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Volume 8a

on the Yellowstone Basin and Adjacent Coal Area

Northeast Wyoming Planning Area Issue Papers

Wyoming

Missouri River Basin Commission
September, 1977

ISSUE PAPERS

NORTHEAST WYOMING

OCTOBER 1977

9/24/77

ISSUE PAPERS

Northeast Wyoming

Foreword

At the outset of the Yellowstone River Basin and Adjacent Coal Areas study, the individuals and agencies actively participating in the study were requested to prepare an issue paper setting forth their constituency's views on (a) what needed to be done to provide for the best use of the area's water and related land resources, and (b) what specific programs or projects should or should not be implemented.

This volume contains the issue papers that were prepared for the Northeast Wyoming planning area. The papers are arranged by type of participant -- local, State and Federal. Individual papers within each subgroup are arranged alphabetically by participating entity.

Study Team members of course contributed much additional material when specific items were analyzed as the study progressed. This material is embodied in the report, and the original documents are contained in the unprinted supporting data in the Missouri River Basin Commission files.

Ad Hoc groups prepared background material for each of the major functions involved in the study. The Ad Hoc reports are bound as appendixes to the general report on the entire Yellowstone River Basin and Adjacent Coal Areas.

League of Women Voters of Wyoming

Miki Straughan, Chairman
Sheridan Unit of LWV
555 Marion
Sheridan, Wyoming 82801
April 8, 1976

ISSUE PAPER Missouri River Basin Commission
SUBJECT: Tongue-Powder

"Two recent opinion polls tell that a majority of American people prefer paying the cost of protecting the environment rather than risking more pollution and that they are unwilling to sacrifice the environment to the need of energy. In other words, people see an environment beneficial to health as no luxury item." (From the National Board Report of the LWV, January '76 issue)

Development of the Tongue-Powder Basins

1) Short and long range goals - things that should and should not be done.

While there has been a great push to develop coal, oil and gas, there has been little concentrated effort by the federal or local governments to put into effect mandatory conservation policies while at the same time developing environmentally safe energy.

It appears that the goals now being set are for short term gain without the long term more important goals of supplying energy that will leave the environment unscarred for future generations and permit continued undamaged productivity. Relaxation of environmental standards, utilization of too much water for industry or moving too many people into an area where they cannot be properly accomodated should not be done. These short-sighted activities cause degradation of air and water quality, sewage problems, over-crowded schools, housing shortages, inadequate police and fire protection, and encroachment on agricultural land by industry and residents. Attempts to farm more marginal lands result in rapid depletion of soil quality. Wildlife habitats dwindle. Explosive population influx strains the stability of social relationships. Rapid industrial development dislocates people physically and socially. Increased taxes and price levels are most damaging to those on fixed incomes and inevitably lead to a widening of the gap between the economically disadvantaged and those who control industrial development.

2) Floating revenue bonds or selling municipal water are ways of raising needed capital, but most local governments in the Yellowstone Basin rely principally upon the property tax as the means of funding their operations. These other ways of generating revenue are generally reserved for the larger cities.

Communities also receive reapportioned state tax revenues. The reapportionments are generally small and vary considerably with the type of tax levied and the individual tax structure. Revenue sharing is a new source of revenues for local governments--2/3 of a state's revenue sharing allocation is apportioned to units of local governments.

State revenues are also derived from state and federal leasing and royalty payments, federal assistance programs (including revenue sharing), and federal grants.

In Wyoming, the royalties paid to the State from production of minerals on state lands go to the permanent fund, while federal mineral royalties are used only for roads and schools. In Montana, the state share of federal leasing and royalties is divided equally between the highway and school fund, while state leasing and royalty revenues go to the state school trust. And in North Dakota both state and federal leasing and royalty revenues go to the state school fund.

Service demand lags, capital shortages, jurisdictional disputes, and a rapidly fluctuating population base have the potential for severely testing the structure of local government and non-government services, within the limits of foreseeable revenues. Additional study and site specific development plans are needed before any firm cost and revenue estimates can be made, and before any firm strategy to remedy these problems is undertaken.

In fiscal 1971-72, average per capita personal income in the Rocky Mountain region over all was $4,011. Of this amount per capita federal taxes absorbed $989; state and local taxes $526. A total of $1,515 or 37.8% of income paid in taxes.

In Wyoming, per capita income was $4,219, just slightly higher than the Rocky Mountain average. Unfortunately, the tax burden was higher also, although no state income tax is imposed in Wyoming. Per capita federal taxes totaled $1,074; state and local taxes $540. A total of $1,614 in taxes, 38.3% of personal income.

From Wyoming Taxpayer's Association Report May '73

3) Specific projects, programs and policies considered necessary to meet objectives of 1.

Agriculture should continue to be the basis of the economy while developing geo-thermal, wind and solar resources, thus preventing long range damage to land, air and water. People will be employed in these fields as well as in the tourist industry and in food processing plants in addition to a minimal number of individuals in mining and drilling. Fossil fuels should be used as a back up form of energy where necessary and gradually replaced with less depleteable forms of energy.

A plan called the "Shell Valley Policy" could be considered for the Tongue-Powder region. The objectives of the plan are:

Protect and promote rural atmosphere
Protect agriculture as an enterprise
Protect pastoral open space
Prevent flood damage
Protect fish and wildlife resources
Promote air quality

These objectives coupled with the Land Use Planning goals adopted by the Wyoming Land Use Commission are worthy ones. Especially important is the goal to encourage energy conservation which should include a tangible reward for those who do and penalties for those who do not conserve.

4) Information available on projects and programs listed under item 3.

An example of what could be done is the study conducted by a California Engineering Consultant. The city of Sacramento proposes to spend one billion dollars building a nuclear plant which they claim is necessary. The completed study and analysis showed that if $2,000 were spent on every residence in Sacramento to improve its energy efficiency, as much power could be saved as the nuclear energy plant would generate. The cost would be a half billion dollars.

When BLM, DEQ, OSHA, FDA, US Forest Service, or any other governmental protection agency issues permits within its jurisdiction, it should have had enough properly trained individuals actually in the field collecting the data. If there are grazing permits, there should be adequate personnel to carry out enforcement. There is an opportunity to put many more people to work protecting the environment while permitting industry to develop. Jobs are involved in research for acquiring impact information. These people should be paid by the government but a portion of business and industry taxes should be earmarked for continued training and salaries for these government employees. A new industry should not be developed until there are adequate personnel to evaluate impact at all levels. Mechanisms should also be prepared for continuing evaluation and monitoring of the completed facility. Persons responsible for the necessary paper work and administration should have the authority to enforce rules and regulations promptly.

Before a project can be considered economically beneficial, the per capita cost of supporting and servicing a large number of people in a relatively short time should be ascertained. Data has been collected by the Denver Institute showing the economic gains impact created by 100 families arriving during a specific time period vs. the cost per 100 families for necessary services, i.e., schools, sewage, etc. The Sheridan Area Planning Agency is presently collecting similar data.

Experimental solar and geo-thermal plants should be supported on a large scale by the federal government in the Basin area. School programs should be funded so that young people are encouraged in these fields.

5) League Publications, newspaper clippings, tax information and other data will be included here.

Resource Material

Regional Energy/Jobs Newsletter - U.S. Dept. Labor

Clippings from Sheridan Press, Seattle Times, LWV Publications

Wyo. U. term paper '69

Sheridan Area Planning Agency

Northern Great Plains Resource Program

Paul Shore

League of Women Voters of Wyoming

Miki Straughan, Chairman
Sheridan Unit of LWV

Tax Structure of the State of Wyoming

Floating revenue bonds or selling municipal water are ways other than the property tax utilized by local governments. Local governments rely principally upon the property tax as the other ways of generating revenue are generally reserved for the larger cities.

Communities also receive reapportioned state tax revenues. They are generally small and vary considerably with the type of tax levied and the individual tax structure. Revenue sharing is a new source of revenues for local governments--2/3 of a state's revenue sharing allocation is apportioned to units of local governments.

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Revenue -- service demand lags, capital shortages, jurisdictional disputes, and a rapidly fluctuating population base have the potential for severely testing the structure of local government and non-government services. Additional study and site specific development plans are needed before any firm cost estimates can be made and before any firm strategy to remedy these problems is undertaken.

League of Women Voters of Wyoming

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August 10, 1976

Missouri River Basin Commission Tongue-Powder
Yellowstone Basin - Level B Study

The following is presented for consideration -- A Case For Resource Conservation Equaling the efforts of Energy Production.

"Among overall objectives of the Bureau of Mines, the one having the most immediate application to the Powder-Tongue Basin is assurance of a mineral production capability by the private sector to meet projected national <u>demands</u>." From Issue Paper presented by the Bureau of Mines 6/6/76. The question is, should demands, rather than needs, be met in a national emergency? The U.S. has doubled the use of electricity between 1960 and 1970 though there was only an 11% increase in population.

Although power companies and other large energy producers speak frequently of energy conservation, there is always the threat of unemployment if more energy is not produced even though at times this production takes place at an alarming rate and in a rampant manner. The argument that it is a proven fact that "energy means jobs", often stops real conservation measures from taking hold. It is as much a fact that labor saving devices which use more energy, also use less man power in their production. A plant that takes thousands of men to construct, may take only a handful of individuals to keep operating, thus putting thousands of people out of work and fostering an unstable and transient form of life-style.

Our congress is still catering to pressure groups who have spokesmen for existing technologies. Genuine alternative industries do not. People must insist upon somber, rational policy based not on the pork barrel but the national interest.

2- Equal effort for Energy Conservation

At the present time we see a capital scramble in energy. A statement made by Assistant Treasury Secretary Gerald Parsky was, "More economical projects, including more economical domestic energy projects, will be 'crowded out' by the forced diversion of funds to the less economic synfuels projects..."

Synthetic Fuels Needs:

Synthetic gas is the major use of coal outside of new thermal electric capacity. Natural gas used annually in the US currently = 25 trillion cu. ft. One 250,000,000 dallar plant like El Paso's proposal = 92 billion cu. ft. per year. Therefore, to replace current natural gas with synthetic gas would require a capital outlay of approximately $400 billion. Total for half gas replacement =$200 billion. Total for liquification = easily $100 billion for coal & oil shale.

Other indications of depletions of capital is that present synfuels commercialization programs within ERDA call for a total of $11 billion in loans, loan guarantees (which deplete the capital market even if not the public coffers) grants and price supports for eventual fuel products.

Nuclear needs including conventional fission, breeder and fusion will easily total $575 billion dollars. At some point we must decide what direction to go without diffusing capital to a needless extent. From the Congressional Office of Technology Assessment: "ERDA's concentration on a high-technology, hardware-oriented approach has meant that the states have largely been excluded from a meaningful role. The present ERDA program is often compared to the development of the H-bomb and to the landing on the moon. These programs, however, required a highly centralized management system designed to marshal technical expertise toward an easily defined goal.

The energy crisis presents a problem well-suited to decentralized, local solutions. Initiatives at the local and state level --particularly in areas like energy conservation and solar energy --are likely to produce the most dramatic results.

A wild guess of the cost of retrofitting, made by Malcolm Wallop, Wyoming State Senator, is $100 billion dollars for existing homes and is tied up closely with home building capital availability. With government putting less into the large energy companies, perhaps innovative, independent pioneers would push us forward toward a more humane, sensible energy base.

Meaning of the Capital Crunch:

With a finite resource base becoming a reality, we will face a new economic status quo without the old endlessly expanding pie from which all options and alternatives for change, including those in the energy field, could be fed.

If there isn't enough to go round, then the political arena allocates the scarce resources (not just govt. capital, though every government dollar spent on synfuels is a dollar unavailable in the private sector for a small entrepreneur interested in solar subdivision of urban solar retrofitting.)

Economists at the New York stock Exchange estimate a $500 billion dollar "capital gap" between now and 1985!

Projected private investment	=	$4.5 trillion
Internal corporate savings	=	2.9 trillion
Personal savings	=	1.1 trillion

Therefor, needed: = 4.5 trillion and available, 4.0 trillion dollars, making the difference between what is needed and what is available, $500 billion dollars.

Not only are the current energy production methods resulting in Malcolm Wallops' "Capital Crunch", but the EPA calculated in 1968 that the cost to the nation of polluted air and water was $16.1 billion dollars.

Conservation takes leadership and public education. Yes, a recycling of bottles, metals, paper, methanol made from human and animal wastes, a form of gas rationing, and restrictions on teens using cars to hot-rod would be steps in the right direction. An allotment of gas could be spent on getting to and from work with an equitable amount more but certainly not enough for cross country trips every year, motor boating, auto racing etc. A moratorium on gas guzzeling autos could be set. Perhaps that would encourage development of efficient, non-polluting fuels. Buildings and energy consuming equipment should be required to be energy efficient and people educated to use them in the most efficient manner.

4. Equal effort for Resource & Energy Conservation

The Energy crisis should be treated as such by government employees & officials, industrialists and businessmen.

The price of indiscriminate energy production, without goals other than profit, without leadership or energy policy may be costly indeed.

The reclaimed land, in the Northern Great Plains, which no longer holds indiginous plants & grasses when facing the customary cyclical drought in 20 or so yrs., unable to reseed, may turn into a massive dust bowl much as did Oklahoma in the 30s'. The water, with tables lowered from too many stripping operations and infiltrated with saline seepage and other harmful minerals may destroy the streams and rivers. Our headlong rush into short-sighted development may in the long run turn into a long range disaster.

References:

Wyoming Senator Malcolm Wallop - Notes from an alternative energy seminar

A study of <u>Energy in New England</u> (1973)

<u>The Rape of the Great Plains</u> by K. Ross Toole

* "Energy Policy Project of the Ford Foundation"
Issue Paper by Ronald Pense, U.S. Bureau of Mines 6/'76

*copy of page 472 attached

ISSUE PAPER

By W.B. Oliver

The energy policy goals expressed by the Energy Research Development Authority (ERDA) are well founded and should be supported. These goals are:

- To maintain the security and policy independence of the nation.
- To maintain a strong and healthy economy.
- To provide for future needs so that life styles remain a matter of choice and are not limited by the unavialability of energy.
- To contribute to world stability through cooperative international efforts in the energy sphere.
- To protect and improve the nation's environmental quality by assuring that the preservation of land, water, and air resources is given high priority.

It these goals are to be achieved, it is clearly in the national interest to encourage development of its commercial coal deposits and a coal synthetic fuels industry as rapidly as possible. For instance, long-range energy supply and demand projections suggest that sufficient conventional energy supplies may not be available to meet Free World demand for liquid and gaseous fossil fuels by the decade of the 1990's. At the same time, the U.S. has a very substantial domestic reserves of both coal and oil shale. Although coal can be utilized directly in many industrial and utility applications and nuclear energy may become the principal fuel for electric utilities, the nation will continue to have a large and unique need for liquid and gaseous fuels for use as petrochemical feedstocks and in the transportation sector. Energy supplies from a commercial synthetic fuels industry offer the potential to help meet these longer term needs.

However, when recognizing the potential of the industry, the factors affecting its development must also be recognized.

1. The incentive/disincentive factor. The major incentive needed for long-term development of a commercially viable synthetics industry is the removal of government-imposed disincentives. It is inconsistent to propose incentives for a synthetic industry to overcome unnecessary disincentives. In addition to correcting price control disincentives, legislative action is also needed to provide a better balance between the necessity for secure domestic energy supplies and the necessity to preserve the nation's environment. Examples are a need to materially shorten delays in NEPA proceedings and remove potential barriers to responsible development which may be present under other laws, such as the Clean Air Act.

2. The capital formation factor. The basic prerequisite for discovering, defining, and developing the nation's domestic resources is the ability of domestic energy producers to generate the required capital. It has been estimated that from 1975 to 1995, cumlatively, the U.S. will need more than 425,000 oil and gas wells; 48 refineries (150 thousand barrels per day each); over 170 large coal mines (5 million tons per year); 1900 unit trains (100 cars each); 10 oil shale synthetic plants (50 thousand barrels per day each); 10 coal gasification plants (250 million cubic feet per day each); 4 coal

liquefaction plants (50 thousand barrels per day each); and 40 uranium mines and mills (2 million pounds per year each). To accomplish this, the capital needed of the U.S. energy companies over the next decade has been projected at over $500 billion.

3. The resource availability factor. Within the area of immediate concern, the Tongue and Powder River Basin, there are sizable resources of both coal and water which must be used to achieve the goals mentioned above. Studies have shown that these resources exist in sufficient quantities to meet the requirements for the near and long term. Careful planning and cooperation between industry, the agriculture/ranching interests, and the appropriate government bodies will allow the region's environment to be protected and local resource demands to be fulfilled, while at the same time permitting the development of this area's energy resources.

In summary, this nation must develop its commercial coal deposits and a synthetic fuels industry. If coal production is to be expanded to the extent needed, and a coal synthetics industry developed, then industry must have the proper incentives with full recognition of the capital requirements of such development; and when an area has the resource base, then ways must be found to develop that resource in a responsible manner.

WBO:vm

PRESENTATION TO TONGUE-POWDER STUDY TEAM - YELLOWSTONE BASIN STUDY

W. B. OLIVER

MAY 5, 1976

The U.S. has been going through a period of great uncertainty as to the amount and cost of energy that will be required and the sources and form in which it will be supplied. This uncertainty still continues. Three and a half years ago, on November 11, 1972, to be precise, El Paso Natural Gas Company filed an application for FPC approval of the first commercial coal gasification project--the Burnham Coal Gasification Complex near Farmington, New Mexico. This plant was projected to start operation in 1976 and to be in full production by 1977. Three months later, Texas Eastern and Pacific Lighting filed application for the WESCO Gasification Project, also in New Mexico, and also scheduled to start operation in 1976. These coal gasification plants were expected to be forerunners of a series of such plants, soon to be followed by plants producing liquid fuels from coal.

This same thing was happening in the Powder River Basin, where the large surface minable coal reserves looked attractive for potential coal gasification. Several have been in various stages of consideration and design, including possible projects by Panhandle Eastern-Peabody in southern Campbell County, by Texaco near Lake De Smet, and by Cities Service and Northern Natural. Exxon also investigated the possibility of building a plant in Wyoming.

Coal requirements for synthesis were projected to be in excess of 100 $\bar{M}$T by 1985 and in the 250-300 $\bar{M}$T range by 1990.

It is now 1976, the scheduled start-up year for the two New Mexico plants, so let us see where they stand. The estimated investment in the El Paso plant has more than <u>doubled</u> to over $1 B, and the projected cost of gas from $1.50 to $3/MCF in 1975 dollars. El Paso has requested that the FPC defer consideration of its application, and this project appears to be, if not dead, at least asleep.

The WESCO project has similarly escalated in cost; and, although an FPC certificate has been granted, the terms do not assure recovery of the invested capital. The project is accordingly nonfinancible from private sources.

Close to Wyoming, we understand that the possible cost of the proposed Michigan-Wisconsin Pipeline project in North Dakota could reach $1.7 B (assuming a continuation of an inflationary environment) and that the cost of gas could be on the order of $4/MCF.

The Panhandle Eastern project in Wyoming has been delayed, but is still moving forward. One of the big problems is apparently that of raising the capital which will be required. Of course, this plant, if it proceeds, would not use water from the Yellowstone River system. The Exxon plant has been deferred indefinitely, and our information is that the Northern Natural has also. Texaco has, as you are well aware, applied for federal aid in constructing an initial demonstration plant in the Lake De Smet area. This is one of several applicants for plants of this type, and it may or may not be approved.

This raises the question as to why the synthetics plants are not being built. The basic technology exists for the production of synthetic gas from coal and synthetic oil from shale; the technology to produce liquid fuels from coal is much less well developed. A number of factors are effectively deterring complete commercialization of synthetics by the private sector. By and large, these constraints are in the form of uncertainties that are of sufficient magnitude to constitute unacceptable risk and therefore become effective prohibitions to private investors.

Among the more significant impediments to the beginning of a viable synthetics industry are these:

1. Legislative and regulatory uncertainties. Oil price controls, gas price regulation, threatened divestiture legislation, accessibility of federal resources, unreasonable environmental regulations, and uncertain fiscal policy.

2. Financial uncertainty. Synthetic plants are inherently capital intensive. Costs in the process construction industry have doubled since 1972, resulting in a significant increase in financial risk. In addition, investors may be unwilling to provide capital because the uncertain legislative and regulatory environment may jeopardize the completion or profitability of the project.

3. Technological uncertainties. Although the process technology has been proven in laboratory or even pilot-scale operations, substantial uncertainties remain about commercial-scale operations. These questions can be answered only by building and operating large-scale plants to provide field information.

4. Timing uncertainties. Abnormally long lead times complicated by delays in approvals, environmental reviews, and litigation.

These uncertainties compound the risks inherent in the tremendous investments required by private industry to advance beyond the present pre-commercial stage. We believe that even though these uncertainties exist, the nation must keep open its options for rapid development of synthetics capability. This can be facilitated by government stimulation and encouragement of further advances in the pre-commercial stage until such time as a commercially viable synthetics industry is possible. We also believe that an effective and efficient synthetics industry can best be developed by the private sector, and a government-subsidized industry would be an ongoing burden to the nation's taxpayers.

Within industry, most companies believe the major incentive needed for long-term development of a commercially viable synthetics industry is the removal of government-imposed disincentives. It is inconsistent to propose new incentives to compensate for existing disincentives. In addition to correcting price control disincentives, legislative action is also needed to provide a better balance between the necessity to preserve the nation's environment and the necessity for secure domestic energy supplies. Examples are a need to materially shorten delays in NEPA proceedings and to remove potential barriers to responsible development which may be present under other laws, such as the Clean Air Act.

As far as what type of government assistance is needed to accomplish the development of a synthetics industry, the opinions of various companies are quite different. Some of the companies feel that the guarantee of a loan by the government would be quite helpful. Still others, such as our own company, feel that price decontrols for production, accelerated depreciation, investment tax credits, direct grants, or grants convertible to loans would supply the necessary incentive. It is felt that commercialization of economically viable technologies for shale oil and gas from coal can best be achieved by progressing from large pilot plants to "pioneer" plants. Conceptually, a "pioneer" plant differs from a "demonstration" plant in that <u>each</u> major element of a "pioneer" plant would be of commercial size and no segment of the plant would contain principal reactors or process units designed especially for demonstration purposes only. Typically, a "pioneer" plant might be about ten times as large as the 1000-3500 tons per day in a "demonstration" plant.

With regard to coal as a solid fuel, the expectation is for significant growth in the market, particularly in view of the problems and delays encountered with nuclear generation. Strong growth in the general industrial market is also anticipated as market forces augmented by government pressures further the use of coal in lieu of oil and gas.

Environmental regulations limiting sulfur dioxide emissions of power plants have caused a major shift in coal demand from high sulfur coal areas in the east to the low sulfur coal in the west, and particularly in the Powder River Basin. Much of this coal will meet the sulfur requirements for new plants (1.2# $SO_2/\overline{M}BTU$), and thus it will be moved by rail to remote plant locations.

Regular runs of unit trains are already hauling coal east and south, more is under contract, but not yet being mined, and there is a potential for further large increases in coal shipments. Delays have been caused by the moratorium on coal leasing, which has made it difficult for new concerns to enter the business, and litigation over environmental questions, which has delayed the development of new mines and the construction of the Gillette-Douglas railroad to provide rail access to some of the mines. The Supreme Court has agreed to hear this suit (Sierra Club vs. Kleppe) and has stayed injunctions aginst development of mines by ARCO, Kerr-McGee, and Carter and expansion of the Wyodak mine. The injunction against construction of the Gillette-Douglas line has also been stayed, but there is a new impediment, for the ICC has recently rescinded its construction permit pending additional study of a complaint by the Sierra Club.

Although the final outcome of the suit is not yet known, the companies are optimistic and are undertaking mine construction. We are not privy to the private planning of the various companies, but understand the status of development in the eastern Powder River Basin area to be as follows:

AMAX

Present mine is being expanded to 15 MT/year or more and a second mine is to be opened north of Gillette.

ARCO

Sierra Club injunction has been stayed. The mining plan has been approved by DOI. There will be a sizable work force at the site this month and about 300 by summer. Reno Junction Trailer Park will be ready for occupancy in June. Mining could start up in 1978 or 1979 when railroad is completed from Douglas. Projected 1985 employment is about 500.

CARTER

Sierra Club injunction has been stayed. The mining plan has been approved by DOI. Construction activity resumed at Rawhide Mine. Preparation underway for a second mine at Caballo, south of Gillette. Projected 1985 employment at both mines is 589.

MOBIL

Plans to initiate mine construction in 1977. Projected 1985 employment is 650.

KERR-MCGEE

Sierra Club injunction stayed. The mining plan has been approved by DOI. Charging ahead at Jacobs Ranch and will be ready when railroad from Douglas reaches mine--perhaps 1979. Projected 1985 employment is about 400.

Wyodak

Sierra Club injunction stayed. The mining plan has been approved by DOI. Expected to expand production to serve new Black Hills and PP&L 350 MW power plant. Projected 1985 employment is about 150.

Peabody

Proposed Panhandle Eastern-Peabody gasification operation appears to be on back burner. Now Peabody plans utility mine north of Gillette with construction starting in 1977. Projected 1985 employment is around 550.

Sun

Cordero Mine under construction with silos poured. They have let the contract for erection of mining equipment and for construction of rail spur. All mine facilities are scheduled for completion by mid-December.

Let me reemphasize that these are all commercial mines--with the exception of Wyodak, the coal will be moved by rail to distant plant sites.

If operations develop as projected, these seven companies will be operating nine mines, employing 3,800 people, and producing on the order of 125-150 $\bar{M}$T/yr. by 1985. This estimate is essentially the same as one recently prepared by the National Coal Association, and I have a copy of this available if you would like one. The combined requirement for well water for these mines will probably be less than 2,000 acre-feet per year, and this should be easily supplied by wells from local, lenticular sands at each mine. (This is exclusive of much larger volumes for dust abatement, etc., taken from pit water.)

This is the way we see the picture--at the present time. Reasonable certainty of projection is impossible until the federal government settles on a firm energy policy and ground rules for operations. For example, there is now a bill before the House that would require SO_2 scrubbers on all new coal-fired generating plants. If plants burning low sulfur coals have to make the same large investments as those burning high sulfur coals, there will be little incentive to burn low sulfur coal in the same area. Powder River coal, even though mined at low cost, will tend to be made less competitive in the distant markets by the high cost of transportation. The prime market for this coal would be for conversion to synthetic fuels.

In brief, we see a continuing development of coal mining and shipment to distant plants for several years to come. These mines

SHOULD NEED VERY LITTLE WATER, AND THAT NEEDED WILL BE AVAILABLE LOCALLY, WITHOUT AFFECTING OTHER WATER SUPPLIES. SYNTHETICS PLANTS HAVE BEEN DEFERRED AND WILL DEPEND ON PROPER INCENTIVES WITH FULL RECOGNITION OF THE CAPITAL REQUIREMENTS OF SUCH DEVELOPMENT.

WBO:VM
4/28/76

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April 17, 1976

ONGOING ISSUES IN THE YELLOWSTONE RIVER BASIN

The Yellowstone River Basin has histroically been characterized by an agricultural economy, and has been primarily a rural, sparsely populated area. Within the past decade the vast coal fields in the Basin have begun to be developed, and many energy companies have made extensive plans for future mining and coal-conversion in the Basin.

The federal government is actively promoting large-scale development of Western coal, and has continuously failed to adopt a coherent energy policy that would define: 1. energy needs (including conservation guidelines), 2. priorities for energy sources (including use of fossil fuels vs. development of alternate, clean energy sources) and 3. guidelines for how those sources should be developed (including plans for dealing with adverse, industry-caused social, economic and environmental impacts).

In addition, the states in the region have failed to adopt energy policies delineating the extent and the methods whereby the energy resources within their borders should be developed. Problems are also evident in the proper enforcement of the state laws that have been passed.

Coal development and agriculture are now competing strongly for the region's limited resources, including water, land, capital and labor, without vital and important government-imposed guidelines. This competition is causing many of the ongoing conflicts in the Basin, which cannot be resolved until the people in the region, and the nation, determine what their priorities are regarding energy development versus food production in the Northern Great Plains region.

The most intense conflicts that have emerged are:

1. the struggle between agriculture and industry over the region's scarce water; and
2. the struggle between maintaining the existing rural, small-town way of life, and trying to accomodate large industry-related population increases.

If no energy development policy is developed for this regoin, the energy industry will continue to have an edge on agriculture in both of these arenas, due to industry's vastly superior financial resources.

The water right situations in all states in the Basin are convoluted and complex, administered in a laissez faire fashion. These facts, coupled with the availability of capital to industry, make it extremely easy for industry to take advantage of this largely unregulated situation. Many coal-energy companies have already purchased large tracts of agricultural land, with the attached water rights. They have also tied up water rights on most of the streams in the Basin, usually in excess of the amount of water those streams actually carry. If those rights are converted into industrial storage rights (reservoirs), a trend becoming widespread, much of the water that has been historically used for irrigation and livestock, will no longer be available for those uses. Changes in state water laws will be necessary to correct this imbalance.

Most of the communities in the Basin are too small to successfully absorb the population impacts attendant upon large-scale coal development. Attempts to do so mean transition from small agriculture-oriented towns to industry-oriented cities, and great changes in their way of life.

In addition, there are only limited funds available to alleviate the impacts of population upon these communities, and to date, the existing residents have been forced to foot the bills, by paying higher taxes.

The state of Wyoming is developing a land-use plan, implementing its Industrial Facility Siting Act, and enforcing its mining and reclamation laws. But without a stated energy policy at both the state and federal level, the development of this area's resources will continue to be chaotic and counter-productive to the best interests of the region and the nation as a whole.

Powder River Basin Resource Council

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April 17, 1976

Program Name: COAL EXPORT POLICY FOR THE YELLOWSTONE RIVER BASIN

Implementation: State legislation will be necessary, which could be enforced by Public Service Commissions, or Facility Siting Councils in the states.

Source of Information:

Completed by: Lynn Dickey and Frances Hoadley

Date Completed: April 17, 1976

Reference Documents: A Comparative Case Study of the Impact of Coal Development on the Way of Life of People in the Coal Areas of Eastern Montana and Northeastern Wyoming, by the Institute for Social Science Research, University of Montana, Missoula, June 30, 1974

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- "Energy Development in the West: Is it the Prelude to an Agricultural Disaster", by Richard Dirks, Assistant Professor, Department of Atmospheric Science, University of Wyoming, Journal of Soil and Water Conservation, Nov-Dec, 1974, Vol 29, No. 6, copyright, 1974.
- Coal Development Alternatives, An Assessment of Water Use and Economic Implications, by The Department of Economic Planning and Development, State of Wyoming, December, 1974
- Effect of Coal Development in the Northern Great Plains, by the Northern Great Plains Resource Program, April, 1975
- Final Environmental Impact Statement, Eastern Powder River Coal Basin Of Wyoming, by the Department of Agriculture, Interstate Commerce Commission, and Department of the Interior, October 18, 1974.
- "Missouri River Development Policy and Community Development", by Bernard D. Shanks, Associate Professor, Renewable Natural Resources Division, University of Nevada, presented at the 11th American Water Resources Conference, Baton Rouge, Louisiana, November 11, 1975.
- "Social Consequences of Boom Growth in Wyoming" by ElDean Kohrs, Phd. Paper given at the Rocky Mountain American Association of the Advancement of Science Meeting, April 24-26, 1974, Laramie, Wyoming.
- "Social Impact Assessment of Proposed Laramie River Station", Dept. of Sociology, University of Wyoming, December, 1975.
- U.S. Environmental Protection Agency, "Effects of Sulfur Oxide in the Atmosphere on Vegetation" and EPA Report #EPA-R3-73-030, June, 1973

National Economic Development Account

Beneficial Effects:

Industrial Water and Water for Coal Power:

It is widely agreed that if this Country's energy problems are to be successfully dealt with for the long-term, it will be necessary to implement extensive energy conservation measures, and to find sources of energy other than depletable fossil fuels, Efforts in both directions will most surely be enhanced if the social, economic and environmental costs from power and synthetic gas production facilities are borne by the consumers of those products, instead of hidden from them in the sparsely populated Yellowstone River Basin states.

In addition, industrial water can be found much more readily and cheaply, and with less adverse effects upon other water users, if it is taken from more water-rich sections of the country.

For these reasons, a coal export policy would preserve water in the Yellowstone River Basin and would benefit the nation by providing for the development of industrial water where it is most suitable.

Irrigation (agriculture):

The nation's need for food for its own people and for export to other countries continues to grow as world population increases.

There is a substantial amount of range land and dry crop land in the Basin which is suitable for irrigation, if water were made available, which would occur if water is not used for mineral-conversion in the Basin.

In addition, agricultural land (much of it prime bottom land) which would be taken out of production by mineral conversion facilities, secondary developments, housing, shopping and service facilities, huge reservoirs, residual solid wastes, and so forth, will be allowed to remain available to agriculture, and to gain in production from technological and scientific improvements if the coal export program is implemented. In addition to that land which would be directly taken out of agricultural production by a mineral-conversion industry, much more agricultural land would be adversely affected due to increased harassment and vandalism, land separation by roads and perhaps railroads, increased fencing, adjustments in livestock management plans, to name a few.

Recreation, Fish and Wildlife, Navigation; Hydro-electric Power, Municipal:

Water supplies for all the above will not be encroached upon and reduced by industrial use. Minimum stream flow problems will be avoided. The ability of free-flowing streams to sustain fish, be available for navigation, etc. will be assured. The Basin's water recreation qualities (uncrowdedness, etc.) would be maintained. Municipal water supply shortages due to massive industrial population increases would be avoided.

Water Quality;

The Basin's relatively clean water supply would be maintained; mountain streams would retain their sediment and waste-flushing capacity. If the area's "excess" water were used by the mineral-conversion industry, there would be a water pollution increase, coupled with reduced stream flow to flush those wastes.

Unemployment and Underemployment:

The high unemployment areas of this nation are the metropolitan areas whose people and industries desire more energy. It would benefit the nation to give those areas the jobs created by energy and synthetic gas production, than to dislocate potential workers and bring them to an area whose communities haven't the facilities to accommodate them, and whose way of life is alien to them.

Externalities:

The social, economic and environmental costs from power and synthetic gas production facilities would be borne by the consumers of those products, thus providing some incentive for energy conservation and development of alternate energy sources. They will be paying the true costs of the energy they consume.

The railroad, which is a common carrier of great value to the nation, will benefit financially from the hauling of raw energy sources, thus helping eliminate future tax-payers' subsidies.

Adverse Effects: None

Environmental Quality Account

Beneficial Effects:

Areas of Natural Beauty and Human Enjoyment:

The Yellowstone River Basin is replete with natural areas, many of which would be threatened by a mineral-conversion industry. For example, there is a stretch of the Tongue River in Wyoming which is being considered for "Wild and Scenic River" status because of its particular natural and scenic qualities. That same stretch also contains a potential reservoir site where Pacific Power and Light could store water (for which they have filed valid applications) for use in power generation plants proposed for the area.

Many areas such as the one described, are unique to this part of the country, and could be preserved under the proposed export policy.

Biological, Geological and Ecological Elements:

Many species of fish and wildlife in the Basin would be greatly reduced in numbers with a mineral conversion industry in this area, due to reductions of water supply, habitat, migration corridors, and uninhabited areas.

In addition, livestock, crops and ranchers and farmers themselves can be considered biological communities, and their existence would also be threatened for the same reasons. Inflated prices and wages that come with sudden population increase would also add to agricultural burdens. The already depressed agriculture industry would face an insurmountable task trying to adapt to these additional burdens.

There are also many very unique historical sites and areas in the Basin, including homesteads, teepee rings, and archaeological sites (many as yet unexplored) which stand better likelihood of being preserved with an export policy.

As for the natural ecosystem of the Basin, it is quite a fragile one, due to scarce precipitation, thin soils, and so forth. Wind erosion is a very serious problem, as are the very real dangers of drought and its attendant loss of forage and of stock, and of water for human and livestock consumption, fire danger, and so forth. There is no way to know how much disruption the ecosystem can absorb without being irreversibly damaged. Even long-term mined-land reclamation has not been successfully demonstrated yet.

Large numbers of people and air and water pollution accompanying a mineral conversion industry would only disrupt the natural ecosystem further.

Water Quality:

Implementation of the mineral export program would obviate increased water pollution from the mineral conversion industry. The capacity of streams to flush sediment and wastes would be preserved. Powder River, which already carries a very high sediment load, would be especially impacted if an export policy were not implemented.

Air Quality:

An export policy would aid greatly in the protection of one of the last reservoirs of clean air in the nation.

Recent studies conducted by various agencies, including the University of Wyoming Atmospheric Sciences Department, indicate that increases of particulate emissions in arid and semi-arid areas might well result in decreased precipitation. The Yellowstone River Basin is a semi-arid area, and particulates are one of the major pollutants from coal-conversion plants.

Many aréas of the Basin are particularly prone to extended or frequent periods of thermal inversion, wherein pollutants are trapped in the lower level of the atmosphere, and thus not allowed to disperse. Any increase in air pollution, will thus increase the danger to human and animal health. Many crops, such as barley and alfalfa, are particularly sensitive to sulfur dioxide, which is one of the major pollutants from coal-conversion plants.

Adverse Effects:

None except:

Air Quality:

The export policy could result in further deterioration of already low-quality air in the metropolitan areas of the country.

Regional Development Account

Beneficial Effects:

Irrigation (Agriculture):

In addition to the agricultural benefits outlined under the NED Account, the regional costs of trans-basin diversions could be avoided with an export policy. Although comprehensive studies have yet to be performed, the impacts of removing water from other semi-arid areas into the Basin could have profound impacts upon the ecological balance of the areas from which water was removed. Trans-basin diversions would remove water that would have otherwise been available for industrial or agricultural development in those areas.

Industrial and Coal-fired Power: See NED Account

Municipal, Food, Hydro-Electric, Fish and Wildlife, Navigation, Recreation: See NED Account

Employment Impact and Induced Employment Impact:

Following is a possible employment scenario, with an export Policy:

Suppose half the people born in Wyoming between 1957 and 1967 want to live here, and that 3/4 of those people will want to have jobs here that do not now exist. According to U.S. census records, that would add 27,000 Wyoming natives to the work force between 1975 and 1985. During the same ten year period, it is not unreasonable to expect another 4,000 non-native workers to move into Wyoming. This would mean the addition of 31,000 new workers. If we assume that all these workers have the average of a spouse and a child apiece, we are talking about a population increase of nearly 100,000 people, a sizeable and economically healthy rate of growth.

Where could these people work? Let's look at mines. The Department of Economic Planning and Development, in a study done in 1974, found that one ten-million-ton-per-year surface mine (the average-size mine proposed for the Powder River Basin) employs 286 permanent workers. The study also indicates that each of these workers would create an additional 1.5 jobs for service and associated workers. That's 715 jobs for each mine.

The Northern Great Plains Resource Program study, released in August of 1975, offers three different scenarios for coal development in Wyoming. If we assume a high rate of mine development, certainly possible with the 92 federal coal leases now existing, we could develop a scenario like this:

By 1985, 16 more average-size coal mines, exporting all their coal, will be located in Wyoming. These 16 mines will provide 11,440 permanent jobs.

The DEPAD report mentioned above found that the rail line planned from Gillette to Douglas would provide, directly and indirectly, 723 permanent jobs and the proposed slurry line from Gillette another 187. If we suppose another two rail lines and another two slurry lines will be required to ship coal from Wyoming, we are talking about a permanent coal-induced work force of 14,170 workers.

Using DEPAD calculations, a construction force of 7781 workers would be needed to build and service thses mining and transportation systems. If we follow a scenario somewhere between the high and middle NGPRP scenarios, there will be sufficient new mines in the coal fields of Wyoming to keep this construction force employed well into the next century -- certainly enough time, if we start now, to plan for our growth in the 21st century.

If we add this construction force of 7781 onto the 14,170 jobs created by mining and transportation, we have a total of 21,951 new jobs in the next ten years, and an assurance that we will be able to maintain a force that size into the next century.

Conservatively estimating that 2000 people will leave the Wyoming work force in the next ten years due to retirement, death, etc., then the rest of the state's industries--agriculture, tourism, oil and gas and other minerals, etc. need only to be able to provide a total of 7049 jobs to take care of the rest of the potential 31,000 new workers in the state during the next ten years, and an equally healthy rate of growth can be projected into the next century.

Externalities:

With a mineral export policy, a number of regional subsidies for cheap energy to mid-west and eastern consumers (at the expense of encouraging energy conservation) will be avoided. Those subsidies include, socio-economic dislocations, increased demand on scarce water, disruption of fragile ecosystems, deterioration of air quality, and the transformation of a rural, agricultural area into an urban, industrialized area.

To the extent that construction of further large reservoirs in the Basin is avoided, so will be avoided further impacts similar to those now being experienced w th existing reservoirs: flooding of prime agricultural land, increased taxes, and the disruption of viable farm units and established social structures.

Adverse Effects: None

Social Well-Being Account

Beneficial Effects:

Stabilized Population:

While sizes of mines, plants, unit trains and slurry lines differ, the DEPAD report "Coal Development Alternatives" has assigned average sizes which we will use here. A ten-million-ton-per-year strip mine would cause a population increase of 1788 people, including employees, families, service personnel, etc., in four years. This population would then remain for the life of the mine.

A unit train designed to handle 61 million tons per year would increase the population by 1831 people in ten years and then stabilize. A slurry line of 25 million tons per year capacity would show an initial population jump of 3019 people the first year of construction, but then decline to and remain constant at 469 people by the third year.

Mines, unit trains and slurry lines would cause a large jump in population, hopefully only temporary, that will be traumatic. But if their construction is carefully planned and controlled so it isn't done all at once, Wyoming could probably deal with the impacts adequately without the dramatic deterioration of the quality of education, health care, mental health, housing conditions, peace, and general quality of life that have been demonstrated when rural towns experience the large and sudden population increases associated with mineral conversion facilities.

A coal-fired mine-mouth, electric generator producing 1000 megawatts would cause a population peak of 5466 people during the fourth year of its construction. The permanent population increase after construction would be 1125 people.

A gasification plant producing 250 million standard cubic feet of synthetic gas per day would cause 9063 people to move into the area around it by the fourth year of its construction. This population would decrease to and stabilize at 5312 people when the plant went into production.

In all mineral-conversion processes, there is a population peak during construction that is significantly larger than the permanent population, and these construction workers will be on the site for several years. If, for example, two of the three companies who have indicated an interest in building gasification plants in Campbell County (Arco Carter and Kerr-McGee) did so, and their two-year construction periods overlapped, Gillette could expect a population increase of 18,000 during construction, and if all the construction workers left after construction, a permanent population increase of 10,500. To plan and provide even minimally for an 18,000 population increase, and then have over 7500 people leave would leave behind some really overwhelming problems. And the permanent population would be, not only larger than is necessary for healthy economic growth, but so large it would permanently change the society and culture of the County, doubling the demand on the already overloaded services and facilities there.

Distribution of Income:

If large-scale industrialization occurs in Wyoming, the people who will be the most severely affected financially will be those on low and fixed incomes. As the cost of living increases, the value of money decreases, and without an increased income to compensate, the impact will be great.

In areas that become industrialized, inflation sets in in the retail and service sector, the cost if capital increases, taxes are increased to pay for impact, and power costs due to mixing high-cost coal power with hydro-power. All these things result in less income to ranchers and farmers, because they can't pass increased costs on to their consumers; and to retired people, because they receive no increase in income to compensate for increased costs. Greatly increased federal Social Security, welfare, and subsidies, will be required if these people are to maintain an acceptable living standard.

Two of the most impacted areas within Wyoming, Rock Springs and Gillette, have the highest inflation rate, and the highest rate of increase in the cost of living in the state. As a result, people on fixed and low incomes in those communities have been badly hurt economically.

Most Wyoming communities have a high percentage of retired people compared to the national average. And 16% of the households in Wyoming depend on some type of retirement funds for income.

The greater the economic development, the greater will be the cost to ranchers and farmers and retired. With an export policy, the inflation rate will not be artificially stimulated, serving to maintain an even and reliable distribution of income.

Increased Recreation and Fish and Wildlife Days:

Because of the demand which mineral conversion places on water supplies, its disruptive use of land, and its associated population increases, the number of recreation and fish and wildlife days would be greatly decreased per person. A mineral export policy would reduce those decreases substantially.

Increased Employment:

See the possible scenario outlined in the "Regional Development" Account.

Stabilization of Economic Conditions:

With an export policy, water would ramain available for smaller-scale, cleaner and more stable industrial development, such as the manufacturing of goods and equipment.

The national need for energy is quite unstable at this time (having been reduced from a 7% annual growth rate to 2%) and the need for synthetic gas is questionable (note conflicting reserve statistics, and large new finds, such as the field discovered in southwest Wyoming last month).

An economy based on smaller-scale industries such as agriculture and manufacturing would not only be more stable, but more diversified, since there would be enough water for both. The tremendous conflict over water now raging between the energy industry and agriculture, would not be repeated with smaller-scale, less water-demanding industries.

By perserving the region's agricultural economy, a coal export policy will assure that the region will have a stable economic base after its minerals are gone. A coal export policy will also prevent "boom-bust" cycles in the region's communities, and allow permanent and even growth.

Adverse Effects:

Population impacts would be substantially mitigated with the export policy. The jobs attendant with mineral-conversion facilities would be taken to the people in the metropolitan areas who need those jobs. To locate the industry here would require the dislocation of many urban Americans to a part of the country where communities would be unable to adequately accommodate them, and tbe life-style would be alien to them.

The export policy program will substantially reduce the adverse population impacts attendant with mineral development.

Powder River Basin Resource Council

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Program Name: Mining Limited to those areas of the Yellowstone River Basin where the least possible damage will be done to ground and surface water resources, and where reclamation is the most feasible. Areas to be protected from mining would include alluvial plains, riparian communities, and areas underlain by coal beds that are significant aquifers.

Implementation: State laws will be needed to implement necessary restrictions, and federal laws will be needed to regulate federal lands. The Environmental Protection Agency, and the environmental supervisory agencies of the states would be the logical implementors.

Source of Information:

Completed by: Lynn Dickey and Frances Hoadley

Date Completed: April 17, 1976

Reference Documents: "Biogeochemical Limitations on Western Reclamation", Robert Curry, Director, Sierra Club Research, March 1975

-- "Deep-Mined Coal Termed Essential for Clean Energy", article quoting EPA Director Russell Train, Washington Post, Sept. 27, 1973

-- Effect of Coal Development in the Northern Great Plains, by the Northern Great Plains Resource Program, April, 1975

-- Facts About Coal in the United States, by the Environmental Policy Center, Washington, D.C., April, 1974

-- Hydrologic Effects of Strip Coal Mining near Decker Montana, Montana Bureau of Mines, June 1974

-- "It's Back to the Pits for Coal's New Future", Edmund Faltermayer, Fortune Magazine, June, 1974

-- "The Coal Industry's Controversial Move West", Business Week Magazine, May 11, 1974

-- "The Western Low Sulfur Coal Myth", Environmental Policy Center, Washington, D.C.

-- "West Virginia Coal as an Alternative to the Energy Crisis", Norman Kilpatrick, Research Analyst, West Virginia Legislature,

National Economic Development Account

Beneficial Effects:

Municipal and Industrial Water:

Western coal deposits often serve as aquifers, bearing substantial ground water. The mining of a coal seam usually produces more than enough water to supply the mining operation itself. For example, the Amax Belle Ayr mine in Campbell County produces an average of over 100 gallons of water per day. This limited mining program would make the water from mined coal seams available to the mining industry. It would also preserve the underground water from coal seams not open to mining, for use by municipalities and other users.

Flood Control, Recreation, Fish and Wildlife, Power, Navigation:

Will not be significantly affected by this Program.

Irrigation (Agriculture):

Agriculture will benefit substantially from this Program. Strip mines throughout the Yellowstone River Basin are lowering surrounding ground water tables significantly, and are drying up wells used for stock and domestic water and irrigation. In the case of the Decker mine in Montana, water tables are expected to be lowered for a radius of 20 miles outside the mine itself.

If areas where ground water would be severely affected are withdrawn from mining, agricultural water supplies will be protected.

In addition, many strip mines are operating or planned in fertile alluvial valley areas, critical for the growing of winter hay for livestock. Those areas would be preserved for agriculture under this program.

Third, once the coal in this area has been stripped, the land will most likely be returned to agricultural production. There is considerable question of the rehabilitation potential of much of the land in the Basin due to poor soils and lack of moisture. Return to agricultural productivity would be better assured if only those areas that could be reclaimed would be mined.

Water Quality;

Production of alkaline waters, discharge of sulfates and pyrite from spoil runoff, siltation and turbidity problems often accompany strip mining. Disruption of fish feeding and spawning habits occurs when siltation smothers food sources and freshly laid eggs. Total dissolved solids, sodium adsorption ratios, and pH of stream and river waters have historically experienced order of magnitude changes as a direct result of strip mining.

Limiting of mining to areas not intersected by natural streams or alluvial sub-surface drainage areas will do much to protect water quality.

Unemployment and Underemployment:

Up until the last few years, West Virginia and Kentucky ranked first and second in the nation's coal production, primarily from underground coal. That production has now slacked off considerably, and many coal-mining towns in those states are now in quite a depressed state due to the coal industry's shift to the West.

Restricting Western coal development should result in a substantial return to deep mining in these areas, thus solving what is becoming a critical unemployment problem. In addition, strip mining employs 1/3 less people per ton mined, and so does less to aid the nation's unemployment problems than does deep mining.

Externalities:

Putting the brakes on the coal industry's move west will 1. encourage development of massive eastern low-sulfur coal reserves, 2. speed the already impressive development of long-wall deep mining techniques (which improve both the safety and productiveness of deep mines), and 3. speed the development of sulfur removal techniques (which can already remove 40% of coal's sulfur content before it is mined) and 4. encourage development of techniques to utilize the methane produced in underground mines.

Only 3% of the nation's coal is recoverable through strip-mining. If coal is to become a prime fuel in this country while we develop alternate sources, it is necessary to continue and to increase production from the nation's deep mines. In addition, energy and fuel will be conserved, because eastern coal is so much closer to the consumers.

Adverse Effects: None

Environmental Quality Account

Beneficial Effects:

Areas of Natural Beauty and Human Enjoyment:

The more fragile areas of the Basin will be preserved.

Biological, Geological and Ecological Elements:

Biological--In addition to the direct benefits to maintenance of water quality described in the NED account, implementation of this program will result in the following benefits to wildlife and range productivity:

Alluvial valleys are invariably the best protected and most utilized winter range for wildlife species. Human activity in alluvial areas can effectively reduce the carrying capacity of an area by a factor of several times the actual area being developed. A section of alluvial lands might function as the only winter range for an area of 20 or 30 sections. Thus, mining the alluvial section would remove the entire 20 or 30 sections from wildlife habitat. Deer and elk do not fly south for the winter. They must find food and shelter in bottom lands.

Alluvial bottom lands provide unique (and often aesthetically outstanding) riparian communities. The biological productivity of stream-side areas is several times that of surrounding hillside and plateau areas. While mining of stream bottoms might directly affect only 5% of a given area's surface, up to 80% of that area's biological carrying capacity could be temporarily or permanently destroyed.

Subdivision of attractive bottomlands by increased populations attending extensive coal mining must also be considered in any quantitative assessment of biological impacts.

Ecological--Temporary destruction of riparian communities and productive bottom land soils cannot be quickly corrected following cessation of mining. Erosion and siltation problems, uncovering of toxic spoil materials, and soil sterility are real problems experienced by rehabilitation researchers on a regular basis. Restoration of any ecological community to its former level of productivity is nearly impossible; restoration to former diversity is impossible without many years of natural succession. The ability of "reclaimed" lands to maintain nutrient cycling stability and long-term (10-15 years) productivity has not been demonstrated. It seems unwise to sacrifice the most fertile bottom lands when numerous alternatives are available.

Geological--Stream recharge is often a function of subsurface flows, in such varied aquifers as coal beds and alluvial deposits. Mining of aquifers can not only dry up wells and disrupt subsurface flows, it can also dry up surface flows, including free-flowing streams and springs. Springs are a vital source of water for wildlife and livestock in the Northern Plains. Maintenance of aquifer integrity and protection of natural hydrologic systems would accrue if this program is implemented.

Water Quality: See NED Account

Air Quality:

Reduction of dust, diesel emissions, will both occur if this Program is implemented.

Adverse Effects:

Areas of Natural Beauty and Human Enjoyment Lost:

Some will be lost to strip-mining, though hopefully only temporarily. Many beautiful riparian areas would be preserved.

Archeological, Historical and Cultural Elements Lost:

Those that are in areas which are mined, including moose and eld winter range areas, will be lost permanently, in all liklihood.

Irreversible Considerations:

Protection of ecologically significant areas, agriculturally productive bottom lands, and fragile hydro-systems cannot be considered irreversible.

That mining that would not be covered by the restrictions of this Program would result in irreversible damage to ecologic stability, groundwater quality, and increased wind erosion, and human pressure on all natural systems in the area.

This program would serve to reduce the magnitude of such irreversible effects, but would not eliminate them.

Water Quality:

Mining areas not restrained by the provisions of this program would experience some aquifer disruption, some surface water quality impact, and potential reduction in natural stream flow. Stream flushing capacity and Total Dissolved Solids increase would occur to some extent, but would be limited by the implementation of this Program.

Air Quality:

This Program would allow some deterioration in air quality from fugitive dust and diesel emissions.

Regional Development Account

Beneficial Effects: Same as those under the NED account

Regional Benefits:

Employment and Induced Employment Impact:

Following is a possible scenario under the Limited Mining Program:

Suppose half the people born in Wyoming between 1957 and 1967 want to live here, and that 3/4 of those people will want to have jobs here that do not now exist. According to U.S. census records, that would add 27,000 Wyoming natives to the work force between 1975 and 1985. During the same ten year period, it is not unreasonable to expect another 4,000 non-native workers to move into Wyoming. This would mean the addition of 31,000 new workers. If we assume that 111 these workers have the average of a spouse and a child apiece, we are talking about a population increase of nearly 100,000 people, a sizeable and economically healthy rate of growth.

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By 1985, 16 more average-size coal mines, exporting all their coal, will be located in Wyoming. These 16 mines will provide 11,440 permanent jobs. The DEPAD report mentioned above found that the rail line planned from Gillette to Douglas would provide, directly and indirectly, 723 permanent jobs and the proposed slurry line from Gillette another 187. If we suppose another two rail lines and another two slurry lines will be required to ship coal from Wyoming, we are talking about a permanent coal-induced work force of 14,170 workers.

Using DEPAD calculations, a construction force of 7781 workers would be needed to build and service thses mining and transportation systems. If we follow a scenario somewhere between the high and middle NGPRP scenarios, there will be sufficient new mines in the coal fields of Wyoming to keep this construction force employed well into the next century -- certainly enough time, if we start now, to plan for our growth in the 21st century.

If we add this construction force of 7781 onto the 14,170 jobs created by mining and transportation, we have a total of 21,951 new jobs in the next ten years, and an assurance that we will be able to maintain a force that size into the next century.

Conservatively estimating that 2000 people will leave the Wyoming work force in the next ten years due to retirement, death, etc., then the rest of the state's industries--agriculture, tourism, oil and gas and other minerals, etc. need only to be able to provide a total of 7049 jobs to take care of the rest of the potential 31,000 new workers in the state during the next ten years, and an equally healthy rate of growth can be projected into the next century.

Externalities:

Some coal will be saved for future use.

Acverse Effects: None

Social Well-Being Account

Beneficial Effects:

Stabilized Population:

Some of the East-to-West migration that would result from unlimited mining will be halted. Population in some of the Eastern underground coal-bearing states will be stabilized.

Distribution of Income:

Coal income will be more evenly distributed across the country, as opposed to being concentrated in the West.

Increased Recreation and Fish and Wildlife Days:

Implementation of this Program would protect local fisheries and native game range.

Protection of fishery quality and productivity would yield opportunities for increased use by new local residents, assuming proper management by State Fish and Game authorities.

