US Army Corps
of Engineers
Walla Walla District

Reconnaissance Report
Mud Lake, Idaho

October 1989

US Army Corps
of Engineers
Walla Walla District
Bldg. 602, City-County
Airport, Walla Walla,
WA 99362-9265

Public Notice

Public Notice No:

Date: May 1990

Contact: Gary G. McMichael

Phone: (509) 522-6632

NOTICE OF COMPLETION OF RECONNAISSANCE REPORT-- MUD LAKE, IDAHO

I am announcing completion of a reconnaissance report of Mud Lake, Idaho. This study investigated alternative solutions to the flooding problem of Mud Lake.

The Mud Lake area is a closed basin located on Camas Creek, 20 miles west and 50 miles north of Idaho Falls in Jefferson County, Idaho. The lake is formed by a 10-mile long embankment constructed many years ago by local farmers to confine the lake and make it possible to farm the land and provide water elevation so that irrigation canals can deliver water to farms. The capacity of the lake is 45,000 acre-feet. The embankment protects farmland which has been improved by leveling and drainage and developed with homes, farm buildings, private and county roads, and local businesses. Over 20,000 acres of cropland are irrigated with water from the lake. Crop production supplies feed, which is critical for the livestock industry, in two counties and is a major supplier for Idaho, Montana, and other states. A flood emergency channel, which is an extension of the Owsley Canal, can serve as an outlet for Mud Lake, but it is dependent upon the canal company lift pumps. In past years, the lake has risen to dangerous levels due to above average inflow to the basin. This resulted in prolonged flood fight activities by the locals, state, and Corps. Even with a substantial flood fight effort, the existing embankment nearly failed when the water level reached a gage height of 10.7 feet in the spring of 1984.

Previous studies by the Corps of Engineers indicated that extensive improvement of the embankments to the Corps of Engineers design standards is not economically feasible. Thus, the solution to the flood problem appears to involve interception of flows above the lake and seepage of those waters into the ground or to pump water from the lake into an enlarged Owsley Canal or the Jefferson Canal.

The reconnaissance study determined that four alternatives have benefit-to-cost ratios that exceed unity. The four alternatives are as follows:

1. Wildlife Refuge Enlargement. The area north of Camas Creek between the state and Federal wildlife refuges is flooded during high runoff years. This alternative considers the possibility of purchasing or leasing this land and constructing a dike along the county road on the south side of this area. This area could store approximately 22,000 acre-feet of floodwaters, when needed, and could also be managed to provide wildlife and irrigation benefits.

2. Jefferson Canal Diversion Pond. Additional pumps installed in Mud Lake could be used to transport water from the lake to a disposal area west of the lake on Idaho National Engineering Laboratory land via the existing Jefferson Canal. A dike would be required around the disposal area to prevent flooding of the adjacent cropland, and a canal would be needed from Mud Lake to the pump site to ensure water availability to the pumps when the gage height reaches 8 feet.

3. Lone Tree Dam. About 1920, a dam was built on Camas Creek upstream of Mud Lake to store irrigation water. The reservoir would not hold water due to fractures or lava tubes in the basalt under the reservoir, and the dam was breached in 1924. If the dam were rebuilt, water could be impounded during high runoff years and allowed to percolate into the groundwater table.

4. Western Diversion. In 1969, under "Operation Foresight," the Corps constructed a diversion from Camas Creek, just above the old Lone Tree Reservoir, along a former irrigation ditch to the east of Camas Creek. This diversion infiltrates approximately 500 cfs into the basalt formation, which eventually returns to Camas Creek as groundwater inflow. It is proposed to construct a similar diversion to the west of Camas Creek at the same diversion point which could divert an additional 500 cfs.

A meeting was held on February 1, 1990, with the Mud Lake water users and the Jefferson Soil and Water Conservation District on the subject of project sponsorship. Considerable interest in a project was expressed by the local people, particularly concerning the Lone Tree Dam alternative. However, they would like to delay further study until 1992 because they are presently cost sharing a groundwater study with the U.S. Geological Survey which is to be completed in 1992.

Further information on this study or a copy of the report may be obtained from Mr. Gary McMichael, Chief of Plan Formulation Branch, Building 613A, Corps of Engineers, City-County

Airport, Walla Walla, Washington 99362-9265. His telephone umber is (509) 522-6632.

/signed/
James A. Walter
Lieutenant Colonel, Corps of Engineers
District Engineer

CF: Gifford

CENPW-PL-PF (CENPW-PL-PF/15 Nov 89) (1110-2-1150a) 4th End
Mr. Gifford/ss/522-6634
SUBJECT: Mud Lake Reconnaissance Report, Dated October 1989

DA, Walla Walla District, Corps of Engineers, Walla Walla, WA 99362-9265 24 April 1990

FOR Commander, North Pacific Division, ATTN: CENPD-PL

1. There remains only a few copies of the Mud Lake Reconnaissance Report so additional copies will need to be printed. Being that study funds were depleted preparing the report, an additional $5,000 will be required to fund the work requested in your 3rd endorsement.

2. The draft final report and the proposed Chief's report will be provided to you for your review 3 weeks after we receive the required funding. Fifty-Seven copies of the final report and 6 copies of the Chief's report will be sent to you 3 weeks after the draft report has been approved by CENPD.

FOR THE COMMANDER:

2 Encls
nc

L. V. ARMACOST, P.E.
Chief, Planning Division

GIFFORD/PL-PF/s

McMICHAEL/PL-PF

VEIGHEY/PM-PB

BEECHIE/PL

ARMACOST/PL

IM-SM

EN

CENPD-PL-PF (CENPW-PL-PF/15 Nov 89) 3rd End Mr. Toma/rm/FTS 8-423-3826
SUBJECT: Mud Lake Reconnaissance Report, Dated October 1989

CDR, North Pacific Division, Corps of Engineers, P.O. Box 2870, Portland, OR 97208-2870

FOR Commander, Walla Walla District

1. We do not concur with your request to defer initiation of the Mud Lake feasibility study until 1992. In accordance with paragraph 2-8.g.(4), SECTION 11 (Study Procedures and Reports) of ER 1105-2-100, where no Federal action is recommended, a final report to the Congress will be prepared, regardless whether the study is terminated in the reconnaissance or feasibility phase. A final report to Congress does not preclude your District from initiating the Mud Lake study under a new study authority at a later time. In this case, the Mud Lake study would be reinitiated under the Continuing Authority Program to complete the reconnaissance phase. Completion of the reconnaissance phase will require updating of the reconnaissance report and HQUSACE certification of the reconnaissance report, the negotiated Feasibility Cost Sharing Agreement, and the letter of intent.

2. The reconnaissance report or a letter report summarizing the reconnaissance report (see Table 2-2 of ER 1105-2-100) would suffice as a final report. Least cost should determine the selection between submitting the reconnaissance report or a letter report. As part of the final report, it is suggested that the paragraph 5 of Table 2-2, Preliminary Financial Analysis, summarize the results of the economic analysis and reflect the strong non-Federal sponsorship for the study. Also, this paragraph should indicate that the non-Federal sponsor will not have the financial capability to cost share the feasibility phase until 1992. Paragraph 7 of Table 2-2, Recommendations, should indicate that no further Federal action is recommended at this time. However, when the non-Federal sponsor obtains the financial capability to continue studies, the Mud Lake study would be reinitiated under the Continuing Authority Program.

3. In accordance with ER 1105-2-100, "for reports that recommend no Federal action, fifty copies of the report and one copy of the proposed Chief's report will be sent to WLRC; six copies of the report and one copy of the proposed Chief's report will be sent to HQUSACE (CECW-P); and one copy of each of these documents will be sent to ASA(CW)." Therefore, we will need a total of 57 copies of the report and 3 copies of the Chief's report to forward to higher authority.

4. Request that a draft of the final report and proposed Chief's Report be provided this office for review and approval prior to printing. You are also requested to provide a schedule for providing draft and final reports.

\signed\

2 Encls
nc

PAT M. STEVENS IV
Brigadier General, USA
Commanding

CENPW-PL-PF (CENPD-PL-PF/15 Nov 89) (1110-2-1150a) 2nd End
Mr. Gifford/ss/522-6634
SUBJECT: Mud Lake Reconnaissance Report, Dated October 1989

DA, Walla Walla District, Corps of Engineers, Walla Walla, WA 99362-9265 9 March 1990

FOR Commander, North Pacific Division

1. A meeting was held 1 February 1990 with the Mud Lake water users and the Jefferson Soil and Water Conservation District on the subject of sponsorship of a Section 205 study for Mud Lake. Considerable interest was expressed by the locals in the study, particularly the study of the Lone Tree Dam alternative. But they would like to delay the study until 1992.

2. They are presently cost sharing a groundwater study with the U.S. Geological Survey which is to be completed in 1992. This means they are limited financially in their ability to support the Section 205 study. Also, the information from the groundwater study would be helpful to the Section 205 study.

3. It is recommended that we defer initiation of the feasibility level study of Mud Lake at this time. A public notice announcing completion of the reconnaissance study will be issued.

2 Encls
nc

JAMES A. WALTER
LTC, EN
Commanding

GIFFORD/PL-PF/s

McMICHAEL/PL-PF

BEECHIE/PL

ARMACOST/PL

TURNER/EA

KURKJIAN/DE-D

WALTER/DE

IM-SM

EN

CF: Gifford

CENPD-PL-PF (CENPW-PL-PF/15 Nov 89) 1st End Mr. Anderson/rm/326-3829
SUBJECT: Mud Lake Reconnaissance Report, Dated October 1989

CDR, North Pacific Division, Corps of Engineers, P.O. Box 2870, Portland, OR 97208-2870 2 January 1990

FOR Commander, Walla Walla District

1. The revised report addresses our previously stated technical concerns. However, the question of non-Federal sponsorship remains open as there is no identification of a sponsor which is willing to share the costs of the next phase and which understands the cost sharing requirements of project implementation. Therefore, you are requested to provide a Letter of Intent from the sponsor.

2. Provided a suitable sponsor is identified, we concur with your recommendation to continue studies under the Continuing Authorities Program, Section 205 of the Flood Control Act of 1948. Upon receipt of the Letter of Intent we will act on conversion to Continuing Authorities.

3. Completion of the reconnaissance phase requires preparation and negotiation of the Feasibility Cost Sharing Agreement. Also, the report must include a preliminary financial analysis assessment, and a summary of study management, coordination, and public views and comments (ER 1105-2-100, Table 2-2). The report should be signed by the District Commander.

4. We note on Page 10, under Average Annual Damages, with a safe levee height of 8 feet, the average annual damages are $514,000 (987,000 - (987,000-41,000)/2), not $473,000 as reported. This serves to increase the benefits by $41,000 if the with-project damages are correct.

FOR THE COMMANDER:

\signed\

JAMES B. ROYCE
Colonel, Corps of Engineers
Deputy Commander

2 Encls
nc

CENPW-PL-PF (1110-2-1150a) 15 November 1989

MEMORANDUM FOR Commander, North Pacific Division,
ATTN: CENPD-PL-PF

SUBJECT: Mud Lake Reconnaissance Report, Dated October 1989.

GIFFORD EN-CB

1. Enclosed for review and approval is one copy of the subject report (Encl 2). Nine additional copies are being forwarded under separate cover.

2. The Mud Lake Reconnaissance Report, dated April 1989, has been extensively revised and the date on the cover changed to October 1989. The revised report is responsive to the CENPD comments transmitted by 1st End to CENPW-PL-PF letter, dated 27 April 1989, subject: Mud Lake Reconnaissance Report, dated April 1989 (Encl 1).

3. Your early approval will allow us to proceed under Section 205, Continuing Authority.

2 Encls
as

JAMES A. WALTER
LTC, EN
Commanding

GIFFORD/cmh/EN-CB

G. MCMICHAEL/PL-PF

BARRETT/PL

ARMACOST/PL

TURNER/EA

KURKJIAN/DE-D

WALTER/DE

MAIL ROOM

EN FILES

CENPD-PL-PF (CENPW-PL-PF/27 Apr 89) 1st End Mr. Anderson/rm/326-3829
SUBJECT: Mud Lake Reconnaissance Report Dated April 1989

CDR, North Pacific Division, Corps of Engineers, P.O. Box 2870, Portland, OR 97208-2870 15 JUN 1989

FOR Commander, Walla Walla District

1. There is sufficient uncertainty with justification of the proposed project that we request you resubmit a revised report which addresses the enclosed comments. Provided adequate responses and revisions are made, we will support your recommendation to continue the study under Section 205 of the Continuing Authorities Program.

2. If the revised report is responsive to these comments, we do not believe a Reconnaissance Resolution Conference (RRC) with Washington level staff, as required by ER 1105-2-100, will be necessary. Therefore, we intend to request an exemption from the requirement to hold an RRC when we forward the revised report for Washington level review.

3. The draft Feasibility Cost Sharing Agreement, letter of intent, and preliminary financial analysis (see ER 1105-2-100) should be submitted with the revised report. Sample FCSA's (with Scopes of Work) from Continuing Authorities studies will be provided under separate cover for your information and use.

\signed\

JAMES B. ROYCE
Colonel, Corps of Engineers
Acting Commander

2 Encls
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Added 1 encl

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
WALLA WALLA, WASHINGTON 99362-9265

REPLY TO
ATTENTION OF:

CENPW-PL-PF (1110-2-1150a) 27 April 1989

MEMORANDUM FOR Commander, North Pacific Division

SUBJECT: Mud Lake Reconnaissance Report Dated April 1989

1. Enclosed for review and approval are 15 copies of the subject report.

2. The Lone Tree Detention Dam is the NED plan and is acceptable to the local interests. The estimated cost of the project is approximately $2 million. Being that the cost is under $5 million, the feasibility phase could be conducted under Section 205 Continuing Authority.

3. Discussions are underway with local interests concerning the study cost-sharing requirements for the Detailed Project Report. The draft Feasibility Cost-Sharing Agreement, along with a letter of intent from the sponsor, will be furnished to you as soon as negotiations with the sponsor have been completed.

4. I recommend that a feasibility study be made of the Lone Tree Detention Dam under Section 205 once feasibility study cost-sharing arrangements have been completed.

\signed\

Encl (15 cys)

JAMES A, WALTER
LTC, EN
Commanding

CENPD-PL-PF 13 June 1989

CENPD COMMENTS ON
MUD LAKE RECONNAISSANCE REPORT

1. One major purpose of a reconnaissance report is to clearly identify the sensitivity of project justification to key with- and without-project assumptions. The report should better document this in several areas, one of which is the consideration of "freeboard benefits" for the Mud Lake dike. A safe dike height of 9-1/2 feet was selected in order to compute damages and benefits. However, the lake elevations have exceeded 9-1/2 feet in the past without dike failure. Therefore, unless there are unusual circumstances as to why the dike did not fail when 9-1/2 feet was exceeded, such as flood-fighting activities, the analysis must assume some credit for "freeboard benefits" between the "safe height" and the top of the dike. Using the procedure recommended in EP 1105-2-45, 1-8. b., the benefits and damages change considerably. That is, once credit is given for the freeboard providing some flood damage protection, the total average annual damages go down and consequently, the possible benefits are also reduced. Our analysis indicates that the benefit-to-cost ratio for the proposed plan (with 9-1/2 foot failure) becomes less than 0.8 when "freeboard benefits" are accounted for.

2. Project justification is also sensitive to the assumption regarding stage height at which the Mud Lake dike would fail. To reflect this sensitivity, the report should present the benefit-to-cost ratios of higher safe height assumptions. This sensitivity is shown in the following table of remaining average annual damages and benefits with different failure assumptions (without consideration of "freeboard benefits").

Failure Height	A.A.D	A.A.B.	BCR
9-1/2'	$392,000	$308,000	1.4
10'	$216,000	$176,000	0.8
10-1/2'	$101,000	$ 42,000	0.2

The report should include history of lake elevations in the recent past to judge the suitability of the dam failure assumptions.

3. It is possible that water diverted to groundwater by the proposed Lone Tree detention dam will make its way to Mud Lake in a subsequent year and negate the benefits of the project to a degree, if the subsequent year experiences a large run-off. This potential needs to be investigated, as it affects the proposed project and the other alternatives, and might affect choice of

alternatives. While we agree that in-depth sensitivity analysis may be more appropriately addressed in the feasibility phase, the report should nonetheless address this situation.

4. The following geotechnical aspects need to be addressed in the revision:

a. The burial of 2 five-foot diameter culverts in the embankment is an unacceptable practice because embankment settlement will deform and possibly break the conduits. The outlets should be buried in the foundation rock or placed in rock at an abutment. See EM 1110-2-2300, Earth and Rockfill Dams General Design and Construction. The use of seepage rings or collars on an outlet conduit was discontinued many years ago because the difficulty of compacting the soil around the seepage collars actually lead to increased seepage.

b. The typical dam section shows two downstream gravel filters which is an error. The downstream filter next to the core should be a sand filter as discussed in paragraph 4d of the report. The upstream filter should be a sand and gravel filter.

c. In paragraph 4d., Main Dam Embankment, the statement that the core of the dam will be a 20-foot wide vertical wall is misleading. The word wall implies concrete wall, not a silt core as shown.

d. The assumptions made for the foundation conditions at the Lone Tree dam site would support the use of a roller compacted concrete dam. This would delete the need for an off-channel spillway and further reduce the cost of the project, and should be considered.

e. The use of the probable maximum flood as the design standard for the detention dam spillway may be overly conservative, given the size of the structure and the degree of human habitation downstream. Reference should be made to EM-1110-2-1101 to address this question.

5. On page one, the Study History, indicates that a National Dam Safety Inspection was made in 1982. The results from that study should be identified in the report. Further, if the dike is at risk, rehab of the dike should be investigated as an alternative to dike raise.

6. There is no real estate write-up provided. It appears that LERRD will consist of at least 290 acres and 3,100 feet of road right-of-way, but there is no mention of the interest required or who owns and controls the land.

7. The land value estimate of $100/acre appears conservative and there is no cost shown for additional right-of-way.

8. The scope of work appended to the FCSA must be in considerably more detail than that in the report. More explanation of the $186,000 line item for "project design" is necessary. For example, surveys and geo-tech needs to be broken out to allow a check not only of the adequacy of the work proposed, but also a review of the split between appropriate work in the feasibility phase and plans and specifications phase.

9. Current Section 205 guidelines call for the feasibility phase to cost no more than 15 percent of project implementation costs; an explanation must be provided if this cost target is exceeded. The estimated feasibility cost of $400,000 exceeds the target by $100,000. Nevertheless, depending on survey and exploration costs, $400,000 may not be out-of-line for the project proposed for implementation.

10. Due to uncertainties involved with the proposed project, and from the standpoint of requirements of NEPA, it will not be acceptable to narrow the study to consideration of only the tentatively selected plan in the next phase. Also, caution is advised regarding initiation of expensive work like surveys or geo-tech, until there is reasonable assurance that the best plan is selected.

11. Cost sharing for the feasibility phase is shown incorrectly (page 13, Division of Plan Responsibilities). If the DPR costs more than $40,000, then all DPR costs are shared 50/50 with the non-Federal sponsor.

12. Conflicting lengths of the Mud Lake dike are shown on page 5, paragraph 3 and page 9, paragraph E.

SUMMARY

This reconnaissance report of the Mud Lake Basin in eastern Idaho was conducted under the Upper Snake River Basin study authority. The purpose of the study was to identify alternatives to reduce flooding around Mud Lake, which is the sump for a closed basin.

Alternatives considered were:

a. Wildlife Refuge Enlargement. Store floodwaters on lands located between and on the existing State and Federal wildlife refuges.

b. Jefferson Canal Diversion Pond. Pump excess water from the lake through Jefferson Canal to a sump area on Idaho National Engineering Laboratory lands west of the lake.

c. Lone Tree Dam. Detain and sink floodflows in the old Lone Tree Reservoir site on Camas Creek before the water enters Mud Lake.

d. Western Diversion. Divert additional floodflows from the present intake point 1 mile above Lone Tree Dam site to the west of Camas Creek. The levee would follow the existing Lea-Egbert Canal.

e. Raise Mud Lake Dike. Store additional floodwaters at Mud Lake.

All of the alternatives are economically feasible, except for raising the Mud Lake dike. Based on the preliminary study, the most economical solution is to rebuild the old Lone Tree Dam. The Lone Tree Dam alternative has an estimated cost of about $2 million, net annual benefits of $112,000, and a benefit-to-cost ratio of 1.5 to 1.

It is recommended that a detailed study be undertaken to determine more precise costs, benefits, and impacts of all the alternatives discussed in this report, except Raise the Mud Lake dike. This detailed study should be done under Section 205 of the Flood Control Act of 1948 as the estimated construction costs are well within the $5 million, limit of that authority.

RECONNAISSANCE REPORT
MUD LAKE, IDAHO

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RECONNAISSANCE REPORT
MUD LAKE, IDAHO

I. PURPOSE.

This report presents results of a reconnaissance investigation of the feasibility of solving flooding problems in the vicinity of Mud Lake, Idaho. Mud Lake is the lowest point in the drainage basin and has no outlet. Increased surface and groundwater inflow to the lake in recent years has necessitated pumping water from the lake into nearby lava flows, upstream diversion, and temporary ponding on adjacent wildlife refuges to prevent failure of the lake dike.

II. STUDY AUTHORITY.

This study is made under the authority of a 19 March 1954 resolution of the Senate Committee on Public Works as follows:

"Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be and is hereby, requested to review the report of the Chief of Engineers on Columbia River and Tributaries, Northwestern United States, submitted in House Document Numbered 531, Eighty-First Congress, Second Session, with a view to determining whether any modification of the recommendations contained therein is advisable at this time, with particular reference to the Upper Snake River Basin above Weiser, Idaho."

III. SCOPE OF STUDY.

This preliminary investigation provides an evaluation of physical, economic, social, and environmental factors associated with various alternatives to reduce the impact of flooding in the vicinity of Mud Lake, Idaho. The depth of detail used for this study is only that necessary to establish if further study is warranted on any of the alternatives under consideration. Use has been made of available topographic maps, aerial photos, existing data, and information from prior reports and studies.

IV. STUDY HISTORY.

The U.S. Geological Survey (USGS) began studies of the Mud Lake basin in 1925. The first Corps study was a Columbia River and Tributaries "308" Report in 1948 that appraised the 1945-46 failures of the Mud Lake Dike. A design memorandum was completed in 1957 and Section 205 reports in 1970 and 1976. Some work was done under Operation Foresight in 1969, and a National Dam Safety Inspection was made in 1982. Studies have also been done by USGS, Idaho Department of Water Resources (IDWR) and the University of Idaho.

Following a flood fight at Mud Lake in June 1984 in which the Corps participated, a local steering committee requested assistance from the Corps in solving the flooding problems around the lake. The steering committee was made up of the various agencies, counties, and irrigation and flood control districts. This request was supported by IDWR. The Walla Walla District received funding in March 1988 to conduct this reconnaissance study.

V. STUDY PARTICIPANTS AND COORDINATION.

Study participants included the Soil Conservation Service, Idaho Flood Control District No. 5, and the University of Idaho.

The U.S. Fish and Wildlife Service, in cooperation with the Idaho Department of Fish and Game, provided a Planning Aid Letter.

The University of Idaho made a Cultural Resources Study and a hydrological model of the basin.

Coordination has been maintained with all interested agencies and groups through various local meetings.

VI. RESOURCES AND ECONOMY OF THE STUDY AREA.

The Mud Lake watershed is a closed basin located in northwest Jefferson County and northeast Clark County. See figure 1. The top of the drainage area begins at the Continental Divide and terminates in Mud Lake, approximately 30 miles northwest of Idaho Falls. Three major subwatersheds (Medicine Lodge Creek, Beaver Creek, and Camas Creek) comprise about 991,000 acres of the watershed. See figure 2.

In 1982, the U.S. Army Corps of Engineers Phase I, Inspection Report, stated that only Camas and Beaver Creeks subwatersheds contributed surface runoff to Mud Lake. These two subwatersheds consist of about 723,200 acres. Outflow from Medicine Lodge Creek seeps into the ground before it reaches Mud Lake.

The Camas and Beaver Creeks' basins have two distinctly different regions--physically and geographically. The northern part of the basin is mountainous in character with elevations up to about 10,000 feet msl. This area has a well defined and fairly dense pattern of drainage in canyons and steep narrow valleys. By contrast, the lower area is a broad sloping plain interrupted in places by small volcanic buttes and cinder cones. This part has a rough surface with hummocks and dunes, but it has some fairly deep topsoils. Elevations of this southern area slope gradually southward from about 6,400 feet msl at the base of the mountains to 4,775 feet msl at Mud Lake, a closed basin.

The climate of the area is usually dominated by Pacific Maritime air masses imported by prevailing westerly winds. These air masses are responsible for moderate temperatures, and they also carry moisture from which most of the precipitation is received. Mean annual temperatures are about 54 degrees Fahrenheit (F) in the lower areas and 35 degrees to 40 degrees F in the mountains. The temperature on the plains averages below freezing from November through March. Usually there are several days each year of temperatures below 0 degrees F. Some extremely cool temperatures, lower than minus 30 degrees F, have been recorded in the vicinity, but prolonged periods of subzero temperatures are uncommon. Maximum temperatures seldom exceed 100 degrees F and the highest average monthly temperatures are between 60 degrees and 70 degrees F. There are approximately 90 frost free days in the area.

Normal annual precipitation ranges from less than 9 inches near Mud Lake to about 30 inches in the mountains and, for the area as a whole, averages about 16 inches. May and June are the months of greatest precipitation in the plains area. The winter months produce the greatest amount of precipitation in the mountainous area. July and August are months of least precipitation.

Rainfall intensities are usually low and storm durations are seldom more than a few days. Maximum recorded 24-hour amounts in the area are slightly in excess of 2 inches and have occurred as summer thunderstorms. There have not been any recorded occurrences of serious floods from rain.

Most of the winter precipitation occurs as snowfall; and, in the mountains, over half of the year's precipitation accumulates on the ground as snowpack. Newly fallen snow usually contains less than 20 percent moisture; but, as the snow accumulates, it becomes more dense and the water equivalent increases to about 40 percent of the total snow depth. Maximum snow depth and water equivalent usually are attained in March or April, after which the snow is generally melted by warmer spring temperatures. From records of four snow courses in or near the basin that are 6,000 and 7,000 feet msl, the average maximum depth of snow and of water equivalent is about 42 inches and 14 inches, respectively.

Streamflows in Camas and Beaver Creeks have somewhat regular patterns with low flows occurring July through February and high flows occurring from March or April through May or June. This is typical of streams that derive their runoffs principally from snowmelt. Runoff originates largely in the northern mountainous headwater areas of the basins. Surface flows ordinarily begin to diminish in Camas Creek near Kilgore, Idaho and in Beaver Creek near Spencer, Idaho. Because of pervious soils and efficient groundwater aquifers, a large percentage of the total generated runoff does not reach Mud Lake as surface flow. At least half of the flow originating in Camas Creek and over 80 percent of the flow originating in Beaver Creek is lost to groundwater above Camas. During peak discharges in

Camas Creek there are generally large losses of water experienced as it flows over the sand and gravel in the Camas National Wildlife Refuge. This causes approximately half of the flow of Camas Creek to be lost before it reaches Mud Lake.

Annual runoff volumes vary with seasonal precipitation received. Average runoff in these areas is relatively small. Little or no surface runoff originates in the lower, drier areas of the watershed.

Records of streamflows have been obtained at a number of locations on Camas and Beaver Creeks since 1921. The combined average annual flow of Camas and Beaver Creeks at Camas, Idaho representing virtually all of the surface flow of the Mud Lake basin, is approximately 29,000 acre-feet. The largest annual flow was 103,000+ acre-feet in 1984. The maximum combined flood of record at Camas was about 1,400 cubic feet per second (cfs) on 2 May 1952.

Mud Lake storage results from (1) seasonal runoff from the tributary area and groundwater inflow to Camas Creek, and (2) groundwater discharge areas northeast of Mud Lake. The groundwater apparently originates principally from the upper basin of Camas and Beaver Creeks. Groundwater is also derived from adjacent areas, including the area of Henry's Fork, the irrigated area on Egin Bench, and possibly from Medicine Lodge Creek. In average and high runoff years, flows from Camas and Beaver Creeks contribute water to the lake. The lake also receives a significant amount of moisture by direct precipitation.

A record of lake storage has been maintained since 1921 by the USGS. The record shows that Mud Lake exhibits a fairly regular pattern of stages with maximums usually occurring in April or May and minimums usually occurring in September or October. Fairly uniform rates of change in these stages occur during the intervening filling and emptying periods. The maximum recorded lake content was 61,600 acre-feet in May 1923. The average minimum storage has been about 6,700 acre-feet. Zero storage was recorded in October 1937. The average annual increase in storage during filling periods has been about 30,500 acre-feet. The maximum observed increase in storage was 49,600 acre-feet between October 1983 and June 1984. The minimum seasonal increase was 15,700 acre-feet between October 1983 and April 1984 (see appendix A, table A-1).

A probable maximum flood (PMF) inflow resulting from snowmelt and rain has been estimated by the Soil Conservation Service from envelope curves of the derived PMF's for the Snake River Basin. It is estimated that this flood would have a maximum flow of 50,000 cfs and a 5-day volume of 150,000 acre-feet.

A thunderstorm PMF was derived from thunderstorm rainfall estimates in "Probable Maximum Precipitation, Northwest States," Hydrometeorological

Report 43, U.S. Weather Bureau, and with a Snyder unit hydrograph. Because the real extent of thunderstorms is effectively limited to about 500 square miles, the storm was assumed to be centered over the Beaver Creek basin (drainage area = 510 square miles). The resulting flood would have a peak flow of 9,700 cfs and a volume of 20,000 acre-feet.

The Mud Lake watershed includes Federal, State, and private lands.

Federal Lands		Acres
U.S. Forest Service		274,000
Bureau of Land Management		200,000
U.S. Fish and Wildlife Service		13,000
U.S. Sheep Experiment Station		30,000
Department of Energy		6,000
State		
Mud Lake State Wildlife Management Area		9,000
Other		61,000
Private		398,000
	Total	991,000

Land use in the watershed includes the following:

Land Use		Acres (Est.)
Cropland (Dry)		20,000
Cropland (Irrigated)		120,770
Woodland		350,000
Wildlife Land		23,200
Pasture and Hay Land (Irrigated)		12,500
Rangeland		400,000
Other		14,000
	Total	991,000

Mud Lake provides irrigation water to approximately 26,000 acres. An additional 2,620 acres are partially irrigated from the lake. Supplemental water for these acres is pumped from wells. There are approximately 120 operating farm units in the area.

Primary crops grown in the service area are small grains and hay, with some potatoes grown under sprinkler irrigation near the town of Hammer, Idaho. Although some wheat is raised, spring barley is the primary grain crop with an average yield of 115 bushels per acre. Most hay fields yield two cuttings per season with average seasonal yield of 4 to 4.5 tons per acre.

Surface irrigation systems are generally well maintained, good quality earthen systems. Concrete structures have not proven to be feasible because of adverse soils and slopes. Soil erosion from irrigation in the Mud Lake area, as well as the other cropped area in the watershed, is not a problem.

Many migratory species of wildlife are native to the watershed. All species of upland game and nongame animals common to the area can be found in the upper watershed. Two wildlife refuges are located adjacent to Mud Lake. One of these, the Mud Lake State Wildlife Management Area, is operated by the State of Idaho. The other, the Camas National Wildlife Refuge, is operated by the U.S. Fish and Wildlife Service (USFWS). Flooding, sedimentation, and high groundwater problems have been shown to have an adverse effect on wildlife habitats, both wetland and upland. Local personnel of the USFWS and the Idaho Fish and Game Department (IDFG) are supportive of some type of project activity to reduce flooding problems in the area.

VII. EXISTING MUD LAKE DIKE.

A. Background.

Settlers came into the Mud Lake area to raise livestock in the late 1800's. The Mud Lake dike was built to provide water for farming and to limit the area covered by the lake. The current dike was built as a cooperative effort between the irrigation district and the flood control district. The original dikes were constructed in the 1920's. It has been continually improved as both need and funds have become available. In recent years, Mud Lake dike has been widened to accommodate trucks. Rock riprap has been applied to about 3,800 feet of dike.

Mud Lake dike is an 11-foot-high, 10-mile-long, earthfill structure. The reservoir stores approximately 38,000 acre-feet of water at a gage height of 8.0 (4,782.99 feet msl). The design, if any, is unknown. The dike appears stable, although foundation seepage is apparent.

There is no spillway or low level outlet for the dike. All water leaves the lake either by evaporation, percolation, or by pumping from various locations. The total pumping capacity on the reservoir is estimated to be 576 cfs.

The USGS has Mud Lake gage heights recorded from 1921 to the present. See appendix A, table A-1. In 29 out of 68 years, the maximum gage height has been above 8 feet. In 7 out of 68 years the maximum gage height has been at or above 9 feet. In 1984 the maximum gage height was recorded for the period of record at 10.61 feet.

