BIG LOST RIVER BASIN WATER RESOURCES ASSESSMENT

Phase 1 Report

for

Custer Development Corporation
Mackay, Idaho

CH2M HILL

September 1979

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WATER RESOURCES

ASSESSMENT

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Mackay, Idaho

by

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INTRODUCTION

AUTHORIZATION AND FUNDING

Work for this report was completed under a contract approved by the Custer Development Corporation (CDC) on 14 June 1979. The contract was approved by the State of Idaho on 20 June 1979. The work for this study has been accomplished in accordance with a request for proposals from the Custer Development Corporation dated 5 April 1979 and the CH2M HILL proposal dated 4 May 1979 titled "Proposal-Feasibility Study-Assessment of Water and Power Development Potential of the Big Lost River Valley."

The work was partially funded with grants from the State of Idaho and the Economic Development Administration to the CDC under Grant No. 07-06-02088.40, effective 10 January 1979.

SCOPE OF WORK

The scope of the study is basically an assessment of the potential for development of the water resources in the Big Lost River Valley.

The CH2M HILL proposal dated 4 May 1979 recommended a two-phase approach to the assessment. Phase 1 would examine a large number of projects and, based principally on available data, assess the current potential feasibility of these projects considering potential costs and benefits. For those appearing to have merit, more detailed examination would be conducted in Phase 2.

On the basis of the 4 May 1979 proposal, as modified by agreement with the Custer Development Corporation on 29 May 1979, the study subjects were to be grouped in the following categories.

1. Groundwater recharge in the Chilly Flats area

   The goal of this element is to examine the potential for causing additional infiltration of surface water into the groundwater supply in the Chilly Flats area. Through this addition, the intent is to augment the late season flow of the Big Lost River, tributary to the Mackay Reservoir and below.

2. Lowhead hydroelectric generation in the Big Lost River Valley

   This element examines the potential for adding hydropower generation at Mackay Dam as well as other sites in the valley.

3. Natural head irrigation in the Big Lost River Valley

   The goal of this alternative is to provide water at sprinkler operating pressure to farms throughout the valley by using a pipeline distribution system utilizing available elevation differences to develop the required pressure.

   Should excess head be available at some points along the pipeline, this element would examine the potential for hydropower development at that site.

4. Reduced leakage through and around Mackay Dam

   There is a significant seepage under and through Mackay Dam which reduces the quantity of stored water available from each year's runoff and reduces the quantity that can be carried over from one year to the next. Possibly, advances in seepage control procedures would permit reducing the seepage.

5. Examine additional storage potential

   This element examines the feasibility of increasing the height of Mackay Dam and storing additional water in the Mackay Reservoir if element 4 proves to be feasible. In addition, the element examines previously studied storage sites to determine if storage might now be feasible with consideration of other benefits, particularly hydropower.

6. Cedar Creek diversions

   Examine the potential for piping or otherwise conveying flow from Lower and Upper Cedar Creeks directly to Mackay Reservoir or directly into the irrigation distribution system so that these flows are available more directly for irrigation.

The costs presented in this report should be considered as order of magnitude cost estimates. For the most part, the costs are developed from curve data giving cost versus size and other approximate procedures. The cost figures presented will generally fall in the range of 50 percent higher to 30 percent lower than the actual cost which would be incurred if construction were undertaken at this time. The costs developed are intended only for initial screening of alternatives and not as a basis to develop financing.

The costs presented are at anticipated January 1980 price levels. Construction costs have been escalating at the rate of 10 to 15 percent per year in recent years.

In general, all costs were developed by CH2M HILL for this report. For Antelope Dam and Reservoir (discussed in Section 6), costs were taken from an SCS report and adjusted for change in price levels. For hydropower potential, procedures being used in the Rural Energy Initiatives Program were used.

Most of the data presented in the report are based on existing data and data from CH2M HILL experience rather than detailed field work. Field inspection work was done for the Chilly Flats area recharge project, for the natural head irrigation project, and for a seepage reduction/replacement dam project at Mackay Reservoir. The field work consisted of a site visit by study staff and visual examination of the project areas.

ACKNOWLEDGMENTS

Throughout the course of the Phase 1 study, the government officials of the Big Lost River Valley in both Custer and Butte Counties were very cooperative and helpful in furnishing the information, data, and suggestions. We wish to especially acknowlege the help of the Custer Development Corporation Board and staff, the Big Lost River Irrigation District Board Chairman and staff, and the District 34 watermaster.

STUDY AREA

The Big Lost River Valley lies on the north side of the Snake River Plain. The valley extends from Arco, on the north edge of the plain, northwestward 55 miles. The elevation in the basin ranges from 5,300 feet at Arco to 5,900 feet at Mackay and to the highest point in Idaho on Mount Borah at 12,660 feet.

The drainage basin boundary and location map are shown in Figure 1.

Geologically, the basin in the reach from above Mackay to Arco consists of relatively deep alluvium on the valley floor underlain by relatively impervious rocks underneath and on each side. Because of the pervious nature of the alluvium, there is a continual interchange of water between the surface streams and groundwater as streams traverse the valley. In places, the entire flow of the Big Lost River is below ground until forced to the surface by some relatively impervious zone of the valley fill material. Also, because of the alluvium filling the valley floor there is a large groundwater reservoir which is relatively available through wells.

The average annual rainfall at Mackay is 9.8 inches. The distribution and quantity of the rainfall is such that agriculture depends largely upon irrigation for crop production.

The principle economic activity in the valley is agriculture, although a significant portion of the labor force in the valley works at the National Laboratory to the southeast.