Protection of alluvial bottom lands and riparian communities would stabilize carrying capacity of native ungulate species and game birds and non-game bird species. Increased opportunities would be provided for big game and game bird hunting; the same would be true for bird watchers and other naturalists, as the population of the region increased due to increased coal development in areas not restrained by this Program.

Increased Employment:

Would occur for many unemployed Eastern deep-miners, and for people who want to move west in the mining industry as well.

See the Possible Scenario outlined in the Regional Development Account.

Stabilization of Economic Conditions:

Will occur in both Eastern deep-mining areas, and western strip-mining areas, because neither will be overwhelmed by boom or depression.

Adverse Effects:

Population Impacts from Local Facilities and Moving of People:

These types of adverse impacts will be avoided to a large degree by the proposed Limited Mining Program.

Material Presented by Frances Hoadley
at
Tongue-Powder Study Team Meeting
at
Gillette, Wyoming
May 5, 1976

1. Lack of any real energy policy on the federal and/or state levels has stampeded the energy companies into massive assaults on the Plains in the name of reaching "Project Independence". A rational energy policy on the federal level will permit responsibilities to be assigned. The national government is not stressing CONSERVATION of anything.

2. The LACK of water is the crux of power generation and coal conversion in Northeastern Wyoming.

3. The struggle between giant industries (coal conversion, power generation, etc.) and the existing agricultural industry over the water that is available. Also, additional storage of water in new reservoirs inevitably destroys the best agricultural land, of which Wyoming actually has little. Residual wastes will gobble more.

4. At issue, the ability of industry (strip-mining operations) to reclaim lost top soil and the ability of energy-generation plants to control the pollutants they create, most particularly the poisonous SO_2.

5. The question of whether there really is enough water in this whole state to support increased populations and industrial use. And whose water is it, anyway? Some of the water leaving Wyoming is pledged to Mexico under treaty. Are we prepared to hazard our relationship with the neighbor to the South?

6. Energy consumption predictions are being based upon a created market, aided and abetted by the construction industry, in which no other forms of energy-generation are considered. Americans continue to live in a Paradise of "clean all-electric" homes while the dirt and destruction is hidden in the wide-open spaces of the West.

7. The issue of Water Rights is very sensitive. The purchase of water rights by industry, to the detriment of certain municipalities and agricultural uses is damaging to the entire state, not just this basin.

8. In many respects, ground and surface water are inseparable. Adequate and pure ground water is a critical aspect of any agricultural use of the land, and in this county it is the only source of domestic water for a burgeoning population. What does strip-mining do to ground water? The answer is that we know startlingly little about it, but what we do know is all bad.

9. At issue are non-monetary benefits of undeveloped waters (wildlife-recreation) upon which this state's reputation as a tourist attraction rests opposed to economic benefits. It comes down to a choice of retaining some of the state's waters as a form of heritage for our youngsters and those who come to look upon Wyoming's beauty.

10. Social problems created by masses of new people converging in small towns are already overwhelming some communities. The ability of local residents to have taxes increased, schools overwhelmed, roads and streets deteriorated, crime dealt with, etc. has reached its limit. Further, there is growing evidence that permanent residents do not like to be stuck with the bonded indebtedness created in attempts to alleviate the problems. The transients move on but leave the debts behind.

11. The costs of producing ground water for municipal or agricultural use are soaring and the water tables being pumped are dropping dramatically. Surface water seems to be the long-term answer, but a major transbasin transfer of water would be a major factor in directing future development. The availability of water along the routes of conveyance, even in rather minor amounts, would result in new towns, alter the economic activities of existing towns, and result in a swiftly changing population pattern. At this time there is little evidence that adequate mechanism for planning exist at any governmental level, particularly on a scale commensurate with the potential impact of redistributing water over large areas.

12. Careful stewardship of the land, learned the hard way over a period of approximately 55 years or more, versus immediate profound exploitation over a period of perhaps 30 years.

13. Consistent disregard in all industrial proposals of the hard fact of drouth which may last several years. Creating another great desert will not serve the Nation's interests.

14. Shipping the coal out of state will serve the interests of the railroads which already have enormous capitol vested, and this business can serve the nation on a time-basis that is feasible,--20 to 35 yrs.

15. Land use plans must be developed which will take into account all soil conditions, climate, aridity, and social conditions.

Possible Projects:

I. Export Policy
   1. Cost & Benefits Analysis

II. Use of Western Coal as a Transition Resource
   1. Areas that are amenable to reclemation
   2. Revitalize the eastern coalbeds which are higher in BTU's

Present status of the Tongue River water rights:

Both the Crows and the Northern Cheyenne tribes and the Federal Government have filed a claim that the water from Tongue River belongs to those Indian tribes. Notice has been served on all Montana users on those waters to this effect.

The Crows and the Federal Government have filed a separate but similar claim.

SUPPLEMENTAL PAPER FROM PRBRC ON MINING ALLUVIAL VALLEYS
November 4, 1976

In the Study Plan Formulation to emphasize the Enviornmental Quality Objectives, p. 10, under sub-point O, appears the following proposed action: "Conserve productive topsoil for future use in producing food and fiber as well as a part of the habitat of man. Provide for the use of land within its carrying capacity, institute wise land use practices so that the land is not degraded, and institute measures to correct past misuses."

Historically, Americans have a record for disregarding the limitations and the fragilities of their land, and this accounts for a great deal of the constant surge westward as the country developed industrially and in population. As farmlands wore out, eroded away, or went under to development the farmers tended to migrate west. When they reached the Great Plains, aided by various Homestead Acts, it became obvious in a few short years that the federal government and its agencies had not really been listening to some of the wiser and more experiences voices that spoke out in a futile effort to prevent some of the misuses which soon were visited upon the plains and prairies. Strip-mining is the latest of the misuses.

Powder River Basin Resources Council is here re-iterating an organizational commitment made two years ago to protect the West's most fertile lands. We are uncertain as to the actual input of any conservation guidelines which may have or may not have gone into the Harza projections, but we do point out that the time limit is too short to do really basic studies on many of the problems arising in the matter of coal-mining and energy development in Northeast Wyoming.

We all know that the coal will be mined under considerable constraints both statutory and economic for the next 20-25 years. In the great stampede to develop their various holdings the mining industry has already begun a process which will have irreversible effects upon the agricultural industry unless the practice can be controlled. Specifically I refer to mining alluvial valleys.

For more than two years now the PRBRC has supported, and it continues to support the federal strip mine and reclamation act. Contained in this crucial legislation is a specific section which offers protection to the West's alluvial valleys, and recognizes their critical importance to agriculture in the Northern Great Plains. This law has twice been vetoed by the President. On the second veto, the override fell three votes short. The strip mine and reclamation act is supported by Wyoming's entire Congressional delegation.

In the recent summer months, a protest has been filed against a major mining company's application to strip mine more than 500 acres of rich bottomland in order to remove 17 million tons of coal over 17 years. This (Whitney Mine) application represents a precedent of major proportions, challenging the ability of Wyoming to regulate strip mining and protect both the agricultural industry and the land base upo which it depends. A decision to approve the Whitney mine will signal both the energy companies and other states that mining can proceed at anytime and in any place.

There are about 2500 acres of irrigated land on Tongue River between Sheridan and the Montana line. These lands are capable of producing as much as 10,000 tons of hay. Since it takes, in this area, about 1½ tons of hay to carry a cow through a winter, about 6500 head could be supported by the hay grown on this land.

Summer range in the same area varies from 15 to 20 acres per cow. The summer range required by the same 6500 cows that could be wintered as described above would be about 100 thousand to 120 thousand acres.

The strip of irrigated land along Tongue River is roughly 7½ miles long by ½ mil wide. The summer range accompanying the irrigated hay lands would be equivalent to approximately 12 to 14 miles on each side of the river.

Mining of these 2500 acres of irrigated bottomland (or alluvial valley) as is presently proposed by several mining companies, will effectively remove the accompanying 100,000 acres of summer range from useful production. If you can't winter your stock, there is no way you can keep it during the summer.

Mining of this alluvial valley would affect about 40 acres of rangeland for every irrigated acre mined. While these figures and ratios will vary from valley to valley, the fact remains the same--mining of alluvial valleys affects wildlife and agriculture for a distance far beyond the mine itself.

Only 2½ per cent of the Powder River Basin is irrigated bottomlands. But to mine these bottomlands is to interrupt or permanently end agricultural operations on a much higher percentage of the lands in the area.

Frances Hoadley
PRBRC

YELLOWSTONE BASIN AND ADJACENT COAL AREA LEVEL B STUDY

FISH AND WILDLIFE ISSUES

FOR

NORTHEASTERN WYOMING

Prepared by the
Wyoming Game and Fish Department
Cheyenne, Wyoming
April 1976

INTRODUCTION

The purpose of this issue paper is to outline the fish and wildlife considerations which should be included in the Missouri River Basin Commission's plan for the conservation, development, and management of the waters and related land resources in the Yellowstone Basin. This paper deals primarily with those specific issues relevant to northeastern Wyoming.

The Wyoming Game and Fish Department under direction of the Wyoming Game and Fish Commission is legally charged with the "control, propagation, management, protection, and regulation of all Wyoming wildlife." To better fulfill this responsibility the Game and Fish Department has formulated a long-range plan for management of the state's fish and wildlife resources. Copies of that plan, entitled A Strategic Plan for the Comprehensive Management of Wildlife in Wyoming, will be provided to the study team with this paper, and much of the information in this paper has been extracted from the Strategic Plan. It should be noted that the Strategic Plan represents the best data currently available to the Department, and these data supersede any information previously furnished.

EXISTING SITUATION

For discussion and planning purposes, Wyoming's fish and wildlife resources are categorized as follows:

I. Terrestrial wildlife
   A. Big game
   B. Small game
   C. Furbearers
   D. Raptors
   E. Nongame birds and mammals
   F. Endangered and threatened terrestrial wildlife

II. Aquatic wildlife
   A. Sport fisheries
   B. Commercial fisheries
   C. Other fishes
   D. Amphibians, reptiles and mollusks
   E. Endangered and threatened aquatic wildlife

I. Terrestrial wildlife

A. Big game (see Strategic Plan pages 9-37, 56-64; Wyoming's Hunting and Fishing Resources 1970 pages 45-81).
Estimated postseason populations, 1975 projected harvest, and the projected number of hunter days for the big game species found in this region are presented in Table 1.

B. Small game (see Strategic Plan pages 38-64; Wyoming's Hunting and Fishing Resources 1970 pages 45-81; Planning Report 9G).
Population estimates are not available for small game species. Projected 1975 harvest and recreation days for this region are presented in Table 2.

Table 1. Big game. Postseason populations, 1975 projected harvest and recreation days for Game Districts 3 and 7.[1]

Species	Postseason population	Harvest	Recreation Days
Pronghorn	92,437	30,488	61,176
Mule Deer	107,832	30,429	176,488
Whitetail Deer	49,650	15,196	75,980
Elk	6,060	1,684	23,576
Moose	40	0	0
Bighorn Sheep	55	0	0
Black Bear	333	33	1,320

[1] See Map page 56 Strategic Plan

Table 2. Small game. Projected 1975 harvest and recreation days for Game Districts 3 and 7.

Species	Harvest	Recreation Days
Cottontail	42,361	21,181
Squirrel	630	420
Snowshoe	912	912
Pheasant	4,825	5,361
Sage Grouse	4,170	2,195
Sharptail	2,277	2,277
Partridge	965	1,073
Mountain Grouse	2,277	2,277
Turkey	1,575	5,250
Ducks	15,314	10,210
Geese	459	2,295

C. Furbearers (see Strategic Plan pages 89-91; Planning Report 8G). Furbearers refers to those mammalian species whose pelts are actually or potentially of commercial value. Furbearing species present in this region include coyote, red fox, bobcat, spotted skunk, striped skunk, racoon, marten, ermine, weasel, mink, badger, jackrabbit, beaver, porcupine, muskrat, and possibly the black-footed jerret and fisher. Little information is available on population levels, distribution, and utilization of these species. The commercial value of this resource has not been quantified, but the harvest of coyotes, bobcats, and foxes is substantial in terms of numbers and dollar volume.

D. Raptors (see Strategic Plan pages 95-96; Wyoming Hawks). Approximately 32 species of raptorial birds are known or thought to occur within Wyoming. In 1974, thirteen persons were licensed to possess raptors for the purpose of falconry and 43 permits were issued for the capture of falcons. Little is known regarding population status and distribution of raptors in the study area.

E. Nongame birds and mammals (see Strategic Plan pages 101-104; Planning Report 1N).
Public interest in nongame wildlife and nonconsumptive use of all wildlife is rapidly increasing. Wyoming has approximately 58 species of nongame mammals and 263 species of nongame birds many of which occur in the study area. A new Game and Fish publication on population status of all Wyoming wildlife should be available by August 1976. The recreational and economic importance of nongame wildlife has not been determined.

F. Endangered and threatened terrestrial wildlife.
This category includes terrestrial wildlife species listed by the U. S. Fish and Wildlife Service as endangered or threatened.
   1. Black-footed ferret (see Strategic Plan pages 89-91)-endangered. This species probably occurs in the study area, but its presence there is unconfirmed.
   2. Peregrine falcon (see Strategic Plan pages 95-96; Wyoming Hawks pages 53-57)-endangered.
      The peregrine falcon is a resident and migrant species within the study area, though little is known regarding population density and distribution.

II. Aquatic wildlife

A. Sport fisheries (see Strategic Plan pages 65-76, 81-82; Wyoming Fishes; stream and lake inventory; Stream Classification Map; Wyoming's Hunting and Fishing Resources 1970 pages 45-81).
Estimated fishing use and biological supply of fishing opportunity are presented in Table 3.

B. Commercial fisheries (see Strategic Plan pages 92-94).
Commercial fishing activities in the region are presently limited to the harvest of minnows for private use or for sale by bait dealers. Two reservoirs in this area, Keyhole and Lake DeSmet, have potential for future commercial exploitation of rough fish. These reservoirs could produce an estimated average yield of 34 tons of carp annually.

Table 3. Sport fisheries. Estimated 1975 fishing pressure and biological supply of fishing opportunity in the Powder, Tongue, Little Missouri, Belle Fourche, Cheyenne, and Niobrara River Drainages.[1]

	1975 pressure (fisherman days)	Total supply (fisherman days)	Supply on public lands and/or access permanently guaranteed	% on public lands and/or access permanently guaranteed
Streams	132,370	196,552	100,610	51.19
Lakes and reservoirs	152,849	324,392	263,278	81.16
TOTAL	285,219	520,944	363,888	69.85

[1]See map Strategic Plan page 66.

C. Other fishes (see Strategic Plan pages 105-106; Wyoming Fishes). There are approximately 46 species of fish found within the study area. Consumptive or nonconsumptive utilization is limited except for game and commercial species. All fishes, however, are vitally important for their intrinsic and ecological value.

D. Amphibians, reptiles, and mollusks (see Strategic Plan pages 107-110; Planning Report 3N).
These species are primarily important for their intrinsic and ecological values. Information on density and distribution of amphibians and reptiles is limited, and on mollusks it is nonexistent.

E. Endangered and threatened aquatic wildlife (see Strategic Plan pages 105-106; Wyoming Fishes pages 13-17; Planning Report 3N).
On a national basis none of the fishes, amphibians, reptiles, or mollusks in the study area are considered threatened or endangered by USFWS. However, several species are peripheral in Wyoming, and their existence within the state could be jeopardized if proper precautions are not taken in planning of future developments. This subject will be discussed further in the forthcoming publication on population status of all Wyoming wildlife to be released August 1976.

1980 AND LONG RANGE OBJECTIVES

Following is a reiteration of the objectives from the Wyoming Game and Fish Department's Strategic Plan. All objectives should be considered in light of the major goal and management framework under each program of the plan.

I. Terrestrial wildlife

A. Big game (see Strategic Plan pages 14-37, 56-64).

On a statewide basis big game objectives were set for 1980, 1985, and 1990. Regional objectives were set for 1980 only. The 1980 objectives for Game Districts 3 and 7 are given in Table 4. The projected change from 1980 to 1990 is also shown; 1990 figures are based on statewide trends and do not necessarily represent the future objectives for these districts.

Table 4. Big game. The 1980 objectives for Districts 3 and 7. Statewide change in objectives for postseason population, harvest, and recreation from 1980 to 1990.

	1980 Objectives			Statewide Projected Change 1980-1990		
Species	Postseason Population	Harvest	Recreation Days	Postseason Population	Harvest	Recreation Days
Pronghorn	79,090	22,712	49,966	- 1%	- 2%	+24%
Mule Deer	103,730	25,919	155,514	+15%	+23%	+34%
Whitetail Deer	45,450	14,137	79,753	-17%	-14%	+22%
Elk	6,075	1,733	25,995	+ 2%	+ 3%	+17%
Moose	60	5	20	0%	0%	0%
Bighorn Sheep	175	4	120	+ 9%	+20%	+20%
Black Bear	333	47	1,880	0%	+ 8%	+ 8%

B. Small game (see Strategic Plan pages 38-64).

The 1980 objectives and statewide projected change in harvest and recreation days for small game animals are presented in Table 5.

C. Furbearers (see Strategic Plan pages 89-91).

The 1980 objective for furbearers is to determine the population status and harvest potential of each species.

D & E. Raptors, nongame birds and mammals (see Strategic Plan pages 95-96, 101-104).

The 1980 objective for raptors and nongame birds and mammals is to initiate and maintain a current status and inventory of all species and estimate the recreational and esthetic importance of this segment of the wildlife resource.

Table 5. Small game. The 1980 objectives for Districts 3 and 7. Statewide change in objectives for postseason population, harvest and recreation days from 1980 to 1990.

Species	1980 Objectives		Statewide Projected Change 1980-1990	
	Harvest	Recreation Days	Harvest	Recreation Days
Cottontail	50,833	25,417	+ 40%	+40%
Squirrel	756	504	+ 39%	+39%
Snowshoe	1,095	1,095	+ 46%	+46%
Pheasant	4,884	6,977	- 18%	+22%
Sage Grouse	5,146	3,027	0%	+71%
Sharptail	3,643	3,036	+ 61%	+61%
Partridge	1,372	1,716	+ 56%	+56%
Mountain Grouse	2,710	2,710	+ 83%	+83%
Turkey	2,158	7,194	+ 25%	+25%
Ducks	22,971	15,314	+ 40%	+40%
Geese	919	4,595	+180%	+12%

F. Endangered and threatened terrestrial wildlife.
No specific objectives, as such, are set for endangered or threatened species, but the following actions are suggested in the Strategic Plan:
1. Black-footed ferret (see Strategic Plan page 90).
    a. Determine the population density and distribution of endangered furbearing species and take the necessary steps to ensure their continued maintenance or increased production.
2. Peregrine falcon (see Strategic Plan page 96).
    a. Determine the population density and distribution of peregrine falcons within the state and take the necessary steps to insure their continued maintenance or increased production.

II. Aquatic wildlife
A. Sport fisheries (see Strategic Plan pages 65-76, 81-82).
The 1980 regional objectives for the sport fisheries program call for

meeting the 1980 projected use of sport fishing opportunity. It can be assumed that the 1985 and 1990 objectives will also call for meeting the projected use in those years. Projected use of sport fishing opportunity for 1980, 1985, and 1990 is presented in Table 6.

Table 6. Sport fisheries. Projected fishing pressure in the Powder, Tongue, Little Missouri, Belle Fourche, Cheyenne, and Niobrara River Drainages of Wyoming.

	Use in Fisherman Days		
	1980	1985	1990
Streams	200,880	252,771	272,375
Lakes and Reservoirs	231,956	291,875	314,513
TOTAL	432,836	544,646	586,888

B. Commercial fisheries (see Strategic Plan pages 92-94).
The 1980 objective for commercial fisheries is to complete initial assessment of commercial fisheries potential for the major waters of the state.

C. Other fishes (see Strategic Plan pages 105-106).
The 1980 objectives relative to all Wyoming fish species are as follows:
1. Maintain a current status and inventory of all fishes and estimate the nonconsumptive recreational and esthetic importance of this segment of the wildlife resource.
2. Locate and develop at least 2 additional interpretive sites for nonconsumptive use of fishes.

D. Amphibians, reptiles, and mollusks (see Strategic Plan pages 107-110).
The 1980 objectives are as follows:
1. Initiate and maintain a current status and inventory of all amphibians and reptiles and estimate the recreational and esthetic importance of this segment of the wildlife resource.
2. Identify and protect habitats containing rare species of mollusks.

E. Threatened and endangered aquatic wildlife.
This section is not applicable at this time.

PROBLEMS AND STRATEGIES

Many of the needed actions, policies, and programs which should be included in the Yellowstone Basin Level B Plan are presented below. Problems are obstacles which stand in the way of meeting long-range wildlife objectives. Strategies are alternatives or possible approaches to solving problems and accomplishing objectives. The strategies in regular type are suggestions for action by the Wyoming Game and Fish Department. The underlined strategies are actions needed from others, and these actions are footnoted as follows:

[1]Actions needed from the state and/or federal legislature.

[2]Actions needed from other government agencies.

[3]Actions needed from the general public, private organizations, or industry.

Most of these problems and strategies are from various programs of the Strategic Plan.

1. CONFLICTING USES OF LAND AND WATER ARE ALTERING HABITATS THUS CAUSING A SERIOUS REDUCTION IN WILDLIFE CARRYING CAPACITY.

    a. Develop and implement more effective methods of environmental surveillance.
    b. Recommend alternatives and/or mitigation for federal, state and private projects that would cause degradation of critical wildlife habitat.
    c. Participate actively in federal, state and local land use planning.
    d. Seek additional sources of revenue to help defray costs of environmental protection work.
    e. Coordinate efforts with land management agencies to insure adequate consideration for wildlife in their long range plans.
    f. Enact legislation recognizing wildlife and recreation as beneficial uses of land and water.[1]
    g. Enact legislation requiring mitigation of and replacement in kind for losses of wildlife and degradation of habitat.[1]
    h. Enact statewide land use standards which provide protection to critical wildlife habitat.[1]
    i. Enact legislation including all federal actions under the Fish and Wildlife Coordination Act.[1]
    j. Coordinate land use practices to be better in harmony with the needs of wildlife.[2,3]
    k. Seek and follow advice from wildlife professionals in the planning phase of development operations.[3]
    l. Enact a state Fish and Wildlife Coordination Act.[1]

2. DESTRUCTION AND ALTERATION OF AQUATIC HABITATS HAVE SERIOUSLY DIMINISHED THE PRODUCTION OF SPORT FISHERIES AND WATERFOWL.

    a. Recommend alternatives, preventative measures, compensation, or mitigation for all projects and practices which diminish the quality of aquatic habitat.

b. Negotiate for more suitable water conditions during periods critical to fish and waterfowl.
c. Negotiate for minimum pools and minimum flows on all waters with significant fisheries and/or waterfowl potential.
d. Encourage private landowners, developers, and other agencies to employ practices which are not detrimental to aquatic habitat.
e. Develop and implement methods to prevent damage to aquatic habitat resulting from logging, mining, and livestock operations.[2,3]
f. Investigate and correct over-appropriation of water from streams which are temporarily dewatered.[2]
g. Enact legislation requiring adequate minimum pools and minimum stream flows on all water projects, with the costs of such features carried as project costs.[1]
h. Enact legislation requiring approval from the State Engineer or other authority before a stream channel can be altered.[1]
i. Enact statewide regulations designed to protect stream channels.[1,2]
j. Enact legislation requiring compensation and/or mitigation, as recommended by the Game and Fish Department on all projects which detrimentally alter aquatic habitat; costs of such features should be carried as project costs.[1]
k. Consult with Department personnel during the planning phase of all projects which will alter aquatic habitat.[3]

3. THE RAPID INCREASE IN WYOMING'S HUMAN POPULATION WILL RESULT IN INCREASED DEMAND FOR WILDLIFE-RELATED RECREATION.
   a. Develop and implement methods whereby recreational opportunity can be provided to more people while still maintaining the quality and diversity of wildlife-related recreation.
   b. Determine effects of increasing human impacts on wildlife population dynamics and distribution.
   c. Develop and implement standardized methods for regularly monitoring demand for wildlife-related recreation.
   d. Increase Departmental emphasis on redistribution of wildlife users.
   e. Increase populations of desired wildlife species which are below the carrying capacity of their habitat.

4. FUTURE DEVELOPMENT OF GROUNDWATER COULD SERIOUSLY AFFECT SOME WILDLIFE POPULATIONS BY DRYING UP SPRINGS AND SMALL STREAMS IN THE ARID REGIONS OF THE POWDER RIVER BASIN.
   a. All groundwater use permits should be issued on the condition that groundwater use will not affect surface water supplies critical to wildlife needs.[1,2]
   b. Develop and implement a system for monitoring small springs and intermittent streams which may be vital to survival of wildlife populations.[2]

5. POPULATION INCREASES WILL CAUSE SPORT FISHING DEMAND TO EXCEED SUPPLY IN THIS REGION IN THE NEAR FUTURE.
   a. Create additional fishing waters through small dam construction and development of strip mine ponds.
   b. Increase fish populations by more intensive stocking on some waters.
   c. Develop more warmwater fishing areas and encourage greater utilization of warmwater fisheries.
   d. Secure access to important waters on private lands.

e. Seek minimum stream flows necessary to enhance existing fisheries.
f. Seek minimum stream flows and minimum pools on new and existing water projects.
g. Enter into agreements with industrial and mining interests and private landowners to develop fisheries in and access to industrial water supplies and small ponds.

6. THERE ARE MANY UNCERTAINTIES REGARDING THE ROLE OF STRIP MINE PONDS AS POTENTIAL FISHERIES IN THIS REGION.
   a. Recommend construction of strip mine fishing ponds around populated areas when a source of quality water is available.
   b. Develop and improve management techniques for strip mine ponds.
   c. Provide mining companies with information on pond configuration and water needs necessary to develop quality fishing waters.
   d. Energy companies should enter into a cooperative agreement with the Game and Fish Department in order to develop sport fisheries on future and existing strip mine ponds.[3]

7. KEYHOLE RESERVOIR, ONE OF THE MAJOR WATERS IN THIS REGION, IS NOT PROVIDING FISHING UP TO ITS POTENTIAL CAPABILITY, AND ITS POTENTIAL PRODUCTION MAY BE LIMITED BY FUTURE WATER REDUCTIONS.
   a. Keep track of water contracts on Keyhole and strive to secure a minimum pool which safeguards fish production and general recreational use.
   b. Minipulate the nongame fish populations to enhance game fish production.
   c. Introduce usable forage species to enhance game fish production.
   d. Develop and implement methods to increase the population of walleye and other important game species.
   e. Investigate the possibility of the state acquiring Keyhole Reservoir and reserving an adequate amount of storage for recreational purposes.

8. CONSTRUCTION OF NEW RESERVOIRS MAY CAUSE A NUMBER OF PROBLEMS SUCH AS INCREASED MANAGEMENT COSTS, DESTRUCTION OF STREAM HABITAT, AND INCREASED PROBLEMS WITH ROUGH FISH.
   a. Participate actively during the planning phase of reservoir developments.
   b. Conduct the research necessary in order to develop more sophisticated reservoir management techniques.
   c. Consult with the Game and Fish Department prior to and during the planning phase of reservoir development.[2,3]
   d. Budget funds to cover conservation pools, minimum stream flows, and initial establishment of fisheries and waterfowl populations as project costs on new reservoirs.[2,3]

9. MUCH OF THE WILDLIFE-RELATED RECREATIONAL OPPORTUNITY IS UNAVAILABLE TO THE GENERAL PUBLIC DUE TO A VARIETY OF ACCESS PROBLEMS.
   a. Work for better Department-public-landowner relations in an effort to increase access on and across private lands.
   b. Develop a system whereby potential acquisitions and easements can be prioritized on a cost/benefit basis.
   c. Enter into cooperative agreements providing for access to private, municipal, industrial lands and waters in exchange for departmental services.

d. Enact legislation requiring identification of all public lands.[1]
e. Eliminate the "redtape" involved in acquiring land and easements.[1,2]
f. Increase awareness of available public land by proper marking and mapping.[2]
g. Enter into cooperative agreements with the Game and Fish Department regarding use of public lands by wildlife and recreationists.[2]
h. Make land exchanges only when opportunity for wildlife-related recreation will be maintained or enhanced.[2]
i. Permit wildlife-related recreation on private lands and waters when not in conflict with other land uses.[3]
j. Provide additional funds earmarked for land, water, and access acquisition.[1]

10. DRAINAGE OF WETLANDS IN NORTH AMERICA REDUCES WATERFOWL PRODUCTION AREAS.
    a. Protect and manage wetlands to maintain the habitat available to ducks in Wyoming.[1]

11. LAND USE AND HABITAT CHANGES ARE RESULTING IN A LOWERED CARRYING CAPACITY FOR DEER IN SOME AREAS.
    a. Define and where possible improve the available mule deer winter range.
    b. Reduce competition between mule deer and elk or livestock in areas selected primarily for the production of mule deer.
    c. Implement practices beneficial to mule deer habitat.[2,3]

12. PHEASANTS ARE LOCATED PRIMARILY ON PRIVATE LANDS AND PRESENT AGRICULTURAL PRACTICES ARE DECREASING THE QUANTITY AND QUALITY OF AVAILABLE HABITAT.
    a. Encourage private landowners and land management agencies to maintain and improve habitat for pheasants.
    b. Inform the public that pheasants must have suitable habitat to survive and that high population levels cannot be maintained without adequate food cover.

13. LACK OF ADEQUATE WATER ON SOME RANGES PREVENTS GOOD ANTELOPE DISTRIBUTION AND HABITAT USE.
    a. Where it is shown to be desirable, promote the development of water sources in arid areas.

14. COMPETITION WITH LIVESTOCK AND OTHER WILDLIFE HAS REDUCED THE CARRYING CAPACITY OF SOME BIGHORN SHEEP RANGES.
    a. Decrease competition between Bighorn and other wildlife species on key Bighorn ranges.
    b. Decrease competition between Bighorn and livestock on key Bighorn ranges.[2,3]
    c. Protect, maintain and enhance areas of Bighorn habitat.[2,3]

15. SOME ELK HERDS ARE DEPENDENT UPON PRIVATE LANDS FOR WINTER RANGE.
    a. Acquire key elk wintering areas where feasible.

FUTURE CONDITIONS WITHOUT A PLAN

Without a comprehensive plan for the conservation, development, and management of the waters and related land resources in the Yellowstone Basin the following conditions are likely to occur:

1. Expansion of the energy and mineral industries will still occur.

2. Increased emphasis will be placed on private and state-supported water development.

3. Fish and wildlife populations and habitat will suffer serious losses since many projects will not be covered under the Fish and Wildlife Coordination Act.

4. Dewatering and uncontrolled alteration of stream channels will continue.

5. Without a coordinated plan of development for the basin it is doubtful that the environmental considerations necessary to safeguard the ecosystem will be incorporated into development plans.

6. It is inevitable that much of the water for fish, wildlife, and agriculture will be acquired for mining and other industrial uses.

7. Many reservoirs will be subject to extreme fluctuations precluding maintenance or development of significant fisheries and waterfowl populations.

CONCLUSIONS

A coordinated comprehensive plan for the conservation, development, and management of the waters and related land resources in the Yellowstone Basin is a necessity if environmental objectives, including fish and wildlife, are to be given equal consideration with economic development of this region. From the standpoint of fish and wildlife objectives, the foremost need is for environmental legislation at the state level including the following aspects:

1. Recognize fish, wildlife and the general environment as important factors contributing to the general well being of the state and nation.

2. Recognize fish, wildlife, and recreation as beneficial uses of land and water.

3. Require full disclosure of the environmental impacts of any proposed actions (not just water development) whether State or privately funded when that action: (a) causes significant damage to fish and wildlife habitat; (b) was not already subject to the NEPA; and (c) was subject to state funding or state administrative review.

4. Require mitigative and/or compensative measures to offset adverse impacts identified in item 3 above.

5. Provide for matching funds as an incentive to encourage the inclusion of fish and wildlife enhancement features in project plans.

6. Require a permit from the State Engineer or other authority before a stream channel can be altered.

With the suggested legislation fish and wildlife objectives can be considered on an equal basis with economic development objectives at the project level. Without this legislation it is probable that long-range fish and wildlife objectives will not be met, and Wyoming stands to suffer major irretrievable losses of its wildlife resources.

SUPPLEMENTARY AND SUPPORTING MATERIAL

1. Wyoming Game and Fish Department. 1975. A strategic plan for the comprehensive management of wildlife in Wyoming. (Volume 1). Wyoming Game and Fish Department, Cheyenne. 110 pp.
   (2 copies furnished--additional copies available at $3.00 each).

2. Wyoming Game and Fish Department Current Status and Inventory Report.
   a. Planning Report 1N -- Nongame Mammals
   b. Planning Report 3N -- Amphibians and Reptiles
   c. Planning Report 8G -- Fur Animals
   d. Planning Report 9G -- Waterfowl
   (Report on population status of all Wyoming wildlife to be available August 1976).

3. Doll, G. F. and C. Phillips. 1972. Wyoming's hunting and fishing resources 1970. Wyoming Game and Fish Department, Cheyenne. 116 pp.
   (Updated report for 1975 expenditures to be available July 1, 1976).

4. Summary sheets from Wyoming Game and Fish Department stream and lake inventory.

5. Fish Division. 1971. Wyoming stream classification map. Wyoming Game and Fish Department, Cheyenne.

6. Baxter, G. T. and J. R. Simon. 1970. Wyoming fishes. Bulletin 4. Wyoming Game and Fish Department, Cheyenne. 69 pp.

7. Williams, R. B. and C. P. Matteson, Jr. 1973. Wyoming Hawks. Bulletin 5. Wyoming Game and Fish Department, Cheyenne. 69 pp.

8. McNiff, P. J. and C. Phillips. 1975. An outdoor recreation plan for Wyoming. Wyoming Recreation Commission, Cheyenne. (Copy not enclosed).
   (See pages 9.26-9.41; Chapter 11, pages 11.1-11.26).

9. Task Force on Fish and Wildlife, Work Group on Needs and Problems. 1971. The Missouri Basin comprehensive framework study: fish and wildlife tentative needs and problems Yellowstone Subbasin. Missouri Basin Inter-Agency Committee. 100 pp.
   (Copy not enclosed. Much of the discussion in this publication is still relevant, however, many of the figures need revision. The game distribution maps on pages 25-32 are current enough for use in the Level B Study. Most of the potential fish and wildlife habitat improvement measures listed for Wyoming in Tables 22 and 25 are still applicable.)

10. Northern Great Plains Resource Program. 1975. Effects of coal development in the northern Great Plains. U. S. Dept. of Interior. 165pp.
   (Copy not enclosed. See pages 60-64, 85, 96)

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

Water Quality Division

HATHAWAY BUILDING

CHEYENNE, WYOMING 82002

TELEPHONE 307 777-7781

MEMORANDUM

TO: Frank Trelease
Wyoming Water Planning Program

FROM: Paul C. Schweiger PCS
Water Quality Division of
Wyoming Department of Environmental Quality

SUBJECT: Yellowstone Level B Issue Paper

DATE: March 22, 1976

Our division is charged with the concern for water quality in the State of Wyoming by authority of §§ 35-502.1 to 35-502.56 known as the "Wyoming Environmental Quality Act." It is the policy and purpose of this act to ". . .enable the state to prevent, reduce and eliminate pollution; to preserve, and enhance the air, water and reclaim the land of Wyoming; to plan the development, use, reclamation, preservation and enhancement of the air, land and water resources of the state; to preserve and exercise the primary responsibilities and rights of the State of Wyoming; to retain for the state the control over its air, land and water and to secure cooperation between agencies of the state, agencies of other states, interstate agencies, and the federal government in carrying out these objectives. . ."

Events that could occur in the absence of a comprehensive plan and which would be of concern to our division include higher periodic concentrations of total dissolved solids and higher concentrations of silt resulting from increased needs for agricultural and domestic water.

Comprehensive planning resulting in the implementation of facilities construction and reservoir management policies should evolve to accomodate domestic, agricultural and industrial water needs.

PCS:cd

REPORT

ON

RECONNAISSANCE STUDIES OF INDUSTRIAL WATER PROJECTS

YELLOWSTONE BASIN AND ADJACENT COAL AREA
LEVEL B STUDY

NORTHEAST WYOMING STUDY AREA

STATE ENGINEER'S OFFICE
WYOMING WATER PLANNING PROGRAM
BARRETT BUILDING
CHEYENNE, WYOMING

AND

BUREAU OF RECLAMATION
U.S. DEPARTMENT OF THE INTERIOR
BILLINGS, MONTANA

JUNE, 1977

Madison Formation Industrial Ground Water Project

Project Proposal

The Madison Ground Water Project is a proposal to pump 15,000 acre-feet of water from the Madison formation and deliver it by pipeline to Gillette, Wyoming, for industrial or municipal uses.

Location and Description

The proposed wellfield would be located southeast of Moorcroft, Wyoming, in Crook County. The wellfield would be scattered over a ten section area on the Black Hills Uplift. The proposed wellfield is near the proposed City of Gillette wellfield but is situated so that it will not interfere with Gillette's wells. A project area map is shown on Figure 1.

Engineering

The project is designed to produce 15,000 acre-feet of industrial or municipal water.

The project would consist of 17 wells approximately 7,000 feet deep. The ground level elevation is about 4300 feet above M.S.L. The potentiometric elevation is estimated at about 3850 feet above M.S.L. The anticipated drawdown is about 400 feet.

Figure 2 shows the proposed layout of the wellfield, collection system and transmission line. The dots indicate the approximate well locations. The solid lines indicate the collection system and the broken line indicates the transmission line.

The project would be constructed over a one-year time period. The seventeen wells would be drilled by one rig and crew working full time and one rig and crew working part time.

The collection system and transmission line will be made of coated welded steel pipe. The transmission line would be 35 miles long and use 36 inch diameter pipe. The transmission line would approximately parallel the U. S. Highway 16 right-of-way. The pipeline would have to ford the Belle Fourche River.

Figure 1 - Madison Ground Water Project Map

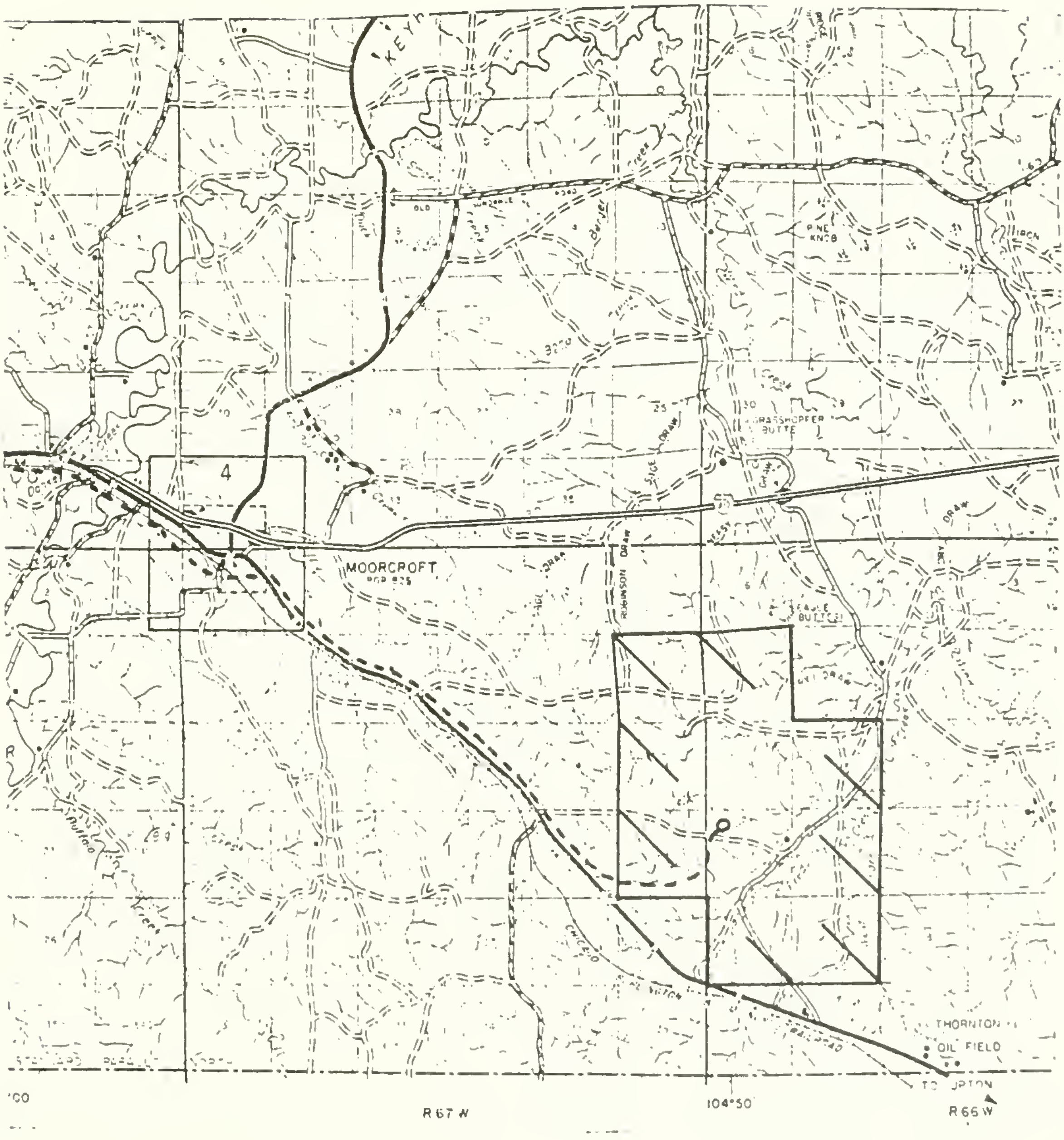
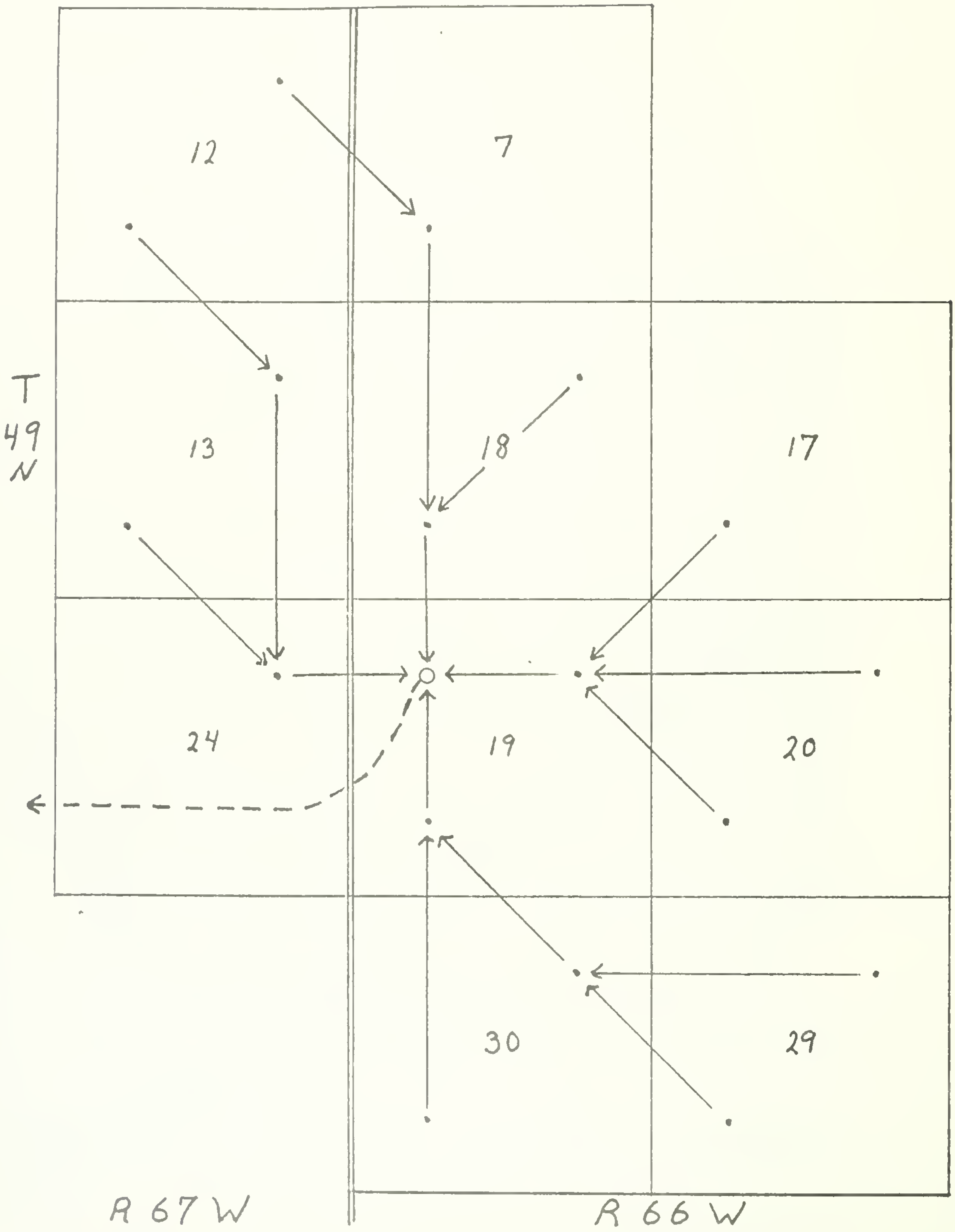


Figure 2 - Well Field Layout



The water would be delivered to Rawhide Reservoir northwest of Gillette. Figure 3 gives the approximate location.

Energy requirements were estimated on the basis of 793,250 kwh per month for the transmission pipeline and 2,133,200 kwh per month for the wellfield. Electricity was estimated at $.02 per kwh.

Economics

The Madison Ground Water Project meets the National Economic Development (NED) criteria. The only benefits considered in the NED account are from the sale of 15,000 acre-feet of industrial water. The industrial water was assumed sold at $425 per acre-foot.[1] This yields a gross annual benefit of $6,375,000. Average annual costs are estimated at $2,710,129. The resulting benefit-cost ratio is 2.35:1.0. Benefits and costs are displayed in the following tables.

[1]Harza Energy Report "Wet cooling processes , which involve relatively high consumptive uses, are economically preferable to dry cooling processes up to a water cost of about $450 per acre foot . . . . "

Figure 3 - Rawhide Reservoir Location Map

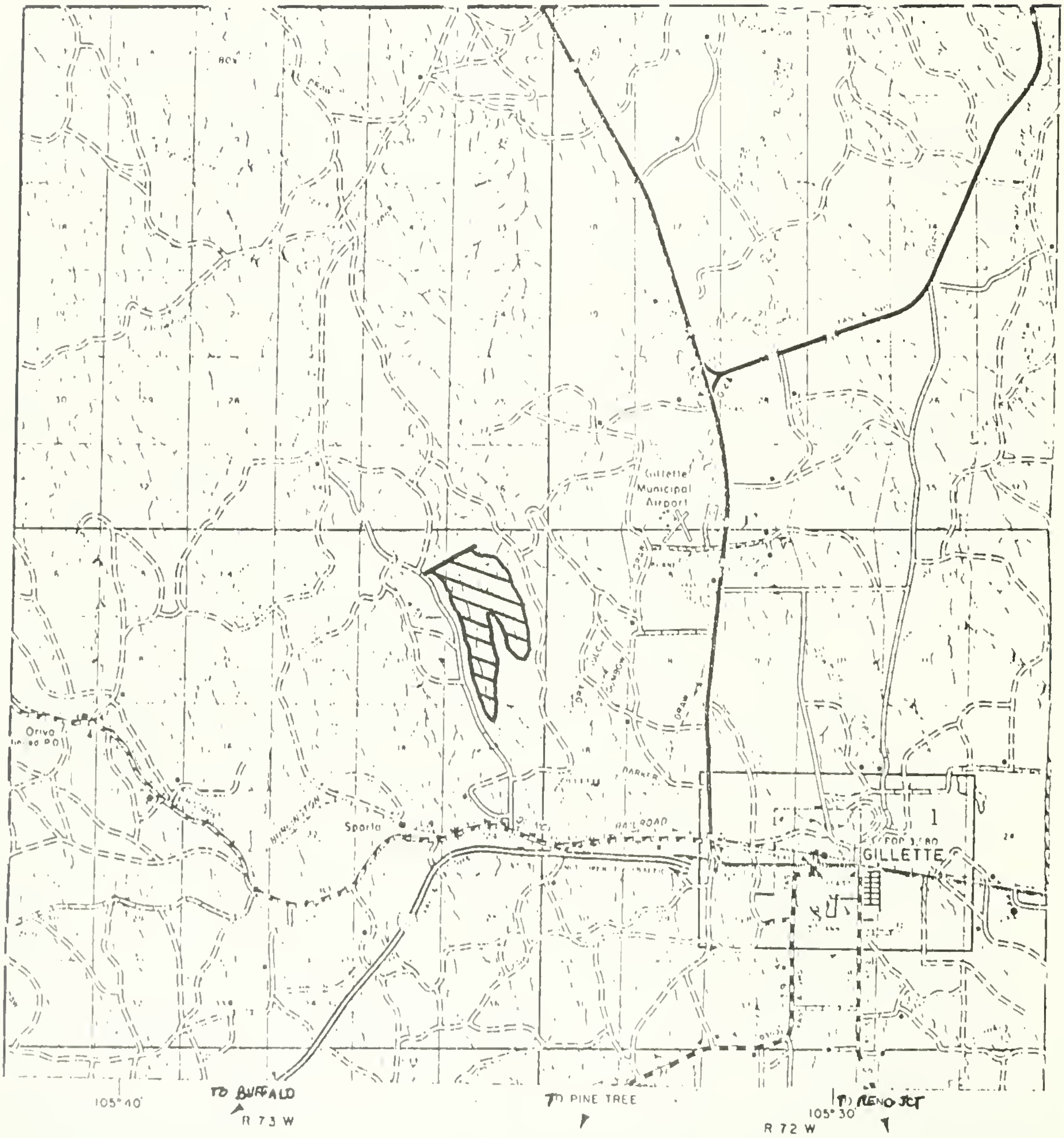


TABLE 1 - PROJECT COSTS

Wellfield		
Wells (complete)	$7,310,000	
Collection System	1,301,100	
Electric System	147,840	
		$8,758,940
Pipeline		
Pipe	$10,675,000	
Pumping plants	308,000	
		$10,983,000
Total Project Costs		$19,741,940

Interest During Construction

Total Project Costs	$19,741,940
Interest Rate	.06375
Interest During Construction	$ 1,258,549

Annual Equivalent Value

Total Project Costs	$19,741,940
Interest During Construction	1,258,549
Total Investment	$21,000,489
Amortization rate 6 3/8% for 40 years	.069628
Annual Equivalent Value	$ 1,462,222

TABLE 2 - DISPLAY OF ACCOUNTS

NED Account

Beneficial Effects	
Industrial water sales (15,000 AF at $425 per acre-foot)[1]	$6,375,000
Adverse Effects	
Investment	$1,678,582
OM&R	172,104
Power	702,348
Replacement	157,095
Total Annual Cost	$2,710,129
Net Benefit	$3,664,871
Benefit - Cost Ratio 2.35:1.0	

RD Account

	Region	Adjacent Region	Rest of Nation	Total
Beneficial Effects				
User Benefits				
Industrial Water Sales	$6,375,000			$6,375,000
Regional Benefits				
Employment (Const.)	397,000	-158,800	-238,200	0
Employment (OM&R)	172,104	- 68,800	-103,304	0
Total Benefits	$6,944,104	$-227,600	$-341,504	$6,375,000
Adverse Effects				
Investment	$1,678,582			$1,678,582
OM&R	172,104			172,104
Power	702,348			702,348
Replacement	157,095			157,095
	$1,710,129			$2,710,129
Net Beneficial Effects	$4,233,975	$-227,600	$-341,504	$3,664,871

Social Well-Being Account

A. Income

1. Community income would increase an average of about $4,000,000 annually due to increased employment to operate, maintain, and construct the project.
2. Economic conditions of the area would be stabilized due to new year-round employment.

B. Employment

1. Project installation, operation, and maintenance will provide increased full-time employment.
2. The water would be an intermediate product in an industrial conversion project which would greatly increase employment.
3. Recreation facilities at Rawhide Reservoir would provide increased seasonal employment.

C. Life, Health and Safety

1. A higher quality municipal water supply could be provided to Gillette.
2. A more adequate water supply could improve living conditions in Gillette.
3. Providing water based recreation in an arid area of Wyoming would add amenities of life to people living in Johnson and Campbell Counties, other Wyoming recreators, and tourists visiting the State.

Environmental Quality Account

A. Wildlife habitat would be disrupted on the 10 sections in the wellfield area.

B. Access roads to the wellfield could cause dust pollution.

C. The main transmission line construction would disturb 35 miles of right-of-way.

D. Rawhide Reservoir would inundate a portion of the upper Rawhide Creek drainage.

E. Rawhide Reservoir could provide recreational opportunity with a 4000 acre-foot minimum pool.

F. Rawhide Reservoir would provide added waterfowl habitat.

June 20, 1977

Lower Clear Creek to Gillette Water Project

Project Proposal

The Lower Clear Creek to Gillette project is a proposal to build a storage reservoir near the mouth of Clear Creek in Sheridan County, Wyoming, and deliver water through a pipeline to a regulating reservoir near Gillette, Wyoming. The water would be for municipal and industrial uses. An alternate plan would be to purchase water stored in Lake DeSmet and convey it by pipeline from the lower reach of Clear Creek to a regulating reservoir near Gillette. The alternatives could be combined into a staged-development plan with the Lake DeSmet storage water being replaced in time by Lower Clear Creek Reservoir water.

Location and Description

Alternative 1 consists of a 250,000 acre-foot storage reservoir upstream from the mouth of Clear Creek in eastern Sheridan County, a pipeline from the reservoir on Clear Creek, and a regulating reservoir near the headwaters of Rawhide Creek.

Figure 1 is a map of the Lower Creek Dam site.

Alternative 2 consits of a pumping plant on the lower Clear Creek, a pipeline from Clear Creek, and an 11,000 acre-foot regulating reservoir on Rawhide Creek.

Figure 2 shows the approximate location of the Clear Creek pumping plant.

Engineering

The project is designed to deliver about 35,000 acre-feet of municipal and industrial water to the Gillette area.

Alternative 1

Lower Clear Creek Dam and Reservoir - The proposed reservoir on lower Clear Creek would have a capacity for 250,000 acre-feet with active capacity at 224,000 acre-feet and a 26,000 acre-foot minimum pool. The firm yield would be 50,000 acre-feet per year.