B. National Dam Safety Inspection.

In 1988 the IDWR changed their definition of a dam so that Mud Lake is no longer classified as a dam, but a dike. However, because it was classified as a dam, a Phase I, National Dam Safety Inspection Report, was prepared by the IDWR in April 1982. The IDWR report concluded that what was called Mud Lake Dam at that time did not meet minimum design requirements for new dam construction. Inadequacies noted in their report included steep slopes, no low level outlet, less than the minimum 12-foot top width at several locations, and an inadequate spillway. The IDWR report recommended that studies be made of means to accommodate excess inflow to the lake and more intensive operations and maintenance procedures. As recommended in the safety inspection report, Flood Control District No. 5 has continued a maintenance program that includes work on flattening the slopes and increasing the top width to 12 feet.

C. Safe Lake Level for Mud Lake.

Federal flood damage reduction projects must be safe and dependable. Therefore, only safe lake levels are appropriate to evaluate Mud Lake flood potential. A safe lake level is particularly critical because there is essentially no outlet capacity. Once the structure begins to breach, there is little chance of avoiding a catastrophic failure. The maximum level for which Mud Lake can be considered dependably safe is 4,783 feet msl. This level allows for 3 feet of freeboard. This freeboard is adequate to prevent overtopping by waves generated with winds that occur infrequently but only about half the speed of maximum recorded winds.

VIII. PROBLEMS, NEEDS, AND OPPORTUNITIES.

A. Problems.

1. Mud Lake dike failure would result in inundation of approximately 23 homes and 12,300 acres of cropland and would damage or destroy the irrigation system on 25,500 acres. Forty farms would be affected with crop losses estimated at over $4.5 million. The safe levee height is 8 feet and safe top of dike height is 11 feet. Potential damage with failure has been evaluated over this range at one-half foot increments.

2. Sediment deposition in Mud Lake.

3. Sediment deposition on Camas National Wildlife Refuge and Mud Lake Wildlife Management Area.

4. Flooding of refuge and wildlife management area ($30,000 damage 1984).

5. Cropland sediment deposition.

6. High dike maintenance costs (approximately $400,000 in 1984).

7. Increased operational costs of Flood Control District No. 5. Pumping during flood stage in 1984 was over $42,000 and approximately $30,000 in both 1985 and 1986.

8. Flat topography around lake makes drainage difficult.

9. High water table on some 24,000 acres.

10. Flooding along Camas, Beaver, and Medicine Lodge Creeks. This affects roads, highways, railroads, fences, utilities, and other facilities. (Fifteen water control structures were damaged in 1984.) The city of Dubois is also vulnerable to flooding.

11. Severe streambank erosion on about 140 miles of channel.

12. Water quality degradation from runoff of feedlots and fields along the streams.

13. Inadequate irrigation water supply in latter part of season on about 55,000 acres in upper watershed.

14. Low flows in streams in late season adversely affect fisheries, wildlife, and livestock water supplies.

15. High water tables due to sinking of streams, irrigation applications (particularly Egin Bench area), and increased precipitation in watershed in recent years.

B. <u>Needs</u>.

1. Control the level of Mud Lake, which has no natural outlet, in order to prevent failure of the dike during years of high inflow to the lake.

2. Conserve all the water in the basin for irrigation purposes. Pumping water from the lake in times of flooding out into the desert reduces the water available for irrigation later in the season.

3. Control water levels on National Wildlife Refuge during flooding.

4. Reduce channel erosion and sedimentation.

C. Opportunities.

1. Divert or store water upstream to control inflow to Mud Lake.

2. Pump water from lake to desert during flood years.

3. Enlarge capacity of Mud Lake.

IX. WITHOUT-PROJECT DAMAGES.

For purposes of economic analysis for this project, it was assumed that flood damages only result when inflows to the lake become greater than the existing diversions and irrigation canals capacity and when the lake level rises resulting in an overtopping or breaching of the levee system.

The most recent detailed economic back-up material was found in a 1976 Section 205 study. This study was used to estimate the flood damages and compute economic benefits for each alternative. Prices and farm yields were updated to current levels and the same damage categories were used as the previous study. We made the assumption that no significant development in the area has occurred since 1976, and land use and crop production are the same as the 1976 study.

Flood damages were calculated for categories of agricultural damages, agricultural damages outside the floodplain, and nonagricultural damages.

A. Agricultural Damages.

Yields for crops under "preflood" conditions were taken from the 1987 crop reports. The yields after a flood were adjusted proportionally to "before" and "after" flood yields used in the previous study. Total gross damages were then calculated by computing the difference between crop values before and after flooding.

Price level - 1987

Alfalfa	$55.00/ton
Potatoes	$4.55/cwt
Wheat	$2.85/bu
Barley	$3.65/cwt ($1.75/bu)

Agricultural damages "saved and added" are the net damages that farmers must pay to bring their land back into production following a flood. They were assumed to be the same as the previous study with prices updated using the "Survey of Current Business, Prices Paid by Farmers for All Commodities." The updated agricultural damages "saved and added" were combined with the gross agricultural damages to give the net agricultural damages.

B. Agriculture Damages Outside the Floodplain.

This damage category is composed of losses to crops caused by loss of irrigation water from Mud Lake. It was assumed that the same amount of area would be affected as was used in the previous study. The 1976 study assumed a 10 percent loss in crop value if irrigation water from Mud Lake was not available. The losses caused by interruption of irrigation water were indexed using "Survey of Current Business, Prices Received All Farm Products."

C. Nonagricultural Damages.

This category includes all buildings, roads, utilities, and improvements. From conversations with local people and field personnel we concluded that there has been little significant development within the floodplain since 1976. It was also assumed that there are the same number of structures and substructures in the floodplain with the same amount of damages to those structures as was calculated in the 1976 study. Prices for nonagricultural damages were indexed using "Dodge Local Cost Index - Idaho Falls," for structures and substructures. Repair of roads and irrigation works were indexed using "Engineering News Record Construction Index."

X. AVERAGE ANNUAL DAMAGES.

The "Without-Project" column of table 1 shows average annual damage at various levels of Mud Lake. Average annual damage ranges from $987,000 at just above safe levee height of 8 feet to $41,000 at top of dike at 11 feet. Using the procedure established in the draft ER 1105-2-100, paragraph 6-166.b. of crediting freeboard with one-half the benefit between safe levee height and top of freeboard produces average annual damage of $473,000 using the following equation:

$$\frac{(\$987,000 - \$41,000)}{2}$$

XI. ALTERNATIVE SOLUTIONS FOR FLOOD CONTROL.

Five alternative solutions were considered for the Mud Lake flood problem. A general description of the alternatives is provided as follows. Also, see appendixes B through F for details.

A. Wildlife Refuge Enlargement.

The area north of Camas Creek between the State and Federal wildlife refuges is flooded during high runoff years. This alternative considers the possibility of purchasing or leasing this land and constructing a dike along the county road on the south side of this area. This area could store approximately 22,000 acre-feet of floodwaters, when needed, and could also be managed to provide wildlife and irrigation benefits.

B. Jefferson Canal Diversion Pond.

Additional pumps installed in Mud Lake could be used to transport water from the lake to a disposal area west of the lake on Idaho National Engineering Laboratory land via the existing Jefferson Canal. A dike would be required around the disposal area to prevent flooding of the adjacent crop land and a canal would be needed from Mud Lake to the pump site to ensure water availability to the pumps when the gage height reaches 8 feet. The economics are based on a diversion of 200 cfs through Jefferson Canal for 75 days.

C. Lone Tree Dam.

About 1920 a dam was built on Camas Creek upstream of Mud Lake to store irrigation water. The reservoir would not hold water due to fractures or lava tubes in the basalt under the reservoir and the dam was breached in 1924. If the dam were rebuilt, water could be impounded during high runoff years and allowed to percolate into the groundwater table. The USGS Water-Supply Paper 818 indicates that wells northeast of Mud Lake show a rise in water levels during the winter which is believed to be the result of groundwater recharge from spring runoff through the streambeds to the north. For this study, it was assumed that 50 percent of the groundwater recharge would show up in Mud Lake six months later and that 50 percent would bypass Mud Lake to the northwest and enter the Snake River Plain Aquifer where it is permanently lost for use by the Mud Lake project.

D. Western Diversion.

In 1969, under "Operation Foresight," the Corps constructed a diversion from Camas Creek, just above the old Lone Tree Reservoir, along a former irrigation ditch to the east of Camas Creek. This diversion infiltrates approximately 500 cfs into the basalt formation eventually returns to Camas Creek as groundwater inflow. It is proposed to construct a similar diversion to the west of Camas Creek at the same diversion point which could divert an additional 500 cfs.

E. Raise Mud Lake Dike.

A 1976 study by the Corps looked at raising the dike around Mud Lake to increase the flood storage capacity. The dike is 10 miles in length and the study did not find it economically feasible to rebuild and raise the dike to Corps standards. This alternative was updated to present day costs and was, again, found not to be economically viable. It will not be considered for further evaluation.

XII. COMPARISON OF ALTERNATIVE PLANS.

The "With-Project" column of table 1 shows average annual damage with Lone Tree Dam over a range of failure levels of Mud Lake Dike. Using the draft ER 1105-2-100, paragraph 6-166.b. procedure, average annual remaining damage is $130,000 using the following equation:

$$\frac{(\$260{,}000 - \$0)}{2}$$

for an average annual benefit of $343,000 ($473,000 - $130,000).

Evaluation of the five alternatives shows that all are economically feasible except for raising Mud Lake Dike. The Lone Tree Dam alternative is the least cost ($2,097,000), provides the greatest net benefits ($343,000 - $231,000 = $112,000), and has the highest benefit-to-cost ratio (1.5 to 1).

The Lone Tree Dam alternative appears to be the most promising alternative, therefore, it was evaluated in detail. Estimated costs and benefits for all alternatives are in table 2.

XIII. THE NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN.

Alternative C, Lone Tree Dam, provides the greatest net benefits and is the NED plan.

Lone Tree Dam would be located in sec. 35, T. 11 N., R. 38 E., Boise Meridian, just downstream of the old Lone Tree Dam. The dam would be approximately 44 feet high with a crest length of 500 feet constructed of com- pacted rock with an earth core. The reservoir would impound approximately 3,000 acre-feet and cover 205 acres. It is estimated that the reservoir would have an infiltration rate of approximately 60 cfs into the underground aquifer. Two 5-foot-diameter outlet pipes would pass 400 cfs and could be closed to increase infiltration volume. Previous studies by

USGS estimate that it will take 6 to 12 months for the groundwater to reach Mud Lake. In normal water years, the flow of Camas Creek would pass through the reservoir without detention. Only when flooding was imminent at Mud Lake or a snow survey indicated flooding could occur, would the gates be partially or fully closed to infiltrate water into the groundwater reservoir or control maximum flows on Camas Creek.

XIV. SOCIAL IMPACTS.

Impoundment of water at Lone Tree Dam does not appear to have any significant adverse social impacts. The land inundated by the reservoir is grazing land and the additional water from occasional flooding should be beneficial to the landowner.

Protection from flooding around Mud Lake and on the National Wildlife Refuge will provide positive social benefits to the community.

XV. CULTURAL RESOURCES.

An archaeological reconnaissance was made of the Lone Tree site in October 1988 by the University of Idaho. This survey indicated that there may be significant archaeological resources in the reservoir area. Since the site will only be flooded occasionally and for short periods there may not be any significant problems. In the event of construction, a more detailed survey should be made. See appendix G for details of the survey.

XVI. ENVIRONMENTAL CONSIDERATIONS.

Construction of the Lone Tree Dam would impact approximately 200 acres of grazed sagebrush, pasture, and riparian habitat. The total area of riparian vegetation may increase over time and fencing of the reservoir could improve overall wildlife habitat.

There would be a temporary loss of riverine aquatic habitat from inundation during reservoir operation. No fisheries benefits are anticipated from the reservoir since it will be only temporary in nature. Some benefits to waterfowl and shorebirds are expected, but they will be limited and occur during a brief period in late spring. Stream channel conditions downstream of the reservoir are expected to improve since high flows and the resulting erosion will be reduced. See appendix H for Planning Aid Letter.

The wildlife refuge enlargement alternative is expected to provide numerous wetland and waterfowl production benefits as previously discussed in the draft planning aid report by USFWS. These benefits, however, were withdrawn from the final report by USFWS due to concerns of flooding expressed by Camas Refuge personnel. This alternative could provide multi-use benefits, including creation of over 2,500 acres of high value wetlands. These benefits could be credited to the North American Waterfowl Agreement, which the Corps entered into with the Department of Interior. Consequently, the Corps conducted further coordination directly with the Camas Refuge management personnel subsequent to completion of the USFWS Planning Aid Letter. This coordination has resulted in an understanding that the Corps will investigate constructing a west-side diversion as a means to fill a refuge enlargement impoundment and limiting impounded water to approximately 4,785 feet msl. Refuge personnel feel that this plan could provide significant additional opportunity for waterfowl benefits on the refuge as well as the opportunity to enlarge the refuge. See appendix H, Planning Aid Letter, for additional discussion of alternatives.

XVII. DIVISION OF PLAN RESPONSIBILITIES.

The project would be a local flood control project cost-shared by a local sponsor and the Federal Government under the provisions of PL 99-662. A Detailed Project Report would be prepared prior to plans and specifications. The study cost would be cost-shared as follows: (1) Costs will be cost-shared equally between the local sponsor and the Government and (2) up to 50 percent of the local cost-sharing may be in-kind.

Plans, specification, and construction costs will be cost-shared as follows: (1) The local sponsor is required by PL 99-662 to provide a cash payment equal to 5 percent of project costs; (2) the local sponsor must provide all lands, easements, rights-of-way, relocations, and disposal (LERRD); (3) additional funds, if necessary, will be provided by the local sponsor to bring their share up to 25 percent of project costs; (4) the Federal Government will provide 75 percent of project costs, or the balance, whichever is less; and (5) local cost-share must be at least 25 percent, but not more than 50 percent.

For the wildlife enlargement, alternative project construction costs allocated to wildlife enhancement and determined to be national in scope could be 100-percent Federal costs; and, the operation, maintenance, rehabilitation, and replacement costs could be 75-percent Federal costs.

XVIII. CONCLUSIONS.

Lone Tree Dam appears to be the NED plan. It would provide major flood control benefits for Mud Lake, and it would also conserve water for later use in the basin by infiltration to the groundwater. Three other alternatives have benefit-to-cost ratios that exceed unity; and, therefore, they should be investigated further in the detailed studies.

Detailed studies of the wildlife refuge enlargement alternative should include an evaluation of the wildlife benefits that could be associated with the additional wetlands in the Mud Lake area. It may be that this alternative will be designated the NED plan once the wildlife benefits are known.

All of the alternatives have a construction cost under $5 million; consequently detailed studies can be accomplished under Section 205 of the 1948 Flood Control Act.

XIX. RECOMMENDATIONS.

It is recommended that a detailed study be undertaken to determine more precise costs, benefits, and impacts of all the alternatives discussed in this report, except raise the Mud Lake Dike. This detailed study should be done under Section 205 of the Flood Control Act of 1948.

TABLE 1

MUD LAKE RECONNAISSANCE STUDY
BENEFIT CALCULATIONS

[(With-Project) condition is 3,000 acre-foot Lonetree Detention Dam with 60 cfs infiltration for 60 days.]

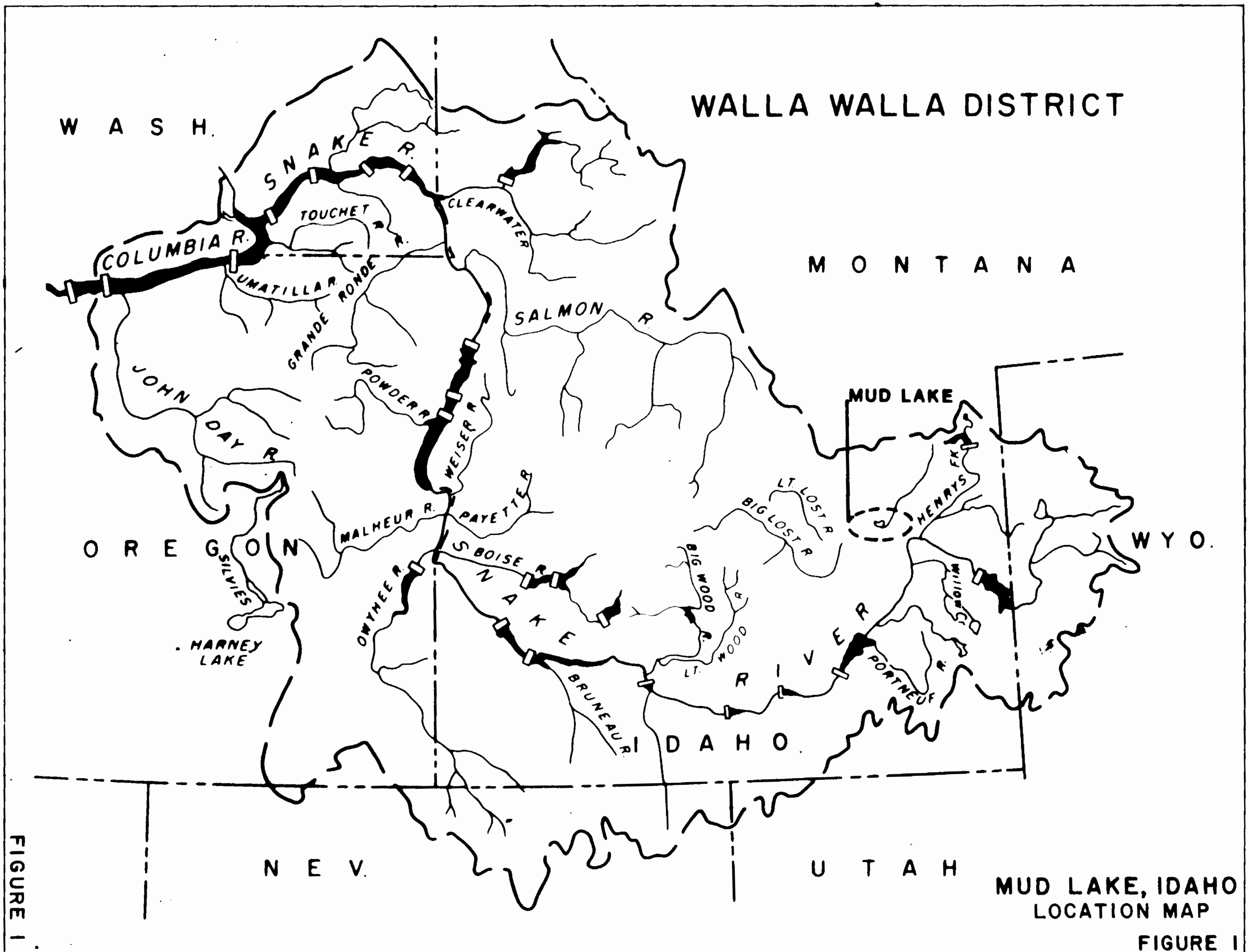
	Average Annual Damages		
Failure Height	Without-Project	With-Project	Damages Prevented
8 feet	$986,634	$259,703	$726,931
8 1/2 feet	$820,156	$209,127	$611,028
9 feet	$636,161	$146,947	$489,214
9 1/2 feet	$391,804	$83,306	$308,498
10 feet	$215,843	$39,693	$176,150
10 1/2 feet	$101,273	$11,323	$89,950
11 feet	$41,090	0	$41,090

TABLE 2

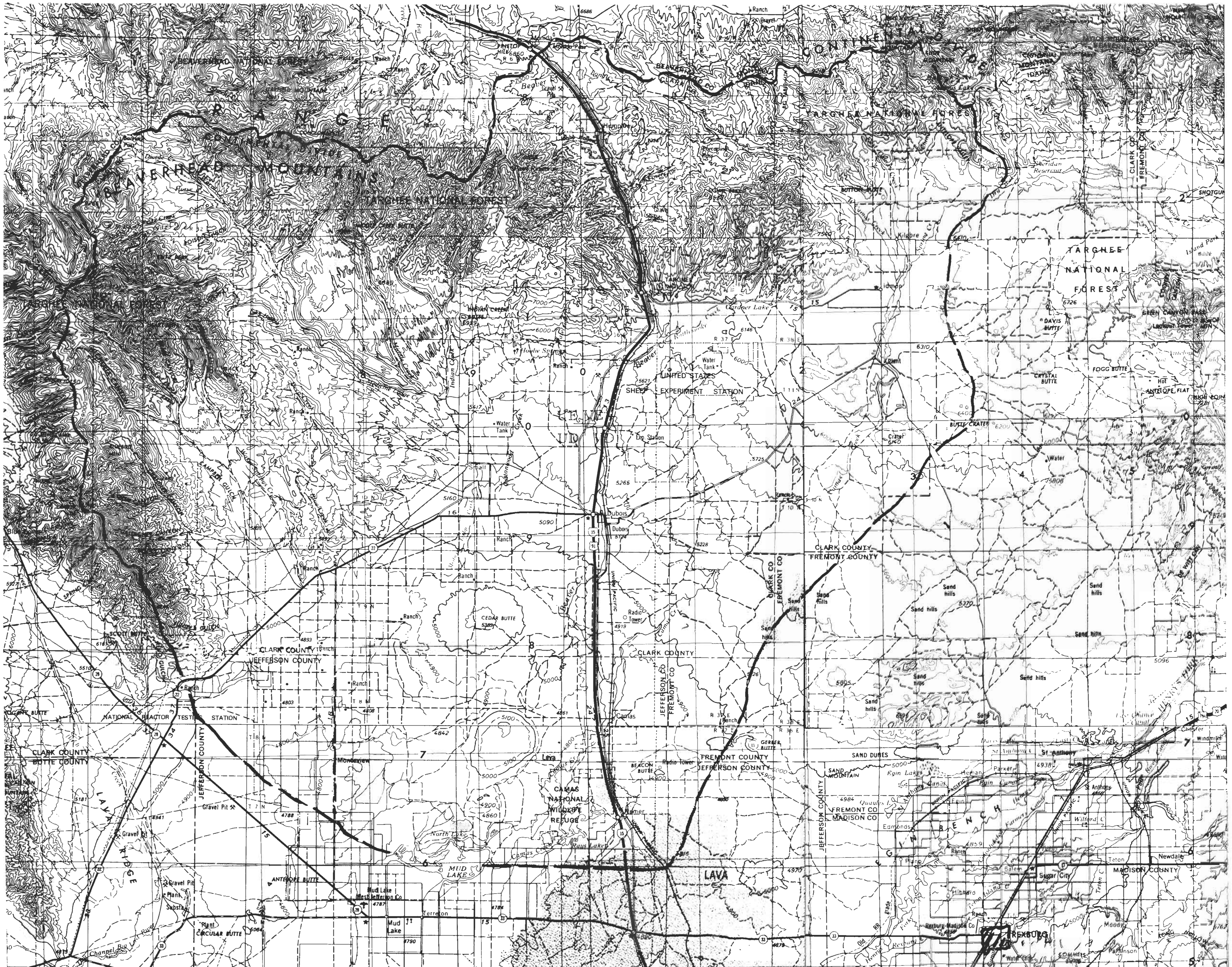
COMPARISON OF ALTERNATIVES

Alternative	Construction Cost	Interest During Construction	Total Investment Cost	Total Annual Cost	Annual[1/] Benefits	Net Annual Benefits	Cost-To-Benefits Ratio
Raise Mud Lake Dike (with 3 ft. freeboard)	$16,048,000	$712,000	$16,760,000	$1,509,000	$268,000	($1,241,000)	0.18
Enlarge Refuge	$4,015,000	$174,000	$4,189,000	$419,000	$451,000	$32,000	1.08
Jefferson Canal	$3,323,000	$144,000	$3,467,000	$396,000	$421,000	$46,000	1.06
Lone Tree Dam	$1,975,000	$122,000	$2,097,000	$231,000	$343,000	$112,000	1.48
Western Diversion	$3,157,000	$280,000	$3,437,000	$344,000	$451,000	$107,000	1.31

1/ Giving Mud Lake Dike credit for one-half of 3-foot-freeboard benefit (8 feet to 11 feet).



MUD LAKE, IDAHO
LOCATION MAP
FIGURE I



MUD LAKE, IDAHO
WATERSHED MAP

DRS 5/26/88 FIG. 2

APPENDIX A

HYDROLOGY

APPENDIX A

HYDROLOGY

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MAP

PLATES

PLATES (Continued)

No.

TABLE

APPENDIX A

HYDROLOGY

1. INTRODUCTION.

This appendix describes the hydrologic features of Mud Lake and its tributaries, past flooding in the basin, and the hydrologic aspects of proposed projects which reduce the flood threat of overtopping of Mud Lake's dikes.

2. BASIN DESCRIPTION.

a. General.

Mud Lake is located in a wide, flat plain about 30 miles northwest of Idaho Falls, Idaho. A map of the basin is shown on map A-1. Mud Lake is part of a body of water that is perched some 250 feet above the Snake River Plain Aquifer by thick clay strata. The contributing surface drainage basin area is Camas Creek with its major tributary, Beaver Creek. Beaver Creek joins Camas Creek about 5 miles above Mud Lake and drains approximately 45 percent of the Mud Lake Basin. The headwaters of Camas and Beaver Creeks are on the south slopes of the Continental Divide and the two streams flow generally in a southerly direction to enter Mud Lake. Other streams to the north and west flow in a southerly and easterly direction and disappear into the lava beds north, west, and south of Mud Lake. These streams include Cottonwood, Medicine Lodge, and Birch Creeks, Big Lost and Little Lost Rivers. In addition to the surface contribution to the lake, Mud Lake receives considerable supply from groundwater sources. Prior to development in the vicinity of Mud Lake, excess water beyond the natural lake's capacity flowed over lava beds to the south and disappeared therein. At the present time, Mud Lake has no natural surface outlet.

b. Topography.

An area of about 1,130 square miles is topographically a tributary to Mud Lake, but about 200 square miles or more of this area has little if any runoff that reaches Mud Lake by surface flow. This topographical drainage area lies in a fan shape with a maximum width of about 32 miles near the northern part of the basin and a length of about 56 miles.

The basin has two distinctly different regions physically and geologically. The northern part of the basin is mountainous with elevations up to about 10,000 feet msl and with a well defined and fairly dense pattern of drainages in canyons and steep narrow valleys. By contrast, the lower area is a broad sloping plain interrupted in places by small volcanic buttes, cinder cones, hummocks, and dunes. Elevations of the southern area, in the vicinity of Mud Lake, range from 4,778 to 4,800 feet msl.

c. Geology and Soils.

The geology and groundwater conditions of the Mud Lake region are discussed in detail in the USGS Water-Supply Paper 818. The area is a part of the Snake River Plain and is characterized by relatively recent lava flows and associated volcanic cones. Interrelated with these lava flows in the Mud and Market Lake areas are sedimentary deposits which serve as confining aquifers for artesian waters and perched groundwater bodies. The surface material in the area where lava rock is not exposed is horizontally stratified, unconsolidated clays, silts, and sands. These materials, being lake deposits, are characteristically deficient in coarse sizes.

d. Vegetation.

The northern part of the basin has very little topsoil, but does have a moderate growth of native vegetation including Douglas Fir and Lodgepole Pine forests. In the lower region of the basin, there is very limited vegetation consisting principally of native grasses, weeds, sagebrush, and greasewood, with cultivated crops of hay and potatoes predominating the area around Mud Lake and the lower reach of Camas Creek.

e. Development.

The Mud Lake Basin is not a highly developed area. The principal industry in the area is agriculture. Related industries are largely concerned with providing services, supplies, equipment, and transportation for the principal industry. The mountainous areas in the northern part of the basin offer a variety of tourist attractions for summer recreation.

3. CLIMATE.

a. General.

The climate of the area is generally moderate. It is usually dominated by Pacific Maritime air masses imported by prevailing westerly winds. These air masses are responsible for moderate temperatures and carry moisture from which most of the precipitation is received. Occasionally, dry continental air masses invade the area and cause extreme temperatures. The area has an abundance of sunshine and usually low humidity.

b. Precipitation.

Normal annual precipitation ranges from less than 9 inches near Mud Lake to about 30 inches in the mountains; and, for the area as a whole, averages about 16 inches. May and June are the months of greatest precipitation in the plains area, but in the mountains precipitation is greatest during the winter months. July and August are the months of least precipitation.

The area is subject to occasional rainstorms consisting of orographic precipitation or resulting from convective activity. Intensities usually are low and storm durations are seldom more than a few days. Maximum recorded 24-hourly amounts in the area are slightly in excess of 2 inches and have occurred as summer thunderstorms. There have not been any recorded occurrences of serious rain floods in the area.

Most of the winter precipitation occurs as snowfall; and, in the mountains, over half of the year's precipitation accumulates on the ground in the snow pack. Maximum snow depths and water equivalents usually are attained in March or April; and, after that time, the snow is generally melted by warmer spring temperatures. From 1 April records of four snow courses in or near the basin and between 6,000 and 7,000 feet msl, the average snow depth and the average snow water equivalent are about 42 inches and 14 inches, respectively.

c. Temperature.

Mean annual temperatures are about 54 degrees F in the lower areas and 35 to 40 degrees F in the mountains. Temperatures in the plains area average below freezing during the months of December through March; and, usually, there are several days a year of temperatures below zero. Some extremely cool temperatures, lower than minus 30 degrees F, have been recorded in the vicinity on several occasions, but prolonged periods of sub-zero temperatures are uncommon. Maximum temperatures seldom exceed 100 degrees and the highest average monthly temperatures are between 60 and 70 degrees F.

4. STREAMS AND LAKES.

a. Camas Creek.

Camas Creek heads in several branches that rise in high and heavily timbered parts of the Centennial Mountains and flow into the high basin known as Camas Meadows. There are numerous springs in this basin, and the water table is very close to the surface. At a point about 5 miles south of the village of Idmon the basin narrows, forming a lava canyon, above which all the branches unite to form Camas Creek. This canyon extends to a point a few miles above the community of Camas. Below the canyon, the creek flows over sand and gravel to Rays Lake, which is characterized by some lava outcrops. From Rays Lake it flows to Mud Lake over sand and clay. The total length of the channel is approximately 66 miles and the drainage area above Camas, Idaho, is approximately 400 square miles.

b. Beaver Creek.

Beaver Creek, which heads in the high peaks along the Continental Divide, flows in a canyon to a point some distance below Spencer and then on into a lava gorge about 50 feet deep to Dubois, where the stream loses water rapidly in coarse gravel. For about 2 months during the spring flood period, the creek usually has water throughout its length and discharges into Camas Creek about 2 miles south of Camas; but, during the remainder of the year, the creek is generally dry below a point about 3 miles south of Dubois. The creek channel has a total length of approximately 48 miles and drains an area of 510 square miles.

c. Mud Lake.

Mud Lake is a shallow body of water with an area of about 11 square miles when filled to 4,783 feet msl, which corresponds to a stage of 8.0 feet. Under present conditions, the lake is a relatively narrow body of water lying east and west along the north edge of what originally was a lake of about 8 miles in diameter. Development of agricultural areas prior to 1921 induced control and limitation of the lake by construction of earth dikes around the south and west sides. Relocating of the dikes northward since 1921 has reduced the lake surface area at 4,783 feet msl by almost 50 percent. Presently, earth dikes up to a maximum of about 8-foot height above natural ground confine Mud Lake. Levees have also been constructed along both banks of the lower reaches of Camas Creek.

5. STREAMFLOWS.

Streamflows in Camas and Beaver Creeks have somewhat regular patterns with low flows during July through February and high flows from March or April through May or June; typical of streams that derive their runoffs principally from snowmelt. Summary hydrographs of three USGS stream gaging stations on the Camas and Beaver Creeks are shown on plates A-1 through A-3. Runoff originates largely in the northern mountainous headwater areas of the basins. Because of pervious soils and efficient groundwater aquifers, a large percentage of the total generated runoff does not reach Mud Lake as surface flow. Surface flows ordinarily begin to diminish near Spencer, Idaho, in Beaver Creek and near Kilgore, Idaho, in Camas Creek. Half or more of the flow originating in Beaver Creek is lost to groundwater above Camas, Idaho. During the peak discharges in Camas Creek, there are generally large losses experienced as it flows over the sand and gravel in the Camas National Wildlife Refuge, before reaching Mud Lake. These streams have no surface outlet to streams that reach the ocean; Mud Lake is their ultimate surface flow destination.

Annual runoff volumes vary with seasonal precipitation received and average runoff in the Camas and Beaver Creeks, basins is relatively small because the basins ordinarily do not receive much precipitation. Little or no surface runoff originates in the lower, drier parts of the basins.

Records of streamflows have been obtained at a number of locations on Camas and Beaver Creeks since 1921. The following tabulation shows average and extreme annual runoffs recorded at several locations on Camas and Beaver Creeks.

Stream and Location	Area (square miles)	Number of Years	Recorded 1/ Annual Runoff (acre-feet) Average	Maximum	Minimum
Camas Creek					
near Kilgore	210	16	66,900	112,800 2/	30,480
at Camas	400	62	26,500	71,700	640
Beaver Creek					
at Spencer	120	19	28,900	61,200	10,500
at Dubois	220	55	16,300	67,700	0
at Camas	510	65	6,900	43,300	0

1/ To determine the total runoff volume for some water years, unrecorded low-flow periods have been estimated.

2/ Recorded volume for 28 April through 30 September 1969. Estimate of full water year volume is about 120,000 to 130,000 acre-feet.