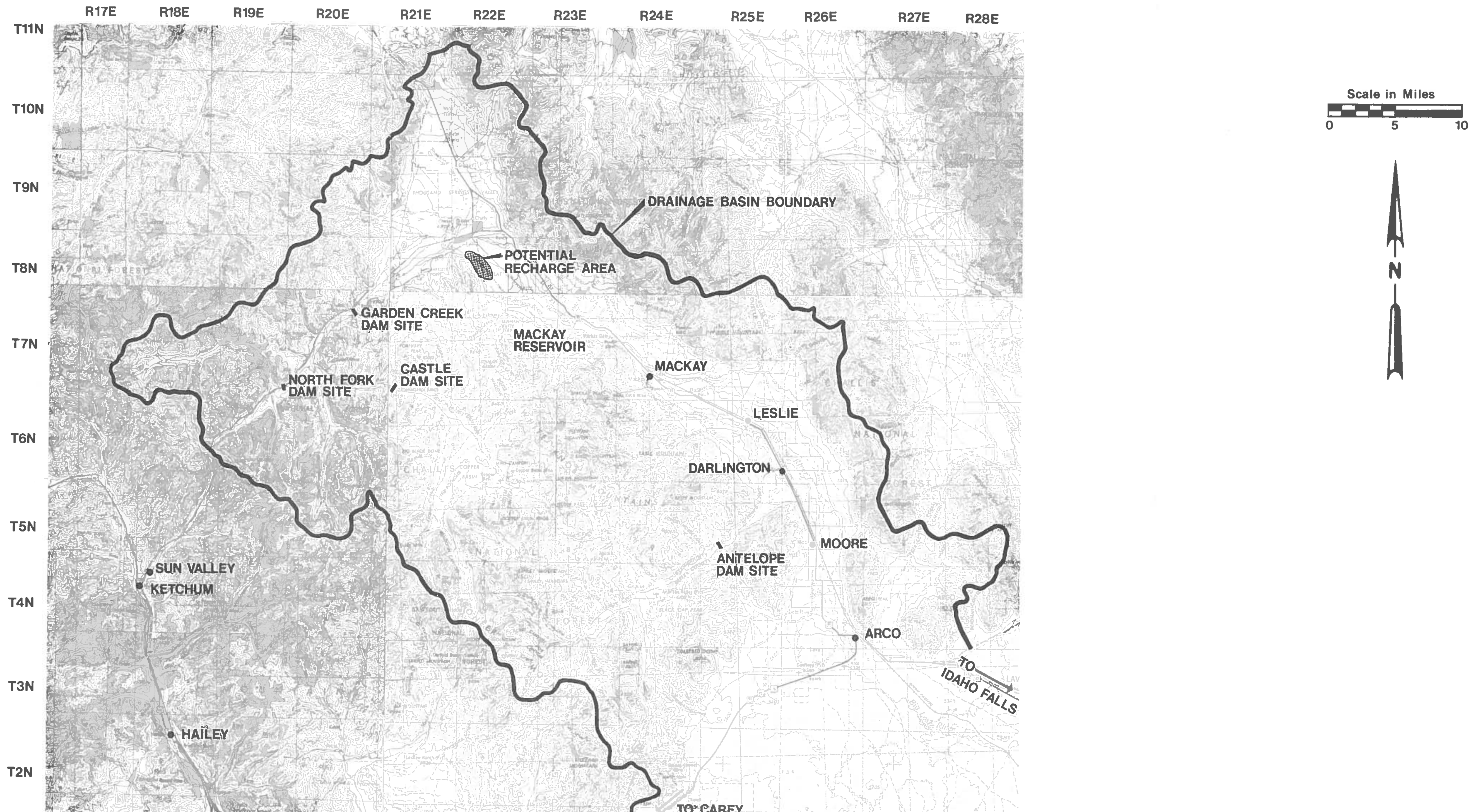

FIGURE 1
Big Lost River Basin
Area Map

CH2M HILL

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SECTION 2

SECTION 2

GROUNDWATER RECHARGE IN THE CHILLY FLATS AREA

The goal of this alternative is to infiltrate added water into the groundwater in the Chilly Flats area. By adding water to the groundwater, particularly during periods of excess surface runoff, the total stored water in the valley can be increased. Since much of the groundwater in the Chilly Flats area eventually shows up as surface flow in the vicinity of Mackay Narrows (1.5 miles downstream from the dam), added infiltration in the Chilly Flats area would provide some needed additional storage.

WATER AVAILABLE FOR RECHARGE

The maximum average volume of water available for artificial recharge in the Chilly-Barton Flats is 5,700 acre-feet per year. During the 17 years of usable record (water year 1961 - 1977) the recharge potential ranged from 0 to 28,240 acre-feet per year. The average recharge rate during periods available for recharge is 250 cfs, ranging from 19 to 690 cfs. The monthly and yearly summary of recharge potential is shown in Table 2-1. The calculated values of recharge were computed only for days that Mackay Reservoir was considered to be full (greater than 44,000 acre-feet). During those days, the streamflow at the USGS gage below the Mackay Dam was subtracted from the flow at Howell Ranch. This procedure assumes that no water is lost (naturally recharged) in the reach between Howell Ranch and the reservoir. If 100 cfs is lost on the average in this reach, then the average volume available for artificial recharge is 3,400 acre-feet

TABLE 2-1
AVAILABLE RECHARGE SUPPLY

	MAY			JUNE			JULY			
Water Year	Average Recharge Volume (af)	Number of Days of Recharge	Average Recharge Rate (cfs)	Average Recharge Volume (af)	Number of Day of Recharge	Average Recharge Rate (cfs)	Average Recharge Volume (af)	Number of Days of Recharge	Average Recharge Rate (cfs)	Yearly Total (af)
1961										
1962										
1963	1,380	1	690	14,780	30	246				16,160
1964				5,266	8	329	1,500	5	150	6,766
1965										
1966										
1967				2,100	3	350	1,280	6	107	3,380
1968				4,476	9	249				4,476
1969				2,340	12	98				2,340
1970				12,056	23	262	486	13	19	12,542
1971				3,180	10	159	1,228	11	56	4,408
1972				4,388	16	137				4,388
1973										
1974				2,640	5	264	1,950	11	89	4,590
1975				28,240	22	642				28,240
1976	10,350	13	398							10,350
								TOTAL		97,640
								AVERAGE		5,743

NOTE: These volumes do not take into account diversions for irrigation between the Howell gage and Mackay Reservoir. Those diversions would reduce the flow available for recharge.

per year. The computation of this volume does not consider diversions made between the Howell gage and Mackay Dam. The volume would thus be somewhat high especially for the higher flows.

RECHARGE METHODS

Three major methods of artificial recharge are: recharge wells, recharge pits and basins, and surface spreading. Recharge wells can be eliminated from consideration because of the high initial cost ($10,000 to $20,000 per well) and the need for large settling basins to remove all sediment from the flood flows prior to recharge. The sediment must be removed to prevent plugging of the groundwater aquifer at and near the well bore.

For recharge pits or basins, the initial recharge rate is estimated to be 100 acre-feet per acre per day. Because of the shallow depth to water, however, the soil will become quickly saturated if the recharge water is confined to a series of recharge pits. If pits are to be used, the total holding capacity would have to be in the range of 3,000 to 5,000 acre-feet. For these reasons, recharge pits can be eliminated from consideration. Therefore, the only practical alternative is surface spreading. The minimum estimated surface area for this type of facility ranges from 850 to 1,450 acres, assuming a depth to water of 20 feet and porosity of the soil equal to 20 percent.

The preceding analyses were based on average volumes of potential recharge water and complete saturation of the soil to the land surface. The optimal sizing of a recharge facility should account for these and, therefore, should be designed somewhat larger.

For preliminary purposes, a diversion structure in Section 12, T8N R21E has been assumed. A canal from the diversion to spreading areas, on public domain, in Sections 8, 9, 10, and 15, T8N R22E would be about 5 miles long.

ESTIMATED COSTS

The estimated capital costs are broken down into the river diversion, main canal, and spreading furrow preparation categories.

Annually, there would have to be a program to renew and open up the spreading furrows. The frequency with which this must be done would vary with the frequency of use and the sediment load. For preliminary purposes, reworking one-half of the area each year has been assumed. For operation of the headgate to deliver water to the spreading area, use the cost for water distribution by the watermaster of approximately $0.20/cfs day. For preliminary purposes, the cost of the diversion dam and canal maintenance has been assumed as 5 percent of the capital cost per year.

These costs are summarized in Table 2-2.

TABLE 2-2

TOTAL ESTIMATED COSTS

<u>Capital Costs</u>

River diversion	$ 20,000
Flow measurement	5,000
Canal - 5 miles @ $8,000	40,000
Spreading area - 1,000 ac @ $10/ac	10,000
TOTAL ESTIMATED CAPITAL COST	$ 75,000

<u>Annual Costs</u>

Debt Service on Capital Cost - 10 years @ 8%	$ 11,000
Spreading area rework - 500 ac @ $10/ac	5,000
Water distribution - 1,700 cfs days @ $0.20	300
Dam and canal maintenance - 5%/year	3,000
TOTAL ESTIMATED ANNUAL COSTS	$ 19,300

DISCUSSION AND RECOMMENDATION

Although the recharge is technically feasible, the procedure is full of uncertainty with respect to detail. For example, the Crosthwaite report (Reference 1, page 101)[1], indicates a range of time for the recharge to reach the Mackay Reservoir of 3 to 18 months. This range results both from lack of sufficently detailed data on the groundwater system and from expected variation from year to year. For maximum utility, the recharge site will have to be carefully located so the major portion of the increased flow will be in Mackay Reservoir in time for use when required. Further, since the water available for recharge is not adequate to supply a significant added quantity to all lands served by the reservoir, distribution of the added supply would be difficult.

The analysis to determine, with a reasonable certainty, the location of the recharge point relative to Mackay Reservoir requires a large volume of data and field work. Even with the data, the groundwater system is so complex that a testing period, to test the system operation, would be necessary. The maximum volume of water which is available for recharge (as developed in Table 2-1) is relatively small. The actual volume available would be still less because of diversions between Howell gage and the reservoir. For these reasons, the project would be marginal.

The added storage and delayed delivery would be beneficial. The cost of the water is in a reasonable range.

Should a decision be made to examine this alternative in Phase II, beneficial work would include identification of the effects of irrigation diversions between the Howell gage

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[1]References are listed separately at the end of the report.

and Mackay Reservoir and some work to better localize the optimum spreading facility location.

SECTION 3

SECTION 3

HYDROPOWER GENERATION AT MACKAY DAM

The purpose of this element of the study is to examine the potential for installing hydropower facilities at Mackay Dam. Power facilities potential at other sites is considered with the site under other elements. This Phase I report attempts to assess the potential only to the extent necessary to provide a decision basis for whether or not to explore the potential further.

EXISTING FACILITIES[1]

The existing Mackay Dam was constructed during the period 1909 to 1917. The dam is a sand, gravel, and cobblestone fill; approximately 70 feet high and 1,430 feet long at the crest. The crest width of the dam, 5 feet below the top, is 160 feet. About 1956, an additional 5 feet of embankment was added on the crest. The added embankment has a top width of 15 feet. The upstream embankment slope is 3 to 1 and the downstream slope is 2 to 1. There is at least a partial sheet steel piling and concrete core wall in the dam.

