Public domain depletions result from two general practices:

1) Impoundments
2) Land treatment measures.

The impoundments are principally stock watering reservoirs averaging about 3 acres in size. Depletion results from consumptive use by livestock and by surface evaporation. The stockwater dams are of earth-fill construction, with a minimum depth of 12 feet to insure that water will be available during extended dry periods. A few flood control impoundments of moderately larger size have also been built. The total number of impoundments in the Platte-Niobrara Subbasin is about 600. The approximate design life is 100 years for key installations and 25 years for those of less importance. Most reservoirs are expected to ultimately fill with silt. It has been found by experiment that 1 cubic yard of structural material in place will intercept 5 cubic yards of sediment.

The second form of depletion results from land treatment measures, such as contour furrowing, rangeland pitting, water spreading, dikes, and water diversions. Although a certain amount of depletion results from land treatment practices through surface evaporation or contribution to ground water, the net result is beneficial. These treatment practices hold more water on the land than they dissipate, and they reduce soil erosion, as well as contributing to improved range management practices. In the subbasin approximately 120,000 acres of public lands have been treated.

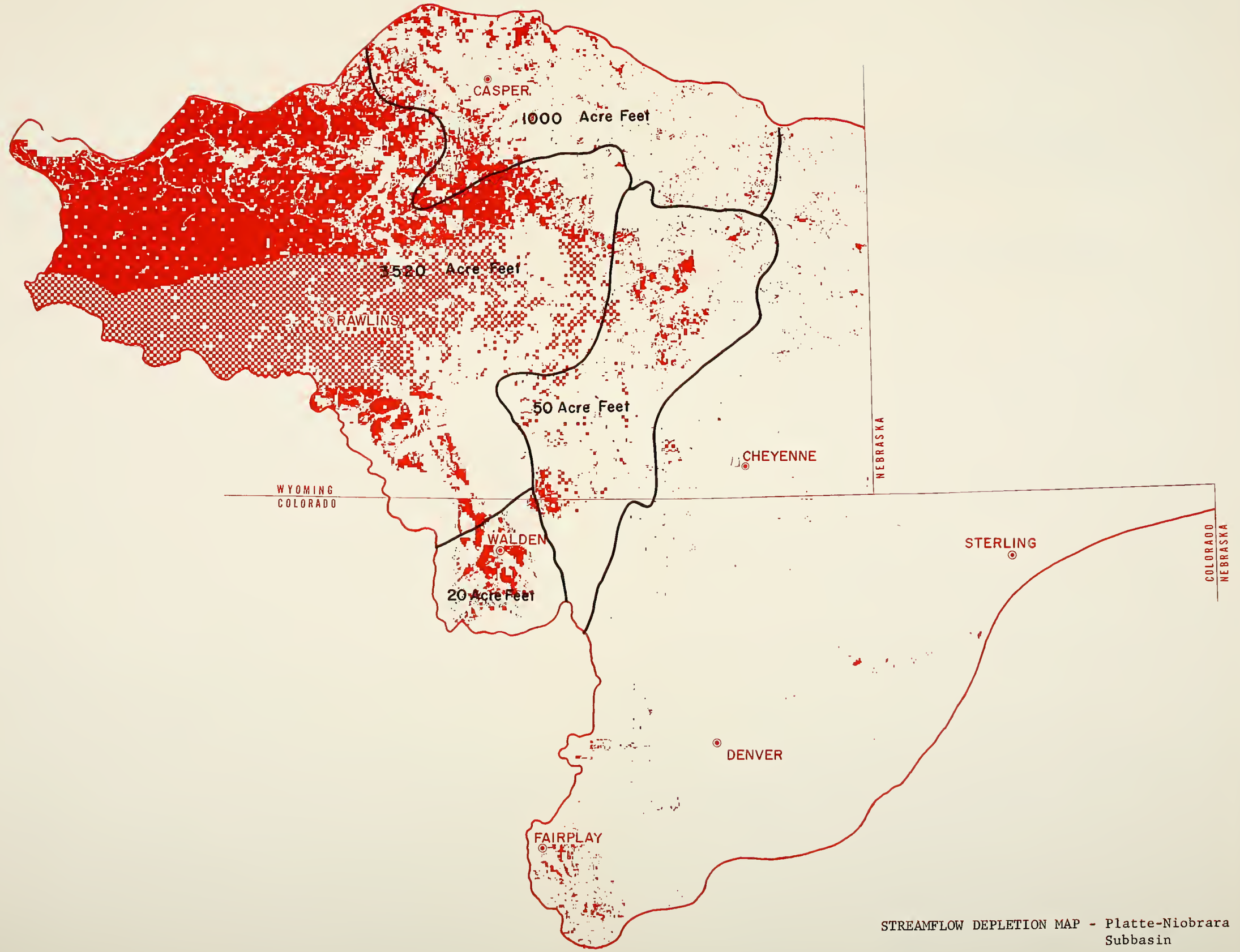
The accompanying table summarizes watershed depletions from impoundments and land treatment practices on the public domain.