6. MUD LAKE STORAGE.

Mud Lake storage results from both seasonal runoff from the tributary area and groundwater supplies, part of which is acquired by pumping from artesian wells into Camas Creek and part of which flows to the lake by artesian and gravity springs from areas north of Mud Lake. In average and high runoff years, flows from upper Camas and Beaver Creeks reach and contribute water to the lake. The groundwater supplies probably originate from the upper basins of Camas and Beaver Creeks; but, in part, may be derived from adjacent areas, including the Henrys Fork basin, to the east; the irrigated area on Egin Bench, about 30 miles east of Mud Lake; and possibly from the Medicine Lodge Creek basin, to the west (see map A-1).

The record of lake storages has been obtained since 1921 by the USGS. Mud Lake exhibits a fairly regular pattern of stages and storages with maximums usually in April or May, minimums usually in September or October, and fairly uniform rates of change in stages and storages during the intervening filling and emptying periods. In this period, the average annual maximum storage has been about 37,400 acre-feet, and the greatest maximum storage was 61,600 acre-feet in May 1923. The average annual minimum storage has been about 6,700 acre-feet, and zero storage was recorded in October 1937. The average annual increase in storage during filling periods has been about 30,500 acre-feet. The maximum observed increase in storage was 49,600 acre-feet between October 1983 and June 1984 and the minimum seasonal increase was 15,700 acre-feet between October 1933 and April 1934. The maximum seasonal decrease in storage was 51,600 acre-feet between June and October 1984 and the minimum seasonal decrease was 17,600 acre-feet between April and July 1934. Minimum increases of storage reflect water supply shortages in the area.

The water outflow from the lake is principally by diversion for irrigation and flood control, with lesser amounts by evaporation and percolation. However, the volumes or rates of egression are not fully measured and are not too well known. Water is taken from the lake for irrigation of some 25,000 acres of land and has averaged 75,000 acre-feet per season for the past 27 years. "Free water surface" evaporation rate at Mud Lake is shown as 40 inches per year in NOAA Technical Report NWS 33, "Evaporation Atlas for the Contiguous 48 United States." The lake area varies considerably, but the average annual loss from the lake by evaporation and transpiration is estimated to be about 15,000 to 20,000 acre-feet for present lake conditions. Losses to deep percolation from the lake are very indefinite and vary with the depth to the groundwater table beneath the lake. At times in the past when the groundwater levels in the vicinity of the lake were high, the losses ceased and gains in storage were recorded.

A compilation from USGS water-supply papers of recorded maximum Mud Lake storage content and gage heights is listed in table A-1.

7. BASIN WATER BALANCE MODEL.

A monthly water balance computer model was developed for the Mud Lake Basin. Data from the USGS and Watermaster records for water years 1960 through 1986 were used to develop the model. Recorded data included streamflows of Camas and Beaver Creeks at Camas, Idaho; well and spring inflows; irrigation usage; floodwater diversions; Mud Lake evaporation losses; and Mud Lake storage contents. Using the above data, historical monthly gains/losses for Mud Lake and for the reach of Camas Creek below Camas, Idaho, were computed.

The monthly water balance model was used to evaluate possible adverse effects on the year-to-year operation of the Mud Lake basin system by the proposed projects. However, the water balance model was not used to determine the effect of proposed projects on Mud Lake's annual maximum storage content frequency curve because the model is a monthly model and the period of record used in the model is relatively short.

Some of the floodwaters which are lost to ground water at the proposed Lone Tree Dam or at the proposed Western Diversion Canal will most likely make its way into Mud Lake at a later time. The USGS Water-Supply Paper 818 indicates that wells northeast of Mud Lake show a rise in water levels during the winter, which is believed to be the result of groundwater recharge from spring runoff through the streambeds to the north. For this study, it was assumed that 50 percent of the groundwater recharge would show up in Mud Lake 6 months later.

It was assumed in this study that the operation of the Mud Lake system that has occurred in the past would continue to occur in the future and that any proposed project would be superimposed on this operation. Thus, the effect of the Lone Tree Dam project or the Western Diversion Canal on the Mud Lake system is to delay floodwaters from reaching Mud Lake during its peak storage period and to provide a net loss of floodwaters. This effect was verified using the monthly water balance computer model for the proposed Lone Tree Dam. The 1984 water-year, a high runoff year, streamflows and operations was repeated in the model for the 1985 water-year and the proposed Lone Tree Dam operation superimposed. However, if pumping out of Mud Lake to wastelands were reduced in the late summer of 1984 because operation of the Lone Tree Dam had reduced the lake levels, then the delayed groundwater entering Mud Lake could have a negating effect on the flood regulations for the following water-year.

In the feasibility study, the current operating criteria of the Mud Lake system should be examined. Changes to the operating criteria may be found that would reduce the flooding potential at Mud Lake without seriously impacting irrigators. Volume forecasting procedures for the Mud Lake basin should also be examined.

8. FLOODS.

Mud Lake storage results from both seasonal runoff from the tributary area and groundwater supplies. During seasons of greater-than-average inflow, the lake fills and the dikes and levees are threatened with overtopping and sloughing. Several times the lake level has approached the top, leaving very little freeboard. In order to keep the lake from overtopping the dikes, water has been evacuated from the lake by pumping it into a wasteway canal which carried it to lava beds south of Mud Lake. The flood threat is aggravated to a considerable extent by wave action on the lake, burrowing animals, and vegetation growing in the embankment. The wave problem approaches a form of beach erosion in which the narrow saturated earth embankments along the west and south shores of Mud Lake are eroded during periods of wind action. Leakage is induced by the activities of burrowing animals and the roots of vegetation. Instances of erosive action to the dikes by floating ice, blown by wind, have also been cited as a contributing factor to flood threats. On a few of the more damaging occasions, newspaper accounts and personal records described roughly the time and extent of flooding. According to information available, 300 acres were flooded in 1945 due to dike failure and a much larger area was flooded in 1946.

Drainage from the agricultural area around the lake is toward the lake. Failure of a portion of the dikes would result in lowering of the earth embankment with water escaping until the lake level is equalized with the water level outside of the dikes. Under these conditions, it becomes very difficult to repair the damaged sections and reclaim the lands before extensive flood damages have resulted. If a flood of much greater portion than the dikes can accommodate should occur, very severe and extensive damages would result. Local interests spend considerable monies each year in flood fight operations and in repair and maintenance of the embankments. The critical period usually occurs during the late spring months and is about 30 to 45 days duration. A failure of the dikes in the spring would result in loss of newly seeded growing crops. The growing season is so short that by the time repairs would be possible and the ground dried out by pumping of floodwaters, there would be neither time to raise a crop nor water available for irrigation. In addition to the agricultural losses, numerous housing facilities and county and farm roads would be damaged if the dikes were to fail.

9. FLOOD FREQUENCY ANALYSES.

a. Historic Mud Lake.

The magnitude of future maximum annual storages in Mud Lake may be estimated to some degree by analyzing maximum annual storages of the 66-year period, 1921 to 1986. These maximum annual storages were analyzed using the log-Pearson Type III distribution. The resulting frequency curve is shown on plate A-4. It should be noted that during this period there have been a number of changes that affect maximum annual storages in Mud Lake. First, the dikes confining Mud Lake have been moved several times over the years. This has changed the amount of evaporation from the lake and the operation of the lake, especially during high runoff years. Secondly, pumping water from the lake to desert wastelands has been done in high runoff years to reduce the risk of overtopping the dikes. Also, a diversion canal near Lone Tree Dam has been used since 1969 to divert Camas Creek floodwaters into the groundwater and to wastelands.

b. Mud Lake Regulated.

Regulated annual maximum Mud Lake storage content frequency curves were developed for the four proposed projects and are shown on plates A-5 through A-8. For each proposed project, it was assumed that operation of the Mud Lake system that has occurred in the past would continue to occur in the future and that any proposed project and its operation would be superimposed on this operation. In developing the regulated frequency curve for each project, certain assumptions were made, which are described below.

For the Lone Tree Dam project, it is estimated that 60 cfs would be lost to the groundwater through the bottom of the reservoir, while water is retained in the reservoir. This is based on data collected in the spring of 1930 by the USGS and reported in Water-Supply Paper 818. There was a net inflow to the reservoir of 2,650 acre-feet recorded during a 32-day period with a reduction in stored water of approximately 1,200 acre-feet. The water would be retained in the reservoir for up to 60 days during the spring high flow period. Thus, approximately 7,200 acre-feet could be diverted into the groundwater. This, combined with 3,000 acre-feet of storage capacity in the reservoir, could reduce the annual maximum Mud Lake storage content by up to 10,200 acre-feet.

For the Western Diversion Canal project, it is estimated that up to 22,000 acre-feet of water could be diverted from Camas Creek through the canal project. This is based on the determination that 22,000 acre-feet of Camas Creek flows could have been diverted through a 500 cfs capacity canal during the spring of 1984, a high runoff volume year. Thus, Mud Lake's annual maximum storage content could be reduced by up to 22,000 acre-feet.

For the Wildlife Refuge Enlargement project, it was determined that 22,100 acre-feet of storage would be available to store excess floodwaters.

For the Jefferson Canal Diversion Pond project, it is estimated that up to 30,000 acre-feet of water could be pumped out of Mud Lake via Jefferson Canal to the diversion pond. This is based on the assumption that 200 cfs of Mud Lake water could be pumped to the diversion pond for 75 days before Mud Lake's storage content peaks.

10. STANDARD PROJECT FLOOD.

The limited scope of studies for this report prohibited the development of a standard project flood for the drainage area. Also, because of the complexity of Mud Lake inflows and the nature of the proposed improvements, it is impractical to offer preliminary estimates of a standard project flood.

11. SPILLWAY DESIGN FLOW.

An estimate of the probable maximum flood (PMF) for Camas Creek at the Lone Tree Dam site of 29,000 cfs was determined using regional correlation equations. This estimate of the PMF was used as an estimate of the Spillway Design Flow (SDF) for the proposed dam. A reduction in the magnitude of the SDF for the proposed dam spillway will be considered during the feasibility study.

12. WIND-WAVE ANALYSIS FOR MUD LAKE.

Wind generated waves were studied for use in determining the safe lake level for the Mud Lake dikes. Procedures of ETL 1110-2-305, dated 16 February 1984, for determining design wave height were used.

Wind data recorded at the Idaho Falls, Idaho, airport was assumed to be representative of possible winds at Mud Lake. Wind data for the Idaho Falls Airport has been summarized in "Climatological Handbook, Columbia Basin States, Hourly Data, Volume 3, Part A," dated June 1968.

Wind directions that would generate waves that would impinge on the dikes are winds from the west to winds from the southeast. Fetch length for winds from these directions when the lake is filled to 4,784 feet msl is 2.4 miles. This fetch length was used for the wind-wave analysis.

Forecasting curves for shallow-water waves for constant depth of 10 feet were used in computing design wave heights. Design wave heights were then translated into wave run-up heights using procedures in the Coastal Engineering Research Center "Shore Protection Manual," dated 1977. The dikes have an average slope of one vertical to two horizontal and a five-foot water depth over the toe of the dikes which was used to translate a wave height to a wave run-up height.

A fastest 1-mile wind speed of 51 miles per hour from the west is reported in the climatological handbook for the Idaho Falls Airport during the month of May. For this wind speed, a design wave height of 2.6 feet was computed which translated to a wave run-up height of 5.1 feet.

Using information given in table III-3 of the Climatological Handbook, a wave run-up height versus percent of time curve for the April through June period was developed. This curve is shown on plate A-9. Wave run-up heights for specific hourly average wind speeds and average days per year occurrence are shown in the following tabulation.

WAVE RUN-UP HEIGHTS FOR SPECIFIC WIND SPEEDS

Average Days Per Year	Hourly Average Wind Speed (miles per hour)	Wave Run-up Height (feet)
5	13	1.5
1.25	19	2.1
0.35	25	2.8
0.04	32	3.65

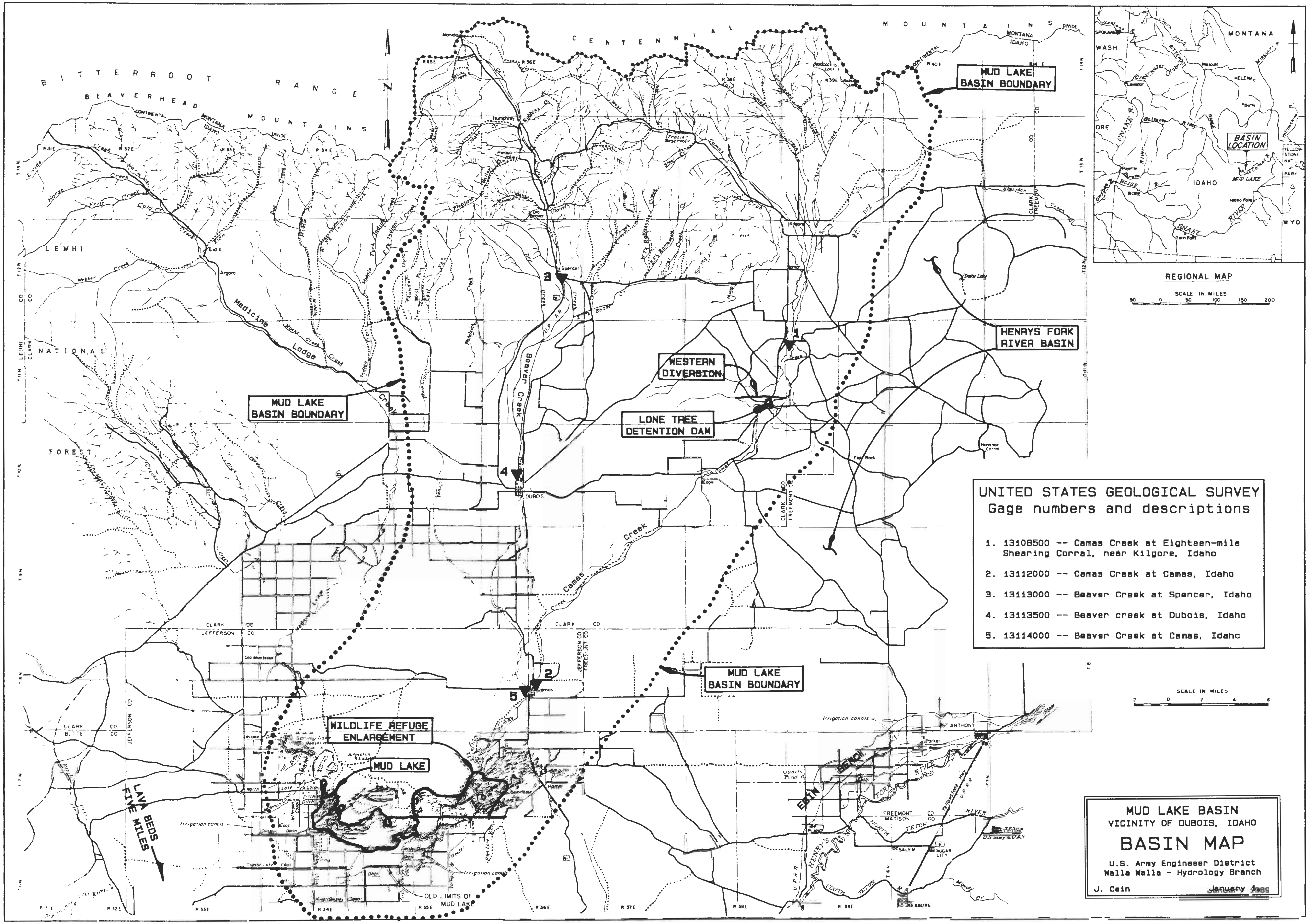
13. SAFE LAKE LEVEL--MUD LAKE.

Determining a safe lake level for Mud Lake requires judgment as well as analysis. Most of the structure does not meet Corps design criteria. However, the structure has held water for nearly 70 years with varying degrees of emergency action. As there is very little release capability from Mud Lake once water gets to it, exceeding the lake capacity and breaching the dam would be catastrophic.

In 1984, the lake level reached a gage height of 10.6 feet. Structural failure was prevented through combined local, National Guard, and Corps emergency actions. Fortunately, winds were calm and there was very little wave action. During the event, sections of the embankment became saturated and trucks had difficulty working on top of the levee. Based on eye witness accounts, structural failure was barely avoided.

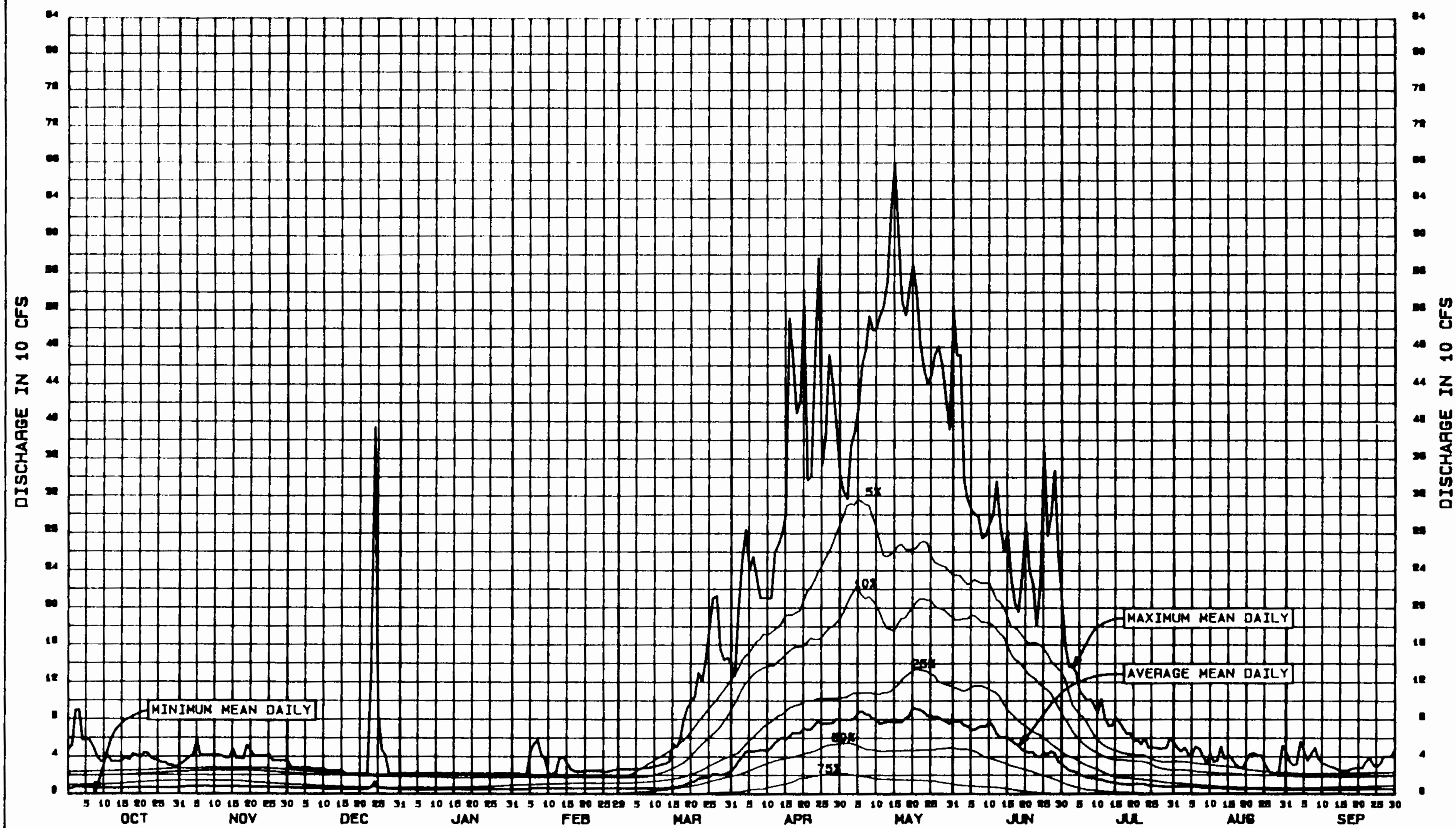
Only dependable protection is appropriate in evaluating flood damage prevention. A Federally developed flood control project cannot depend on extraordinary, heroic efforts as part of the operation criteria.

The minimum embankment height for Mud Lake is a lake level, plus wave run-up, that does not overtop the embankment. Wind records at Idaho Falls show that the hourly average wind speed is 13 miles per hour. Hourly winds greater than 20 miles per hour are frequently exceeded. A 25 to 30 miles per hour wind speed is exceeded only infrequently. A 25 to 30 miles per hour wind speed for the Mud Lake area results in a wave height of approximately 3 feet. The corresponding maximum gage height for 3 feet of freeboard is 8 feet, or a safe lake elevation of 4,783 feet msl. Based on examination of the Mud Lake levees and discussions with local officials, this is a reasonable, dependable, and safe lake level for the flood control project.



MUD LAKE BASIN BOUNDARY
HENRYS FORK RIVER BASIN
WESTERN DIVERSION
LONE TREE DETENTION DAM
WILDLIFE REFUGE ENLARGEMENT
MUD LAKE
OLD LIMITS OF MUD LAKE
LAVA BEDS FIVE MILES
BITTERROOT RANGE
BEAVERHEAD MOUNTAINS
CENTENNIAL MOUNTAINS
LEMHI NATIONAL FOREST
Beaver Creek
Camas Creek
Medicine Lodge Creek
DUBOIS
REGIONAL MAP
SCALE IN MILES
BASIN LOCATION
MONTANA
IDAHO
WASH
ORE
WYO.
UNITED STATES GEOLOGICAL SURVEY
Gage numbers and descriptions
1. 13108500 -- Camas Creek at Eighteen-mile Shearing Corral, near Kilgore, Idaho
2. 13112000 -- Camas Creek at Camas, Idaho
3. 13113000 -- Beaver Creek at Spencer, Idaho
4. 13113500 -- Beaver creek at Dubois, Idaho
5. 13114000 -- Beaver Creek at Camas, Idaho
MUD LAKE BASIN
VICINITY OF DUBOIS, IDAHO
BASIN MAP
U.S. Army Engineer District
Walla Walla - Hydrology Branch
J. Cain
January 1989

MAP A-1



NOTES:

1. USGS GAGING STATION NUMBER = 13113500.
2. PERIOD OF RECORD = 1922-24, 1929, 1931-73.
3. DRAINAGE AREA = 220 SQUARE MILES.
4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

BEAVER CREEK
AT DUBOIS, IDAHO

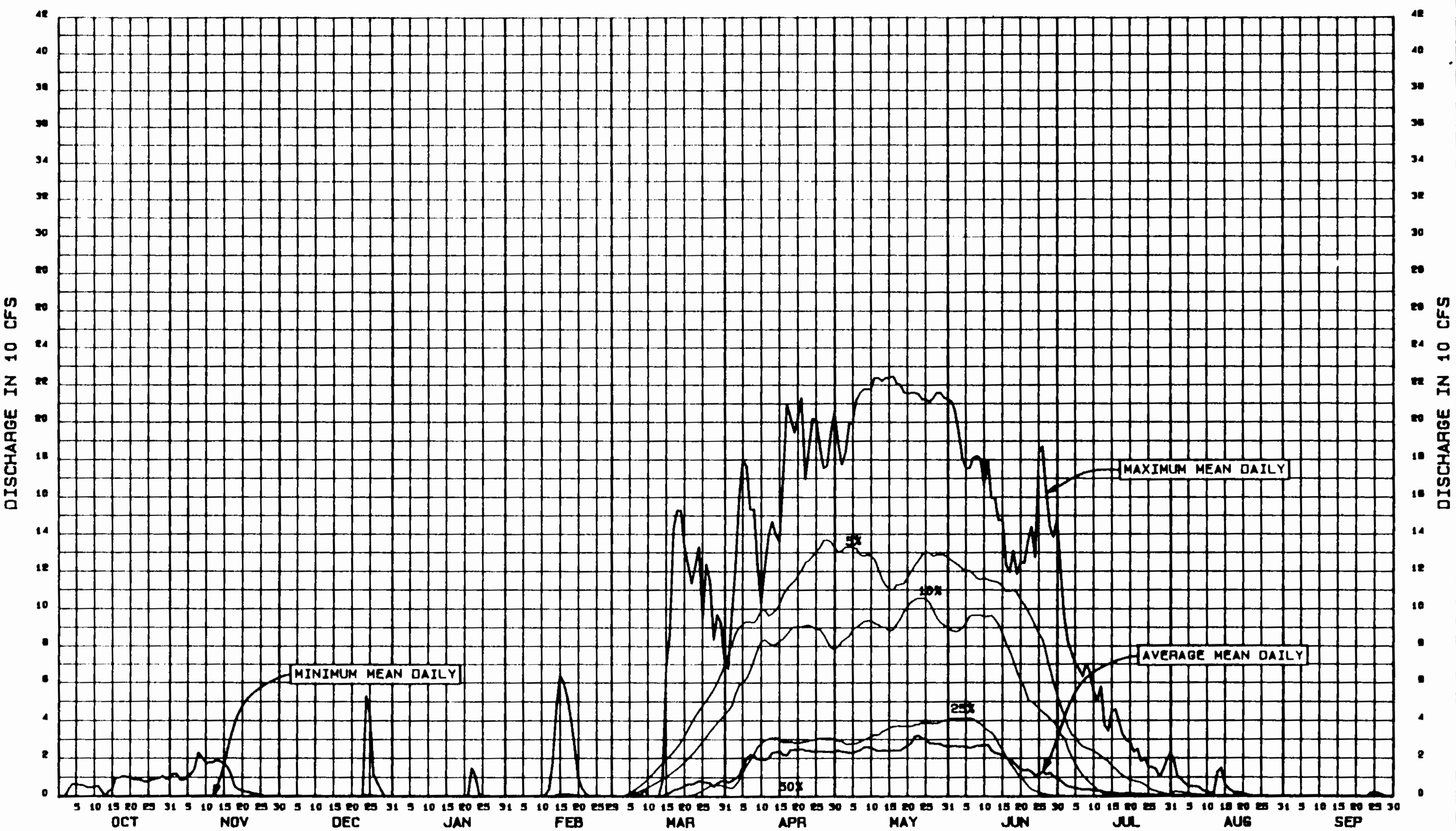
SUMMARY HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

SCHUSTER APRIL 1989

13113500

PLATE A-1



NOTES:

1. USGS GAGING STATION NUMBER = 13114000.
2. PERIOD OF RECORD = 1922-70.
3. DRAINAGE AREA = 510 SQUARE MILES.
4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

BEAVER CREEK
AT CAMAS, IDAHO

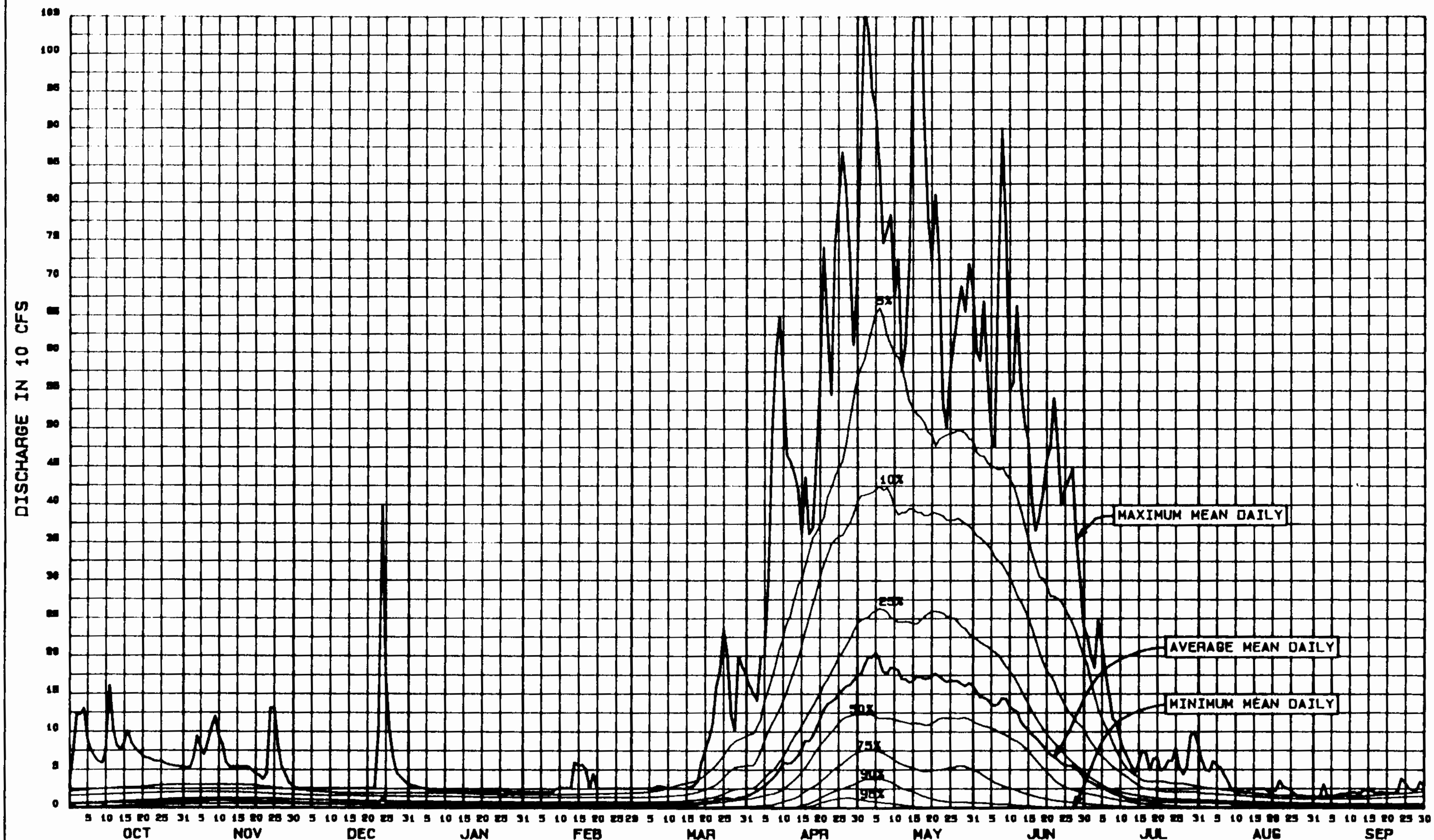
SUMMARY HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

SCHUSTER APRIL 1989

13114000

PLATE A-2



NOTES:

1. USGS GAGING STATION NUMBER = 13112000.
2. PERIOD OF RECORD = 1927-70, 1972-82, 1984-85.
3. DRAINAGE AREA = 440 SQUARE MILES.
4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

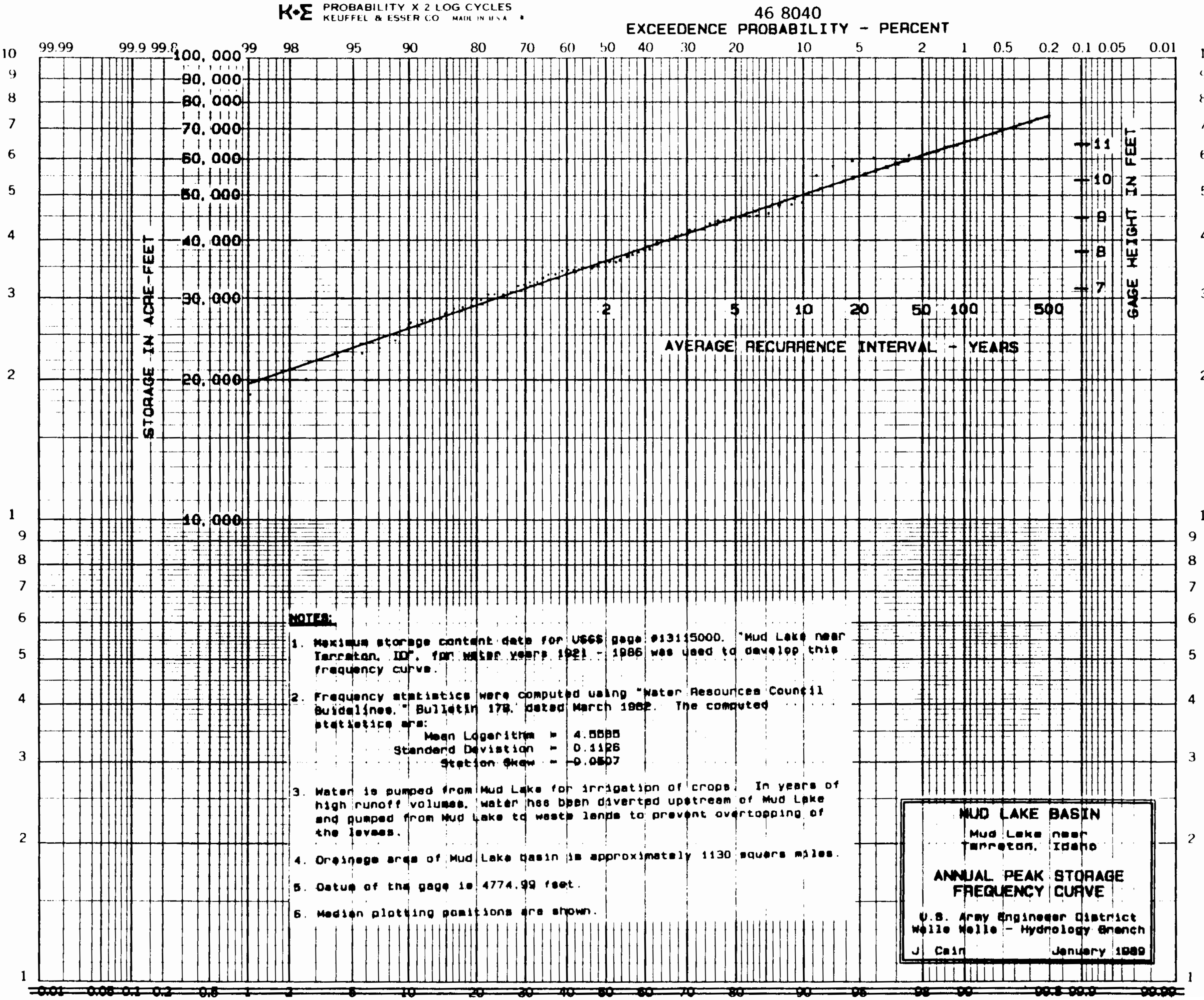
CAMAS CREEK
AT CAMAS, IDAHO

SUMMARY HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

SCHUSTER MARCH 1989

13112000



NOTES:

1. Maximum storage content data for USGS gage #13115000. "Mud Lake near Terreton, ID", for water years 1921 - 1986 was used to develop this frequency curve.
2. Frequency statistics were computed using "Water Resources Council Guidelines," Bulletin 17B, dated March 1982. The computed statistics are:
   - Mean Logarithm = 4.5585
   - Standard Deviation = 0.1126
   - Station Skew = -0.0507
3. Water is pumped from Mud Lake for irrigation of crops. In years of high runoff volumes, water has been diverted upstream of Mud Lake and pumped from Mud Lake to waste lands to prevent overtopping of the levees.
4. Drainage area of Mud Lake basin is approximately 1130 square miles.
5. Datum of the gage is 4774.99 feet.
6. Median plotting positions are shown.