The spillway is an uncontrolled concrete channel in the right (southwest) abutment of the dam.

The outlet consists of a tunnel, through the right abutment, approximately 10 feet square with an arched roof. The

[1] Most of the descriptive material is taken from "Phase I Inspection Report, National Dam Safety Program," for Mackay Dam, U.S. Army Corps of Engineers, September 1978.

control, at the inlet of the tunnel, consists of a tower with five motor-operated 4- by 8-foot slide gates at two levels. The first 50 feet of the outlet conduit is a 10-foot-diameter riveted steel pipe. The remainder of the outlet, except at the downstream end, is concrete-lined tunnel. The outlet was originally designed for control of release at the downstream end; icing problems at the gates forced an operational modification to move the control to gates in the outlet tower. At the downstream end, the tunnel again enters a portion of steel pipe with branches exiting at five outlets into a plunge pool below the toe of the dam.

The top of the dam is elevation 6076 feet above mean sea level with a storage capacity of 55,100 acre-feet and a reservoir surface area of 1,652 acres. The spillway crest elevation is 6067 feet above mean sea level with a storage capacity of 44,500 acre-feet and a surface area of 1,341 acres. Invert of the outlet at the downstream end is at 5095 feet above mean sea level, approximately.

Mackay Dam is constructed on deep, uncemented alluvium. Records of the cutoff under the dam are sketchy. In any case, it is apparent from the quantity of seepage past the dam that complete cutoff was not achieved. Seepage under the dam, through the dam and abutments ranges from about 25 cubic feet per second (cfs) at low reservoir stages to about 140 cfs when the reservoir is full. These flow estimates are based upon the USGS gaging station located about 1-1/2 miles downstream from the dam. Studies indicate the gage measures most of the flow passing the section at Mackay Dam including deep percolation. The seepage has occurred since initial filling. The very thick section of the dam embankment apparently forms a stable dam for the site.

The approximate hydrologic and hydaulic analyses made as part of the Phase I Inspection Report indicate that the probable maximum flood would result in about a 1-foot over-topping of the dam about the tenth day of the runoff. Based on these approximate analyses, the report recommends more detailed work on the reservoir hydrology to verify if there is a problem or not.

In addition, the Corps report indicates that additional analysis is desirable to determine the seismic stability of the structure.

Maintenance work recommended in the report includes the following.

a. Clear all vegetation from the dam embankment.

b. Rehabilitate the seepage collection systems so that all seepage can be measured and recorded.

c. Seal the opened construction joints in the spillway and repair one hole resulting from a rock fall.

d. Scale the limestone cliff, above the right side of the spillway, to minimize future damage from rock falls on the spillway.

e. Riprap the upper 5 feet of the embankment.

With these exceptions, the Phase I inspection report indicates no major problems with the dam and reservoir.

The dam and reservoir are owned and operated by the Big Lost River Irrigation District headquartered in Mackay, Idaho.

HYDROLOGY

The drainage area at the site is 788 square miles. The average annual flow, based upon 61 years of record through 1977, is 218,800 acre-feet as measured at the USGS gage 1.6 miles downstream from the dam. As previously indicated, a significant quantity of seepage passes either through the dam, under the dam, or through the abutments. Total seepage would range from 50 to 75 thousand acre-feet per year which does not appear as storage in the reservoir. The reservoir is operated solely for irrigation. Normally there is no release from the reservoir from about the middle of October through the end of April. During that period, instream flow uses are supplied principally by seepage past the dam.

Adjusting for seepage and eliminating the period when there is no or only small release during the non-irrigation season, yields the following flow duration data.

Flow, cfs	Percent of Time Flow is Exceeded
100	75
250	50
500	30
750	20
1,000	10
1,500	2

A gross head of approximately 67 feet is available for power generation from the spillway crest elevation to the centerline of the present end of the outlet pipe. The water surface elevation in the plunge pool below the outlet is approximately 10 feet below the outlet pipe centerline. Thus, the gross head available is about 77 feet.

Potential energy production at the site was estimated by an approximate operation analysis for the period 1970 to 1976. Flows and reservoir stages used were based on recorded data, correcting for seepage and disregarding fall into the plunge pool. The analyses indicate that 8,000 to 9,000 megawatt hours of energy could be produced annually.

PROJECT FORMULATION AND EVALUATION

Table 3-1 summarizes three generation alternatives examined for the site. Between 8,000 and 9,000 megawatt hours annually of electric generation would be available from Mackay Dam at a cost of approximately $0.04 per kilowatt hour. Energy cost assumes that the capital cost of the project could be financed over a period of 35 years at a 7 percent interest rate.

RECOMMENDATION

Based upon this analysis, which is intended to be conservatively high for project costs, further examination of hydropower generation at the Mackay Reservoir is recommended.

TABLE 3-1
HYDROPOWER AT MACKAY
DAM AND RESERVOIR

General Data	Alternative 1	Alternative 2	Alternative 3
Number of units	1	2	3
Turbine capacity, each (cubic feet per second)	1,000	500	250
Rated head (feet)	55	55	55
Generator capacity, each (megawatts)	4.0	2.0	1.0
Total plant capacity (megawatts)	4.0	4.0	3.0
Average annual energy generation (megawatt hours)	8,000	8,700	8,200
Capital Costs (Million Dollars)			
Turbine and generator	$0.80	$0.86	$0.66
Plant electrical equipment	.27	.27	.22
Switchyard	.14	.14	.12
Transmission line	.04	.04	.04
Miscellaneous equipment	.08	.08	.07
Site preparation	.11	.11	.11
Penstock	.00	.02	.02
Powerhouse, civil costs	.40	.62	.74
Switchyard, civil costs	.02	.02	.01
Construction cost, subtotal @ 7-1978	$1.9	$2.2	$2.0
Construction cost, subtotal @ 1-1980	$2.1	$2.4	$2.2
Cost including allowance for contingencies at 20 percent	$2.5	$2.9	$2.7
Cost including allowance for legal, engineering, administrative, and fiscal cost and interest during construction @ 26 percent	$3.1	$3.6	$3.3
Annual Costs (Thousand Dollars)			
Debt service on capital cost at 7 percent for 35 years	$240	$280	$250
Operation and maintenance cost at 3 percent of total capital	60	70	70
Total Annual Cost	$300	$350	$320
Energy cost per kWh (dollars)	$0.038	$0.040	$0.039

As discussed on 14 September 1979, the U.S. Department of Energy has a loan program to make available funds for feasibility studies at projects which show promise. Data on loan application procedures have been forwarded to the Lost River Electric Cooperative, Inc. for its consideration. Should the Cooperative elect to proceed with a feasibility study, further CDC work on this alternative, may not be necessary.

SECTION 4

SECTION 4

NATURAL HEAD IRRIGATION

INTRODUCTION

The Big Lost River Irrigation District serves some 32,000 acres of irrigated farmland in the Big Lost River Valley. As shown in Figure 1, these lands extend from the vicinity of Mackay, in the north, 25 miles southeasterly to the area south, east, and west of Arco. Water is diverted from the Big Lost River, at several locations, into a network of canals and ditches which convey the water to the individual farms. The major features of the irrigation district are Mackay Reservoir with 44,000 acre-feet of storage and two canals, one of which goes down each side of the valley. Under the existing system, many of the farmers and ranchers use surface methods of irrigation with some 40 to 50 percent pumping out of the open ditches for irrigation with sprinklers. The existing open ditch system has excessive seepage losses which add to high water table conditions in some areas of the valley floor. The present average annual diversion of water for irrigation below Mackay Dam based on a 47-year period from 1922 to 1968 is 169,000 acre-feet or about 5.0 feet per acre (based on 34,000 acres).

SCOPE OF WORK

The purpose of this investigation is to examine the feasibility of converting the open ditch system into a closed distribution system. This would provide gravity pressure for sprinkler irrigation. It would also eliminate the seepage losses from the open ditch system and would allow the individual farmers to eliminate their individual pumps presently used for spinkler irrigation. By elimination of the conveyance losses more water would be available for other downstream uses.

DESIGN CRITERIA

The closed distribution system was sized to provide pressure for sprinkler irrigation through the head available from the elevation difference along the length of the valley floor. The criteria used in sizing the distribution system were based on the consumptive use requirements given in Table 4.1.