ANNUAL STREAMFLOW DEPLETIONS

Tributary Basin	BLM Depletion (acre ft)	BLM Relative Depletion In Tributary Basin (%)	All Depletions In Tributary Basin (acre ft)
Sweetwater-North Platte above Alcova, Wyoming	3,670	21.0	17,400
North Platte, Wyoming, Alcova to Whalen	1,000	3.2	31,000
North Platte, Colorado	20	.5	20,700
Laramie River, Colorado and Wyoming	50	1.0	5,300
All Other Areas, Platte-Niobrara System	--	--	94,200
	4,740	2.8 (average over entire subbasin)	168,600

STREAMFLOW DEPLETION MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



STREAMFLOW DEPLETION MAP - Platte-Niobrara Subbasin

Sedimentation

The physical diversity, degree of resource development, and population pressures make the Platte-Niobrara Subbasin the most complex of all the subdrainage systems in the Missouri River Basin. The discharge of the Platte River and its tributaries is affected throughout the system by reservoirs and diversions. This makes it difficult to interpret available data on suspended sediment discharge or on reservoir sedimentation.

Due to the complexities of measuring and estimating, the hydrologists who assembled original data for the accompanying sedimentation map consider the yield values to be adequate only for preliminary planning in drainage areas of 100 square miles or larger. The larger the planning area, the more reliable the data will be. In view of the diversity of drainage conditions, a field reconnaissance is recommended prior to final planning for individual projects. This is true because of numerous local areas of very high sediment yield in drainages of less than 100 square miles.

Sediment yield in the Platte-Niobrara Subbasin ranges from less than 50 tons per square mile per year, to a maximum of 1,000 tons. About 40 percent of the public land is in the area of less than 50 tons, and nearly all of the remainder is in the 100 to 400 ton class.

The low-yield area extending northwestward from Rawlins, Wyoming to the head of the Sweetwater drainage system, is physiographically a combination of mountain headwaters areas, and the Wyoming Basin. In the former, sediment yields are low because of adequately protected soils, and resistance to erosion. In the Wyoming Basin, sediment yield to master streams per unit of basin area is small, due to low runoff and because much of the Basin has internal drainage. Public lands in the mountain areas of North and South Park, Colorado, are also among the lowest yielding lands. It should be noted that the Antero and Eleven Mile Canyon Reservoirs effectively settle sediment loads carried by the South Platte River in its headwaters reaches. The South Platte River valley with its densely populated Denver metropolitan area, generates an insatiable demand for water, with domestic use having first priority. It could well be that the most valuable product of unimproved lands in the upper South Platte drainage is the volume of water contributed for the use of Denver. Approximately 60,000 acres of public land are found in South Park, Colorado.

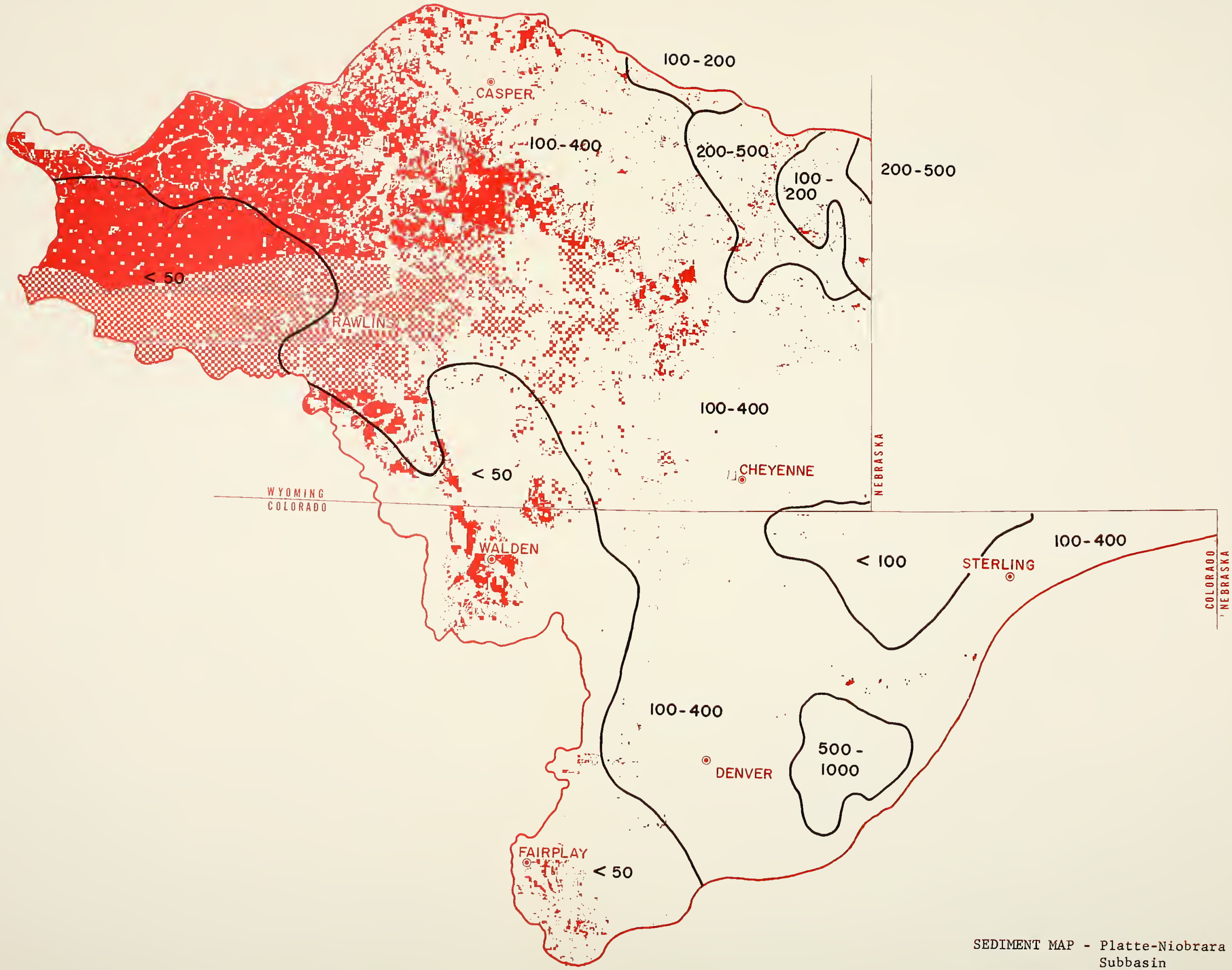
The great acreage of public land in the Wyoming Basin sector extending eastward from South Pass City and Rawlins, Wyoming, is in the moderate-yield sediment category of 100 to 400 tons per square