MUD LAKE BASIN

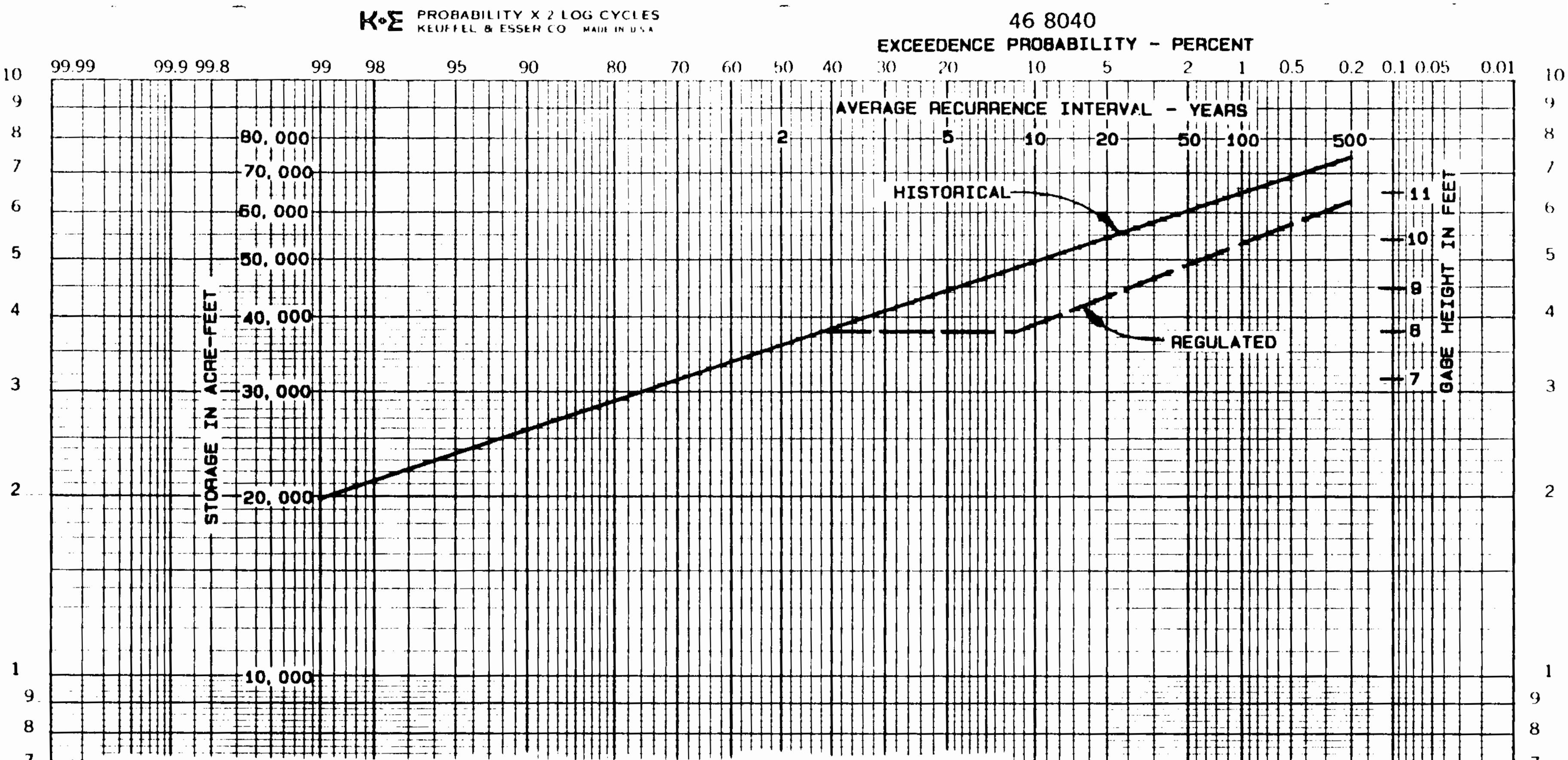
Mud Lake near Terreton, Idaho

ANNUAL PEAK STORAGE FREQUENCY CURVE

U.S. Army Engineer District
Walla Walla - Hydrology Branch

J. Cain — January 1989

PLATE A-4



NOTES

1. The regulated frequency curve is for a regulation objective of 37,930 acre-feet (8.0 feet stage). Mud Lake's annual maximum storage content could be reduced by up to 10,200 acre-feet from operating Lone Tree Dam to prevent overtopping of the Mud Lake levees. This is based on a storage capacity of 3,000 acre-feet in the reservoir and that 60 CFS is lost to the ground water for up to 60 days through the reservoir bottom.

2. Maximum storage content data for USGS gage # 13115000, "Mud Lake near Terreton, Idaho for water years 1921-1986 was used to develop the historical frequency curve. Frequency statistics were computed using "Water Resources Council Guidelines," Bulletin 17B, dated March, 1982. The computed statistics for the historical frequency curve are:

   Mean Logarithm = 4.5585
   Standard Deviation = 0.1126
   Station Skew = -0.0507

3. The historical frequency curve reflects the operation of Mud Lake during the period of 1921-1986. In years of high runoff volumes, water has been diverted upstream of Mud Lake and pumped from Mud Lake to waste lands to prevent overtopping of the levees.

4. Drainage area of Mud Lake basin is approximately 1,130 square miles.

5. Datum of the gage is 4,774.99 feet.

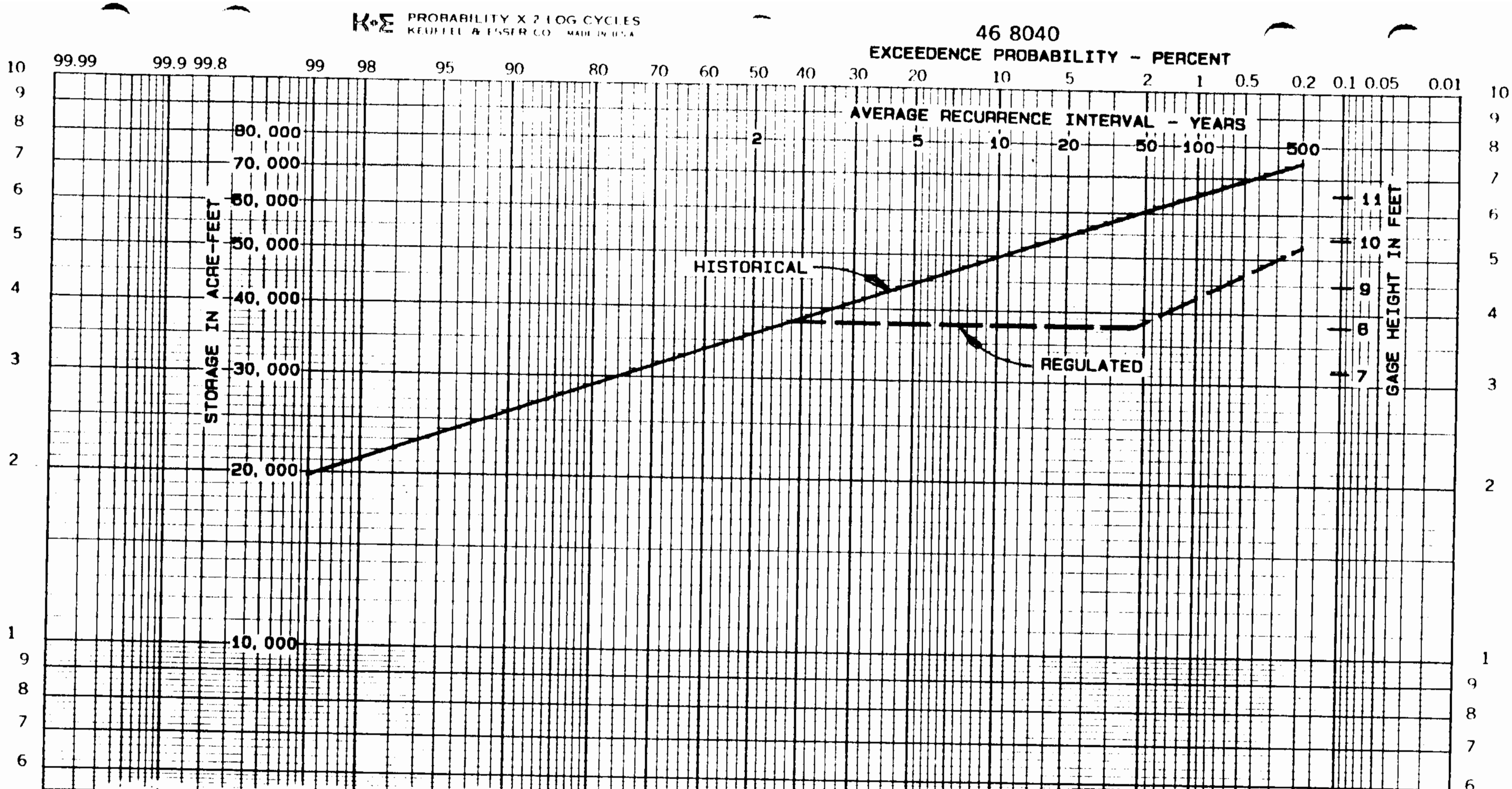
MUD LAKE BASIN
MUD LAKE NEAR TERRETON, IDAHO

REGULATED ANNUAL PEAK STORAGE FREQUENCY CURVE DUE TO OPERATION OF LONE TREE DAM

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. CAIN — OCTOBER 1989

PLATE A-5



NOTES

1. The regulated frequency curve is for a regulation objective of 37,930 acre-feet (8.0 feet stage). Up to 22,000 acre-feet of Camas Creek flows could be diverted through a 500 CFS capacity Western Diversion Canal to prevent overtopping of the Mud Lake levees.

2. Maximum storage content data for USGS gage #13115000, "Mud Lake near Terreton, Idaho for water years 1921-1986 was used to develop the historical frequency curve. Frequency statistics were computed using "Water Resources Council Guidelines," Bulletin 17B, dated March, 1982. The computed statistics for the historical frequency curve are:

Mean Logarithm	=	4.5585
Standard Deviation	=	0.1126
Station Skew	=	-0.0507

3. The historical frequency curve reflects the operation of Mud Lake during the period of 1921-1986. In years of high runoff volumes, water has been diverted upstream of Mud Lake and pumped from Mud Lake to waste lands to prevent overtopping of the levees.

4. Drainage area of Mud Lake basin is approximately 1,130 square miles.

5. Datum of the gage is 4,774.99 feet.

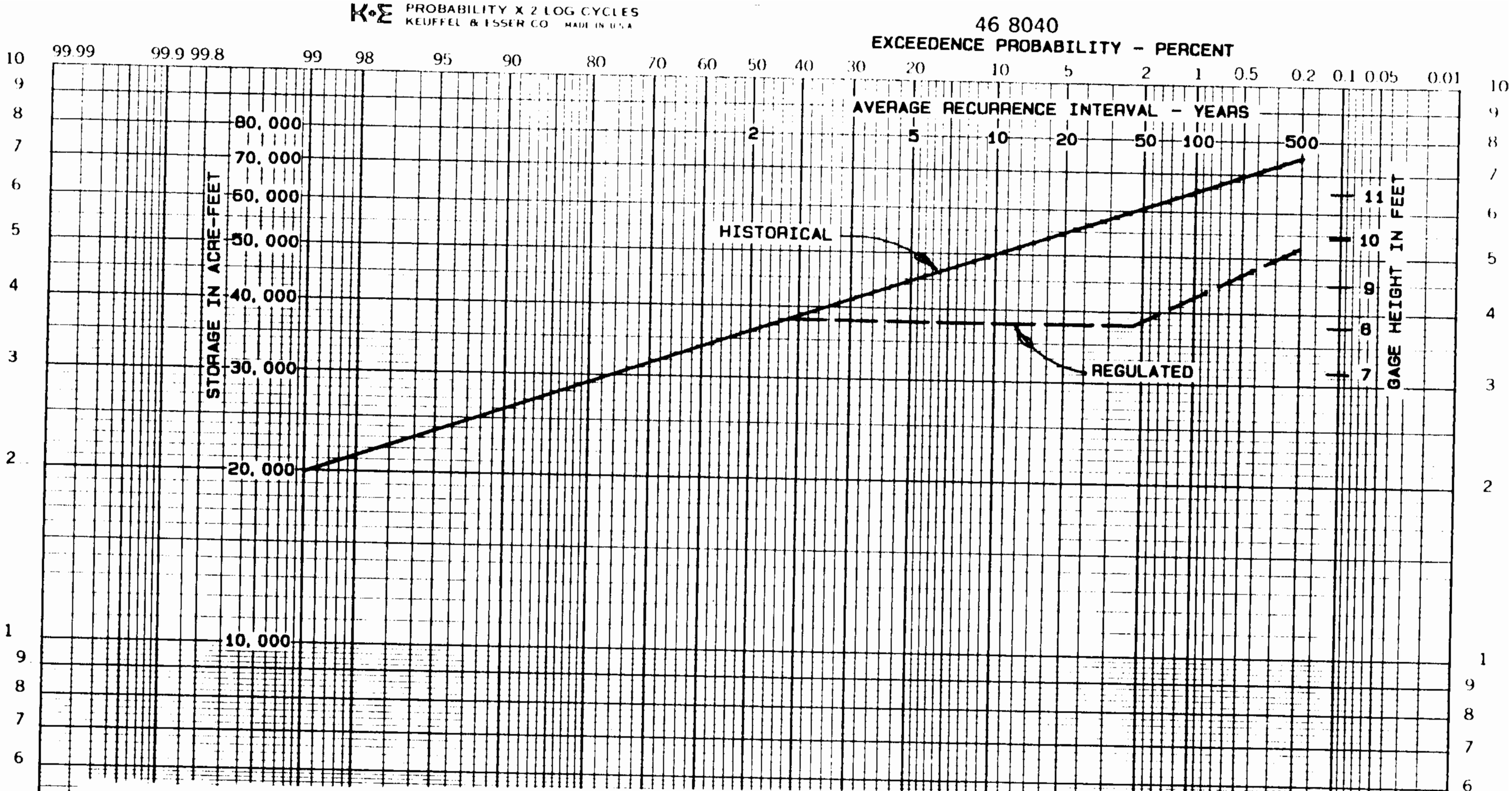
MUD LAKE BASIN
MUD LAKE NEAR TERRETON, IDAHO

REGULATED ANNUAL PEAK STORAGE FREQUENCY CURVE DUE TO OPERATION OF WESTERN DIVERSION CANAL

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. CAIN — OCTOBER 1989

PLATE A-6



NOTES

1. The regulated frequency curve is for a regulation objective of 37,930 acre-feet (8.0 feet stage). Up to 22,100 acre-feet of Camas Creek flows could be stored in the Wildlife Refuge Enlargement area to prevent overtopping of the Mud Lake levees.

2. Maximum storage content data for USGS gage #13115000, "Mud Lake near Terreton, Idaho for water years 1921-1986 was used to develop the historical frequency curve. Frequency statistics were computed using "Water Resources Council Guidelines," Bulletin 17B, dated March, 1982. The computed statistics for the historical frequency curve are:

Mean Logarithm	=	4.5585
Standard Deviation	=	0.1126
Station Skew	=	-0.0507

3. The historical frequency curve reflects the operation of Mud Lake during the period of 1921-1986. In years of high runoff volumes, water has been diverted upstream of Mud Lake and pumped from Mud Lake to waste lands to prevent overtopping of the levees.

4. Drainage area of Mud Lake basin is approximately 1,130 square miles.

5. Datum of the gage is 4,774.99 feet.

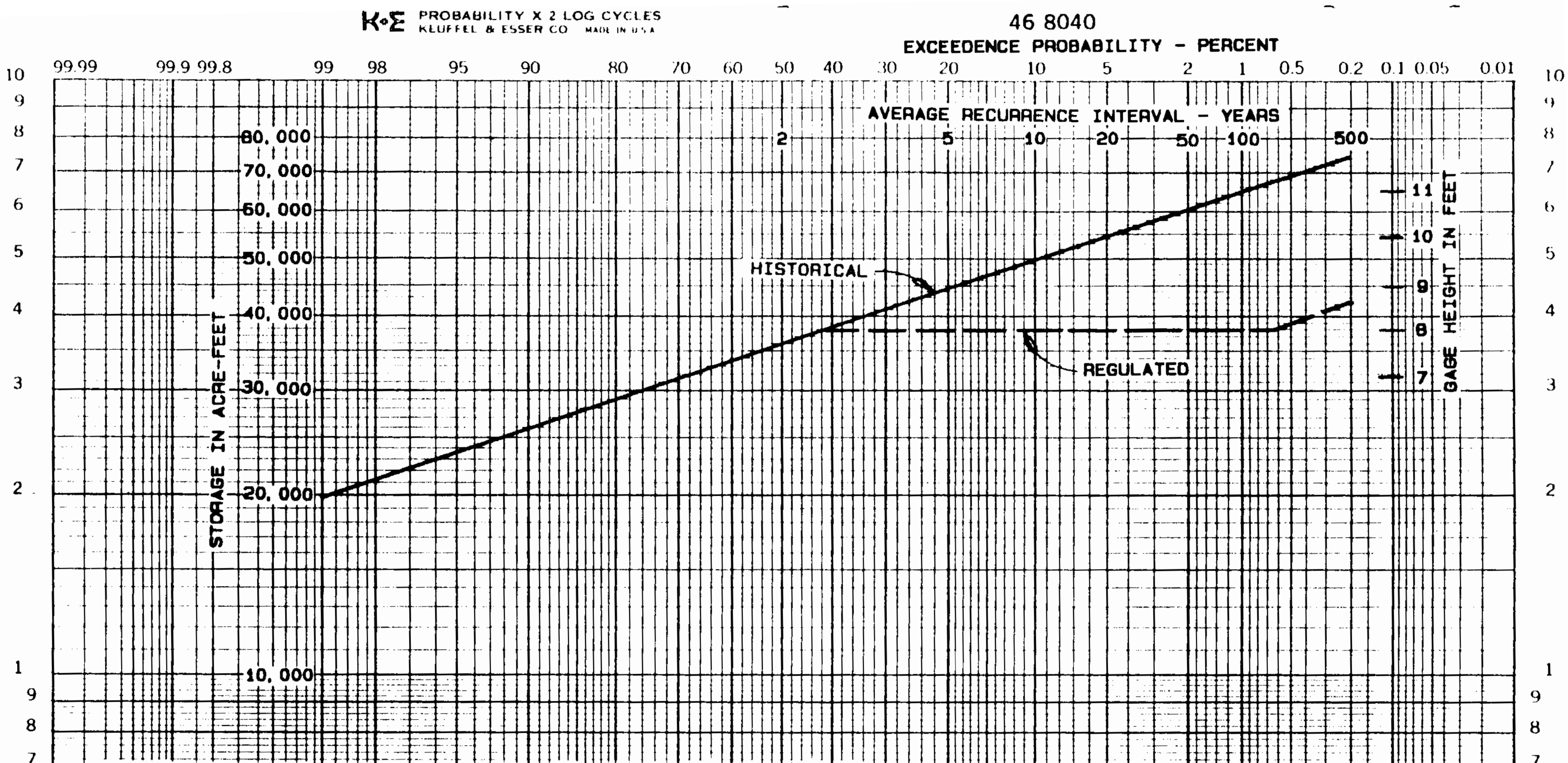
MUD LAKE BASIN
MUD LAKE NEAR TERRETON, IDAHO

REGULATED ANNUAL PEAK STORAGE FREQUENCY CURVE DUE TO OPERATION OF WILDLIFE REFUGE ENLARGEMENT

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. CAIN — OCTOBER 1989

PLATE A-7



NOTES

1. For development of the regulated frequency curve, up to 30,000 acre-feet of water could be pumped from Mud Lake through Jefferson Canal to the desert, ground water recharging pond to control Mud Lake stage. In determining the 30,000 acre-feet diversion limit, 200 CFS could be pumped from the lake into Jefferson Canal for up to 75 days before reaching Mud Lake annual maximum stage. Also, the storage capacity of the ground water recharging pond did not limit pumping from the lake during the 75 days.

2. Maximum storage content data for USGS gage # 13115000, "Mud Lake near Terreton, Idaho for water years 1921-1986 was used to develop the historical frequency curve. Frequency statistics were computed using "Water Resources Council Guidelines," Bulletin 17B, dated March, 1982. The computed statistics for the historical frequency curve are:

Mean Logarithm = 4.5585
Standard Deviation = 0.1126
Station Skew = -0.0507

3. The historical frequency curve reflects the operation of Mud Lake during the period of 1921-1986. In years of high runoff volumes, water has been diverted upstream of Mud Lake and pumped from Mud Lake to waste lands to prevent overtopping of the levees.

4. Drainage area of Mud Lake basin is approximately 1,130 square miles.

5. Datum of the gage is 4,774.99 feet.

MUD LAKE BASIN
MUD LAKE NEAR TERRETON, IDAHO

REGULATED ANNUAL PEAK STORAGE FREQUENCY CURVE DUE TO PUMPING INTO JEFFERSON CANAL

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. CAIN OCTOBER 1989

PLATE A-8

K•E 20 X 20 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

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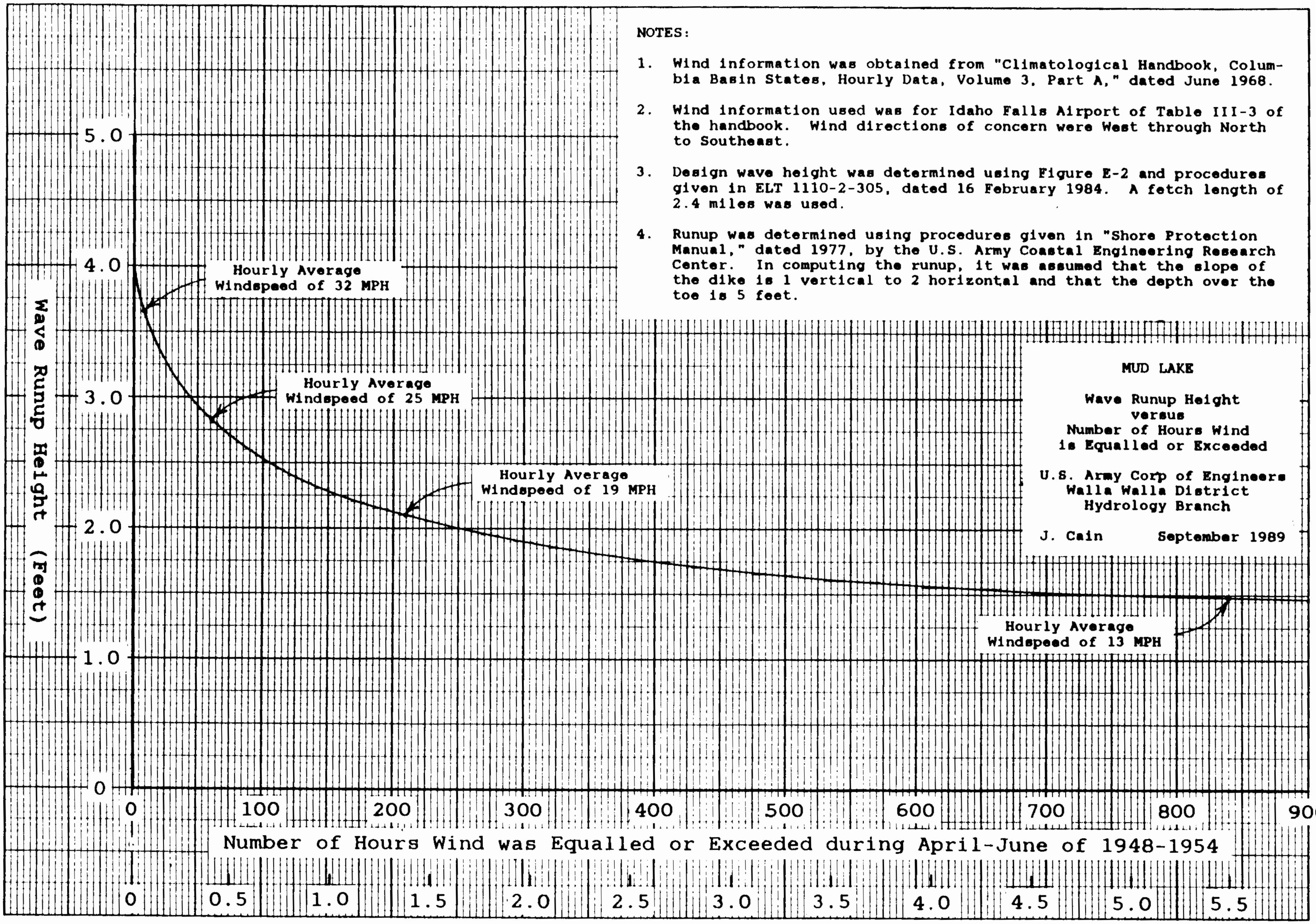

Percentage of the 15,288 hours of April-June of 1948-1954

NOTES:

1. Wind information was obtained from "Climatological Handbook, Columbia Basin States, Hourly Data, Volume 3, Part A," dated June 1968.
2. Wind information used was for Idaho Falls Airport of Table III-3 of the handbook. Wind directions of concern were West through North to Southeast.
3. Design wave height was determined using Figure E-2 and procedures given in ELT 1110-2-305, dated 16 February 1984. A fetch length of 2.4 miles was used.
4. Runup was determined using procedures given in "Shore Protection Manual," dated 1977, by the U.S. Army Coastal Engineering Research Center. In computing the runup, it was assumed that the slope of the dike is 1 vertical to 2 horizontal and that the depth over the toe is 5 feet.

MUD LAKE

Wave Runup Height versus Number of Hours Wind is Equalled or Exceeded

U.S. Army Corp of Engineers
Walla Walla District
Hydrology Branch

J. Cain September 1989

PLATE A-9

TABLE A-1

MUD LAKE ANNUAL MAXIMUM STORAGE CONTENT AND GAGE HEIGHT

Water-Year	Maximum Storage (acre-feet)	Maximum Gage Height (feet)	Water-Year	Maximum Storage (acre-feet)	Maximum Gage Height (feet)
1921	55,040	8.65	1955	30,600	7.02(w)
1922	59,410	8.99	1956	30,500	7.00(w)
1923	61,660	9.20	1957	29,800	6.78(w)
1924	60,000	9.07	1958	27,000	6.34(w)
1925	47,700	8.08	1959	22,900	5.64(w)
1926	57,700	8.90	1960	26,900	6.36(w)
1927	35,200	6.88	1961	27,600	6.67(w)
1928	34,800	6.83	1962	35,800	7.82(w)
1929	32,500	6.56	1963	37,900	8.20(w)
1930	26,400	5.83	1964	34,700	7.84(w)
1931	28,800	6.19	1965	36,700	8.08(w)
1932	28,500	6.15	1966	34,300	7.56(w)
1933	30,500	6.43	1967	34,400	7.50(w)
1934	18,600	4.52	1968	32,100	7.21(w)
1935	23,500	5.45	1969	31,900	7.38(w)
1936	24,300	5.59	1g70	38,100	8.12(w)
1937	22,500	5.28	1971	44,700	9.08(w)
1938	22,000	5.19	1972	39,500	8.37(w)
1939	32,600	6.83	1973	42,100	8.72(w)
1940	29,800	6.44	1974	39,700	8.29
1941	30,900	6.60	1975	39,700	8.27
1942	35,800	7.25	1976	40,900	8.45
1943	35,900	7.57	1977	41,100	8.47
1944	36,100	7.59	1978	33,900	7.82
1945	44,200	8.57	1979	33,700	7.34
1946	45,100	8.62(w)	1980	42,000	8.60
1947	45,300	8.58	1981	34,600	7.48
1948	47,300	8.84	1982	34,800	7.52
1949	43,500	8.55	1983	44,700	9.00
1950	42,200	8.39(w)	1984	61,000	10.61
1951	37,200	7.73(w)	1985	48,300	9.58(w)
1952	44,100	8.77(w)	1986	45,700	9.13
1953	38,300	7.89	1987	41,000	8.46
1954	33,100	7.10	1988	35,200	7.58

(w) Gage reading was effected by wind.

<u>Notes</u>
(1) This table was compiled from information reported in USGS Water-Supply Papers for Idaho.
(2) The storage volume versus gage height relationship has changed during this period due to relocation of Mud Lake's dikes.

APPENDIX B

WILDLIFE REFUGE ENLARGEMENT

APPENDIX B

WILDLIFE REFUGE ENLARGEMENT

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APPENDIX B

WILDLIFE REFUGE ENLARGEMENT

1. PERTINENT DATA.

Basin	Camas Creek
Location	1 mile NE. of Mud Lake, Idaho
Dike:	
Type of fill	Compacted random fill
Maximum height	12 feet
Top width	12 feet
Volume	215,000 cubic yards
Length	36,000 feet

2. PROJECT LOCATION.

The proposed project will include the southern portion of the Camas National Wildlife Refuge and the eastern portion of the North Lake Wildlife Management Area, both located in the vicinity of Mud Lake, Idaho. Mud Lake is located in Jefferson County about 35 miles west of the city of Rexburg.

3. PROJECT DESCRIPTION.

a. Existing Facilities.

Wildlife resources in and around Mud Lake are protected and managed in two existing refuges: Idaho's North Lake Wildlife Management Area and the Camas National Wildlife Refuge. One or both of these areas currently allows the local flood control district to flood parts of the refuge during periods of major runoff. The amount of flood storage is limited however, by the natural topography and existing control structures.

b. Proposed Project.

To create additional storage volume and increase soil percolation during floods, a control structure would be built across Camas Creek to allow flooding of parts of the two wildlife areas (see plate B-1). Approximately 6.8 miles of low dike would be built along county road 1900 North which is the southern border of the Camas refuge and the southeastern border of the North Lake Wildlife Area.

c. Hydrology.

Streamflows have somewhat regular patterns with low flows averaging 50 cfs from July through February and high flows averaging about 300 cfs from March or April through May or June. The runoff originates largely in the mountainous headwaters north of the lake as a result of spring snowmelt. The basin drains about 1,000 square miles.

d. Geology and Foundation Conditions.

The area is part of the Snake River Plain and is characterized by relatively recent lava flows and associated volcanic cones. Interrelated with these flows in the Mud Lake area is sedimentary deposits which serve as confining aquifers for artesian waters and perched groundwater bodies. The surface material is horizontally stratified, unconsolidated clays, silts, and sands.

4. PROPOSED FEATURES.

a. Land and Relocations.

The project will require purchase of or flood easement on 2,750 acres of State and locally owned land and 3,400 acres of Federally owned land. No relocations are anticipated.

b. Dike.

Two options were looked at: (1) Raise county road 1900 North where it forms the southern border of the Camas National Wildlife Refuge, and (2) build a narrow dike along the north shoulder of the road. The latter option requires considerably less material and is therefore the preferred plan and is reflected in this report.

The crest of the dike will be at 4,792 msl (see plate B-2) and will create 22,100 acre-feet of flood storage with 2 feet of freeboard. The top-of-dike capacity will be about 37,900 acre-feet. The dike will extend from about 1 mile west of Interstate 15 to the eastern end of Mud Lake, a distance of 6.8 miles. The pond-side slope of the dike will be 2.5h:1v and the south side of the dike will have a 2h:1v side slope. The crest width will be 12 feet.

c. Control Structures.

A new gate structure will be built on Camas Creek to control the pond elevation and regulate flows into Mud Lake (see plate B-2). It will consist of a concrete structure with four 5- by 6-foot slide gates capable of passing 500 cfs. When necessary, additional flows will overtop a "fuse-plug" section of dike located adjacent to Mud Lake on the west end of the project. The fuse-plug will be a 200-foot long section of dike with a crest of 4,790.5 feet msl. High flows will overtop and destroy this section of the dike; however, the adjacent ground level will be high enough to prevent draining the entire pond.