Figure 1 - Lower Clear Creek Dam and Reservoir

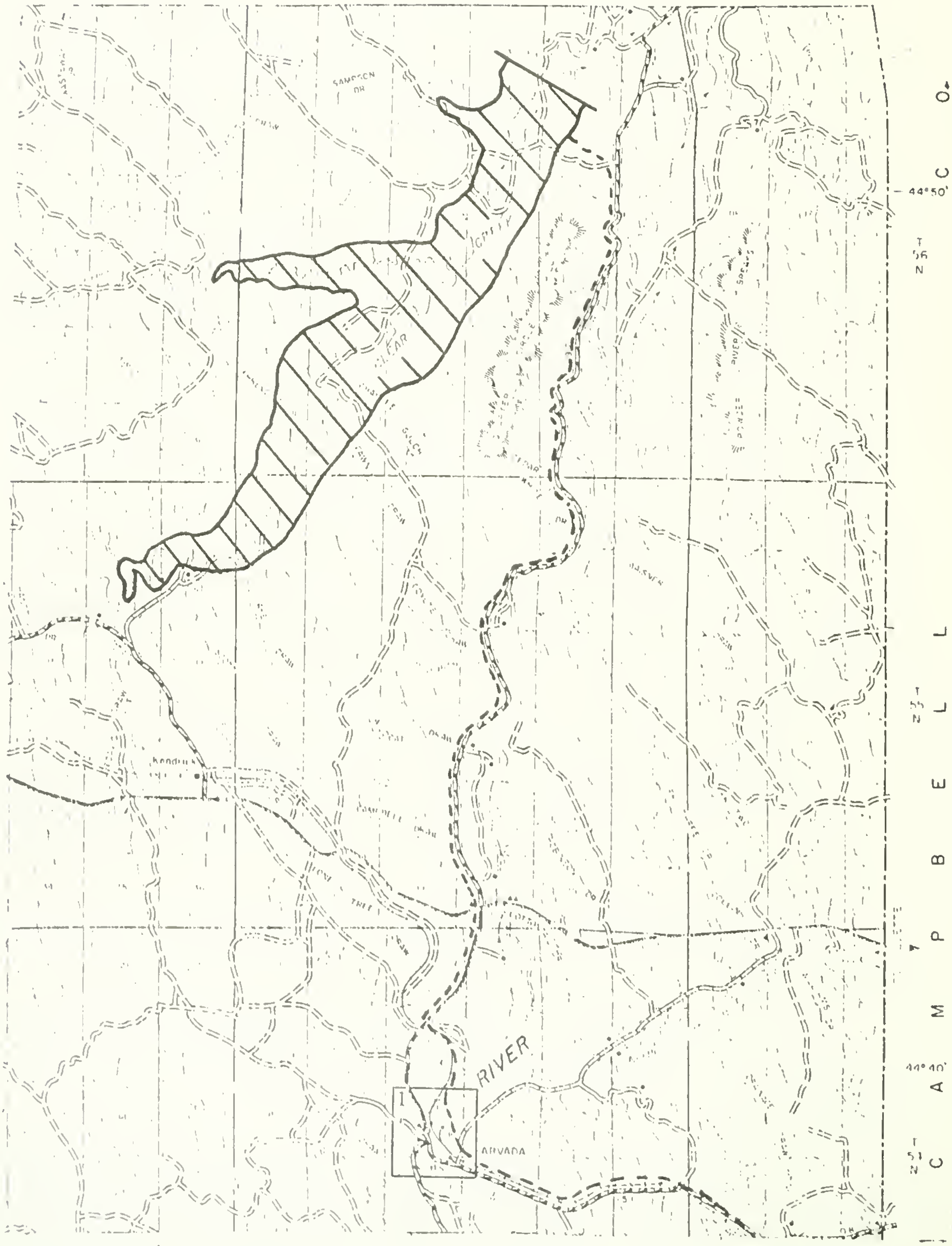
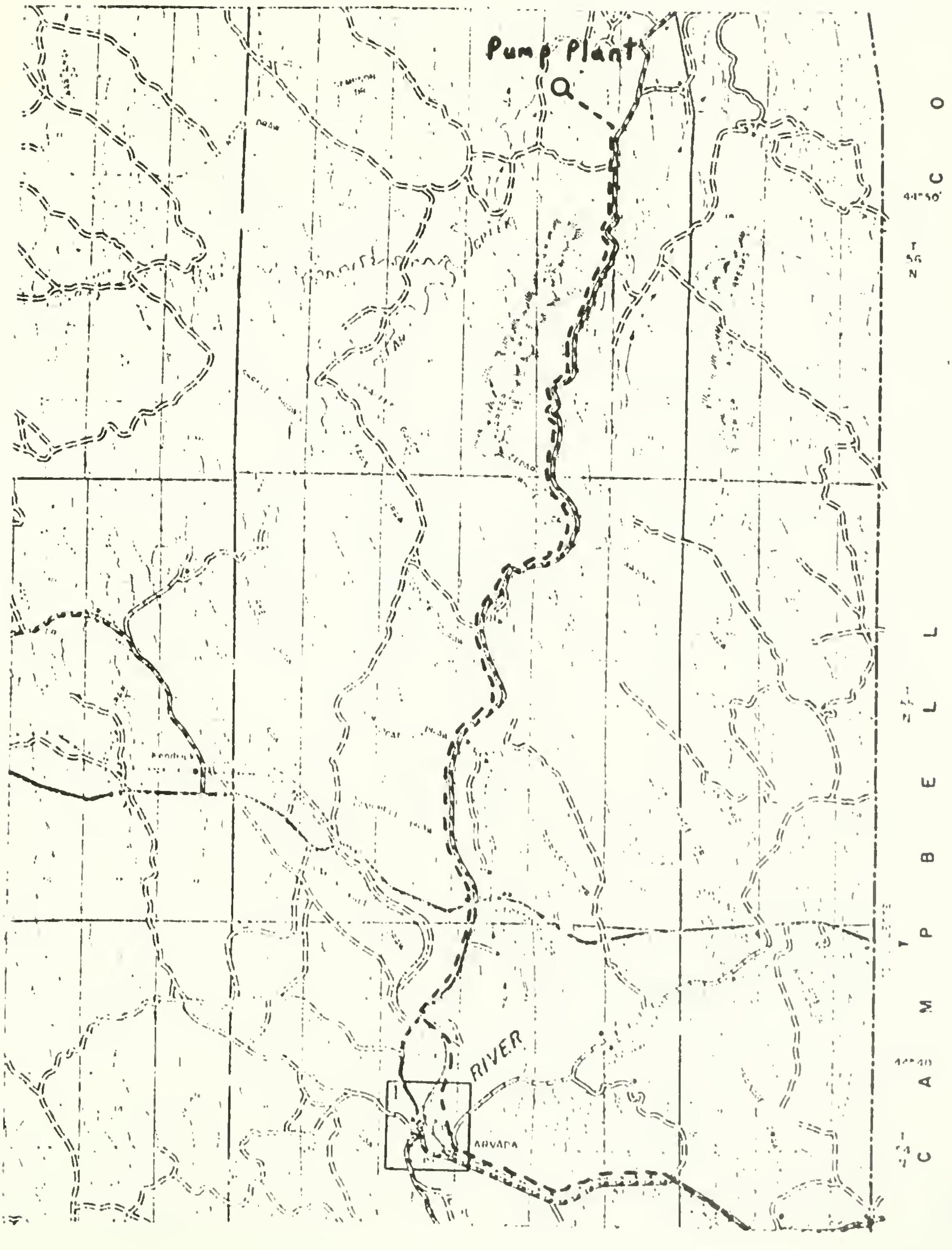


Figure 2 - Clear Creek Pumping Plant



The dam would be an earth fill structure 185 feet high with a dam crest elevation of about 3700 feet.

Pumping Plants - The static lift from Clear Creek to the delivery point is 1060 feet. The total design head is 1473 feet. The water would be lifted by 7 pumping plants. Each plant would be situated to pump against approximately 215 feet total design head. The river plant would cost $1,252,000 and the relift pumps would cost $1,127,000 each (USBR E&R Center "Pumplt" program).

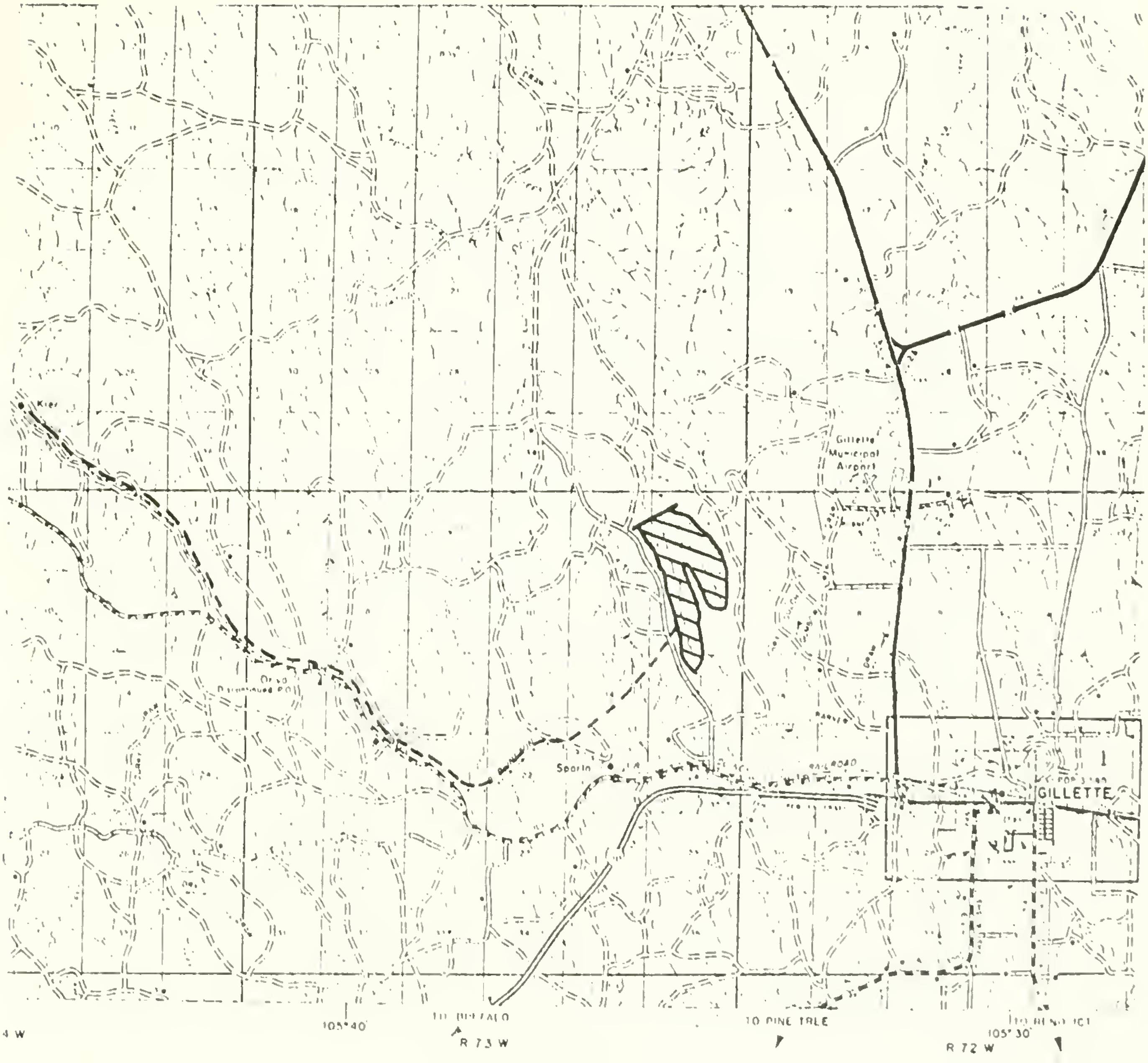
Clear Creek to Gillette Pipeline - The proposed pipeline would be a 51 inch diameter line 55 miles long. The pipe would be concrete pipe with a cost of $71 per foot (USBR E&R center "pipe" program). The installation cost would be about $7.75 per foot (USBR estimate). The pipeline would follow the railroad right-of-way most of the way to Gillette. The pipeline would require 7 surge tanks at $15,000 each.

Rawhide Dam and Reservoir - The proposed reservoir would be the delivery point for the water. Its major function would be for regulation of delivery and short term carryover storage. The reservoir would have a total capacity of 11,000 acre-feet, 2,000 acre-feet for flood storage, 4,000 acre-feet minimum pool and 5,000 acre-feet active storage. Figure 3 shows the approximate location of Rawhide Reservoir.

The dam would be an earth fill structure with a crest elevation of 4,560 feet and a maximum water surface elevation of 4556 feet. The estimated field cost is $3,184,000.

Energy requirements were estimated on the basis of 79,700,000 kwh per year. The power was estimated assuming the pumps would pump 16 hours per day off-peak at a flow rate of 75 cfs. Power cost was estimated at $.02 per kwh.

Figure 3 - Rawhide Reservoir



Alternative 2

This alternative would not include Lower Clear Creek Dam; however, the rest of the project would be the same. In this alternative water would be purchased out of Lake DeSmet and then run down Clear Creek to the river pump plant. This alternative assumes that Texaco would be willing to sell water to other industrial interests. When Texaco's water needs reach levels where Lake DeSmet is fully needed, Lower Clear Creek Dam could be constructed to relieve the need for the Lake DeSmet storage for the pipeline to Gillette.

Economics

Alternative 1 meets the National Economic Development (NED) criteria. The only benefits considered in the NED account are from the sale of 35,000 acre-feet of industrial water. The industrial water was assumed to be sold at $425 per acre-foot. This yields a gross annual benefit of $14,875,000. Average annual costs are estimated at $10,535,300. The resulting benefit-cost ratio is 1.41:1.0.

Alternative 2 is more difficult to analyze economically because Texaco's price on Lake DeSmet water is unknown. However, if the project is only intended to repay itself and not to generate income above costs and water is sold to the final consumer at $425 per acre-foot[1], then the project would have a favorable benefit-cost ratio if Texaco were paid about $280 per acre-foot of water.

Recreation was not included in the analysis because of lack of information.

Benefits and costs for both alternatives are displayed in the following tables.

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1 [1]Harza Energy Report "Wet cooling processes, which involve relatively high consumptive uses, are economically preferable to dry cooling processes up to a water cost of about $450 per acre foot . . . "

TABLE 1 - Project Costs - Lower Clear Creek Dam

Project Cost	$76,220,000
Interest During Construction	
Project Cost	$76,220,000
Interest at 6 3/8% for 4 years = 16%	.16
Interest During Construction	$12,195,000
Annual Equivalent Value	
Project Cost	$76,220,000
Interest During Construction	12,195,000
Total Investment	$88,415,000
Amortization Rate	.06388
Annual Equivalent Value	$ 5,647,950
Rounded to:	$ 5,648,000

TABLE 2 - Project Costs - Clear Creek Pipeline and Rawhide Dam

Pumping Plants	$ 8,013,000
Pipeline	22,975,000
Dam	3,184,000
Land & Rights	30,000
Total Field Costs	$34,202,000
Other Costs (30% of Field Cost)	10,260,000
Total Project Costs	$44,462,000
Interest During Construction	
Total Project Costs	$44,462,000
Interest Rate	.06375
Interest During Construction	$ 2,834,453
Rounded to	$ 2,834,500
Annual Equivalent Value	
Total Project Costs	$44,462,000
Interest During Construction	2,834,500
Total Investment	$47,296,500
Amortization Rate	.06388
Annual Equivalent Value	$ 3,021,300

TABLE 3 - Display of Accounts

NED Account

	Alternative 1	Alternative 2
Beneficial Effects		
Industrial Water Sales (35,000 AF @ $425/AF)	$14,875,000	$14,875,000
Rec User Days _____@ $______		
Adverse Effects		
Investment		
Clear Creek Dam	$ 5,648,000	
Pipeline and Rawhide Dam	3,021,300	$ 3,021,300
Rec Facilities		
OM&R		
Clear Creek Dam	100,000	
Pipeline and Rawhide Dam	1,766,000	1,766,000
Rec Facilities		
Water Purchases (Paid to Texaco)		9,800,000
Total Annual Cost	$10,535,300	$14,587,300
Net Beneficial Effects	$ 4,339,700	$ 287,700
Benefit-Cost Ratio	1.41:1.0	1.02:1.0

RD Account

	Alternative 1				Alternative 2			
	Region	Adjacent Region	Rest of Nation	Total	Region	Adjacent Region	Rest of Nation	Total
Beneficial Effects								
User Benefits								
Industrial Water Sales	$14,875,000			$14,875,000	$14,875,000			$14,875,000
Rec User Days								
Regional Benefits								
Employment (Const.)								
Clear Creek Dam	1,694,400	- 677,800	-1,016,600	0				
Pipeline & Rawhide Dam	906,400	- 362,600	- 543,800	0	906,400	- 362,600	- 543,800	0
Rec Facilities								
Employment (OM&R) & Rec O&M	1,866,000	- 746,400	-1,119,600	0	1,766,000	- 706,400	-1,059,600	0
Total Benefits	$19,341,800	$-1,786,800	$-2,680,000	$14,875,000	$17,547,400	$-1,069,000	$-1,603,400	$14,875,000
Adverse Effects								
Investment & Rec	$ 8,669,300			$ 8,669,300	$ 3,021,300			$ 3,021,300
OM&R & Rec	1,866,000			1,866,000	1,766,000			1,766,000
Water Purchases					9,800,000			9,800,000
Net Beneficial Effects	$ 8,806,500	$-1,786,800	$-2,680,000	$4,339,700	$ 2,960,100	$-1,069,000	$-1,603,400	$ 287,700

Social Well-Being Account

A. Income

1. Community income would increase about $8,800,000 under Alternative 1 or about $3,000,000 under Alternative 2 annually due to increased employment to construct, operate, and maintain the project.
2. Economic conditions of the area would be stabilized due to new year-round employment.

B. Employment

1. Project installation, operation, and maintenance will provide increased full-time employment.
2. The water would be an intermediate product in an industrial conversion project which would greatly increase employment.
3. Recreation facilities at Lower Clear Creek Reservoir and Rawhide Reservoir would provide increased seasonal employment.

C. Life, Health and Safety

1. A higher quality municipal water supply could be provided to Gillette.
2. A more adequate water supply could improve living conditions in Gillette.
3. Providing water based recreation in an arid area of Wyoming would add amenities of life to people living in Johnson and Campbell Counties, other Wyoming recreators, and tourists visiting the State.

Environmental Quality Account

A. Lower Clear Creek Reservoir would inundate about 17 miles of Clear Creek, 500 irrigated acres, and about 8300 acres of range land.

B. Effects on the existing channel catfish population of Lower Clear Creek Reservoir needs to be assessed.

C. Loss of wildlife habitat in the proposed reservoir areas needs to be assessed.

D. Rawhide Reservoir would inundate 300 acres of range land.

E. No permanent stream would be inundated by Rawhide Reservoir.

F. Minimum pools in both Lower Clear Creek and Rawhide Reservoirs would provide habitat for a fishery.

G. The pipeline construction would disturb 55 miles of right-of-way during construction.

H. The two reservoirs would provide added waterfowl habitat.

I. The two reservoirs would provide added recreational opportunities.

YELLOWSTONE RIVER BASIN LEVEL B STUDY

ISSUE PAPER ON WYOMING'S YELLOWSTONE RIVER COMPACT WATER SUPPLIES

Wyoming Water Planning Program
April 12, 1976

I. Yellowstone River Compact

The Yellowstone River Compact apportions water among the states of Wyoming, Montana, and North Dakota. The compact has specific provisions regarding the division of water between Wyoming and Montana on the interstate tributaries of the Yellowstone River. The following information is from the Wyoming Framework Water Plan, subsequent updatings, and other information.

Bighorn River Basin

The surface water availability of Wyoming's Bighorn River Basin is subject to the terms of the Yellowstone River Compact. Under the compact all pre-1950 water rights are entitled to a supplemental water supply exclusive of the compact percentage allocations to the individual states. Assuming that all pre-1950 water rights in the Clarks Fork and Bighorn River Basins were supplied supplemental water, an estimated additional 420,000 acre-feet per year average annual depletion would result. In addition, Wyoming is entitled to 60% of the remaining unused and unappropriated water of the Clarks Fork for an estimated annual average of 429,000 acre-feet, and Wyoming's 80% allocation of the Bighorn River system averages about 1.8 million acre-feet per year.

Although there is an apparent abundance of water available in the Bighorn River system, developing a useable firm water supply is dependent upon the availability of storage water. Water for new uses is physically available from Buffalo Bill, Boysen, and Yellowtail Reservoirs. Use of all of Wyoming's compact allocation would require the construction of additional storage and at least a portion of the water supply would have to be diverted from Yellowtail Reservoir or from the river system below Yellowtail Dam. There is a need for intra-basin diversions of water or diversions from streams in the Bighorn River Basin with water surpluses to other streams in the Bighorn River Basin which are water short, in order to provide full water supplies for existing uses.

The Clarks Fork has a considerable water supply available for future uses in Wyoming. Water uses from tributary streams do have shortages in some instances and supplemental water supplies could be developed to alleviate the shortages in many instances.

Tongue and Powder Rivers

The Tongue and Powder Rivers within Northeastern Wyoming are interstate tributaries of the Yellowstone River and are also subject to the terms of the Yellowstone River Compact. If the pre-1950 water rights are provided a supplemental water supply, the total additional depletion from the two rivers would average about 74,000 acre-feet per year. Of the remaining unused and unappropriated water in the Tongue River, Wyoming is allocated 40%, amounting to an average of about 96,400 acre-feet per year. In the Powder River, Wyoming's 42% allocation is estimated to average about 120,700 acre-feet per year. Water supply studies show that if a drought year such as 1961 reoccurs, Wyoming's allocation in such a year would be little if any in either the Tongue or Powder River; therefore, reservoir storage is required to develop firm water supplies in these streams by providing carry-over storage from years of abundant supply for use in drought years.

Possible Issues Affecting Water Supplies

Claims to federal reserved water rights and Indian water rights could affect the quantities of water available for future uses in Wyoming from Yellowstone River tributaries. The State of Wyoming estimates assume that future uses by federal government would not expand past present uses which are the recreational, stock water, and public land improvement uses such as now exist. Indian water uses are treated in the same manner as other water uses so far as projections and planning are concerned. Since development of any new Indian water uses affects the future economies of local areas of the states as well as that of the Indians, new Indian water uses are assumed to be a part of the compact allocation of the state in which the uses are made. The assumption is supported by the language of the U. S. Supreme Court decision in the Arizona vs. California case. It is believed that treating future Indian water uses in this manner would not impair their water rights, as required in Article VI of the Yellowstone River Compact, and would allow equitable apportionment of Indian rights along with other rights.

Indian reservations that could affect Yellowstone River Compact allocations include the Wind River and Crow reservations on the Wind-Bighorn River and Northern Cheyenne Indian Reservation that borders on the Tongue River in Montana. Neither the Clarks Fork nor the Powder Rivers are affected by Indian reserved water rights. Waters from these two streams would not be affected by the Indian water rights issues whereas the Indian claims on the Bighorn and Tongue Rivers could affect uses from those streams in the future.

Downstream commitments of water supplies have been shown in the past to become dependent upon water supplies originating in upstream states. In the Pick-Sloan Missouri Basin Project, however, the Milliken-O'Mahoney amendment specified that consumptive uses of water occurring in the states west of 98th meridian were to have preference over navigation in the Lower Missouri River. Thus, the upstream-downstream water commitment issue for the Yellowstone River Basin appears limited to the states of Wyoming, Montana, and North Dakota because the huge flows in the Missouri River are more than adequate to supply the consumptive water needs of downstream states, and instream use for navigation cannot require water bypasses away from upstream consumptive uses.

Commitment of water to instream flows could also reduce the quantities of water supplies available for man's consumptive uses from the Yellowstone River and its tributaries. Commitment of water to instream flows apparently was not contemplated in the Yellowstone River Compact, at least not flows at the mouths of the interstate tributaries, as Article V of the compact indicates that additional diversion of water for consumptive uses could be made in Wyoming and Montana so long as there is streamflow at the compact stream gages. Of course, it might be possible for either Montana or Wyoming, or both states, to allocate a portion of their compact water supply to instream flow.

Another factor that can greatly affect availability of water for the Montana-Wyoming coal industry is the political opposition of diversions of water for industrial purposes whether such uses are inside or outside of the Yellowstone River Basin. For example, possible political opposition might preclude commitment of water originating in the Wind-Bighorn-Clarks Fork River Basin for industrial use that would be diverted downstream for use in Eastern Montana-Wyoming coal industries.

Benefits of a Plan

A plan allowing for a given quantity of municipal-industrial water could result in the satisfactory quantification of remaining water supplies that could remain available for other uses on the various interstate tributaries of the Yellowstone River in both Wyoming and Montana. The adoption of such a plan along with identification of multipurpose water development projects would enhance the agriucltural, municipal, recreational development of the entire Yellowstone River Basin while providing for the industrial water supplies. The possibility needs to be explored of establishing an industrial water supply repayment program from which funding could be derived for participating agricultural and multipurpose water projects. The production of hydro-electric power has traditionally been used for established funding for participating irrigation projects. Why not also use industrial water sales to provide for participating water projects?

Adoption of a plan could also enhance or conserve environmental attributes in a variety of ways. An example would be diversion of water for industry at a downstream location, thereby insuring instream flows to that point and perhaps not even requiring new storage facilities. Another example would be construction of a reservoir which could include the function of regulating high and low flows into improved downstream flows.

II. Future Conditions Without a Plan

Future conditions without a plan are very difficult to predict. It could be that individual companies will continue to proceed on an individual basis to procure water supplies by relatively small water development projects that are relatively uncoordinated and non-interrelated. It is also quite likely that some industrial companies will continue the practice of acquiring already developed irrigation water rights and transferring water use to industrial use, which would also require construction of additional reservoirs in the process.

In the absence of a planned, coordinated program, agricultural potential of the Wind-Bighorn-Clarks Fork River Basin would not benefit from funding which could result from an integrated agricultural-energy water development and management program. If, however, an acceptable plan can be derived it may be possible to provide water supplies for supplemental and new land irrigation along with improved stream flows and recreational opportunities as an adjunct to the development of industrial water supplies. Ideally, a plan might be derived which could receive enough support to achieve a participating program to enhance the industrial, agricultural, and recreational economies of the area.

Several water projects in Wyoming that will provide industrial water supplies are now being developed. Although two of the presently ongoing water developments are not in the Yellowstone Basin and adjacent coal area, coal from the study area will be utilized with the water supplies, and these uses should be considered as part of the projected coal and water development for the study area. These constructed or committed projects include:

1. Lake DeSmet Enlargement; total capacity 200,200 acre-feet active, and 39,000 acre-feet dead storage; estimated water supply - 60,000 acre-feet per year industrial water supply. (Texaco)

2. Middle Fork Powder River Reservoir; total capacity estimated industrial water supply - 25,000 acre-feet per year, supplemental supply averaging 5,500 acre-feet per year for agriculture. (Carter Oil and Arco)

3. Rehabilitation of LaPrele Dam (tributary of North Platte River), diversion of North Platte surplus waters, and Madison wells; estimated water supply 4,800 acre-feet per year. (Panhandle Eastern Pipeline Company, 270 million cubic feet per day coal gasification plant)

4. Grayrocks Dam on Laramie River, groundwater wells, and water rights transfer; total storage capacity 104,100 acre-feet; industrial water supply 30,650 acre-feet per year, irrigation water supply, 22,000 acre-feet per year for the Corn Creek project in Goshen County. (Laramie River Station of Basins Electric, 1,500 mw) (Note: The Corn Creek project includes storage water from Glendo Reservoir)

5. Madison wells of Energy Transportation System, Incorporated in Niobrara County (40 well permits granted); water supply - 15,000 acre-feet per year for coal slurry pipeline purposes.

THE STATE OF WYOMING

Commissioner of Public Lands and Farm Loans

STATE CAPITOL BUILDING CHEYENNE, WYOMING 82002

April 15, 1976

PLEASE ADDRESS REPLY TO THE COMMISSIONER

Mr. Frank Trelease
Wyoming Water Planning Agency
Central Avenue
Cheyenne, Wyoming

INTER-OFFICE MAIL

Dear Frank:

This letter with attachments will serve as our Issue Paper for both the Wind-Bighorn and Tongue-Powder sections of the Yellowstone Level B Study. Our concern is for vegetative management and protection in relation to water yield and quality on: 1) all State land and 2) private forest land.

In addition, protection from fire on private non-forested watershed lands is necessary to reduce sedimentation that results after wildfire. Fire protection programs that we coordinate do reduce rural land fire losses. However, the counties of Bighorn, Park, and Washakie are not current cooperators with us in fire control activities. These are the only counties not currently cooperators with the state. Until these counties become cooperators, fire protection within their boundaries cannot be considered adequate; thus water will be impacted, especially its quality from sedimentation after range and forest fires on non-federal lands. It is therefore desirable that if they do not wish to participate in the Cooperative Fire Control Program, they should form some type of organized fire protection system of their own.

We will soon have a district office located in the Bighorn Basin, probably at Basin, Wyoming, which will aid in achieving both total protection and management on non-federal forest land. Silvicultural activities on private forest land should be conducted only with sound forest management and conservation plans prepared under the direction of professional foresters. All private forest landowners should have such management plans. Without adequate planning forest resources can be depreciated and related values, such as water, will be degraded from increased erosion and sedimentation. However, it must be recognized that good management on all non-federal forest land cannot be achieved without adequate funding.

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STATE WATER 97
PLANNING FUND

The attachments cover legal status of the State Board of Land Commissioners, Land Office, and Wyoming State Forestry Division. Forestry Division Objectives are also included, all of which are renewable resource and water related.

Michael H. Gagen will be our representative for contacts on Yellowstone Level B planning. He coordinates our Watershed Management program, including PL-566, Type IV Studies, and the like. He can be reached by telephone in Cheyenne at 777-7586.

Very truly yours,

Carl E. Johnson
State Forester

BEL/jm

Attach:

STATE BOARD OF LAND COMMISSIONERS

The State Board of Land Commissioners consists of five elective officials; Governor, Secretary of State, State Auditor, State Treasurer, and State Superintendent of Public Instruction.

The Board has the direction, control, leasing, care and disposal of all lands heretofore or hereafter granted or acquired by the State for the benefit and support of public schools or for any other purpose whatsoever, subject to the limitations contained in the constitution of the State, and the laws enacted by the Legislature. (36-14)

Statutes concerning the State Board of Land Commissioners as they relate to the Wyoming State Forestry Division are:

1. To manage the lands, under the multiple-use principle, for the support of the public schools and other institutions for which the land was granted or acquired, for the best interests of the State of Wyoming. (36-20)
2. To protect State, other public and private lands from fire, and to cooperate with such other parties or authorities. (36-21)
3. To safeguard the State land from destruction from causes other than fire. (36-20)

COMMISSIONER OF PUBLIC LANDS

The Commissioner of Public Lands is responsible for the administration and care of all State land received by the State Board of Land Commissioners. Administration of these is conducted under the various laws and Board Rules and Regulations. (36-34)

WYOMING STATE FORESTRY DIVISION

The Wyoming State Forestry Division is a division of the Office of Commissioner of Public Lands. The Wyoming State Forester is the statutory head of the Forestry Division, appointed by the State Board of Land Commissioners to conduct the responsibilities assigned to the Division by Law or by Board policy.

Wyoming Statute 36-21 is the enabling legislation under which the Forestry Division functions and is as follows:

a. The state forester shall, under the general supervision of the commissioner of public lands, have direction of all forest interests and all matters pertaining to forestry within the jurisdiction of the State of Wyoming.

b. The state forester shall:

   (i) Take such action as may be deemed necessary by the state board of land commissioners to extinguish forest and range fires;

   (ii) Assist the county sheriff in the enforcement of all laws pertaining to the protection of forest and range lands from fire;

   (iii) Collect data relative to forest conditions;

(iv) Prepare an annual report on the progress and conditions of state forestry work;

(v) Recommend plans for improving the state system of forest protection, management and replacement;

(vi) Whenever it is deemed essential and to the best interest of the state, cooperate with counties, cities, towns, corporations, or individuals for the protection, management and replacement and planting of trees, woodlots and timber tracts;

(vii) Promote the development of the forest industry;

(viii) Cooperate with federal agencies to fulfill the intent of this section.

The objectives of the Wyoming State Forestry Division are:

1. To conduct a planned management program based upon the multiple-use principle, which will provide maximum income to the various funds for which the land was granted.
2. To manage State forest lands in such a manner as to insure or enhance the perpetuation of all resource values.
3. To manage the forest under a sound planned sustained yield basis based on:
    a. To remove annually the current growth plus mortality in such manner that the residual tree stands will remain in a thrifty, productive, or reproducing condition.
    b. To utilize harvesting practices which will remove mature and over mature timber on a silviculturally sound basis and which will provide for optimum regeneration.

c. To improve the productivity and composition of young stands of timber through commercial and pre-commercial thinnings.

d. To reforest non-stocked and under-stocked forest land with superior or improved seed or seedlings through an accelerated program of planting and/or direct seeding.

e. To salvage all fire killed, blow-down and insect and disease damaged timber as losses occur.

f. To obtain and keep current an inventory of timber on State-owned forest lands.

g. To obtain and maintain a system of land and timber records including status, inventory, condition, timber depletion, stand improvement, special uses, maps, etc.

h. To promote the quality of forest industries within the State by raising the productivity of the State and private forest land and encouraging improved utilization and marketing of the forest products by cooperating with private, state and federal agencies engaged in such promotion.

4. To assist the Office of Commissioner of Public Lands in the leasing of State land for Special Use purposes, such as commercial, industrial and recreational uses. Recreational use leases may be for cabin sites, private camp sites, golf courses, youth groups, and ski or winter sports areas where they are suitable, and where there is no conflict with other lessees or other uses of equal value.

5. To provide technical and practical assistance to the private forest landowners in the State concerning forest conservation and the establishment and maintenance of forest stands, plantations, windbreaks and shelterbelts, and urban trees.

6. To conduct an effective program of fire management through pre-suppression and suppression organizations on State and private lands, based upon:

   a. To promote fire protection for all State and private lands in the State.

   b. To prevent as many fires as possible through an effective fire prevention program.

   c. To attain and maintain the highest possible preparedness, consistent with financing, manpower, and available facilities, prior to and during the fire season each year, and to maintain the minimum necessary preparedness during the remainder of each year.

   d. To confine fires to as small an area as possible, consistent with reasonable suppression costs, and to control each fire within the first burning period (by 10:00 A.M. the day after fire discovery).

7. Slash disposal (hazard reduction) is a part of fire prevention and a tool of forest management, based upon:

   a. To provide economically feasible slash disposal in keeping with sound, progressive forest and environmental management practices, while at the same time providing effective fire protection to residual timber stands and the property of others.

b. To reduce slash hazards to further reforestation in conjunction with the total forest management program on State lands.

c. To promote slash and hazard reduction from timber harvest operations on private lands.

8. To independently, and through cooperation with the federal government, weed and pest districts, and private forest landowners, adopt and carry out measures to control, suppress and eradicate outbreaks of forest pests and tree diseases.

9. To assist the Office of Commissioner of Public Lands in the management, care, acquisition, or disposal of State lands.

10. To assure proper land use planning on private forest lands through the cooperation of landowners.

TONGUE-POWDER AND ADJACENT COAL AREA SUBBASIN AGRICULTURE ISSUE PAPER

Prepared by
State Department of Agriculture
Department of Economic Planning and Development
Agricultural Extension Service
Wyoming Water Planning Program

Introduction

Description

There are about 14,510,400 acres of land area and 14,800 acres of water area in Northeastern Wyoming. The total area is about 14,525,200 acres, or 22,695 square miles.

There are about 160,585 acres of irrigated land and 346,500 acres of dry cropland and summer fallow in the drainage area of Northeastern Wyoming. The remaining lands are used for grazing, except inhabited areas, recreation areas, parks, Federal lands where the grazing of livestock is not permitted for management purposes, and badlands and mountainous areas where access is too difficult to efficiently use the land for grazing purposes.

The descripiton of the agricultural economy of Northeastern Wyoming is based on data for entire counties. Campbell, Crook, Johnson, Niobrara, Sheridan, and Weston Counties reasonably represent conditions in the Area. Parts of Johnson, Niobrara, and Sheridan Counties lie outside the drainage area. Parts of Converse and Natrona Counties are in the drainage area, but only a minor acreage of irrigated land and dry cropland in these two counties lies within the Northeastern Wyoming drainage area.

The Agricultural Census shows that the value of all farm products sold in 1969 is about $57,310,000 in the Northeastern Wyoming area (Table 1). Livestock and livestock products contribute about 94.84 percent of the value of all farm products sold, crop sales amount to about 5.08 percent, and farm forest products amount to less than one-tenth of one percent of total agricultural sales.

TABLE 1 -- Farm and Ranch Income and Sales, Production Expense, Number of Farms, and Farm Size
1969 Census of Agriculture

Item	Unit	County[1]						Total
		Campbell	Crook	Johnson	Niobrara	Sheridan	Weston	
All Agricultural Products	Dollars	11,135,799	8,574,978	8,989,445	8,016,099	12,937,534	7,656,167	57,310,022
All Livestock, Poultry, and Product Sales	Dollars	10,526,493	7,960,458	8,808,942	7,516,868	12,062,235	7,478,513	54,353,509
All Livestock and Products as a Percent of All Products	Percent	94.53	92.83	97.99	93.77	93.23	97.68	94.84
All Crop and Hay Sales	Dollars	609,306	578,097	179,414	499,231	873,299	174,442	2,913,789
All Crops Sold as a Percent of All Products	Percent	5.47	6.74	2.00	6.23	6.75	2.28	5.08
Forest Product Sales	Dollars	--	36,423	1,089	--	2,000	3,212	42,724
Forest Products as a Percent of All Products	Percent		.43	.01		.02	.04	.08
Farm Production Expense	Dollars	8,719,276	7,214,415	6,974,250	6,574,739	11,600,726	6,387,391	47,470,797
Farms and Ranches	Number	479	484	273	328	497	246	2,307
Average Farm Size	Acres	6,408	3,196	7,803	4,692	3,036	6,323	4,920
Average Sales Per Farm	Dollars	23,248	17,716	32,928	24,439	26,031	31,122	24,842

[1] Portions of Johnson, Niobrara, and Sheridan Counties are outside the Northeast Wyoming Area. Parts of Converse and Natrona Counties are in the Northeast Wyoming drainage area.

There are 1,906 commercial farms and ranches and 401 part-time farms, retirement farms, and other farms, for a total of 2,307 farm and ranch units.

The 1969 total gross sales of all farm products sold vary from $7,656,167 in Weston County to $12,937,534 in Sheridan County. The average sales per farm and ranch unit in the six-county area were $24,842 in 1969 (Table 1).

The Wyoming Cooperative Crop and Livestock Reporting Service reports show that from 1950 to 1970 the pounds of beef marketed in Wyoming increased from about 287 million pounds to about 572 million pounds, an increase of about 99 percent. Sheep marketing for the same period increased from about 71 million pounds to about 99 million pounds. Beef cattle and sheep are the principal sources of cash income in Northeastern Wyoming.

In the six-county area all cattle and calves on hand January 1 increased from 285,000 to 467,000 head, or an increase of about 64 percent between 1950 and 1975. During the same period sheep numbers increased from 304,000 to 339,000, or an increase of slightly more than 12 percent.

There was no significant change in the amount of irrigated land and dryland used for hay and forage production, but there were significant increases in yields per acre and total forage production to provide the winter feed base for the increased livestock numbers.

Net income for the period has fluctuated from year to year with no discernible trend in total personal income originating in agriculture. The income of persons engaged in agriculture has improved because of a decline in the number of persons working in on-farm agriculture rather than from growth of the agricultural industry.

During the period 1930 to 1960 every county in Northeastern Wyoming has shown a substantial decline in farm population. Wyoming has experienced a downward trend in agricultural employment similar to the national trend in agriculture. However, the rate of decline has been lower in Wyoming than in the Nation or the states composing the Rocky Mountain region. Agriculture accounts for a larger share of total employment in Wyoming than in the United States or the Rocky Mountain region and is the fourth largest industry in Wyoming as measured in terms of employment.

There are an estimated 276,000 acres of dry cropland and about 70,500 acres of summer fallow for a total of 346,500 acres, which is about 2.39 percent of the land area in Northeastern Wyoming.

The 1967 to 1970 average use of the dry cropland area was: hay - 44.8 percent, barley and oats - 11.2 percent, wheat - 21.3 percent, and summer fallow - 21.3 percent. Wheat is an important dryland cash crop. Dryland hay, oats, and barley provide an important forage and feed-grain base for the livestock industry.

The irrigated lands of Northeastern Wyoming were mapped during the irrigation season of 1970. For the mapping program, irrigated land was defined as land watered for agricultural purposes by artificial means, including water spreading. These lands include subirrigated lands and seeped areas under ditches, as well as lands irrigated directly by ditches, sprinklers, groundwater developments, and water spreading systems. Lands that are under ditches or water spreading systems that clearly have not been irrigated for a number of years were excluded. However, lands classified as idle lands in the crop-distribution analysis were included. Idle lands are defined as lands which are occasionally irrigated but are not irrigated in an average or poor water year. Idle lands also include those cropland acres on which a crop was planted but not harvested. Some grazing benefits may be realized from idle lands. The idle lands were deducted from the total irrigated land to determine the average annual irrigated acreage.

There are about 8,500 acres of land irrigated wholly or partially from groundwater. This acreage includes lands with an original supply and lands receiving a supplemental supply from groundwater sources. There are about 25,000 acres of water spreading. The remainder of the irrigated lands are supplied from storage and surface flows.

Table 2 is a tabulation of the irrigated land in Northeastern Wyoming. A total of 160,585 acres of irrigated land was mapped, of which 23,860 acres were idle. The average area irrigated is about 136,725 acres. These figures include conventional irrigation and water spreading. About 52 percent of the irrigated lands have shortage to full season water supply. The total water supply is about 69 percent of needs.

TABLE 2 -- Tabulation of Irrigated Land in Northeastern Wyoming
(Acres)

Study Subarea	Total Acres Irrigated	Idle	Average Acres Irrigated
1. Tongue River	64,320	6,175	58,145
2. Clear Creek	35,320	5,350	29,970
3. Crazy Woman Creek	12,090	1,880	10,210
4. Powder River	18,900	2,705	16,195
5. Little Powder River	3,230	990	2,240
6. Little Missouri River	7,760	2,380	5,380
7. Belle Fourche River	6,540	1,945	4,595
8. Cheyenne River	12,425	2,435	9,990
Total	160,585	23,860	136,725

Source: Wyoming Water Planning Program

Economic Importance of Agriculture

Irrigated and dry cropland to provide a winter feed base for the livestock enterprise and grazing lands for summer forage are all interdependent components of the ranch enterprise. The western portion of the Study Area is largely dependent on irrigation for hay production. The central and eastern portion of the Study Area has some irrigation and a large acreage of dryland hay.

State Statistical Reporting Service figures indicate that in 1974 about 98,700 tons of dryland hay were harvested in the Northeastern Wyoming area, or about 67.6 percent of all nonirrigated hay production in Wyoming. Dryland hay production in 1974 was about 42 percent of the total hay production in the Area.

The combination of rangeland, irrigation, and dryland hay and crop production has enabled Northeastern Wyoming to support more than its share of Wyoming's livestock production on an area basis.

The 1970 normal crop distribution, yields, value of production, and net return to land are summarized in Table 3 for the irrigated lands within the drainage boundaries of the Study Area. The estimated gross annual value of irrigated crop and pasture production in the Study Area is about $5,353,650. The net return to irrigated land in the Area is about $785,490.

Production cost data developed by James Owen of the University of Wyoming in a thesis, "Irrigation Water Values in Portions of Wyoming's Tongue and Powder River Basins", was used in estimated production costs in the Area.

The net return to land in Table 3 does not necessarily measure the full value of irrigated lands to the farm and ranch enterprise as essentially all hay and feed grains produced are marketed through livestock.

TABLE 3 -- Northeastern Wyoming - Summary of 1970 Normal Crop Distribution, Yield, Production, Value of Production, Production Costs, and Net Return to Irrigated Land

Crop	Acres	Yield Per Acre	Production	Price[1]	Value of Production (Dollars)	Production Costs (Dollars)	Net Return[2] to Land (Dollars)
Alfalfa	62,580	2.4 Ton	150,190	23.20	3,484,410	3,037,630	446,780
Native Hay	9,465	1.1 Ton	10,410	23.20	241,510	215,140	26,370
Other Hay	11,820	1.3 Ton	15,370	23.20	356,580	364,880	- 8,300
Barley	2,690	43.0 Bu	115,670	.97	112,200	105,820	6,380
Oats	7,600	49.0 Bu	372,400	.68	253,230	300,730	-47,500
Suger Beets	415	16.2 Ton	6,720	14.46	97,170	66,610	30,560
Corn Silage	1,100	10.0 Ton	11,000	8.12	89,320	71,320	18,000
Pasture	41,055	2.3 AUM[3]	94,430	4.50	424,930	406,030	18,900
Aftermath Grazing		AUM[4]	65,400	4.50	294,300	--	294,300
Idle	23,860						
Total	160,585				5,353,650	4,568,160	785,490

[1] Average prices 1967 to 1970. Silage estimated at 35 percent of hay price.

[2] Gross value of production less fixed costs of production, operating costs, and all other production costs except interest on land investment.

[3] Animal Unit Month grazing.

[4] Aftermath grazing yields are estimated at 1.0 AUM for native hay and other hay, 0.5 AUM for alfalfa, and 1.25 for small grain.

Source: Wyoming Water Planning Program, the University of Wyoming Agricultural Sectory Study, and other University of Wyoming data on costs of production.

In the Owen study 28 complete farm budgets were taken. These units were evaluated as dryland ranch units with no water supply, and these same units were evaluated with the present assumed water supply and irrigated lands to support the ranch unit. The change in net income from the dryland condition to the condition with the present water supply resulted in a net increased return to land and water which ranged from $2.93 to $7.96 per acre-foot of water consumptively used. Capitalizing these values with an appropriate discount rate would yield the perpetuity value of the water right. Bids equal to or greater than these values would supposedly be necessary to draw water rights out of their agricultural uses.

Objectives

Increased Agricultural Production

The northeastern portion of Wyoming is a leading livestock production area. The six-county area had a January 1, 1975, cattle inventory of 467,000, 27.6 percent of the total State inventory and 339,000 sheep, 28.5 percent of the total State inventory. The six-county area used to approximate the study area makes up about 19.5 percent of the total area of Wyoming. Therefore, it appears that the study area contributes substantially more than its share of red meat production.

The past national trend shows a sharp increase in per capita beef consumption and a decrease in lamb and mutton consumption, and this trend is expected to continue. Projected national needs for lamb and mutton indicate that no expansion in sheep and lamb production will be needed by 1980, but that moderate expansion will be needed for the years 2000 and 2020. Projected national needs for beef production show a sharp increase through the projection period.

It is estimated that livestock feeding and management efficiencies and the projected increase in crop yields will provide the feed grains and forage necessary for livestock producers in the Study Area to show a moderate increase in beef production and maintain sheep and lamb production at about its present level.

Competition for water by the mineral sector and the availability of a water supply at a reasonable cost are factors which will probably affect expansion of irrigation in the Study Area.

It has been estimated that industrial companies have purchased large acreages of irrigated lands in the Area. The water rights on these lands will eventually be converted from agricultural uses to industrial uses. It is assumed in making the irrigated lands projections that water spreading and other developments will offset these losses to industry. The total irrigated acreage is thus projected to remain nearly constant throughout the projection period.

There is a substantial acreage of capability class I, II, and III dry cropland and rangeland which would be suitable for irrigation development if an irrigation water supply were available at a reasonable cost. Soils in each land capability class and land use are tabulated for the six counties in Northeastern Wyoming (Table 4). It is the availability of suitable water (and economics) and not land resources that will likely prohibit future expansion of irrigation in the Study Area.

TABLE 4 -- Soils, Northeastern Wyoming

Capability Class	Irrigated Lands - Acres[1]						
	Campbell	Crook	Johnson	Niobrara	Sheridan	Weston	Total
I		3,863			1,750	1,335	6,948
II			32,583	870	74,802	2,500	110,755
III	8,768	5,632	11,600	100	1,687	2,500	30,287
IV	1,000	10,088		3,109	13,036	5,832	33,065
V							
VI	1,000		950		512	500	2,962
Total	10,768	19,583	45,133	4,079	91,787	12,667	184,017
	Rangeland - Acres						
	Campbell	Crook	Johnson	Niobrara	Sheridan	Weston	Total
I							
II		2,149	2,966	4,017	5,743	3,351	18,226
III	61,992	107,912	1,483	195,144	31,320	17,896	415,747
Total	61,992	110,061	4,449	199,161	37,063	21,247	433,973
	Dry Cropland - Acres						
	Campbell	Crook	Johnson	Niobrara	Sheridan	Weston	Total
I						832	832
II		4,212			162	4,217	8,591
III	41,088	42,477		36,725	1,889	21,980	144,159
IV	72,305	47,616	5,860	20,278	30,407	27,575	204,041
Total	113,393	94,305	5,860	57,003	32,458	54,604	357,623

[1] Irrigated acreage in Conservation Needs Inventory does not agree with the mapped acreage.

Source: Soil Conservation Needs Inventory, June 1970.

Changes in crop distribution for 1980 were determined by the University of Wyoming as part of the Agricultural Sector Study. Historical trends and Wyoming's share of national production were used to establish these changes in land use and crop distribution. Crop distribution and yield projections for the years 2000 and 2020 were made by the Wyoming Water Planning Program.

Projected changes in crop distribution are minor. Increased native hay will occur on new water spreading developments. Yield projections are based on data provided by the University of Wyoming, the Great Plains Agricultural Council, and Economic Research Service. Current normal and projected yields were established for each land resource area and expanded to the Northeastern Wyoming Study

Area for average yields. The 1970 normal and projected yields, crop distribution, and production are presented in Table 5.

TABLE 5 -- Irrigated Lands - Yields, Distribution, and Production

Projected Yields

Crop	Unit	1970 Normal Yield	1980	2000	2020
Alfalfa	Tons/acre	2.4	2.8	3.7	4.4
Native Hay	Tons/acre	1.1	1.1	1.2	1.3
Other Hay	Tons/acre	1.3	1.8	2.3	2.9
Barley	Bu/acre	43.0	57.0	73.0	84.0
Oats	Bu/acre	49.0	64.0	82.0	98.0
Sugar Beets	Tons/acre	16.2			
Corn Silage	Tons/acre	10.0	13.0	19.0	21.0
Pasture	AUM/acre	2.3	2.6	3.6	4.5
Aftermath Grazing					
Alfalfa	AUM/acre	.5	.5	.5	.5
Native Hay	AUM/acre	1.0	1.0	1.0	1.0
Other Hay	AUM/acre	1.0	1.0	1.0	1.0
Small Grain	AUM/acre	1.25	1.25	1.25	1.25

Crop Distribution

Crop	1970 Normal Acres	1980 Acres	2000 Acres	2020 Acres
Alfalfa	62,580	64,270	64,700	65,000
Native Hay	9,465	12,260	12,630	12,930
Other Hay	11,820	11,000	10,500	10,000
Barley	2,690	3,200	3,700	4,300
Oats	7,600	8,000	8,500	9,100
Sugar Beets	415			
Corn Silage	1,100	1,500	2,200	2,900
Pasture	41,055	40,770	40,770	40,770
Idle	23,860	20,000	18,000	16,000
Total	160,585	161,000	161,000	161,000

Crop Production

Crop	Unit	1970 Normal	1980	2000	2020
Alfalfa	Ton	150,190	179,960	239,390	286,000
Native Hay	Ton	10,410	13,490	15,160	16,810
Other Hay	Ton	15,370	19,800	24,150	29,000
Barley	Bu	115,670	182,400	270,100	361,200
Oats	Bu	372,400	512,000	697,000	891,800
Sugar Beets	Ton	6,720			
Corn Silage	Ton	11,000	19,500	41,800	60,900
Pasture	AUM	94,430	106,000	146,770	183,460
Aftermath Grazing	AUM	65,440	69,400	70,730	72,180

Source: University of Wyoming, the Great Plains Agricultural Council, Economic Research Service, and Wyoming Water Planning Program.

Projected yield increases assume improved water management, additional land leveling, improved water supply resulting from improved efficiency, development of supplemental supplies from storage facilities and groundwater of some small storage facilities for supplemental supply, and improved cultural and management practices. New technologies will facilitate increased agricultural productivity.

Additional capital will be required. The agricultural labor force will decline, but at a slower rate than in the past. Agriculture will continue to be a strong base for business and the service industries in the Area.

Constraints to Agriculture

Agriculture is faced with many constraining factors. Among these are: increased construction and development costs, the cost-price situation in agriculture production, and the limited low-cost investment capital.

Agriculture is also faced with several institutional and potential legal constraints, including the National Environmental Policy Act and the Army Corps of Engineers' regulations on dredge and fill on navigable waters. These constraints will be discussed later in the paper.

Without Situation

Agriculture in Northeast Wyoming will likely remain as a major livestock production area in Wyoming even without a comprehensive development plan. However, its importance will probably diminish.

In the absence of a comprehensive multipurpose development plan, it appears likely that the recent trend of energy related industries buying up senior agricultural water rights will continue. Development of replacement irrigation water supplies may be prohibitively expensive because of rising construction costs.

The Department of Economic Planning and Development and the Wyoming Farm Loan Board, through their existing loan program, has financed substantial irrigation development in Northeast Wyoming. Between January, 1970, and June, 1975, the Department of Economic Planning and Development and the Wyoming Farm Loan Board provided financing for development of 2242 acres of new irrigated lands and development of supplemental supplies or improved irrigation systems for 4665 acres in the study area (Source: State Department of Economic Planning and Development Annual Reports 1970-75). Private interests are presently financing some irrigation development and the Farmers' Home Administration also provides a limited amount of financing for water resource development on a continuing basis. These developments will tend to partially offset the irrigated lands taken out of production due to water rights that are expected to be transferred to industrial uses.

Recent legislation has increased the amount of funds available to be loaned under the State loan program. This could result in the State financing a larger portion of the new land and supplemental water supplies developed or it could mean an increased acreage will be developed.

These estimated developments could be modified or changed due to pending controls under EPA, Corps of Engineers' regulation, and land use planning efforts. The EPA, through the State Department of Environmental Quality, will handle permits on feedlots and for irrigation. The regulations for both are in the formulation stage and their eventual impact is not known. An area wide waste treatment planning process (208 planning) has been initiated by the Department of Environmental Quality, and is being carried out by Powder River Areawide Planning Organization (PRAPO).

The Army Corps of Engineers have developed regulations to control dredge and fill operations on navigable waters. The effect on the Study Area agriculture is not presently known but could be significant.

The State has instituted a land use planning program. This program will be handled primarily at the local level and local values and concerns will be the basis for the final plans developed. It appears that if new irrigated land developments have local support, they will be included in the local plans.

Another constraining factor that future agriculture development must face is Federal and Indian water rights claims.

Projects

There are numerous agricultural water development project potentials in Northeast Wyoming. These potentials are in many cases large developments requiring large investments to build. These large projects are more feasible for development as water sources for industrial development.

Table 6 shows future irrigation potentials that have been identified. These are not the only potentials but are the ones that were felt to be the most feasible at the time.

Table 6 - Identified Future Irrigation Potentials in Northeast Wyoming - August, 1974

Project	New Acres	Supplemental Supply Acres
Sheridan Canal		11,000
Middle Fork Powder Reservoir	860	4,600
Hazelton	-	3,000
Private Development	-	4,000
Total	860	22,600

Source: Wyoming Water Planning Program

The following is a brief description of the projects listed in Table 6 above:

Sheridan Canal

This project would provide supplemental irrigation water to 11,000 acres in the Tongue River Drainage. Two alternatives have been identified and analyzed by the SCS. Alternative one involved a 9,000 acre-foot reservoir on the South

Fork of Tongue River while alternative two involved an 11,000 acre-foot reservoir on the South Fork of Tongue River and a diversion from the Little Tongue River to Wolf and Soldier Creeks.

Middle Fork Powder Reservoir

This project is a joint development between agriculture interests and industrial interests. The project is funded by a Wyoming Farm Loan Board loan. Without the inclusion of the industrial interests this project would not be in process of being built.

Hazelton

The Hazelton Project is on the Middle Fork of Crazy Woman Creek and involves a 3,000 acre-foot reservoir. This project will provide a supplemental irrigation water supply to 3,000 acres of existing irrigated lands. This project was also identified as a small watershed project.

Private Development

These are individual developments that have not been identified by individual size and location. These projects would probably be financed through the State loan program.

Table 7 shows the small watersheds that have been identified in Northeast Wyoming for analysis as PL 566 projects. The projects and their present status are listed in the table.