mile annually. Due to data interpretation uncertainties resulting from settling of sediment from the North Platte River into reservoirs upstream from Casper, the intermediate or higher sediment values might be used in planning, until an inspection of a particular project area is made. For final project planning, the establishment of a sediment sampling station would be appropriate. In the North Platte drainage, with its closely regulated mainstem flow, the primary demand for water comes from irrigated agriculture.

Sediment production can be reduced by the use of watershed protection measures such as re-seeding, water spreading, and proper rates of grazing. Intensive vegetative or mechanical practices, or both, plus proper management, are needed to stabilize high sediment producing lands. According to 1966 estimates, 46 percent of private rangelands, and 38 percent, or 2 million acres of Bureau of Land Management ranges, was adequately managed or treated. One million acres of public land were estimated to be in need of augmented management practices only, and 2,269,000 acres needed vegetative or mechanical treatment in addition to further management attention.

SEDIMENT MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
LOSSES IN TONS PER ACRE PER YEAR



SEDIMENT MAP - Platte-Niobrara Subbasin

Land Resource Regions

In broad terms of land use, there are two major Land Resource Regions in the Platte-Niobrara Subbasin, as follows:

1) Western Range and Irrigated Region
2) Rocky Mountain Range and Forest Region.

Several geographically associated Land Resource Areas, each identified by its principal features of soil or topography, combine to form each Region. Only the Regions are shown on the accompanying map, however, partly because they are reasonably descriptive of major land use, and partly because numerous boundary lines in the map's small space would be confusing.

The following table summarizes the major uses of the public lands. Besides the uses of Pasture and Range, and Forest and Woodland identified in the table, there is a third major designation, Cropland. Since none of the public land is used for cultivated crops, however, that heading is omitted from the table.

PUBLIC LAND USE

Region	BLM			Regional Total All Lands*
	Pasture & Range	Forest & Woodland	Total	
	----------(acres)----------			
Western Range and Irrigated Region	4,778,000	--	4,778,000	22,470,000
Rocky Mountain Range and Forest Region	345,000	146,000	491,000	6,945,000
	5,123,000	146,000	5,269,000	29,415,000

*Colorado and Wyoming portion of the subbasin.

Of the 5,269,000 acres of public domain in the subbasin, 91 percent, or 4,778,000 acres, is found in the Western Range and Irrigated Region. Public lands comprise 20 percent of the Region's surface area. Low rainfall, unfavorable soils, steeply sloping

topography, and a severe climate characterizes the Region. These disadvantages made the land relatively undesirable to early settlers, and probably accounts for the large acreage remaining in public ownership. Hardy and palatable perennial forage grasses make the Region well suited to grazing use; over 75 percent is devoted to grazing. Virtually all of the public domain is in rangeland or pasture. The land pattern is well blocked, contributing to effective management.

The Rocky Mountain Range and Forest Region includes mountains and intervening rangelands. It extends westward to the Continental Divide. The mountains are rugged, the basins are broad, and there are remnants of high plateaus. Grazing is the leading land use, with 81 percent of the land serving that purpose. Approximately 6 percent, or 345,000 acres of the grazing land, is public domain. There are also 146,000 acres of public domain Forest and Woodland. These areas are at relatively high elevations, principally in the rugged mountains and valleys in Colorado and southern Wyoming. In addition, some public domain occurs in the Laramie Mountain Range of Wyoming. The land pattern is less concentrated than in the subbasin's other Region, but it is still sufficiently compact in most locations to permit effective management.

LAND RESOURCES REGIONS MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN

Rocky Mountain Range and Forest Region

CASPER

Western Range and Irrigated Region

RAWLINS

CHEYENNE

NEBRASKA

WYOMING

COLORADO

WALDEN

Rocky Mountain Range
and Forest Region

STERLING

COLORADO

NEBRASKA

Western Range and Irrigated Region

DENVER

FAIRPLAY

LAND RESOURCES REGIONS MAP - Platte-Niobrara
Subbasin

Livestock

Of the 5,269,000 acres in the Platte-Niobrara Subbasin administered by the Bureau of Land Management, vegetation produced on 97 percent, or 5,111,000 acres, makes an important contribution to the growth and maintenance of ranch cattle and sheep. The remaining 3 percent of public domain has a capability classification of VIII, Waste or Barren, which contributes little to the livestock industry, but does provide wildlife habitat and watershed values.