The system sizing criteria used were:

- An irrigation season extending from May 1 to September 15

- A cropping pattern of 35 percent alfalfa, 10 percent potatoes, 25 percent small grains, and 30 percent pasture

- Peak week irrigation demand 25 percent greater than the peak month average daily demand

- Application efficiency of 75 percent

- System sizing capacity of 6.25 gpm/acre

- Maximum velocity of 8 feet per second in the pipelines

- Coefficient of friction, C = 120

- Minimum pressure at highest sprinkler of 50 psi

- Irrigation turnout to every 80 acres

TABLE 4-1

CROP CONSUMPTIVE USE

FOR BIG LOST RIVER VALLEY

NEAR ARCO, IDAHO

Crop	Total Net Irrigation Requirement (Inches)	Peak Month Net Irrigation Requirement (Inches)	Application Efficiency (%)	Total Gross Irrigation Requirement (Inches)	Peak Month Gross Irrigation Requirement (Inches)
Alfalfa	19.16	6.21	75	23.95	7.76
Pasture	15.64	5.12	75	19.55	6.40
Potatoes	17.75	6.53	75	22.19	8.16
Small Grains	9.85	5.84	75	12.31	7.30

Two alternatives were investigated to determine their economic feasibility.

ALTERNATIVE 1

The first alternative as shown in Figure 2 consists of a diversion from the Big Lost River into a large diameter pipe immediately below Mackay Dam. The main transmission pipe would bypass the town of Mackay and then run adjacent and parallel to the railroad tracks to the town of Moore. At that point the pipeline would turn south following a county road and section lines for approximately 4-1/2 miles. At this point the line would split with one branch running east for approximately 2-1/2 miles and one branch would run west. The two branches are necessary to serve the irrigated land on each side of the exposed lava formation located west of the City of Arco. After its intersection with the railroad tracks, the branch running to the east would once again run parallel with the railroad tracks for approximately 8 miles. Approximately 1 mile southeast of the above mentioned turning point a branch main, referred to as the middle branch, takes off and runs south following the section lines to serve the area between the town of Arco, Ferris Slough, and the exposed lava formation. After running to the west for 1-1/2 miles, the west branch would turn to the south for 6-1/2 miles.

Lateral mains would take off from the transmission main every half-mile. The laterals would run in an east-west direction and would have a turnout for every 80 acres. With this alternative it would require one crossing beneath the railroad for each lateral. This would provide a supply pipeline from which sprinkler lines 1/4-mile in length could run in both directions.

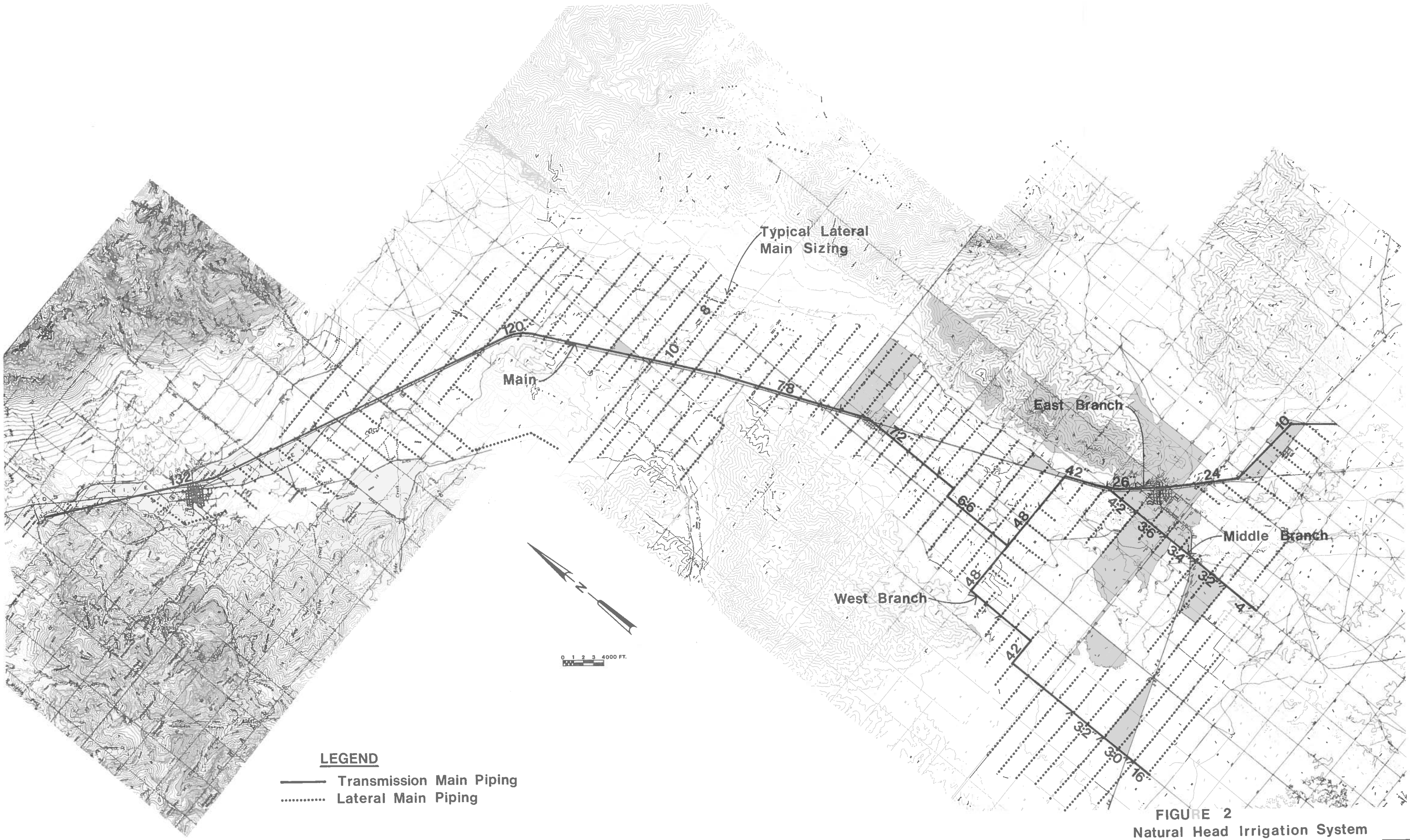

FIGURE 2
Natural Head Irrigation System
ALTERNATIVE 1
Transmission Main Piping Down Center of Valley

CH2M HILL

Approximately 262,000 feet of main transmission pipe varying in size from 132-inch with 3/8-inch wall thickness at the head and to 10-inch in diameter, and 12 gage wall thickness at the lower end would be required. The lateral mains consisting of approximately 1.1 million feet of pipe would vary in size from 8 to 10 inches with 12 gage wall thickness. Two booster pumps would be required on the lateral mains along the first 5 miles to provide the minimum desired operating pressure of 55 psi in the lateral main.

ALTERNATIVE 2

The concept for Alternative 2 is to run a pipeline down each side of the valley following the existing canal alignments (see Figure 3). This plan would be essentially a distribution pipeline to serve the lands between the mountains and the railroad tracks on either side of the valley. Under this plan, the railroad crossing required for each lateral main in Alternative 1 would be eliminated and the size of the transmission piping would be reduced. This created a branch on the easterly side of the valley called the east branch and one on the westerly side of the valley referred to as the west branch. Both branches would divert water from the Big Lost River just downstream from Mackay Dam. The west branch would then follow the alignment of the Darlington Ditch to its confluence with the Hanrahan Ditch. At this point it would turn east along the section line for about 3-1/2 miles and then turn south following the Blaine Canal right-of-way for approximately 8 miles to a common point where the west branch of Alternative 1 turned south. From that point the same alignment as used in Alternative 1 will be followed.