5. OPERATION AND MAINTENANCE.

Operation will only require opening and closing of the control gates and coordination with managers at the two wildlife refuges. Maintenance will require periodic inspections and cleaning.

6. COST ESTIMATE.

a. Construction Costs.

Quantities, capacities, and project features developed for the estimate are based on measurements taken from 7.5 minute USGS quadrangles and assumptions as stated above. The total cost for lands and damages is based on the estimated land value and the estimated administrative cost for land acquisition.

A contingency factor of 20 percent was used. Costs for engineering and design, and supervision and inspection were estimated based on curves relating government costs on civil works projects to direct construction costs. Engineering estimate sheets are in table B-1. The estimated construction cost is $4,015,000 based on a 12-foot top width of the dike. The construction cost of a dike with a top width of 8 feet in sections where the height of the dike is less than 4 feet was estimated to be $3,600,000.

b. Investment Cost.

Interest during construction was estimated assuming a 2-year construction period with 80 percent of the work being done in the first year. Payments were made at midyear and compounded at 8.875 percent annually. The estimated total investment cost is $4,189,000.

c. Annual Cost.

Assuming a 50-year service life and interest at 8.875 percent, the amortized cost of the investment is $377,100. Operation and maintenance are estimated to be 1 percent of construction cost or $41,900. Thus, the complete average annual cost is $419,000.

TABLE B-1

FILENAME: REFUGE3	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 1 OF 3
LOCATION: LOCATION		ESTIMATED BY: PORTER/PERRY
FEATURES: BUILD LEVEE NEXT TO ROAD - UNIFORM 12' WIDTH		DATE: 04-Oct-89

PERTINENT DATA: Feb 1989 Price level

Build levee parallel to road to elevation 4792
to create ponding area between wildlife refuges.

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES					
Lands (Federally owned)	ACRES	3,400	0	0	
Lands (State and Locally owned)	ACRES	2,750	165.00	455,000	
S/T				455,000	
Contingencies		20%		91,000	
Acquisition costs (Non-Federal)				24,000	
Acquisition costs (Federal)				8,000	
TOTAL LANDS AND DAMAGES				578,000	
02. RELOCATIONS					
None anticipated				0	
S/T				0	
Contingencies				0	
TOTAL RELOCATIONS		None		0	
11. LEVEES					
Mob, demob, and prework	LS	1	75,000	75,000	
Clear and grub	ACRE	52	2,000	104,000	
Levee					
Stripping foundation	CY	24,500	1.60	39,200	
Excavation, common	CY	226,900	2.50	567,250	
Embankment fill	CY	181,500	4.50	816,750	
Slope treatment				0	
Gravel blanket	CY	33,200	14.00	464,800	
Associated minor items				0	
Gravel for levee crown	CY	8,800	16.00	140,800	
(6" road base course)				0	
S/T				2,207,800	

TABLE B-1 (Continued)

FILENAME: REFUGE3	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 2 OF 3
LOCATION: LOCATION		ESTIMATED BY: PORTER/PERRY
FEATURES: BUILD LEVEE NEXT TO ROAD - UNIFORM 12' WIDTH		DATE: 04-Oct-89
PERTINENT DATA: Build levee parallel to road to elevation 4792 to create ponding area between wildlife refuges.		Feb 1989 Price level

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
11. LEVEES (continued)					
Concrete gate structure					
Care and diversion of water	LS	1	75,000	75,000	
Excavation	CY	111	6.00	670	
Concrete	CY	37	300.00	11,110	
Cement	CW	209	4.00	840	
Re-bar	LBS	4,444	0.60	2,670	
Backfill, random	CY	34	2.50	90	
Backfill, rock	CY	69	8.50	580	
Gates and embedded items	EA	4	23,500	94,000	
(5x6 CI gates complete w/operators,	c)				
Miscellaneous metals	LBS	600	2.50	1,500	
S/T				2,394,260	
Contingencies		20%		478,852	
TOTAL LEVEES				2,873,100	
50. CONSTRUCTION FACILITIES					
COE facilities					
Trailer	EA	1	9,000	9,000	
Pickup truck	EA	2	12,000	24,000	
Contractor facilities	EA	1			
(Buried in Mob and Demob)					
S/T				33,000	
Contingencies		20%		6,600	
TOTAL FACILITIES				39,600	

TABLE B-1 (Continued)

FILENAME: REFUGE3 — ENGINEER'S ESTIMATE — RECON BUDGET

PROJECT: RECON STUDY FOR MUD LAKE, IDAHO — SHEET 3 OF 3

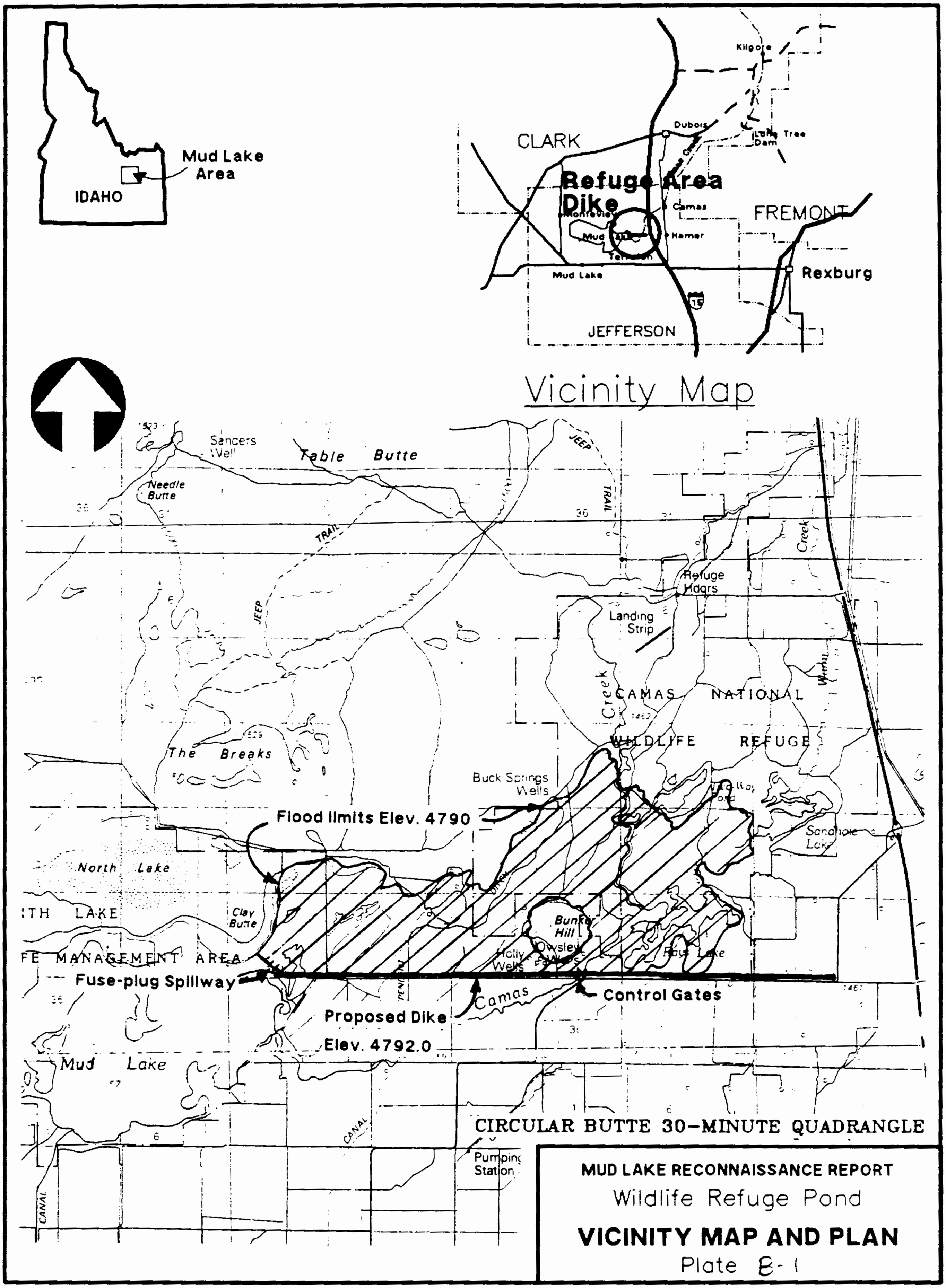
LOCATION: LOCATION — ESTIMATED BY: PORTER/PERRY

FEATURES: BUILD LEVEE NEXT TO ROAD - UNIFORM 12' WIDTH — DATE: 04-Oct-89

PERTINENT DATA: — Feb 1989 Price level

Build levee parallel to road to elevation 4792
to create ponding area between wildlife refuges.

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES				578,000	
02. RELOCATIONS				0	
11. LEVEES				2,873,100	
50. CONSTRUCTION FACILITIES				39,600	
S/T				2,912,700	
30. ENGINEERING AND DESIGN		10.00%		291,300	
31. SUPERVISION AND INSPECTION		8.00%		233,000	
TOTAL PROJECT COST				4,015,000	
INTEREST DURING CONSTRUCTION	1	8.875%		174,400	
				==============	
TOTAL INVESTMENT COST *********************				4,189,000	
AVERAGE ANNUAL COST	50	8.875%		377,100	
OPERATION AND MAINTENANCE		1.00%		41,900	
				==============	
TOTAL ANNUAL COST				419,000	

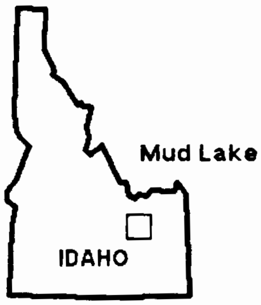


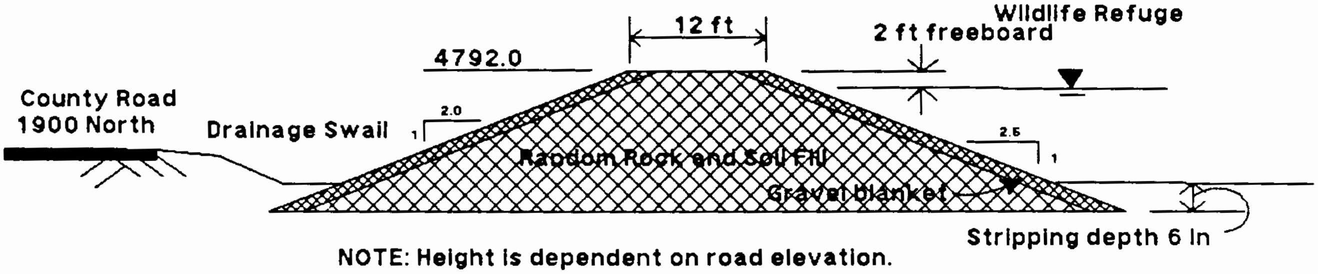
MUD LAKE RECONNAISSANCE REPORT

Wildlife Refuge Pond

VICINITY MAP AND PLAN

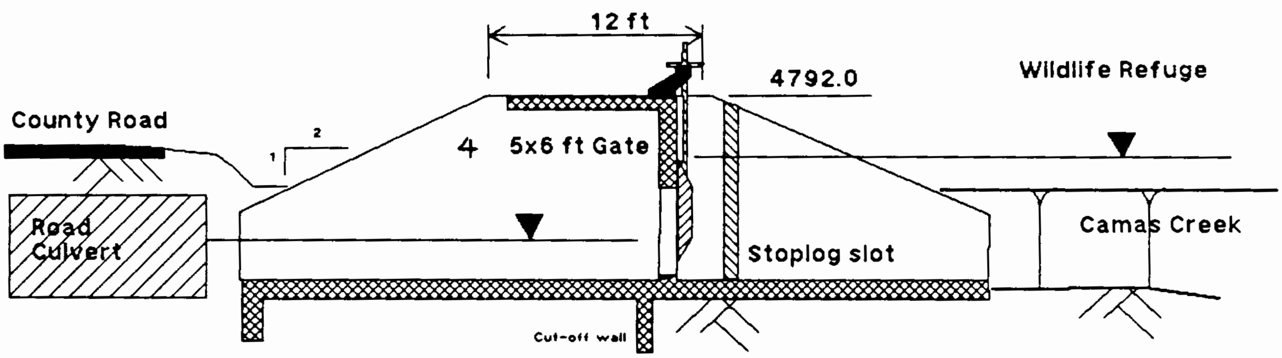
Plate B-1





TYPICAL DIKE SECTION

NOT TO SCALE



SECTION THRU CONTROL STRUCTURE

NOT TO SCALE

MUD LAKE RECONNAISSANCE REPORT

Wildlife Refuge Pond

TYPICAL SECTIONS

Plate B-2

APPENDIX C

JEFFERSON CANAL DIVERSION POND

APPENDIX C

JEFFERSON CANAL DIVERSION POND

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APPENDIX C

JEFFERSON CANAL DIVERSION POND

1. PERTINENT DATA.

Basin	Mud Lake
Location	5 miles west of Mud Lake, Idaho
Diversion:	
Pumps	
Existing	50 cfs at Mud Lake, 200 cfs at canal lift station
Proposed	150 cfs at Mud Lake (4 portables at 17,000 gpm each)
Pumping head	Approx. 6 feet at Mud Lake, 12 feet at canal lift station
Dike:	
Type of fill	Random rock and earth
Height	6 feet (average)
Top width	12 feet
Volume	231,000 cubic yards

2. PROJECT LOCATION.

The recharge pond area is 5 miles west of Mud Lake and is located in sections 20, 21, 28, and 29 of T. 7 N., R. 33 E., in the Boise Meridian, northeast of highway 28 (see plate C-1). The pumping station will be located in section 20.

3. PROJECT DESCRIPTION.

a. Existing Conditions.

The existing Jefferson Irrigation Canal has a capacity of 200 cfs. The canal brings water from wells and springs north of Mud Lake to farms west of the lake. A pump has been installed on Mud Lake for occasional use when excess lake water is available. Its capacity is assumed to be 50 cfs. The United States Atomic Energy Commission (AEC) owns a large tract of undeveloped land several miles west of Mud Lake that borders a segment of the irrigation canal. During extreme floods, water from Mud Lake is either pumped into the canal; or the bank of the canal is breached, allowing water to flow directly into the canal; or the bank of the canal is breached, allowing water to flow directly into the canal. Subsequently, the water is released onto farms and open prairie adjacent to the AEC's land.

b. Proposed Project.

The project consists of a containment dike enclosing 3.5 square miles of AEC land. Pumps will be provided to lift water from Mud Lake into Jefferson Canal. A turn-out structure will be built into the wall of the canal adjacent to the pond to control flow into the pond.

c. Hydrology.

The pond is not on Camas Creek or any other natural waterway. It will be filled from Jefferson Canal, an irrigation channel which connects the site with Mud Lake, 5 miles to the east.

d. Geology and Foundation Conditions.

No subsurface explorations have been conducted. Information is based entirely upon surface observations. The near surface formations appear to be either igneous extrusions with a very thin surface layer of sandy silt, probably of wind-blown origin or impervious lake bottom. From historical well records, it appears that the underlying basalt is a relatively efficient aquifer and is porous enough to transfer large quantities of groundwater. It is assumed that the designated recharge pond is large enough to percolate 200 cfs on a relatively continuous basis. Since the pond is west of Mud Lake, it is expected that any water detained and percolated here will continue to flow westwardly toward Magic Reservoir and will be lost to local irrigators.

4. PROPOSED FEATURES.

a. Land and Relocations.

The proposed site is owned by the Federal Government as part of the National Reactor Testing Station but is not required for facilities or testing. Approximately 2,100 acres will be required. No relocations are anticipated.

b. Diversion and Care of Water.

The canal turn-out will be built in the spring prior to irrigation season. No diversion or care of water will be required.

c. Pumps.

Four 17,000 gpm portable pumps will be used to increase the withdrawal capacity from Mud Lake from 50 cfs to 200 cfs, the full capacity of Jefferson Canal. The first cost for the units will include the self-contained pumps and a fenced 1/4-acre storage area, probably offsite. It is planned to use the county road separating Jefferson Canal and Mud Lake as a staging area for placement of the pumps during operation. Vehicular traffic during operation will be detoured to other roads.

d. Dike.

The containment dike around Jefferson Pond will have a 12-foot top width at 4,795.0 feet msl and 2h:1v side slopes. It will be constructed with relatively homogeneous soil from inside the pond. This will reduce the overburden and should increase the rate of percolation which, as noted above, was assumed to be 200 cfs.

e. Turn-out.

A small control structure similar to that shown on plate C-2 will be built to discharge water into the pond. Stop logs will be used to control flow into the pond rather than operating gates because of the additional maintenance required of metal gates and the infrequency of use.

5. OPERATION AND MAINTENANCE.

The sponsor will transport and set up the portable pumps at the lake when needed. Traffic will be detoured around the pumps during operation.

Since the pumps will be self-contained units consisting of relatively standard parts, it is anticipated that maintenance can be handled by local repair shops. Some routine annual maintenance will be required at the recharge pond and the sponsor will be required to remove and install the stop logs at the turn-out structure as needed.

6. COST ESTIMATE.

a. Construction Costs.

Quantities, capacities, and project features are based on measurements taken from 7.5 minute USGS quadrangles and assumptions as stated above. The total cost for lands and damages is based on the estimated land value and the estimated administrative cost for land acquisition.

A contingency factor of 20 percent was used. Costs for engineering and design, and supervision and inspection were estimated based on curves relating government costs on civil works projects to direct construction costs. Engineering estimate sheets are in table C-1. The estimated construction cost is $3,323,000.

b. Investment Cost.

Interest during construction was estimated assuming a 1-year construction period. Payment was made at midyear and compounded at 8.875 percent annually. The estimated total investment cost is $3,467,000.

c. Annual Cost.

Assuming a 50-year service life and interest at 8.875 percent, the amortized cost of this investment will be $312,000. It is estimated that the existing pumps require 340 kilowatts to pump 50 cfs into the lower canal and lift 200 cfs into the upper canal. The operation cost for pumping the additional 150 cfs into the canal is $14.25/hour/pump. Pumping will begin at Mud Lake when the water level reaches the 8-foot mark on the staff gage. From the 65 years of data provided by the USGS Water Supply Papers, Mud Lake equalled or exceeded that gage mark an average of 29 days per year. Pumping costs will therefore be approximately $49,000 per year. Maintenance is estimated to be 1 percent of construction cost or $35,000. Thus, the complete average annual cost will be $396,000.

TABLE C-1

FILENAME: JEFF	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 1 OF 6
LOCATION: Mudlake, Idaho		ESTIMATED BY: PORTER/BLODGETT
FEATURES: JEFFERSON CANAL DIVERSION POND		DATE: 12-Oct-89
PERTINENT DATA:		Feb 89 Price level
Build pond to elevation 4795; top width = 12'		BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES					
Lands	ACRES	2,100			Already Federal
S/T					
Contingencies	PERCENT	10.00%			
Acquisition costs (non-Federal)	TRACTS	1	5,000	5,000	
Acquisition costs (Federal)		1	2,000	2,000	
TOTAL LANDS AND DAMAGES				7,000	
02. RELOCATIONS					
None anticipated					
S/T					
Contingencies		10%			
TOTAL RELOCATIONS		None			
08.2 ROADS					
Care of traffic	LS				
Base course	CY				
Top course	CY				
Asphaltic concrete	TON				
Guard rails	LF				
Paint stripe	LF				
S/T					
Contingencies		20%			
TOTAL ROADS		None			
				14,000	(ROUNDED)

TABLE C-1 (Continued)

FILENAME: JEFF	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 2 OF 6
LOCATION: Mudlake, Idaho		ESTIMATED BY: PORTER/BLODGETT
FEATURES: JEFFERSON CANAL DIVERSION POND		DATE: 12-Oct-89
PERTINENT DATA:		Feb 89 Price level
Build pond to elevation 4795		BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
09. CANALS					
Mob, demob, and prework	LS	1	25,000	25,000	
Clearing and grubbing	ACRE	19	2,000	37,930	
Canal and access road					
Excavation, common	CY	51,268	1.60	82,030	
Shape and compact	SY	42,909	1.00	42,910	
Crown gravel topping	CY	2,996	16.00	47,930	
S/T				235,800	
Contingencies		20%		47,160	
TOTAL CANALS				283,000	
11. LEVEES					
Clearing and grubbing	ACRE	47	2,000	94,000	
Embankment					
Stripping, foundation	CY	157690	$1.60	252,300	
Excavation, common	CY				
Excavation, rock	CY				
Foundation compaction	SY	157690	$1.00	157,690	
Borrow excavation, random	CY	261638	$2.80	732,590	
Borrow excavation, impervious	CY				
Embankment fill	CY	209310	$0.90	188,380	
Slope treatment					
Gravel blanket	CY	21710	$14.00	303,940	
Associated minor items					
Staff gage (approx. 10 feet)	LS	1	$200.00	200	
S/T				1,729,100	
Contingencies		20%		345,820	
TOTAL EMBANKMENT				2,074,900	

TABLE C-1 (Continued)

FILENAME: JEFF	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 3 OF 6
LOCATION: Mudlake, Idaho		ESTIMATED BY: PORTER/BLODGETT
FEATURES: JEFFERSON CANAL DIVERSION POND		DATE: 12-Oct-89
PERTINENT DATA:		Feb 89 Price level
Build pond to elevation 4795		BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
15. DIVERSION STRUCTURES					
Concrete (including rebar & cement)	CY	16.4	250	4,090	
Embeded items	LBS	300.0	3	750	
Riprap	CY	6.5	28	180	
Timber stop logs	BF	112.0	1	110	
S/T				5,130	
Contingencies		20%		1,026	
TOTAL DIVERSION STRUCTURES				6,200	

TABLE C-1 (Continued)

FILENAME: JEFF	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 4 OF 6
LOCATION: Mudlake, Idaho		ESTIMATED BY: PORTER/BLODGETT
FEATURES: JEFFERSON CANAL DIVERSION POND		DATE: 12-Oct-89
PERTINENT DATA:		Feb 89 Price level
Build pond to elevation 4795		BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
13.B PUMPING PLANT					
Platform for portable pumps					
Clearing and grubbing	ACRE	0.31	2,500	790	
Levee protection (riprap)	CY	22	28	620	
Additional levee volume	CY				
Gravel top course	CY	101	16	1,610	
Excavation of pits	CY	255	6	1,530	
Fencing of storage yard	LF	417	12	5,010	Chainlink 8' w/ 3-st
Portable pumps					
17,000 GPM	EA	4	95,000	380,000	quote
12,000 GPM	EA		72,000		
S/T				389,560	
Contingencies		10%		38,956	
TOTAL PUMPING PLANT				428,500	

TABLE C-1
Sheet 4 of 6

TABLE C-1 (Continued)

FILENAME: JEFF	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 5 OF 6
LOCATION: Mudlake, Idaho		ESTIMATED BY: PORTER/BLODGETT
FEATURES: JEFFERSON CANAL DIVERSION POND		DATE: 12-Oct-89
PERTINENT DATA:		Feb 89 Price level
Build pond to elevation 4795		BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
19. BUILDINGS, GROUNDS, AND UTILITIES					
No auxiliary buildings	EA				
No landscaping	ACRE				
No utilities	LS				
S/T					
Contingencies		20%			
TOTAL BUILDINGS AND GROUNDS					
50. CONSTRUCTION FACILITIES					
COE facilities					
Administration trailer	LS	1	9,000	9,000	
Lab equipment	EA	1	7,000	7,000	
Fencing w/gate and lock	LF	400	8	3,200	CHAINLINK 5'
Contractor facilities					
(Burried in Mob & Demob)					
S/T				19,200	
Contingencies		20%		3,840	
TOTAL BUILDINGS AND GROUNDS				23,040	

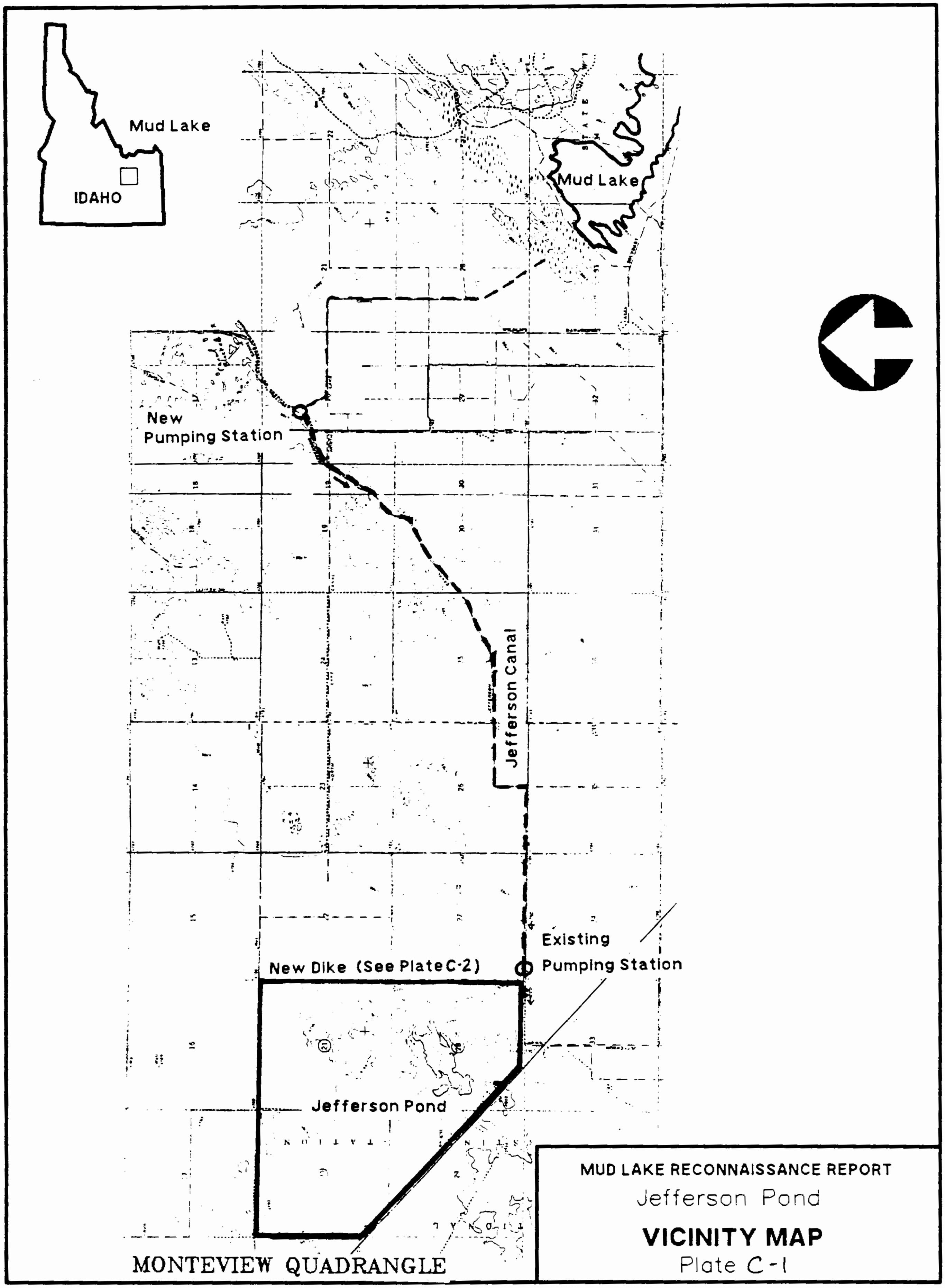
TABLE C-1 (Continued)

FILENAME: JEFF	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: RECON STUDY FOR MUD LAKE, IDAHO		SHEET 6 OF 6
LOCATION: Mudlake, Idaho		ESTIMATED BY: PORTER/BLODGETT
FEATURES: JEFFERSON CANAL DIVERSION POND		DATE: 12-Oct-89
PERTINENT DATA:		Feb 89 Price level
Build pond to elevation 4795		BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES				7,000	
02. RELOCATIONS					
08.2 ROADS					
09. CANALS				283,000	
11. LEVEES				2,074,900	
13.B PUMPING PLANT				428,500	
15. DIVERSION STRUCTURES				6,200	
19. BUILDINGS, GROUNDS, AND UTILITIES					
50. CONSTRUCTION FACILITIES				23,040	

CONSTRUCTION S/T				2,816,000	
30. Engineering and design		10%		281,600	<= Could be reduced
31. Supervision and Inspection		8%		225,300	using off-the-
				------------	shelf pumps.
TOTAL PROJECT COST				3,322,900	
INTEREST DURING CONSTRUCTION	1	8.875%		144,300	
				============	
TOTAL INVESTMENT COST				3,467,000	
**********************					
AVERAGE ANNUAL COST	50	8.875%		312,100	
ESTIMATED ANNUAL POWER COST				49,000	
MAINTENANCE		1.00%		35,000	
TOTAL ANNUAL COST				============	
*****************				$396,000	

TABLE C-1
Sheet 6 of 6

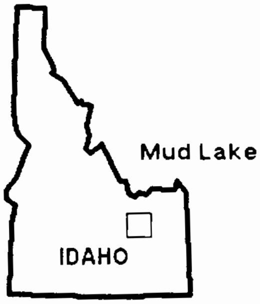


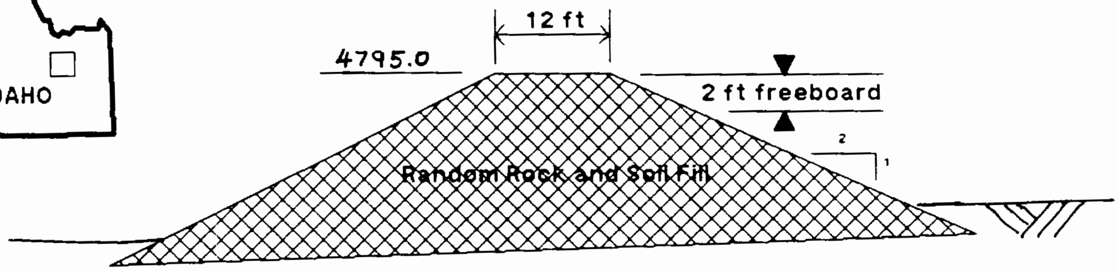
MUD LAKE RECONNAISSANCE REPORT

Jefferson Pond

VICINITY MAP

Plate C-1

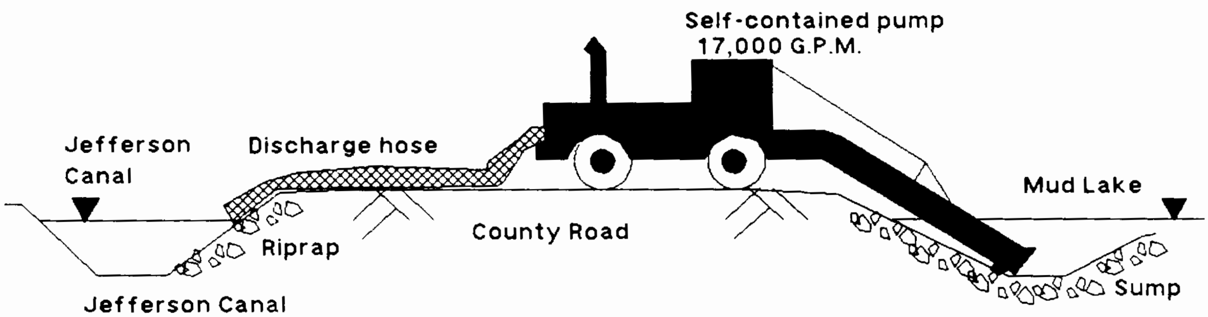




NOTE: Height is dependent on cross slope.

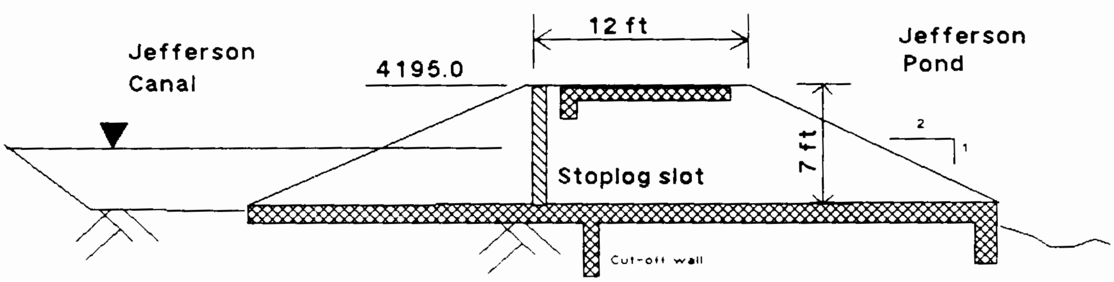
TYPICAL DIKE SECTION

NOT TO SCALE



TYPICAL PUMP DIVERSION

NOT TO SCALE



SECTION THRU TURN–OUT

NOT TO SCALE

MUD LAKE RECONNAISSANCE REPORT

Jefferson Pond

TYPICAL SECTIONS

Plate C-2

APPENDIX D

LONE TREE DAM

APPENDIX D

LONE TREE DAM

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PLATES

APPENDIX D

LONE TREE DAM

1. PERTINENT DATA.

Basin	Camas Creek
Drainage area	220 square miles
Location	8 miles SW. of Idmon, Idaho
Reservoir:	
Capacity	2,870 acre-feet
Normal pool	N/A
Area at maximum pool	205 acres
Dam:	
Main embankment:	
Type of fill	Compacted rock with earth core
Crest elevation	6,114.0 feet msl
Height	44 feet
Top width	24 feet
Volume	50,300 cubic yards
Spillway:	
Crest type	Concrete sill in rock saddle
Crest elevation	6,102.5 feet msl
Crest width	8 feet
Crest length	500 feet
Crest control	2-foot flashboards
Outlet Works:	
No. of conduits	2
Diameter	5 feet
Control	Single cast iron slide gate

2. PROJECT LOCATION.

The remains of Lone Tree Dam are located in Clark County on Camas Creek about 8 miles south and 1 mile west of Idmon, Idaho, in sec. 35, T. 11 N., R. 38 E., in the Boise Meridian (see plate D-1). The new dam will be built just downstream from the old dam.