PUBLIC DOMAIN CONTRIBUTION TO LIVESTOCK PRODUCTION

Usable Range	Number of Permittees	Number of Cattle*	Number of Sheep*	Grazing Use
(acres)				(AUM's)
5,111,000	950	229,000	594,000	470,000

*These livestock also utilize non-Federal rangelands.

Of the public lands in the Platte-Niobrara Subbasin, 4,974,000 acres are in Wyoming, mainly in the western part of the drainage. In Colorado, there are 295,000 acres of public domain concentrated mostly in the North and South Park areas. Bureau of Land Management Districts in the subbasin include large parts of the Casper, Lander, and Rawlins Districts in Wyoming, parts of the Canon City and Glenwood Aprings Districts in Colorado.

Grazing capacity on public lands is computed in animal unit months (AUM's), which represent the amount of forage sufficient to support a mature cow, or the equivalent, generally considered to be five sheep, for a period of 1 month. Grazing fees, based on the animal unit month, are established by the Secretary of the Interior at a rate equal to a specified percentage of the average market price per pound of beef and lamb in the 11 western states during the preceding calendar year. During 1971, the fee was 44¢ per animal unit month.

In Wyoming, over 95 percent of the land surface is devoted to some type of agriculture, and grazing is the principal use. Less than 5 percent is cultivated, and most of the crops produced are used for livestock feed. About 84 percent of Jackson County, Colorado is used for livestock production. Beef production is the major livestock enterprise, and management practices are oriented toward cow-calf, or cow-calf-yearling production programs. Livestock from the upper parts of the Platte-Niobrara Subbasin are sold mainly as feeders at central markets in Omaha, Denver, Salt Lake City, and Ogden.

Although less significant now than previously, the range sheep industry is an important segment of the subbasin's economy, especially in Wyoming. Most range sheep winter entirely on the desert, which includes a high percentage of public lands. It is common practice to trail sheep 100 or more miles from summer range to the desert. Some ranches, however, prefer to move their bands by truck due to the time involved. Most sheep are sheared at permanent cooperative sheds. An alternative to this is the use of mobile crews with portable units. Most shearing is accomplished prior to the lambing season. When lambing is done under range conditions, it frequently results in a low percentage lamb crop as revealed by a 1964 study showing an average 74 percent lamb crop in the Rawlins area. A good average would be 90 percent or more. Most range lambs go to livestock feeders by direct purchase, order buyers, auction sales, or indirectly to feeders through central markets. Some lambs are classified as "grass fat" and go directly to meat processing plants.

Wyoming sheep numbers declined from 3.5 million in 1941 to 2 million in 1965, mostly because of competition from man-made fibers. Even so, two towns in the subbasin, Rawlins and Casper, rank first and second respectively as United States wool markets. Each dollar of product sales by the Wyoming sheep-and-wool industry generates a direct return of $1.60 to local business and to government agencies. In addition, there is an estimated indirect return of 70 cents.1/

1/ "The Economic Value of the Wyoming Sheep-and-Wool Industry to Wyoming's Economy." Cir. No. 168, April 1961, Agr. Exp. Station, University of Wyoming.

Stockwater

Perennial streams, springs, and directly utilized snow provide 65 percent of the water consumed by livestock grazing the public lands of the Platte-Niobrara Subbasin in Wyoming and Colorado. Stockwater dams provide 30 percent, and wells 5 percent. The western portion of the subbasin, where most of the public lands are located, is often moisture-deficient due to short term drought in localized areas, and occasionally to long term shortages over large areas.

A major problem in the subbasin is the imbalance in stockwater distribution. Except in mountain areas, the western section is semiarid. Large areas of public domain, especially west and northeast of Rawlins, are grazed on a seasonal basis, greatly dependent on the availability of surface runoff or snow as a source of water. Snow is especially important. Eaten directly by sheep as their only source of moisture, it enables them to remain on the range throughout the winter. The use of snow on winter ranges reduces the need for stockwatering ponds and reservoirs, and helps to compensate for the low surface runoff.

Five major reservoirs on the North Platte River, impounding over 3 million acre feet of water, stabilize the system as a watering source. Multi-purpose dams also provide stockwater in the northern part of the subbasin.

The chemical quality of water in the subbasin is generally good. Exceptions, however, are several Platte River tributaries above Casper, Wyoming with high concentrations of dissolved solids; these are the Medicine Bow River, and Bates, Poison Spider, and Casper Creeks.

In Colorado, there is normally sufficient precipitation to provide surface runoff adequate for livestock water on the 295,000 acres of public domain found in the Platte River drainage of the State.

Stockwater ponds on public lands throughout the subbasin number about 600, with 1,800 surface acres. The 229,000 cattle and 594,000 sheep grazing the public domain consume an estimated 3,639,000 gallons of water daily. Sixty percent of the 5,111,000 acres of public domain used for grazing is adequately supplied with stockwater under the standard formula recommending 3/8 to 3/4 of a mile travel distance to water for rolling terrain, and 3/4 to 1 mile on level ground.