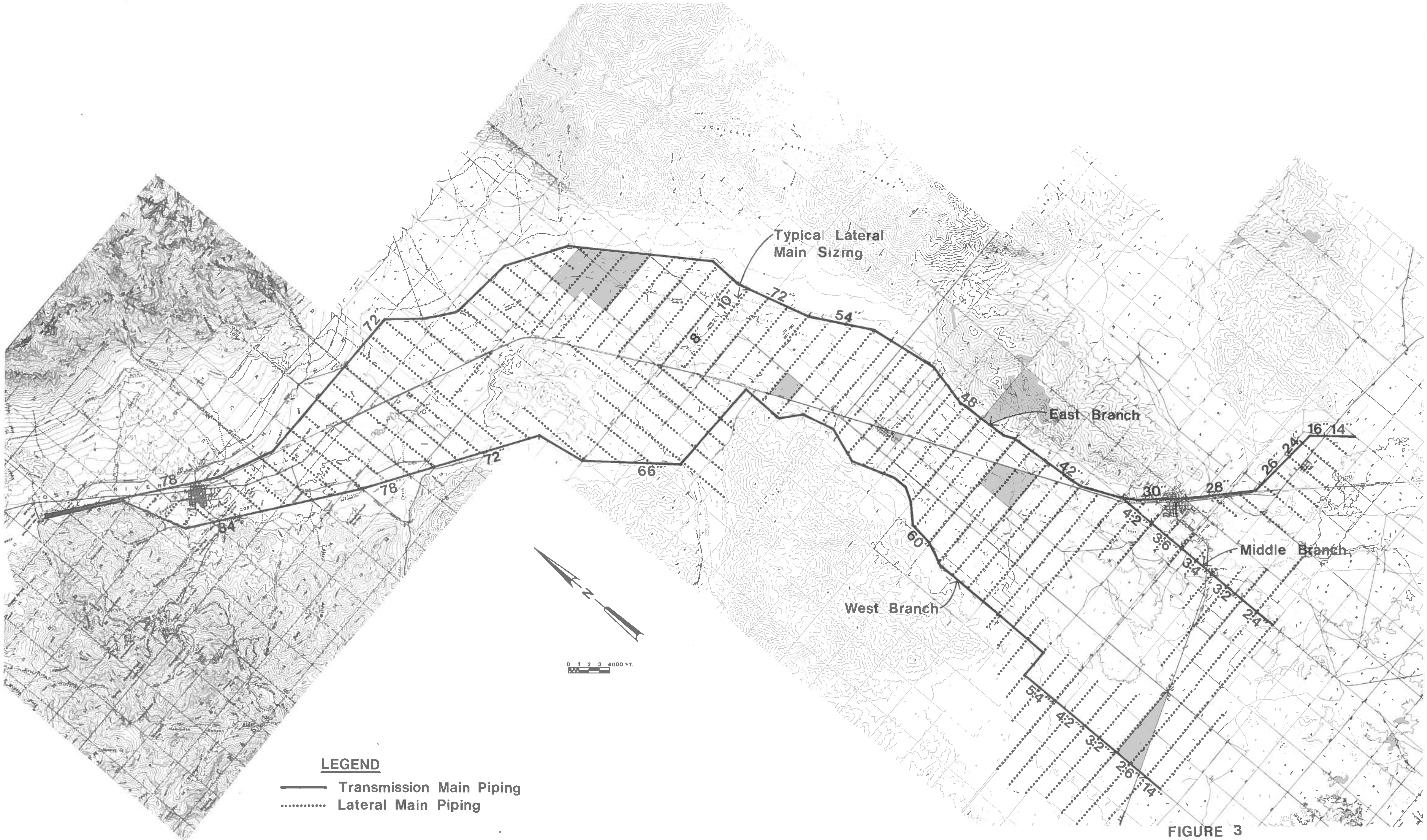

FIGURE 3
Natural Head Irrigation System
ALTERNATIVE 2
Transmission Main Piping Down Both Sides of Valley

The east branch of Alternative 2 would follow the same alignment as Alternative 1 to a point approximately 1 mile southeast of Mackay. The pipeline would then turn east following the section line to its intersection with the Burnett Ditch. From that point the Burnett Ditch right-of-way would be followed to its intersection with Hill Road. The pipeline would then run parallel to Hill Road to a common point where the east branch of Alternative 1 turned south and ran parallel to the railroad track. From that point the alignment is the same as used in Alternative 1. Lateral mains were layed out at every half-mile with a delivery point to every 80 acres. Lateral main under this alternative did not cross beneath the railroad tracks.

The main transmission pipelines running down either side of the valley would consist of approximately 310,000 feet of pipe ranging in diameter from 84 inches with 1/4-inch wall thickness at the upper end to 14 inch with 12 gage wall thickness at the lower end. One million one hundred nine thousand feet of lateral main varying in size from 8 to 10 inches with 12 gage wall thickness would be required. Eight booster pumps would be required along the first 15 miles of the west branch to boost the pressure leaving the transmission main from approximately 25 to 55 psi.

For Alternative 2, pipe wall thicknesses are little more than the minimum required for handling. Because of this factor, little cost change would be expected with use of reinforced concrete pipe or other pipe materials.

Booster pumps were needed at the head end for the first several thousand feet to provide the minimum required pressure. In sizing the facilities it was necessary to determine what acreage is presently under irrigation. Since the total area within the boundary shown on Figures 2 and 3 is roughly double the reported irrigated acreage, the system was designed to provide water at 6.25 gpm to 40 out of every 80 acres. A tabulation of lateral main lengths to provide water under these conditions showed that the total acreage served was within 2-1/2 percent of that currently being reported.

WATER DIVERSIONS

Under the existing system the annual average diversion for irrigation from the Big Lost River below Mackay Dam is 169,000 acre-feet. With the closed distribution system alternatives discussed herein, the average annual diversion is expected to be approximately 65 to 70,000 acre-feet per year. The difference or savings of approximately 100,000 acre-feet would be available for other downstream uses such as irrigating new or additional lands, stream resource management, and municipal or industrial uses.

COSTS

The estimated construction costs for the two alternatives are summarized in Table 4-2.

TABLE 4-2
CAPITAL COST ESTIMATE

Item	Alternative 1	Alternative 2
Pipe Materials	$25,238,000	$18,160,000
Trench, Excavation, & Backfill	11,475,000	11,251,000
Pipe Coating, Lining, & Corrosion Protection	15,399,000	14,838,000
Installation	6,142,000	5,939,000
Railroad Crossings	285,000	75,000
Booster Pump Stations	55,000	300,000
Headworks	50,000	50,000
Turnouts	425,000	425,000
Subtotal (rounded)	$59,000,000	$51,000,000
Contingencies (+20%)	12,000,000	10,000,000
Subtotal	$71,000,000	$61,000,000
Engineering, Legal, & Administration (+15%)	10,000,000	9,000,000
TOTAL ESTIMATED CONSTRUCTION COST	$81,000,000	$70,000,000

FINANCIAL ANALYSIS

The financial feasibility of converting the Big Lost River Irrigation District's open ditch system into a gravity pressurized closed distribution system was analyzed at a reconnaissance level of detail. Information for the study was obtained from cost of production studies published by the University of Idaho, information obtained in studies of similar areas, and conversations with people knowledgeable about the area. The budgets presented in this study represent the type of operation that will exist during the repayment period when the area has been converted to sprinkler irrigation.

Payment Capacity

Under sprinkler irrigation with a full water supply, an increase in production over existing conditions can be expected. In the following analyses a 20-25 percent increase in average crop yields has been assumed. Payment capacity has been estimated on the basis of a representative cropping pattern with alfalfa hay grown in rotation with grain and potatoes. The crop budgets presented in Tables 4-3, 4-4, and 4-5 indicate an annual per acre residual income available for loan repayment amounting to $5.20 for alfalfa, $107.50 for potatoes, and $22.25 for grain. These values are based on a yield of 4 tons per acre of alfalfa, 250 sacks of potatoes per acre, and 75 bushels of grain per acre. Assuming a residual income for pasture equal to alfalfa and a cropping pattern of 65 percent alfalfa and pasture, 25 percent grain, and 10 percent potatoes, the weighted average payment capacity would be approximately $20 per acre. This amount would be available as revenue to pay for system improvements.