3. PROJECT DESCRIPTION.

a. Existing Facilities.

Lone Tree Dam was apparently built by a corporation of local farmers some time prior to 1924 to provide irrigation water for its members. However, the dam was breached and abandoned a short time later in part because of intolerable percolation losses; apparently to the extent that more water was available without the dam than with it. Based on limited information, it has been calculated that the basin would have realized a net loss of about 60 cubic feet of water per second with a full reservoir.

b. Proposed Project.

A new dam will be built directly downstream from the existing Lone Tree Dam to promote groundwater recharge.

c. Hydrology.

Streamflows in Camas Creek follow a regular pattern of high flows from the end of February through the month of June and lower flows during the rest of the year. Because of pervious soils and efficient subterranean aquifers, a large percentage of the basin precipitation does not reach the stream; and, much of the remaining streamflow percolates through the open streambed. Average summer and autumn flows are about 30 cfs and peak spring flows may exceed 1,500 cfs. The probable maximum flood was estimated at 29,000 cfs.

d. Geology and Foundation Conditions.

No subsurface explorations have been conducted. Information is based entirely upon surface observations. The near surface formations appear to be igneous extrusions with a very thin surface layer of sandy silt, probably of wind-blown origin. It was assumed that the surface soil layer is only 1-foot thick and that initial surface preparation will require the removal of the top 2 feet of bedrock. From historical well records it appears that the underlying rock is a relatively efficient aquifer. It is expected that half the water impounded and percolated at Lone Tree Dam will arrive at Mud Lake via subterranean lava tubes 6 months later. Since percolation is the purpose of Lone Tree Dam, no foundation grouting is planned.

4. PROPOSED FEATURES.

a. Land and Relocations.

The reservoir will flood approximately 205 acres at maximum pool. The total land requirement will be 290 acres. Since the site is uninhabited, no relocations are anticipated.

b. Reservoir.

The reservoir will be operated solely for flood control; no conservation pool will be maintained. The maximum controlled pool will be 6,102.5 feet msl which is the elevation of the spillway crest without flashboards. The storage capacity at the spillway crest is 1,600 acre-feet. The design surcharge pool is 6,109.0 feet msl. Table D-1 presents the area and capacity relationship of the reservoir.

TABLE D-1

AREA-CAPACITY

Elevation (msl)	Area (acres)	Capacity (acre-feet)
6,080	10.0	70
6,090	55.0	400
6,100	117.0	1,250
6,110	205.0	2,870
6,120	345.0	5,610

c. Diversion and Care of Water.

A small cofferdam approximately 15 feet high and a pipe diversion using 500 feet of 27-inch-diameter corrugated metal pipe will be built to dewater the construction area while the outlet works and base of the dam are being built. It is assumed that the dam will be operational within 1 year.

d. Main Dam Embankment.

For this study, an earth and rockfill dam was used. A roller compacted concrete dam was considered, but it does not have an apparent economic advantage. The top will be 6,114.0 feet msl and have a width of 30 feet as shown on plate D-2. Both the upstream and downstream faces will slope 2h:1v. The core of the dam will be a 20-foot-wide silt zone protected by sand and gravel filters. Approximately 38,300 cubic yards of rock and gravel fill, 2,000 cubic yards of sand, and 9,900 cubic yards of fine silt will be required. The rockfill will come from spillway excavation. The silt will come from the old dam. Riprap will not be required because the rockfill, including the facing, will be coarse enough to preclude erosion. The crest will receive a 4-inch layer of crushed base rock to facilitate light traffic.

e. Regulating Outlet.

The outlet works will consist of an intake trash rack, 2 cut-and-cover conduits founded in bedrock, and a simple concrete terminal structure and stilling basin. The outlet works will pass 400 cfs, 50 cfs more than the average mean daily flow. The pipes will be 5 feet in diameter with simple single-gate intakes located at the upstream toe of the dam. Operators and air vents will extend up the sloping face of the dam to a small operating house. Secondary gates and bulkheads will not be required because the dam will not hold a permanent pool. A portable electric generator and power operators will be housed onsite for operation purposes. If necessary, the gates may be operated by hand.

f. Spillway.

The spillway will be designed to handle 29,000 cfs. It will consist of a 8-foot-wide by 4-foot-deep unreinforced concrete sill (see plate D-2). Flashboard brackets and timber are included for additional capacity.

g. Access Roads.

Access to the project will require 3,800 feet of new access road and 3,100 feet of guardrail.

5. OPERATION AND MAINTENANCE.

Only minimum operation and maintenance will be required at Lone Tree Dam due to the short filling schedule and the lack of supporting facilities. A pickup truck was included in the project cost estimate for use by operating personnel, but maintenance and storage of the vehicle will be the responsibility of the sponsor.

6. COST ESTIMATE AND AVERAGE ANNUAL COST.

a. Construction Costs.

Quantities, capacities, and project features are based on measurements taken from 7.5 minute USGS quadrangles and assumptions as stated above. Total cost for lands and damages is based on the estimated land value and the estimated administrative cost for land acquisition. A contingency factor of 20 percent was used. Costs for engineering and design, and supervision and inspection were estimated based on curves relating government costs on civil works projects to direct construction costs. Engineering estimate sheets are in table D-2. The estimated construction cost is $1,975,000.

b. Investment Cost.

Interest during construction was estimated assuming a 2-year construction period with 80 percent of the work being done in the first year. Payments were made at midyear and compounded at 8.875 percent annually. The estimated total investment cost is $2,097,000.

c. Annual Cost.

Assuming a 100-year service life and interest at 8.875 percent, the average annual cost of construction is $188,800. Operation and maintenance are estimated to be 2 percent of construction cost or $41,900. Thus, the total average annual cost is $231,000.

TABLE D-2

FILENAME: LONETREE.WK1	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: MUD LAKE, IDAHO		SHEET 1 OF 5
LOCATION: NE OF MUDLAKE IN CLARK COUNTY, IDAHO		ESTIMATED BY: PORTER/BLODGET
FEATURES: LONE TREE DAM		DATE: 02-Oct-89
PERTINENT DATA: Rebuild dam with earth and raise to elevation 6114.		Feb 89 Price level

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES					
Lands (Easement)	ACRE	1	1,000	1,000	
Lands (Fee)	ACRE	290	125	36,300	
Contingencies	PERCENT	20.00%		7,500	
Acquisition costs (Non-Federal)	TRACTS	1	7,000	7,000	
Acquisition costs (Federal)		1	3,000	3,000	
TOTAL LANDS AND DAMAGES				$54,800	
02. RELOCATIONS					
None anticipated				0	
Contingencies				0	
TOTAL RELOCATIONS		None		0	
04.2 EARTH DAMS					
Mobilization and preparatory work				70,000	
Diversion and care of creek					
Cofferdam					
Earth embankment	CY	1,700	$3.50	5,950	
27-inch diameter CMP	LF	500	$30.00	15,000	
Removal of cofferdam and CMP	LS	1	$3,000	3,000	
Excavation and foundation work					
Clearing and grubbing	AC	9.1	$2,500	22,760	
Stripping	CY	8,630	$1.60	13,810	
Foundation preparation	SY	8,210	$20.00	164,200	
Embankment					
Borrow excavation, impervious (from old dam)	CY	12,425	$3.00	37,280	
Borrow excavation, gravel	CY	7,450	$8.00	59,600	
Borrow excavation, rock (from new spillway)	CY	42,938	$7.00	300,560	
Fill, impervious	CY	9,940	$2.00	19,880	
Fill, sand	CY	1,990	$3.00	5,970	
Fill, gravel	CY	3,970	$3.00	11,910	
Fill, rock	CY	34,350	$1.00	34,350	
S/T				$764,270	

TABLE D-2 (Continued)

FILENAME: LONETREE.WK1 — E N G I N E E R ' S   E S T I M A T E — RECON BUDGET

PROJECT: MUD LAKE, IDAHO — SHEET 2 OF 5

LOCATION: NE OF MUDLAKE IN CLARK COUNTY, IDAHO — ESTIMATED BY: PORTER/BLODGET

FEATURES: LONE TREE DAM — DATE: 02-Oct-89

PERTINENT — Feb 89 Price level

Rebuild dam with earth and raise to elevation 6114.

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
Outlet works:					
Intake structure					
Concrete	CY	19	$200.00	3,750	
Cement	CW	10,600	$4.00	42,400	
Re-bar	LB	2,300	$0.60	1,380	
Trashracks with guides	LB	4,000	$2.00	8,000	
Vent pipes, 6-in steel	LS	282	$17.00	4,790	
Main conduit					
Trench through foundation	CY	2,139	$8.00	17,110	
Bedding	CY	402	$16.00	6,430	
60-in cement lined welded steel pipe	LF	660	$200.00	132,000	
Concrete backfill	CY	0	$120.00	0	
Compacted backfill	CY	1,257	$5.00	6,290	
Concrete, outlet structure	CY	19	$250.00	4,690	
Cement	CW	2,250	$4.00	9,000	
Re-bar	LB	2,300	$0.60	1,380	
Stilling basin excavation, rock	CY	70	$8.00	560	
Gate operating house, 8x20, steel utili	EA	1	10,000	10,000	
Intake Gates and Equipment					
Gates with frames, 60-in CI, complete	EA	2	19,480	38,960	
Operator extensions	LF	282	19	5,350	
Operator extension support blocks	EA	14	36	510	
Gate operating machinery	EA	2	300	600	
Portable electric gate operator	LS	1	2,700	2,700	
Portable electric generator	LS	1	3,750	3,750	
Maintenance tools and supplies	LS			5,000	
S/T				$304,650	
Spillway					
Excavation (dozer w/ripper)	CY	42,000	$2.00	84,000	
Mass concrete (sill and abutments)	CY	600	$120.00	72,000	
Cement	CW	2,820	$4.00	11,280	
Re-bar	LB	0		0	
Steel H-posts for flashboards	LB	3,060	$1.50	4,590	
Wood flashboards	BF	4,500	$1.00	4,500	
S/T				$176,370	

TABLE D-2 (Continued)

FILENAME: LONETREE.WK1	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: MUD LAKE, IDAHO		SHEET 3 OF 5
LOCATION: NE OF MUDLAKE IN CLARK COUNTY, IDAHO		ESTIMATED BY: PORTER/BLODGET
FEATURES: LONE TREE DAM		DATE: 02-Oct-89
PERTINENT DATA: Rebuild dam with earth and raise to elevation 6114.		Feb 89 Price level

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
Associated Items					
Staff gage (approx. 50-feet long)	LS	1	550	550	
Pickup truck, 4wd	EA	1	12,000	12,000	
2-way radio (police band ?)	EA	1	1,000	1,000	
Archaeological monument	LS	1	2,000	2,000	
S/T				15,550	
S/T DAM				1,260,840	
Contingencies		20%		252,200	
TOTAL DAM				$1,513,040	
08.2 ACCESS ROADS					
Site clearing					
Clearing and grubbing	ACRE	2.2	2,500	5,520	
Excavation				0	
Excavation, mostly rock	CY	1,200	8	9,600	
Roadway				0	
Gravel surfacing 4-inches	CY	710	17	12,070	
Guard rails	LF	3,100	15	46,500	
Project signs	EA	2	500	1,000	
Warning and speed signs	EA	4	250	1,000	
S/T				75,690	
Contingencies		20%		15,100	
TOTAL ROADS				$90,790	
19. BUILDINGS, GROUNDS, AND UTILITIES					
No auxiliary buildings	EA	0		0	
No landscaping	ACRE	0		0	
No utilities	LS	0		0	
S/T				0	
Contingencies		20%		0	
TOTAL BUILDINGS AND GROUNDS				$0	

TABLE D-2 (Continued)

FILENAME: LONETREE.WK1	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: MUD LAKE, IDAHO		SHEET 4 OF 5
LOCATION: NE OF MUDLAKE IN CLARK COUNTY, IDAHO		ESTIMATED BY: PORTER/BLODGET
FEATURES: LONE TREE DAM		DATE: 02-Oct-89
PERTINENT Rebuild dam with earth and raise to elevation 6114.		Feb 89 Price level

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
50. CONSTRUCTION FACILITIES					
COE facilities					
Administration trailer	LS	1	9,000	9,000	
Lab equipment	EA	1	7,000	7,000	
Fencing w/gate and lock	LF	400	8	3,200	
Contractor facilities					
(BURIED IN MOB AND DEMOB)					
S/T				19,200	
Contingencies		20%		3,800	
TOTAL FACILITIES				$23,000	
				65,200	(ROUNDED)

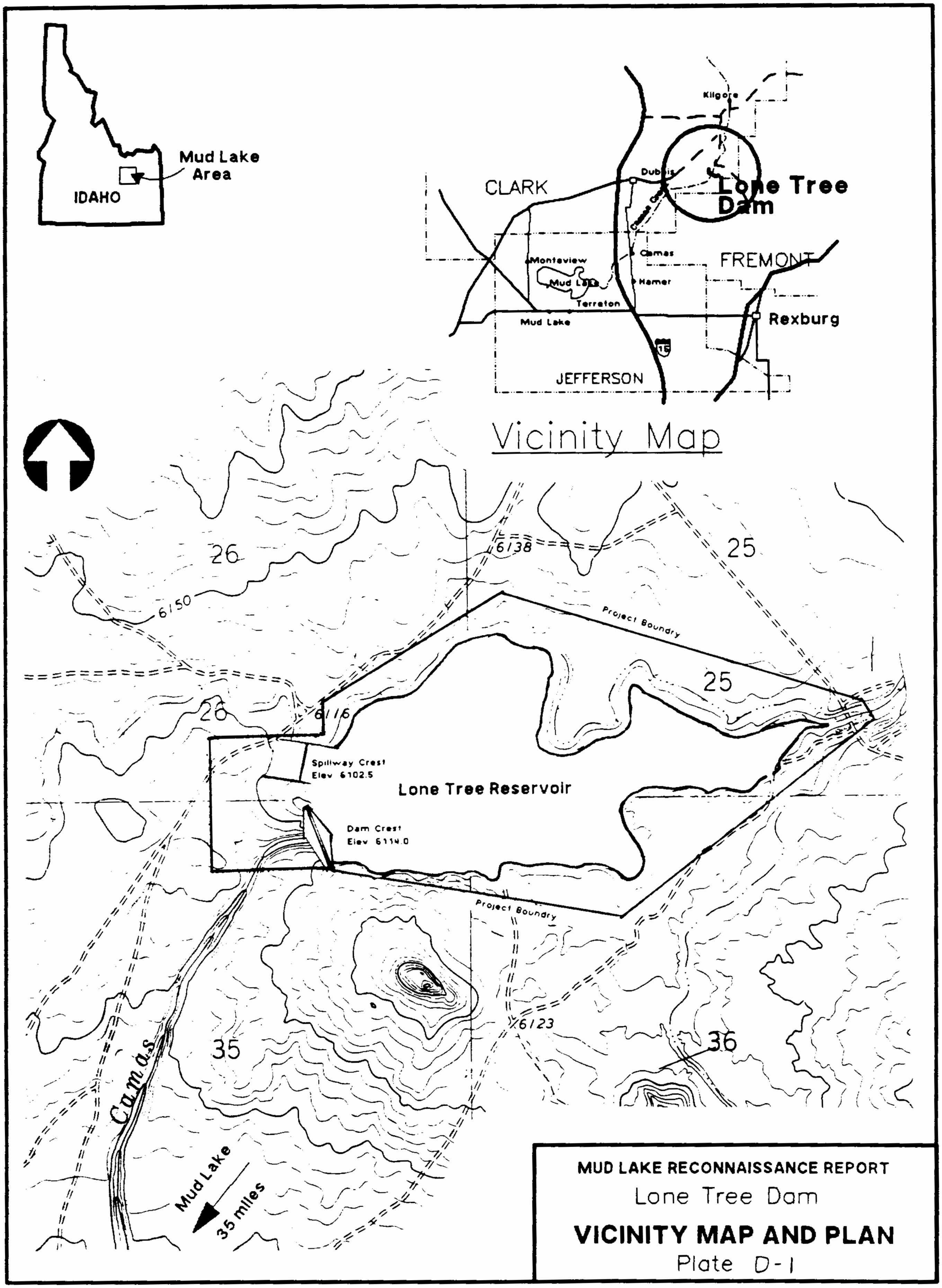
TABLE D-2 (Continued)

FILENAME: LONETREE.WK1	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: MUD LAKE, IDAHO		SHEET 5 OF 5
LOCATION: NE OF MUDLAKE IN CLARK COUNTY, IDAHO		ESTIMATED BY: PORTER/BLODGET
FEATURES: LONE TREE DAM		DATE: 02-Oct-89
PERTINENT Rebuild dam with earth and raise to elevation 6114.		Feb 89 Price level

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES				54,800	
02. RELOCATIONS				0	
04.2 EARTH DAMS				1,513,040	
08.2 ACCESS ROADS				90,790	
19. BUILDINGS, GROUNDS, AND UTILITIES				0	
50. CONSTRUCTION FACILITIES				23,000	

SUBTOTAL CONSTRUCTION				$1,627,000	
30. ENGINEERING AND DESIGN		10.00%		162,700	
31. SUPERVISION AND INSPECTION		8.00%		130,200	

S/T				$1,920,000	
TOTAL PROJECT COST				1,975,000	
		Period			
INTEREST DURING CONSTRUCTION	80%	0.50	8.875%	68,600	
	20%	1.50	8.875%	53,700	
				============	
TOTAL INVESTMENT COST *********************				$2,097,000	
AVERAGE ANNUAL COST	50	8.875%		188,800	
OPERATION AND MAINTENANCE		2.00%		41,900	
				============	
TOTAL ANNUAL COST				$231,000	

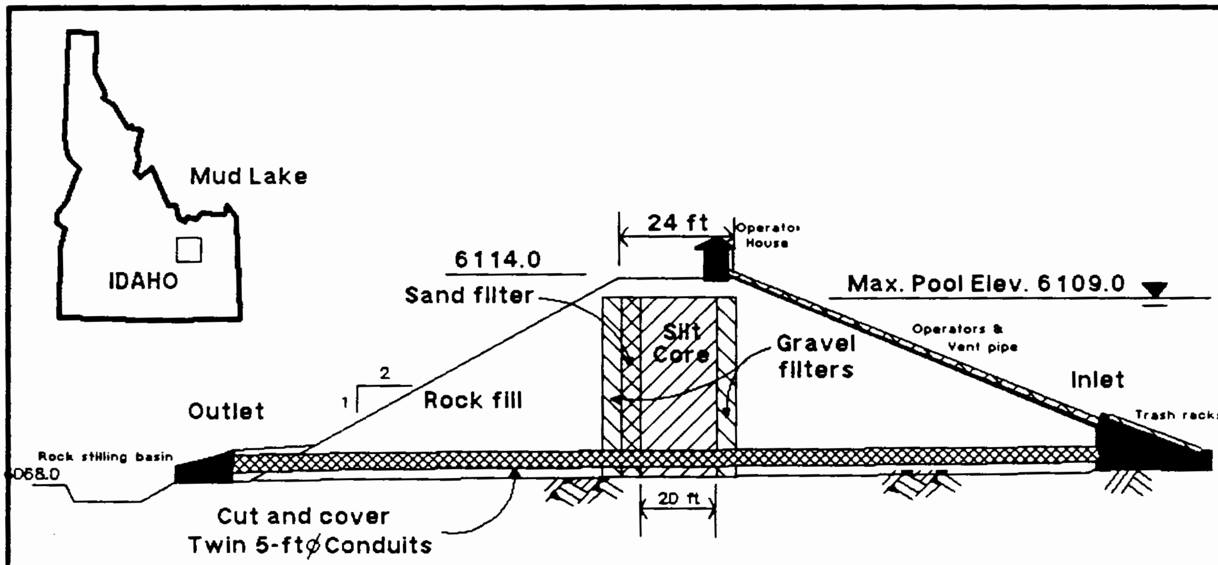


MUD LAKE RECONNAISSANCE REPORT

Lone Tree Dam

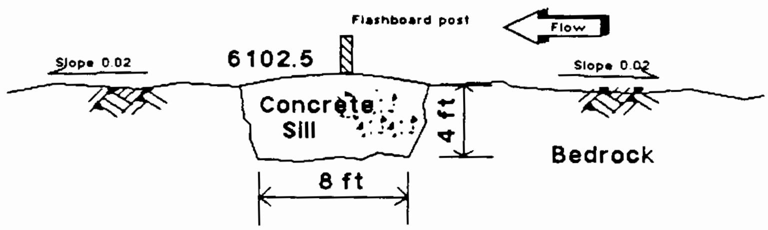
VICINITY MAP AND PLAN

Plate D-1



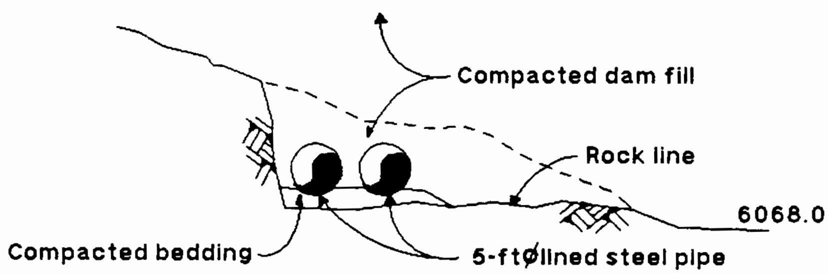
TYPICAL DAM SECTION

NOT TO SCALE



TYPICAL SPILLWAY SECTION

NOT TO SCALE



TYPICAL OUTLET SECTION

NOT TO SCALE

MUD LAKE RECONNAISSANCE REPORT

Lone Tree Dam

TYPICAL SECTIONS

Plate D–2

APPENDIX E

WESTERN DIVERSION

APPENDIX E

WESTERN DIVERSION

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TABLE

PLATES

APPENDIX E

WESTERN DIVERSION

1. PERTINENT DATA.

Basin	Camas Creek
Location	8 miles SW. of Idmon, Idaho
Diversion:	
Structure	Concrete
Elevation	6,120.0 feet msl
Control	4 5- by 6-foot slide gates
Capacity	500 cfs
Dike:	
Type of fill	Rock and earth
Maximum height	12 feet
Top width	12 feet
Length	26,500 feet

2. PROJECT LOCATION.

The diversion channel will follow the Lee-Egbert Canal located in sections 25, 26, 27, 28, 34, and 35 T. 11 N., R. 38 E., of the Boise Meridian (see plate E-1).

3. PROJECT DESCRIPTION.

a. Existing Conditions.

There are two existing irrigation diversions from Camas Creek about 1 mile above Lone Tree Dam. The east diversion was enlarged a few years ago to allow it to divert 500 cfs of floodwater into a tributary drainage about 1.5 miles east of Camas Creek. Some of that water is lost in the diversion channel, but most of it is spread out to percolate into the ground as it flows back toward Camas Creek. The Lee-Egbert irrigation ditch is the western diversion.

b. Project Description.

It is proposed to build a single levee about 200 feet downhill from the existing Lee-Egbert Canal (see plate E-2). Floodwater will be confined between the levee and the hillside.

c. Hydrology.

Streamflows in Camas Creek follow a regular pattern of high flows from the end of February through the month of June and lower flows during the rest of the year. Because of pervious soils and efficient subterranean aquifers, a large percentage of the basin precipitation does not reach the stream; and, much of the remaining streamflow percolates through the open streambed. Average autumn flows are about 30 cfs and peak spring flows may exceed 1,500 cfs.

d. Geology and Foundation Conditions.

No subsurface explorations have been conducted. Information is derived entirely from surface observations. The near surface formations appear to be igneous extrusions with a very thin surface layer of sandy silt, probably of wind-blown origin. From historical well records, it appears that the underlying rock is a relatively efficient aquifer. It is expected that some of the water impounded and percolated by this diversion will arrive at Mud Lake via subterranean lava tubes about 6 months to 1 year later.

4. PROPOSED FEATURES.

a. Land and Relocations.

The diversion will require an easement of approximately 470 acres, following the alignment of the Lee-Egbert Canal and averaging about 770 feet wide. An additional 400 acres will be required in the drainage basin that the canal empties into. The need for this will depend on future percolation tests. Since the area is uninhabited, no relocations are anticipated; although, one gravel access road that now runs up the west bank of the creek will require culverts. Future studies may determine that a dip crossing would be sufficient since maintenance personnel could use existing bridges east or west of the project when necessary.

b. Diversion and Care of Water.

Average flows in Camas Creek during the summer and fall months are in the 25 to 50 cfs range. It will, therefore, be necessary to leave a berm between the river and the new control structure during construction.

c. Diversion Structure.

The existing diversion and control structure will be replaced by a 7-foot-high by 100-foot-long structure with four 5- by 6-foot slide gates. It may be possible to combine this with the existing eastern diversion.

d. Dike and Channel.

The project will use a single dike to create a channel between the dike and the natural hillside. The embankment will have a uniform top width of 12 feet with 2h:1v side slopes. To estimate construction volumes, the natural ground slope was measured at 1,000-foot intervals along the proposed alignment and used to compute the cross-sectional area necessary to pass the design flow with the same energy gradient as the Lee-Egbert Canal. Thus, the height of the dike and the overall width of the channel vary from station to station. Freeboard was assumed to be 2 feet.

Several termination points were evaluated to determine the total flow distance from diversion until return to Camas Creek. The chosen alignment is 26,500 feet long and is designed to carry the full 500 cfs for the full length of the channel.

e. Construction.

It was assumed that the levee could be constructed of scraped up top soil and rock found on the uphill side of the levee below the existing Lee-Egbert Canal. This should improve percolation rates and not affect flows in the existing canal in any way. A small amount of dumped riprap would be required at the diversion intake and at the downstream terminus of the channel to prevent possible erosion due to nonuniform flows. Crushed rock would be used on the levee crown to support maintenance traffic.

5. OPERATION AND MAINTENANCE.

Minimum operation and maintenance will be required. It was assumed that the channel will need to be cleared of brush and grasses every few years.

6. COST ESTIMATE.

a. Construction Costs.

Quantities, capacities, and project features are based on measurements taken from 7.5 minute USGS quadrangles and assumptions as stated above. Total cost for lands and damages is based on the estimated land value and the estimated administrative cost for land acquisition. A contingency factor of 20 percent was used. Costs for engineering and design, and supervision and inspection were estimated based on curves relating government costs on civil works projects to direct construction costs. Engineering estimate sheets are in table E-1. The estimated construction cost is $3,157,000.

b. Investment Cost.

Interest during construction was estimated assuming a 2-year construction period. Payments were made at midyear and compounded at 8.875 percent annually. The estimated total investment cost is $3,437,000.

c. Annual Cost.

Assuming a 50-year service life and interest at 8.875 percent, the average annual cost of construction is $309,400. Operation and maintenance are estimated to be 1 percent of construction cost or $34,400. Thus, the total average annual cost is $344,000.

TABLE E-1

FILENAME: LEE-EGBERT.WK1 — ENGINEER'S ESTIMATE — RECON BUDGET

PROJECT: MUD LAKE — SHEET 1 OF 4

LOCATION: NORTH OF MUD LAKE, IDAHO — ESTIMATED BY: PORTER/BLODGET

FEATURES: LEE-EGBERT CANAL EXPANSION — DATE: 22-Feb-89

PERTINENT DATA: — Feb 89 Price level
BUILD WESTERN DIVERSION FROM LONE TREE DAM
(5-MILE LONG LEVEE ALONG LEE-EGBERT CANAL) — BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES					
Pasture	ACRE	0		0	
Waste (marginal range land)	ACRE	470	100	47,000	
S/T				47,000	
Contingencies		20%		9,000	
TOTAL LANDS & CONTINGENCIES				56,000	
Acquisition Costs (Non-Federal)		20%		9,000	
Acquisition Costs (Federal)		6%		3,000	
TOTAL ESTIMATED COST OF ACQUISITION				68,000	
02. RELOCATIONS					
Utilities	EACH	None		0	
Structures	EACH	None		0	
S/T				0	
Contingencies		0%		0	
TOTAL RELOCATIONS				0	
08.3 BRIDGES					
4-ft diameter CMP	LF	400	$65.00	26,000	
Gravel fill for road	CY	520	$4.50	2,340	
(same as levee material)				0	
Gravel topping	CY	60	$16.00	960	
S/T				29,300	
Contingencies		20%		5,860	
TOTAL, BRIDGES				35,200	

TABLE E-1

FILENAME: LEE-EGBERT.WK1	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: MUD LAKE		SHEET 2 OF 4
LOCATION: NORTH OF MUD LAKE, IDAHO		ESTIMATED BY: PORTER/BLODGET
FEATURES: LEE-EGBERT CANAL EXPANSION		DATE: 22-Feb-89
PERTINENT DATA: BUILD WESTERN DIVERSION FROM LONE TREE DAM		Feb 89 Price level BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
11. LEVEES					
Mob, Demob, & Prework	LS	1	100,000	100,000	
Clear & grub	ACRE	22	2,000	43,100	
Levee:					
Stripping foundation	CY	34,770	$1.60	55,630	
Excavation, common (mostly rock)	CY	179,420	$6.00	1,076,520	
Embankment fill	CY	143,540	$4.50	645,930	
Slope treatment					
Riprap	CY	50	$28.00	1,400	
Associated minor items					
Gravel for levee crown	CY	1,470	$16.00	23,520	
Concrete gate structure					
Care and diversion of water	LS	1	$75,000	75,000	
Excavation	CY	110	$6.00	660	
Concrete	CY	40	$300.00	12,000	
Cement	CW	210	$4.00	840	
Re-bar	LBS	4,440	$0.60	2,660	
Backfill, random	CY	40	$2.50	100	
Backfill, rock	CY	70	$8.50	600	
Gates and enbedded items					
(5x6 CI gates complete w/operators	EA	4	$23,500	94,000	
Miscellaneous metals	LBS	500	$2.50	1,250	
S/T				2,133,210	
Contingencies		20%		426,642	
TOTAL LEVEES				2,559,900	

FILENAME: LEE-EGBERT.WK1 — ENGINEER'S ESTIMATE — RECON BUDGET

PROJECT: MUD LAKE — SHEET 3 OF 4

LOCATION: NORTH OF MUD LAKE, IDAHO — ESTIMATED BY: PORTER/BLODGET

FEATURES: LEE-EGBERT CANAL EXPANSION — DATE: 22-Feb-89

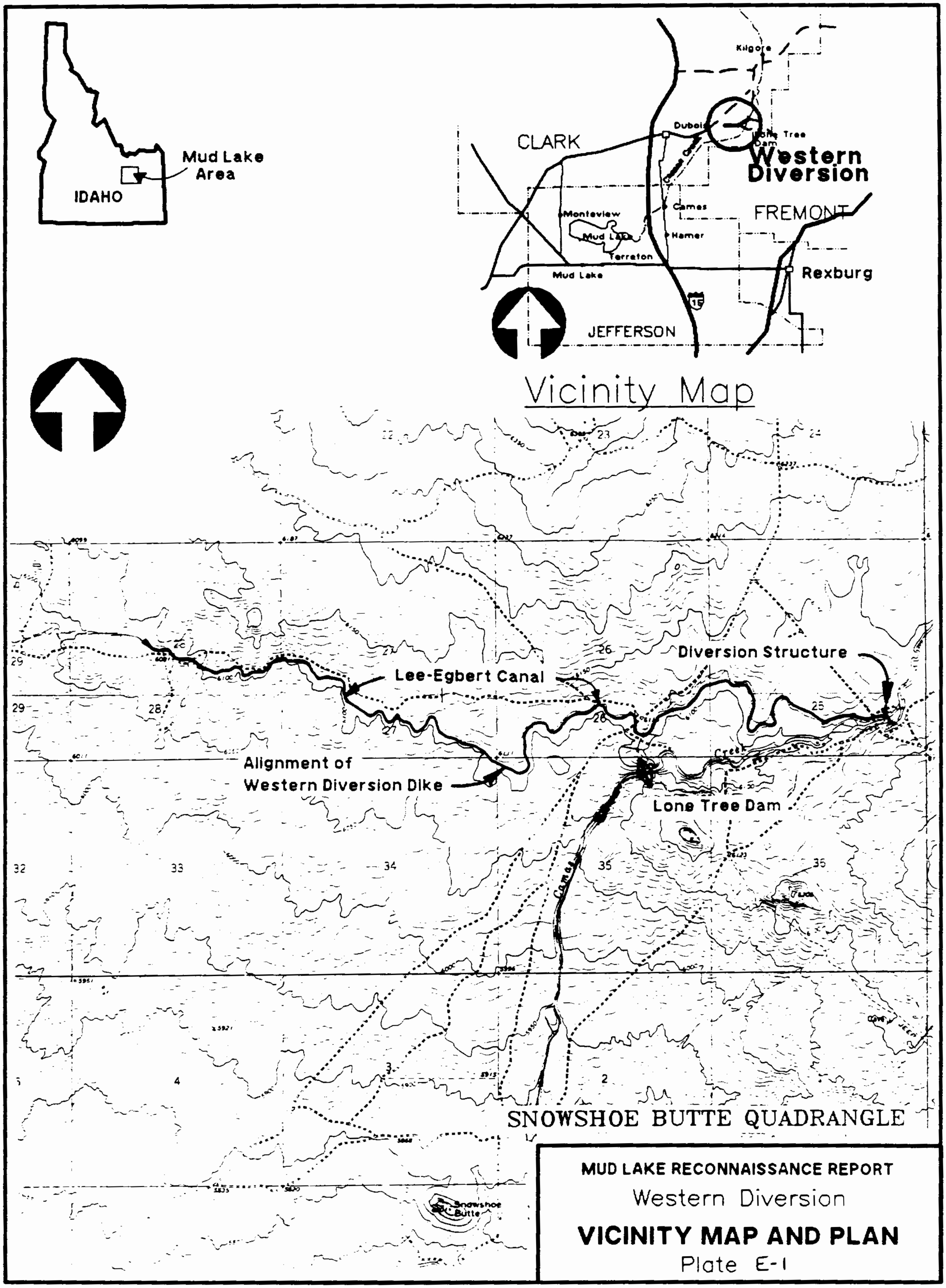
PERTINENT DATA: Feb 89 Price level
BUILD WESTERN DIVERSION FROM LONE TREE DAM
BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
50. CONSTRUCTION FACILITIES					
COE facilities				0	
Administration trailer	LS	1	9,000	9,000	
Lab equipment	EA	1	7,000	7,000	
Fencing w/gate and lock	LF	400	8	3,200	
Contractor facilities					
(Burried in Overhead)					
S/T				19,200	
Contingencies		20%		3,840	
TOTAL CONSTRUCTION FACILITIES				23,000	