Coal Resources

The Platte-Niobrara Subbasin contains a relatively small percentage of the 450 billion tons of coal reserves in the Missouri Basin. Even so, the gross tonnage is sufficient that it could play an important part in future energy requirements.

Within the Platte drainage in Wyoming, the coal lies in level, unaltered beds of fair to good thickness, that can be mined by open pit methods. The coal contains very little sulphur, which makes it valuable for industrial use in this time of pollution danger to the environment.

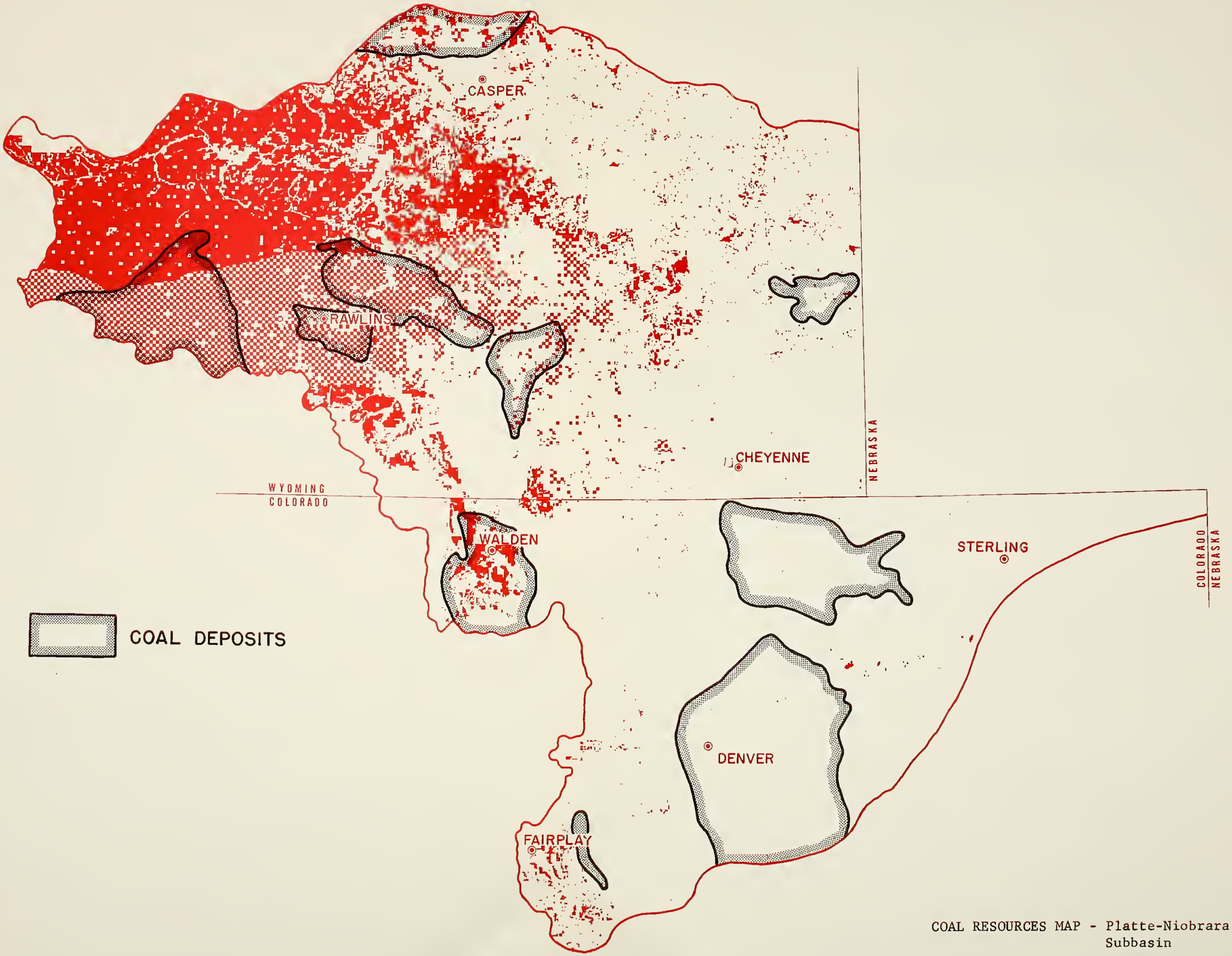
From the 1860's to the mid-1950's, Wyoming's coal fired the Union Pacific's steam locomotives. Now, diesel engines transport low-sulphur coal from Wyoming to fire steam-electric generating plants, some as far away as the midwestern States. Public domain overlying the coal-bearing lands of the Platte subbasin in Wyoming, amounts to about 950,000 acres, lying generally in the checkerboard pattern of the Union Pacific railroad grant.

In Colorado, the rising Rocky Mountains twisted and warped the coal beds. Due to their distortion and depth, they are best adapted to mining by underground methods, which are more costly than the strip mining of Wyoming. Most of eastern Colorado's coal mines have been shut down for a number of years. This includes even the mines near Walden, in North Park, which were mined by stripping the overburden, but still could not remain competitive. About 75,000 acres of public land occur in the coal-bearing regions of North Park.