TABLE 4-3
BUDGET FOR IRRIGATED ALFALFA HAY

Item		Amount Per Acre
Gross Receipts		
4.0 tons @ $50/ton		$200.00
Farm Investment		
Land	$ 800.00	
On-Farm Irrigation System	200.00	
Total Investment	$1,000.00	
Production Expenses		
Seedbed Preparation & Planting		
Seed (planted with barley)		
15 lb @ $2/lb = $30.00		
Ave. per year (30 ÷ 5)	$ 6.00	
Growing Costs		
Irrigate (labor only)		
(2 hrs @ $3.45/hr.)	$ 6.90	
Fertilizer		
(20 lbs P_2O_5 @ 0.25/lb	5.00	
Fertilizer Application	3.50	
Insect Control	4.25	
SUBTOTAL	$ 19.65	
Miscellaneous Production Expenses		
($25.65 x 15%)	$ 3.85	
Harvest Costs		
Swath, Bale, & Haul		
(4.0 tons @ $16/ton)	$ 64.00	
Depreciation & Repairs		
On-Farm Irrigation System	$ 21.30	
Taxes ($1,000 x 1%)	10.00	
TOTAL PRODUCTION EXPENSES	$ 124.80	
Return to Management ($200 x 5%)	$ 10.00	
Return on Investment		
($1,000 x 6%)	$ 60.00	
TOTAL COSTS		$194.80
RESIDUAL NET FARM INCOME		
(PAYMENT CAPACITY)		$ 5.20

TABLE 4-4
BUDGET FOR IRRIGATED POTATOES

Item		Amount Per Acre
Gross Receipts		
250 cwt @ $3.25/cwt		$812.50
Farm Investment		
Land	$ 800.00	
On-Farm Irrigation System	200.00	
	$1,000.00	
Production Expenses		
Seedbed Preparation & Planting		
Plow	$ 10.00	
Disk	5.00	
Harrow	2.00	
Plant	20.00	
Seed (20 cwt @ $5.30/cwt)	106.00	
SUBTOTAL	$ 143.00	
Growing Costs		
Fertilizer (Including application)	$ 105.00	
Spraying & Chemicals (4 Applications)	100.00	
Cultivate (1 x $10)	10.00	
Irrigate (labor only) (8 hrs @ $3.45/hr)	27.60	
SUBTOTAL	$ 242.60	
Harvest Cost		
Dig (250 cwt @ $0.40/cwt)	$ 100.00	
Haul & Store (250 cwt @ $0.35/cwt)	87.50	
SUBTOTAL	$ 187.50	
Depreciation & Repairs		
On-Farm Irrigation System	$ 21.30	
Taxes ($1,000 x 1%)	10.00	
TOTAL PRODUCTION EXPENSES	$ 604.40	
Return to Management ($812.50 x 5%)	$ 40.60	
Return on Farm Investment ($1,000 x 6%)	$ 60.00	
TOTAL COSTS		$705.00
RESIDUAL NET FARM INCOME (PAYMENT CAPACITY)		$107.50

TABLE 4-5
BUDGET FOR IRRIGATED SMALL GRAINS

Item		Amount Per Acre
Gross Receipts		
75 Bu @ $2.60/Bu		$195.00
Farm Investment		
Land	$ 800.00	
On-Farm Irrigation System	200.00	
Total Investment	$1,000.00	
Production Expenses		
Seedbed Preparation		
Disk & Harrow	$ 5.50	
Harrow	2.00	
Fertilizer (40 lbsN @ $.20)	8.00	
Fertilizer Application	3.50	
SUBTOTAL	$ 19.00	
Planting		
Drill	$ 3.50	
Seed (2 Bu @ $5.20/Bu)	10.40	
SUBTOTAL	$ 13.90	
Growing Costs		
Irrigate (labor only) (4 hrs @ $3.45/hr)	$ 13.80	
Miscellaneous Production Expenses ($46.70 x 15%)	$ 7.00	
Harvest Cost	$ 18.00	
Depreciation & Repairs on Farm Irrigation System	$ 21.30	
Taxes ($1,000 x 1%)	$ 10.00	
TOTAL PRODUCTION EXPENSES	$ 103.00	
Return to Management ($195 x 5%)	$ 9.75	
Return on Farm Investment ($1,000 x 6%)	$ 60.00	
TOTAL COSTS		$172.75
RESIDUAL NET FARM INCOME (PAYMENT CAPACITY)		$ 22.25

Custom rates were used in the analysis for most farm operations. This is a convenient analytical procedure since custom rates include charges for labor, depreciation, repairs, and return on investment.

Depreciation on the investment in the on farm irrigation system was included as an expense. This would not be an "out-of-pocket" expense and, therefore, could be considered as available for payment of the loan. A return to management equal to 5 percent of gross receipts and a return on investment equal to 6 percent of the estimated farm investment were added to production expenses in calculating the residual income available for loan payment.

Annual Debt Service

The total estimated annual debt service for the conversion from an open to closed distribution system is given in Table 4-6 for three different types of financing. The annual per acre cost for Alternative 1 ranges from $97 to $279, and that for Alternative 2 ranges from $84 to $241, depending on method of financing. The first method, or no interest, would be through a government loan program such as the U.S. Bureau of Reclamation P.L. 984 loan programs. P.L. 984 financing would require that the project be broken down into three or more smaller elements since the maximum project size for P.L. 984 projects is $26 million. The second method would be a low interest loan through the federal government. The last option is to sell bonds on the open market.

TABLE 4-6

ANNUAL COSTS

	ALTERNATIVE #1			ALTERNATIVE #2		
	No Interest (30 Years)	6 7/8% (30 Years)	9% (20 Years)	No Interest (30 Years)	6 7/8% (30 Years)	9% (20 Years)
Capital Cost	$2,707,266	$6,464,953	$8,897,432	$2,339,266	$5,586,169	$7,688,000
O&M Costs[1] Administration & Insurance Operating Expenses Repairs and Maintenance	590,690	590,690	590,690	510,380	510,380	510,380
Booster Pump Power Costs[2]	2,779	2,779	2,779	4,478	4,478	4,478
TOTAL ESTIMATED ANNUAL COST	$3,300,735	$7,058,422	$9,490,901	$2,854,124	$6,101,027	$8,202,858
ANNUAL PER ACRE COST (Based on 34,000 Irrigated Acres)	$97	$208	$279	$84	$179	$241

[1] Based on 1% of capital costs

[2] Energy costs were based on $2.13 per kW for all kW of demand and 1.543 cents per kWh for the first 200 kWh per kW of demand and 1.040 cents per kWh for all additional kWh

HYDROPOWER POTENTIAL

As the pipeline progresses down the valley the elevation conditions and the friction losses in the pipe fluid flow are such that the pressure increases. At some points there is significant pressure in excess of what is required to operate the sprinkler system. The excess pressure combined with the flow in the pipeline offers the potential to generate electrical energy.

An examination of the energy generation potential indicates a potential revenue available from power sales of $200-400 thousand per season with either alternative. This amount would be insufficient to reduce the remaining costs to be borne by irrigation benefits to feasible levels.

RECOMMENDATION

Based on the estimated construction and annual operation and maintenance costs in comparison with the residual net farm income, the conversion of the Big Lost River Irrigation District's existing open ditch distribution system to a closed gravity pressurized system does not appear financially feasible.

Even if acreage irrigated could be doubled, the cost per acre would be significantly greater than the repayment capacity for the system outlined. To serve more area, the system outlined would have to have increased capacity which would increase the capital costs.

On this basis, no further work on this alternative is recommended at this time. The alternative should be reevaluated in 5-10 years, however, as changes in relative relations between crop prices, energy costs and construction costs could well alter the present conclusions. Potential for extensive conversion to other crops could also completely change the economic feasibility picture.

SECTION 5

SECTION 5

REDUCED SEEPAGE AT MACKAY DAM

INTRODUCTION

The existing Mackay Dam was constructed in the early 1900's. The dam was originally intended to be constructed to a height of 120 feet, but because of excess leakage observed during construction, construction of the dam was stopped at a height of 75 feet.

The dam has a history of considerable leakage. Estimated leakage rates vary from 30 cfs at low reservoir water levels to 130 cfs when the reservoir is at maximum pool elevation.

Two alternatives were considered for reducing seepage at Mackay Dam:

1. Blanket the entire reservoir
2. Construct a cutoff and blanket the upstream slope of the dam

ALTERNATIVE 1

Blanketing the entire reservoir with a relatively impervious earth liner was not considered feasible because there does not appear to be an adequate volume of material available within a reasonably close hauling distance.

ALTERNATIVE 2

Two schemes were considered for constructing a cutoff at the existing Mackay Dam.

- Constructing a slurry trench partial cutoff to a depth of 50 feet
- Constructing a slurry trench cutoff to a depth of 100 feet

Borings reported in Reference 2 indicate recent alluvial sands and gravels to depths greater than approximately 100 feet. In this analysis, the alluvial deposits were assumed to become cemented and less porous at a depth of about 100 feet. This assumption would have to be verified with additional borings and in-hole permeability tests at Mackay Dam, if this alternative is taken.

Partial cutoffs are a relatively ineffective means of reducing seepage under a dam on a previous foundation. Although the 50 foot deep partial cutoff penetrates 50 percent of the assumed pervious gravels, the cutoff only reduces seepage under the dam by about 25 percent.