Table 7 - Small Watershed Projects and their Status
Northeast Wyoming

Project	Status
South Redwater Creek	Terminated 5/64
Sussex	Inactive
Arch Creek	Inactive
Inyan Kara Creek	Inactive
Cabin Creek	Suspended 6/71
South Tongue River	Inactive
Hazelton	Active
North Fork Crazy Woman	Active

Source: Soil Conservation Service, September 1974

The projects listed in Table 6 and Table 7 indicate that potential for agriculture water developments exists in Northeast Wyoming. Development of these projects may require joining with industry to facilitate funding.

RECONNAISSANCE STUDIES
Of
POTENTIAL SMALL AGRICULTURAL PROJECTS

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

NORTHEAST WYOMING STUDY AREA

Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming
February 1977

INTRODUCTION

Proposed small agricultural projects in the Northeast Wyoming Study Area that have been identified as potential projects for consideration in the Yellowstone Basin and adjacent Coal Area Level B Study have been investigated by the Soil Conservation Service. The investigations, which were made in 1976, are reconnaissance type studies. The studies are based on findings of earlier studies wherever such information is available. Reports of the 1976 reconnaissance studies are presented in this volume.

Reports on proposed projects for which evaluations were completed, and which appear to be feasible projects are enclosed in Part One of this volume in the following order:

1. Cabin Creek
2. Middle Fork Crazy Woman
3. Skull Creek
4. South Tongue River

Those proposed projects for which evaluations were not completed are reported in Part Two. Some of those projects are infeasible; others are part of a larger development proposal; still others are of such a nature or size that they do not lend themselves to a small agricultural project approach. Abbreviated reports of these proposed project areas are in the following order:

1. Arch Creek
2. Clear Creek, Rock Creek, Piney Creek
3. Goose Creek
4. Inyan Kara Creek
5. Little Bighorn-Pass Creek
6. North Fork Crazy Woman
7. Prairie Dog
8. Redwater Creek

Reconnaissance Study

CABIN CREEK

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
U. S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming

December 1976

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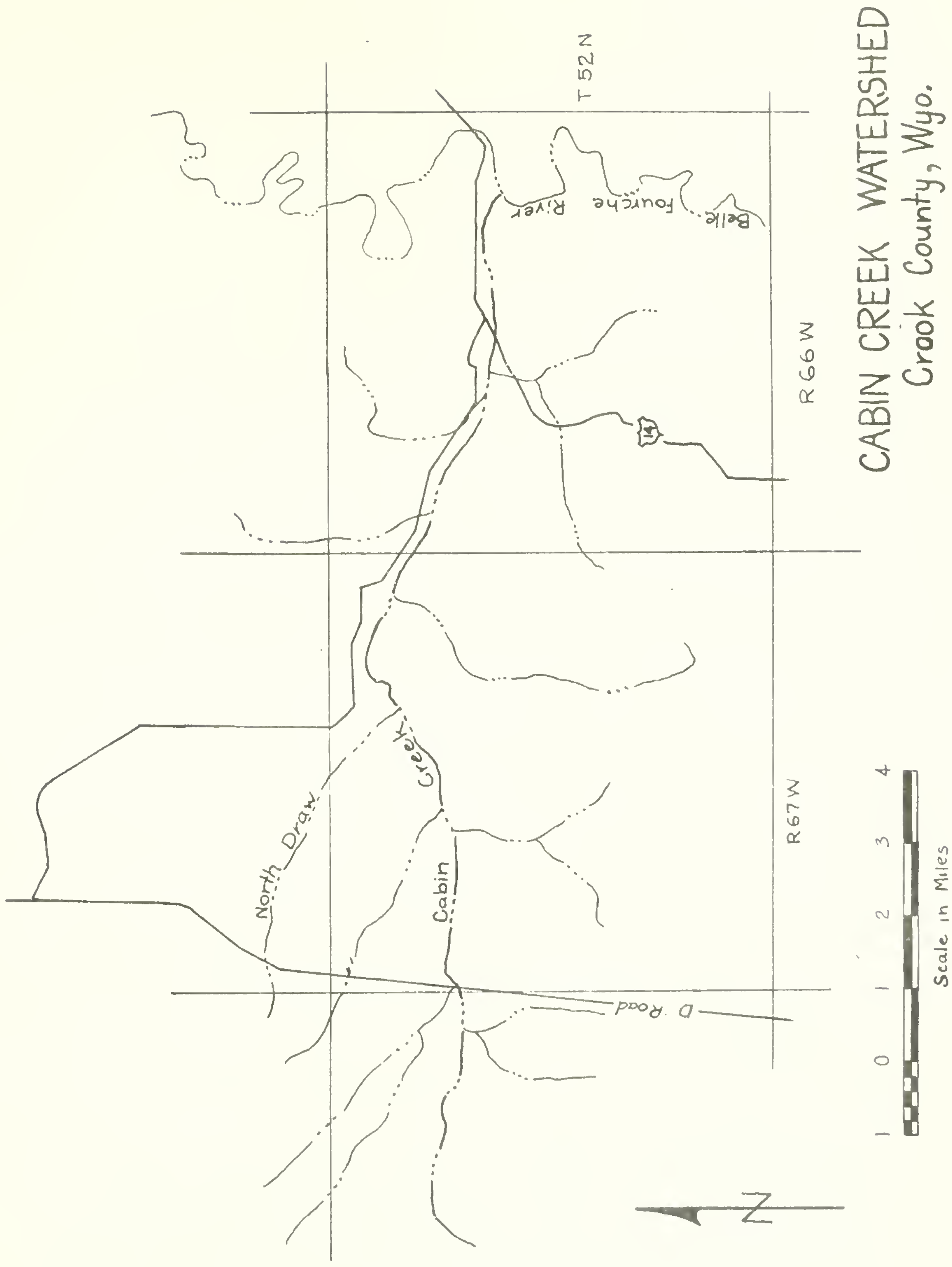

CABIN CREEK WATERSHED
Crook County, Wyo.

SUMMARY

Cabin Creek is a tributary of the Belle Fourche River in Crook County, Wyoming. Frequent flooding in the drainage area causes floodwater, sediment and erosion damage to crops, agricultural property, roads and bridges along Cabin Creek and contributes to sediment damage in the Belle Fourche River. Flood flows also prevent use of the small diversion structures that could provide needed irrigation water to hayland in this ranching area.

Proposals to provide a high level of flood damage reduction and irrigation benefits with a number of multipurpose reservoirs do not appear to be economically feasible. The use of waterspreading systems for flood prevention is also not feasible.

Preliminary investigation by the Soil Conservation Service identified one multipurpose dam which appeared to be a feasible structural proposal. The dam would provide some damage reduction benefits and store floodwater for irrigation benefits to about 330 acres.

This reconnaissance study is based on the findings of the 1968 to 1970 preliminary investigations of the Soil Conservation Service and evaluates the proposal of one multipurpose dam as presented to local sponsors in November 1970.

By updating the estimated costs and benefits of the 1970 proposal to 1975 costs and prices, the installation cost of the structure was estimated to be $397,240. The benefit cost ratio is about 1.0 to 1.0.

LOCATION AND DESCRIPTION

Cabin Creek is in western Crook County, Wyoming. The creek is a tributary of the Belle Fourche River and enters the river about ten miles downstream from Keyhole Dam and about eight miles upstream from Devils Tower National Monument. The drainage area is about 66 square miles.

The upper drainage area is rolling topography of moderate relief. The lower drainage area has more deeply entrenched tributaries in narrow valleys with steeper side slopes.

The soil in the watershed is fine textured and of high runoff producing characteristics. The upland along the edges of the watershed have soils with moderate intake rates. The central part of the watershed is made up of soft shales of shallow depth, low permeability and with sparse vegetative cover. Along the floodplains fine textured alluvial soil is deep and well developed.

The watershed is at an elevation of 3940 to 4600 feet above mean sea level. The average annual precipitation is about 15 inches, 70 percent of which occurs in the period of April through October. Summer rains of short duration and high intensity occur over small areas within the watershed.

About five percent of the land within the watershed is managed by the U.S. Bureau of Land Management and about seven percent is owned by the State of Wyoming. The remainder of the land is divided among about 55 individual ownerships.

About twelve ranches are headquartered in the watershed. Livestock production is the main enterprise with some small grain used as a cash crop. The amount of rainfall and the area of land available for cropping limit the dependable returns from cash crops and require a ranch type operation.

Land cover and use is about 7 percent woodland, 77 percent range, and 13 percent dry crop. A small area of hayland receives supplemental water by occasional flooding. Woodland is scattered areas of pine. The range includes good grass stands and grass with sagebrush. Range cover varies from good or excellent cover on some of the upper edges of the watershed to areas of nearly barren shale. Small grain, improved grass for pasture, and native grass cut for hay are principal crops. There is no urban area within the watershed.

PROBLEMS

Floodwater damage along the lower portion of the main stem of Cabin Creek is a major watershed problem. Channel flow and overbank flooding cause channel erosion and damage to waterspreading developments. Damage from overbank flooding includes field erosion, debris deposition, crop damage, loss of harvested hay, and damage to fences, roads and bridges.

Floodwater from Cabin Creek contributes in some measure to the flood damage and sediment damage which occurs within the Belle Fourche River Valley below the watershed. Included in the Belle Fourche River floodplain are agricultural lands, irrigation pumps, and recreational areas of the Devils Tower National Monument.

There is a need for and an interest in some irrigation development. Attempts to practice irrigation on the main stem of Cabin Creek have been abandoned because flood flows destroyed diversion structures and caused increased erosion.

Preliminary investigations indicated that major floods occured in about 10 years during a period of 20 years. Flooding is generally caused by a high intensity rainfall which is a part of a general storm lasting several days. The antecedent moisture may be high because of preceding lighter rains.

POSSIBLE SOLUTIONS

Floodwater retarding structures on the major tributaries of Cabin Creek could reduce the flood flow to a rate that would permit operation of irrigation works. Storage of floodwater above the irrigable land could improve late season water supply for the needed irrigation. Early investigations show that a large number of reservoirs would be required to provide the desired protection and that a project to provide a large measure of damage reduction and agricultural water management benefits was not economically feasible.

A preliminary investigation by the Soil Conservation Service in 1968 to 1970 evaluated proposals to build waterspreading systems for flood prevention and found that the proposals were not economically feasible as a watershed structural program. The combined benefits from flood control and agricultural water management did not justify the cost of installing and maintaining the spreader systems on an area that was large enough to provide the desired damage reduction. Costs of spreader systems were relatively high because of the relatively steep slopes and small confined areas that were needed to provide the flood prevention benefits.

Selected smaller areas along Cabin Creek appear to be suitable for development of waterspreading systems for increased crop yields.

Preliminary estimates by the Soil Conservation Service indicated that a multipurpose dam which would provide some flood damage reduction with some agricultural water management benefits could be installed as a feasible project. These estimates were presented to the project sponsors in November 1970.

PROPOSED PROJECT

Structural Works

A multipurpose dam as identified by the Soil Conservation Service in November 1970 is presented here as the structural works of a Cabin Creek project. In this reconnaissance report the structure is evaluated by accepting the costs and benefits as estimated in 1970 and updating costs and prices to 1975 levels. Operation of the dam and reservoir would result in reduced damage to roads, bridges, crops, agricultural land and other agricultural property and would provide storage of irrigation water to benefit about 330 acres of irrigated land.

The proposed dam would be located on Cabin Creek above the confluence of North Draw and Cabin Creek in section 10, T52N, R67W. Reservoir storage capacity would include 700 acre-feet for sediment, 1,000 acre-feet for irrigation and 1,800 acre-feet for floodwater. About 210 acres would be covered with water at the elevation of the irrigation pool and about 350 acres would be inundated at the elevation of the floodwater pool.

Estimated Cost

The estimated construction cost updated to 1975 is $289,800. Total estimated installation cost is $397,240. Estimated average annual operation and maintenance cost is $2,050.

Economic Effects

The project will provide benefits from flood damage reduction and agricultural water management. Flood damages to roads and bridges, crop and pasture, and agricultural properties will be reduced by $8,480 annually. In addition, about 330 acres of land currently subject to flooding will be brought into irrigated production. Irrigation water for these acres will be stored in the project reservoir. Irrigation benefits are estimated to be $13,600 annually.

Project benefits and costs are shown below:

Average Annual Benefits		
Flood damage reduction	$ 8,480	
Irrigation	13,600	
Secondary	4,400	
Total benefits		$26,480
Average Annual Costs 1/		
Installation	$24,400	
Annual OM&R	2,050	
Total annual cost		$26,450
Average Annual Net Benefit		$ 30

Benefit:Cost Ratio 1.0:1.0

1/ Amortization: 100 years at 6 1/8%

DISPLAY OF ACCOUNTS

National Economic Development Account

Beneficial effects	
Flood damage reduction	$ 8,480
Irrigation	13,600
Externalities	4,400
Total beneficial effect (annual equivalent value)	$26,480
Adverse effects	
Installation cost	$24,400
Annual OM&R	2,050
Total annual cost	$26,450
Net beneficial effects	$ 30

Regional Development Account	Region	Adjacent Region	Rest of Nation
Beneficial effects			
User benefits			
Flood damage reduction	$ 8,480		
Irrigation	13,600		
Regional benefits			
Employment impact 1/	7,400		
Induced and stemming from 2/	27,200		
Externalities	4,400		
Total beneficial effects (annual equivalent value)	$61,080		
Adverse effects			
Investment	$ 2,670 3/		$20,110
Annual OM&R	2,050		
Externalities 4/	1,620		
Total adverse effects (annual equivalent value)	$ 6,340		$20,110
Net beneficial effects	$54,740		-$20,110

1/ Amortized construction cost x .3 + OM&R.
2/ Irrigation benefit x 2.0.
3/ Sponsor's share of amortized costs less land rights.
4/ Land rights amortized over 100 years @ 6 1/8%.

Social Well-Being Account

A. Income

1. Net ranch income would be increased about $15,000 annually.

2. Ranch income would be stabilized because of increased and more reliable crop production.

3. Community income would be increased an average of nearly $55,000 annually because of increased employment and business generated by project installation and project output.

4. Community income would be stabilized by more dependable agricultural production.

B. Employment

1. Producing the increased agricultural output of the project will more efficiently utilize underemployed labor resources committed to ranches in the project area.

2. Project installation, operation, and maintenance will provide an average annual of one part-time job.

3. The production of increased agricultural output will provide additional part-time or seasonal employment on farm and in the agribusiness industry of the area.

C. Life, Health, and Safety

1. The threat of flooding will be reduced to area ranches.

Environmental Quality Account

A. About 200 acres of rangeland will be committed to reservoir use; about 150 acres of rangeland will be subject to periodic inundation.

B. Suspended sediment will be decreased in Cabin Creek and in a short reach of the Belle Fourche River.

Reconnaissance Study

MIDDLE FORK CRAZY WOMAN

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming
November 1976

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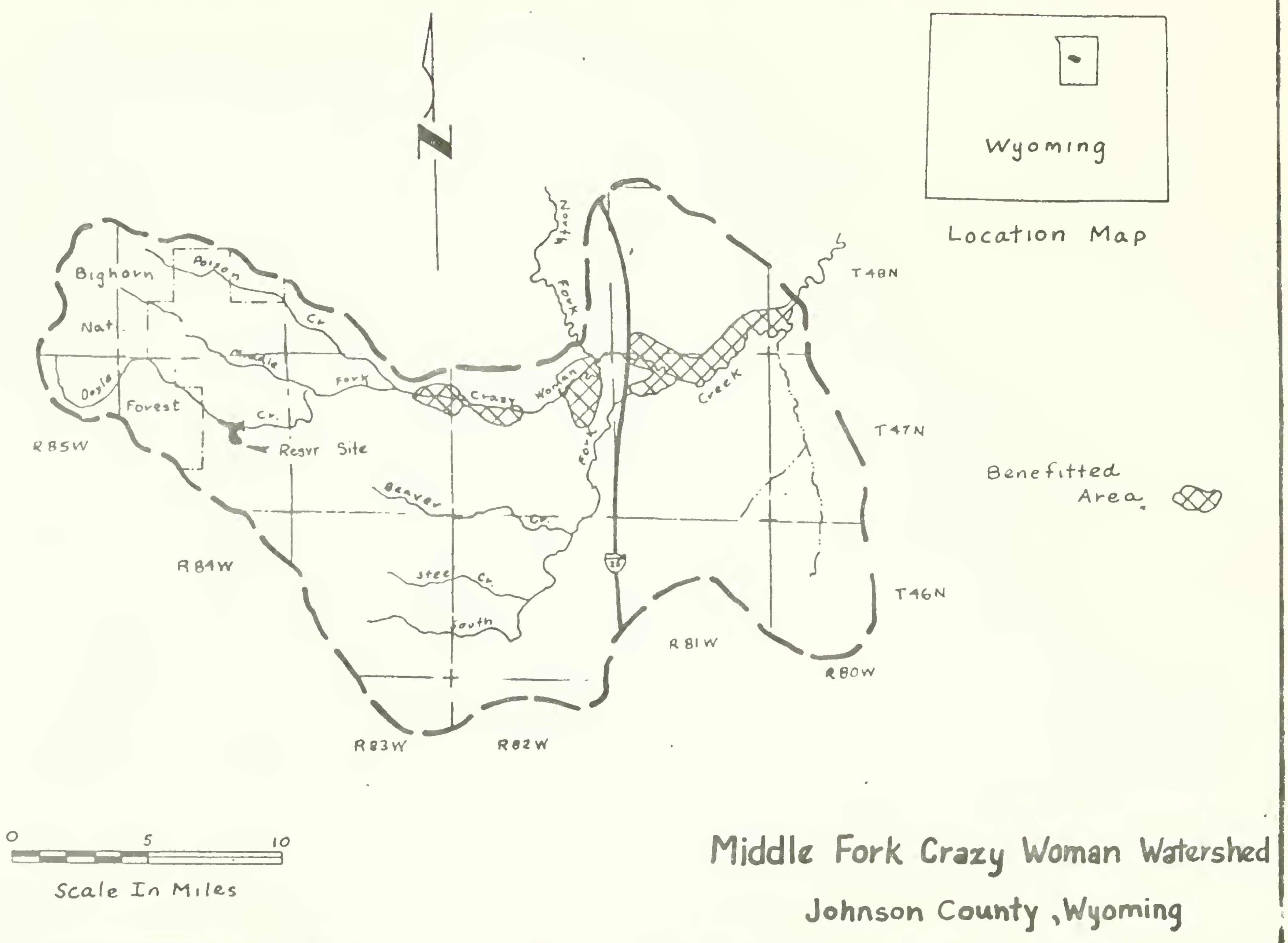

Wyoming
Location Map
Benefitted Area
T48N
T47N
T46N
R80W
R81W
R82W
R83W
R84W
R85W
Bighorn
Nat.
Forest
Poison
Cr.
Middle
Fork
Crazy
Woman
Creek
North
Fork
Doyle
Cr.
Resvr Site
Beaver
Cr.
Cr.
South
0
5
10
Scale In Miles
Middle Fork Crazy Woman Watershed
Johnson County, Wyoming

MIDDLE FORK CRAZY WOMAN

SUMMARY

A planned multipurpose irrigation water storage and recreation reservoir on Doyle Creek can improve the irrigation water supply for about 3,000 acres of irrigated land along Crazy Woman Creek. The irrigated land, located along the Middle Fork of Crazy Woman Creek and along Crazy Woman Creek below the confluence of Middle Fork and South Fork, is part of an area of about 4,770 acres being irrigated for production of livestock feed. With 1,400 acres that now have a full supply, about 4,400 acres will be assured of a full season supply in an average year.

The recreation pool will have a surface area of about 265 acres.

The estimated average annual primary benefits are $72,000 from irrigation and $159,000 from recreation. The estimated average annual cost is $146,000.

The estimated increase in water depletion is 2,300 acre-feet per year.

Rights to store the water of Crazy Woman Creek already exceed the estimated flows available to store. A proposed Crazy Woman Dam has a permit or pending application for storage that will be earlier in priority than rights to store on the Doyle Creek site. Crazy Woman Dam is to be located downstream from the irrigated area and is proposed for a capacity of about 64,000 acre-feet. If storage rights in Crazy Woman Dam are exercised, there will be little water to store for upstream projects. To develop an irrigation water supply project for the Middle Fork, it will be necessary to secure adequate rights to store water above the irrigated land.

LOCATION AND DESCRIPTION

The watershed is located in Johnson County in north central Wyoming. The watershed comprises the Middle and South Forks of Crazy Woman Creek and extends downstream about 6 miles below the confluence of South Fork and Middle Fork. Crazy Woman Creek, a major tributary of the Powder River in Wyoming, drains a portion of the east slopes of the Bighorn Mountains. The drainage area of the watershed is approximately 346 square miles. Major tributaries are Doyle Creek and Poison Creek on the Middle Fork and Beaver Creek and Steel Creek on the South Fork. Elevations range from about 4,000 feet in the lower watershed to about 10,000 feet on the mountains.

The land use and ownership within the watershed is as follows:

Land Use	
Irrigated Cropland	3%
Rangeland	90%
Woodland	7%

Land Ownership	
Private	77%
State	4%
Forest Service	10%
BLM	8%
Other	(Less than 1%)

The major economic activity within the watershed is livestock production. Almost 90 percent of the watershed area is used for grazing of cattle and sheep. This activity is dependent on the irrigated lands for the production of hay, alfalfa, and grain as winter feed. About 6,420 acres are irrigated within the watershed. Of these, about 1,650 acres are in the South Fork area and 4,770 acres are along the Middle Fork and below the confluence of the two streams. In the lower end of the watershed, the North Fork of Crazy Woman Creek contributes to the available water supply.

The Bighorn Mountain area, in addition to being utilized as summer range, produces some forest products and is utilized as a recreation and hunting area. U. S. Highway 16, which crosses the mountains, provides easy access to the upper reaches of the Crazy Creek Drainage.

PROBLEMS AND NEEDS

The primary water related problem within the watershed is the shortage of late season irrigation water. Streams are typical of the mountain west with excessive flows from snowmelt in May and June receding to very low levels by early July. Without storage, this severely limits the acreage that can be dependably irrigated. A number of small dams for irrigation water storage have been built near the irrigated land. There are few suitable storage sites remaining below the mountains above the irrigated land.

Secondary to the water shortage are the problems of sedimentation and floodwater damage. The lower portion of the watershed is subject to erosion, especially during the spring storm period. Floodwater damages are minor in the upper parts of the watershed, but become increasingly more severe in the lower reaches. Floods have washed out bridges and fences, and inundated ranch buildings.

The Bighorn Mountains are a popular recreation area. The developed recreation areas, reservoirs and streams that are readily accessable and available to the public are heavily used. There is an increasing need for waterbased recreation in the mountain area.

PROPOSED PROJECT

A reservoir to be located on Doyle Creek, and with an irrigation water storage capacity of 4,400 acre-feet will provide the supplemental water needs of 3,000 acres of irrigated land in an average year. Additional storage capacity in the reservoir will provide a permanent pool for recreational use. The irrigated land lies along the Middle Fork of Crazy Woman Creek. With 1,400 acres already adequately supplied, there will remain along the Middle Fork, about 370 acres that have a severe water shortage. No additional water will be supplied to the irrigated land in the South Fork area. The project will have little effect on the floodwater or erosion damages in the lower watershed.

Engineering

The structural works consist of a multipurpose dam on Doyle Creek in section 23, T.47N., R.84W. The location is about one mile upstream from the Prospector dam site, which was identified by the Bureau of Reclamation. An earth dam about 95 feet high will store 4,200 acre-feet of water for a recreation pool and 4,400 acre-feet for irrigation. Water will be stored during the period of spring runoff and released into Doyle Creek as needed. Irrigation water will be diverted from Middle Fork at the present points of diversion.

Structural data is shown below:

Drainage Area (Sq. Mi.)	27.2
Storage Volumes (Ac. Ft.)	
Sediment	100
Recreation	4,200
Irrigation	4,400
Floodwater	300
Total	9,000
Surface Areas (Ac.)	
Sediment Pool	25
Recreation Pool	265
Irrigation Pool	415
Flood Pool	430
Top of Dam	545
Elevations (Ft. MSL)	
Bottom of Dam	7,650
Sediment Pool	7,670
Recreation Pool	7,721
Irrigation Pool	7,734
Flood Pool	7,735
Top of Dam	7,745
Height of Dam (Ft.)	95
Volume of Fill (C. Y.)	600,000

The estimated construction cost of the dam is $1,566,000. Estimated average annual operation and maintenance cost is $12,000.

The estimated installation cost and annual cost are shown below:

Installation Cost-Structural Measures
(Dollars) 1/

Item	Estimated Cost
Construction	1,566,000
Engineering Services	190,000
Project Administration	274,000
Land Easements and R/W	150,000
Total Installation Cost	2,180,000

1/ Price Base: 1975

Annual Cost-Structural Measures
(Dollars) 1/

	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Dam	117,000	12,000	129,000
Project Administration	17,000		17,000
Total	134,000	12,000	146,000

1/ Price Base: 1975
2/ 100 years @ 6 1/8%

Rehabilitation of on-farm systems is needed for more efficient use of stored water. Water is applied by surface methods on most of the irrigated land. Sprinklers are in use on about 15 percent of the irrigated acres. Application methods are expected to remain the same with the project installed.

The improved water supply should result in some change in irrigated crops. The area in alfalfa is expected to increase from the current 20 percent to about 35 percent with a corresponding decrease in pasture.

Soils

Most of the soils in the irrigated area are deep and moderately permeable with high available water holding capacity. Most of the soils are alkaline. They are grouped in the 1.0 intake family. Available moisture holding capacity is in excess of 9 inches in the 5 foot root zone. Principal soil series are Haverson, Kim, Stoneham and Zigweid.

Present irrigation includes some fine textured, very strongly alkaline, soils. These soils are similar to soils of the Absted and Petrie series.

Also included as irrigated land are narrow alluvial bottoms of small acreage, some of which have saline soils.

Representative profiles of the named series are listed below:

Haverson - In a representative profile the surface layer is moderately alkaline loam about 4 inches thick. The underlying layer is moderately alkaline loam that is stratified with thin lenses of clay loam and sandy loam. This material reaches to a depth of 60 inches or more.

Kim - In a representative profile the surface layer is moderately alkaline loam about 5 inches thick. The underlying layer is moderately alkaline silt loam that reaches to a depth of 60 inches or more.

Stoneham - In a representative profile the surface layer is neutral sandy loam about 4 inches thick. The subsoil is mildly alkaline clay loam about 10 inches thick. The substratum is moderately alkaline or strongly alkaline clay loam and loam that reaches to a depth of 60 inches or more.

Zigweid - In a representative profile the surface layer is mildly alkaline loam about 6 inches thick. The subsoil is moderately alkaline loam about 14 inches thick. The substratum is moderately alkaline loam that reaches to a depth of 60 inches or more.

Soils that are described as being similar to those of the Absted and Petrie series are strongly alkaline clay or silty clay over very strongly alkaline clay with root zones of 40 inches to 60 inches or more in depth. Use as irrigated land is usually limited to grass pasture.

Hydrology

The water source for the project is Doyle Creek, a tributary of the Middle Fork of Crazy Woman.

Streamflow records for the Middle Fork of Crazy Woman near Greub and several miscellaneous discharge measurements of the flow on Doyle Creek were used to estimate the yield to the site. Water yield from Doyle Creek in an 80 percent chance year by month is estimated as follows:

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep
80% Chance Yield A.F.	380	130	120	100	95	130	410	960	1,300	1,060	435	365

Additional streamflow records were obtained for two years on the Middle Fork near Hazelton and on Doyle Creek. However, these records have not yet been used to update the above estimates.

The proposed reservoir will provide a full season supply 5 years out of 10 to an additional 3,000 acres along the Middle Fork. This would result in a total of 4,400 acres being assured of a full supply. The remaining 370 acres can be irrigated until about July 1.

Availability of water supply: A senior water storage permit held by industrial interests preempts a reliable water supply for the proposed reservoir.

Water needs: Water diversion damand by month is shown as follows in acre-feet per acre:

	May	June	July	Aug.	Sept.	Oct.
Diversion Demand AF/AC	.32	.63	.90	.72	.35	.11

The additional water depletion with the project is estimated to be 2,300 acre-feet annually.

The water is of good quality and suitable for irrigation.

Economics

Supplemental irrigation water supply provided by the project will result in economic benefits from increased crop yields and induced changes in the cropping pattern. Additional storage would assure the maintenance of a permanent pool of at least 265 acres for recreational use. Average annual primary benefits are estimated to be $72,000 from irrigation and $159,000 from recreational use. Secondary benefits are estimated to be $32,000 annually. The proposed project would have little effect on the flooding problem of the lower reaches of the watershed.

Average annual costs of the proposed project of $146,000 produce a benefit-cost ratio of 1.8 : 1.0. Table 1 shows the comparison of benefits and costs for structural measures. Cost allocation by purpose is shown in Table 2. Both tables are shown on the following page.

Table 1 - Comparison of Benefits and Costs
for Structural Measures
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Avg. Annual Cost 2/	Benefit Cost Ratio
	Recreation	Irrigation	Secondary	Total		
Combined Structural Measures	159,000	72,000	32,000	263,000	129,000	2.0:1.0
Project Administration					17,000	
TOTAL	159,000	72,000	32,000	263,000	146,000	1.8:1.0

1/ Price Base: Current Normalized
2/ Price Base: 1975

Table 2 - Cost Allocation
(Dollars)

	Purpose		Total
	Recreation	Irrigation	
Proposed Project	972,100	933,900	1,906,000*

* Does not include project administration.

DISPLAY OF ACCOUNTS

National Economic Development Account

Beneficial effects	
Irrigation	$ 72,000
Recreation	159,000
Externalities	32,000
Total beneficial effects (average annual value)	$263,000
Adverse effects	
Installation cost	$134,000
OM&R	12,000
Total annual cost	$146,000
Net beneficial effect	$117,000

Regional Development Account

Regional Development Account	Region	Adjacent Region	Rest of Nation
Beneficial effects			
User benefits			
Irrigation	$ 72,000	-0-	-0-
Recreation	159,000	-0-	-0-
Regional benefits			
Employment impact 1/	41,000	-0-	-0-
Induced and stemming from 2/	462,000	-0-	-0-
Externalities	32,000	-0-	-0-
Total beneficial effects (average annual value)	$766,000	-0-	-0-
Adverse effects			
Investment	$53,000 3/		$74,000
OM&R	12,000		-0-
Externalities 4/	7,000		-0-
Total adverse effect (average annual value)	$72,000		$74,000
Net beneficial effect	$694,000		-$74,000

1/ Amortized construction cost x .30 + OM&R
2/ Irrigation and recreation benefits x 2.0
3/ Sponsors share of amortized cost less land rights
4/ Land rights amortized @ 6 1/8% for 100 years

Social Well-Being Account

A. Income

1. Net ranch income would be increased about $30,000 annually.

2. Ranch income would be stabilized because of increased and more reliable crop production.

3. Community income would be increased an average of $600,000 annually because of increased employment and business generated by project installation and project output.

4. Community income would be stabilized by more dependable agricultural production.

B. Employment

1. Project installation, operation and maintenance will provide an average annual of 3 full time jobs.

2. Production of increased agricultural output will create about an additional 6 seasonal on-farm jobs.

3. Increased agricultural output will generate about an additional 3 full time jobs in the agribusiness industry of the region.

4. Producing the increased agricultural output of the project will more efficiently utilize the presently underemployed labor resources committed to ranches in the project area.

C. Life, Health, and Safety

1. Increased income would allow beneficiaries to more actively participate in social, cultural, recreational and community activities of the region.

2. Recreational opportunities of region residents will be enhanced through the formation of the permanent pool of 265 acres.

Environmental Quality Account

A. The reservoir will cover about one mile of live stream.

B. About 400 acres of mountain grazing land will be committed to a water storage use.

C. About 150 acres of barren ground will be exposed by the annual drawdown of the reservoir.

D. About 250 acres of flat water can be made available for fishing and recreation use.

Reconnaissance Study

SKULL CREEK

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming
December 1976

PREFACE

This reconnaissance report of Skull Creek is an update of a preliminary study of the BAIRD RESERVOIR FARM IRRIGATION RC&D MEASURE which was prepared by the Soil Conservation Service in May 1976.

The entire summary report of the preliminary RC&D measure study is presented in this report. No change was made in the proposed plan or in the estimated structural quantities, installation costs or average annual benefits as presented in the RC&D measure summary. The unit dollar values used in the RC&D measure study are considered to be the equivalent of current normalized prices for agricultural products and of 1975 costs.

An addendum to the RC&D measure summary was prepared to provide a project evaluation at the interest rate being used in the Yellowstone Basin and Adjacent Coal Area Study. The RC&D measure summary describes two alternate plans and two levels of irrigation water use. The alternative proposal that includes both irrigation and recreation as purposes and that which would provide a partial irrigation water supply to 960 acres was selected for economic reevaluation. The interest rate of 6-1/8 percent that was used in the reevaluation results in average annual costs that differ from those displayed in the tables of the RC&D measure summary. The effects of the project, as determined in the reevaluation, are displayed in the four accounts that make up the Addendum. The reevaluation, as displayed in the Addendum, results in a Benefit-Cost ratio of 1.3:1.

The amount of water to be used is not indicated in the report of May 1976. The estimated average annual depletion of water resulting from the project is 1,100 acre feet.

An RC&D measure plan is currently being prepared for the Baird Reservoir Farm Irrigation Measure.

CONTENTS

BAIRD RESERVOIR FARM IRRIGATION

RC&D Measure

May 1976

I PLANNING AREA AND RESOURCES

A. The Planning Area

The measure is located in Weston County about 11 miles northwest of Newcastle on Skull Creek. The measure area covers about 48,000 acres which includes about 47,000 acres above the existing reservoir (commonly known as the YT Reservoir) and about 1,000 acres below the reservoir.

Topography varies from slightly undulating to steep. On the average, there are 137 days between 32°F. freezes. The normal annual precipitation is 14.1 inches.

Rangeland which comprises 58% of the area and woodland which covers 32% of the area are used for grazing. Cropland totals about 3900 acres (9%) of which about 500 acres are irrigated.

There are no known historic, geologic, or archeological sites in the planning area.

Antelope, sage grouse, deer, and waterfowl can be found in the area. Deer use the low lying areas as winter habitat and migrate to the wooded areas during the summer. Skull Creek has been designated as a Class V fishery by the Wyoming Game and Fish Department.1/

B. Evaluation of Resource Capabilities

The major water related problem is an inadequate irrigation water supply during the summer and fall months. On the average, no water is available for irrigation after the last of May.

A preliminary evaluation of recreation needs for Weston County indicates a need for trout fishing water. It is anticipated that additional picnicking and camping facilities will be needed in the future.

Some erosion occurs on the rangeland and cropland; however, no critical erosion areas exist. Some short reaches of Skull Creek show signs of erosion resulting from spring runoff, but none are critical sediment producing areas.

1/ A Class V fishery has very low production - often incapable of sustaining a fishery. For more information see Wyoming Stream Fishery Classification by Wyoming Game and Fish Commission (1971).

Soils in the irrigable area are clay loam and loams. Water intake rates vary from moderate to low. Some soils in the area are underlain by shale and are moderately to strongly saline. Runoff is medium to rapid and the hazard of erosion is moderate to high.

There is potential to provide supplemental water for the existing cropland by storing excess spring runoff in an irrigation reservoir. Additional fishing could be provided with a multi-purpose reservoir.

II PLANNING OBJECTIVES AND ALTERNATIVES

A. Sponsor Objectives

The objective of the sponsors is to increase production on the cropland and more efficiently utilize the water resources of Skull Creek. The sponsors have a desire to improve irrigation water management, reduce flooding of meadows, and maintain or improve the overall economy of the operating units.

B. Alternative Planning Considerations

A single purpose irrigation water storage reservoir was the first consideration. The reservoir would store 2000 acre feet which is the yield expected from Skull Creek eight years out of ten. Storage capacities would then be 2000 acre feet for irrigation, 500 acre feet for sediment, and 500 acre feet for flood detention for a total capacity of 3000 acre feet. Two levels of use were evaluated. One to provide a full season supply to 660 acres and the other to provide a part season (through July) to 960 acres. A full season supply would provide three cuttings of hay each year and a part season supply would provide two cuttings of hay each year.

Associated treatment systems such as canal rehabilitation, diversion dam and headgate would be required. Land treatment practices needed on the upper watershed include seeding, brush management, woodland improvement, proper grazing management, stockwater ponds, terraces, and diversions. Land treatment practices will be included in conservation plans prepared by the Beaver Skull Conservation District.

Storing water for recreation was also considered. A pool area of 150 acres is required to store water a minimum of ten feet deep. This would provide about 5250 visitor days annually for trout fishing and boating. A gravel access road and other necessary facilities would be provided. Filling the recreation pool would require a reservoir operation plan where a portion of the irrigation water would be stored in the recreation pool each year until it is full.

III INSTALLATION COSTS

A. Single Purpose Irrigation

Total costs are estimated to be $619,000, including $540,500 for installation of structural works and $78,500 for land treatment practices.

Land treatment costs include $73,500 for practices on the upper watershed and $5,000 for technical assistance. Technical assistance will be for new conservation plans, conservation plan revision, and assistance needed in installing land treatment practices.

The total installation cost estimate of $540,500 includes $403,500 for construction, $34,000 for associated treatment systems, $32,500 for engineering services, $15,000 for construction inspection, $17,000 for project administration, $37,500 for land rights, and $1,000 for water rights. See Table 1 for cost sharing.

B. Multi-Purpose Irrigation & Recreation

Total costs are estimated to be $883,400, including $804,900 for installation of structural works and $78,500 for land treatment measures.

Land treatment costs include $73,500 for practices on the upper watershed and $5,000 for technical assistance. Technical assistance will be for new conservation plans, conservation plan revision, and assistance needed in installing land treatment practices.

The total installation cost estimate of $804,900 includes $597,000 for construction, $34,000 for associated treatment systems, $57,500 for engineering services, $40,000 for construction inspection, $30,400 for project administration, $45,000 for land rights and $1,000 for water rights. See Table 2 for cost sharing.

IV OPERATION AND MAINTENANCE

The sponsors will be responsible for operation and maintenance of the structural works. An operation and maintenance agreement will be entered into between the sponsors and the Soil Conservation Service prior to signing a project agreement. The estimated annual operation and maintenance cost for a single purpose irrigation reservoir is $5,000, and for a multipurpose irrigation and recreation reservoir is $8,000.

TABLE 1

Cost Sharing and Economic Feasibility
(Irrigation)

Item	RC&D Share	Local Share	Total
Land Treatment	$ 5,000	$ 73,500	$ 78,500
Construction	$201,750	$201,750	$403,500
Associated Treatment Systems	17,000	17,000	34,000
Engineering Services	32,500	-0-	32,500
Construction Inspection	15,000	-0-	15,000
Project Administration	12,000	5,000	17,000
Land Rights	-0-	37,500	37,500
Water Rights	-0-	1,000	1,000
Total Installation Cost	$278,250	$262,250	$540,500
TOTAL COST	$283,250	$335,750	$619,000

COST:

Installation cost amortized @ 6 3/8% interest for 100 years	$34,500
Average Annual Operation, Maintenance and Replacement	5,000
Total Average Annual Cost	$39,500
Average Annual Cost per Acre irrigated - $41.00	

BENEFITS:

Irrigation (960 acres - part supply)		$46,900
Secondary		7,100
Total		$54,000
Less average annual cost		39,500
Net Benefits		$14,500
Benefit - Cost ratio	1.36:1	
Irrigation (660 acres - full supply)		$34,200
Secondary		5,100
Total		$39,300
Less average annual cost		39,500
Net Benefits (Loss)		($ 200)
Benefit - Cost ratio	0.95:1	

TABLE 2

Cost Sharing and Economic Feasibility
(Irrigation & Recreation)

Item	RC&D Share	Local Share	Total
Land Treatment	$5,000	$73,500	$78,500
Construction	$298,500	$298,500	$597,000
Associated Treatment Systems	17,000	17,000	34,000
Engineering Services	37,500	20,000	57,500
Construction Inspection	27,500	12,500	40,000
Project Administration	21,400	9,000	30,400
Land Rights	4,800	40,200	45,000
Water Rights	-0-	1,000	1,000
Total Installation Cost	$406,700	$398,200	$804,900
TOTAL COST	$411,700	$471,700	$883,400

COST:

Installation cost amortized @ 6 3/8% interest for 100 years	$51,400
Average Annual Operation, Maintenance and Replacement	8,000
Total Average Annual Cost	$59,400
Average Annual Cost per Acre irrigated - $62.00	

BENEFITS:

Irrigation (960 acres - part supply)	$46,900
Recreation @ $4.00/visitor day	21,000
Secondary	9,200
Total	$77,100
Less average annual cost	$59,400
Net Benefits	$17,700

Benefit - Cost ratio 1.5:1

Social Well-Being Account

A. Income

1. Net income on two ranches would increase by about $34,000 annually.

2. Ranch income would be stabilized because of increased and more reliable crop production.

3. Community income would be increased an average of $200,000 annually because of increased employment and business generated by project installation and project output.

4. Community income would be stabilized by more dependable agricultural production.

B. Employment

1. Project installation, operation and maintenance will provide an average annual of two full time jobs.

2. Production of increased agricultural output will create about an additional four seasonal on-farm jobs.

3. Increased agricultural output will generate about an additional three full time jobs in the agri-business industry of the region.

C. Life, health, and safety

1. Increased income would allow beneficiaries to more actively participate in social, cultural, recreational, and community activities of the region.

2. Area users would benefit from increased recreational opportunities provided at Baird Reservoir.

Environmental Quality Account

A. The land use of about 440 acres will be changed from non-irrigated rangeland to irrigated hayland.

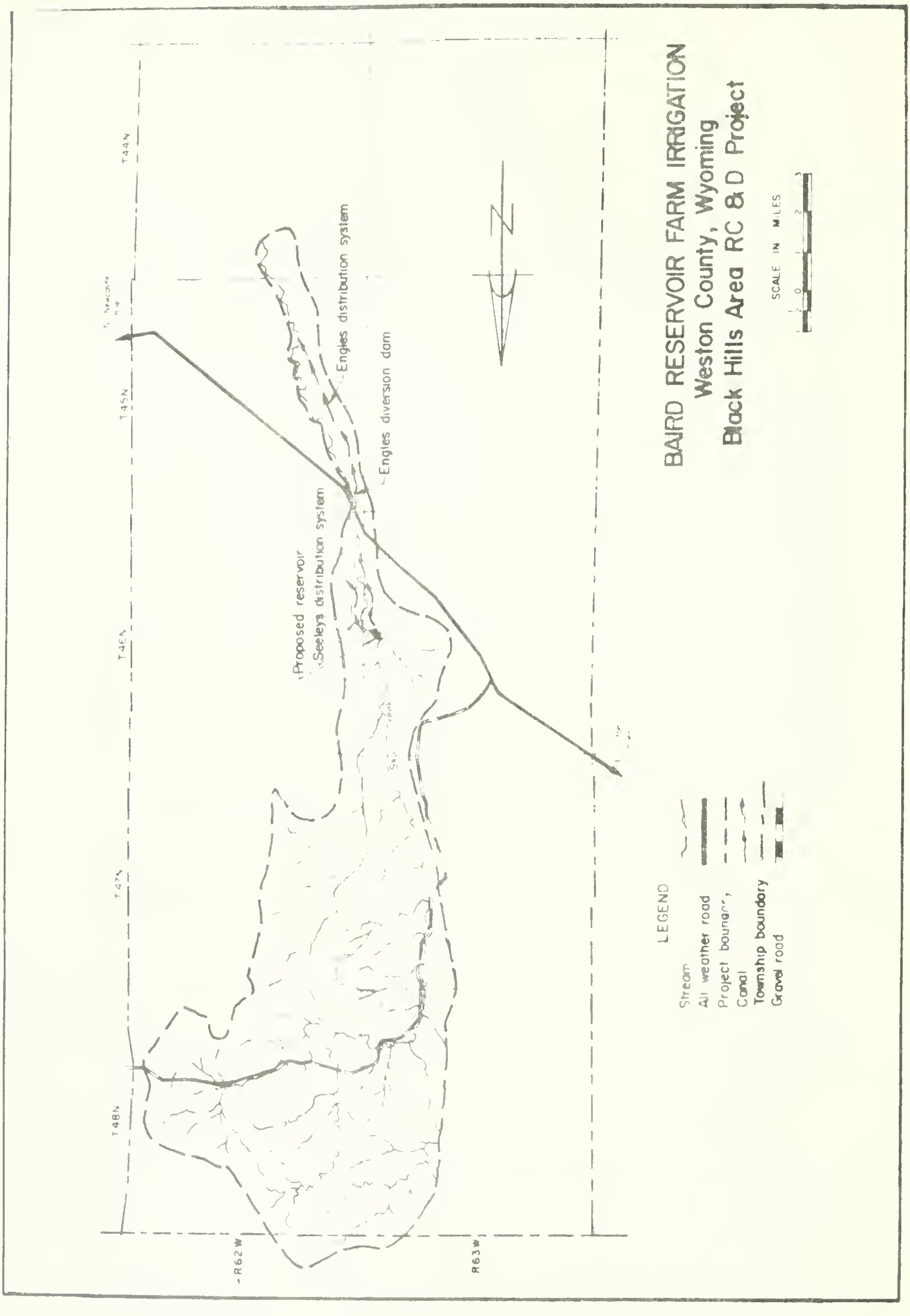
B. About 200 acres of non-irrigated rangeland will be committed to reservoir and recreation use.

C. Concentrations of soluble salts will be higher in the irrigation return flow than in natural flood flow.

TABLE 3

STRUCTURAL DATA

	Unit	Single Purpose Reservoir	Multi-Purpose Reservoir
Height of Dam	ft.	45	50
Capacities			
Sediment	ac. ft.	500	500
Irrigation	ac. ft.	2000	2000
Recreation	ac. ft.	-0-	1500
Flood Detentions	ac. ft.	500	500
Surface Area			
Sediment	ac.	70	70
Recreation	ac.	-0-	150
Irrigation	ac.	200	250
Flood Detention	ac.	250	285


BAIRD RESERVOIR FARM IRRIGATION
Weston County, Wyoming
Black Hills Area RC & D Project
SCALE IN MILES
LEGEND
Stream
All weather road
Township boundary
Gravel road
Canal
T44N
T45N
T46N
T47N
T48N
R62W
R63W
Engles distribution system
Engles diversion dam
Proposed reservoir
Seeleys distribution system

ADDENDUM

Adverse effects and net beneficial effects were computed for this addendum using an interest rate of 6 1/8% rather than the 6 3/8% used in the original May 1976 report. The effects shown in these displays therefore do not equal the net benefits and cost figures shown in Table 2 of the report.

DISPLAY OF ACCOUNTS

National Economic Development Account

Beneficial effects	
Irrigation	$46,900
Recreation	21,000
Externalities	9,200
Total beneficial effects (annual equivalent value)	$77,100
Adverse effects	
Installation cost	$49,400
OM&R	8,000
Total annual cost	$57,400
Net beneficial effects	$19,700

Regional Development Account	Region	Adjacent Region	Rest of Nation
Beneficial effects			
User benefits			
Irrigation	$ 46,900	0	0
Recreation	21,000	0	0
Regional benefits			
Employment impact 1/	19,000	0	0
Induced and stemming from 2/	135,800	0	0
Externalities	9,200	0	0
Total beneficial effects (annual equivalent value)	$231,900	0	0
Adverse effects			
Investment	$ 22,000 3/	0	$25,000
OM&R	8,000	0	0
Externalities 4/	2,500	0	0
Total adverse effects (annual equivalent value)	$ 32,500	0	$25,000
Net beneficial effects	$199,400		-$25,000

1/ Amortized construction cost x .30 + O&M.
2/ Primary benefits x 2.0.
3/ Sponsor's share of amortized cost less land rights.
4/ Land rights amortized @ 6-1/8% for 100 years.

Reconnaissance Study

SOUTH TONGUE RIVER

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming
November 1976

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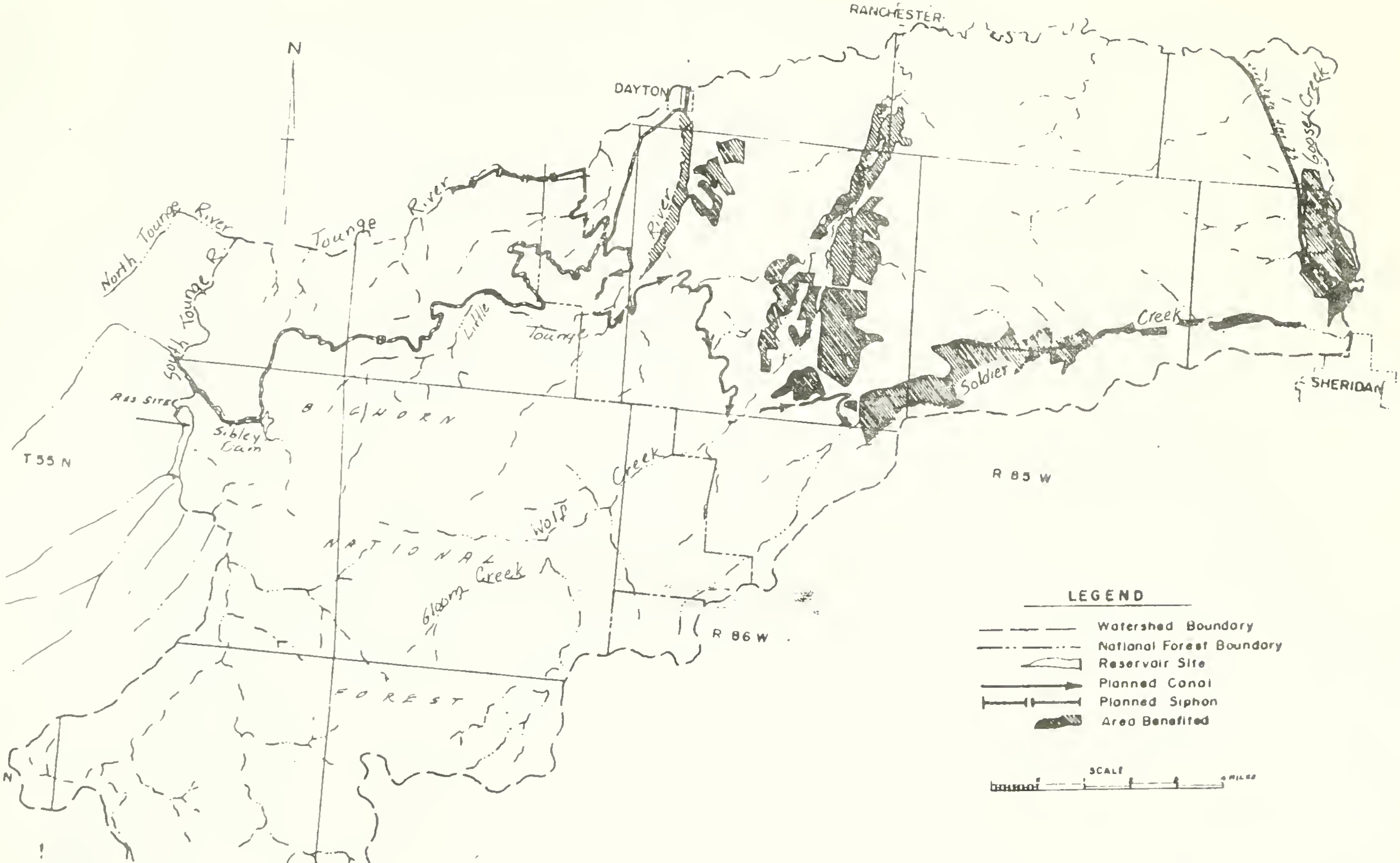

SOUTH TONGUE RIVER WATERSHED
Sheridan County, Wyoming

SOUTH TONGUE RIVER

SUMMARY

The project is planned to provide supplemental water to about 9,200 acres of irrigated land along the Little Tongue River, Wolf Creek and Soldier Creek in the area north and west of Sheridan, Wyoming. These acres are currently irrigated with water from direct diversion of the flows in the nearby streams and have a water shortage in the latter part of each irrigation season. The supplemental water will come from direct diversion from the Tongue River and from storage to be provided on the South Tongue River. The irrigated acres are to have a full season supply an average of 7 years out of 10. A supplemental supply of nearly 16,000 acre-feet is needed to provide a full season supply in the year of 70 percent chance yield. Storage will provide 8,000 acre-feet each year and the balance to meet the need 7 years in 10 will come from direct diversion.

The increased water depletion is estimated to be about 7,000 acre-feet per year.

The structural proposal is for a storage dam about 5 miles above the confluence of the South Tongue and North Tongue Rivers; a diversion from the Tongue River at a point about 5 miles below the confluence of South Tongue and North Tongue Rivers; an inverted siphon through Tongue Canyon to the mouth of the canyon; and a canal from the Tongue River to Soldier Creek.

The dam site and diversion location are within the Bighorn National Forest. Special use permits will be needed for these structures.

Average annual costs of the installation, operation and maintenance of the proposed structural measures are $343,000. Average annual primary and secondary benefits from irrigation are estimated to be $356,980. The benefit cost ratio of 1.04:1.0 indicates economic feasibility of the project.

The volume of water proposed for storage in reservoirs that have permits or pending applications already exceeds the apparent volume of water that will be available from the Tongue River drainage. The Tongue River may not supply all of the proposed water uses. Availability of water for the South Tongue River project will depend on priorities set for the use of the available water.

LOCATION AND DESCRIPTION

The South Tongue River Watershed is located in Sheridan County, Wyoming. The watershed includes the Little Tongue River, Wolf Creek, Soldier Creek and part of the South Tongue River. These streams drain a portion of the east slope of the Bighorn Mountains. The maximum elevation of the drainages is about 10,000 feet. The upper part of the watershed is within the Bighorn National Forest and is an area of high recreation use.

The lower half of the watershed is used primarily for livestock production and the irrigation of hayland is essential to ranching operations. The lower area includes about 16,000 acres of irrigated land, 700 acres of dry cropland and about 70,000 acres of range.

The irrigated land lies at an elevation of 4,000 to 5,000 feet and is used primarily to produce feed for livestock.

PROBLEMS AND NEEDS

Agricultural Water Management

A water shortage occurs on lands that are irrigated with water from the smaller streams within the watershed. Irrigation water is supplied by direct diversion of the natural stream flows of Little Tongue River, Wolf Creek and Soldier Creek and by some water imported from Goose Creek. Runoff, most of which is the result of snowmelt that occurs in May and June, is adequate to meet irrigation needs until the end of June. A water shortage normally begins in early July and extends through the irrigation season. Irrigated acres within the watershed for which a supplemental water supply is needed are, by subbasin: Little Tongue River, 819 acres; Wolf Creek, 3,095 acres; Soldier Creek, 4,006 acres; Goose Creek, about 1,280 acres; for a total of 9,200 acres. Additional irrigated land lying along the Tongue River is supplied by direct diversion from the Tongue River. This land is considered to have a full season supply under present conditions.

Flooding

Occasional flooding has occurred in the communities of Dayton and Ranchester along the Tongue River. The Downer addition to the City of Sheridan has a flood problem caused by Soldier Creek. Limited flooding of meadowland occurs on all of the streams.

PROJECT PROPOSAL

The proposed project is planned to provide a supplemental supply of water to the 9,200 acres of irrigated land that are identified as having a late season water shortage.

The source of the supplemental supply is the Tongue River. The Tongue River was selected because of its dependable water yield and because suitable sites are not available to store the spring flows of those streams that provide the original supply. Storage on the South Tongue River will be developed to provide a part of the late season water needs.

The structural proposal is for the storage of water on the South Tongue River at Shutts Flats, about 5 miles upstream from the confluence of the South Tongue and North Tongue Rivers; diversion of water from the Tongue River near Sheep Creek into an inverted siphon which will extend down Tongue Canyon to the mouth of the canyon; and a canal from Tongue River to Soldier Creek. The supplemental water will be delivered to the streams and canals serving the irrigated area.

The storage site and part of the siphon location are within the Bighorn National Forest. Special use permits will be required for these structures on public land.