From the South Platte headwaters near Fairplay, Colorado, and along the eastern front of the Rockies northward to Cheyenne, there is very little public domain in conjunction with the coal beds. This region, with its large Denver population, is a heavy electric power user, obtaining most of its energy from coal-fired plants. Further north, near Glenrock, Wyoming, the Dave Johnson steam plant on the North Platte River burns great quantities of lignite mined from an open pit nearby.

COAL RESOURCES MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



COAL RESOURCES MAP - Platte-Niobrara Subbasin

The Rocky Mountain Range and Forest Region includes mountains and intervening rangelands.

Bentonite Deposits

The accompanying map shows approximate locations of the bentonitic geological formations and known outcrops of bentonite in the Wyoming and Colorado portions of the subbasin; processing plants are also designated.

Public domain in the Platte-Niobrara Subbasin amounts to about 53,000 acres, or 50 percent of all subbasin lands with bentonite potential.

BENTONITE BEARING ACREAGE

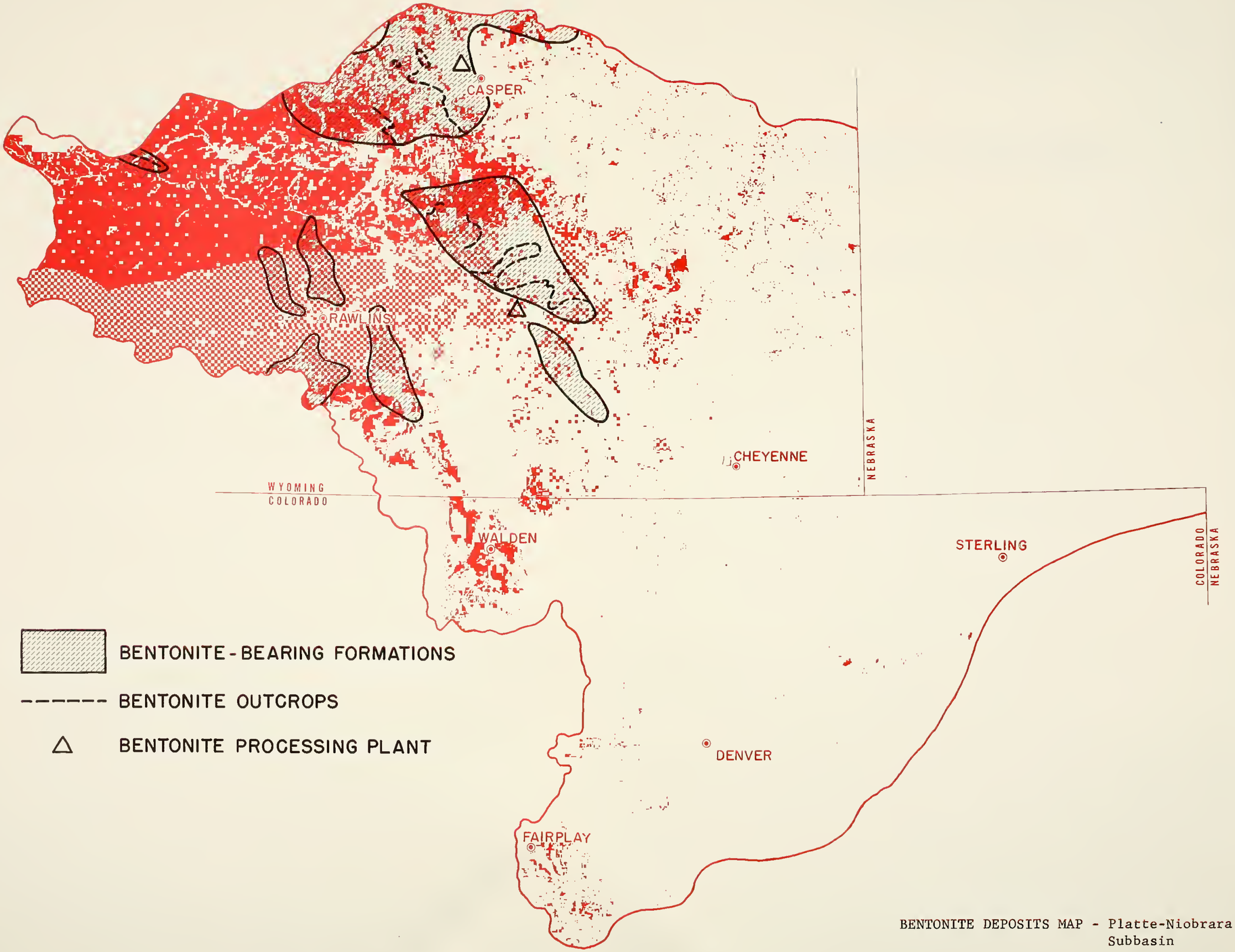
	Within Bentonite Formations
	(acres)
Public Domain	53,000
Other Land	52,000
TOTAL	105,000

The bentonite deposits in this subbasin are largely undeveloped. The Geological Survey has mapped and sampled several deposits around Casper, Wyoming, and concluded there are large reserves of bentonite suitable for foundry use. The more favorable deposits range in thickness from 4 to 9 feet. A plant to process bentonite from nearby deposits was constructed at Casper during 1946, and has operated almost continuously since. Production is limited to local demand.