The 50 foot deep cutoff could be constructed using conventional drag line and slurry wall techniques. Cost of the partial cutoff is estimated at $0.5 million.

The 100 foot deep cutoff was assumed to completely penetrate the pervious gravels and essentially eliminate seepage under the dam.

The 100 foot deep cutoff would have to be excavated using specialized slurry trench construction techniques (ICOS SYSTEM). Cost of the 100 foot deep cutoff is estimated at $6.8 million.

Either the 50 foot or 100 foot deep cutoff would require blanketing the upstream slope of the dam with a relatively impervious soil. The only suitable material observed during the field trip was a clayey silt found on the west side of the reservoir. The material was light tan to gray and appeared to be a tuff or ash deposit of the Challis Volcanics. The material was non-plastic to slightly plastic and very erodible. Because of the erodibility of the clayey-silt and the open graded, pervious nature of the embankment, a well graded filter gravel would be required on both sides of the soil blanket.

For either the 50 foot cutoff or the 100 foot cutoff, the upstream blanket could be constructed using conventional earth moving equipment. The existing riprap would have to be removed and replaced after the soil blanket and filter gravel had been placed. Cost of blanketing the upstream slope is estimated at $0.67 million.

The total annual cost for the 50-foot cutoff at 7 percent interest for 30 years would be $94,000 per year for debt service. No change in operation and maintenance cost is expected.

The total annual cost for the 100-foot cutoff at 7 percent interest for 30 years would be $600,000 per year for debt service. No change in operation and maintenance cost is expected.

BENEFITS AND REVENUE

The benefits of sealing the foundation are that more of the water passing the Mackay Dam would be forced to appear in the reservoir. There it could be stored for controlled release as needed during the irrigation season. Further, the release at nearly any time of year could be used for power generation at the proposed power plant.

With partial cutoff, approximately 5,000 acre feet of additional storage could be obtained. This water would be adequate to supply approximately 1,200 acres of new land. Based on the repayment capacity of approximately $20 per acre, developed in Section 4, the annual revenue would be about $24,000 from irrigation. There would be some small net added power revenue of $1,000 to $2,000 per year. The total added revenue would be approximately $25,000 to $26,000 per year. This revenue, however, would be inadequate to pay the estimated $94,000 annual cost for the 50-foot cutoff.

The 100-foot cutoff is expected to increase average winter storage in Mackay Reservoir approximately 12,000 acre feet per year. This would be adequate to supply approximately 3,000 acres of new land, which could produce revenue of approximately $60,000 per year. Net revenue from power would amount to about $12,000 per year for a total annual revenue of approximately $72,000. This revenue is, however, far short of the $600,000 annual cost of the work required for the 100-foot cutoff.

REPLACEMENT DAM

The Crosthwaite report (Reference 1) indicates that most of the Big Lost River flow is surface flow at Mackay Narrows. One boring (reported in Reference 3) indicates that the alluvium at Mackay Narrows may be less extensive than at Mackay Dam. These factors suggest the possibility of a replacement dam at the Narrows to more fully control the river flow.

A brief look at such a structure, constructed with the same spillway crest elevation as Mackay Dam, indicates the enlarged reservoir would store about 16,000 acre feet more water than Mackay Reservoir now does. A check of the costs show, however, that the costs are much too great to be supported by the power and irrigation revenue made possible by the greater storage.

RECOMMENDATION

The work outlined above to reduce seepage through and around Mackay Dam is not justified on the basis of the revenue directly attributable to the added storage. Should a safety problem develop as a result of the seepage, reduction of the seepage is certainly technically feasible. The major question would be the degree to which the reduction could be accomplished. The seepage reduction would probably be considered concurrently with raising the dam to increase the reservoir storage capacity.

The replacement dam at the Narrows does not merit further consideration at this time.

SECTION 6

SECTION 6

ADDITIONAL SURFACE STORAGE

Previous studies (Reference 4; pages: Vol IV - 267 to 271, 275; Reference 7; pages 13-19; Reference 5; pages 37-39) have identified several potential reservoir sites in the Big Lost River Basin. The USBR (Reference 4; pages: Vol. IV - 267-271) studied the Antelope Dam and reservoir and concluded that the project was not feasible. The SCS (Reference 7; pages 13-15) examined a project for the same site, but with a larger reservoir, and concluded that a feasible project existed. The SCS (Reference 7, pages 18 and 19) looked at a project called Upper North Fork Dam (location not specifically identified in the report) and preliminarily indicated a feasible project might exist there. The SCS, in the same report, considered the Castle damsite and preliminarily indicated a feasible project. The Castle project was also mentioned in another report (Reference 6; page 38), but no study other than potential runoff and storage capacity was apparently done. The joint USBR and COE report (Reference 4; page: Vol. IV - page 275) identified several sites without any data other than the location given.

For this element of the assessment, the goal is to re-examine the previously identified sites, and update costs and benefits to see if the feasibility picture for any of them justify further examination. Examination of previous reports, mentioned above, showed that only the Antelope site had sufficient data to permit updating costs. For the other sites, preliminary cost estimates were developed for this study.

ANTELOPE RESERVOIR

For the Antelope site the project as outlined in Reference 7, pages 13-15 was taken as the basis. The costs given there were updated to current levels. In addition, a check of the potential to add hydropower was also made. That check indicated the installed capacity would be on the order of 0.7 megawatts. Our previous experience indicates that plants with installed capacity of less than 1 megawatt are not economically feasible at this time.

The results of the study of the Antelope site are shown in Table 6-1. The data shown there indicate that the costs are too high to be repaid by the potential revenues.

UPSTREAM STORAGE SITES

Of all the upstream sites identified, the Garden, Castle, and North Fork (Wildhorse) sites appear to have the most potential as a reservoir site. Since no previous cost studies, (with sufficient detail reported) had been done for any upstream sites, this study limited examination to these three better sites.

For the Garden, Castle, North Fork (Wildhorse) sites, reconnaissance level studies were done to develop a reservoir in each case with capacity to store the average annual runoff, with some conservation and power pool.

Results of these examinations are shown in Tables 6-2, 6-3, and 6-4. Based on this examination none of the sites are economically feasible at this time, even assuming funds would be available at no interest for a 30 year period to finance irrigation facilities.

RECOMMENDATION

None of the sites examined show sufficient potential revenue to repay the costs incurred. On this basis no further work for any of those sites is recommended.

TABLE 6-1
ANTELOPE DAM & RESERVOIR

Location:	Section 29, 30 T 5N R 25E (Reference 4; page: Vol. IV-275)
Stream:	Antelope Creek (Reference 4; page: Vol. IV-275)
Average Annual Runoff:	30,000 ac ft (Reference 7; pages 13-15)
Dam Height:	95 feet (Reference 7; pages 13-15)
Reservoir Storage Capacity:	20,000 ac ft (Reference 7; pages 13-15)

BENEFITS

IRRIGATION

Lands served:	6,000 acres

HYDROPOWER POTENTIAL

Installed capacity:	0.7 megawatts - too small to be economically feasible at this time.

COSTS

CAPITAL	1961 Levels (Reference 7; Pages 13-15)	1980 Levels
Dam, reservoir, & appurtenances	$2.38 million	$8.1 million
Canal distribution facilities	.45 million	1.5 million
Total Project Cost	$2.83 million	$9.6 million
ANNUAL COSTS		
Irrigation Facilities Financed @ 0%		
Debt Service 30 years @ 0% interest	--	$320,000
Operation & Maintenance Cost	$11,000	33,000
Total Annual Cost	--	$350,000
Annual Cost Per Acre	--	58
Irrigation Facilities Financed @ 7%		
Debt Service 30 years @ 7% interest	--	$780,000
Operation & Maintenance Cost	$11,000	33,000
Total Annual Cost	--	$810,000
Annual Cost Per Acre	--	135

TABLE 6-2
GARDEN DAM & RESERVOIR

Location:	Section 35, T 8N., R20 E. (Reference 4; page: Vol. IV-275)
Stream:	Big Lost River (Reference 4; page: Vol. IV-275)
Average Annual Runoff:	180,000 acre feet (Reference 6; page 39)
Dam Height:	235 feet
Reservoir Storage Capacity:	Total 150,000 ac ft Active 125,000 ac ft Conservation & Power 25,000 ac ft

BENEFITS

IRRIGATION

Lands served:	If all new, 30,000 acres; if supplemental 50 percent supply 60,000 acres

HYDROPOWER POTENTIAL

Installed capacity:	3.8 megawatts
Average annual energy Production:	19,000,000 kWh