To meet recommendations providing for fish and recreation, the reservoir is planned to provide a permanent pool of about 2,000 acre-feet.

The large volume of water that accompanies the snowmelt precludes storage for flood prevention. Therefore, flood control is not included in the proposed project. A separate program of local protection may be appropriate for flood control at specific locations.

Engineering

The structural works consist of a dam on the South Tongue River at Shutts Flats, an inverted siphon in Tongue Canyon and a canal from the Tongue River to Soldier Creek.

The damsite is about one mile upstream from U. S. Highway 14. An earth dam about 100 feet high will form a reservoir of 8,000 acre-foot capacity for irrigation water. The storage pool, when full, will have a surface area of about 235 acres. A permanent fish and recreation pool will have a surface area of about 127 acres and contain about 2,000 acre-feet above a 300 acre-foot sediment pool. Irrigation water will be released, as needed, into the South Tongue River to be carried in the natural channels to the diversion structure downstream. Structure data for the dam is shown in Table 1.

The inverted siphon will begin at a diversion from the Tongue River near Sheep Creek in Section 8, T56N, R87W, and extend down Tongue Canyon for a distance of about 20,000 feet to an outlet on the south bank of the Tongue River at the mouth of the canyon. The siphon will be exposed except at the inlet and ~~and~~ at the existing campgrounds. The capacity of the siphon will be 125 c.f.s. Maximum static head will be 685 feet.

The canal will extend south and east from the siphon outlet to Soldier Creek. Maximum canal capacity will be 125 c.f.s. Canal structures will provide for exchange of water at Little Tongue River and at Wolf Creek. About 70 crossing structures will serve existing roads, ranch access and as crossings for equipment and livestock. The canal location is approximately at the location of the frequently proposed Sheridan Canal.

Structure data for the siphon and canal are shown in Table 2.

The estimated installation cost of structural measures is shown in Table 3. Estimated average annual operation and maintenance cost is $8,400 for the dam, $19,400 for the siphon and $6,200 for the canal. Estimated annual cost of structural measures is shown in Table 4.

The planned structural works will deliver water from the Tongue River to existing canals and farm irrigation systems. Rehabilitation of existing works, land treatment and improved water management are part of the on-farm work to be done to effectively use the supplemental water supply. The present methods of surface application of water will continue in use.

Soils

The predominant soils under irrigation are deep, slowly permeable to moderately permeable soils with high available water holding capacities (over 9 inches in the 5 foot root zone). Identified soil series are Haverson, Kim and Wyarno.

The Haverson soils are deep and have medium to moderately fine textured surface horizons and substratums. They are calcareous to the surface. The Kim soils are moderately permeable, deep, and have medium to moderately fine textured surface horizons and substratums. They are calcareous to the surface.

The Wyarno soils are deep, slowly permeable and have fine textured surface, subsurface horizons and substratums. They are decalcified to depths of 6 to 8 inches.

Also included are unnamed soils that are described as deep, slowly permeable soils that have fine textured surface horizons and substratums. They are calcareous to the surface.

Hydrology

Flow History - The estimated annual yield of the Tongue River and of the tributaries within the watershed for a 70 percent chance of occurrence is tabulated below.

Stream Flow - 70 Percent Chance - In Acre-Feet

Month	Little Tongue near Dayton (Gaging Station)	Wolf Creek at Wolf (Gaging Station)	Soldier Creek (at base of mountains)	South Tongue River (Below reservoir site)	Tongue River Near Dayton (Above diversions)	Tongue River Near Acme (Gaging Station)
October	120	455	88	1,372	4,600	10,000
November	101	350	75	1,029	3,450	9,000
December	88	298	61	882	3,220	8,000
January	82	245	52	784	2,875	7,000
February	76	210	61	637	2,530	7,000
March	88	245	170	686	2,645	11,000
April	246	682	1,251	1,568	5,520	17,000
May	2,035	5,005	1,671	12,789	27,945	62,000
June	2,589	6,685	525	19,208	35,880	81,000
July	624	2,100	175	6,027	14,030	21,000
August	145	700	131	2,352	7,015	6,000
September	106	525	114	1,666	5,175	8,000
Annual	6,300	17,500	4,374	49,000	115,000	247,000

Water Demand and Dependability - The available water supply under present conditions is the natural streamflow of Little Tongue River, Wolf Creek and Soldier Creek, and the water imported into the watershed from Goose Creek. No measurement has been made of the volume of water imported. The supply from Goose Creek is estimated. The table below shows estimated dependable supply for a year of 70 percent chance, average gross irrigation demand, and corresponding shortage for the watershed.

Estimated Water Shortage - Acre-Feet

Month	Demand	Supply	Shortage
April	40	2,180	
May	3,410	9,630	
June	6,420	11,500	
July	10,290	4,000	6,290
August	8,110	1,470	6,640
September	3,800	1,100	2,700
October	1,040	910	130
TOTAL	33,110		15,760

The demand, as shown in the above table, was computed for 9,200 acres with an overall project efficiency of 45 percent. A supplemental supply of about 15,760 acre-feet will provide a full season supply in a year of 70 percent chance yield. A minimum diversion capacity of 110 c.f.s. would be needed to supply the estimated monthly shortage of 6,640 acre-feet. It does not appear that the diversion for supplemental water should be planned to satisfy the occasional peak use rate which approaches 220 c.f.s. gross. A capacity of 125 c.f.s. is recommended.

The estimated increase in water depletion with project is 7,000 acre-feet per year.

The streamflow at the proposed reservoir site is adequate to fill the 8,000 acre-foot reservoir in May or June. The natural streamflow of the Tongue River will need to supply the balance of the supplemental needs. The flow in the Tongue River is adequate to meet the needs.

Availability of Water - The use of water in the Tongue River drainage is controlled by the Yellowstone River Compact. The Wyoming share of the average unused and unappropriated water in the Tongue River was estimated by the Wyoming Water Planning Program in April, 1972, to be about 96,000 acre-feet per year. It therefore appears that the yield of the South Tongue and Tongue River may be adequate for the proposed project.

Major potential reservoirs identified from the Wyoming State Engineer's records in March of 1972 as having permits or pending applications have a total planned capacity of more than 360,000 acre-feet. With almost any interpretation of the interstate compact or any assumptions regarding water rights in Montana, Wyoming or the Northern Cheyenne Indian Reservation, it is apparent that the Tongue River drainage cannot supply water for all of the proposed water uses.

Availability of water for this proposal will depend on the priorities established for the use of Tongue River water.

Economics

The proposed project appears economically feasible with a benefit-cost ratio of 1.04:1.0. Average annual primary benefits from irrigation are estimated to be $316,380 with secondary benefits totalling $40,600. Average annual costs are estimated to be $343,000. Benefits and costs are shown in tabular form on page 11.

Project installation is not expected to change the cropping pattern. Increased yields made possible by supplemental water supply will increase net income per acre by $28.15 on Solider Creek, $16.98 on Little Tongue River, and $30.17 on Wolf Creek. A total of 9,200 acres are affected by the project. The irrigated lands produce livestock support crops of alfalfa, barley and tame pasture.

The proposed project includes a permanent recreation pool of 2,000 acre-feet. Benefits were not evaluated for recreation or fish and wildlife enhancement. The possibility of such benefits should be investigated if the project is pursued in the future.

TABLE 1 - STRUCTURAL DATA

DAM

Drainage Area (Sq. Mi.)	70	
Elevation Permanent Pool (MSL)	7,779	
Elevation Irrigation Pool (MSL)	7,822	
Maximum Height of Dam (Ft.)	100	
Volume of Fill (Cu. Yd.)	350,000	
Capacity		
Sediment (Ac. Ft.)	300	(0.08)*
Fish and Recreation (Ac. Ft.)	2,000	
Irrigation (Ac. Ft.)	8,000	(2.10)*
Total (Ac. Ft.)	10,300	
Surface Area		
Fish and Recreation Pool (Acres)	127	
Irrigation Pool (Acres)	235	

* Capacity Equivalents in inches over watershed

TABLE 2 - STRUCTURAL DATA

SIPHON AND CANAL

Designation	Length of Reach (Feet)	Capacity (c.f.s.)	Slope	Canal Dimensions		Velocity		Excavation (Cu.Yd.)
				Width (Ft.)	Depth (Ft.)	As Constructed (fps)	Aged (fps)	
Siphon	20,000	125		(48"	Diam.)	(10)		
Canal To Little Tongue River	35,000	125	.001	12	3.2	2.9	2.3	156,000
To Wolf Creek	60,000	115	.001	12	3.1	2.9	2.2	259,000
To Soldier Creek	22,000	100	.001	10	3.1	2.8	2.1	60,000

TABLE 3 - ESTIMATED PROJECT INSTALLATION COST

COST ITEM	UNIT	AMOUNT PLANNED	ESTIMATED COST DOLLARS 1/	
Construction				
Dam	Each	1.	1,141,000	
Siphon	Mile	3.7	1,925,000	
Canal	Mile	22.	473,000	
Subtotal Construction				3,539,000
Engineering Services				350,000
Land Easements & R/W				
Crossing Structures			130,000	
Canal Land Easements			68,000	
Subtotal Land Easements & R/W				198,000
Project Administration				700,000
TOTAL STRUCTURAL MEASURES				4,787,000

1/ Base Price 1975

TABLE 4 - ANNUAL COST

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Dam, Siphon and Canal	264,000	34,000	298,000
Project Administration	45,000		45,000
GRAND TOTAL	309,000	34,000	343,000

1/ Price Base 1975

2/ 50 years @ 6 1/8 percent interest

TABLE 5 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/		Total	Avg. Annual Cost 2/	Benefit-Cost Ratio
	Irrigation	Secondary			
Dam, Siphon and Canal	316,380	40,600	356,980	298,000	1.2:1.0
Project Administration				45,000	
GRAND TOTAL	316,380	40,600	356,980	343,000	1.04:1.0

1/ Price Base Current Normalized

2/ Price Base: 1975

DISPLAY OF ACCOUNTS

National Economic Development Account:

Beneficial effects	
Irrigation	$316,400
Externalities	40,600
Total beneficial effects (average annual value)	$357,000
Adverse effects	
Installation cost	$309,000
OM&R	34,000
Total annual cost	$343,000
Net beneficial effect	$ 14,000

Regional Development Account:

	Region	Adjacent Region	Rest of Nation
Beneficial effects			
User benefits			
Irrigation	$316,400	0	0
Regional benefits			
Employment impact 1/	105,000	0	0
Induced and stemming from 2/	632,800	0	0
Externalities	40,600	0	0
Total beneficial effects (average annual value)	$1,094,800	0	0
Adverse Effects			
Investment	$114,200 3/	0	$182,000
O&MR	34,000	0	0
Externalities 4/	12,800	0	0
Total adverse effects (average annual value)	$161,000	0	$182,000
Net beneficial effect	$933,800		-$182,000

1/ Amortized construction cost X .30 + OM&R
2/ Irrigation benefits X 2.0
3/ Sponsor's share of amortized cost less land rights
4/ Land rights cost amortized @ 6 1/8% interest for 50 years.

Social Well-Being Account:

A. Income

1. Net ranch income would be increased about $200,000 annually.

2. Ranch income would be stabilized because of increased and more reliable crop production.

3. Community income would be increased an average of $940,000 annually because of increased employment and business generated by project installation and project output.

4. Community income would be stabilized by more dependable agricultural production.

B. Employment

1. Project installation, operation and maintenance will provide an average annual of 8 full time jobs.

2. Production of increased agricultural output will create about an additional 26 seasonal on-farm jobs.

3. Increased agricultural output will generate about an additional 14 full time jobs in the agribusiness industry of the region.

4. Producing the increased agricultural output of the project will more efficiently utilize the presently underemployed labor resources committed to ranches in the project area.

C. Life, Health and Safety

1. Increased income would allow beneficiaries to more actively participate in social, cultural, recreational and community activities of the region.

2. Increased agricultural production during the last half of the growing season would reduce the fire hazards because of the larger amount of lush vegetation.

3. The impoundment of water would provide increased recreational opportunities to users.

Environmental Quality Account:

A. The reservoir will inundate about one mile of fishing stream.

B. The reservoir will inundate about 230 acres of wildlife area or potential camping area.

C. A barren area of about 110 acres will be exposed by the annual reservoir drawdown.

D. Streamflow rates between the reservoir and the diversion structure will be decreased during periods of peak flow and increased during seasons of low flow.

E. The 2,000 acre-foot permanent pool will have about 120 acres of flatwater available for fishing and recreation use.

F. A 48-inch diameter pipe will be exposed in Tongue Canyon for about 2 miles or more.

ARCH CREEK

SUMMARY

The drainage area of Arch Creek was included in a PL 566 watershed application in 1963, and as a result of a watershed screening for the Yellowstone Level B Study, it was listed in the Soil Conservation Service issue paper as a potential project.

Watershed problems were identified in a reconnaissance study conducted for the Level B. Also used in this evaluation was information developed during a preliminary investigation conducted by the Soil Conservation Service in 1968. An economically feasible structural solution to these problems has not been identified. This report contains the findings of the reconnaissance study team.

SETTING

Arch Creek is a tributary of the Belle Fourche River and drains part of Crook and Weston Counties. The creek enters the river about four miles downstream from Keyhole Reservoir and about 16 miles upstream from Devils Tower National Monument. The drainage area is about 90 square miles.

Soil in the watershed is fine textured and of high runoff producing characteristics. Much of the area is soft shale of shallow depth, low permeability, and with sparse vegetative cover. Land cover and use is largely native range (an estimated 6% of the land is cropped).

Average annual percipitation is about 15 inches, 70 percent of which occurs in the period April through September. Summer rain of short duration and high intensity occur over small areas within the watershed.

PROBLEMS

Floodwater damage along the lower end of Arch Creek was identified early as a problem. There is some damage throughout the watershed to fences, roads, bridges, and channels. Floodwater from Arch Creek contributes to some extent to the flood damage and sediment damage that occurs within the Belle Fourche River Valley below the watershed.

One of the damages from floodwater is that caused by the suspended solids carried into the Belle Fourche River. About 4,000 acres may be irrigated in Wyoming below Keyhole Reservoir with water directed or pumped from the Belle Fourche River. Relatively clean water is released from the reservoir for irrigation, but irrigation is interrupted when silt laden floodwater from tributaries below the reservoir enter the Belle Fourche River. Muddy water is bypassed to protect pumps and distribution systems. The interruption in water service results in loss of crop production, and cleaning of equipment after floods results in added cost and additional delay in water delivery.

A renewed interest in an Arch Creek project results largely from the sediment problems at the mouth of the creek and in the Belle Fourche River.

There is a need for some supplemental water supply for the few irrigated acres in the watershed. Land in the Belle Fourche River bottom can use water from Keyhole Reservoir.

SOLUTIONS

A reservoir site that would serve largely as a sediment trap was identified in the 1968 preliminary investigation. The site is located about five miles above the mouth of the creek. No project structural work was identified to protect the upper reaches of the stream. The preliminary investigation suggested a capacity of 26,000 acre-feet for floodwater and 1,000 acre-feet for sediment. An estimate of water yield indicates that about 500 acre-feet of water may be added as dependable supply for irrigating land along the lower end of Arch Creek and at the mouth of the creek.

The 1968 estimated structural cost was updated to current costs for this report.

Floodwater damage and damage reduction was based on the findings of the 1968 investigation. Sediment damage reduction was estimated considering that Arch Creek is one of many tributaries to the Belle Fourche River that contribute to the sediment problems.

Arch Creek is recognized as having a relatively high sediment yield. It is one of about three major tributaries draining the relatively open area below Keyhole Reservoir and above Devils Tower National Monument. The drainage area controlled by the proposed reservoir is about 85 square miles. This area is about 13 percent of the total area draining into the Belle Fourche River between Keyhole Reservoir and Devils Tower National Monument, and about 7 percent of the drainage area of the Belle Fourche River between Keyhole Reservoir and the South Dakota State line; a distance of about 80 valley miles.

ECONOMIC EFFECTS

The estimated average annual cost of the project is in excess of $30,000. Benefits are derived from two sources:

a. Reduced damages from floodwater and sediment, and
b. Supplemental irrigation water supply

The benefit: cost ratio is 0.5:1.0.

CLEAR CREEK, ROCK CREEK, PINEY CREEK

Each of these creeks were identified in the watershed screening process for the Yellowstone Basin and Adjacent Coal Area Level B Study as potential projects for canal rehabilitation.

The subject was reviewed at Buffalo in June, 1976 by Soil Conservation Service personnel from the Field Office and the Water Resources Planning Staff.

These project proposals would be rehabilitation of systems. Replacement of structures, consolidation, lining, pipe and controls are all needed. Storage is desirable on Clear Creek for the area around Buffalo; there have been a number of proposals for such storage.

With the current construction work on Piney Creek, Clear Creek and Lake DeSmet; industrial water demand; and the uncertainty of industrial development, it is unlikely that the area is ready to approach the irrigation canal improvement on a project basis. Maintenance and replacement in the systems is expected to continue on a piecemeal basis as needed. None of the tributaries in the area will be evaluated for the Yellowstone Level B Study.

July 1976

Reconnaissance Study

GOOSE CREEK

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming
November 1976

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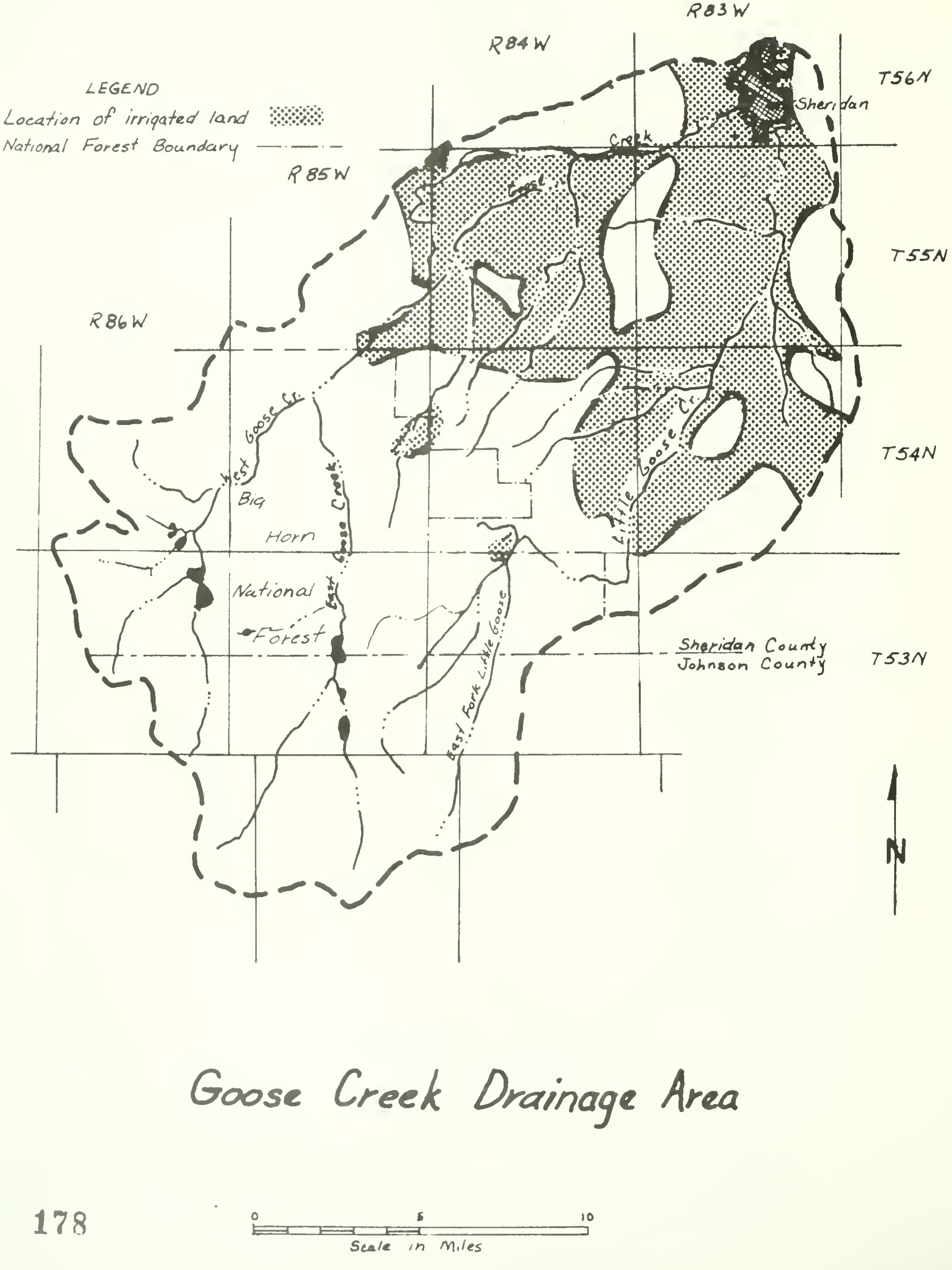

Goose Creek Drainage Area

GOOSE CREEK

SUMMARY

The irrigated land in the area of Goose Creek in Sheridan County has a late season water shortage. There is a need for about 16,000 acre-feet per year of supplemental water to serve an area of about 10,000 acres. The irrigated land would be productive when irrigated with a full season water supply. The increased crop production is needed to support the ranching operations in the area. Development of a supplemental water supply may result in a water depletion of about 7,000 acre-feet per year.

A number of proposals for structural works that would supply the water needs have been presented. To date none of the proposals have been accepted by all who were involved. Earlier plans may have been economically feasible, but they did involve high costs and problems of land rights.

Although there is no current structural plan to develop a water supply for the water-short area, the area and the irrigation water supply problem are described here because the need for water still exists and there is still interest in developing a supplemental water supply; water currently flows in Goose Creek and in nearby streams in sufficient quantity to meet the irrigation needs; and future development to meet at least part of the need may occur through project action or through action of the individuals or small groups of irrigators.

DESCRIPTION

Irrigated Area

The irrigated area lies along the tributaries of Goose Creek and extends downstream to the City of Sheridan. The elevation is about 4,000 feet. Average annual precipitation is about 15 inches; the average frost-free (28°F.) period is about 150 days. Crop production is largely feed for livestock. The annual net irrigation requirement is about 1.5 feet.

The irrigated land includes soils of the Ulm and Wyarno series, which are deep, fine textured, slowly permeable soils with high water holding capacity; Fort Collins soils, which are deep, moderately fine textured and moderately permeable with high water holding capacity; Haverson soils, which are deep, medium to moderately fine textured and moderately permeable soils with high water holding capacity; and Bankard soils, which are deep, excessively drained, coarse textured and rapidly permeable with low water holding capacity.

About 29,000 acres are irrigated by direct diversions from the Goose Creek tributaries and with supplemental supplies that are stored in the mountains.

Water Source Area

The Goose Creek drainage rises in the Bighorn Mountains at elevations of nearly 12,000 feet. The drainage area above the irrigated land is about 220 square miles. In the mountain area there are nine storage reservoirs with a combined capacity of about 19,000 acre-feet that are used for irrigation water storage for land in the Goose Creek drainage.

PROBLEMS

A late season water shortage occurs on about 10,000 acres of the irrigated land in the Goose Creek drainage. The land is irrigated to produce feed for livestock. The additional feed that could be produced with full season irrigation is needed to support the ranching enterprise in the area.

An annual net irrigation of 17 or 18 inches is needed for the crops grown. The shortage which begins in July is estimated to be about 8 inches, net. Direct flows are not available in Goose Creek or in neighboring streams to supply the need. A stored volume of about 17,000 acre-feet may be required to provide the supplemental water at the irrigated area.

The existing storage reservoirs on the tributaries of Goose Creek utilize, as far as can be determined, the available economically feasible storage sites in the higher mountain plateau. This area is in the Bighorn National Forest.

Storage sites below the mountains will probably be limited in size and more suitable for development by individual irrigators.

WATER SUPPLY

The average annual flow of Goose Creek below Sheridan is about 130,000 acre-feet. Of the discharge, more than 55,000 acre-feet is the flood flow that occurs in May and June. Storage of a part of this flood flow would supply the supplemental water needed on the irrigated land on Goose Creek.

The Tongue River below Tongue Canyon also discharges more than 100,000 acre-feet in an average year. With annual storage, the Tongue River flows are also adequate to meet the needs for supplemental water on Goose Creek.

Potential reservoirs on the Tongue River in Wyoming have permits or pending applications to store the unappropriated and unused water in the Tongue River. If water is used as appropriated in the lower Tongue River, there may be no water available to store for the land along Goose Creek.

EARLY PLANS

A plan for developing irrigation in the Tongue River basin was proposed by the Bureau of Reclamation and modified and revised in other studies. The basic plan was to store water on the Tongue River at one or more of several named reservoir sites and direct Tongue River water to various tributaries of the Tongue River. The Goose Creek area was included in the plan. The South Tongue River proposal, studied for the Total Water Management Program, is a variation of the same general plan. Applications for permits to store were filed for some of the proposed sites. All proposed storage sites were in the Bighorn National Forest.

INYAN KARA CREEK

Inyan Kara Creek, in Crook and Weston Counties, is a tributary of the Belle Fourche River. The area was covered in a PL 566 watershed application in 1963. It was listed in the Soil Conservation Service issue paper in April, 1976, as a potential project to be investigated for the Yellowstone Level B Study.

Water related problems include some flood damage on the lower watershed and a late season water shortage for the irrigated land on Inyan Kara Creek and on the smaller tributaries.

The drainage pattern of the watershed is such that a number of reservoirs would be required to provide supplemental water supplies to the irrigated land and to provide flood damage benefits to other than the lowest reach of the main stem. Under the terms of the Belle Fourche River compact, the size of each reservoir is limited. No favorable project for development of the water resources on a watershed basis has been identified.

There may be potential for developing supplemental water supplies for individual operators or for very small groups within the watershed. One such development, the Spring Branch Reservoir which serves a total of 200 acres of irrigated land in two ownerships, is now being installed as an R C & D measure. Future water supply development or irrigation system improvement is expected to be carried out in similar small works. No evaluation of a potential watershed project will be made for the Level B Study.

Reconnaissance Study

LITTLE BIGHORN-PASS CREEK

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
U.S. DEPARTMENT OF AGRICULTURE
Casper, Wyoming
November 1976

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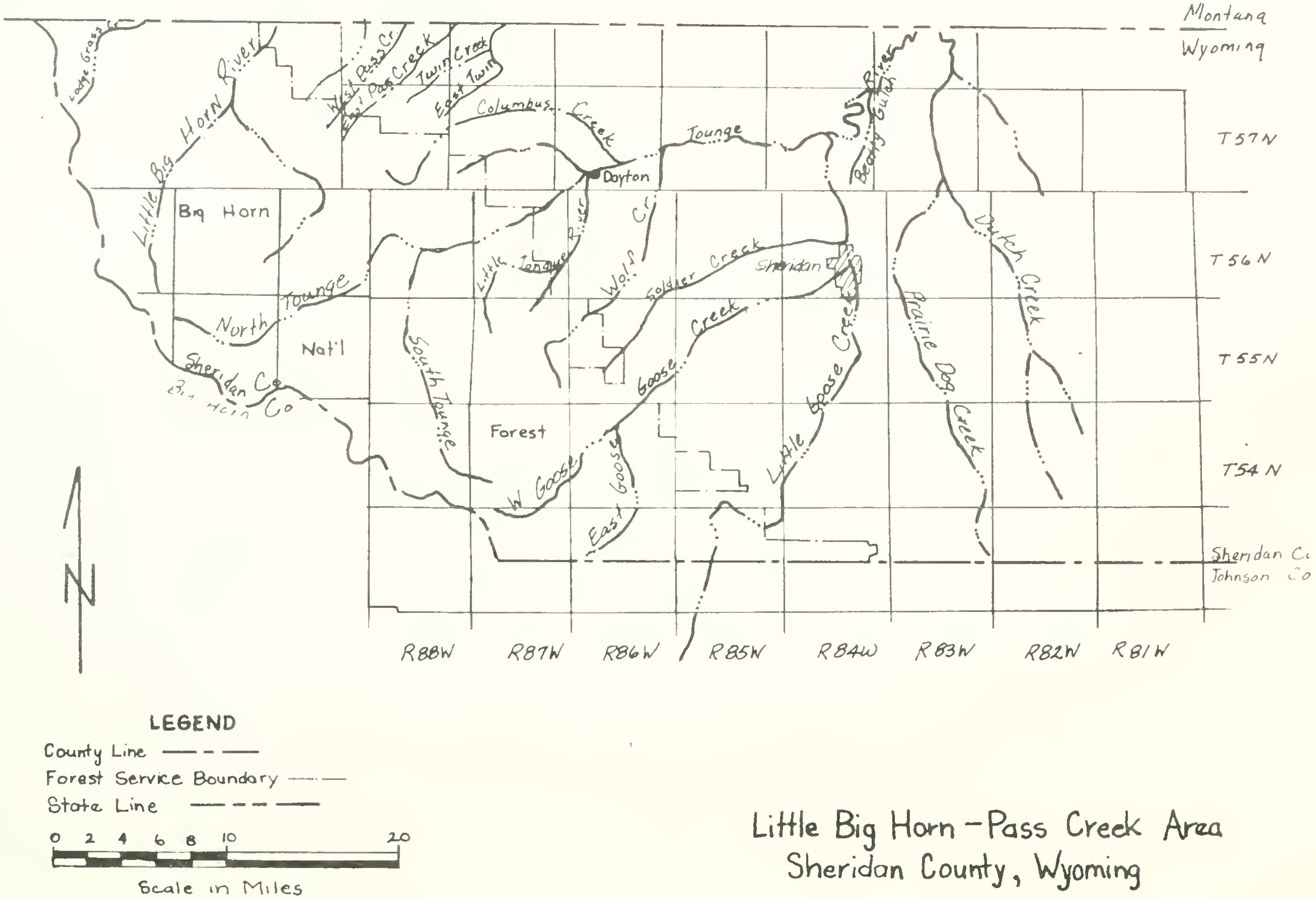

Little Big Horn – Pass Creek Area
Sheridan County, Wyoming

SUMMARY

The drainage area of the Little Bighorn River within Wyoming has been proposed as a source of water for a water storage project that would include water supplies for irrigation in Sheridan County, Wyoming. The proposal was identified through a watershed screening for the Yellowstone Basin and Adjacent Coal Area Level B Study. The proposed project would divert water from the Little Bighorn River and its tributaries within Wyoming and carry water through the drainage areas of Tongue River, Wolf Creek, and Goose Creek. Water would be stored within the Little Bighorn River drainage area as well as in Beatty Gulch which is a tributary to Tongue River northeast of Sheridan, Wyoming. It is indicated that there are storage permits to store 70,000 acre-feet of project water in Wyoming.

The proposed water development included supplemental supplies for presently irrigated land and supplies for irrigating as much as 10,000 acres of presently non-irrigated land.

It now appears that the lands to be developed for irrigation have not been identified and that the agricultural purpose of the project is doubtful. Although no project is identified for evaluation, the available information on irrigation water requirements for the area and the water supplies are included here.

The streams selected for a water source drain a high runoff area and supply water to irrigate about 16,000 acres in Wyoming and Montana. The estimated average annual outflow from Wyoming is about 133,000 acre-feet; the average annual flow of the Little Bighorn River near the mouth of the river is 197,000 acre-feet.

Agriculture and industry have a need for water in the project area. All of the Little Bighorn River streams enter the Crow Indian Reservation at the Montana State line.

DESCRIPTION

Water Supply Area

The Little Bighorn River drainage area in Wyoming contains about 300 square miles. The western tributaries rise in the Bighorn Mountains at an elevation of about 10,000 feet above mean sea level. The major streams, which are Lodge Grass Creek, Little Bighorn River, Pass Creeks and Twin Creeks leave Wyoming at elevations of 5,000 to 4,000 feet. The topography consists of relatively steep uplands intersected by canyons. Because of the steep grades few reservoir sites exist on the main channels. About 2,500 acres are irrigated in the eastern part of the area.

Possible Irrigation Area

Potential canals from the Little Bighorn River to Beatty Gulch would cross the Pass Creeks, Twin Creeks and the lower tributaries of the Tongue River, including Columbus Creek, Little Tongue River, Wolf Creek, Soldier Creek and the Goose Creeks. In the area of each of these streams there is irrigated land that has a need for some supplemental water and non-irrigated land that is suitable for irrigation.

Agricultural areas that might be served by project canals include much of the irrigated land or potentially irrigated land that is described in the reconnaissance study reports of Goose Creek, South Tongue River and Prairie Dog Creek.

The potential irrigation area is at an elevation of about 4,000 feet. The average annual precipitation is about 15 inches. The net irrigation requirement for hay, with small grain used for reestablishment of hay crops, is about 1.5 feet per year. Using long canals and storage, the water depletion for irrigation use may be about 2 acre-feet per acre per year.

HYDROLOGY

Water Yield and Use

The estimated average annual water yield of the Wyoming portion of the Little Bighorn River drainage area is about 136,000 acre-feet. The estimated water depletion resulting from the works of man is about 3,000 acre-feet per year. The estimated average annual outflow of the tributaries in Wyoming is 133,000 acre-feet; of this outflow the Little Bighorn River flows about 102,000 acre-feet. The average annual flow of the Little Bighorn River near the mouth of the river is about 197,000 acre-feet.

There are about 2,500 acres irrigated in the Wyoming portion of the Little Bighorn River basin; an estimated 13,000 acres are irrigated in the Montana portion of the river basin. With a full water supply the consumptive use of irrigation water by crops on the 15,500 acres would be about 23,000 acre-feet per year; the estimated water depletion from irrigation would be about 30,000 acre-feet per year.

Availability of Water

There are many potential uses for the water in the Little Bighorn River Basin. There is need for agricultural, industrial or municipal water in the basin, in the nearby Tongue River basin and in the Powder River basin.

The existing 15,500 acres of irrigated land experience water shortages. Supplemental supplies would be used for irrigation if storage were provided.

About 8,000 acres have adjudicated water rights in Wyoming. Additional non-irrigated areas in Montana are suitable for irrigation. The cooperative Type IV Study of the Wind - Bighorn - Clarks Fork River Basin, made by the States of Wyoming and Montana and by agencies of the U. S. Department of Agriculture, identified potential watershed projects in the Montana portion of the Little Bighorn River basin that would supply irrigation water to about 5.200 acres of presently non-irrigated land.

An estimated 24,000 acres of irrigated land in the Tongue River Basin in Wyoming experience a water shortage. A full supply of irrigation water would increase crop consumptive use about 16,000 acre-feet per year. Additional areas of irrigable land have been proposed for irrigation. Existing permits and pending applications in Wyoming may exceed the volume of water in the Tongue River Basin that is available for use in Wyoming.

Industrial interests in the Powder River Basin also have a need for additional water. Montana - Wyoming aquaducts studies have identified the Little Bighorn River as a possible source of 40,000 acre-feet of municipal and industrial water.

The Yellowstone River Compact recognizes the existing rights to irrigation water and to supplemental supplies for irrigation but the unused and unappropriated water in the Little Bighorn River was not proportioned to the States. Water rights of the Federal Reservations are not clear; Reservations on the Little Bighorn River are the Bighorn National Forest which is the source of much of the surface flow and the Crow Indian Reservation into which each of the tributaries in the Wyoming portion flow at the Montana State line.

NORTH FORK CRAZY WOMAN

North Fork Crazy Woman Creek was a PL 566 watershed application that was accepted in 1971. It was identified in a watershed screening for the Yellowstone Level B Study in 1976 as a potential project for irrigation water development and for system improvement.

After discussion in June, 1976, between Soil Conservation Service personnel from the Field Office and the Water Resources Planning Staff, it was decided that recent construction of reservoirs within the North Fork area has provided storage for much of the irrigated area needing supplemental water and has used most of the flood flow that may be available to store. No project for supplemental water supply is probable. Neither is a watershed project for rehabilitation of the many canal systems likely. No evaluation will be made for the Yellowstone Level B Study.

Reconnaissance Study

PRAIRIE DOG

YELLOWSTONE BASIN AND ADJACENT COAL AREA

LEVEL B STUDY

Soil Conservation Service
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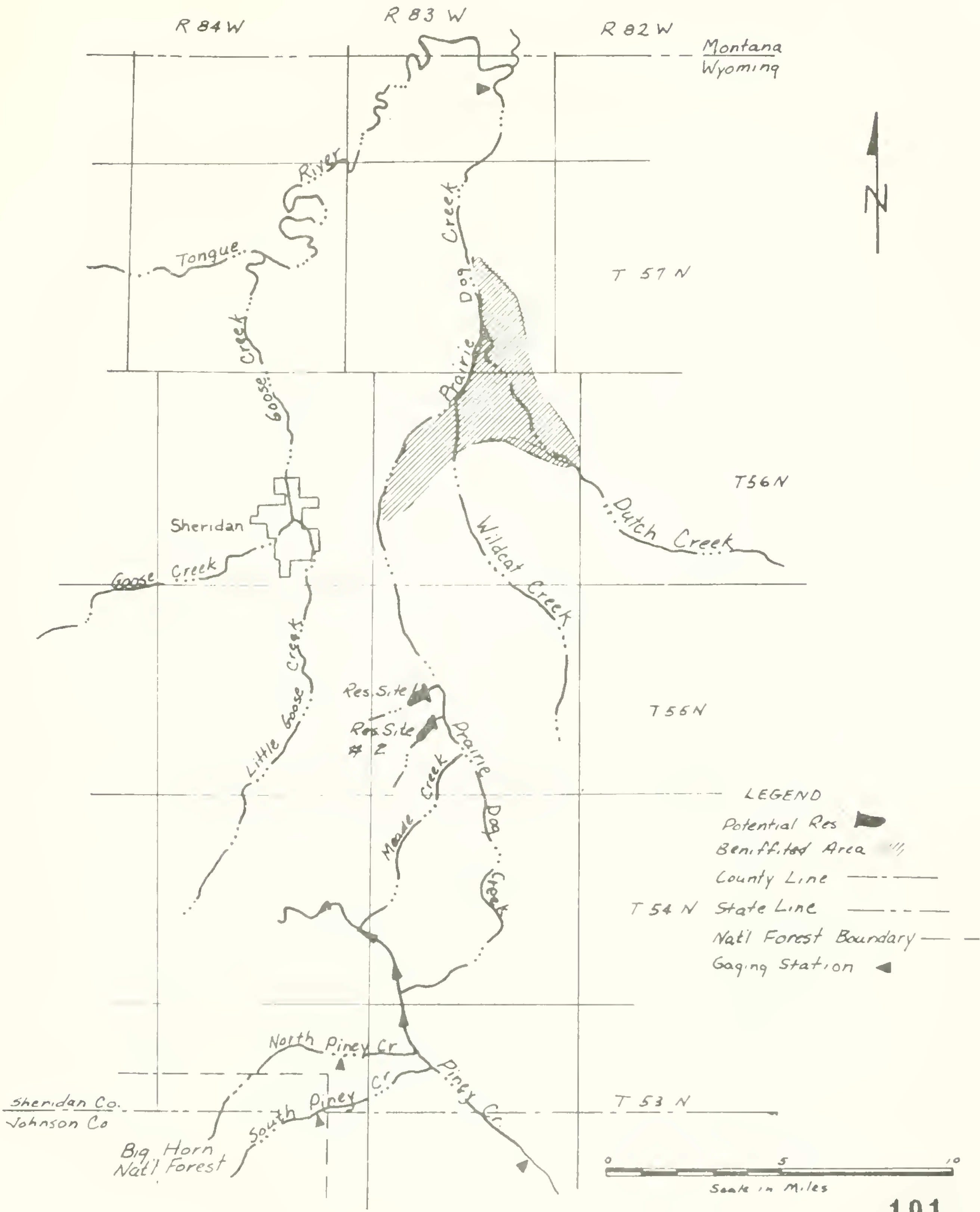
Prairie Dog Project Area



PRAIRIE DOG

SUMMARY

The Prairie Dog project is a proposal to irrigate about 1,500 acres of presently non-irrigated cropland near the confluence of Dutch Creek and Prairie Dog Creek in Sheridan County, Wyoming.

The water source would be North Piney Creek and South Piney Creek. Diversion from the Piney Creeks would be made in the Spring and Fall when there is no demand for direct diversion for irrigation. The existing interbasin diversion system which delivers water to Prairie Dog Creek would be used and Prairie Dog Creek would serve as a carrier.

New structural works for the irrigation system include two storage dams to store about 5,000 acre-feet of water on small tributaries near Prairie Dog Creek along with a reservoir supply canal and distribution canals about 18 miles long.

The estimated water depletion resulting from the project is 3,300 acre-feet per year.

The proposal would also provide for rehabilitation of the existing inter-basin diversion serving irrigated lands in the Prairie Dog Creek drainage. The existing system includes a severely eroded wash which may soon need structural work, even without project. Water would be carried past the wash in a one-mile length of pipe.

The estimated installation cost of structural measures for new irrigation is $2,890,000. The proportionate share of rehabilitation costs for the interbasin diversion will bring the total estimated cost for development of new irrigation to more than the limitation of $2,000 per acre. Because the estimated cost exceeds the limit the project analysis was not completed. Project benefits were not estimated.

The water yield of Piney Creek is already over appropriated. If water is used as currently appropriated, there will be no water available for the Prairie Dog Project.

LOCATION AND DESCRIPTION

The area proposed for irrigation lies at the confluence of Prairie Dog Creek and Dutch Creek about 8 miles northeast of Sheridan, Wyoming at an elevation of about 4,000 feet, msl. The average annual precipitation is about 15 inches. The average annual temperature is about 45^{o}F., and the average frost-free (28^{o}F.) period is about 150 days. The current use of the potential irrigated land is for production of non-irrigated hay and small grain. The area suitable for irrigation exceeds 3,000 acres. The estimated net irrigation requirement for production of hay and grain is 1.5 feet per year.

Prairie Dog Creek is a tributary of the Tongue River, which it enters about one-half mile south of the Wyoming-Montana State line. Prairie Dog Creek and its tributary Dutch Creek rise near the south boundary of Sheridan County, Wyoming at elevations generally below 5,000 feet. The combined drainage area above the proposed irrigation area is about 300 square miles. The water yield of the drainage area is relatively low.

There is some irrigated land along Prairie Dog Creek. Much of this land has a supplemental water supply from North Piney Creek and South Piney Creek, which are within the Clear Creek Drainage. The Prairie Dog Creek channel is used as a carrier for water that is imported from the Clear Creek Basin.

The proposed water source is North Piney Creek and South Piney Creek which head in the Bighorn Mountains in northwestern Johnson County at elevations over 12,000 feet. Water yield at this elevation is quite high. Water is presently used to irrigate land along Piney Creek and is diverted to Rock Creek and to Lake DeSmet for late season release to irrigated land in Piney Creek and Clear Creek.

In the vicinity of the community of Story, at the Johnson County-Sheridan County line, existing diversions from the Piney Creeks direct water over the divide into the Tongue River basin to irrigate about 12,000 acres along the upper tributaries of Little Goose Creek and along Prairie Dog Creek.

PROBLEMS

The development of irrigated land with a dependable supply of water and the resulting increase in hay and grain production is considered desirable in the Dutch Creek-Prairie Dog Creek area. The increased production will supply winter feed to support the local agricultural industry which is primarily the production of livestock. There is interest in developing an irrigation project for an area of 2,000 to 3,000 acres.

An erosion problem exists in the system which is presently used to direct water from the Piney Creeks to the Tongue River basin. In the original systems that import water to Prairie Dog Creek and the nearby tributaries of Goose Creek, water was transported to the divide and permitted to fall in three separate steep washes for a drop in elevation of 200 feet or more.

The eroded channels that have developed are unsightly and not fully stabilized. Erosion continues to cause turbidity and minor sediment problems downstream. Continued erosion may eventually cause damage to improved land at Story.

One of the concerned irrigation ditch companies has recently shown a renewed interest in controlling the erosion. Although the washes have long been accepted as a problem there is no current plan or request for assistance to plan for a solution. Continued use of the diversions may require structural measures at an early date.

PROJECT PROPOSAL

The proposed Prairie Dog project calls for the diversion of water from the Piney Creek drainage during periods when stream flow is available for diversion, provision for storing the diverted water until it is needed for irrigation and delivery of the stored water to land along Dutch Creek and Prairie Dog Creek near the confluence of the two streams.

Because of the problems of water supply, including the limited rate of streamflow and the freezing problems associated with Winter diversions, the area to be developed for irrigation is limited, for this analysis, to 1,500 acres.

The diversion and delivery of water to the Prairie Dog Creek drainage will utilize the existing systems and channels. The project will include stabilizing the severely eroded wash in the existing system that is to be used in the Prairie Dog project.

Engineering

The proposed structural works include two irrigation water storage dams on the tributaries of Prairie Dog Creek; a diversion canal to supply the two new reservoirs; a canal to deliver water from Prairie Dog Creek to the irrigated land; and erosion control structures in the existing interbasin diversion system.

Two earth dams are to be located on small tributaries of Prairie Dog Creek. Tentative locations are in Township 55 North of Range 83 West. Each reservoir will store 2,500 acre-feet. Release rates will be adequate to meet the peak use requirements of the 1,500 irrigated acres.

A reservoir supply canal about 5 miles long will be built to carry water from the upper Prairie Dog Creek to the reservoirs.

About 18 miles of canal will be needed to deliver stored water to the irrigated fields. The canal will begin at the storage sites or in Prairie Dog Creek directly below the storage sites and will be in the general area of the existing Ninemile Ditch.

Reservoir and canal data are shown in tables 1, 2, and 3.

The eroded wash in the existing diversion from Piney Creeks to Prairie Dog Creek will be controlled by using about one mile of 30-inch diameter pipe to carry a flow of 120 cfs through about a 400 foot loss in elevation.

The estimated installation cost of structural measures is shown in tables 4 and 5.

Soils

The soils proposed for irrigation vary from fine sandy loam to clay loam. All of the soils are deep with root zones of 60 inches or more. Permeability is moderate to moderately slow and water-holding capacity is high (over 9 inches in the 5-foot root zone). The predominant soil series are Fort Collins, Kim, Ulm, and Wyarno. A brief description of a representative profile of each identified soil series follows:

Fort Collins - The surface layer is neutral fine sandy loam about 5 inches thick. The upper part of the subsoil is mildly alkaline loam about 3 inches thick, and the lower part is mildly alkaline clay loam about 13 inches thick over strongly alkaline loam about 9 inches thick. The substratum is strongly alkaline loam that reaches to a depth of 60 inches or more.

Kim - The surface layer is moderately alkaline loam about 5 inches thick. The underlying layer is moderately alkaline silt loam that reaches to a depth of 60 inches or more.

Ulm - The surface layer is neutral loam about 3 inches thick. The upper part of the subsoil is mildly alkaline clay loam about 15 inches thick. The lower part of the subsoil is moderately alkaline clay loam about 8 inches thick. The substratum is strongly alkaline clay loam that reaches to a depth of 60 inches or more.

Wyarno - The surface layer is neutral clay loam about 4 inches thick. The upper part of the subsoil is mildly alkaline clay about 6 inches thick, and the lower part is moderately alkaline clay loam about 3 inches thick. The substratum is moderately alkaline clay loam that reaches to a depth of 60 inches or more.

Hydrology

Tabulated below are average stream flows and estimated 80 percent chance flows at gaging stations on the upper Piney Creeks. Stations "near Story" are about 2 miles above Story and upstream from diversions for irrigation on Piney Creek and in the Tongue River basin. Flows at the South Piney Creek station are regulated by three irrigation water storage reservoirs that have a total capacity of 9,700 acre-feet. There is one diversion from South Piney Creek to Rock Creek above the station "near Story".

Month	South Piney Creek near Story		North Piney Creek near Story		Piney Creek at Kearny	
	Average	80 % Chance	Average	80 % Chance	Average	80 % Chance
Oct.	1,810	1,500	665	520	1,670	1,130
Nov.	1,295	1,060	548	420	1,897	1,300
Dec.	1,071	880	449	350	1,712	1,180
Jan.	913	750	385	290	1,454	1,010
Feb.	782	660	350	270	1,336	920
March	917	750	418	330	1,735	1,180
April	1,551	1,280	1,564	1,210	4,147	2,810
May	7,079	5,810	9,628	7,450	16,924	11,550
June	17,586	14,430	9,225	7,130	21,918	14,950
July	9,993	8,180	2,105	1,620	5,778	3,950
August	7,088	5,810	910	710	1,506	1,010
Sept.	3,608	2,950	668	520	1,419	970
ANNUAL	53,693	44,000	26,916	20,800	61,495	42,000

The average annual discharge of Piney Creek at Ucross (near the mouth of the stream), is about 61,700 acre-feet.

A short period of record on Prairie Dog Creek near Acme (about one mile above the mouth of the stream), indicates an annual outflow from Prairie Dog Creek of about 30,000 acre-feet.

Water need: The estimated net irrigation requirement for hay and grain is about 1.5 feet per year. If the efficiency of use of stored water is 40% with use of return flows, a diversion of 3.7 feet each year will provide a full supply to the irrigated land. With the existing flows in lower Prairie Dog Creek during the irrigation season, storage of 3.3 acre-feet per acre should provide a full supply in at least an average of 8 years out of 10.

Dependability of flow: Assuming that there are neither irrigation water uses nor ice problems prohibiting diversions from the Piney Creeks in October, November, March and April, there is available, to divert from North and South Piney Creeks, a volume of more than 7,000 acre-feet an average of 8 years out of 10. Permitting 20 percent of the flow to remain as instream flow, a volume of 6,000 acre-feet can be directed to Prairie Dog Creek. With channel losses of 10 to 15 percent of diversions a volume of 5,000 acre-feet could be stored on Prairie Dog Creek 8 years out of 10. If the storage requirement is 3.3 feet per year the storage of 5,000 acre-feet should be adequate to irrigate 1,500 acres.

Availability of water: Water rights on the Piney Creeks include original direct flow rights of more than 450 cfs for the irrigation of about 32,000 acres. The rights to the use of surplus water for irrigation are about equal to the original direct flow rights. Adjudicated rights, permits and pending applications to store water from Piney Creek, total more than 100,000 acre-feet. The original direct diversion rights for irrigation alone exceed the 80 percent chance flow of Piney Creeks in the month of highest water yield. The water of Piney Creeks is already appropriated. There will be no water available for the Prairie Dog project if all of the existing water rights are exercised.

Water quality: The water in Piney Creek is of good quality for irrigation.

The estimated water depletion resulting from the project is 3,300 acre-feet per year.

Economics

Total costs for new irrigation structural measures and a proportionate share of rehabilitation costs for the interbasin diversion exceed $3,000,000, or $2,000 per acre. For this reason, the project was not analyzed further and benefits were not computed.

Table 1 - Structure Data - Dams

Site	Drainage Area	Height of Dam	Volume of Fill	Principal Spillway		Emergency Spillway		Surface Area Storage Pool Elevation
				Type	Release Rate	Type	% Chance of Use	
	Sq. Mi.	Feet	Cu. Yd.		cfs			Acres
1	2	90	360,000	RCP	50	Earth	2	90
2	2	85	340,000	RCP	50	Earth	2	100

Table 2 - Reservoir Capacity

Site	Drainage Area	STORAGE CAPACITY PLANNED			Additional Storage Capacity Available
		Sediment	Irrigation	Total	
	Sq. Mi.	Acre-Feet			Acre-Feet
1	2	200	2,500	2,700	1,000
2	2	200	2,500	2,700	2,000

Table 3 - Structure Data - Canals

Canal	Length	Capacity	Bottom Width	Depth	Velocity	Volume of Excavation
	(Miles)	(cfs)	(ft)	(ft)	(fps)	(C.Y.)
Reservoir Supply Canal	5	80	5	3	3-	61,000
Distribution Canal	12 6	50 25	4 3	3- 2-	3- 3-	108,000 24,000

TABLE 4 INSTALLATION COST
New Irrigation Structural Measures

Item	Cost
Construction Cost:	
Dam No. 1	$ 760,000
Dam No. 2	730,000
Supply Canal with Structures	200,000
Distribution Canal with Structures	420,000
SUBTOTAL-CONSTRUCTION COST	$2,110,000
Engineering Services	320,000
Project Administration	280,000
Land Easements and Rights-of-way	180,000
TOTAL STRUCTURAL MEASURES	$2,890,000

TABLE 5 INSTALLATION COST
Rehabilitation of Interbasin Diversion

Item	Cost
Construction Cost	$700,000
Engineering Services	50,000
Project Administration	70,000
Land Easements and Rights-of-way	10,000
TOTAL	$830,000

REDWATER CREEK

Redwater Creek, in eastern Crook County, was named in 1976 as a potential project for storing water for irrigation. Discussions between Soil Conservation Service field personnel and local residents who might be most concerned indicate that the area named is North Redwater Creek and the upper reaches of Redwater Creek. The area is not associated with the area proposed for revegetation in the 1954 request for assistance under the PL 566 Watershed Protection and Flood Prevention program.

It appears that we are not far enough along in recognizing problems or opportunities to identify a project to evaluate. There may be some interest in improved water supply and in new irrigation, particularly sprinkler systems. There have been some individual sprinkler installations in recent years. Development may continue as individual systems or very small groups.

Flood damage has been reported in the Redwater Creek drainage including frequent reports of flooding in the area near Beulah. Flood damage survey reports filed by Soil Conservation Service District Conservationists in 1962, 1970, and 1973 do not indicate a potential for a flood prevention project.

December 1976

NORTH END PLANNING UNIT - BIGHORN NATIONAL FOREST

Purpose and Intent

The North End Planning Unit is characterized by inaccessible country. The terrain is basically small hills with deep canyons. The three notable canyons in the area include Devil's Canyon, Tongue Canyon and Little Horn Canyon. There are four roadless areas within the Area, including EA, EB, EK and EM.

Critical issues within the area include:

1. Congressional action including possible Tongue River Wild River proposal.

2. Complex long standing resource problems, involving range, wildlife and recreation conflicts. Examples of this include key calving areas, coordination with two adjacent elk winter pastures - overlapping wildlife, recreation and cattle use in Little Horn Canyon.

3. Potential water development critical to regional development of coal resources. Pending water litigation on Little Horn River is of national significance.

4. Timber stands in area are very decadent. Comandra rust is a serious problem and insects are a problem. Ponderosa pine has epidemic populations of bark beetle in the area and an isolated outbreak of Engelmann spruce bark beetle occurred in the area four years ago.

5. Identify management opportunities in the roadless areas containing 105,000 acres.

6. Three areas of particular interest occur in this unit - Bull Elk Park Natural Area, proposed Cook Stove Basin Natural Area and the proposed Devil's Canyon Scenic Area.

7. Potential subdivision in Tongue River and need to acquire Blackburn property.

8. Unique black bear area with a high population of black bear in Dry Fork.

9. Deteriorated range including stock driveway.

10. Potential for trespass on to Crow Reservation Lands.

11. Existing Transportation System is not meeting current needs.

The Level of Planning Required

Resource data already available will enable us to plan at Level I for most activities. The planning level will be between Level I and 2, which will meet our needs. Complete soils information will be the major data missing for doing Level I planning and this is not considered essential as we will have the geology and landform information for the entire unit.

Adjacent National Forest Units, Other Federal, State, and Local Agencies Who Should be Involved in the Study.

1. Bureau of Land Management, Worland District.

2. Bureau of Indian Affairs, Crow Agency.

3. National Park Service, Big Horn Canyon National Recreation Area.

4. U.S.D.A., Soil Conservation Service.

5. Wyoming Commissioner of Public Lands, State Forester.

6. Wyoming Game and Fish Department.

7. Regional Planning Office, Big Horn County, et al.

8. Sheridan County Planner.

9. Various State Agencies such as State Archeologist.

GOOSE PLANNING UNIT - Bighorn National Forest

Purpose and Intent

The Goose Planning Unit includes all of the Goose Creek Drainage except for that portion of the drainage in the Cloud Peak Primitive Area. The area is largely covered by timber with the exception of several large parks. Roadless Area No. BL occupies the east portion of the Planning Unit. In addition to the roadless area, one of the critical issues is existing and proposed water developments. A number of major reservoirs occur in this area and additional developments have been proposed.