The bentonitic geological formations shown around the Rawlins, Wyoming area are undeveloped.

BENTONITE DEPOSITS MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN



BENTONITE DEPOSITS MAP - Platte-Niobrara Subbasin

Fish and Wildlife

Ten percent, or 536,000 acres of the public domain in the Platte-Niobrara Subbasin, is important fish and wildlife habitat. Most of this habitat is in the subbasin's western portion in Wyoming, as shown on the accompanying map. The areas delineated on the map are essentially public domain with interspersed private holdings.

KEY FISH AND WILDLIFE HABITAT ON PUBLIC DOMAIN

	Land	Water		Total
		Open	Stream	
	(acre)	(acre)	(miles)	(acre)
Key Wildlife Areas	533,000	1,000	--	534,000
Key Fishing Areas	--	--	59	--
Stock Ponds	--	1,800	--	1,800
	533,000	2,800	59	535,800

Big game, mostly deer and antelope, with moderate numbers of elk, bighorn sheep, and black bear use more than 500,000 acres. Ninety-four percent of the key habitat area is pasture and range; the remainder is forest and woodland. The Bureau of Land Management reserves 57,000 AUM's of forage for big game use in the subbasin.

KEY PUBLIC DOMAIN FISH AND WILDLIFE HABITAT BY TYPE

	Forest and Woodland	Pasture and Range	Total Land*	Natural Water	Artificial Water
				Stream	Open
	-----(acres)----		(acres)	(miles)	(acres)
Big Game	33,000	475,000	508,000	--	--
Upland Game	--	113,000	113,000	--	--
Fishing Areas	--	--	--	59	1,000
Waterfowl	--	--	--	4	1,000

*Area total exceeds the 535,800 acres of the preceding table due to overlapping species habitat.

Public domain provides access and fishing areas on 59 miles of streams and 1,000 surface acres of open water. In the west, cold water fish such as rainbow, brook, and cutthroat trout are found at high elevations; brown trout and whitefish are found at lower elevations. Warm water fish such as walleye, catfish, crappie, bass, perch, bluegill, and bullheads live in the streams and lakes of the eastern portion. Land management influences the streamflow, siltation, and other factors that affect a fishery. Good management of the public domain will help maintain and improve important streams such as the upper reaches of the North and South Platte Rivers.

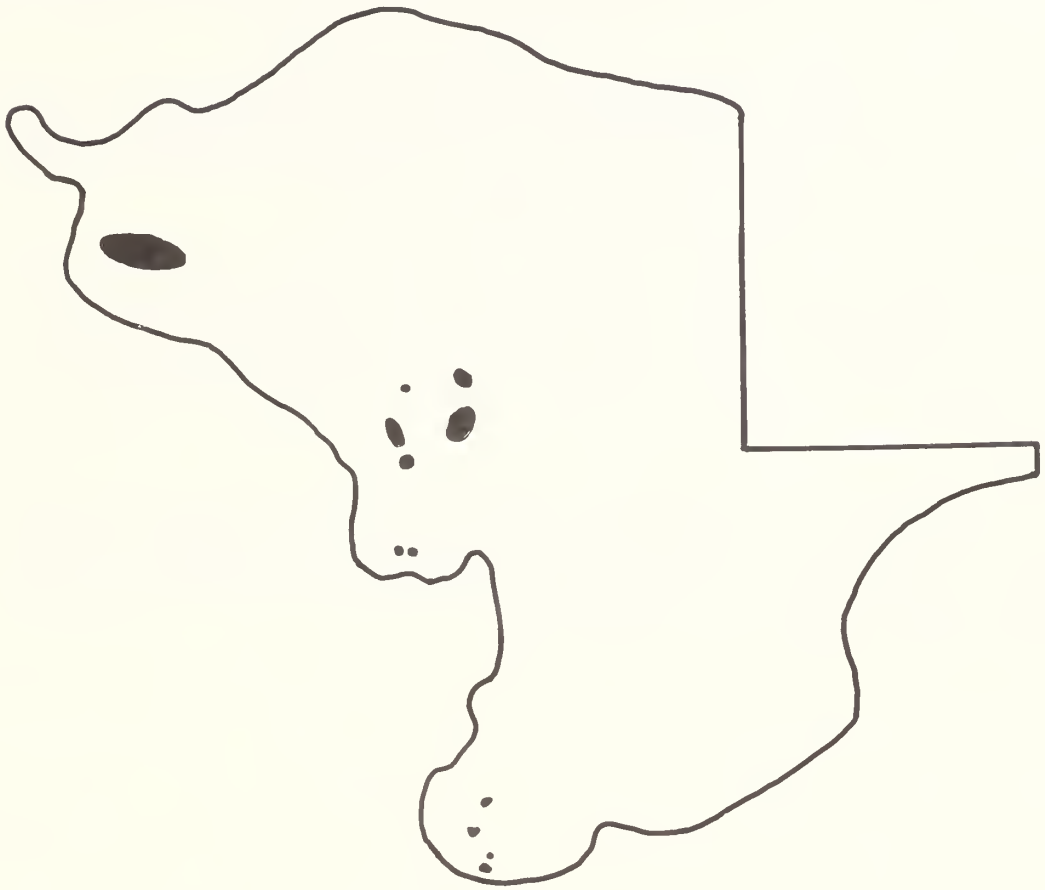
WATERFOWL NUMBERS, ALL LANDS, PLATTE-NIOBRARA SUBBASIN