TABLE E-1

FILENAME: LEE-EGBERT.WK1	E N G I N E E R ' S E S T I M A T E	RECON BUDGET
PROJECT: MUD LAKE		SHEET 4 OF 4
LOCATION: NORTH OF MUD LAKE, IDAHO		ESTIMATED BY: PORTER/BLODGET
FEATURES: LEE-EGBERT CANAL EXPANSION		DATE: 22-Feb-89
PERTINENT DATA: BUILD WESTERN DIVERSION FROM LONE TREE DAM		Feb 89 Price level BLODGETT 6746

ITEM	UNIT	QUANTITY	UNIT PRIC	AMOUNT	REMARKS
01. LANDS AND DAMAGES				68,000	
02. RELOCATIONS				0	
08.3 BRIDGES				35,200	
11. LEVEES				2,559,900	
50. CONSTRUCTION FACILITIES				23,000	
CONSTRUCTION S/T				2,618,000	
30. ENGINEERING AND DESIGN		10.00%		261,800	
31. SUPERVISION AND INSPECTION		8.00%		209,400	
TOTAL PROJECT COST				3,157,000	
INTEREST DURING CONSTRUCTION	2	8.875%		280,200	
TOTAL INVESTMENT COST ***********************				3,437,000	
AVERAGE ANNUAL COST	50	8.875%		309,400	
OPERATION AND MAINTENANCE		1.00%		34,400	
TOTAL ANNUAL COST ******************				344,000	

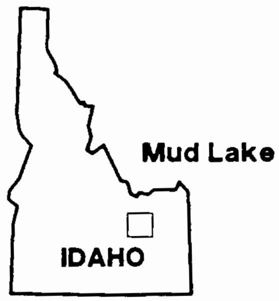


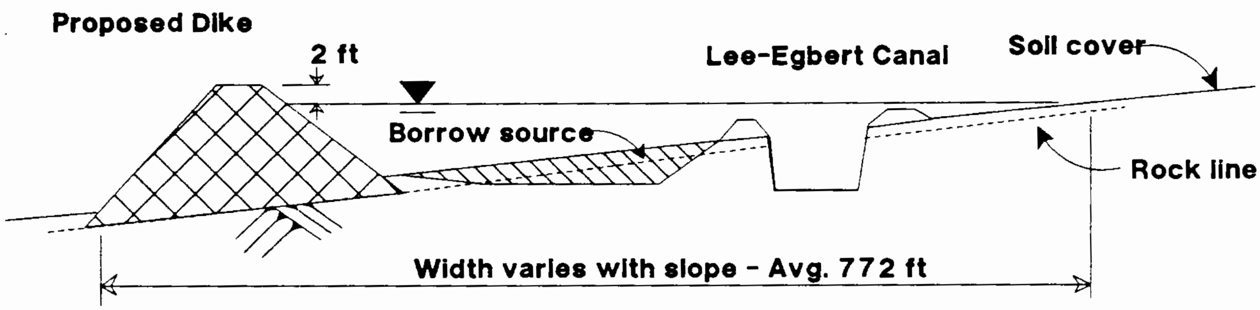
MUD LAKE RECONNAISSANCE REPORT

Western Diversion

VICINITY MAP AND PLAN

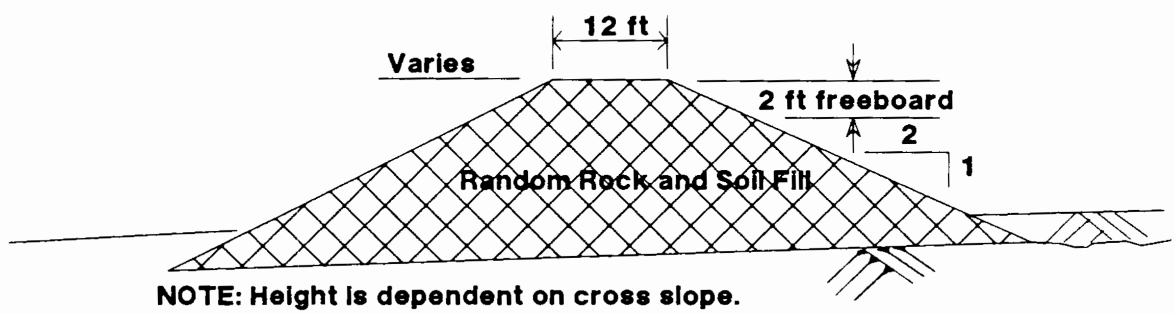
Plate E-1





TYPICAL CHANNEL SECTION

NOT TO SCALE



NOTE: Height is dependent on cross slope.

TYPICAL DIKE SECTION

NOT TO SCALE

MUD LAKE RECONNAISSANCE REPORT
Western Diversion
TYPICAL SECTIONS
Plate E - 2

APPENDIX F

RAISE MUD LAKE DIKE

APPENDIX F

RAISE MUD LAKE DIKE

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TABLE

Plates

APPENDIX F

RAISE MUD LAKE DIKE

1. PERTINENT DATA.

Basin	Camas Creek
Drainage area	1,130 square miles
Location	30 miles west of Rexburg, Idaho
Dike:	
Crest elevation	4,789.0 feet msl
Control	Pumps
Height	14 feet average
Length	10 miles
Type of fill	Compacted earth
Top width	12 feet
Capacity	37,930 acre-feet at 4,783.0 feet msl
Spillway:	
Type	Concrete weir
Elevation	4,784.0 feet msl
Length	1,400 feet

2. PROJECT LOCATION.

Mud Lake is located in eastern Idaho, approximately 30 miles west of Rexburg, Idaho. The center of the lake is sec. 6 T. 6 N., R. 35 E., of the Boise Meridian (see plate A-1).

3. PROJECT DESCRIPTION.

a. Existing Mud Lake Dike.

Mud Lake is formed from a natural depression in the eastern end of Idaho's Camas Valley. It has no natural outlet except to groundwater. Since settlement of the area, dikes have been built to successively claim more and more of the fertile lake bed for agriculture. Mud Lake is currently composed of a 10-mile long dike averaging about 10 feet in height and varying in top width and cross section.

b. Past Studies by the Corps of Engineers.

There have been three previous studies of Mud Lake; in 1957, 1970, and in 1976. The 1976 Detailed Project Report has been used as the basis for this estimate.

c. Project Description.

The project includes rehabilitation and raising of the existing dike which forms the south and west boundaries of Mud Lake and installation of a flood warning system.

d. Hydrology.

Streamflows have somewhat regular patterns with low flows averaging 50 cfs from July through February and high flows averaging about 300 cfs from March or April through May or June. The runoff originates largely in the mountainous headwaters north of the lake as a result of spring snowmelt. The basin drains 1,130 square miles.

e. Geology and Foundation Conditions.

The area is part of the Snake River Plain and is characterized by relatively recent lava flows and associated volcanic cones. Interrelated with these flows in the Mud Lake area is sedimentary deposits which serve as confining aquifers for artesian waters and perched groundwater bodies. The surface material is horizontally stratified, unconsolidated clays, silts, and sands.

4. PROPOSED FEATURES.

a. Dike.

It is proposed to rehabilitate the embankment to Corps standards and to construct a spillway to ensure the integrity of the dike during extreme flood conditions (see plate F-2). The existing embankment would be cleaned of all trees and brush, deep-grubbed, rolled, and compacted to obliterate rodent damage. The embankment would then be raised to 4,789.0 feet msl to provide 3 feet of freeboard over a normal operation pool of 4,786 feet msl. The embankment would have a top width of 12 feet and 3h:1v slopes on the lake side and 2.5h:1v slopes on the land side. Riprap would be placed on the lake side to reduce erosion and rodent damage.

b. Spillway.

A spillway with a crest length of 1,400 feet and a crest of 4,786 feet msl would be constructed through the embankment about 7,200 feet east of the Owsley Canal outlet channel (see plate F-1). It would pass a design flood of 4,000 cfs with 1 foot of surcharge. The spillway control weir would consist of a vertical concrete wall protected on the downstream side with riprap. The water will only flow over the spillway until the water level in the basin reaches the same elevation as Mud Lake.

c. Flood Warning System.

It is also proposed to install a runoff volume forecast system to provide early information on potential flood conditions.

5. OPERATION AND MAINTENANCE.

Once the gravel cover has been placed on the dike, maintenance and inspection problems should become negligible. The current problem of thick grasses and forbs making perfect habitat for ground-dwelling rodents and concealing their burrows will be solved.

6. COST ESTIMATE.

a. Construction Costs.

Quantities, capacities, and project features are based on the 1976 estimate presented in "Detailed Project Report, Camas and Beaver Creeks, Mud Lake, Idaho," dated September 1976. Costs were updated to February 1989 price levels using the Corps of Engineers Civil Works Construction Cost Index System.

A contingency factor of 20 percent was used. Costs for engineering and design, and supervision and inspection were estimated based on curves relating government costs on civil works projects to direct construction costs. Engineering estimate sheets are in table F-1. The estimated construction cost is $16,048,000.

b. Investment Cost.

Interest during construction was estimated assuming a 1-year construction period and a single payment at midyear. Compounded at 8.875 percent annually, the estimated total investment cost is $16,760,000.

c. Annual Cost.

Assuming a 50-year service life and interest at 8.875 percent, the average annual cost of the investment is $1,509,000. Since operation and maintenance are estimated to be the same as currently required, the average annual cost is also $1,509,000.

TABLE F-1

FILENAME: MUDLAKE2	ENGINEER'S ESTIMATE	RECON BUDGET
PROJECT: MUD LAKE		SHEET 1 OF 2
LOCATION: IDAHO FALLS, IDAHO		ESTIMATED BY: Porter/Blodgett
FEATURES: MAIN DAM		DATE: 22-Feb-89

PERTINENT DATA:

UPDATE 1976 DPR ESTIMATE

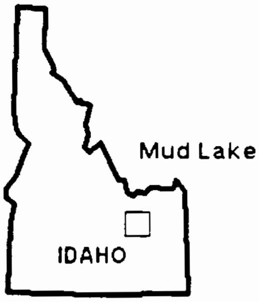
Feb 89 Price level

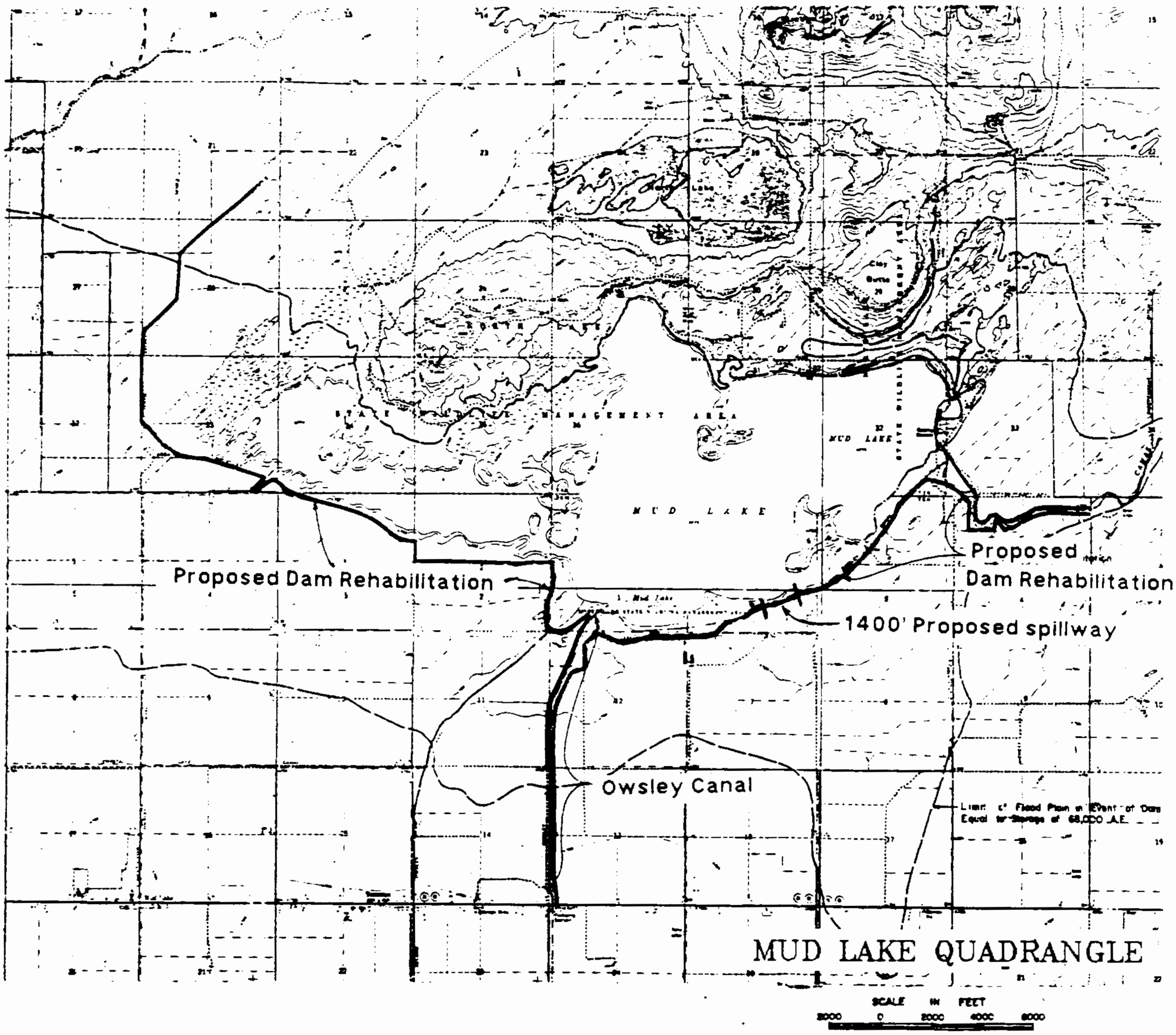
ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Mob, demob, and prework	JOB	1	2,500.00	2,500	
Clear and grub	AC	85	1,200.00	102,000	
Excavation	CY	393,740	4.00	1,574,960	
Foundation preparation	AC	139	2,500.00	346,500	
Random impervious embankment	CY	366,760	4.00	1,467,040	
Gravel bedding	CY	222,080	12.00	2,664,960	
Gravel filter	CY	97,870	15.00	1,468,050	
Riprap	CY	138,630	25.00	3,465,750	
Toe backfill	CY	37,400	2.00	74,800	
Spillway	JOB	1	150,000.00	150,000	
S/T				11,316,600	
Contingencies 20%		20%		2,263,300	
TOTAL CONSTRUCTION				13,600,000	

TABLE F-1 (Continued)

FILENAME: MUDLAKE2	ENGINEER'S ESTIMATE				RECON BUDGET
PROJECT: MUD LAKE					SHEET 2 OF 2
LOCATION: IDAHO FALLS, IDAHO				ESTIMATED BY:	Porter/Blodgett
FEATURES: MAIN DAM				DATE:	22-Feb-89
PERTINENT DATA: UPDATE 1976 DPR ESTIMATE				Feb 89 Price level	

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
04.2 EARTH DAMS				13,600,000	
19. BUILDINGS, GROUNDS, AND UTILITIES					
50. CONSTRUCTION FACILITIES				0	
SUBTOTAL CONSTRUCTION				13,600,000	
30. ENGINEERING AND DESIGN		10.00%		1,360,000	
31. SUPERVISION AND INSPECTION		8.00%		1,088,000	
TOTAL PROJECT COST				16,048,000	
INTEREST DURING CONSTRUCTION	1	8.875%		712,000	
				==============	
TOTAL INVESTMENT COST **********************				16,760,000	
AVERAGE ANNUAL COST	50	8.875%		1,508,900	
OPERATION AND MAINTENANCE		No Change		0	
				==============	
TOTAL ANNUAL COST ******************				1,509,000	



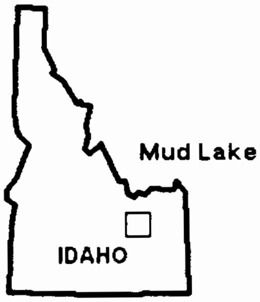


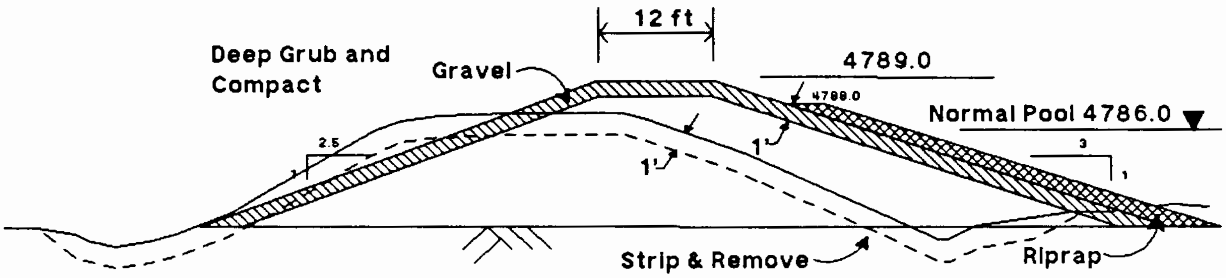
MUD LAKE RECONNAISSANCE REPORT

Rehabilitate Mud Lake Dike

VICINITY MAP

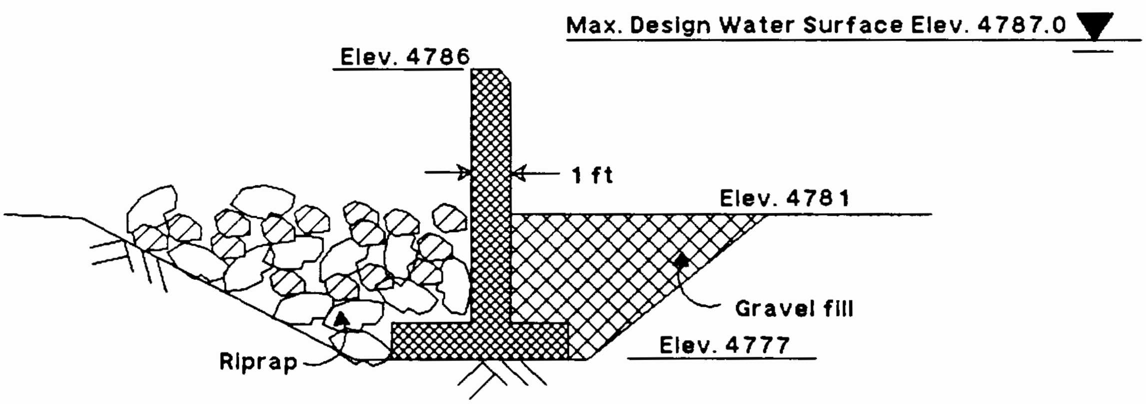
Plate F - 1





TYPICAL DIKE SECTION

NOT TO SCALE



TYPICAL SPILLWAY SECTION

NOT TO SCALE

MUD LAKE RECONNAISSANCE REPORT

Rehabilitate Mud Lake Dike

TYPICAL SECTIONS

Plate F–2

APPENDIX G

CULTURAL RESOURCES STUDY

AN ARCHAEOLOGICAL RECONNAISSANCE OF THREE AREAS ADJACENT TO MUD LAKE AND CAMAS CREEK, JEFFERSON AND CLARK COUNTIES, SOUTHEASTERN IDAHO

by

Robert Lee Sappington

Introduction

Between 24 and 28 October 1988 I conducted a feasibility level archaeological reconnaissance at three locations in southeastern Idaho which are subject to flooding from Camas and Beaver creeks. I was accompanied in these investigations by Mr. John Leier, Archaeologist, Walla Walla District, Corps of Engineers. The purpose of our investigation was simply to get a "feel" for the archaeological potential of these areas; no attempt was made to conduct a systematic reconnaissance.

The Mud Lake watershed is a closed basin located in northwest Jefferson County and northeast Clark County. The top of the drainage begins at the Continental Divide near Yellowstone National Park and terminates in Mud Lake. The northern portion of the basin is mountainous with elevations up to 10,000 ft. above sea level; the lower areas consist of a broad sloping plain broken by cinder cones and dunes, with an elevation of 4775 ft. above sea level at Mud Lake. In the early 1900s, a dike was built around the lake to provide water for farming and it has been improved periodically but there is no spillway or low level outlet; at present it is a 10 ft. high, 13 mi. long, earthfill structure. In the early 1980s, high water levels caused water to go over the dike and flood surrounding cropland and farm buildings. In 1984, an abnormally high snowpack in the Camas and Beaver creek drainages resulted in runoff that exceeded the storage capacity of Mud Lake and emergency measures were required to prevent the dike from breaching.

The Reconnaissance

The first area we examined is the Jefferson Sump area located 8 mi. west of the community of Mud Lake and immediately east of State Highway 28. This area is located on the 1969 USGS Monteview 7.5' quadrangle map and involves most of sections 20, 21, 28, and the northeast corner of section 29, Township 7 North, Range 33 East, BM (Boise Meridian). This is a lowlying area north and west of existing levees with very little surface relief; household and other trash has been dumped here since the 1960s. Surface visibility was good with ground cover consisting of lowlying sagebrush, grass, and weeds. Approximately 3 linear mi. were examined by conducting random transects in several different directions. Only modern trash was encountered; it is very unlikely that potentially significant archaeological resources are present here.

The Flood Storage/Refuge Expansion area is located on the east side of Mud Lake on the 1964 USGS Rays Lake 7.5' quadrangle map. This locality consists of lowlying areas between Rays Lake and Mud Lake which have probably long been subject to flooding; slightly higher dunes are occasionally present here and cinder knolls and buttes are located north of the project area. We first examined the vicinity of Holly Wells and Bunker Hill. This area has been highly disturbed by construction of wells, canals, buildings, and power lines; one tertiary obsidian flake was observed. We next examined several higher areas east of the main road (1750 N) in the central and north central portions of section 28. We also examined the center of section 22 and both sides of the road from the center of section 21 as far as the collapsing buildings in the southwest corner of section 22. This area has been highly disturbed by construction of buildings and overgrazing; considerable amounts of modern debris were observed but there was no evidence of prehistoric or historic cultural resources. It is highly unlikely that potentially significant cultural resources are present here.

The Lone Tree Diversion and Reservoir Site is located in portions of sections 25, 26, 35, and 36, Township 11 North, Range 38 East, BM, on the 1972 USGS Snowshoe Butte 7.5' quadrangle map. We began our survey near the former dam and made two transects east along the north side of Camas Creek to the existing bridge; we then made two transects west along the south side of the creek back to the dam site. One of us walked along the creek bed and examined the cut banks as much as possible; the other travelled in a roughly parallel fashion at a distance of 20-100 m. Surface visibility was fairly good with vegetation consisting of low sagebrush, grass, and weeds. Modern artifacts such as beverage cans were observed occasionally and the area has been grazed considerably but no major disturbance has occurred. Fire cracked rock and large bone fragments were also occasionally observed in the cut banks and two areas exhibited considerable surficial amounts of cultural material consisting of obsidian flakes, cores, and several tools. The concentration of lithic artifacts north of the creek, in the extreme northeast corner of section 35 and the extreme southwest corner of section 36, was recorded as 10-CL-525. The more extensive site with deeper deposits south of the creek, in the south central portion of section 25 and the northwest corner of section 36, was recorded as 10-CL-526. Relatively more lithic material was observed here, including a projectile point comparable to the Elko series, dated 4000-600 years BP. A fairly recent log barn constructed with wire nails is also present at 10-CL-526; associated materials consisting of stove parts, a glass marble, and vessel glass were observed but this structure is not likely to be historically significant. However, the depth of the cut banks indicates that potentially quite significant buried prehistoric components are present at both sites here.

Summary

Preliminary level archaeological reconnaissance at three proposed project areas in the vicinity of Mud Lake and upper Camas Creek in southeast Idaho indicates that potentially significant cultural resources are present in only one of these areas. Neither the Jefferson Sump area west of Mud Lake nor the Flood Storage/Refuge Expansion area east of Mud Lake appears to possess potentially significant archaeological resources. Both these lowlying places are subject to flooding and neither possesses springs or other resources which would attract either prehistoric or historic inhabitants of the region. No further archaeological investigations are recommended in either area.

However, two potentially significant archaeological sites were recorded in the proposed Lone Tree Diversion and Reservoir area and it is quite likely that other sites are also present. If construction is ever planned here, it is recommended that both sites be tested and that more extensive reconnaissance be conducted across the project area.

APPENDIX H

PLANNING AID LETTER

United States Department of the Interior

FISH AND WILDLIFE SERVICE

BOISE FIELD OFFICE
4696 Overland Road, Room 576
Boise, Idaho 83705

April 20, 1989

See Distribution List

Enclosed is the final Planning Aid Report for the Mud Lake Reconnaissance Study. It contains the Fish and Wildlife Service's (Service) assessment of the project alternatives and recommendations, should the project go into feasibility level investigations. Based on further discussions with Refuge staff, our assessment and recommendations for Alternative 1 - refuge expansion changed considerably from what was reported in the draft.

Sincerely yours,

for Ralph Myers

Signe Sather-Blair
Federal Projects Coordinator

Enclosure

Distribution:
Corps of Engineers, Walla Walla, WA
USFWS, SE Refuge Complex, Pocatello, ID
USFWS, FWE, Portland, OR
IDFG, Region 6, Idaho Falls, ID
IDFG, Wildlife Bureau Chief, Boise, ID
IDFG, Hdqtrs., Boise, ID
Mud Lake WMA, Terreton, ID
BLM, Idaho Falls District, Idaho Falls, ID

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Planning Aid Report

April 1989

Prepared for:

U.S. Army Corps of Engineers

Walla Walla District

PRELIMINARY BIOLOGICAL EVALUATION

Mud Lake

Prepared by:
Timothy Bodurtha
Signe Sather-Blair
Vicki Saab

Charles H. Lobdell
Field Supervisor

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INTRODUCTION

In May 1988, the Walla Walla District of the U.S. Army Corps of Engineers (Corps) and the U.S. Fish and Wildlife Service (Service) initiated a reconnaissance-level evaluation to identify the potential fish and wildlife impacts, needs, and opportunities, related to proposed water resource development alternatives intended to address flooding in the area of Mud lake, Idaho. This Planning Aid Report was prepared by the Service in fulfillment of its obligations as defined in the Scope of Work. It is based on existing information needs with minimal field investigations. If feasibility-level studies are required, information needs identified in this report should be addressed during the Fish and Wildlife Coordination Act investigations. This report was prepared pursuant to the Fish and Wildlife Coordination Act of 1958, as amended and the National Environmental Policy Act of 1971.

The objectives for this reconnaissance level report include the following:

1. Describe existing conditions for fish and wildlife and their habitat.

2. Describe the future without the project conditions for fish and wildlife and their habitat.

3. Describe the future with the project conditions for fish and wildlife and their habitat.

4. Describe existing fish and wildlife resource utilization (user-days).

5. Describe in qualitative terms any project-related impacts or benefits to the fish and wildlife resources.

6. Identify data gaps and study needs to be addressed during the feasibility phase.

7. Identify preliminary mitigation/enhancement opportunities.

PROJECT DESCRIPTION

BACKGROUND

The project area is located in Jefferson and Clark counties, Idaho about 48.3 km (30 miles) northwest of Idaho Falls (Figure 1). The watershed drains a 401,058 ha (991,000 acres) area, which begins at the Continental Divide and ends at Mud Lake. Three sub-drainages comprise the watershed; Camas Creek, Beaver Creek, and Medicine Lodge Creek. Only Camas and Beaver creeks contribute surface flows to Mud Lake. Medicine Lodge Creek flows into the lava beds before reaching the lake. Additional supplies of water are received from groundwater sources.

Mud Lake is situated in a natural depression of a large lakebed. Mud Lake Dike was constructed in the 1920's as a cooperative effort between irrigation

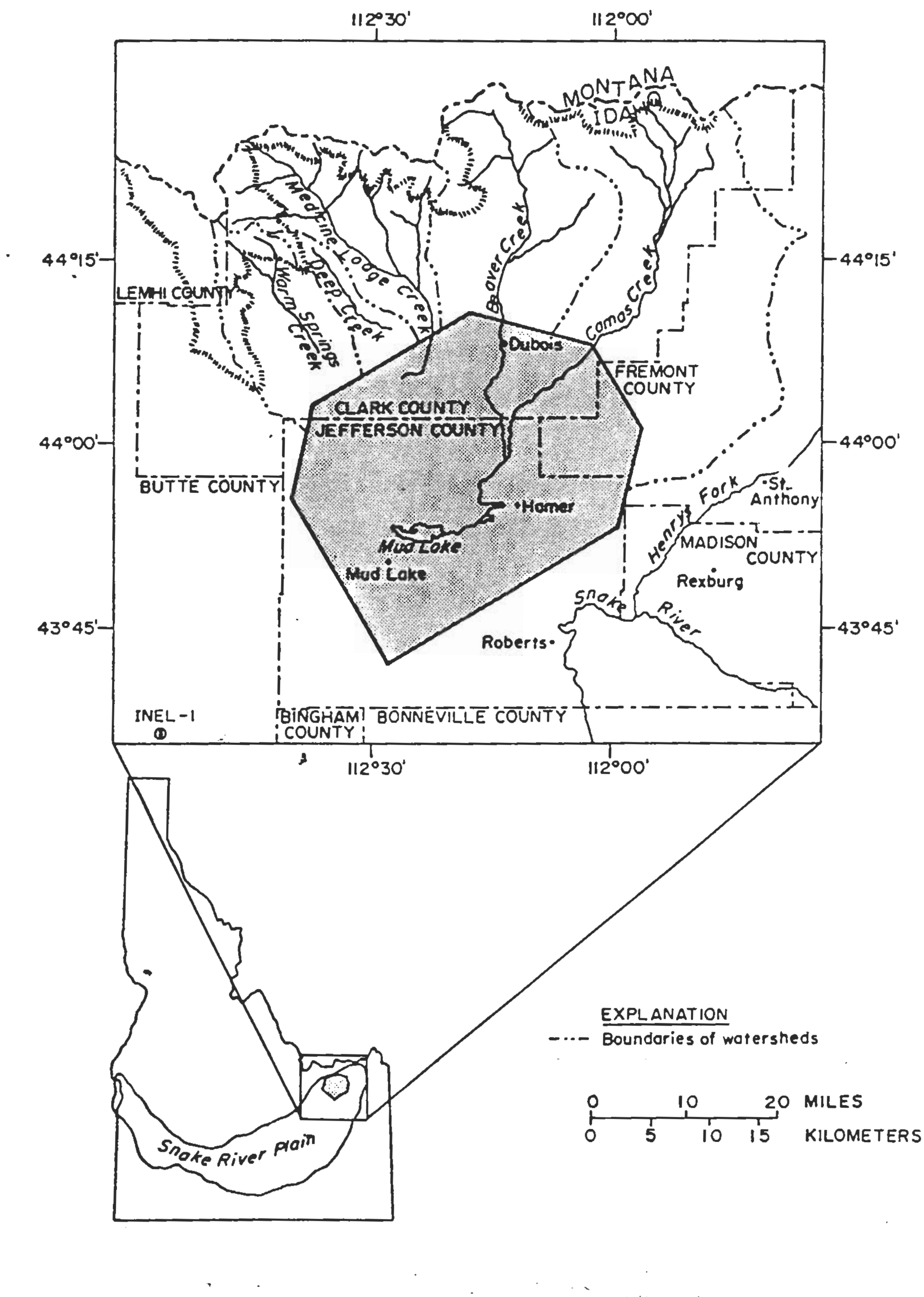

Figure 1. Vicinity of project area.

and flood control districts. There is no natural outlet or spillway for the dike. Water is removed by pumping at various locations. Agricultural development of the area during the last 40 years has constricted the lake through the use of earth dikes on the south, west, and east sides. This has resulted in a lake surface area 50 percent smaller than the original lake size (Corps of Engineers 1970).