There are complex long standing resource problems that have already been identified within the Unit.

Much of the timber is very decadent and it forms a nearly solid cover except for several large parks.

Wildlife is another one of the key values in the area and several problem grazing allotments having deteriorated range are in this Unit. There is a critical need to re-evaluate the fire problem in the area as the fuels are heavy and contiguous and there is no access. A potential is there for a fire in excess of 5,000 acres.

Ponderosa pine bark beetle has reached epidemic proportions in the ponderosa pine on the east side of the Planning Unit.

Subdivisions are being developed along the Forest Boundary in this Unit and coordinated planning with the county is necessary.

The municipal water supply for Sheridan is located in the Planning Unit.

Elk habitat requirements are limited in the Unit and the herd is increasing. Moose habitat is also critical.

Unique wildlife in the area include wolverine and pine marten.

There are problems associated with heavy dispersed recreation use.

Current transportation system is not meeting current needs and is causing resource damage.

The Level of Planning Required

Resource data already available will enable us to plan at Level I for most activities. Complete soils data is not available and is not considered necessary to meet our planning objectives. The planning level will, therefore, be between I and 2.

Adjacent National Forest Units, Other Federal, State, and Local Agencies Who Should be Involved in the Study.

1. U.S.D.A., Soil Conservation Service.

2. Wyoming Commissioner of Public Lands, State Forester.

3. Wyoming Game and Fish Department.

4. Sheridan County Planner.

5. Other State Agencies, including State Archeologist.

PAINTROCK - PINEY -- BIGHORN NATIONAL FOREST

Purpose and Intent

The Paintrock - Piney Unit includes much of the area studied during the Cloud Peak Wilderness Area Study. Most of the area is undeveloped and it includes roadless areas BJ, BI, BH and BD.

The critical issues within the area include:

1. Rock Creek Elk Study, which involves improving habitat for elk adjacent to Red Lowe Elk Pasture.

2. Wilderness access to Cloud Peak.

3. Proximity to the Wilderness Area.

4. Extensive water developments.

5. Municipal water supplies for Buffalo.

6. Long standing resource conflicts including cattle and elk conflicts on west side.

7. Extensive stands of decadent timber needing management to prevent the build up of insects and disease.

8. The potential for a large burn is extreme due to the 140,000 acres of continuous fuels without access.

9. Existing transportation system is not meeting current needs and is causing resource damage.

The Level of Planning Required

Resource data already available will enable us to plan at Level I for most activities. Complete soils data is not available and is not considered necessary to meet our planning objectives. The planning level will, therefore, be between I and 2.

Adjacent National Forest Units, Other Federal, State, and Local Agencies Who Should be Involved in the Study

1. U.S.D.A., Soil Conservation Service.

2. Bureau of Land Management, Buffalo District
   Worland District.

3. Wyoming Commissioner of Public Lands, State Forester.

4. Sheridan County Planner.

5. Johnson County Planner.

6. Regional Planning Office, Big Horn County, et al.

7. Various other State offices including State Archeologist.

U.S. HIGHWAY 14 PLANNING UNIT - BIGHORN NATIONAL FOREST

Purpose and Intent

This Planning Unit is highly developed and the complexity of management is related to good access and large numbers of people. Both U. S. 14 and 14-A are included in the Unit along with most of the better Forest Development Roads.

The critical issues are as follows:

1. Concentrated recreation use including a number of developed recreation sites.

2. Unique scenic areas such as Shell Canyon, Shell Falls and Fallen City.

3. Grazing and wildlife conflicts including some deteriorated range.

4. Fire occurrence is relatively heavy and the extensive areas of downfall contribute to the possibility of a large fire.

5. There is mixed ownership in some critical areas along the highway.

6. Roadless Area FC is located in the west portion of the Unit between U.S. 14 and 14 A. This roadless area contains 52,000 acres.

7. There are extensive areas of unstable soil within this Unit. Special management is required on these soils.

8. The area receives heavy winter sports use.

9. Most of the critical moose winter range is in this Unit.

10. There are a number of potential reservoir sites that would conflict with recreation use and eliminate critical moose areas.

11. Mining activity is accelerating in this Unit.

12. Sagebrush is reinvading forage lands.

13. Existing transportation system is not meeting current needs and is causing resource damage.

The Level of Planning Required

Resource data already available will enable us to plan at Level I for most activities. Complete soils data is not available and is not considered necessary to meet our planning objectives. The planning level will, therefore, be between I and 2.

Adjacent National Forest Units, Other Federal, State, and Local Agencies and Their [illegible] Involved in the Study

1. U.S.D.A., Soil Conservation Service.

2. Federal Highway Administration.

3. Bureau of Land Management, Worland District.

4. Wyoming Game and Fish Department.

5. State Highway Department.

6. Sheridan County Planner.

7. Regional Planning Office, Big Horn County, et a.

8. Other State offices including State Archeologist.

Format for Additional Planning Unit Information

Forest	Bighorn	Bighorn	Bighorn	Bighorn
Unit or ES Name	North End	Goose	Paintrock-Piney	U.S.Highway 14
Planning Area	1	1	1	1
Coordinating Forest	Bighorn	Bighorn	Bighorn	Bighorn
Congressional District	1	1	1	1
Counties First	Sheridan	Sheridan	Johnson	Sheridan
Second	Big Horn	Johnson	Big Horn Sheridan	Johnson
NF Area, M Acres	177	99	*213	258
Other Area, M Acres	0	1	0	3
Roadless Areas (Yes or No)	Yes	Yes	Yes	Yes
Lead Director	6	6	4	
A-95 Notification (Mo/Yr)	1/78	1/79	1/80	1/81
DES Filing (Mo/Yr)	6/78	6/79	6/80	6/81
FES Filing (Mo/Yr)	12/78	12/79	12/80	12/81

*Includes 160 M Cloud Peak Primitive Area

RECREATION ON NATIONAL FOREST LANDS
NORTHEAST WYOMING PLANNING AREA
YELLOWSTONE LEVEL B STUDY

GENERAL DESCRIPTION

The prime recreation resource of this area consists largely of the mountain areas which partially encircle the planning area on three sides. These mountains provide numerous opportunities for forest and mountain recreation and offer scenic diversity in contrast to the overall plains-like appearance of the planning area. Recreation attractions of national significance are limited to the Bighorn National Forest and Devil's Tower National Monument, but the planning area is located between two major recreational areas, the Black Hills and the Yellowstone National Park complexes. The majority of recreational use is generated by tourists en route to other destinations. The communities of Buffalo and Newcastle receive substantial economic benefit from tourist trade.

Except for wildlife, recreational resources in the plains portions of the planning area are limited. Lake De Smet and Keyhole Reservoir offer water-based recreation and a few scattered historic sites provide for limited recreation activities. High value wildlife habitat for antelope and upland game birds is found throughout the plains portion. Mule deer and whitetail deer are generally plentiful. This wildlife resource attracts substantial numbers of out-of-state hunters.

FOREST SERVICE LANDS

Forest Service lands consist of three units of the National Forest system: the Bighorn, Black Hills and Medicine Bow National Forests, and the Thunder Basin National Grassland. The National Forests occur primarily in three isolated mountain ranges on the west, south and east margins of the planning area. The Thunder Basin National Grassland includes substantial acreage scattered across a large portion of the central plains of the planning area.

The Bighorn National Forest encompasses all of the Bighorn Mountains in Wyoming. As the crest of the Bighorns forms the boundary between the two Wyoming planning areas, only half of the Forest, 560,000 acres, is within the northeast Wyoming area. The Bighorn National Forest possesses national recreational significance. Depending on the direction of travel, the Bighorns are the first, or last, occurrence of Rocky Mountains. Visitors to the Bighorns come not only from local population centers, such as Sheridan or Billings, but from all parts of the country. This out-of-area use includes both travelers passing through the Bighorns en route to Yellowstone or other locations, and vacationers making the Bighorns their destination.

Located on the eastern edge of the planning area in Crook County are 175,000 acres of the Black Hills National Forest. This section of the Black Hills Forest encompasses the Bear Lodge Mountains as well as a small portion of the Black Hills The Black Hills in Wyoming are less spectacular and less intensively developed compared to areas in South Dakota, and possess attractions primarily of local interest. The Wyoming areas are, however, becoming more popular as the central portions of the Black Hills become more crowded.

On the south edge of the planning area in Converse and Natrona Counties lies a small portion of the Laramie Mountain Range. Within these mountains are 80,500 acres of the Laramie Peaks Division of the Medicine Bow National Forest. This area is an extremely rugged mountain outlier possessing outstanding scenic qualities. These mountains are primarily of value from a local use standpoint, offering few national attractions.

The 572,000 acres of Thunder Basin National Grassland consist largely of scattered federal lands intermingled with State and private ownerships. These lands are semiarid short- and mid-grass prairie interspersed with badlands and ponderosa pine parklands. The extensive grassland and sagebrush communities provide important habitat for antelope and other prairie wildlife. Antelope hunting on the Grassland and surrounding areas is a major national attraction. With the exception of antelope and other wildlife, recreation resources are limited on the Grassland.

EXISTING USE

Table 1 shows existing use on Forest Service lands by type of activity within the planning area. By far the largest activity is camping, followed by fishing and hunting. With the exception of fishing, most of which occurs in free flowing rivers and streams, water-based activities are limited on the National Forests and Grassland. Snowmobiling, although less significant in terms of present use, is growing in popularity and accounts for almost all winter activities. The recent national increase in cross-country skiing is not yet in evidence in this planning area, although opportunities for this activity are available on Forest Service lands.

Other dispersed recreation activities such as hiking, sightseeing, mountain climbing, horseback riding, and general nature study are major Forest uses, but are only partially relfected in table 1.

Table 1A shows use rates for various activities in the Bighorn National Forest within the planning area in Johnson and Sheridan Counties. As in the planning area as a whole, camping is by far the largest single activity, followed by fishing and hunting. A major camping attraction is the proposed Cloud Peak Wilderness, which attracts large numbers of visitors from upper midwest states. Cold water streams rising in the Bighorns are a major local attraction in an area surrounded by dry plains. Nearly 90 percent of all fishing on Forest Service lands occurs on the Bighorn National Forest. Other water-based activities are limited by cold water temperatures, although a few large reservoirs, over 100 acres, have been developed. Hunting, especially for elk, accounts for only 9 percent of total Forest use, but is the primary activity during autumn months. The increase in winter sports in recent years, especially snowmobiling, is also in evidence in the Bighorns.

Recreation in the Black Hills National Forest in Wyoming differs significantly from the planning area as a whole. Hunting, primarily for big game, is by far the largest use, accounting for nearly 55 percent of all use. Camping, snowmobiling, picnicking, and fishing are the next most popular activities, table 1B. Much of the use in this part of the Black Hills Forest appears to be from local people. Use on the Black Hills National Forest accounts for 15 percent of all use on Forest Service lands in the planning area.

Use preference on National Forest lands in the Laramie Mountains follows the same general pattern as the planning area. Fishing, the second most popular activity on National Forests in the planning area, is only a minor use because of the scarcity of live streams in the Laramie Mountains. Camping, picnicking, and hunting for big game account for 85 percent of all Forest use. Although winter sports are increasing in popularity, opportunities for snowmobiling and other winter activities are limited because of the very rugged topography. Most visitors to this National Forest are from Casper and the surrounding communities. The Laramie Peaks Division accounts for only 7 percent of total use on Forest Service lands in the planning area.

The Thunder Basin National Grassland has the lightest use of all Forest Service lands, accounting for only 5 percent of total use. Hunting for big game is the largest use, followed by fishing, snowmobiling and waterfowl hunting. Camping and picnicking make up 15 percent of all Grassland activities, but most of this use is believed to occur only in conjunction with other activities. Most visitors to the Grassland are from the surrounding communities, except during the hunting season when substantial numbers of out-of-area sportsmen come to hunt antelope.

DEVELOPED FACILITIES

Table 2 lists Forest Service facilities by county within the planning area. A total of 32 campgounds has been developed with a capacity of 1,175 people at any one time, along with 11 picnic grounds with a capacity for 910 people, 4 organization sites with a capacity for 400 people, 4 observation facilities, 1 boating site and 7 commercial establishments. Generally, these facilities appear adequate to handle existing use, and except for a few high-use weekends, can accommodate moderate increases in use.

As can be seen in table 2, the Bighorn National Forest in Johnson and Sheridan Counties has over 80 percent of all developed facilities. A number of the seven commercial facilities operated on Forest Service lands by private concessionaires are presently under-utilized and could represent unused capacity that might accommodate additional use. The Thunder Basin National Grassland receives about 2,000 visitor days of camping use each year, but no facilities exist to accommodate this activity.

DISPERSED RECREATION RESOURCES

Dispersed resources consist of natural or cultural features or areas to which people may be attracted in their recreation pursuits. Table 3 lists the present and potential acreages of dispersed resources. The acreages listed do not represent results from comprehensive inventories, but were gathered from a variety of general studies. Almost all data are, therefore, fragmentary in nature and unsuitable for detailed program formulation purposes. The table, however, is valuable for identifying the relative scarcity of recreation resources.

Interpretation of the table is aided if the acreages listed for each element are compared with the total acreage of Forest Service lands in the planning area, 1,400,000 acres. With the exception of big game habitat, most dispersed resources occupy extremely small amounts of land. For example, potential wilderness occupies only about 6 percent of the total Forest Service land base, while rivers and streams occupy only 0.03 percent of the land base.

Tables 3A, 3B, 3C, and 3D list dispersed resources by Forest Service administrative unit. The majority of the dispersed recreational resources is found on the Bighorn National Forest. All roadless and potential wilderness resources identified to date are located in the Bighorn Mountains. Although most of the identified wildlife habitat is shown to be on the Bighorn Forest, substantial acreage also exists on all of the other Forest Service units. A primary wildlife resource on the Bighorn Forest is a large elk herd. Other wildlife resources include critical habitats for moose, black bear, wolverine and pine marten. The cold water streams rising in the Bighorns are quite unique in this planning area and provide an important cold water fishery. Dispersed resources of special interest include the Bull Elk Park Natural Area, the Tongue River with potential for Wild and Scenic River classification, the proposed Cloud Peak Wilderness, and Fallen City, a unique scenic area. Dispersed recreation resources on the Black Hills National Forest are similar to those in the Laramie Mountains. Fishing and hunting in a mountainous setting provide the primary recreation base. Because of the more favorable terrain, snowmobiling and cross-country skiing opportunities are much greater than in the Laramie Mountains. Unique recreational resources include the Inyan Kara Creek Historical Area, which is listed on the National Register of Historic places, and a small elk herd (table 3B).

Dispersed resources in the Laramie Mountains are not as well identified as in the Bighorns. The primary resource is the scenic mountainous and forest terrain in an area largely devoid of such environments. The few cold water streams provide a limited fishery while wildlife habitat for deer and elk provides mountain hunting opportunities (table 3C).

Recreation resources on the Thunder Basin Grassland differ substantially from the forest and mountain Forest Service lands. The primary recreation resource in this prairie environment is wildlife. Expansive areas of native range support an antelope herd of over 12,000 head, while the rougher breaks and wide stream valleys support over 4,000 whitetail and mule deer. A small elk herd was introduced into the Rochelle Hills in 1966 by private landowners and has grown to about 100 head. Other game species include sage grouse, sharp-tailed grouse, wild turkey and mourning dove. Waterfowl is primarily migratory in nature and includes a variety of ducks and geese as well as sandhill cranes. Live streams are rare in the Grassland and support only nongame fish. But 22 reservoirs support active fisheries of brook and rainbow trout, bass, crappie and bullhead. Except for fish and wildlife, recreation resources on the Grassland are limited, differing little from adjacent plains areas (table 3D).

PROBLEMS AND CONCERNS

Problems on Forest Service lands primarily arise because of increasing demands on a limited forest resource base. Conflicting land uses, enforcement, and access are the three main problem areas. Conflicting land uses include both existing and potential competitive uses. Present competition between big game and domestic livestock vying for the same forage is leading to deterioration of the habitat and decreasing game populations. Placer mining in stream channels, both past and present, causes degradation of fish habitat and often destroys the esthetic stream environment. Potential conflicts can be expected from increased recreational use, especially between snowmobilers and cross-country skiers. Such conflicts become especially critical in this planning area where the acreage of suitable recreational lands is limited. Deterioration of recreation resources may result from potential water developments, especially on the Tongue River within the Bighorn National Forest.

Enforcement of Forest regulations associated with recreation use has increased substantially during the past few years. Such infractions consist largely of vandalism, wildlife harassment and poaching, improper off-road vehicle use, and general misdemeanor misconduct. With continuing population growth, these problems can be expected to become more severe, both in absolute numbers of infractions and in the severity of damage to the resource base.

Access to recreational areas is a problem for all types of activities, whether they be intensive uses at developed sites or dispersed pursuits in back country areas. Increasing use has taxed the existing transportation system in many areas of the National Forest. Primitive roads and trails are particularly inadequate to handle the increasing use as people seek more remote areas for recreation. Heavy use in the proposed Cloud Peak Wilderness has begun to threaten the wilderness resource as well as the quality of recreational experiences. Legal access has also become a problem where transportation routes cross private lands. In many cases, public rights-of-way have not been acquired from private landowners. As use over such routes increases, problems may arise between the public and private landowners, and may lead eventually to road closures.

FUTURE DEMANDS

(To be included at a later date.)

PROGRAM OPPORTUNITIES

(To be included at a later date.)

TABLE 1
EXISTING RECREATION DEMAND (USE)
NATIONAL FOREST LANDS

STATE WYOMING FOREST ALL PLANNING AREA NE WYOMING

TYPE OF ACTIVITY	ANNUAL VISITOR DAYS	CONVERSION FACTOR	ANNUAL ACTIVITY DAYS 1/
LAND BASED ACTIVITIES			
SIGHTSEEING	11,000	4.0	44,000
SNOWMOBILING 2/	19,300	2.0	38.600
HIKING & WALKING	14,000	2.0	28,000
CAMPING	162,800	1.5	244,200
PICNICKING	26,800	6.0	160,800
HUNTING 3/	74,100	3.0	222,300
SKIING 4/	400	2.4	960
TOTAL LAND BASED	308,400		738,860
WATER BASED ACTIVITIES			
POWER BOATING	0	2.4	0
NON-MOTORIZED BOATING 5/	2,200	1.7	3,740
SWIMMING	400	6.0	2,400
WATER SKIING	0	4.0	0
FISHING	82,300	3.0	246,900
HUNTING 6/	3,300	3.0	9.900
TOTAL WATER BASED	88.200		262.940

SOURCE: RIM REPORTS, FORM 2300-1K

1/ Activity & Recreation day are assumed to be equal. Activity day calculated by multiplying Visitor Day by the Conversion Factor.
2/ Snowmobiling = Ice & Snowcraft Travel
3/ Land Based Hunting includes hunting for big game, small game & upland birds.
4/ Skiing includes both downhill & cross country skiing.
5/ Non-motorized Boating inlcudes canoeing, sailing & rowing.
6/ Water Based Hunting = Waterfowl Hunting

TABLE 1A

EXISTING RECREATION DEMAND (USE)

NATIONAL FOREST LANDS

STATE WYOMING FOREST BIGHORN PLANNING AREA NE WYOMING

JOHNSON & SHERIDAN COUNTIES

TYPE OF ACTIVITY	ANNUAL VISITOR DAYS	CONVERSION FACTOR	ANNUAL ACTIVITY DAYS 1/
LAND BASED ACTIVITIES			
SIGHTSEEING	10,900	4.0	43,600
SNOWMOBILING 2/	9,000	2.0	18,000
HIKING & WALKING	12,100	2.0	24,200
CAMPING	142,200	1.5	213,300
PICNICKING	15,900	6.0	95,400
HUNTING 3/	24,600	3.0	73,800
SKIING 4/	100	2.4	240
TOTAL LAND BASED	214,800		468,540
WATER BASED ACTIVITIES			
POWER BOATING	0	2.4	0
NON-MOTORIZED BOATING 5/	2,200	1.7	3,740
SWIMMING	0	6.0	0
WATER SKIING	0	4.0	0
FISHING	72,300	3.0	216,900
HUNTING 6/	0	3.0	0
TOTAL WATER BASED	74,500		220,640

SOURCE: RIM REPORTS, FORM 2300-1K

1/ Activity & Recreation day are assumed to be equal. Activity day calculated by multiplying Visitor Day by the Conversion Factor.
2/ Snowmobiling = Ice & Snowcraft Travel
3/ Land Based Hunting includes hunting for big game, small game & upland birds.
4/ Skiing includes both downhill & cross country skiing.
5/ Non-motorized Boating inlcudes canoeing, sailing & rowing.
6/ Water Based Hunting = Waterfowl Hunting

TABLE 1B
EXISTING RECREATION DEMAND (USE)
NATIONAL FOREST LANDS

STATE WYOMING FOREST BLACK HILLS PLANNING AREA NE WYOMING
BEARLODGE & SPEARFISH RD's CROOK COUNTY

TYPE OF ACTIVITY	ANNUAL VISITOR DAYS	CONVERSION FACTOR	ANNUAL ACTIVITY DAYS 1/
LAND BASED ACTIVITIES			
SIGHTSEEING	100	4.0	400
SNOWMOBILING 2/	6,800	2.0	13,600
HIKING & WALKING	1,100	2.0	2,200
CAMPING	9,800	1.5	14,700
PICNICKING	4,800	6.0	28,800
HUNTING 3/	32,400	3.0	97,200
SKIING 4/	300	2.4	720
TOTAL LAND BASED	55,300		157,620
WATER BASED ACTIVITIES			
POWER BOATING	0	2.4	0
NON-MOTORIZED BOATING 5/	0	1.7	0
SWIMMING	0	6.0	0
WATER SKIING	0	4.0	0
FISHING	4,400	3.0	13,200
HUNTING 6/	300	3.0	900
TOTAL WATER BASED	4,700		14,100

SOURCE: RIM REPORTS, FORM 2300-1K

1/ Activity & Recreation day are assumed to be equal. Activity day calculated by multiplying Visitor Day by the Conversion Factor.
2/ Snowmobiling = Ice & Snowcraft Travel
3/ Land Based Hunting includes hunting for big game, small game & upland birds.
4/ Skiing includes both downhill & cross country skiing.
5/ Non-motorized Boating inlcudes canoeing, sailing & rowing.
6/ Water Based Hunting = Waterfowl Hunting

TABLE 2
NATIONAL FOREST RECREATIONAL FACILITY INVENTORY, BY COUNTY,
N.E. WYOMING STUDY AREA, YELLOWSTONE RIVER BASIN, WYOMING, 1976

CAMPING FACILITIES INDIVIDUAL CAMPGROUNDS	FAMILY UNITS	ACREAGE	CAPACITY[1/]
CONVERSE COUNTY			
1. Campbell Creek	9	3 (2)[2/]	45
CROOK COUNTY			
1. Bearlodge	7	1 (2)	35
2. Reuter	24	5 (5)	120
	31	6 (7)	155
JOHNSON COUNTY			
1. Canyon	4	2 (6)	20
2. Circle Park	10	5 (7)	50
3. Coffeen Park	5	2 (3)	25
4. Cross Creek	5	2 (3)	25
5. Crazy Women	6	2 (3)	30
6. Doyle	18	8 (5)	90
7. Frying Pan Lake	3	3 (2)	15
8. Middle Fork	8	3 (4)	40
9. South Fork	8	4 (4)	40
10. Tiehack	8	3 (2)	40
	75	34 (39)	375
SHERIDAN COUNTY			
1. Dead Swede	22	10 (4)	110
2. East Fork	11	6 (4)	55
3. Little Goose	3	2 (3)	15
4. North Tongue	11	6 (5)	55
5. Owen Creek	7	3 (6)	35
6. Prune Creek	20	8 (6)	100
7. Sibley Lake	10	3 (3)	50
8. Tie Flume	25	10 (5)	125
9. Ranger Creek	11	5 (4)	55
	120	53 (40)	600
TOTAL FOR PLANNING AREA (22 Sites Total)	235	96 (88)	1,175

PICKNICKING FACILITIES

PICNIC SITES	FAMILY UNITS	ACREAGE	CAPACITY
CAMPBELL COUNTY			
1. Soda Well	2	1 (1)[2/]	10
CROOK COUNTY			
1. Cook Lake	27	2 (6)	115
JOHNSON COUNTY			
1. Hettinger	24	3 (6)	120
2. Hunter Corrals Trail Head	16	2 (2)	80
3. North Fork	7	3 (4)	35
	37	8 (12)	235
SHERIDAN COUNTY			
1. Burgess	5	2 (2)	25
2. Dead Swede	6	3 (2)	30
3. East Fork	8	3 (2)	40
4. Pine Island	26	3 (2)	130
5. Sibley Lake	8	4 (4)	40
6. Twin Lakes	10	5 (5)	50
	110	28 (29)	550
TOTAL FOR PLANNING AREA (11 Sites Total)	174	39 (48)	910

ORGANIZATION FACILITIES

ORGANIZATION SITES	FAMILY UNITS	ACREAGE	CAPACITY
JOHNSON COUNTY			
1. E La Ka Wee	40	2 (6)	200
2. Johnson County Youth Camp	8	5 (5)	40
	48	7 (11)	240
SHERIDAN COUNTY			
1. Camp Bethel	20	11 (8)	100
2. Mountain Camp	20	23 (45)	100
	40	34 (53)	200
TOTAL FOR PLANNING AREA (4 Sites Total)	88	41 (64)	440

OBSERVATION FACILITIES

OBSERVATION SITES	FAMILY UNITS	ACREAGE	CAPACITY
JOHNSON COUNTY			
1. Hospital Hill	6	1 (1)	30
2. Loaf Mountain Overlook	20	3 (4)	100
	26	4 (5)	130
SHERIDAN COUNTY			
1. Sand Turn	30	3 (1)	150
2. Scojer Spring	8	2 (2)	40
	38	5 (3)	190
TOTAL FOR PLANNING AREA (4 Sites Total)	64	9 (8)	320

COMMERCIAL FACILITIES LODGES & RESORTS	FAMILY UNITS	ACREAGE	CAPACITY
JOHNSON COUNTY			
1. Caribou	32	8 (8)[2/]	160
2. Lucasta	7	9 (5)	36
3. Pines	13	9 (6)	65
4. South Fork Inn	10	7 (6)	50
5. Spear O Wigwam	10	7 (5)	50
	72	40 (30)	361
SHERIDAN COUNTY			
1. Arrowhead	42	26 (12)	210
2. Bearlodge	49	22 (12)	244
	91	48 (24)	454
TOTAL FOR PLANNING AREA (7 Sites Total)	163	88 (54)	815

BOATING FACILITIES BOATING SITES	FAMILY UNITS	ACREAGE	CAPACITY
SHERIDAN COUNTY			
1. Sibley Lake	12	1 (1)	60
TOTAL FOR PLANNING AREA (1 Site Total)	12	1 (1)	60

[1/] Capacity based on all family units occupied by 5 people each, or the total capacity of the site at any one time, whichever is appropriate.

[2/] Figure in parenthesis is net acreage of peripheral area outside of the actual developed site required to maintain the character of the facility.

SOURCE: U.S. Forest Service RIM Reports, Form 2300-2A, 1975.

TABLE 3

DISPERSED RECREATION AREA INVENTORY
NATIONAL FOREST LANDS

STATE WYOMING FOREST ALL PLANNING AREA NE WYOMING

TYPE OF AREA	PRESENT ACREAGE 1/	POTENTIAL ADDITIONS 1/
WILDERNESS & PRIMITIVE	0	82,071
ROADLESS - DEFERRED	30,500	N/A
ESSENTIALLY ROADLESS	24,478	N/A
UNUSUAL INTEREST		
ARCHEOLOGICAL	N/A	N/A
HISTORICAL	1,278	N/A
COMBINED TOTAL	N/A	
GEOLOGICAL	N/A	2,650
SCENIC	N/A	N/A
VEGETATION	N/A	N/A
TOTAL UNUSUAL INTEREST	N/A	N/A
IDENTIFIED WILDLIFE HABITAT		
BIG GAME HABITAT	1,022,585	N/A
UPLAND BIRD HABITAT	135,520	N/A
WATERFOWL HABITAT	13,971	N/A
CRITICAL HABITATS	52,720	N/A
TOTAL WILDLIFE HABITAT	N/A 1/	
FISH HABITAT		
COLD WATER	3,118	N/A
WARM WATER	[illegible]	N/A
TOTAL FISH HABITAT	3,125	N/A
WATER AREAS		
LAKES/PONDS	1,392	0
RIVER/STREAMS	478	0
RESERVOIRS/IMPOUNDMENTS	1,501	300
TOTAL WATER AREA	3,371	300
BOATING		
FLAT WATER	703	300
MOVING WATER	N/A	0
TOTAL BOATING	703	300
ZONES		
ROADSIDE	19,759	N/A
TRAILSIDE	1,584	N/A
WATERFRONT	7,733	N/A
BUFFER	498	N/A
TOTAL SPECIAL ZONES	N/A 1/	N/A
HIKING & RIDING	N/A	N/A

1/Columns are not additive due to possible double counting.

TABLE 3A
DISPERSED RECREATION AREA INVENTORY
NATIONAL FOREST LANDS

STATE WYOMING FOREST BIGHORN PLANNING AREA NE WYOMING JOHNSON & SHERIDAN COUNTIES

TYPE OF AREA	PRESENT ACREAGE 1/	POTENTIAL ADDITIONS 1/
WILDERNESS & PRIMITIVE	0	82,071
ROADLESS - DEFERRED	30,500	N/A
ESSENTIALLY ROADLESS	718	N/A
UNUSUAL INTEREST		
ARCHEOLOGICAL	N/A	N/A
HISTORICAL	N/A	N/A
COMBINED TOTAL	N/A	N/A
GEOLOGICAL	N/A	2,650
SCENIC	N/A	N/A
VEGETATION	N/A	N/A
TOTAL UNUSUAL INTEREST	N/A	N/A
IDENTIFIED WILDLIFE HABITAT		
BIG GAME HABITAT	502,585	N/A
UPLAND BIRD HABITAT	30,520	N/A
WATERFOWL HABITAT	13,440	N/A
CRITICAL HABITATS	62,720	N/A
TOTAL WILDLIFE HABITAT	N/A 1/	N/A
FISH HABITAT		
COLD WATER	3,021	N/A
WARM WATER	0	N/A
TOTAL FISH HABITAT	3,021	N/A
WATER AREAS		
LAKES/PONDS	1,392	0
RIVER/STREAMS	346	0
RESERVOIRS/IMPOUNDMENTS	1,222	200
TOTAL WATER AREA	2,960	200
BOATING		
FLAT WATER	659	200
MOVING WATER	N/A	N/A
TOTAL BOATING	N/A	N/A
ZONES		
ROADSIDE	6,763 2/	N/A
TRAILSIDE	1,684 2/	N/A
WATERFRONT	7,048 3/	N/A
BUFFER	490	N/A
TOTAL SPECIAL ZONES	N/A 1/	N/A
HIKING & RIDING	N/A	N/A

1/Columns are not additive due to possible double counting.
2/Acreage shown is area of roads or trails. Total travel influence zone = 27,950A.
3/Acreage shown is area of water and shorelines. Water influence zone = 33,925A.

TABLE 3B

DISPERSED RECREATION AREA INVENTORY
NATIONAL FOREST LANDS

STATE WYOMING FOREST BLACK HILLS BEARLODGE RD PLANNING AREA NE WYOMING CROOK COUNTY

TYPE OF AREA	PRESENT ACREAGE 1/	POTENTIAL ADDITIONS 1/
WILDERNESS & PRIMITIVE	0	0
ROADLESS - DEFERRED	0	0
ESSENTIALLY ROADLESS	N/A	N/A
UNUSUAL INTEREST		
ARCHEOLOGICAL	N/A	N/A
HISTORICAL	1,278	N/A
COMBINED TOTAL	N/A	N/A
GEOLOGICAL	N/A	N/A
SCENIC	N/A	N/A
VEGETATION	N/A	N/A
TOTAL UNUSUAL INTEREST	N/A	N/A
IDENTIFIED WILDLIFE HABITAT		
BIG GAME HABITAT	N/A	N/A
UPLAND BIRD HABITAT	N/A	N/A
WATERFOWL HABITAT	N/A	N/A
CRITICAL HABITATS	N/A	N/A
TOTAL WILDLIFE HABITAT	N/A	N/A
FISH HABITAT		
COLD WATER	37	N/A
WARM WATER	N/A	N/A
TOTAL FISH HABITAT	N/A	N/A
WATER AREAS		
LAKES/PONDS	0	0
RIVER/STREAMS	27	0
RESERVOIRS/IMPOUNDMENTS	34	N/A
TOTAL WATER AREA	61	N/A
BOATING		
FLAT WATER	34	N/A
MOVING WATER	0	N/A
TOTAL BOATING	34	N/A
ZONES		
ROADSIDE	655	N/A
TRAILSIDE	0	N/A
WATERFRONT	281	N/A
BUFFER	8	N/A
TOTAL SPECIAL ZONES	N/A 1/	N/A
HIKING & RIDING	N/A	N/A

1/ Columns are not additive due to possible double counting.

TABLE 3C
DISPERSED RECREATION AREA INVENTORY
NATIONAL FOREST LANDS

STATE WYOMING FOREST MEDICINE BOW / LARAMIE PEAK RD PLANNING AREA NE WYOMING / CONVERSE & NATRONA COUNTIES

TYPE OF AREA	PRESENT ACREAGE[1/]	POTENTIAL ADDITIONS[1/]
WILDERNESS & PRIMITIVE	0	0
ROADLESS - DEFERRED	0	0
ESSENTIALLY ROADLESS	23,760	0
UNUSUAL INTEREST		
ARCHEOLOGICAL	0	N/A
HISTORICAL	0	N/A
COMBINED TOTAL	0	N/A
GEOLOGICAL	0	N/A
SCENIC	0	N/A
VEGETATION	0	N/A
TOTAL UNUSUAL INTEREST	0	N/A
IDENTIFIED WILDLIFE HABITAT		
BIG GAME HABITAT	20,000	N/A
UPLAND BIRD HABITAT	5,000	N/A
WATERFOWL HABITAT	0	N/A
CRITICAL HABITATS	0	N/A
TOTAL WILDLIFE HABITAT	25,000	N/A
FISH HABITAT		
COLD WATER	50	N/A
WARM WATER	0	N/A
TOTAL FISH HABITAT	50	
WATER AREAS		
LAKES/PONDS	0	0
RIVER/STREAMS	90	0
RESERVOIRS/IMPOUNDMENTS	0	N/A
TOTAL WATER AREA	90	N/A
BOATING		
FLAT WATER	0	N/A
MOVING WATER	0	0
TOTAL BOATING	0	N/A
ZONES		
ROADSIDE	623	N/A
TRAILSIDE	0	N/A
WATERFRONT	560	N/A
BUFFER	0	N/A
TOTAL SPECIAL ZONES	1,183	N/A
HIKING & RIDING	100	N/A

1/Columns are not additive due to possible double counting.

TABLE 3D
DISPERSED RECREATION AREA INVENTORY
NATIONAL FOREST LANDS

STATE WYOMING FOREST MEDICINE BOW THUNDER BASIN NG PLANNING AREA NE WYOMING

TYPE OF AREA	PRESENT ACREAGE 1/	POTENTIAL ADDITIONS 1/
WILDERNESS & PRIMITIVE	0	0
ROADLESS - DEFERRED	0	0
ESSENTIALLY ROADLESS	0	0
UNUSUAL INTEREST		
ARCHEOLOGICAL	0	N/A
HISTORICAL	0	N/A
COMBINED TOTAL	0	N/A
GEOLOGICAL	0	N/A
SCENIC	0	N/A
VEGETATION	0	N/A
TOTAL UNUSUAL INTEREST	0	N/A
IDENTIFIED WILDLIFE HABITAT		
BIG GAME HABITAT	500,000	N/A
UPLAND BIRD HABITAT	100,000	N/A
WATERFOWL HABITAT	531	N/A
CRITICAL HABITATS	0	N/A
TOTAL WILDLIFE HABITAT	N/A 1/	N/A
FISH HABITAT		
COLD WATER	10	N/A
WARM WATER	10	N/A
TOTAL FISH HABITAT	20	N/A
WATER AREAS		
LAKES/PONDS	0	0
RIVER/STREAMS	15	0
RESERVOIRS/IMPOUNDMENTS	245	100
TOTAL WATER AREA	260	100
BOATING		
FLAT WATER	10	100
MOVING WATER	0	0
TOTAL BOATING	10	100
ZONES		
ROADSIDE	11,783	N/A
TRAILSIDE	0	N/A
WATERFRONT	1,105	N/A
BUFFER	0	N/A
TOTAL SPECIAL ZONES	N/A 1/	N/A
HIKING & RIDING	N/A	N/A

1/Columns are not additive due to possible double counting.

BLM

Yellowstone Level B Study
Wyoming State Study Team
Bureau of Land Management
March 24, 1976

WYOMING NATIONAL RESOURCE LANDS INVENTORY, SURFACE ONLY

Level B Study Planning Unit	WRC Sub-Basin No.	Name of County	Land Surface in Acres
Clark's Fork	1007	Park	107,000
Wind-Bighorn	1008	Big Horn	1,131,000
		Fremont	1,198,000
		Hot Springs	473,000
		Natrona	192,000
		Park	567,000
		Washakie	951,000
			4,512,000
Tongue-Powder	1009	Campbell	184,000
		Converse	8,000
		Johnson	593,000
		Natrona	343,000
		Sheridan	50,000
		Washakie	16,000
			1,194,000
Adjacent Coal Areas	1011	Crook	74,000
	1012	Campbell	25,000
		Converse	63,000
		Crook	19,000
		Niobrara	132,000
		Weston	65,000
			378,000

Wyoming Study Area Summary

Clark's Fork	107,000
Wind-Bighorn	4,512,000
Tongue-Powder	1,194,000
Adjacent Coal Areas	378,000
	6,191,000

ISSUE PAPER

Powder-Tongue Basin

Ronald Pense
U.S. Bureau of Mines
June 16, 1976

AGENCY OBJECTIVES

Among overall objectives of the Bureau of Mines, the one having the most immediate application to the Powder-Tongue Basin is assurance of a mineral production capability by the private sector to meet projected national demands. The Bureau, therefore, is concerned that water for an appropriate level of mineral development be available in adequate volume, of required quality, and at a reasonable price. In the Powder-Tongue Basin this water requirement has particular reference to energy resource production, viz., petroleum, natural gas, natural gas liquids, uranium, and, to a rapidly increasing extent, coal. The Bureau also is interested in seeing that sufficient water is available for long-range growth of energy conversion facilities, i.e., thermal powerplants and coal gasification and liquefaction facilities.

POTENTIAL MINERAL DEVELOPMENT IN ABSENCE OF COMPREHENSIVE PLAN

Under existing conditions and in the absence of any comprehensive plan, there is almost certain to be a substantial expansion in coal-related activity. Such development is already underway. This is largely because of widening demand for domestic fuel sources capable of providing power generation, and the presence of vast reserves of economically attractive, low-sulfur coal in the Powder-Tongue Basin. Attachment one contains a listing of proposed or planned coal mines, projected coal conversion plants, potential coal slurry pipelines, projected power generating plants, and projected new railroads. This information is based on data available to the Bureau of Mines through October 1975, and encompasses all of Wyoming rather than just the Powder Basin. Uranium production also undoubtedly will rise significantly through 1985, although the uncertain national outlook for atomic generation makes longer-range forecasts difficult. Recent apparent down trends in Basin petroleum, natural gas and natural gas liquids output, still far more important than coal, uranium and other minerals, could, however, if continued and accelerated, at least partially offset mineral value gains from coal and uranium mining over the next decade. Bentonite, the only other significant mineral produced, may increase significantly but not match in importance the energy-related commodities.

PROJECTS, PROGRAMS AND POLICIES CONSIDERED NECESSARY OR DESIRABLE TO MEET AGENCY OBJECTIVES

The Bureau's objectives in the Powder-Tongue Basin are enhanced through its national programs of research and data dissemination to encourage mineral development by the private sector rather than by implementation of specific tangible projects of an essentially local nature.

MATERIAL UNIQUE TO BUREAU OF MINES AND PERTINENT TO POWDER-TONGUE BASIN--MINERAL INFORMATION

General

Total value of mineral production in the Basin, including the entire eight counties of Campbell, Converse, Crook, Johnson, Natrona, Niobrara, Sheridan and Weston, was a record $559 million in 1974, the most recent year for which comprehensive value data are available. Petroleum accounted for $437 million or 78 percent of Basin mineral production, natural gas $19 million or 3 percent, and natural gas liquids $28 million or 5 percent. Bentonite, coal and uranium together comprised $73 million or 13 percent. Other nonmetallic minerals, principally sand and gravel, accounted for the remainder.

The 1974 total mineral value of $559 million represented a 59 percent rise over the previous year's high of $351 million and roughly a two-fold increase over the 1972 level. Most (80 percent) of this doubling between 1972 and 1974 resulted from the sharp rise in petroleum prices. Increases in the prices received for natural gas liquids, the quantities of coal produced, and both the amounts produced and value received for uranium, were responsible for most of the remaining two-year surge. Table 1 shows total value of combined mineral production for the years 1960-74.

TABLE 1. - Total value of mineral production in Tongue-Powder Basin, 1960-74

Year	Value (thousand dollars)
1960	116,665[1]
1961	130,432
1962	124,843
1963	132,151
1964	143,925
1965	153,783
1966	156,699
1967	158,656
1968	176,327
1969	225,035
1970	269,573
1971	262,788
1972	267,233
1973	350,630
1974	558,970

[1]Excludes natural gas and natural gas liquids.

Preliminary 1975 and partial 1976 state-wide data indicate that decreases in output of petroleum and natural gas are beginning to offset increased prices for these commodities. On the assumption that this downward trend will continue for most of Wyoming and that it is indicative of the Powder-Tongue Basin, mineral production value increases through 1985 probably will be more modest.

Mineral Fuels

Crude oil production, after rising irregularly throughout the 1960's, reached a Basin high of 76 million barrels in 1970, double the 1960 output. The record level of 1970 was largely the result of the coming on stream of the Hilight and other new oilfields in Campbell County. A decline set in almost immediately, however, and production has fluctuated between about 65 and 69 million barrels during subsequent years. The largest field in the Basin in 1975--and the second largest in the State--was the Salt Creek in Natrona County which produced 9.8 million barrels. The Hilight field which peaked in 1970 and has declined greatly since, was the second largest Basin producer in 1975 at 5.7 million barrels.

Rising domestic petroleum prices in the last few years have resulted in greatly increased values being received for crude oil. The 1974 value of $437 million was 69 percent greater than in 1973 and virtually double the 1970 value of $224 million.

Natural gas output, after maintaining a level of 21 billion cubic feet to 24 billion cubic feet during most of the 1960's, rose sharply thereafter to a height of 92.6 billion cubic feet in 1972. The discovery of new oilfields with substantial amounts of associated gas in Campbell County, such as Hilight, accounted for most of the increase. The completion of new gathering lines was principally responsible for the leap from 30.1 billion cubic feet in 1969 to 82.6 billion cubic feet in 1970.

While natural gas production has decreased since 1972, price increases have cushioned the decline. Through 1974, the last year for which comprehensive value data are available, the value of Basin gas had risen for five consecutive years, reaching a 15-year high of $18.6 million. Preliminary 1975 state-wide data indicate, however, that the drop in production that year was so sharp as to outweigh increased prices, quite possibly leaving the Basin with an overall lower value for its gas in 1975.

Production of natural gas liquids, following a sharp increase from approximately 2.0 million barrels in 1970 to a record 6.2 million barrels in 1973, now also appears to be on a downward trend. Price increases have been even more rapid than those for natural gas, nevertheless. After passing gas in total value in 1973, natural gas liquids were half again as valuable to the Basin in 1974--$28 million compared to $18.6 million. Preliminary data for 1975 suggest, moreover, that price increases for natural gas liquids are continuing to outweigh declining output and to increase total value to the Basin.

Table 2 shows petroleum, natural gas and natural gas liquids production by quantity and value for 1960-74.

TABLE 2. - Production of petroleum, natural gas and natural gas liquids, quantity and value, 1960-74

Year	Petroleum (thousand barrels)	Petroleum (thousand dollars)	Natural gas (million cubic feet)	Natural gas (thousand dollars)	Natural gas liquids (thousand barrels)	Natural gas liquids (thousand dollars)
1960....	37,862	95,033	NA	NA	NA	NA
1961....	42,060	105,150	20,569	1,073	1,668	3,745
1962....	39,070	97,285	22,008	3,213	2,055	4,300
1963....	44,038	101,254	23,188	3,291	1,985	4,307
1964....	46,258	116,033	22,690	2,841	1,429	2,755
1965....	50,646	126,615	21,972	2,901	1,235	2,400
1966....	49,454	126,602	24,237	3,297	1,566	3,151
1967....	49,626	128,035	22,544	3,293	1,554	3,096
1968....	55,617	146,833	21,575	3,150	2,203	4,530
1969....	68,528	191,878	30,076	4,421	2,464	4,659
1970....	76,351	223,710	82,560	12,136	1,957	3,694
1971....	68,860	213,431	90,720	13,116	3,202	6,735
1972....	64,596	207,435	92,565	14,995	6,034	13,515
1973....	67,870	259,163	86,130	15,589	6,220	19,421
1974....	66,938	437,191	75,855	18,585	4,966	27,950

Output of coal--all surface mined--has increased fairly regularly since 1960, reaching 8.1 million tons in 1975. The most significant rise came in 1973-74 when production jumped 2.8 million tons or 56 percent. Principal factors were a 2.4-million-ton increase in output from the Belle Ayr mine in Campbell County which was just then reaching full production, and a 0.5-million-ton increase in output from the Big Horn No. 1 mine in Sheridan County. In 1975, according to Wyoming data, there were four significant producing coal mines in the Powder-Tongue Basin. These were: Amax Coal Company's Belle Ayr mine (3.3 million tons), Big Horn Coal Company's Big Horn No. 1 mine (0.8 million tons), Pacific Power and Light Company's Dave Johnson mine in Converse County (3.2 million tons), and Wyodak Resources Development Corporation's Wyodak mine in Campbell County (0.8 million tons). The Welch Coal Company operated a small mine producing 18,000 tons in Sheridan County. Table 3, based on data from Wyoming state sources, shows annual coal production by county for the Basin, 1960-75.

TABLE 3. - Coal production by county, 1960-75
(thousand tons)

Year	Campbell	Converse	Sheridan	Total
1960......	459	526	382	1,367
1961......	447	826	349	1,622
1962......	483	770	357	1,610
1963......	496	1,030	376	1,902
1964......	489	1,004	432	1,925
1965......	491	1,251	349	2,091
1966......	475	1,565	326	2,366
1967......	505	1,415	348	2,268
1968......	540	1,390	218	2,148
1969......	558	1,504	346	2,408
1970......	641	1,844	1,465	3,950
1971......	647	1,732	1,777	4,156
1972......	656	2,622	974	4,252
1973......	1,595	2,899	463	4,957
1974......	4,040	2,687	1,018	7,745
1975......	4,075	3,232	806	8,113

The coal reserve base of the Powder-Tongue Basin totals 44.0 billion tons, or 83 percent of Wyoming's overall reserve. About 33.6 billion tons, or slightly over three-quarters of the Basin total, is in Campbell County alone. Approximately 22.7 billion tons of the Basin reserve (52 percent) is deep minable coal and 21.3 billion tons (48 percent) strippable. About 29.6 billion tons, two-thirds of the Basin reserve base, is known to be low-sulfur coal (1 percent or less sulfur content). Approximately 11.1 billion tons or 25 percent has been identified as medium-sulfur coal (1 percent to 3 percent sulfur), and only about 0.3 billion tons as high-sulfur coal (more than 3 percent sulfur). The sulfur content of 3.0 billion tons, or 7 percent of Basin coal, is unknown. Except for 23 million tons of deep-minable bituminous coal in Crook (1 million tons) and Weston (22 million tons) Counties, all coal is subbituminous grade. Table 4 shows the Basin's subbituminous coal reserve base by county, type or mining and sulfur content.

Uranium

Production of uranium from the Powder-Tongue Basin declined almost continuously during the early and middle 1960's, dwindling to virtual extinction in 1968. Most of the decrease was the result of the mining out of previously identified reserves and a lack of new exploration activity and ore body finds. A general resurgence of prospecting in 1966, however, lead to the discovery of significant new reserves, and an upward production trend began in 1969. Initially this was principally

TABLE 4. - Subbituminous coal reserve base by county, type of mining and sulfur content (million tons)

County[1]	Deep: Low sulfur (1% or less)	Deep: Medium sulfur (1-3%)	Deep: High sulfur (3% or more)	Deep: Unknown	Deep: Total	Strip: Low sulfur (1% or less)	Strip: Medium sulfur (1-3%)	Strip: High sulfur (3% or more)	Strip: Unknown	Strip: Total	Grand total
Campbell	11,434	633	155	1,791	14,013	10,674	8,708	105	105	19,592	33,605
Converse	894	177	0	0	1,071	472	93	0	0	565	1,636
Johnson	1,274	627	0	413	2,314	641	372	0	0	1,013	3,327
Natrona	25	10	0	0	35	0	0	0	0	0	35
Sheridan	4,051	444	0	695	5,190	89	3	0	0	92	5,282
Weston	0	0	0	36	36	0	0	0	0	0	36
Total	17,678	1,891	155	2,935	22,659	11,876	9,176	105	105	21,262	43,921

[1]No subbituminous coal reserve base in Crook and Converse counties.

because of expanding output at new eastern Gas Hills operations of Union Carbide Corporation in Natrona County. The opening of Exxon Company U.S.A.'s Highland mining operations in Converse County in 1972 accelerated the movement. By 1973-74 production in both quantity and value was two to three times that of the previous Basin high of 1960. Incomplete data for 1975 preclude evaluation of 1975 Basin uranium levels. But substantial increases are expected in 1976 when this new Bill Smith mine of Kerr McGee Nuclear Corporation (700 tons of ore daily) and possibly the Morton Ranch mine of United Nuclear Corporation (100 tons of ore daily) come on stream in Converse County.

As of January 1, 1976, there was one uranium ore processing plant within the hydrological boundaries of the Tongue-Powder Basin. This was a facility of Exxon near Douglas in Converse County with a nominal processing capacity of 3,000 tons of ore daily. In addition, a 1,200-ton-a-day plant of Union Carbide was situated just outside the hydrological Basin in the northwestern area of Natrona County.

Uranium ore reserves in Campbell, Converse, Crook, Johnson, Natrona, Niobrara, Sheridan, and Weston counties were listed as of January 1, 1976 at 39,800 tons of U_3O_8 at maximum "forward costs" of \$10 per pound, 82,000 tons at \$15, and 114,000 tons at \$30. "Forward costs" are those operating and capital costs yet to be incurred at the time an estimate is made. Profit and "sunk" costs, such as past expenditures for property acquisition, exploration and mine development are not included. Therefore, the various "forward costs" are independent of the market price at which the estimated reserve would be sold.

Nonmetallics

Bentonite is easily the most important mineral commodity in the Basin, following mineral fuels and uranium. Production rose uninterruptedly during 1960-69 and irregularly thereafter. The 1974 figures of 1.4 million tons of output and \$17.5 million for value were roughly 2.5 times corresponding levels in 1960. Crook County accounted for almost 70 percent of 1974 production, with additional output from Johnson, Natrona, and Weston Counties. Incomplete reserve data for the Basin places usable reserves at a minimum of 30 million tons: 15 million tons in the Colony area of Crook County and 15 million tons in the Kaycee area of Johnson County.

Sand and gravel is usually produced in all counties, but output is not significant. In fact, the one million tons recorded in 1974 was the lowest mined since 1960. Total value in 1974 was \$2.2 million.

Stone is the only other nonmetallic now produced, but output is erratic and insignificant in quantity and value. Pumice for road building purposes has been produced irregularly: from 1960-64 modest amounts were produced in Sheridan County, with additional quantities coming from Campbell County in 1962-63. Small amounts of sodium sulfate were produced during 1965-70 from saline deposits in Natrona County, but there is little apparent potential for resumption of this mining.

Metallics

The only metallic mineral known to have been produced in the Basin between 1960 and 1975 was vanadium. Minor amounts were obtained during the mid-1960's when uranium ores from Crook, and to a much lesser extent Converse, Counties were processed at a mill in South Dakota.

ATTACHMENT 1

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
North Rawhide Campbell Co., north of Gillette (1)	Carter Mining Co. P.O. Box 209 Gillette, WY 82716 C.E. Smith, Jr. President 307-682-7253		?300	Strip Sub BIT	1978 5 1985 12	Indiana & Michigan Elec. Co. for 1300 MW Power Plant; Nebraska City Power Station for power plant	Moist. 31.0 Ash 6.0 S .4 BTU 8.1K	Wyodak Bench #1 25 Bench #2 82	20 - 240	Planned for 1976. Construction delayed by Sierra Club injunction. Subsidiary of EXXON Corp.
Rochelle Mine Campbell Co. southern boundary (2)	Peabody Coal Co. Panhandle Eastern Coal Co. 45 S. Main St. Sheridan, WY 82801 307-674-6114		225	Strip Sub BIT	1980 5 - 11	Wyo. Coal Gas Co. (Panhandle Eastern Pipeline) Converse or Campbell Co.	Moist. 28.0 Ash 5.6 S .3 BTU 8.4K	Wyodak 52	20 - 150	Joint venture of Powder River Coal Co., a subsidiary of Peabody Coal Co., a subsidiary of Panhandle Eastern Pipeline called Pan Eastern Coal Co.
Black Thunder Campbell Co., south of Gillette (3)	Atlantic-Richfield Co., 316 S. Gillette Ave., Gillette, WY 82716 Brook Beaird		?250	Strip Sub BIT (C)	1980 7-10	Neb. Public Power Dist. for 500MW power plant. Okla. Gas & Elec. Co. for 1100 MW power plant Southwestern Public Service Co. for 720 MW power plant	Moist. 28.1 Ash 4.8 S .3 BTU 8.6K	Wyodak 60 - 73	15-240	Planned to open 1975. Delayed by Sierra Club injunction.