COSTS

CAPITAL COST

Dam reservoir & appurtenances	$110 million
Hydropower facilities	3 million
Total Project Cost	$113 million

ANNUAL COSTS

Irrigation Facilities Financed @ 0%	
Debt Service	
30 years @ 0% interest on irrigation facilities	$3,700,000
35 years @ 7% interest on power facilities	200,000
Operation & Maintenance	
Irrigation facilities	200,000
Power facilities	100,000
Total Annual Cost	$4,200,000
If power valued at $0.05/kWh, power revenue is:	$1,000,000
This leaves, to be paid from irrigation revenue:	$3,700,000
Annual cost per acre for new land supply	$ 107
Annual cost per acre for supplemental supply	$ 53
Irrigation Facilities Financed @ 7%	
Debt Service	
30 years @ 7% interest on irrigation facilities	$8,900,000
35 years @ 7% interest on power facilities	200,000
Operation & Maintenance	
Irrigation facilities	200,000
Power facilities	100,000
Total Annual Cost	$9,400,000
If power valued at $0.05/kWh, power revenue is:	$1,000,000
This leaves, to be paid from irrigation revenue:	$8,400,000
Annual cost per acre for new lands supply	$ 280
Annual cost per acre for supplemental supply	$ 140

TABLE 6-3
CASTLE DAM & RESERVOIR

Location:	Section 32, T 7N., R 21E. (Reference 4; page: Vol. IV-275)
Stream:	East Fork Big Lost River (Reference 4; page: Vol. IV-275)
Average Annual Runoff:	90,000 ac ft (Reference 6, page 39)
Dam Height:	255 feet (Reference 6, page 39)
Reservoir Storage Capacity:	110,000 ac ft (Reference 6, page 39) 85,000 ac ft active with 25,000 ac ft power & conservation pool

BENEFITS

IRRIGATION

Lands served:	If all new 22,000 acres; if supplemental supply 50 percent 45,000 acres

HYDROPOWER POTENTIAL

Installed capacity:	3.1 megawatts
Average annual energy production:	16,000,000 kWh

COSTS

CAPITAL COSTS

Dam, reservoir, & appurtenances	$67.0 million
Hydropower facilities	2.4 million
Total Project Cost	$69.0 million

ANNUAL COSTS

Irrigation Facilities Financed @ 0%	
Debt Service	
30 years @ 0% interest on irrigation facilities	$2,200,000
35 years @ 7% interest on power facilities	190,000
Operation & Maintenance	
Irrigation facilities	130,000
Power facilities	50,000
Total Annual Cost	$2,600,000
If power valued at $0.05/kWh power revenue is:	$ 800,000
This leaves, to be paid from irrigation revenue:	$1,800,000
Annual cost per acre for new land supply	$ 81
Annual cost per acre for supplemental supply	$ 40
Irrigation Facilities Financed @ 7%	
Debt Service	
30 years @ 7% interest on irrigation facilities	$5,400,000
35 years @ 7% interest on power facilities	190,000
Operation & Maintenance	
Irrigation facilities	130,000
Power facilities	50,000
Total Annual Cost	$5,800,000
If power valued at $0.05/kWh, power revenue is:	$ 800,000
This leaves, to be paid from irrigation revenue:	$5,000,000
Annual cost per acre for new land supply	$ 230
Annual cost per acre for supplemental supply	$ 110

TABLE 6-4
NORTH FORK DAM & RESERVOIR
(Wildhorse Site)

Location:	Section 30, T 7 N., R 20 E. (unsurveyed)
Stream:	North Fork Big Lost River (Reference 4, page: Vol. IV-275)
Average Annual Runoff:	77,000 ac ft (Reference 5, page: 258)
Dam Height:	205 feet
Reservoir Storage Capacity:	Total 85,000 ac ft Active 75,000 ac ft Conservation & Power 10,000 ac ft

BENEFITS

IRRIGATION

Lands served:	If all new 19,000 acres; if supplemental 50 percent supply 38,000

HYDROPOWER POTENTIAL

Installed capacity:	2.6 megawatts
Average annual energy production:	10,000,000 kWh

COSTS

CAPITAL COST

Dam, reservoir, & appurtenances	$60 million
Hydropower facilities	3 million
Total Project Cost	$63 million

ANNUAL COSTS

Irrigation Facilities Financed @ 0%	
Debt Service	
30 years @ 0% interest on irrigation facilities	$2,000,000
35 years @ 7% interest on power facilities	200,000
Operation & Maintenance	
Irrigation facilities	100,000
Power facilities	100,000
Total Annual Cost	$2,400,000
If power valued at $0.05/kWh power revenue is:	$ 500,000
This leaves, to be paid from irrigation revenue:	$1,900,000
Annual cost per acre for new land supply	$ 100
Annual cost per acre for supplemental supply	$ 50

Irrigation Facilities Financed @ 7%	
Debt Service	
30 years @ 7% interest on irrigation facilities	$4,800,000
35 years @ 7% interest on power facilities	200,000
Operation & Maintenance	
Irrigation facilities	100,000
Power facilities	100,000
Total Annual Cost	$5,200,000
If power valued at $0.05/kWh, power revenue is:	$ 500,000
This leaves, to be paid from irrigation revenues:	$4,700,000
Annual cost per acre for new land supply	$ 250
Annual Cost per acre for supplemental supply	$ 120

SECTION 7

SECTION 7

CEDAR CREEK DIVERSIONS

Both Upper and Lower Cedar Creeks discharge from their mountain channels to a channel across the alluvial fan. In each case, canals divert irrigation water from the creeks near the canyon mouth. Flow which passes the diversion quickly sinks into the very pervious materials of the fan. Even large flows seldom come close to reaching the river as a surface stream. This situation raises the prospect for conveying the water, excess to the irrigation rights, by means of a pipeline directly to Mackay Reservoir so that the water is more readily available for irrigation.

There are flow records available for Lower Cedar Creek above the diversions for the years 1967 to 1973. There are no flow records available for Upper Cedar Creek. Conversations with water users indicates that there would be little water passing the diversion on Lower Cedar Creek during the irrigation season. This is because there is so much shrinkage, from the diversion to the delivery point, that essentially all available flow is diverted to obtain the decreed right quantity at the point of use. Further consideration indicates that conveyance would have to be via pipeline because of the problem with open canal operation in the winter.

An analysis of the Lower Cedar Creek records indicate that, during the period December through April each year, the flow is 5 cfs, or less 62 percent of the time and from 5-10 cfs, 36 percent of the time. If all flow less than 10 cfs during this period were diverted a total of approximately 1,500-2,000 acre-feet would be available. Based on the average slope from the area of the former power plant site to Mackay Dam, a 14-inch pipeline would be required to carry the water approximately 30,000 feet. The estimated project cost for the pipeline is $830,000. The annual cost of this project would be $28,000 for debt service at 0 percent interest for 30 years, plus an estimated $9,000 per year operation and maintenance. The revenue available to repay these costs would be inadequate.

Upper Cedar Creek has about the same size water shed at the canyon mouth as Lower Cedar Creek. Lower Cedar Creek, however, has a spring flow contribution for which the source may lie outside the basin (Reference 1; page 61). On the basis of that report, the flow for Upper Cedar Creek would probably be only about 2/3 that of Lower Cedar Creek. The length of pipeline would be about 80 percent as long so that the Upper Cedar Creek diversion also would not be economically feasible.

On these bases, no further work on either of these alternatives is recommended.

REFERENCES

REFERENCES

1. Water Resources in the Big Lost River Basin; South-Central Idaho; by E. G. Crosthwaite, C. A. Thomas and K. L. Dyer, USGS 1970.

2. Investigation; Mackay Dam Bondholders' Committee; Big Lost River Irrigation Company; April 1911; The Arnold Company.

3. Geologic Report on Mackay Dam; Big Lost River Project Idaho; by C. D. Jarrard, USBR; September 1950.

4. Upper Snake River Basin; Plans, Studies and Data; Vol. IV, Part II; U.S. Bureau of Reclamation, U.S. Army Corps of Engineers; 1961.

5. Water Resources Data for Idaho; Water Year 1977; U.S. Geological Survey.

6. Water Conservation Review; Big Lost River, Idaho; U.S. Department of Agriculture, Soil Conservation Service; February 1955.

7. Preliminary Investigation Report; Big Lost River Watersheds; Butte and Custer SCD; November 28, 1961. Only a "Review Copy" of the report was available.