	Wintering	Breeding
Canada Goose	15,300	2,400
Snow Goose	10	--
Mallard	171,900	59,800
Pintail	3,000	15,950
Teal	3,000	11,300
Shoveler	100	4,700
Gadwall	100	6,100
Widgeon	1,100	5,400
Other ducks	5,400	10,600
TOTAL	199,910	116,250

Waterfowl habitat includes 1,000 acres of open water and 4 miles of streams on the public domain. Over 116,000 waterfowl breed in the entire subbasin, and approximately 200,000 are winter residents. There are opportunities to increase these numbers; for example, fenced stockponds and water-spreaders will add nesting sites and food. Improvements would also benefit other wildlife, and prevent erosion and reservoir siltation.

Upland gamebirds find important habitat on 113,000 acres of the public domain, most of which is pasture and range.

KEY WILDLIFE LANDS ON OR ASSOCIATED WITH PUBLIC DOMAIN IN PLATTE-NIOBRARA SUBBASIN



Wildlife Habitat Areas

Classification and Multiple Use Act

The 5,269,000 acres of public domain in the Platte-Niobrara Subbasin are concentrated across south-central Wyoming, in the Sweetwater and North Platte River systems.

A pattern of nearly solid public land extends southward from South Pass, Wyoming, across the Great Divide Basin, and to the edge of the railroad grant lands, 20 miles north of the Union Pacific main line. A checkerboard pattern, with alternate sections of public and private land, continues south to the drainage divide common to the Platte and Colorado River systems.

The heavy concentration of public land has maximum dimensions of about 90 by 160 miles; to the east the amount diminishes towards Casper, Wyoming, and southward it becomes nominal in the North Platte headwaters area of North Park, Colorado.

A retention classification covers the areas of solid public land and the Federal holdings interspersed with the railroad grant lands. The classification reflects judgment by administrative officials and the participating public as to the significance of these public land areas in the local economy and the desirability of retaining them in public ownersnip.

Public lands without a classification in the region south and west of Casper, Wyoming, the Woods Landing area on the Wyoming-Colorado state line, and in North and South Park, Colorado, will be managed under other classification authority than that found in the Classification and Multiple Use Act.

CLASSIFICATION AND MULTIPLE USE MAP - Platte-Niobrara
Subbasin

RED PATTERN INDICATES PUBLIC DOMAIN
CROSSHATCH INDICATES RETENTION AREA

CASPER

RAWLINS

CHEYENNE

NEBRASKA

WYOMING
COLORADO

WALDEN

STERLING

COLORADO
NEBRASKA

DENVER

FAIRPLAY

CLASSIFICATION AND MULTIPLE USE MAP - Platte-Niobrara Subbasin

PUBLIC LAND INVENTORY AND INVESTIGATION
MISSOURI RIVER BASIN PROJECT
BUREAU OF LAND MANAGEMENT, 1947-1972

Hydrologic Area	Public 1/ Land Inventoried	Preliminary Report Published	Detailed Report Published
	(acres)		
Bad River	8,800		1949
Belle Fourche River	193,500	1952	1957
Big Dry Creek	1,062,400		2/
Bighorn Basin	3,658,300	1950	1953
Cannonball River	900		1948
Glendo Area	521,500		1951
Grand River	16,100		1948
Heart River	700		1948
Kansas River	3,800		1948
Knife River	500		1948
Little Missouri	560,500	1954	1959
Lower Cheyenne	103,000		1953
Lower Marias	209,600	1949	1953
Lower Platte	18,500		1948
Lower Yellowstone	552,400	1949	1958
Middle Yellowstone	343,200		1969
Milk River	2,994,500	1953	1960
Missouri-Souris, Montana	34,100		1952
Missouri-Souris, North Dakota	22,000		1951
Montana Pumping Area	185,200	1951	2/
Moreau River	89,100	1950	1954
Musselshell River	890,000		1971
Niobrara Basin	7,200		1951
North Dakota Pumping Area	14,600		1951
North Platte & Great Divide Basin	4,898,600	1950	1962
Oahe Unit	3,800		1949
Powder River	1,877,400	1949	1956
South Dakota Pumping Area	6,000		1949
South Platte	137,400	1949	1953
Sun River-Teton	215,200		1953
Tongue River	181,000		1967
Upper Cheyenne	276,900	1950	1957
Upper Missouri	1,092,600	1952	1954
Upper Yellowstone	138,700		1965
White River	22,000		1951
Wind River Basin	1,272,900	1947	1949
TOTAL	21,612,900 1/		
Summary Report	20,195,000		1972

1/ Includes Bureau of Land Management Withdrawals, and Land Utilization Project Areas administered by BLM. Acreages correct at time of original field inventory; later reductions through land disposal and balance of withdrawals over restorations result in Summary Report figure of 20,195,000 acres.

2/ Combined Big Dry Creek-Montana Pumping Area Report; publication date will follow Summary Report, scheduled 1972.

GPO 840-082