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
Big Horn #1 Sheridan Co., north of Sheridan at Acme (4)	Big Horn Coal Co. (Peter Kiewit Sons) Box 274, Sheridan WY 82801 John Ratchye, VP 307-672-3401	69	69	Strip Sub BIT	1974 1.0 1980 1.5	Various mid-western power companies	Moist. 24.5 Ash 5.8 S. .7 BTU 9.3 K	Bench #1 22-26 Bench #2 21-25 Bench #3 10-11	15 - 250	Expansion of present mine to meet contractual obligations.
Sorensen Lincoln Co., near Kemmerer (5)	Kemmerer Coal Co. Frontier, WY 83121 Mike Zakotnik 307-877-4452	47	100	Strip Subbit. B	1974 2.4 1980 3 - 4.7	Utah Power and Light Co. Kemmerer, WY;	Moist. 20.9 Ash 4.8 S. .6 BTU 9.5K	Adaville coals 4 - 35	25 - 140 Total relief in Big Pit approx 300-400'	Expansion of present mine to meet contractual obligations Utah Power & Light expanding Naughton Plant from 710 to 1540 MW
Elkol, Lincoln Co., near Kemmerer (6)	Kemmerer Coal Co. (see above)	24	24	Strip Sub BIT	1974 .9 1980 1.1	Allied Chemical, Amalgamated Sugar Co. & others.	Moist. 20.4 Ash 3.0 S .7 BTU 10.2K	Adaville #1 80-100	25-140	Thick Adaville No. 1 coal is reserved for this commercial tipple; spot sales expected to increase.
Wyodak North and South Campbell Co., east of Gillette (7)	Wyodak Resources Develop., P.O. Box 149, Gillette, WY 82716 W. J. Westre 307-682-3410	28	50	Strip Sub BIT	1974 .7 1980 2.2	Black Hills Power & Light Pacific Power and Light	Moist. 29.2 Ash 9.6 S. .8 BTU 8.2 K	Wyodak 80 - 110	20 - 110	Expansion of present mine to meet contractual obligation. For new Wyodak Plant of 780 MW

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
Bridger Sweetwater Co., near Point of Rocks (8)	Bridger Coal Co. PO Box 1688 Rock Springs, WY 82901 Andrew Franklin 307-382-9741	50	200	Strip Sub BIT	1974 .7 1980 7.5	Pacific Pwr. and Light and Idaho Pwr. Co Jim Bridger Plant	Moist. 20.5 Ash 9.7 S. .5 BTU 9.3K	Deadman 15 - 30	40 - 150	Captive mine expansion for Bridger Power plant (2000 MW) Subsidiary of Pacific Power and Light Co.
FMC Mine Lincoln Co., south of Kemmerer (9)	FMC Corp. Box 341 Kemmerer, WY 83101 307-877-4475		50	Strip Sub BIT	1975 .6 ? 1980 1 - 2	See remarks	Moist. 20.9 Ash 4.8 S .6 BTU 9.5K Analysis from Sorensen mine	Adaville#1 40 - 60	40 - 120	Open in 1975 Most production will go to FMC's Green River Trona Plant, Green River, Wyo. some to FMC's pilot coke plant, Kemmerer, WY.
Stansbury No. 1 Sweetwater Co., north of Rock Springs (10)	Stansbury Coal Co. P.O. Box 8789 Denver, CO 80201 Frank Mink 303-433-6841		275	Under-ground BIT.	1975 .1 1980 1.4	Ideal Cement Co. and other industrial users	Moist. 17.5% Ash 4.7% S. 1.1% BTU 10.5 K	Rock Springs #1 9-11	1800	Joint venture of Rocky Mountain Energy Co., a subsidiary of Union Pacific Corp. and Potash Corp. of America, a subsidiary of Ideal Basic Industries, Inc.

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
Belle Ayr (south) Campbell Co., south of Gillette (11)	AMAX Coal Co. P. O. Box 1880 Gillette, WY 82716 Bob James, Supt. 307-682-7295	51	?250	Strip Sub BIT	1974 3 1980 10-15	Colorado & Midwest Power Plants to include Tex. Arkansas.& Pacific North-west to include Oregon	Moist. 26.2 Ash 5.3 S .6 BTU 8.8 K	Wyodak 70'	15 - 200'	Expansion of present mine. Draft EIS released.
Belle Ayr (north) Campbell Co., north of Gillette (12)	AMAX Coal Co. (see above)		?250	Strip Sub BIT	1980 10 - 20	See above	Moist. 29.2 Ash 9.6 S. .8 BTU 8.2 K Analysis from Wyodak mine	Wyodak Bench #1 50 - 120 Bench #2 15 - 80	Less than 200'	Planned for 1977 opening.
Cordero Mine Campbell Co, south of Gillette (13)	Sunoco Energy Dev. Co. 314 S. Gillette Ave. Gillette, WY 82716 James Nichols 307-682-7295		?225	Strip Sub BIT	1976 3 1979 12	San Antonio City Public Service Board & Western Fuels Assn., Torrington, Wyoming	Similar to Belle Ayr south	Wyodak 3 benches each 20	Less than 200'	Subsidiary of Sun Oil Co. Western Fuels Assn. member plants. Held up by Sierra Club suit. Pouring slip forms on silos Aug. 1975.

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
Jacobs Ranch Campbell Co., south of Gillette (14)	Kerr-McGee Corp. 405 Church St. Gillette, WY 82716 307-682-4721		7250	Strip Sub BIT	1977 2 1980 9 - 16	Arkansas Pwr. and Light, Central Louisiana Elec. Co.	Moist. 29.0 Ash 5.8 S. .5 BTU 8.5 K	Wyodak Bench #1 8 Bench #2 43 Bench #3 6	10 - 150	Open 1977 Subsidiary of Kerr McGee Corp.
East Gillette Campbell Co., east of Gillette (15)	Kerr McGee Corp. (see above)		?200	Strip Sub BIT	1980 5- 11	See above	Similar to Wyodak	Wyodak 50 - 75	Less than 200'	Open 1978 Coal to be shipped to Public Service Co. of Okla. for two new 450 MW in NE Okla. On line 1979-80.
Black Butte Sweetwater Co., near Point of Rocks (16)	Black Butte Coal Co. P.O. Box 724, Sheridan Wyoming 82801 307-672-3401	35	200	Strip Sub BIT	1980 4 - 4.5	Idaho Pwr. Co.	Moist. 17.7 Ash 8.5 S. .4 BTU 9.7	Wasatch, Fort Union, Almond & Lance coals 5-26	40 - 150	Open 1977 Joint venture of Bitter Creek Coal Co. a subsidiary of Rocky Mtn. Energy Co. and Wytana, Inc. a subsidiary of Peter Kiewit Sons Co.

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
Thunderbird Campbell Co. (17)	El Paso Natural Gas Co. Western Fuels Assoc.		225	Strip Sub BIT	1979 3 - 5	Western Fuels Assoc. Torrington	See remarks Moist. 27.7 Ash 13.4 S .6 BTU 7.6 K	ULM 12 - 15	Less than 150'	Joint development agreement signed. Have 20,000 acres of prospecting permits formerly held by Wold and Jenkins. Now drilling 75 holes for information for Western Fuel boiler design. Have 120-150 million tons strip reserve in Ulm coal. Analysis from Bethurem prospect, Sheridan Co. Concerned about equipment delays and need for Federal coal lease.
No Name Johnson Co., near Buffalo (18)	Texaco, Inc. Story, Wyoming 82842 Bob Carter 307-683-2830			Strip		See remarks	Moist. 28.5 Ash 7.6 S. .6 BTU 7.9K	Healy 50 - 220		Possible opening 1977. Studying feasibility of coal conversion plant.
No Name Sheridan Co. near Montana line (19)	Public Service Co. of Oklahoma Suite 300 10403 W. Colfax Ave. Lakewood, CO 80215 303-234-0160		40	Strip Sub BIT	1977-78 0.5	Captive mine for Oklahoma power plants				Possible opening in late 1970's. Currently drilling and evaluating reserves.

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OR OVERBURDEN THICKNESS	REMARKS
Rainbow No. 8 Sweetwater Co., near Rock Springs (20)	Gunn-Quealy Coal Co. (Kemmerer Coal Co.) Rock Springs, WY 82901 Jim Diamanti 307-362-3078	70	70	Under-ground BIT	1974 .1 1980 .2	See remarks	Moist. 11.4 Ash 4.2 S .9 BTU 11.7K	Rock Springs #7 4 - 6	300+	Subsidiary of Kemmerer Coal Co. Entire production is converted into synthetic coke at Gunn-Quealy's mine mouth plant. Coke is sold to Monsanto Co. phosphorus plant, Soda Springs, Idaho
Vanguard No. 2 Carbon Co., west of Hanna (21)	Energy Development Co. P.O. Box 6 Hanna, WY 82327 Tom Bennett 307-325-6566	120	120	Under-ground Sub BIT	1974 .2 1980 1 - 2	Iowa Public Service Co.	Moist. 13.0 Ash 11.5 S .4 BTU 9.8K	Bed #50 9 - 5	300	All production to new 520 MW George Neal Plant, Salix, Iowa
Vanguard No. 3 Carbon Co., west of Hanna (22)	Same as above	-	-	Under-ground Sub BIT	1975-1976	Same as above				Proposed new deep mine
Medicine Bow Carbon Co. west of Hanna (23)	Medicine Bow Coal Co. Cedric Hustare, Sec. 500 N. Broadway St. Louis, Mo. 63102 314-231-1010	135	135	Strip Sub BIT	1975 3 1980 3.6	Northern Ind. Public Service Co. & various others	Moist. 12.0 Ash 7.5 S .5 BTU 10.2	Bed No. 62 3 - 60	20 - 200	Opened in 1975. Production to power 500 MW Kankee Valley plant, Wheatfield, In. Joint venture Arch Mineral Corp and Rocky Mtn. Energy Co. which is subsidiary of Union Pacific Corp.

Map Ref. #: ( ) MINE NAME AND LOCATION	OPERATOR	EMPLOYEES Present	EMPLOYEES Max.	MINE TYPE	PROJECTED PRODUCTION MILLION TONS/YR.	POTENTIAL MARKETS	ANALYTICAL INFORMATION	SEAM THICKNESS	DEPTH OF OVERBURDEN THICKNESS	REMARKS
Buckskin mine Campbell Co. 12 miles north of Gillette (24)	Shell Oil Co. P.O. Box 2099 Houston, Texas 77001 Bernard (Bud) G.Long 713-220-4658		?200	Strip Sub BIT	1979 2 1980 4	Shell Oil Co Houston refinery	Moist. Ash S. ? 1.0% BTU 8200	Hyodak 100 split seam	100	Drilling in progress. Held up by Sierra Club suit. Need railroad permits to cross Fed land. General company pull back on expansion in Wyoming.
Grass Creek mine Hot Springs Co. near Grass Creek (25)	Northwestern Resources 113 N. Broadway Billings, MT 59101 Roger C. Rice 406-252-2277 subsidiary of Western Energy Co., Billings, MT.	2	?25	Strip Sub Bit	1975 8,000 ton 1980 .7	Not announced	Moist. 12.1 Ash 9.0 S. .4 BTU 10.8K	Mayfield 20	less than 200	Requesting permission to expand mine to 700,000 tons per year.
No Name mine Carbon Co., near Hanna (26)	Rocky Mountain Energy Co. 4704 Harlan St. Denver, CO 80212 303-433-6841			Under-ground Sub BIT	1977-78 ?	Not announced				In planning stage.

STATE: WYOMING

PROJECTED COAL CONVERSION PLANTS

Map Ref. #: ( ) Project Name and Location	Company/or Project	Product mmcf/day Bbls/day	Type	Completion Date	Water Requirements and Source	Remarks
Champlin - UPRR (1)	Union Pacific Railroad Champlin Petroleum Co.	250	Coal Gasification			Early planning stages. Est. peak const. personnel: 1,125 1/ Est. oper. personnel: 600 1/
Campbell Co. (2)	Carter Oil Co. P.O. Box 120 Denver, CO 80201 F. L. Linauer 303-761-6470	250	Coal Gasification	1982		Studies and planning began in 1976. Est. peak const. personnel: 1,125 1/ Est. oper. personnel: 600 1/

1/ See Note C, p. 67

STATE: WYOMING

PROJECTED COAL CONVERSION PLANTS

Map Ref. #: ( ) Project Name and Location	Company/or Project	Product mmcf/day Bbls/day	Type	Completion Date	Water Requirements and Source	Remarks
Converse Co. 15 miles NE of Douglas (3)	Panhandle Eastern Pipeline Co. Suite 620, Petroleum Club Denver, CO 80202 G. W. Godfrey	250	Coal Gasification	1980	4,750 - 10,000 AF/Y	Seeking water rights. Construction postponed. Est. peak const. personnel: 1,125[1] Est. oper. personnel: 600[1]
Gasification Complex SE Montana NE Wyoming (4)	Northern Natural Gas Co. 2223 Dodge St. Omaha, Nebr. J. R. Brady 402-348-4979	1000	Coal Gasification	1981 - 500 1984 - 500		Ultimately 4 plants of 250 each. Initial development underway. Two plants proposed for Northern Cheyenne Reservation and two north of Gillette. Peabody will supply coal. Est. peak const. personnel: 2,250[1] Est. oper. personnel: 2,400[1]
Lake De Smet (5)	Texaco, Inc. Story, Wyoming 82842 Bob Carter 307-683-2830		Coal Gasification and Liquefaction			In planning.

1/ See Note C, p. 67

POTENTIAL COAL SLURRY PIPELINES

Map ref. #. ( ) From	To	Company	Miles	Diameter Pipe	Completion Date	Water Requirement and Source	Capacity MTY	Remarks
Campbell County 35 mi. s. Gillette (1)	Ark. Power & Light White Bluffs, Ark.	Energy Transportation Systems, Inc. Casper, Wyo. 82601 F. Odasz, Rocky Mtn. Mgr. 307-265-1800	1036	38	1980	15,000 AF/Y from underground wells in Madison formation	25	Delayed in obtaining right-of-way access across railroads. H.B. 1863 in U.S. Congress to enable access.
Fremont Co., Wyo. (2)	Northeast Oregon	Gulf Interstate Northwest Pipeline	800					

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STATE: WYOMING

Map Ref. #: ( ) Power Plant Name and Location	Company or Project	Fuel MTY For Coal	Capacity	Water Requirements and Source	Completion Date	Remarks
Jim Bridger #2, 3, & 4 Rock Springs, Wyo. (1)	Idaho Power Co. Pacific Power & Light Co.	Coal	1500 MW		#2, 500 MW, 1976 #3, 500 MW, 1976 #4, 500 MW, 1979	Planned additions to existing 500 MW unit. Coal supplied by captive Bridger coal mine. Est. oper. personnel: 188[1/] Est. peak const. personnel: 1,500[1/]
Wheatland #1, 2, & 3 Wheatland, Wyo. (2)	Basin Elec. Power Corp. Tri-State Gen. & Trans. Assn.	Coal	1500 MW		#1, 500 MW, 1979 #2, 500 MW, 1981 #3, 500 MW, 1983	Anticipate 2,200 construction workers at peak. Est. oper. personnel: 188[1/]
Wyodak #1 Gillette, Wyo. (3)	Pacific Pwr. & Light Co. Black Hills Pwr. & Light Co.	Coal	330 MW		1977	Will be world's largest air-cooled power plant. Plan to use reclaimed waste water from Gillette's municipal sewage disposal system. Meets plant's needs. Coal provided by Wyodak North and South mines. Est. peak const. personnel: 330[1/]
Naughton #3 & 4 Kemmerer, Wyo. (4)	Utah Power & Light	Coal	860 MW		#3, 430 MW, 1979 #4, 430 MW, 1981	Addition to existing units totaling 710 MW. Coal provided by Kemmerer Coal's Sorensen mine. Est. peak const. personnel: 860[1/] Est. oper. personnel: 108[1/]

1/ See Note B, p. 67

PROJECTED POWER GENERATING PLANTS

STATE: WYOMING

Map Ref. #: ( ) Power Plant Name and Location	Company or Project	Fuel MTY For Coal	Capacity	Water Requirements and Source	Completion Date	Remarks
Seminoe #4 (5)	U.S. Bur. Reclamation	Hydro	4 MW		1977	Addition to 3 existing units totaling 32 MW.
Gillette #1 (6)	See Remarks	Coal	330 MW		1988	Possible plant in Gillette area. May expand by 500 MW in 2000. Est. peak const. personnel: 330 1/ Est. oper. personnel: 41 1/

1/ See Note B, p. 67

LOCATION Map Ref. #: ( )	OPERATOR	LENGTH	TYPE	COMPLETION DATE	DESCRIPTION	REMARKS
Campbell and Converse Co. Gillette - Douglas (1)	Burlington Northern and Chicago & Northwestern Railroads	126 miles	Main Line	1976	Single track with numerous sidings	Delayed by Sierra Club injunction.
Sweetwater County to Black Butte mine (2)	Union Pacific Railroad	3 miles	Spur Line	1976-1977	15,000 feet includes loop	
Lincoln County to FMC strip mine (3)	Union Pacific Railroad	4.5 miles	Spur Line	1975		Probably already under construction.

TABLE 1. - Estimated annual non-energy mineral industry water needs, Yellowstone River Basin Study Area, 1975, 1985 and year 2000

	1975				1985				2000			
	New Water		Consumption		New Water		Consumption		New Water		Consumption	
	(million gallons)	(acre-feet)	(million gallons)	(acre-feet)	(million gallons)	(acre-feet)	(million gallons)	(acre-feet)	(million gallons)	(acre-feet)	(million gallons)	(acre-feet)
Wyoming study area												
Sand and gravel..........	58	178	6	18	58	178	6	18	87	267	9	28
Stone....................	50	153	4	12	25	77	2	6	42	129	3	9
Gypsum[1].................	90	276	36	110	113	347	45	138	150	460	60	184
Lime[2]...................	2	6	2	6	2	6	2	6	2	6	2	6
Copper...................	0	0	0	0	652	2,000	652	2,000	1,826	5,600	1,826	5,600
Total.................	200	613	48	146	850	2,608	707	2,168	2,107	6,462	1,900	5,827
Montana study area												
Sand and gravel..........	102	313	10	31	204	626	20	61	332	1,019	33	101
Stone....................	83	255	6	18	50	153	4	12	83	255	6	18
Lime[2]...................	5	15	5	15	5	15	5	15	5	15	5	15
Chromite.................	0	0	0	0	0	0	0	0	215	660	215	660
Total.................	190	583	21	64	259	794	29	88	635	1,949	259	794
North Dakota study area												
Sand and gravel..........	175	537	5	15	153	469	4	12	241	739	7	21
Stone....................	insig	insig	insig	insig	1	3	insig	insig	1	3	insig	insig
Nonbentonitic clay[3]......	10	31	10	31	10	31	10	31	10	31	10	31
Total.................	185	568	15	46	164	503	14	43	252	773	17	52
Total Yellowstone River Basin Study Area												
Sand and gravel..........	335	1,028	21	64	415	1,273	30	91	660	2,025	49	150
Stone....................	133	408	10	30	76	233	6	18	126	387	9	27
Gypsum[1].................	90	276	36	110	113	347	45	138	150	460	60	184
Lime[2]...................	7	21	7	21	7	21	7	21	7	21	7	21
Nonbentonitic clay[3]......	10	31	10	31	10	31	10	31	10	31	10	31
Copper...................	0	0	0	0	652	2,000	652	2,000	1,826	5,600	1,826	5,600
Chromite.................	0	0	0	0	0	0	0	0	215	660	215	660
Total.................	575	1,764	84	256	1,273	3,905	750	2,299	2,994	9,184	2,176	6,673

[1]Use in wallboard plants.
[2]Use in sugarbeet plants.
[3]Use in brickmaking plants.

YELLOWSTONE BASIN

AND
ADJACENT COAL AREA

LEVEL B STUDY

FINAL ISSUE PAPER

TONGUE-POWDER DIVISION
WYOMING

PREPARED BY

THE BUREAU OF RECLAMATION

MARCH 1977

YELLOWSTONE LEVEL B STUDY
TONGUE-POWDER DIVISION

OBJECTIVE

The plan of water development for the Powder River and adjacent coal areas includes Moorhead Unit with dam and reservoir, Crazy Woman Unit, Ucross Unit, and Piney Unit.

The economy of the study area is based primarily on livestock grazing. Irrigation is used as a means to supplement the winter feed base for livestock. The future of the area depends upon regulation of water for expansion of the agriculture base and full development of the vast coal fields.

Water shortages occur during the critical summer months with eighty percent of the rainfall occurring from April to July. Past irrigation developments have been by the private sector, with little coordination of facilities. An adequate water supply will depend on efficient use of existing structures and judicious addition of others.

Development of the vast coal reserves in the area would require large amounts of water. This, coupled with associated increases in population, would necessitate an integrated plan of water development. Without such a plan, conflicts of interest in the use of water would hinder optimum use of agricultural and mineral resources.

PROPOSED UNITS

Crazy Woman Unit

A semidetailed land classification found 10,120 acres of irrigated land; 4,680 acres of new land under existing ditches; and 25,340 acres of other arable land. Land selected for the unit consists of 4,270 acres of irrigated land; 1,650 acres of new land; and 3,600 acres of land requiring new facilities to be developed by the Bureau of Reclamation (BR).

The 3,600 acres would be served by Hepp Pumping Plant and Canal on Crazy Woman Creek and by Dick Ditch from Middle Fork Crazy Woman Creek. A water supply would be provided by construction of Prospector Reservoir on Bull Creek, supplemented by a diversion from Dull Knife Reservoir.

Dull Knife Reservoir was constructed, with SCS assistance, with capacity to meet only the requirements on North Fork Powder River, so an adequate water supply may not be available to Crazy Woman Unit.

Ucross Unit

The Ucross Unit includes land along Piney Creek below Lake De Smet Dam and on Clear Creek below its confluence with Piney Creek. Irrigation in the unit currently totals 7,480 acres. Irrigable lands under existing facilities total 1,450 acres; there are 1,970 acres for new irrigation under private development, and 1,330 acres for new irrigation by the BR. Storage requirements could be met by enlargement of Lake De Smet Reservoir.

The BR prepared plans to raise the lake level with an earthfill dam and construct facilities to serve 1,330 acres of full-supply land.

Piney Unit

Piney Unit consists of 20,460 acres of irrigated land, 12,270 acres of irrigable land under existing canals, and 2,020 acres of new land along several streams. This includes 11,150 acres irrigated with Piney Creek water along Prairie Dog Creek in the Tongue River drainage. The unit is the area that could be supplied by the proposed Willow Park Reservoir, operated with the existing Cloud Peak and Kearney Reservoirs.

A semidetailed land classification was made in 1949-51. Class 6W land totals 4,400 acres and Class 4P totals 6,300 acres.

Willow Park Reservoir site was proposed to meet storage requirements and would be operated with the existing Cloud Peak and Kearney Reservoirs. Release of water from the three reservoirs would serve supplemental supplies to 4,130 acres under existing diversions from Piney Creek and 11,150 acres on Prairie Dog Creek. Transbasin diversion from South Piney Creek to Prairie Dog Creek would be through existing canals.

Releases from Cloud Peak and Willow Park Reservoirs would be diverted to Rock Creek through the proposed South Piney--Rock Creek Diversion Canal. This water would serve 7,450 acres under existing diversions, 290 acres of new land proposed for private development, and 1,730 acres of new land on Box Elder Creek proposed for Bureau development. Water would be supplied through the proposed Rock Creek--Box Elder Creek Diversion Canal. Diversion from Box Elder Creek to new lands would have been effected by new works consisting of four gravity diversions and three pumping plants.

Since completion of this plan, Reynolds Mining Corporation has filed on all unused water in Piney and Clear Creek Basins and has proceeded with construction to utilize it.

MOORHEAD AND LOWER POWDER PUMPING UNITS

Moorhead Dam and Reservoir will provide storage for flood control, recreation, irrigation, municipal, and industrial use. The dam will be in Montana, about 3 miles north of the Montana-Wyoming State line. The Lower Powder Units will consist of several pumping plants scattered along Powder River Valley near Broadus, Montana. Irrigated lands will be on low benches and bottoms within the Powder River trench.

Dam and Reservoir: Moorhead Dam will be a rolled earthfill structure about 194 feet in height above streambed and about 3,050 feet long at the crest. A gate-controlled, overflow-type spillway will be located on the left side abutment. A river outlet works also will be located through the left abutment. The embankment will contain 9,160,000 cubic yards of fill material.

Moorhead Reservoir will have a surface area of about 18,200 acres, with a maximum width of about 1 mile, and will extend up the Powder River about 30 miles. Pertinent data on capacity and storage are shown in table 1.

Conservation storage will be expected to provide a firm ultimate annual yield of 108,000 acre-feet after considering required downstream releases to satisfy water rights and to maintain basic flows in the river. Sediment deposition would reduce total capacity of the reservoir by 625,000 acre-feet in a 77-year period. This will encroach on all storage functions, reducing the space available for conservation storage to about 275,000 acre-feet. By Year 100, storage would be further reduced by an additional 185,000 acre-feet of sediment. Capacities for each purpose will have to be adjusted by reducing flood control space or conservation space. An alternative would be to consider increasing the height of the dam, which may be shown to be

Table 1

Item	Elevation	Capacity in Acre-Feet: Initial	Year 77	Year 100
Top of Dam	3,554.0			
Surcharge (MWS)	3,548.4	124,000	124,000	124,000
Flood Control	3,542.0	250,000	250,000*	65,000*
Active Conservation	3,527.0	863,500	275,000*	275,000*
Dead & Inactive	3,410.0	36,500	0	0
Sediment	(3,350-3,542)	0	625,000	810,000
Streambed	335±			
Storage Capacity		1,150,000	1,150,000	1,150,000

*Elevations will be adjusted accordingly, depending on the areas in which sediment will be deposited.

feasible upon further study. An increase of 11 feet in elevation would provide approximately 200,000 acre-feet of additional storage.

The recreation plan for Moorhead Dam and Reservoir includes facilities for camping, picnicking, swimming, boating, and other water-oriented forms of recreation.

There will be 93,100 acre-feet per year available for municipal and industrial use in Wyoming and Montana, and 15,000 acre-feet per year for supplemental and full-service irrigation use.

Irrigation: Supplemental water service is proposed for 6,300 acres of land presently being irrigated, and full-service for 5,000 acres of new land. There are 61,600 acres of arable land adjacent to the river, but the area proposed for service was reduced due to lack of interest in irrigation and lack of water.

Unit lands would be on low benches and bottoms within the Powder River trench. The river meanders within the trench, separating the lands into many segments. Most of the proposed pumping units are thus confined to one or two river bends. Each such unit usually contains some overflow bottom, and one or more bench levels; so fields are limited in size and irregular in shape. Soils are stratified and of alluvial origin, ranging from sand to clay.

The first plan (plan number 1) considered storage for M&I water only. Plan number 2 considered storage for M&I water and supplemental water for current irrigation, and plan number 3 considered storage for M&I water and full service to new land for irrigation.

Alternatives: An alternative damsite, located about 13 miles below the Moorhead site, was examined. Costs were found to be excessive because the dam crest would be more than 2 miles long. Below this site, the valley walls are even farther apart, precluding consideration of a dam. Another site in Montana, about 3 miles below Moorhead Dam site, was examined for its capability of providing a smaller reservoir in connection with a reservoir in Wyoming. The upper site, about 45 river-miles above Moorhead damsite, would, in this case, control most of the sediment and provide most of the flood control storage. Preliminary estimates for this combination of dams showed that costs would be 1-3/4 times the cost of Moorhead Dam. Relocation of a highway, a railroad, and a town would be required with the upper site. Three other possible dam and reservoir sites were examined in Wyoming. These alternatives were found to have insufficient storage or were too costly. Offstream storage was found to be impractical because of the limited capacity of the reservoir sites and obvious high costs of diversion works and sediment control.

REJECTED UNITS - UNECONOMICAL

Kaycee Unit

The Kaycee Unit would be based on Hole-in-the-Wall Reservoir, located on the Middle Fork Powder River, to provide a supplemental water supply for 4,000 acres, a full water supply for 4,700 acres, and a water supply for future industrial use.

A new diversion dam would be constructed near the present dam. The existing Sahara Canal would be reconstructed for about 5 miles from the diversion and extended an additional 26 miles. The existing canal, from the end of the reconstructed portion, would be used as a distribution lateral for presently irrigated land. New irrigation works to be constructed would include two pumping plants, 12.8 miles of laterals, and a drainage system.

Land classification shows 6,017 acres of Class 1 and Class 2 lands and 2,678 acres of Class 3 land. The soils of the terraces range in depth from 10 to 20 feet and are underlain by gravel. The gravel bed can be intercepted by drains about nine feet deep. Some of the presently irrigated lands has a high water table, caused by shale barriers. On these lands, it is proposed to construct subsurface drains, relief drains, and outlets.

Buffalo Unit

The Buffalo Unit would consist of Camp Comfort Reservoir and 11,480 acres of land. The reservoir would be the only feature to be constructed by the Bureau of Reclamation. The lands and associated facilities would be developed by private concerns.

The reservoir site is located on Clear Creek, below the confluence of the North and South Forks.

KAYCEE UNIT

SUMMARY SHEETS

	Acre-feet (average annual)
Available water:	
Depleted inflow to reservoir	44,300
Downstream accretions and return flows	17,400
Requirements:	
Industrial water	10,000
Irrigation - Project land	29,200
- Nonproject land	9,800

PROJECT WORKS

Hole-in-the-Wall Dam:

Type	Earthfill
Height above ground surface	210 feet
Crest length	3,300 feet
Crest elevation	5,105 feet

Hole-in-the-Wall Reservoir:

	Acre-feet
Surcharge (5010-5098.6 ft.)	197,180
Active conservation storage (4946-5010 ft.)	40,000
Inactive storage (4910-4946 ft.)	5,000
Dead storage (4895-4910 ft.)	245

Outlet works:

Capacity with water level at 5098.6 feet	1,863 ft^3/s
Capacity with water level at 5010 feet	1,400 ft^3/s

Sahara Diversion Dam:

	Feet
Type - Concrete overflow weir with earthfill dike	
Overflow weir - crest length	110
- height above streambed	7.5
Dike - length	700
- width at crest	20
- height above streambed	19.5-21.5
Canal headworks (controlled by 2 8x5-foot slide gates):	
Capacity	178 ft^3/s

Sahara Canal (new):

Reconstruction of existing canal --------------	5 miles
New construction ------------------------------	26 miles
Initial capacity ------------------------------	178 ft^3/s

Sahara Canal (existing):

To divert from new canal at about mile 6. No rehabilitation of existing canal proposed.

Initial capacity ------------------------------	88 ft^3/s

Laterals:

Total length ----------------------------------	13 miles
Range in capacity -----------------------------	5-25 ft^3/s

Pumping plants (2):

	Capacity ft^3/s	Total dynamic head (ft)	Acres served
Plant No. 1 - High lift	4	65	138
- Low lift	5	23	168
Plant No. 2	3	20	94

Drains:

Open drains required --------------------------	10.8 miles
Closed drains required ------------------------	48.0 miles

The earthfill structure would be 200 feet high, 743 feet in crest length, and have an embankment volume of 1,737,000 cubic yards. The reservoir would impound 10,700 acre-feet of water, including 400 acre-feet of inactive storage. An uncontrolled overflow type spillway, capable of passing 27,000 ft^3/s, would be located on the left abutment.

French Creek Unit

The French Creek Unit includes 3,430 acres located along French Creek near Buffalo, Wyoming, to be served through the existing ditch system from the proposed Horton Reservoir.

The unit acreage of 3,430 acres includes 2,650 acres of presently irrigated land and 780 acres of new land.

The proposed Horton Reservoir would be an earthfill structure 123 feet high and 560 feet long, containing 512,000 cubic yards, and impounding 5,100 acre-feet. The concrete weir spillway would be a 40-foot cut through a saddle adjacent to the left abutment.

ALTERNATIVE RESERVOIR SITES

Moore Reservoir Site

This site was considered to serve either the Ucross Unit or partially serve the Buffalo Unit. It will be considered as a partial alternative to the Camp Comfort Reservoir site and as an alternative to the enlargement of Lake De Smet.

The Moore Reservoir site was rejected as an alternative to the Camp Comfort Reservoir site because it is located below lands in the upper portion of the Clear Creek Basin and would not permit full development of the Buffalo Unit. It was rejected as an alternative to Lake De Smet because of cost.

Little Sourdough Reservoir Site

This site was considered as an alternative to Camp Comfort Reservoir site, but was rejected because of inadequate capacity and water supply. Storage capacity sufficient to supply the upper portion of the Buffalo Unit could be developed, and if developed with the Moore Reservoir site, probably would permit full development of the Buffalo Unit.

Triangle Park Reservoir Site

This site was selected on the basis of early reconnaissance investigations to serve the French Creek Unit. It was rejected in favor of the Horton Reservoir site because of adverse geologic conditions causing seepage.

Bull Creek

This site was selected in the course of early investigations to serve the Buffalo Unit. Later it was rejected for the Camp Comfort site on the basis of comparitive costs and more favorable location of the Camp Comfort site.

Kearney Reservoir Enlargement

This site was considered as an alternative to the selected Willow Park Reservoir site. Rejection was based on severe seepage through a boulder-filled saddle near the right abutment.

Cloud Peak Reservoir Enlargement

This site was considered as an alternative to the Willow Park Reservoir site. It was rejected because of limited capacity without extensive dike work, relatively limited water supply, inaccessibility, and location within Cloud Peak Primitive Area.

SHERIDAN UNIT

This unit contains 38,100 acres of supplemental service land. Water would be supplied by a 25,000 acre-foot reservoir on South Fork Tongue River about 1.5 miles above its confluence with North Fork Tongue River. Reservoir water would be released into the river and would be deflected by a diversion dam located about 5 miles above Dayton, Wyoming, into a canal that would run along the right side of the river for about 2 miles. At this point it would branch into two main canals. One would extend northerly and the other southeasterly. Both canals would release water into various tributaries and creeks for diversion by existing canals to supplement irrigation of 38,100 acres. The south branch of the Sheridan Canal would have an initial capacity of 275 ft^3/s and the north branch 35 ft^3/s. Under this plan, a 25,000 kW powerplant would be installed downstream from South Fork Reservoir.

This unit has been rejected because of high construction costs.

CRAZY WOMAN UNIT
January 1977
$148 Full

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	
5,650 full supply acres	$ 724,100
7,390 supplemental supply acres	831,200
Total beneficial effects	$1,555,300
ADVERSE EFFECTS	
Investment	$ 979,600
OM&R	31,000
Total adverse effects	$1,010,600
NET BENEFICIAL EFFECTS	$ 544,700

CRAZY WOMAN UNIT

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation	1,555,300			1,555,300
Regional benefits				
Employment	735,200	-294,100	-441,100	0
Induced & stemming	2,303,200	-921,300	-1,381,900	0
Total beneficial effects	$4,593,700	-$1,215,400	-$1,823,000	$1,555,300
ADVERSE EFFECTS				
Investment	$ 979,600	$	$	$ 979,600
OM&R	31,000			31,000
Total adverse effects	$1,010,600	$	$	$1,010,600
NET BENEFICIAL EFFECTS	$3,583,100	-$1,215,400	-$1,823,000	$ 544,700

UCROSS UNIT
January 1977
$148 Full

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	
4,750 full supply acres	$682,600
7,480 supplemental supply acres	830,300
Total beneficial effects	$512,900
ADVERSE EFFECTS	
Investment	$398,500
OM&R	51,000
Total adverse effects	$449,500
NET BENEFICIAL EFFECTS	$ 63,400

UCROSS UNIT

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation	512,900			512,900
Regional benefits				
Employment	199,100	-79,600	-119,500	0
Induced & stemming	745,300	-298,100	-447,200	0
Total beneficial effects	$1,457,300	-$377,700	-$566,700	$512,900
ADVERSE EFFECTS				
Investment	$ 398,500	$	$	$398,500
OM&R	51,000			51,000
Total adverse effects	$ 449,500	$	$	$449,500
NET BENEFICIAL EFFECTS	$1,007,800	-$377,700	-$566,700	$ 63,400

PINEY UNIT
January 1977
$148 Full

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	
2,020 full supply acres	$ 266,400
15,280 supplemental supply acres	1,537,800
Total beneficial effects	$1,804,200
ADVERSE EFFECTS	
Investment	$ 733,200
OM&R	74,000
Total adverse effects	$ 807,200
NET BENEFICIAL EFFECTS	$ 997,000

PINEY UNIT

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation				
Full supply acres	266,400			266,400
Supplemental supply acres	1,537,800			1,537,800
Regional benefits				
Employment	573,800	-229,500	-344,300	0
Induced & stemming	2,742,200	-1,096,900	-1,645,300	0
Total beneficial effects	$5,120,200	-$1,326,400	-$1,989,600	$1,804,200
ADVERSE EFFECTS				
Investment	$ 733,200	$	$	$ 733,200
OM&R	74,000			74,000
Total adverse effects	$ 807,200	$	$	$ 807,200
NET BENEFICIAL EFFECTS	$4,313,000	-$1,326,400	-$1,989,600	$ 997,000

MOORHEAD UNIT
January 1975
Plan 1 and 2

PROJECT COSTS

Reservoirs and dams	$85,355,000
Total construction costs	$85,355,000

INTEREST DURING CONSTRUCTION

Total project cost	$85,355,000
Interest during construction (5 years)	$13,070,000

ANNUAL EQUIVALENT VALUE

Total project cost	$85,355,000
Interest during construction	13,070,000
Total investment	$98,425,000
Annual equivalent value	$ 6,044,000

MOORHEAD UNIT
January 1975
Plan 1
NED ACCOUNT

BENEFICIAL EFFECTS	
M&I	$8,263,000
Flood control	388,000
Recreation	95,000
Fish and wildlife	89,000
Total beneficial effects	$8,835,000
ADVERSE EFFECTS	
Investment	$6,044,000
OM&R	69,000
Total adverse effects	$6,113,000
NET BENEFICIAL EFFECTS	$2,722,000

MOORHEAD UNIT
Plan 1

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
M&I	8,263,000			8,263,000
Flood control	388,000			388,000
Recreation	95,000			95,000
Fish and wildlife	89,000			89,000
Regional benefits				
Employment	12,369,000	-4,948,000	-7,421,000	0
Induced & stemming	4,123,000	-1,649,000	-2,473,000	0
Total beneficial effects	$25,327,000	-$6,697,000	-$9,894,000	$8,835,000
ADVERSE EFFECTS				
Investment	$ 6,044,000		$	$6,044,000
OM&R	69,000			69,000
Total adverse effects	$ 6,113,000	$	$	$6,113,000
NET BENEFICIAL EFFECTS	$19,214,000	-$6,697,000	-$9,894,000	$2,722,000

MOORHEAD UNIT
January 1975
6,300 acres supplemental
$38
Plan 2
NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	$ 239,000
M&I	8,263,000
Flood control	388,000
Recreation	95,000
Fish and wildlife	89,000
Total beneficial effects	$9,074,000
ADVERSE EFFECTS	
Investment	$6,044,000
OM&R	1,000
Total adverse effects	$6,045,000
NET BENEFICIAL EFFECTS	$3,029,000

MOORHEAD UNIT
Plan 2

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation	239,000			239,000
M&I	8,263,000			8,263,000
Flood control	388,000			388,000
Recreation	95,000			95,000
Fish and wildlife	89,000			89,000
Regional benefits				
Employment	12,369,000	-4,948,000	-7,421,000	0
Induced & stemming	4,123,000	-1,649,000	-2,473,000	0
Total beneficial effects	$25,566,000	-$6,697,000	-$9,894,000	$9,074,000
ADVERSE EFFECTS				
Investment	$ 6,044,000	$	$	$6,044,000
OM&R	1,000			1,000
Total adverse effects	$ 6,045,000	$	$	$6,045,000
NET BENEFICIAL EFFECTS	$19,521,000	-$6,697,000	-$9,894,000	$3,029,000

MOORHEAD UNIT
January 1975
Plan 3

PROJECT COSTS

Reservoirs and dams	$ 85,355,000
Discharge lines, canals, laterals and drains	2,728,000
Total construction costs	$ 88,083,000

INTEREST DURING CONSTRUCTION

Total project cost	$ 88,083,000
Interest during construction	$ 13,488,000

ANNUAL EQUIVALENT VALUE

Total project cost	$ 88,083,000
Interest during construction	13,488,000
Total investment	$101,571,000
Annual equivalent value	$ 6,238,000

MOORHEAD UNIT
January 1975
$110 Full
Plan 3

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	
5,000 full supply acres 6,300 supplemental supply acres	$ 758,000
M&I	7,080,000
Flood control	388,000
Recreation	95,000
Fish and wildlife	89,000
Total beneficial effects	$8,410,000
ADVERSE EFFECTS	
Investment	$6,238,000
OM&R	38,000
Total adverse effects	$6,276,000
NET BENEFICIAL EFFECTS	$2,134,000

MOORHEAD UNIT
Plan 3

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation	758,000			758,000
M&I	7,080,000			7,080,000
Flood control	388,000			388,000
Recreation	95,000			95,000
Fish and wildlife	89,000			89,000
Regional benefits				
Employment	12,175,000	-4,870,000	-7,305,000	0
Induced & stemming	4,058,000	-1,623,000	-2,435,000	0
Total beneficial effects	$24,643,000	-$6,493,000	-$9,740,000	$8,410,000
ADVERSE EFFECTS				
Investment	$ 6,238,000	$	$	$6,238,000
OM&R	38,000			38,000
Total adverse effects	$ 6,276,000	$	$	$6,276,000
NET BENEFICIAL EFFECTS	$18,367,000	-$6,493,000	-$9,740,000	$2,134,000

MOORHEAD AND LOWER POWDER PUMPING UNITS

EQ ACCOUNT

BENEFICIAL EFFECTS

Areas of natural beauty and human enjoyment: An 18,200 acre reservoir will be created, along with recreational facilities, including access roads, parking areas, picnicing and camping facilities, toilets, and boat ramps. This will provide for water-oriented recreational activities such as boating, fishing, and water contact sports. The quantity and quality of fishing in the Powder River below the dam will be improved to some degree. Opportunities for pheasant hunting may improve, depending on extent of clean farming practices, changes to natural areas, and hunter accessibility. Some waterfowl hunting may also be provided.

Biological, geological, and ecological elements: The potential for establishing a viable fishery in the reservoir is good. The possibility of improving the fishery in the Powder River below the dam is poor to fair. The reservoir will provide some nesting and resting habitat for waterfowl, as well as suitable habitat for other water-oriented wildlife species. Irrigation development along the river has the potential for providing a better interspersion of food and cover for pheasants, depending on the degree of clean farming practices. Some aquatic furbearers and waterfowl may also be benefitted by increased irrigation development.

Archeological, historical, and cultural elements: There are no known archeological, historical, or cultural sites within the project area. However, a thorough archeological survey of the site prior to construction activities may reveal the existence of some historic or prehistoric sites.

Water quality: The project will result in improved downstream water quality by removing settleable solids, releasing cooler water, and by maintaining acceptable minimum flows during seasonal low-flow periods.

Air quality: The conversion of dryland farming acreage to irrigated cropland will help reduce wind erosion on those lands.

MOORHEAD AND LOWER POWDER PUMPING UNITS

EQ ACCOUNT

ADVERSE EFFECTS

Areas of natural beauty and human enjoyment: About 18,200 acres of natural prairie and riparian habitat will be inundated by the reservoir. The dam, recreational facilities, and exposed banklines during drawdown periods will be visual intrusions to the area, as well as pumping plants and electrical transmission systems in the irrigated areas. There will be some reduction in hunting opportunities for deer, antelope, and native grouse species in the reservoir and irrigation development areas.

Biological, geological, and ecological elements: There will be a loss of terrestrial flora and fauna on the 18,200 acres which will be inundated. In addition, there will be a loss of some big game and native grouse species as natural prairie habitat is converted to irrigated agriculture. About 30 miles of free-flowing stream habitat will be impounded. Coal deposits within the reservoir area will not be economical to mine. No other mineral resources will be affected.

Irreversible considerations: Materials used for construction will be irreversibly lost for the life of the project. Reservoir evaporation losses and consumptive use of water for irrigation will be irreversible. Inundation of coal deposits will be irreversible for the life of the project.

Water quality: There will be heavy sedimentation in the reservoir. Some evaporative losses in the impoundment will slightly increase the average salinity of the water downstream.

Air quality: Construction activities will create some temporary dust and aerial exhaust emissions. Exposed reservoir banklines will be subject to wind erosion during drawdown periods. If native rangeland is plowed and cropped, this will expose more land surface to wind erosion. The increased agricultural production will result in increased exhaust emissions and dust caused by farm machinery and will contribute to increases in aerial pollutants at sites of agricultural processing plants.

MOORHEAD UNIT
AND
LOWER POWDER PUMPING UNITS

SWB ACCOUNT

BENEFICIAL EFFECTS

Stabilized population: The construction of the project is expected to take two years. The number of onsite construction people is about 20 people. The total number of construction people and their families is 55 people. The increased income to the area as a result of the project may induce more young people to remain in the area.

Distribution of income: As farmers' incomes increase and they switch over to irrigated farming methods, incomes in the supply end of the agricultural industry will increase.

Stabilization of economic conditions: Farmers will be less dependent on the weather for incomes and also a wider choice of crops to be grown. As a result of the above factors, their average annual incomes will increase.

ADVERSE EFFECTS

Population impacts: Broadus is the main city in the area, with 800 people. The influx of 55 to 60 people could put some strain on the social services. The major areas will be the school, which will increase by 6 to 10 students. Housing and transportation will also present a problem. Water and sewer services will probably be the major problem areas.

KAYCEE UNIT
January 1977
$148 Full

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	
4,700 full supply acres	$ 675,400
4,000 supplemental supply acres	156,000
Recreation	142,000
Flood control	153,700
Total beneficial effects	$1,127,100
ADVERSE EFFECTS	
Investment	$1,696,000
OM&R	531,000
Total adverse effects	$2,227,000
NET BENEFICIAL EFFECTS	-$1,099,900

KAYCEE UNIT

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation				
Full supply acres	675,400			675,400
Supplemental supply acres	156,000			156,000
Recreation	85,200	28,400	28,400	142,000
Flood control	92,200	30,800	30,700	153,700
Regional benefits				
Employment	1,096,500	-438,600	-657,900	0
Induced & stemming	276,300	-110,500	-165,800	0
Total beneficial effects	$2,381,600	-$489,900	-$764,600	$1,127,100
ADVERSE EFFECTS				
Investment	$1,626,500	$	$	$1,626,500
OM&R	531,000			531,000
Total adverse effects	$2,157,500	$	$	$2,157,500
NET BENEFICIAL EFFECTS	$ 224,100	-$489,900	-$764,600	-$1,030,400

BUFFALO UNIT
January 1977
3,920 acres
$148 Full

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	$531,400
Total beneficial effects	$531,400
ADVERSE EFFECTS	
Investment	$856,000
OM&R	24,000
Total adverse effects	$880,000
NET BENEFICIAL EFFECTS	-$348,600

BUFFALO UNIT

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation	531,400			531,400
Regional benefits				
Employment	693,500	-277,400	-416,100	0
Induced & stemming	689,100	-275,600	-413,500	0
Total beneficial effects	$1,914,000	-$553,000	-$829,600	$531,400
ADVERSE EFFECTS				
Investment	$ 856,000	$	$	$856,000
OM&R	24,000			24,000
Total adverse effects	$ 880,000	$	$	$880,000
NET BENEFICIAL EFFECTS	$1,034,000	-$553,000	-$829,600	-$348,600

FRENCH CREEK UNIT
January 1977
3,430 acres
$148 Full

NED ACCOUNT

BENEFICIAL EFFECTS	
Irrigation	
780 full supply acres	$112,100
2,649 supplemental supply acres	103,300
Total beneficial effects	$215,400
ADVERSE EFFECTS	
Investment	$375,800
OM&R	16,300
Total adverse effects	$392,100
NET BENEFICIAL EFFECTS	-$176,700

FRENCH CREEK UNIT

RD ACCOUNT

BENEFICIAL EFFECTS	Region	Adjacent Region	Rest of Nation	Total
User benefits	$	$	$	$
Irrigation				
Full supply acres	112,100			112,100
Supplemental supply acres	103,300			103,300
Regional benefits				
Employment	282,000	-112,800	-169,200	0
Induced & stemming	273,600	-109,400	-164,200	0
Total beneficial effects	$771,000	-$222,200	-$333,400	$215,400
ADVERSE EFFECTS				
Investment	$375,800	$	$	$375,800
OM&R	16,300			16,300
Total adverse effects	$392,100	$	$	$392,100
NET BENEFICIAL EFFECTS	$378,900	-$222,200	-$333,400	-$176,700

YELLOWSTONE LEVEL B STUDY
TONGUE-POWDER DIVISION

EQ ACCOUNT

BENEFICIAL EFFECTS

Areas of natural beauty and human enjoyment: Create three reservoirs with a total capacity of 919,100 acre-feet. Provide recreation facilities--access roads, parking lots, boat ramps, fire grates, toilets.

Biological, geological, and ecological elements: Create some pheasant habitat in irrigated areas. Create some aquatic fur animal habitat in canal and laterals. Create some goose and duck nesting areas. Waste grains would provide waterfowl food. Maintain stable and adequate downstream flows.

Archeological, historical, and cultural elements: None.

Water quality: Remove some silt from streams.

Air quality: None.

ADVERSE EFFECTS

Areas of natural beauty and human enjoyment lost: Inundation of habitat. Visual effect of canal and laterals, diversion dam, pumping plants, dams, powerplants, transmission lines, access road, and recreation facilities. Visual impact from large lake level fluctuations. Displacement of wildlife from project area. Hunting would be lost on inundated acres plus other project lands. Fishing on streams would be eliminated.

Biological, geological, and ecological elements: Average annual streamflows would be decreased. The loss of secluded areas would affect big game animals. Valuable wildlife habitat would be lost. Moderate effect on aquatic fur animals in the main valley. Loss of sage grouse habitat.

Archeological, historical, and cultural elements lost: None.

Irreversible considerations: Area cannot return to its former condition after the economic life of the project is complete.

SWB ACCOUNT

BENEFICIAL EFFECTS

Stabilized population: Construction and operation of the proposed projects would create both temporary construction jobs and permanent onfarm work, thus helping to reverse the recent historical trend of out migration of young people.

Distribution of income: Stabilization of income would result to farmers and service-related commercial industries.

Increased employment: Employment of semiskilled labor would increase thru establishment of farm units.

Stabilization of economic conditions: A dependable water supply will help insure a consistent flow of farm commodities in the area.

ADVERSE EFFECTS

Population impacts: Local service facilities such as waste treatment plants, schools, and law enforcement capabilities may have to be upgraded.

YELLOWSTONE RIVER BASIN AND ADJACENT COAL AREAS

Montana, Wyoming, and North Dakota

LEVEL B STUDY

FLOOD CONTROL AND STREAMBANK EROSION CONTROL ALONG MAIN STEM REACHES

Position Paper By
Corps of Engineers
Missouri River Division
February 1977

The Yellowstone River originates in the cool green reaches of Yellowstone National Park. It travels some 600 miles before joining the Missouri River just across the Montana border in North Dakota. Indians named this stream "Rock Yellow River." The name probably originated from the yellowish rimrocks and bluffs which are evident along the river's lower reaches.

The Yellowstone River system drains one-fourth of Montana's land area and one-third of Wyoming's. Its main tributaries are the Shields, Boulder, Stillwater, Clarks Fork, Bighorn, Tongue, and Powder rivers. All except the Shields River flow in from the south. Swift water is the rule for the upper river, for it drops from an elevation of 7,564 feet above sea level at Yellowstone Lake to 2,831 feet at the mouth of the Bighorn River (an average slope of 15 feet per mile). From its source, the Yellowstone runs through steep-walled canyons almost due north to its confluence with the Shields River. This is a most scenic spot with high mountain ranges appearing at nearly every point.

From its junction with the Shields River, the Yellowstone takes an eastward direction. The river bottom widens and benchlands dotted with cottonwoods, juniper, and scrubby ponderosa pine look down on the valley. Water in the upper river runs clear and sparkling, but silt from tributaries burdens it as it proceeds eastward. By the time the Bighorn and Powder rivers have added their silty cargos, it seems almost a different stream.

The Yellowstone Valley is, in effect, an extended finger of the Great Plains!

(Above description partially extracted from an article in Midland Empire News Journal).

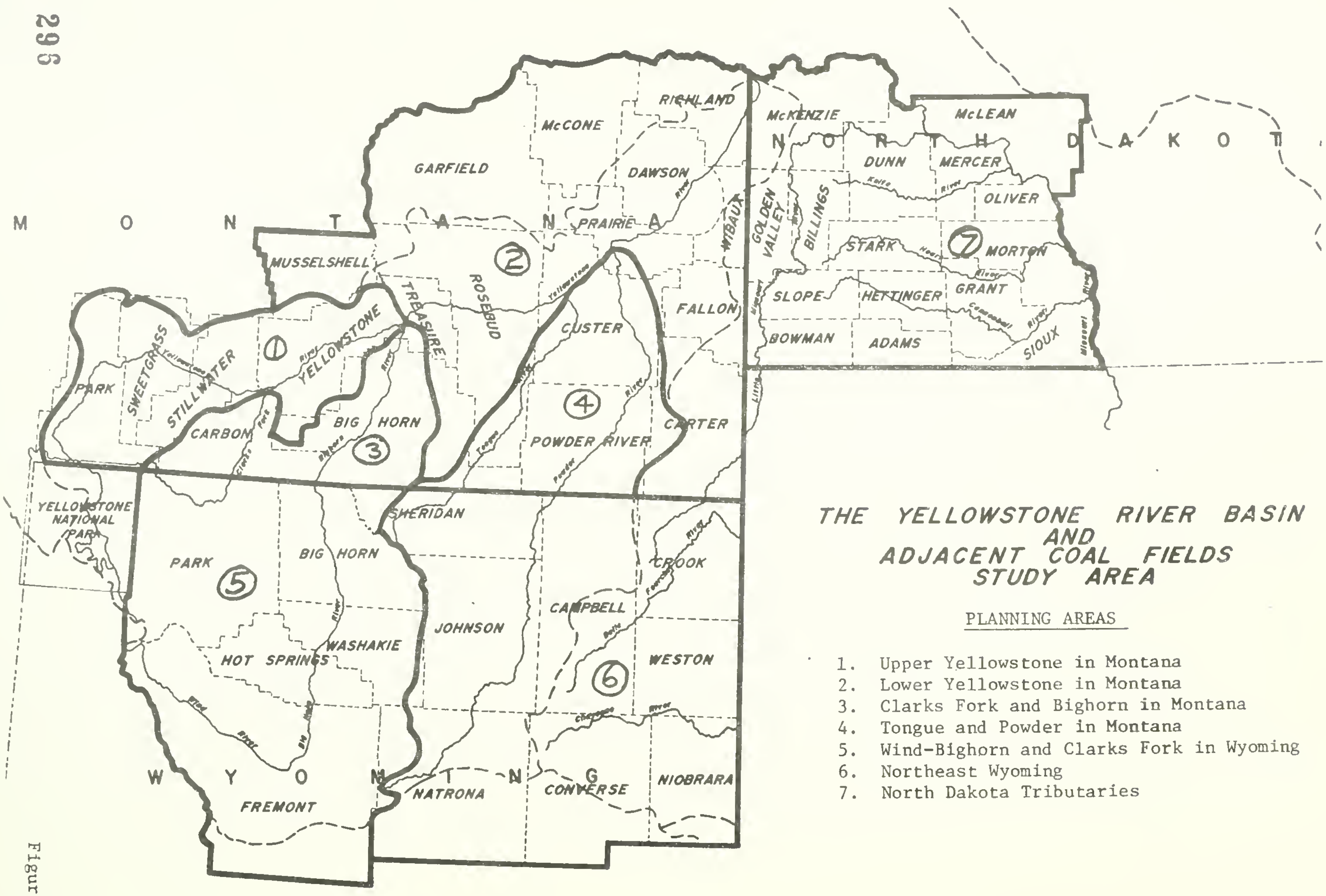

THE YELLOWSTONE RIVER BASIN
AND
ADJACENT COAL FIELDS
STUDY AREA
PLANNING AREAS
1. Upper Yellowstone in Montana
2. Lower Yellowstone in Montana
3. Clarks Fork and Bighorn in Montana
4. Tongue and Powder in Montana
5. Wind-Bighorn and Clarks Fork in Wyoming
6. Northeast Wyoming
7. North Dakota Tributaries
MONTANA
NORTH DAKOTA
WYOMING
McLEAN
McKENZIE
DUNN
MERCER
OLIVER
GOLDEN VALLEY
BILLINGS
STARK
MORTON
SLOPE
HETTINGER
GRANT
BOWMAN
ADAMS
SIOUX
RICHLAND
McCONE
GARFIELD
DAWSON
PRAIRIE
WIBAUX
FALLON
MUSSELSHELL
ROSEBUD
TREASURE
CUSTER
CARTER
POWDER RIVER
BIG HORN
CARBON
STILLWATER
SWEETGRASS
PARK
YELLOWSTONE
YELLOWSTONE NATIONAL PARK
SHERIDAN
CROOK
CAMPBELL
WESTON
JOHNSON
WASHAKIE
HOT SPRINGS
NIOBRARA
CONVERSE
NATRONA
FREMONT

Figure 1

BACKGROUND

During the early phase of the Yellowstone Level B Study, specific tasks were assigned to various agency representatives (federal, state, and local), with a given knowledge and capability to perform the assignments. Each group was to prepare a report describing the 1975 base condition and projected needs remaining to be met in the years 1985 and 2000. Work item No. 6 was assigned to the Corps of Engineers. That task involved updating (1) flood damages from the Missouri River Basin Framework Study and (2) streambank erosion damages from the National Streambank Erosion Assessment. The Corps was given responsibility for main stem reaches having at least 400 square miles of drainage area. The Soil Conservation Service was given responsibility for tributaries having less than 400 square miles of drainage area (Work Item No. 7).

Estimates of flood damages and streambank erosion damages for the main stem reaches were printed in a technical paper distributed in May 1976. That report contains a summary of the primary background material used in developing this position paper which presents potential projects to reduce damages from flooding and streambank erosion. The projections of future flood damages were based on the assumption that current trends toward increased flood plain regulation would continue into the future. Therefore, the flood damage estimates reflect increased flood plain regulation, but no additional structural measures, and would best fit the "without plan" condition. The Without Plan is defined as a baseline of projects and programs that will exist in the absence of future additional federal or state action. This condition establishes a benchmark for comparison against which to measure the beneficial and adverse effects of the National Economic Development (NED), Environmental Quality (EQ), or other alternative plans.

PLANNING AREA DESCRIPTIONS

The Yellowstone River Basin and adjacent coal areas in Montana, Wyoming, and North Dakota cover over 127,000 square miles. The study area was divided into seven planning areas along a combination of hydrologic and state boundaries as shown on Figure 1. The seven planning areas were named and described as follows:

1. UPPER YELLOWSTONE IN MONTANA - The Yellowstone River and its tributaries, except Clarks Fork, located above the mouth of the Bighorn River.

2. LOWER YELLOWSTONE IN MONTANA - The Yellowstone River and its tributaries, except the Tongue and Powder rivers, located below the mouth of the Bighorn River. (Includes the Little Missouri River portion within Montana).

3. CLARKS FORK AND BIGHORN IN MONTANA - The Clarks Fork and Bighorn rivers and their tributaries.

4. TONGUE AND POWDER IN MONTANA - The Tongue and Powder rivers and their tributaries.

5. WIND-BIGHORN AND CLARKS FORK IN WYOMING - The Wind-Bighorn and Clarks Fork rivers and their tributaries.

6. NORTHEAST WYOMING - The Tongue, Powder, Little Missouri, Belle Fourche, and Cheyenne rivers and their tributaries.

7. NORTH DAKOTA TRIBUTARIES - The Yellowstone, Little Missouri, Knife, Heart, Cannonball, and Grand rivers and their tributaries.

AREA OF RESPONSIBILITY

The division of responsibility between the Corps of Engineers and the Soil Conservation Service for developing flood damage estimates and evaluating potential projects was based on the procedure used in the Missouri River Basin Framework Study. Because there are significant differences in flood characteristics and the type of remedial measures needed to reduce flood damages, a general division of flood plain areas was based on the size of contributing drainage areas. Flood plains having drainage areas of less than 400 square miles were designated as "tributary" or upper watershed areas while those having more than 400 square miles were designated as "main stem" reaches.

FUTURE PROSPECTS WITHOUT A PLAN

The means of preventing or reducing flood damages fall into two classes - structural and non-structural. Structural means include:

(1) Dams

(2) Channel modification

(3) Levees

(4) Floodways

(5) Diversions

Structural measures for flood protection could be provided by modifying existing projects and by development of major storage reservoirs, small watershed projects, local protection projects for urban communities, or by channel improvements and rural levees along streams. Non-structural means include:

(1) Flood forecasting

(2) Flood fighting

(3) Floodway regulation

(4) Flood plain management and zoning (including flood insurance)

(5) Land conservation treatment measures

(6) Public purchase of flood plains

(7) Flood proofing of structures

Existing flood forecasting and flood fighting activities will continue and are reflected in loss estimates under existing and future conditions. By definition, the future without plan assumes no major federal or state expenditures for new construction. In other words, lacking plans for future structural measures, the means of reducing flood losses are limited to those nonstructural measures already in force. The States are already implementing flood plain management and zoning to prevent further buildup and increased damage in the flood plain. Strong federal impetus in this direction was added by the Flood Disaster Protection Act of 1973 which requires communities with special flood hazards to undertake prudent flood plain management measures or lose any financial assistance involving federal or federally guaranteed funds. It also provides for flood insurance. As a result, accelerated urban flood plain zoning and regulation seem assured.

STUDY PROCEDURES

The damage estimates were reviewed before various flood control alternatives were evaluated. Proposed projects from the Missouri River Basin Comprehensive Framework Plan, completed in 1971, were considered along with other agency studies undertaken in the past. In addition, an attempt was made to identify any new potential projects or new alternatives through input by local interests. Possible changes to existing projects, either structural or operational, were also considered. All of these potential solutions were then evaluated on a single-purpose basis using the costs and damage reductions (benefits) which would be provided by structures or improved management.

Planning involves a screening process. Planners cannot possibly make a detailed investigation of every conceivable alternative project. Therefore, many projects which would obviously be economically infeasible or physically impracticable are "screened out" of the evaluation process. Since the Yellowstone Level B Study is a reconnaissance level study, many of the remaining potential projects may be deleted during a later detailed investigation (Level C). Even though some of the potential projects are infeasible because of economic reasons or lack local support, they are still presented here for consideration by the State Study Teams. Some day,there may be another source of financial support (such as the States) or environmental considerations (such as with streambank protection) that may dictate a need for construction, even though economic costs far outweigh measurable monetary benefits.

EVALUATION OF POTENTIAL SOLUTIONS

A review of historical flood data indicates that total damages continue to increase, even though a large number of flood control programs have been implemented. There are two reasons for this paradox. First, long term economic trends have resulted in higher values for property, materials, and labor so that the value of improvements subject to flooding also continues to increase and flood losses themselves are consequently higher. Secondly, continuing economic expansion creates demands for land on which new improvements can be located. In many instances this has resulted in substantial encroachments onto the flood plains and additional sets of improvements subject to flood damage.

It is apparent that a need exists for flood plain management. With proper management of the water and the land subject to inundation by flood waters, the trend of increasing flood damages can be slowed materially, if not reversed. However, this is not a simple task. Studies can be made to determine the best use of the flood plain lands, recognizing the flood risk, but implementation of flood plain regulations involves property rights. Thus, legal authority must exist to initiate any planned regulation, and planned regulation of future flood plain development should be accomplished by all planning groups - federal, state, and local. This means that planning should not stop at flood control structures but should incorporate to some degree land use analysis reflecting local requirements for regulation and management of appropriate flood plain development.

Plan formulation during this study incorporated the assumption that proper urban flood plain regulation would occur under future conditions without any resource development plan. This conclusion was based on the fact that flood plain regulation is directed and is being implemented under existing State statutes and federal laws.

FLOOD CONTROL CRITERIA

The general criteria adopted for control of floods and the prevention of losses caused by floods included consideration of the types of areas subject to flood, the amount of average annual flood damage projected over the the long term, and generalized probabilities of flooding. The criteria also included the recognition that flood damage prevention could be achieved to varying degrees by structural and nonstructural means.

Structural measures for control of floods were considered to be important to the economic and social well-being of those urban areas where the existing level of flood damage is realtively high, where extensive improvements have already taken place on the flood plain, and where a large number of people are affected by recurring floods. To test for feasibility, structural measures were formulated for all urban areas having at least $15,000 in average annual flood damages to provide protection against floods having an exceedance frequency of 100 years. It was recognized that during future detailed studies, a more infrequent design discharge would probably be used for urban levees to provide a higher degree of safety. This criterion does not preclude flood plain land use regulation in conjuction with structural measures as a means of limiting future damage levels. In the urban areas where the flood problem is currently relatively minor, non-structural measures are proposed to keep the problem from increasing in intensity.

The application of structural measures to protect rural areas was determined by such basic indices as values in the areas and flood damages being sustained. Generally, the control of floods over relatively long reaches of principal streams would require reservoir regulation of high flows, but experience in the water resources field has shown that it is nearly impossible to justify major reservoirs for flood control in rural areas of the Great Plains because of the relatively low agricultural damages.

The benefits from structures for flood control and flood damage prevention are measured in terms of annual flood losses prevented, areas protected and managed, and land enhancement values created. In relation to other functional water resource developments, structural measures for flood control compete only with preservation of the existing environment. Generally, control of flood flows is a non-consumptive water use and, therefore, is compatible with other in-stream functions.

STREAMBANK EROSION

Bank cutting is the most common form of stream erosion and is most noticeable on the outside of river bends. It is a producer of stream-transported sediment. In many cases, however, partial replacement of soil loss from streambank erosion occurs through deposition on the inside curve in the same general reach. As the process grows more severe, the looping oxbows, typical of an alluvial stream, are formed. While balanced generally in terms of the entire river regime and while resulting in some high fish and wildlife habitat plus fertile floodplains, imposition on private land ownership patterns and damages to these lands are a serious problem.

Streambank erosion is a contributor of sediment which degrades the river water and causes a loss of productive land each year. The erosion is greatest on streams that in the past have been straightened and are now eroding to widen the channel, and on streams with sandy banks. Where streambank erosion is severe, it causes both economic and environmental losses. Past investigations have shown that construction of conventional streambank erosion control works on a broad scale for economic return cannot be justified. Further, it is not possible to compute the environmental benefits.

Under Section 32 of the Streambank Erosion Control and Demonstration Act of 1974, as amended by the Water Resources Development Act of 1976, authority for work under this act has been expanded to include the Yellowstone River from Intake, Montana to its mouth. The original act authorized work on the Missouri River in the reach below Garrison Dam and in the reach between Fort Randall dam and Sioux City. The intent of this program is to develop a demonstration of structural means for controlling bank erosion with a view toward developing the most cost effective and environmentally acceptable means. Several sites have been initially selected along the Missouri River in Nebraska, South Dakota, and North Dakota. Additional sites will be selected on both the Missouri and Yellowstone Rivers as funding and scheduling permit.

FLOOD CONTROL AND STREAMBANK EROSION CONTROL ALTERNATIVES

The updated estimates of current and future flood and streambank erosion damages prepared for this study permitted a re-evaluation of the alternatives which were considered in the past plus any new potentials. The major problem was one of economics - formulating a project whose benefits would exceed its costs. Higher interest rates and rapidly rising construction costs have made this task increasingly difficult despite higher crop prices and property values.

Cost estimates were based on 1975 levels and included all costs associated with development such as land, labor, materials, equipment, contingencies, and costs for engineering, design,and supervision. A general guide to the type and extent of costs which were considered included the following:

(1) Dams and Reservoirs - Primary costs involved right-of-way, relocations, embankment, spillway, outlet works, access roads, and facilities for recreation and fish and wildlife.

(2) Levees - Cost estimates included right-of-way, relocations, embankment, bridge raises, and interior drainage structures.

(3) Channel Modifications - Costs included right-of-way, relocations, excavation and spoil, riprap protection, bridge alterations, control structures, and access roads for operation and maintenance.

(4) Streambank Protection - Costs included right-of-way, earthwork, riprap and revetments, plus access required for operation and maintenance.

Average annual costs were based on 6-3/8 percent interest rate and a 50-year economic life of the project. Estimates of annual operation, maintenance, and replacement costs were also included for each potential project.

Flood control benefits were based on both current and future levels of economic development with future benefits being discounted back to the year when the project was assumed to be operational, in order to obtain the equivalent current benefits. The discount factors used for computing equivalent annual benefits were based on: (1) a straight-line growth between target years, (2) a 50-year economic life, and (3) a 6-3/8 percent interest rate. As it happened, all projects which showed economic justification did so in the near future time period and consequently were evaluated on benefits discounted to 1985. The remaining projects were evaluated under conditions projected for the year 2000, which was the most distant date for which detailed solutions were to be evaluated in accordance with the adopted criteria.

The following section contains a summary of information relative to existing projects, authorized projects, and potential projects for each of the seven planning areas within the Yellowstone River Basin and adjacent coal areas. In addition, the potential projects are presented under the 4-account system of evaluation. Several of the authorized projects are either economically infeasible or lack local support. Some have even been recommended for deauthorization. However, all Corps of Engineers projects which had been authorized in the past, but not constructed, were re-evaluated on a current economic basis and presented here for study team information.

1. UPPER YELLOWSTONE IN MONTANA

A. Existing Projects

Location: Upstream of Big Timber, Montana
Stream: Yellowstone River
Type of Protection: Bank protection upstream of county bridge.
Description: 0.25 miles of riprap along right bank.
Year Completed: 1973
Federal Cost: $49,000

Location: Downstream of Clyde Park, Montana
Stream: Shields River
Type of Protection: Bank protection upstream of Highway 89 bridge.
Description: 0.5 miles of riprapped channel improvement, plus right bank levee.
Year Completed: 1950
Federal Cost: $26,000

B. Authorized Projects

Location: Billings, Montana
Stream: Yellowstone River and tributaries.
Type of Protection: Levees, channels, diversion and drainage structures.
Description: 3 units (see below)
Year Authorized: 1950
Total Cost: $4,595,000

Billings Unit	Stream	Type of Protection	Total Cost
Eastern	Alkali Creek	Channel & levee along right bank	$ 395,000
Southern	Yellowstone R.	Levee & drainage structures	580,000
Western	Hogans Slough plus drainage ditches	Channel & levee diversion along Shiloh Road to Canyon Creek & Yellowstone River	3,620,000

STATUS: Both Eastern and Southern Units recommended for deauthorization in 1975 due to lack of economic justification and local support. A restudy of Western Unit was completed in 1970 which required relocation three miles west due to encroachment on authorized alinement. Feasible project at that time, but local interests couldn't contribute their share of costs ($1,120,000). The City of Billings and Yellowstone County were notified on 23 March 1976 that authorization would expire 5 years from that date unless they can provide required local cooperation.

C. Potential Projects

(1) Billings, Montana Western Unit
(2) Livingston, Montana levee

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Tributary flooding in western Billings, Montana
Potential Project: Construction of a diversion project consisting of a conduit, channels, levees, and a drop structure parallel to Shiloh Road (4.7 miles in length).

National Economic Development Account

Beneficial Effects:

Average annual benefits: $334,000

Adverse Effects:

Installation cost: $3,620,000
Interest during construction: None (short-term construction period)
Annual Investment Cost: $241,700
Annual operation, maintenance, and replacement: $5,300
Total annual Cost: $247,000

Benefit/Cost Ratio: 1.4

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

4 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$534,000 regional growth per year resulting from flood protection;
$362,000 added business created by construction activity.

Adverse Effects:

$247,000 total annual cost: 197 acres lost to land base;
$32,000 average annual residual damages.

Social Well-Being Account

Beneficial Effects:

Protects 2,080 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 60,000 residents;
Encourages more orderly development in protected areas.

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Flooding at Livingston, Montana
Potential Project: Construction of a 2.5 mile levee along the left bank of the Yellowstone River.

National Economic Development Account

Beneficial Effects:

Average annual benefits: $62,000

Adverse Effects:

Installation cost: $1,000,000
Interest during construction: none (short-term construction period)
Annual investment cost: $67,000
Annual operation, maintenance, and replacement: $3,000
Total annual cost: $70,000

Benefit/Cost Ratio: 0.9

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

10 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$99,000 regional growth per year resulting from flood protection;
$100,000 added business created by construction activity.

Adverse Effects:

$70,000 total annual cost; 20 acres lost to land base;
$11,000 average annual residual damages.

Social Well-Being Account

Beneficial Effects:

Protects 300 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 6,000 residents;
Encourages more orderly development in protected areas.

2. LOWER YELLOWSTONE IN MONTANA

A. Existing Projects

Location: Forsyth, Montana
Stream: Yellowstone River
Type of Protection: Levee and bank protection along right bank
Description: 2.5 mile levee
Year Completed: 1948
Federal Cost: $255,000

Location: Upstream of Miles City, Montana
Stream: Yellowstone River
Type of Protection: Raised road embankment for bridge
Description: 0.5 mile levee and riprap
Year Completed: 1950
Federal Cost: $24,000

Location: West Glendive, Montana
Stream: Yellowstone River
Type of Protection: Levee and diversion channel along left bank
Description: 2.2 mile levee and 0.2 mile new channel
Year Completed: 1959
Federal Cost: $230,000

B. Authorized Projects

Miles City, Montana local protection project (See Tongue and Powder Planning Area in Montana for details)

C. Potential Projects

(1) Miles City, Montana levee (See Tongue and Powder Planning Area in Montana for details)
(2) Lower Yellowstone streambank protection

POTENTIAL PROJECT EVALUATION

Type: Streambank Protection

Problem: Streambank erosion along the lower Yellowstone River between Intake, Montana, and the mouth of the river in North Dakota.

Potential Project: Installation of selective river management techniques using variations of several different types of structural bank protection measures at 24 key locations (Streambank Erosion Control Evaluation and Demonstration Act of 1974 plus amendments).

National Economic Development Account

Beneficial Effects:

Protection for extensive areas of irrigated land and irrigation facilities such as intakes, pumping plants, headgates, and pipelines along a 70-mile reach of the Yellowstone River. Because of the innovative and unproven techniques to be tested in this program, Congress has imposed no requirement for a display of economic feasibility and no attempt is made here to do so.

Adverse Effects:

Installation cost: $5,600,000
Annual investment cost: $374,000
Annual operation, maintenance, and replacement: $56,000
Total annual cost: $430,000

Environmental Quality Account

Beneficial Effects:

Elimination of a major source of sediment which will reduce turbidity levels.

Adverse Effects:

Temporary turbidity of river water at construction site. Disruption of vegetative cover on quarry sites to be used during construction. Conversion of some river fringe woodland to cultivated crops will reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

Stabilization of the location of high river banks along the valley lands reducing risk to dwellings, outbuildings, and cultivation activities. This eliminates a significant source of land damage that affects productivity and on-farm stability.

Adverse Effects:

Temporary loss of crop production at construction sites.

Social Well-Being Account

Beneficial Effects:

Protects livelihood of landowners affected. Improved water quality for all uses and general aesthetics of lands and streams.

3. CLARKS FORK AND BIGHORN IN MONTANA

A. Existing Projects

Yellowtail Dam and Reservoir (constructed by the Bureau of Reclamation) is located on the Bighorn River upstream of Hardin, Montana. It was completed in 1966 and has 500,000 acre-feet of flood control storage, of which 250,000 acre-feet is for joint use. This flood control storage benefits those people living along the lower Bighorn River valley plus those located on the flood plain along the lower Yellowstone River.

B. Authorized Projects

(None)

C. Potential Projects

(None)

4. TONGUE AND POWDER IN MONTANA

A. Existing Projects

Tongue River Dam and Reservoir (constructed by State of Montana in 1939) is located on the Tongue River north of Decker, Montana near the Wyoming State line. The reservoir has no storage reserved exclusively for flood control. However, flood damages from specific events may be reduced significantly, depending on the available storage in the reservoir at the time of the flood occurrence. This varies with the seasonal operating plan for the facility.

B. Authorized Projects

Location: Miles City, Montana
Stream: Tongue and Yellowstone Rivers
Type of Protection: Levee along right bank of both streams
Description: 3.0 mile levee
Year Authorized: 1950
Total Cost: $2,367,000
Status: Current study indicates feasibility and local support. The Phase I Advanced Engineering and Design Study is in progress and scheduled to be submitted to Washington in late 1977.

C. Potential Projects

(1) Miles City, Montana levee

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Flooding at Miles City, Montana
Potential Project: Construction of a 3.0 mile levee along the right bank of both the Yellowstone and Tongue Rivers.

National Economic Development Account

Beneficial Effects:

Average annual benefits: $232,000

Adverse Effects:

Installation cost: $2,367,000
Interest during construction: None (short-term construction period)
Annual investment cost: $158,000
Annual operation, maintenance, and replacement: $12,000
Total annual cost: $170,000

Benefit/Cost Ratio: 1.4

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

18 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$371,000 regional growth per year resulting from flood protection;
$236,000 added business created by construction activity.

Adverse Effects:

$170,000 total annual cost: 73 acres lost to land base;
$58,000 average annual residual damages.

Social Well-Being Account

Beneficial Effects:

Protects 1,300 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 9,000 residents;
Encourages more orderly development in protected areas.

5. WIND-BIGHORN AND CLARKS FORK IN WYOMING

A. Existing Projects

Location: Greybull, Wyoming
Stream: Bighorn River
Type of Protection: Levee along left bank
Description: 2.5 mile levee
Year Completed: 1959
Federal Cost: $249,000

Location: Upstream of Lovell, Wyoming
Stream: Shoshone River
Type of Protection: Bank protection between Highway 310 and Burlington Northern Railroad bridges to protect city intake structure.
Description: 0.3 miles of riprap along right bank
Year Completed: 1963
Federal cost: $31,000

Boysen Dam and Reservoir (constructed by Bureau of Reclamation) is located on the Bighorn River upstream of Thermopolis, Wyoming. It was completed in 1952 and has 150,000 acre-feet of storage reserved for flood control plus an additional 150,000 acre-feet of storage for joint conservation and flood-control use.

Buffalo Bill Dam and Reservoir (constructed by Bureau of Reclamation) is located on the Shoshone River upstream of Cody, Wyoming. The reservoir has no storage reserved exclusively for flood control. However, flood damages from specific events may be reduced significantly, depending on the available storage in the reservoir at the time of the flood occurrence.

B. Authorized Projects

(None)

C. Potential Projects

(None)

6. NORTHEAST WYOMING

A. Existing Projects

Location: Sheridan, Wyoming
Stream: Goose and Little Goose creeks
Type of Protection: Levees, channel cutoffs, floodwalls, drop structures, and paved chute.
Description: 6.4 miles of intermittent levees and channel improvements
Year Completed: 1963 (Stage I), 1966 (Stage II)
Federal Cost: $1,967,000

Keyhole Dam and Reservoir (constructed by the Bureau of Reclamation) is located on the Belle Fourche River about 20 miles west of Sundance, Wyoming. It was completed in 1952 and has 140,000 acre-feet of storage reserved for flood control plus 130,000 acre-feet of storage for joint irrigation, flood control, and maintenance of low flows.

B. Authorized Projects

Location: Sheridan, Wyoming (Stage III)
Stream: Goose Creek
Type of Protection: Channel cutoffs, floodwall, and levees upstream of Stage I
Description: 2.4 miles of intermittent levees and channel improvements
Year Authorized: 1950
Total Cost: $894,000
Status: Lacked local financing. The City of Sheridan was notified on 12 December 1975 that authorization would expire 5 years from that date unless they can provide required local cooperation.

Location: Buffalo, Wyoming
Stream: Clear Creek
Type of Protection: Diversion dam one mile upstream from Buffalo with new overflow channel connecting to existing drainage.
Description: Earthen dam and 0.4 mile diversion channel
Year Authorized: 1950
Total Cost: $2,679,000
Status: Considered for deauthorization because it is economically infeasible.

Location: Dayton, Wyoming
Stream: Tongue and Little Tongue Rivers

Type of Protection: Right bank levee on Tongue River plus tie-back levees along Little Tongue River plus some channel straightening.
Description: 2.1 miles of levee and 0.5 mile of channel improvements
Year Authorized: 1950
Total Cost: $497,000
Status: Recommended for deauthorization in 1974 because it is economically infeasible.

C. Potential Projects

(1) Sheridan, Wyoming levees and channel improvement (Stage III)
(2) Buffalo, Wyoming diversion dam and overflow channel
(3) Dayton, Wyoming levee

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Flooding at Sheridan, Wyoming
Potential Project: Construction of 2.4 miles of intermittent levees and channel improvements along Goose Creek upstream of Stage I.

National Economic Development Account

Beneficial Effects:

Average annual benefits: $43,000

Adverse Effects:

Installation cost: $894,000
Interest during construction: None (short-term construction period).
Annual investment cost: $60,000
Annual operation, maintenance, and replacement: $1,000
Total annual cost: $61,000

Benefit/Cost Ratio: 0.7

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

14 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$69,000 regional growth per year resulting from flood protection; $89,000 added business created by construction activity.

Adverse Effects:

$61,000 total annual cost; 31 acres lost to land base;
$7,700 average annual residual damages

Social Well-Being Account

Beneficial Effects:

Protects 200 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 10,000 residents;
Encourages more orderly development in protected areas.

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Flooding at Buffalo, Wyoming
Potential Project: Construction of a diversion dam and overflow channel on Clear Creek.

National Economic Development Account

Beneficial Effects:

Average annual benefits: $149,000

Adverse Effects:

Installation cost: $2,679,000
Interest during construction: None (short-term construction period).
Annual investment cost: $179,000
Annual operation, maintenance, and replacement: $8,000
Total annual cost: $187,000

Benefit/Cost Ratio: 0.8

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

14 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$238,000 regional growth per year resulting from flood protection;
$268,000 added business created by construction activity.

Adverse Effects:

$187,000 total annual cost; 37 acres lost to land base;
$1,000 average annual residual damages.

Social Well-Being Account

Beneficial Effects:

Protects 100 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 3,000 residents;
Encourages more orderly development in protected areas.

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Flooding at Dayton, Wyoming
Potential Project: Construction of 2.1 miles of levees and channel improvements along the Tongue and Little Tongue Rivers.

National Economic Development Account

Beneficial Effects:

Average annual benefits: $19,600

Adverse Effects:

Installation cost: $497,000
Interest during construction: None (short-term construction period).
Annual investment cost: $33,200
Annual operation, maintenance, and replacement: $500
Total annual cost: $33,700

Benefit/Cost Ratio: 0.6

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

11 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$31,000 regional growth per year resulting from flood protection;
$49,000 added business created by construction activity.

Adverse Effects:

$33,700 total annual cost; 13 acres lost to land base;
$1,000 average annual residual damages

Social Well-Being Account

Beneficial Effects:

Protects 60 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 400 residents;
Encourages more orderly development in protected areas.

7. NORTH DAKOTA TRIBUTARIES

A. Existing Projects

Location: Marmarth, North Dakota
Stream: Little Missouri River and Little Beaver Creek
Type of Protection: Raised levee along left bank of both streams
Description: 2.4 miles of levees
Year Completed: 1959
Federal Cost: $170,000

Location: Mandan, North Dakota
Stream: Heart River
Type of Protection: Left bank levee and channel cut-off for Mandan and right bank levee for Training School
Description: 4.4 miles of levee and 0.5 mile channel cut-off
Year Completed: 1959
Federal Cost: $677,000

Location: Mandan, North Dakota
Stream: Lower Heart River
Type of Protection: Additional channel and levee work both upstream and downstream of Mandan
Description: 3.8 miles of levees, drainage structures, and 1.5 miles of channel relocation.
Year Completed: 1963
Federal Cost: $1,961,200

Location: Scranton, North Dakota
Stream: Buffalo Creek
Type of Protecton: Channel straightening and levees along both banks
Description: 1.0 mile of channel improvement plus 0.5 mile of dual levees.
Year Completed: 1959
Federal Cost: $103,000

Location: Haley, North Dakota (6 miles upstream)
Stream: North Fork of Grand River
Type of Protection: Bowman-Haley Dam and Reservoir
Description: 73,200 acre-feet of flood control storage
Year Completed: 1970
Federal Cost: $4,372,000

Location: Riverdale, North Dakota
Stream: Missouri River
Type of Protection: Garrison Dam and Reservoir
Description: 1,500,000 acre-feet of exclusive flood control storage.
Year Completed: 1955
Federal Cost: $300,000,000

Location: Garrison Dam to Lake Oahe
Stream: Missouri River
Type of Protection: Streambank stabilization
Description: Dikes and revetments at seven critical locations
Year Completed: Under construction (80 percent complete)
Federal Cost: $9,200,000

Heart Butte Dam and Reservoir (constructed by the Bureau of Reclamation) is located on the Heart River about 15 miles south of Glen Ullin, North Dakota. It was completed in 1949 and has 150,000 acre-feet of storage reserved for flood control.

B. Authorized Projects

Location: Mott, North Dakota
Stream: Cannonball River
Types of Protection: Channel improvement and levees along both banks.
Description: 2.0 miles of levees and 0.6 mile channel improvement.
Year Authorized: 1958
Total Cost: $2,215,000
Status: Considered for deauthorization because it is economically infeasible.

C. Potential Projects

(1) Mott, North Dakota levee
(2) Lower Yellowstone Streambank Protection (see Lower Yellowstone Planning Area in Montana for details)
(3) Buford-Trenton Irrigation District - interior drainage
(4) Missouri River streambank protection
(5) Knife River National Historic Site - streambank protection

POTENTIAL PROJECT EVALUATION

Type: Local Protection Project
Problem: Flooding at Mott, North Dakota
Potential Project: Construction of a 2-mile levee and channel improvements along both banks of the Cannonball River.

National Economic Development Account

Beneficial Effects:

Average annual benefits: $112,000

Adverse Effects:

Installation cost: $2,215,000
Interest during construction: None (short-term construction period).
Annual investment cost: $147,900
Annual operation, maintenance, and replacement: $5,100
Total annual cost: $153,000

Benefit/Cost Ratio: 0.7

Environmental Quality Account

Beneficial Effects:

Improved human environment through weed reduction, better drainage, and mosquito control.

Adverse Effects:

3 acres of clearing and grubbing would reduce wildlife habitat.

Regional Development Account

Beneficial Effects:

$179,000 regional growth per year resulting from flood protection;
$221,000 added business created by construction activity.

Adverse Effects:

$153,000 total annual cost; 54 acres lost to land base;
$15,000 average annual residual damages.

Social Well-Being Account

Beneficial Effects:

Protects 140 acres of urban land and improvements from flooding;
Enhances the health and social well-being of 1,300 residents;
Encourages more orderly development in protected areas.

POTENTIAL PROJECT EVALUATION

Type: Interior drainage
Problem: Waterlogging at the Buford-Trenton Irrigation District which is located upstream of Williston, North Dakota along the left bank of the Missouri River (near the upstream end of Lake Sakakawea).
Potential Project: Construction of an earth-fill block for the riverward end of the main drain in the West Bottoms, with a gated conduit to permit gravity drainage during low Missouri River stages. When stages are higher, the gates will be closed and the water level in the main drain will be regulated by two 3,600 gallon per minute pumps discharging over the earth block into the Missouri River. A similar installation is proposed for the Middle Bottoms, [redacted]

This plan has been presented by the Corps during formal meetings of the Buford-Trenton Irrigation District in April and July of 1976 and has been indorsed both times as much preferable to land acquisition and meriting a trial. The Corps concluded these works could be designed and accomplished within existing authorities at the Garrison project and has proceeded with the task. It is planned to have the facilities operational by the start of 1978 irrigation season. Total cost of the plan is estimated at $500,000.

Since the solution is implementable within existing Corps authority and no need exists for recommended further action at this time, the on-going planning for improvement of interior drainage need not be included in the Recommended Plan.

POTENTIAL PROJECT EVALUATION

Type: Streambank Protection
Problem: Streambank erosion along the Missouri River between Garrision Dam and Lake Oahe.
Potential Project: Installation of selective river management techniques using variations of several different types of structural bank protection measures at 21 key locations (Streambank Erosion Control Evaluation and Demonstration Act of 1974 plus amendments).

National Economic Development Account

Beneficial Effects:

Prevention of the permanent loss of 60 acres per year of valley lands along the 80-mile reach of the Missouri River downstream from Garrison Dam. Because of the innovative and unproven techniques to be tested in this program, Congress has imposed no requirement for a display of economic feasibility and no attempt is made here to do so.

Adverse Effects:

Installation cost: $7,100,000
Annual investment cost: $474,000
Annual operation, maintenance, and replacement: $71,000
Total annual cost: $545,000

<u>Environmental Quality Account</u>

Beneficial Effects:

Elimination of a major source of sediment which will reduce turbidity levels.

Adverse Effects:

Temporary turbidity of river water at construction site. Disruption of vegetative cover on quarry sites to be used during construction. Conversion of some river fringe woodland to cultivated crops will reduce wildlife habitat.

<u>Regional Development Account</u>

Beneficial Effects:

Stabilization of the location of high river banks along the valley lands reducing risk to dwellings, outbuildings, and cultivation activities. This eliminates a significant source of land damage that affects productivity and on-farm stability.

Adverse Effects:

Temporary loss of crop production at construction sites.

<u>Social Well-Being Account</u>

Beneficial Effects:

Protects livelihood of landowners affected. Improved water quality for all uses and general aesthetics of land and streams.

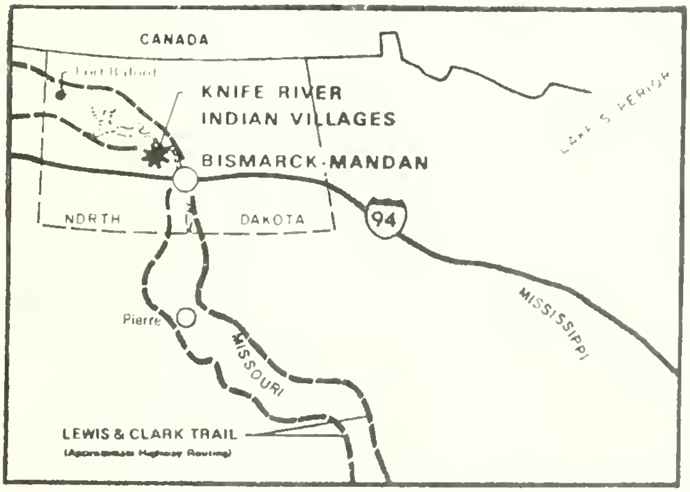
POTENTIAL PROJECT EVALUATION

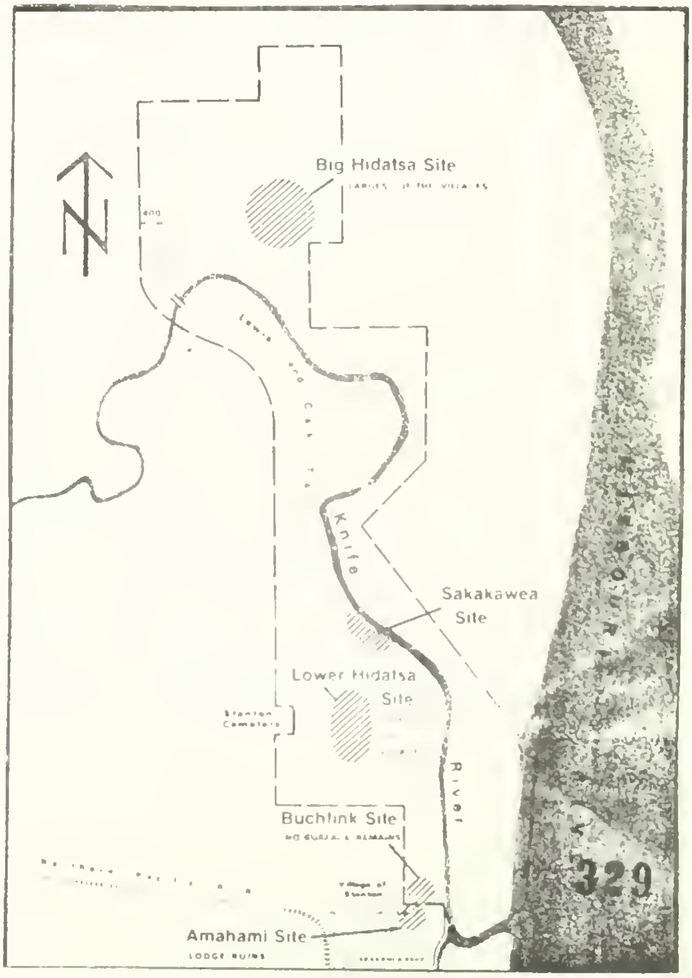
Problem: Streambank erosion at Knife River Indian Villages National Historic Site near Stanton, North Dakota

Potential Project: Construction of a berm and rock protection along an 1,800-foot reach of river bank at the Sakakawea Site.

Owner: The Knife River Indian Villages National Historic Site near Stanton, North Dakota, is administered by the National Park Service. The superintendent of Theodore Roosevelt National Memorial Park at Medora, North Dakota, is in charge of the Stanton Site.

Location: Stanton, North Dakota (1970 population of 517) is located about fifty miles northwest of Bismarck, North Dakota, near the confluence of theKnife River and the Missouri River. The Knife River Indian Villages National Historic Site is located immediately north of Stanton and covers an area of about 1,200 acres (see maps). The streambank erosion problem is located along the Knife River at the Sakakawea Site.





Historical Background: The Hidatsa Indians, along with their Mandan and Arikara neighbors to the south, were village Indians living along the Missouri River at the time of the first Euro-American contact. They gardened and hunted along the Missouri River from the 10th through the 19th centuries. Preserved at the newly established Knife River Indian Villages National Historic Site are house rings of their earth lodges, cache pits and fortifications.

The villagers here on the Knife River were the northwestern-most effective gardeners in North America, but they were heavily dependent upon buffalo hunting and the use of other wild foods. Their ability to survive in this area was due in part to their use of other available foods in addition to the beans, sunflower seeds, squash and corn that they grew. Villages on the terrace rims were centrally located for fishing and flood plain horticulture. Buffalo, elk, deer, antelope, waterfowl, and various small game animals were hunted on the terraces and bluffs.

Indian settlers were well established by the 13th century in villages between the Knife and Heart Rivers. Their early rectangular lodges were clustered in small open villages. The Knife River Village of Buchfink (see map) is believed to be similar to these early sites.

By the late 15th-early 16th centuries, the small villages with rectangular houses were replaced by larger, compact and sometimes fortified villages with circular earth lodges. Such villages ranged in size from those with a few to those with over 100 lodges. In fact, when these villages were lived in, the population was likely greater than it is now in this area of North Dakota.

The earliest circular earth lodges at Lower Hidatsa (see map) were probably occupied by 1675. However, this early occupation may have been Mandan rather than Hidatsa. The Hidatsa cannot be distinguished from the Mandan in the prehistoric records. The key to this separation lies in part in the Knife River Villages and will have to be verified by archeological work at the site.

The first recorded Euro-American visit to the Missouri River Village tribes was made by an explorer la Verendrye in 1738 with a visit to the Mandan. The first documented contact with the Hidatsa was by the explorer David Thompson in 1797.

By the late 18th-early 19th centuries, the Knife River Villages were the main bastions of the Hidatso Indians. Intertribal trade was fortified and expanded by the influence and presence of Euro-Americans within the Villages. During this time the village tribes of the Missouri River rode a wave of prosperity and cultural changes. The Hidatsa and Mandan were middlemen, or brokers, in a trade network between the Crow of the upper Yellowstone; Cheyenne and Arapahoe of the Plains to the southwest; and Assiniboin, Cree, and Dakota of the northeastern Plains.

Although the patterns and objects of trade, resulting social interactions, and pressures changed through time, the trade networks themselves can be traced back through the prehistoric period.

The Lewis and Clark Expedition, arriving in October 1804 at the three Hidatsa villages on the Knife River, wintered through April of 1805 at Fort Mandan, a few miles below the Knife River Villages. Toussaint Charboneau and his Shoshone wife Sakakawea joined Lewis and Clark at Fort Mandan.

Current Conditions: The Knife River Indian Villages National Historic Site was authorized as part of the National Park System on 26 October 1974 to preserve and interpret the irreplaceable archeological resources of the area. The National Park Service is in the process of acquiring the needed land parcels for the National Historical Site. Of primary consideration and importance are the four or five Indian Village Sites, one of which is located along the bank of the Knife River. Due to meandering of the alluvial river, there has been considerable streambank erosion and some loss of the archeological resource at the river village site (Sakakawea). Therefore, the National Park Service requested the Omaha District Office of the Corps of Engineers to design some type of corrective action along that portion of the riverbank adjacent to the Sakakawea Site.

The rise and fall of the Knife River in this area is about 12 feet and the river width about 200 feet. The high earth bank where the village site is situated varies in height from about 20 to 32 feet. The opposite bank varies from only about 10 to 12 feet in height. This bank is much lower since it is actually part of the Missouri River overflow area. This low overbank area provides releif during high flows on the Knife River and reduces the flood threat at the Sakakawea Site.

Alternative Designs: Two physical constraints severely limit the options available for bank protection construction techniques: (1) the proximity of the Indian lodge sites to the river's high bank precludes any construction activity along the high bank, unless extensive measures are undertaken to protect and preserve the lodge sites during the construction activity; and (2) the large sandbar and delta formation at the Knife-Missouri confluence precludes consideration of floating plant to accomplish construction of any bank stabilization measures. In light of these restrictions, the placement of a narrow berm along the toe of the high bank would be essential to implement bank stabilization. Such a berm could be a temporary facility to be removed after construction of the bank stabilization structures. However, considering access for future structure maintenance, it would be desirable to incorporate a permanent berm into the protective system.

Four alternative protection designs were considered. Two of the designs incorporated a small permanent random-fill berm along the high bank toe and provided for riprap or gabion berm slope protection (Riprap consists of a layer of large stones, while gabions are wire baskets containing medim-sized stones). The other two designs indicated direct stabilization of the high bank with riprap or gabions. These latter two designs included the use of a temporary berm to facilitate construction. Gabions would function adequately but they require about the same quantity of stone as riprap protection and with added handling. Also, the wire baskets are susceptible to ice damage.

In addition to the above, piling and retaining wall cribbing stabilization measures were briefly considered. Any type of pile structure would be difficult and expensive to place, because of the numerous rock outcroppings and boulders in the bank and riverbed. Earth-fill timber or metal cribbing lack the flexibility necessary to conform to the irregular bank and bed shapes and to "self-mend" random scour holes. Both piling and cribbing structures are aesthetically and environmentally undesirable.

Based on a preliminary investigation, the typical section indicated on Sketch 1 was recommended as the best project option for the following reasons:

a. It is the most economical plan, considering the construction difficulty factor, as well as material quantities.

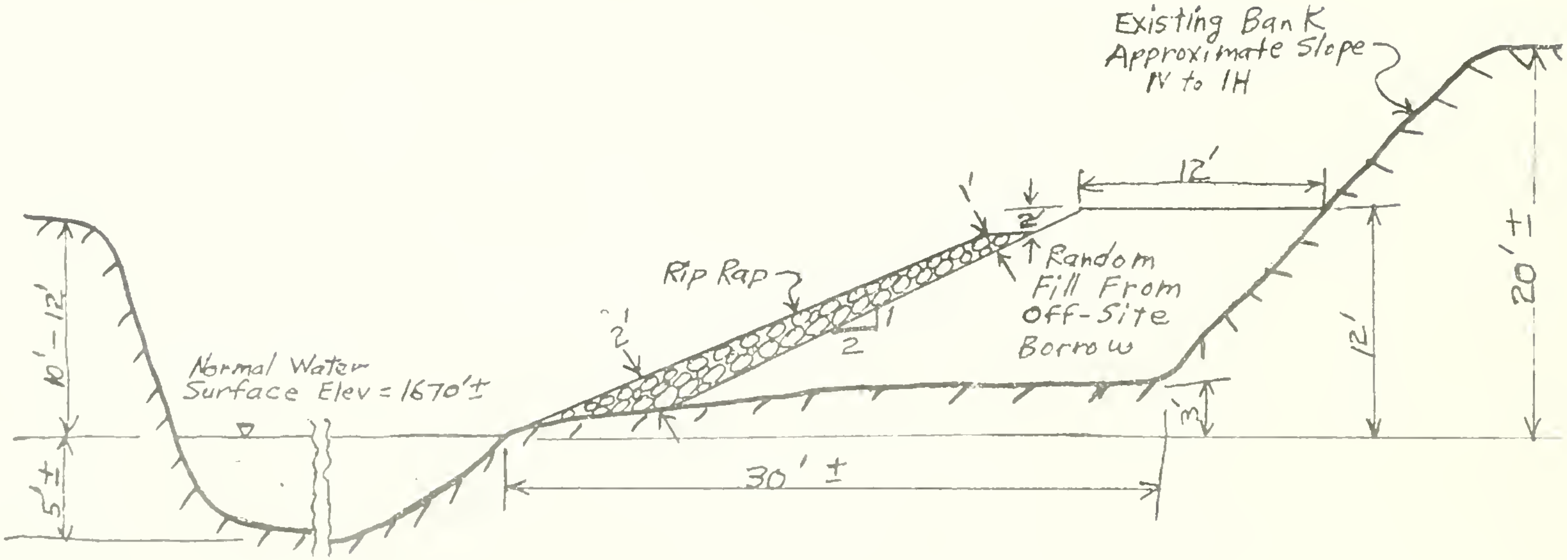
b. Required maintenance would be limited to basically simple, common procedures, such as occasional groundkeeping and the infrequent addition of minor amounts of stone to reinforce deteriorated segments and keep the riprap properly dressed to design line and grade.

c. Maintenance would be easily accomplished by using the permanent berm for access,

d. If desirable, the berm surface could be sufficiently upgraded to provide a public roadway access to the river for fishing or other recreational pursuits.

The following estimate reflects the cost (1975 price levels) anticipated for the Corps of Engineers to design and construct (by contract) 1,800 linear feet of the recommended structural system:

Item	Quantity	Unit	Unit Cost	Total Cost
Fill	12,600	c.y.	$ 2	$25,200
Riprap	3,600	tons	14	50,400
			Subtotal	$75,600
		* Contingencies (20%)		15,200
			Subtotal	$90,800
		Engineering & Design		7,100
		Supervision & Admin		7,100
			TOTAL	$105,000



Scale : 1" = 10'

Section Viewed Looking Downstream

Permanent Berm
Rip Rap Slope Protection
Prepared 10 July 1975

This estimate does not provide for anything other than design and construction of the bank protection. All necessary supplemental actions, such as securing project funds and complying with the National Environmental Policy Act would be performed by the National Park Service.

Four-Account Analysis: The potential plan element is a rather simple case evaluated under the 4-account analysis. There are no measurable beneficial effects under the National Economic Development Account. The degree of tourist visitation would probably not be affected with the project, although the quality of the visitations would probably be enhanced. Adverse effects under the NED Account include the following:

Installation Cost: $105,000
Interest during Construction: none (short-term construction period)
Annual investment cost: $7,013 (6-3/8 percent for 50 years)
Annual OM&R: $525 (one-half of one percent)
Total Annual Cost = $7,538

With similar assumptions, there would be no measurable benefits under the Regional Development Account or the Social Well-Being Account, disregarding the tourism which probably would occur anyway, without the project. There might be a minor amount of undetermined increase in local employment during project construction and operation.

This potential project would help protect an area of archeological and historical significance. One of the principal purposes behind the establishment of the Knife River Indian Villages National Historical Site is to protect their archeological and historical resources. The national significance of the Hidatsa Villages was affirmed in 1964 when the Advisory Board on National Parks, Historic Sites, Buildings and Monuments certified the Big Hidatsa Village for designation as a viable National Historic Site. A primary objective of the area is to preserve the irreplaceable archeological reosources and restore the natural setting of the period of historic importance; and to stabilize and reconstruct the historic scene to best protect the area and still provide adequate public access for the desired visitor experience.

It is believed that the Sakakawea Site on the southwest bank of the Knife River was built by the people of the Lower Hidatsa Village after the river changed its course and left the old village back from the river. Covering about 8 acres, the site was protected by a ditch and palisade (fence of long stakes). About 40 earth lodge sites can be identified today. Pottery, bone, stone, and other artifacts have been found at this site. The potsherds (pieces of earthenware) are decadent Mandan types and the lodges were circular. Considerable contact material and metal projectile points are found there. This is the village where the Shoshone Indian maiden, Sakakawea, was taken by a Hidatsa war party and where she married the French Trader Toussaint Charboneau who lived in the village.

ENVIRONMENTAL PROTECTION AGENCY

MAJOR WATER QUALITY ISSUES IN NORTHEAST WYOMING

The following is a reconnaissance of the major water quality concerns in Northeast Wyoming. Too often, water resources planning has proceeded without adequate consideration of water quality. This report is intended to provide an overview of current and potential water quality issues in the region so that recommendations regarding water quantity management can be integratedd with water quality management.

Water resources can provide an array of beneficial uses including public water supply and other domestic uses, various agricultural uses, industrial water supply, recreation, and serve numerous ecological functions including fish and wildlife. Each beneficial use, however, is predicated on the availability of water of suitable quality for that use.

There can be no doubt of the widespread public interest and support for achieving high quality water resources. Several very significant legislative acts at the Federal and State levels are testimony of the strong public interest in water quality. A major milestone was the enactment of the Federal Water Pollution Control Act Amendments (Public Law 92-500) by the 92nd Congress in October, 1972. The objectives of this Act were clearly stated to include:

> "It is the national goal that the discharge of pollutants into navigable waters be eliminated by 1985; and
>
> It is the national goal that wherever attainable, an interim goal of water quality which provides for protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

To achieve this goal substantial effort has been made in control of point sources of pollution in the study area and also in the evaluation of nonpoint sources of pollution. Water quality inventories and management plans have been developed by the Wyoming Department of Environmental Quality in response to Section 303(e) of Public Law 92-500. These plans describe the general character of the Northeast Wyoming River Basin region, its water quality, and provide a basic framework for future management.

Another important planning effort is the 208 Water Quality Project conducted by the Powder River Areawide Planning Organization. This effort focuses on water quality studies in Sheridan, Johnson, and Campbell counties. The project is charged with developing an implementable water quality management plan by November 1, 1977.

It is not the intent of this issue paper to review the preceeding efforts; however, much valuable information is contained in the reports issued by the Wyoming Department of Environmental Quality and the Powder River Areawide Planning Organization and any interested reader is urged to examine them for more specific information on water quality.

WATER QUALITY ISSUES

The following items are a brief discussion of some of the major water quality issues in the Northeast Wyoming Study Area. Although lack of time prevented a detailed analysis of these issues within the context of the Level B Study, the items are discussed in sufficient detail to be included in the reconnaissance level planning effort for the Yellowstone River Basin.

Energy Development Impact

The Powder River Basin is the scene of increased development in the coal mining industry. At the present time this development primarily centers on the dry, east side of the Powder River Basin. There is, however, a substantial potential for mining on the west side of the Basin. On the west side where streams are perennial there is a greater potential for pollution to the waters. There are many uses of the waters and each of these can cause pollution problems. Now, with mining taking a major role in the area, the possibility of pollution increases. There is a need to determine the cumulative effects of a number of mining operations on a single drainage, as well as the cumulative effects of mining operations in combination with other land use practices on a single drainage. There is also a need to determine the effects of mining operations on groundwaters, especially where those groundwaters contribute to the flow of perennial streams or are a source of domestic or municipal use waters.

Population Growth Impact

The increase in energy development has brought a large increase in population to the area. This growth increase creates strains on maintaining proper sanitary facilities within the area. Municipal sewer treatment systems have become overloaded and as a consequence discharge improperly treated sewage into the streams. Because of these discharges, there are a number of stream segments within the Basin which will not meet the present or future instream water quality standards.

The increased population growth has also resulted in the development of numerous rural subdivisions where central sewage systems are not available. This has meant a large increase in the use of on-site disposal systems. The increase in on-site disposal systems brings with it the increased potential for ground and surface water pollution. In Wyoming, state regulations are basically unenforceable because of the lack of personnel necessary to inspect proposed sites and construction practices.

Improper locations and improper construction are the primary reasons for on-site disposal system failure. The increase in on-site disposal systems usually means an increase in the use of individual water wells. Where densities of both become high, the potential for health hazards always exists, especially if the disposal systems or wells are not properly installed.

Agricultural Impact

Approximately 80% of the water within the Powder River Basin is utilized by agriculture. Yet there does not exist the baseline data necessary to properly evaluate the effects of agricultural practices on the quality of the waters in the Basin. Because of this lack of proper data, imposition of present and proposed Federal regulations controlling discharges of agricultural waters is basically a guessing game.

Reconnaissance studies in the area have shown large increases in total dissolved solids and turbidity in streams where irrigation use is prevalent.

Winter cattle feeding is carried out in irrigated hay fields bordering streams and rivers in the area. The potential of accumulated animal wastes being flushed into the waterways during the spring irrigation season is high.

Sediment loading along the Powder River is high. However, there does not appear to be the data necessary to determine how much of the sediment loading is natural and how much is man-caused.

All of these problems have the potential of being man-caused and, at least to some degree, correctable. Yet without the data to define just what is caused by man and what is a natural occurrence, the imposition of control measures could very well be arbitrary and prove useless.

RECOMMENDATIONS FOR WATER QUALITY MAINTENANCE AND IMPROVEMENT

(1). In areas where salt loadings have the potential to adversely affect the beneficial uses of the waters, regulations should be enacted which would control the amounts of salt loading to an acceptable level.

(2). Education programs are needed to explain the methods and beneficial uses of proper management procedures which will minimize salt loadings as well as other pollutants such as organics, sediment and biological pollutants.

(3). Legislation is needed which will protect groundwater supplies which are used for domestic, municipal and agricultural purposes.

(4). Increased funding by the Federal government in the construction grants program is necessary if municipal discharges are to meet the 1977 secondary standards. The high costs of sewage treatment facilities make it nearly impossible for individual communities to totally fund such construction.

(5). Wastewater planning for small communities in energy impact areas should include a program of septic tank control as an alternative to construction of a collection system and centralized treatment. Such control would influence design, construction, and maintenance of on-lot disposal systems. EPA has just recently started endorsing the septic tank option as a potential alternative for small communities.

Local level control of the use of on-site disposal systems is needed. High densities, improper site selection and improper installation are usually the cause of system failure and groundwater pollution. A local level of control is needed to insure that the regulations are properly enforced.

(6). A major groundwater quality concern raised by the 208's is the pollution/contamination caused by poor drilling practices occurring during the exploratory phase of mineral and coal development. Attention should be given to this through state control.

(7). Once the strip mining legislation is signed, the states should be encouraged to quickly go about defining those lands "unsuitable for mining" in accordance with the guidelines given in the legislation. This would involve the finalization of local land use plans, identification of prime ag lands, and other land use definition exercises. The land classification of "unsuitable lands" will invariably influence the timing and extent of mining activity which, in term, influences the pattern of water resource utilization.

(8). The State of Wyoiming has taken an active role in mining control. One suggestion might be to have personnel representing mining engineering <u>and</u> water quality expertise located at the remote stations near the mine sites. To date, Wyoming has placed only the mine engineer type person in the mining field offices.

RECOMMENDED RESEARCH AND DATA NEEDS

(1). Future water quality monitoring should have the purpose of differentiating non-point source pollution from federal lands versus nonfederal lands. It has been claimed that in the State of Wyoming that the majority of non-point source pollution is related to land use activities on federally managed land. This implies something about the role of the federal agencies in non-point source control.

(2). Studies are needed to determine the amount of man-caused sediment versus natural-caused sediment pollution and to determine whether it is economically as well as environmentally feasible to alleviate the conditions.

(3). The study of groundwaters around mining operations is important. This is especially true for mining activities in alluvial valleys where groundwaters may be important in recharging flowing streams or around groundwater fields which are important as domestic, municipal or agricultural water supplies.

(4). Increased monitoring of ground and surface waters in areas of high septic system usage is important to protect these waters from pollution and aid in the protection against potential health hazards.

(5). In-depth water quality investigations should be undertaken to determine the effects of irrigation practices on the waters of the area.

(6). Investigations of winter cattle feeding on fields bordering streams should be conducted to determine what effects the practice may have on water quality.

(7). Salt loading investigations have been contracted by the Powder River 208. However, there is a need to perform salt loading studies on drainages where pollutants from various sources may reach a cumulative level which could be deleterious to beneficial uses of the waters downstream.

CONCLUSIONS

At both the State and Federal levels, the legal mandates for maintaining and improving water quality are very explicit. Through provisions of the Federal Water Pollution Control Act Amendments of 1972 considerable progress has been made in achieving water quality goals.

Point sources of pollution are being brought under control although increased funding of the construction grants program would help to achieve deadlines for meeting secondary discharge standards. Perhaps the most challenging water quality problems are in the category of nonpoint pollution which includes natural sources, agriculture, and urban runoff. Potential impacts of energy development and related activities also loom as critical water quality issues.

Enforcement of existing legislation, combined with educational programs to encourage individual action to improve water quality, can be an effective strategy for attaining desired water quality standards.