As a result, flood problems around Mud Lake have existed for many years and there have been several previous studies investigating the problem (Corps of Engineers 1957, 1970, 1976). During the early 1980's, high snow pack in the Camas and Beaver creek drainages resulted in a greater than average volume of water that exceeded the storage capacity of Mud Lake. The dikes that impound the lake were threatened with overtopping and sloughing. Emergency measures were required to prevent the dike from breaching. This flooded surrounding croplands, county roads and highways, farm buildings, and various facilities in the Hamer and Mud Lake vicinity. Approximately 800 acres of cropland were inundated as a result of flooding in 1985 (Corps of Engineers 1988). Flooding in 1984 also caused some damage to the Mud Lake Wildlife Management Area (WMA) and Camas National Wildlife Refuge (NWR) (estimated damage cost was $30,000). Local interests spend considerable money some years when spring run-off is high for emergency repairs and maintenance of dikes and also to pump flood waters through canals and into the desert.

Other related problems include: (1) flooding along Camas, Beaver, and Medicine Lodge creeks, which affects roads, fences, utilities and other facilities; (2) severe streambank erosion on approximately 140 miles of stream channel; (3) inadequate irrigation water supply in late summer for 55,000 acres in upper watershed; (4) in late summer low flows in the streams that adversely affect fisheries, wildlife, and livestock water needs, and (5) sediment deposition in Mud Lake WMA and Camas NWR.

ALTERNATIVES

The Corps has identified five alternatives for flood control in the Mud Lake area. A list of the alternatives with a brief description follows:

Alternative 1. Enlarge wildlife refuge and use area to store excess flood water.

This alternative would involve construction of a dike connecting Camas NWR and Mud Lake WMA (Figure 2). Two possible dike alignments are being considered; one would follow Camas Creek (southern alignment) and the other would follow the section line that defines the Camas NWR southern border (northern alignment). The southern alignment would involve constructing a dike 4.8 miles in length. Approximately 3,120 acres of privately owned farmland and pasture would be within the confines of the dike and subjected to increased flooding. The northern alignment would include construction of a 3.7 mile-long dike. Approximately 1,920 acres of privately owned farmland and pasture would be within the confines of the dike and subjected to increase flooding. Under this alternative the affected private lands would be acquired by the federal government in fee title and incorporated either into the national wildlife refuge system or the Mud Lake WMA under the state's administration.

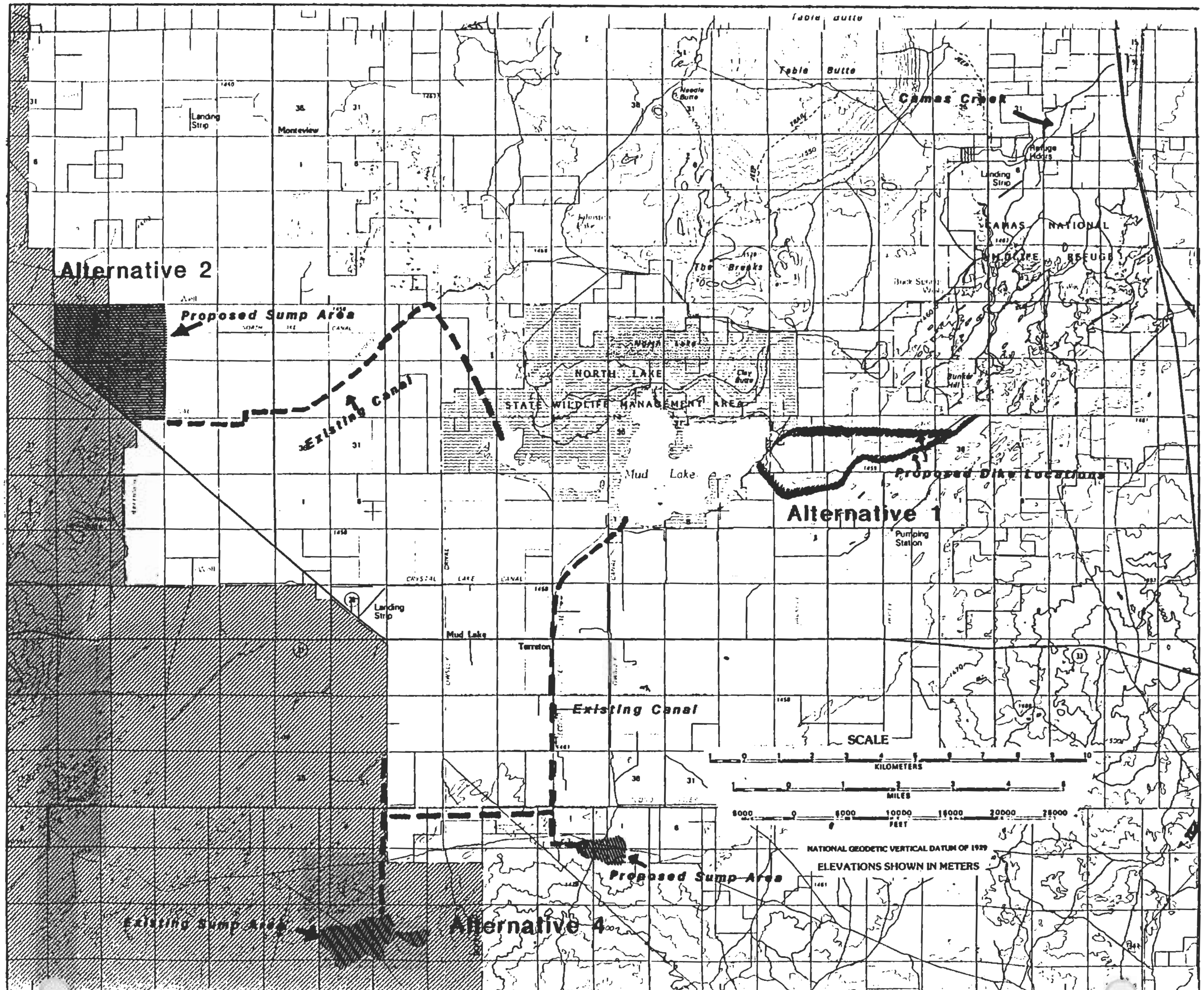

Figure 2. Location of features associated with Alternatives 1,2, and 4.

Alternative 2. Pump water into Jefferson Canal and convey to depression area west of Mud Lake.

This alternative would involve pumping water from Mud Lake into the Jefferson Canal where it would be transported over 5 miles to a sump area approximately 640 acres in size (Figure 2). Sump area is located on federal lands administered by the Idaho National Engineering Laboratory (INEL).

Alternative 3. Rebuild Lone Tree Dam on Camas Creek and modify upper Camas Creek diversion and canal to improve their water transport capabilities. Lone Tree Dam site is located on Camas Creek approximately 48 miles upstream of Mud Lake and east of Dubois, Idaho (Figure 3). The proposed reservoir would be approximately 200 acres in surface area. A dam was constructed at this site many years ago to provide irrigation water. However, the reservoir was inefficient for water storage because water percolated into the underlying lava beds and resurfaced in the agricultural lands below. The dam was removed because the reservoir could not hold water for any length of time.

The Camas Creek diversion structure is located approximately 1.2 miles upstream of the dam site (Figure 3). This structure currently diverts flood flow away from Camas Creek into an existing canal. The canal would be modified to improve its ability to transport water to the aquifer. Lava tubes in and near canal would be opened up to allow better water percolation.

Alternative 4. Enlarge Owsley Canal to pump water to depression areas in the desert southwest of Mud Lake.

This alternative uses the existing canal system to divert flood waters from Mud Lake to two areas south of the lake (Figure 2). One area has been used as a sump site since 1969, the other would be a new site. The existing sump, approximately 585 acres, is located on federal land administered INEL. The new sump would be 135 acres and is located on federal (Bureau of Land Management) and private lands.

Alternative 5. Excavate Lee-Egbert Canal and divert Camas Creek water to a drainage basin.

The diversion would require an easement of approximately 470 acres following the alignment of the Lee-Egbert Ditch (Figure 4). It would average about 770 feet wide. An additional 400 acres would be required in the drainage basin that the canal empties into. The need for this will depend on future percolation tests. Since the area is uninhabited, no relocations are anticipated although one gravel access road that now runs up the west bank of the creek would required culverts.

The existing diversion and control structure will be replaced by a 7-foot high by 100-foot long structure with 4 5x6-foot slide gates. It may be possible to combine this with the existing eastern diversion (Alternative 3).

The project would use a single dike to create a channel between the dike and the natural hillside. The embankment would have a uniform top width of 12 feet with 2h: 1v side slopes.

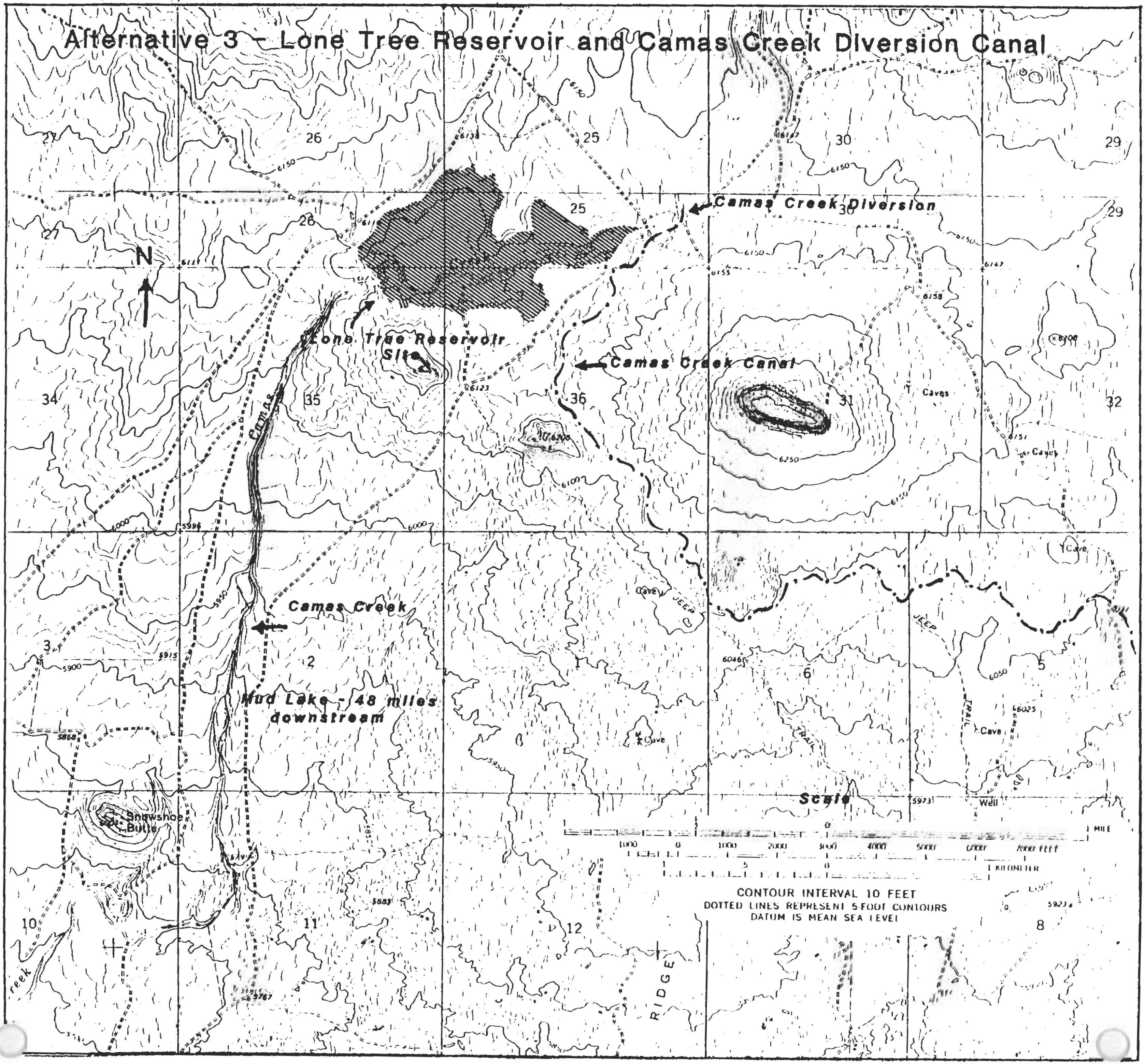

Figure 3. Location of features associated with Alternative 3.

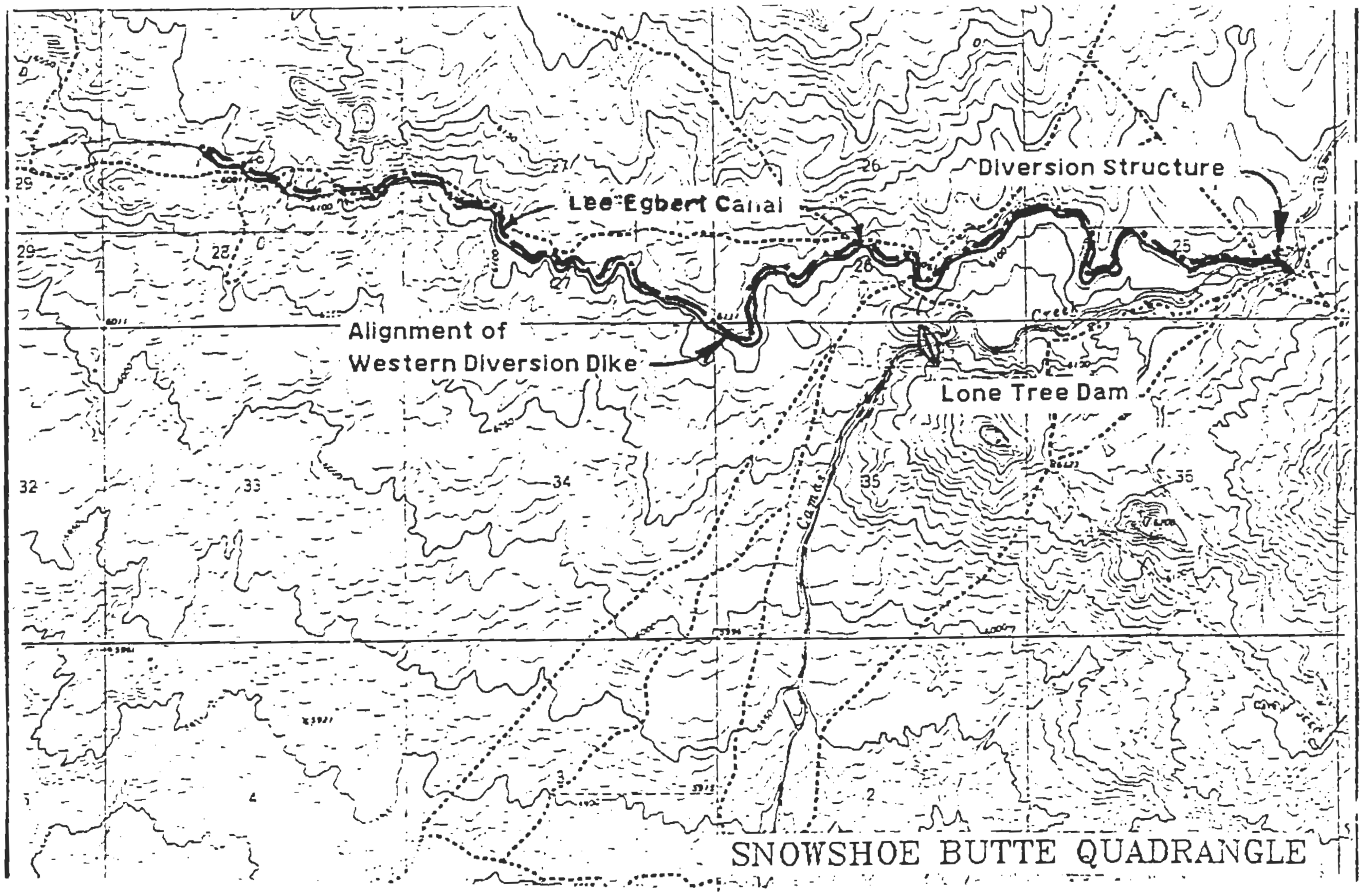

Figure 4. Location of features associated with Alternative 5.

PROJECT AREA DESCRIPTION

TOPOGRAPHY

The northern part of the basin is characterized by high mountains ((3,000 m) (10,000 feet)), steep, narrow valleys, and canyons. By contrast, the southern area is a broad sloping plain at elevations ranging from 1,951 m (6,400 feet) to 1,455 m (4,775 feet) at Mud Lake. The lower area has rough surfaces with cinder cones, small volcanic buttes, hummocks, and dunes. It also has some relatively deep topsoils.

CLIMATE

The climate of the area is influenced primarily by Pacific Maritime air masses from the west that moderate temperatures of the region. Climate of the plains is typical of the eastern Idaho desert with cold winters and dry, hot summers. Extreme cold temperatures have reaches -46oC (-50oF) and extreme hot temperatures 41oC (106oF). The average monthly mean summer high temperature ranges between 21oC and 27oC (70oF - 80oF) and the mean winter low temperatures between -12oC and -7oC (10oF - 20oF). Highest temperatures usually occur in July and lowest in January. Mean annual precipitation for the Mud Lake area is 21 cm (8.3 inches). May and June are the months of greatest precipitation and July and August the least. Mean annual snowfall for the Mud Lake area is 42 cm (16.7 inches).

GEOLOGY AND SOILS

The area is part of the Snake River Plain and characterized by relatively recent lava flows and associated volcanic cones. Sedimentary deposits that serve as confining aquifers for artesian waters and perched ground water are interspersed within the lava flows (Stearns 1930). The surface material where lava rock is not exposed is horizontally stratified, unconsolidated clays, silts, and sands. These materials, being lake deposits, are characteristically deficient in coarse sizes. Irrigation in areas as far as 48 km (30 miles) away has affected ground and surface water flows in this area due to these geologic and soils characteristics (Corps of Engineers 1976).

HYDROLOGY

Streamflows in Camas and Beaver creeks are characterized by low flows (upper part of drainage) to no flows (lower part of drainage) during July through February. High flows characteristically begin in March or April and continue through May or June. A large portion of snow melt run-off in these drainages does not reach Mud Lake as surface flow because of soil and geologic conditions. At least half of the surface flow originating in the Camas Creek drainage and approximately 80 percent of the flow in the Beaver Creek drainage percolates to groundwater aquifers before reaching Mud Lake (Idaho Dept. of Water Resource 1982). The combined average annual flow of Camas and Beaver creeks (which represents almost all of the surface flow into the Mud Lake basin) is 29,000 acre-feet. The largest annual flow was 100,000 acre-feet in 1969 and the maximum flood recorded at Camas, Idaho was 1,400 cubic feet per second (cfs) in May of 1952.

Ground water inflow also contributes water to the Mud Lake area. Most of this ground water originates from the upper basins of Beaver and Camas creeks. However, ground water is also derived from the Henrys Fork area, Egin Bench irrigation area, and possibly from Medicine Lodge Creek (Idaho Dept. of Water Resources 1982).

Mud Lake Dike is a 13-mile, 10-foot high earth-filled structure. There is no spillway or low level outlet for the dike so that all water must be removed by pumping. There are pumps at several locations around the lake with a combined pumping capacity of 750 cfs.

Mud Lake is a shallow reservoir with an average depth of 1.5 m. It has a surface area of 2,849 ha (7,040 acres) when it is at standard full capacity (1,458 m or 4,784 feet msl). The stored lake water provides irrigation for about 10,522 ha (26,000 acres) of farmland. An additional 1,060 ha (2,620 acres) are partially irrigated from the lake.

Maximum water surface elevation usually occurs in April or May and minimum surface elevation in September or October. The maximum recorded lake content was 61,600 acre-feet in May 1983. At a water surface elevation of 4,784 feet msl the lake has a storage capacity of 37,930 acre-feet. The average minimum storage has been 5,800 acre-feet. Zero storage was recorded in October 1937. The average annual increase in storage during filling periods has been about 30,400 acre-feet. The maximum observed increase in storage was 49,000 acre-feet between September 1925 and April 1926. The minimum seasonal increase was 15,700 acre-feet between August 1934 and May 1935.

VEGETATION

Four major vegetative associations occur in the basin, conifer, sagebrush, grass, riparian, and emergent wetland. Undeveloped uplands contain sagebrush-grassland vegetation typical of the southern and eastern Snake River Plain regions. Major vegetation types by dominant shrub species include the following: Wyoming big sagebrush (Artemesia tridentata wyomingensis), low sagebrush (Artemesia arbuscula), and fringed sagebrush (Artenesia frigida). Other types include shadscale (Atriplex confertifolia), mountain mahogany (Cercocarpus ledifolius), and juniper (Juniperus spp.).

Common wetland plant species associated with the WMA and the NWR are bulrush (Scirpus spp.), cattail (Typha spp.), juncus (Juncus spp.), sedge (Carex spp.), and reed canarygrass (Phalaris arundenacea). Additional associates include salt grass (Distichlis spp.), willows (Salix spp.), and cottonwoods (Populus spp.). Russian knapweed (Centaurea picris) is a weed problem in the Mud Lake area.

The most important agricultural crops are small grains, alfalfa hay and potatoes. Grown in lesser amounts are wheat and spring barley, which are grown under sprinkler irrigation.

The cover types in Alternative 1 include croplands, wetlands, and shrublands. The croplands are primarily hay and grain. Wetlands in the northern half of this alternative cover a significant area (Figure 5). The emergent wetlands occur in pothole-like depressions surrounded by rolling hills of sagebrush. Much of the wetland vegetation has been damaged by livestock grazing (D. Wagner, IDFG, pers. commun.). Overgrazing in the uplands has eliminated much of the native grasses (i.e. Agropyron dasystachyum, Oryzopsis hymenoides, Stipa comata). As a result of grazing weedy species such as Russian knapweed have invaded the understory of the sagebrush area.

A mixture of shrub types occur in the Alternative 2 site on INEL. The area is dominated by big sagebrush, winterfat (Eurotia lanata), and rabbitbrush (Chrysothamnus viscidiflorus) (McBride et al. 1978). The area is characterized by sandy loam soil (McBride et al. 1978), indicating that is could be suitable habitat for Astragalus ceremicus var. apus (only plant occurring in the project area that has been given federal status under the Endangered Species Act).

Wetland vegetation is very limited along Camas Creek at the Lone Tree site (Alternative 3). Scrub-shrub (Salix spp.) and emergent (Carex spp., Scirpus spp.) wetland communities have been damaged or eliminated by livestock grazing. Broken lava rock and sagebrush occupy the old reservoir site outside the creek bottom. The proposed canal routes in Alternatives 3 and 5 are in shrub-steppe vegetation communities.

The potential sump area in Alternative 4 is low-lying cropland (about 2/3 of the area) and grazed sagebrush/grass. The existing sump area is an old playa with silty, clay loams. Sagebrush has been eliminated and vegetation is pre-

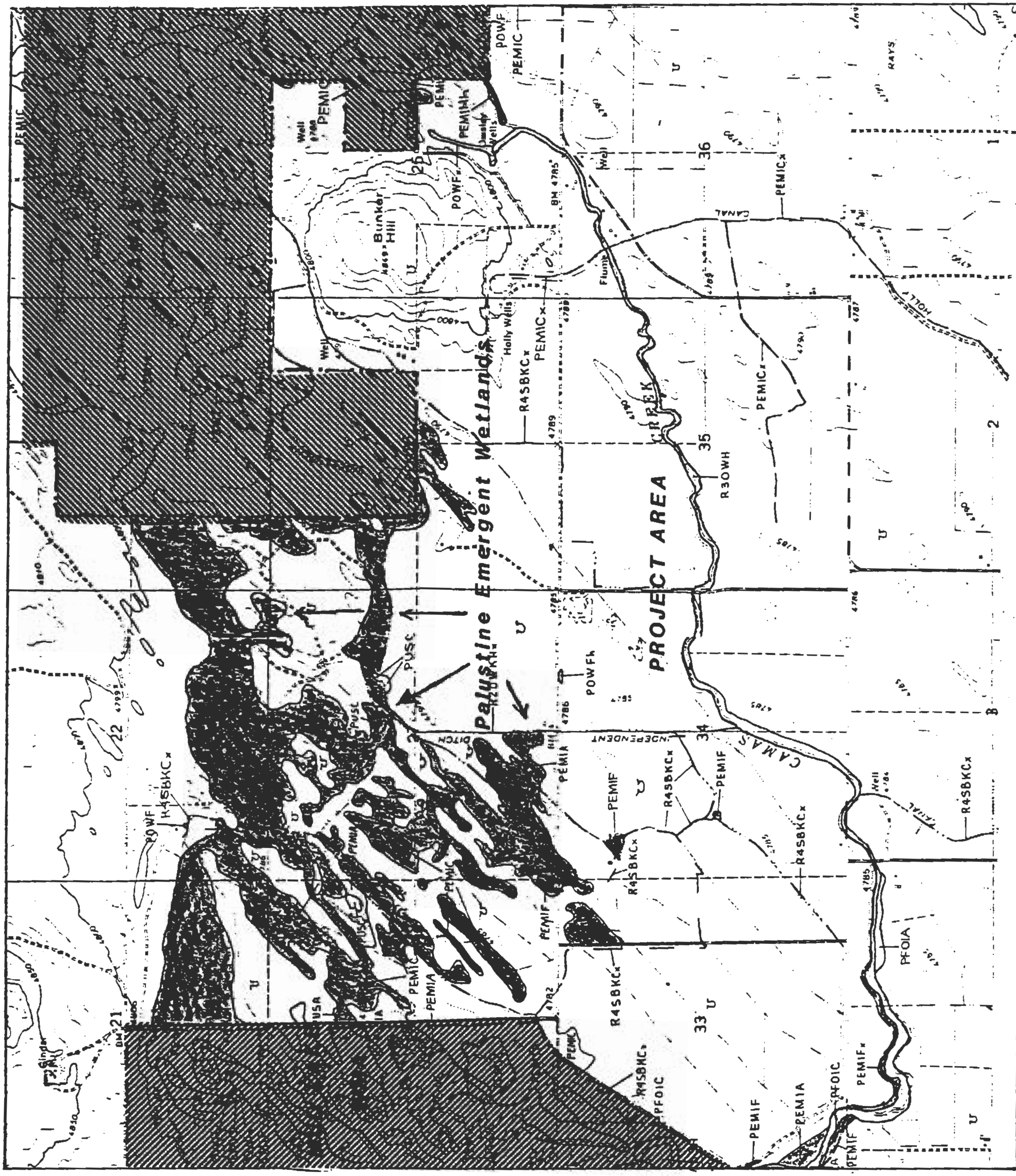

Figure 5. Location of emergent wetlands within Alternative 1 project area. Data were obtained from National Wetland Inventory maps.

dominantly herbaceous weeds (e.g., Russian knapweed and goosefoot (Chenopodium spp.))

LAND OWNERSHIP AND LAND USE

The Mud Lake watershed includes Federal, state, and private lands.

Federal Land		Acres
U.S. Forest Service		274,000
Bureau of Land Management		200,000
U.S. Fish and Wildlife Service		13,000
U.S. Sheep Experiment Station		30,000
Department of Energy		6,000
State		
Mud Lake State Wildlife Management Area		9,000
Other		61,000
Private		398,000
	Total	991,000

Land use in the watershed includes the following:

Cropland (Dry)		20,000
Cropland (Irrigated)		120,770
Woodland		350,000
Wildlife Land		23,200
Pasture and Hay Land (Irrigated)		12,500
Rangeland		400,000
Other		14,000
	Total	991,000

WILDLIFE REFUGES IN THE BASIN

Two wildlife refuges are located within the Mud Lake Basin (Figure 2): Mud Lake WMA administered by Idaho Department of Fish and Game (IDFG) and Camas NWR administered by the Service. Mud Lake WMA was established in 1940 for the production of wildlife and to provide the opportunity for public use. The 3,583 ha (8,853 acres) area is managed primarily for waterfowl production but also produces a variety of upland game, big game, and nongame species.

The Camas NWR was established in 1937 for the purpose of managing the habitat for waterfowl production and for a feeding and resting area for migratory waterfowl. The 4,281 ha (10,578 acre) refuge is interspersed with a variety of wetland types, and upland areas. Camas Creek flows through the length of the refuge and is the source of water for wetlands. However, during the summer months water in the creek percolates into the aquifer before reaching the refuge. As a result water must be pumped from wells during these months to maintain water levels in the wetlands.

EXISTING CONDITIONS

FISH RESOURCES

Mud Lake

Historically, Mud Lake contained large numbers of cutthroat trout (Salmo clarki) but conversion of the lake to a fluctuating irrigation reservoir has, for the most part, eliminated this species. Presently, the lake supports a mixed warm water fishery with yellow perch (Perca flavesceus), largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus) and brown bullhead (Ictalurus nebulosus) (Moore 1986). Utah suckers (Catostomus ardens) and Utah chub (Gilia straria) are the dominant nongame species. Other warm water species present in the lake include black crappie (Pomoxis nigromaculatus), channel catfish (Ictalurus punctatus), and carp (Cyprinus carpio). Water level fluctuations and degree of drawdown appear to limit the Mud Lake fishery. Moore (1986) noted that increased water levels in the lake during the early 1980's appeared to have improved perch and bass population levels. Channel catfish fry were introduced in 1980 and bluegill in 1983 and 1985 but success of these plants is unknown. The lake supports a few hatchery rainbow trout (Salmo gairdneri) but fluctuating water levels and low winter dissolved oxygen have greatly decreased suitability for trout (Moore 1986). Tiger muskie (Esox masquinongy immaculatus, an infertile hybrid fish) were planted in 1988 as predator fish to control nongame fish populations.

Yellow perch are the most numerous game fish in Mud Lake. A creel census conducted in the winter of 1985-86 found 8,030 perch and 29 largemouth bass harvested (Corsi and Elle 1986). Populations that declined in the past appear to be increasing. In June 1980, experimental gillnetting in Mud Lake indicated that over 99 percent of the fish population was Utah chubs and suckers (Ball and Jeppson 1980).

At present largemouth bass, bluegill, and black crappie are below desired levels for a quality fishery. Future management direction by IDFG is to determine the limiting factors contributing to the problem and in the meantime use a supplemental stocking program to provide fish to the public (Moore 1986).

Camas Creek Drainage

Good populations of wild rainbow and brook trout (Salvelinus fontinalis) occur in the headwaters of Beaver and Camas creeks and major tributaries (Moore 1986). Native cutthroat trout are also found in limited numbers in some tributary streams. Brown trout (Salmo trutta) have been released in these areas but are limited. Lower reaches of these streams have limited trout populations due to poor habitat conditions. The majority of fish caught in the upper reaches of these streams are wild rainbow trout (Moore 1986).

Camas Creek from the Jefferson County line to Mud Lake is stocked with hatchery rainbow and brown trout. Below the Bybee wells and Independent Ditch below Buck Springs, the drawdown of Mud Lake causes dewatering in Camas Creek, which is a fish management problem. The invasion of suckers and chubs from Mud Lake into Camas Creek has created an additional problem (Moore 1986).

Management direction for upper reaches of Camas Creek is to maintain the existing wild trout populations by protecting spawning and rearing habitat and to provide a hatchery trout fishery (Moore 1986). The lower reaches will be maintained as a put-and-take fishery using catchable rainbow trout and fingerling brown trout.

WILDLIFE RESOURCES

Waterfowl

Mud Lake WMA and Camas NWR are important areas for waterfowl nesting and migration. Mallards (Anas platyrhyncus), American coots (Fulica americana), redheads (Aythya americana), and Canada geese (Branta canadensis) are the most common nesting waterfowl (IDFG 1984, USFWS 1987).

Mud Lake WMA receives the highest use by waterfowl during spring with up to 5,000 Canada geese, 50,000 snow geese (Chen caerulescens), and 150,000 ducks using the WMA. Fall use has up to 2,500 Canada geese, 90,000 ducks, and 60,000 coots. The WMA has a great potential for producing waterfowl; however, flooding is a frequent problem. The lake is solely managed for irrigation and flood control. About every five to seven years the lake level rises after several species of waterfowl have started to incubate. This has destroyed many nests and IDFG constructed nesting islands above flood levels to alleviate the problem. Most constructed islands were eroded by wave action, ice and flooding and no longer exist (IDFG 1984). In response to the flooding, 75 nesting platforms were constructed prior to June 1986 (Will 1987), which resulted in increased Canada goose production on the WMA (Table 1).

At Camas NWR, duck use has been below or at average since 1981 (Figure 6). Reduced use by pintails is the greatest concern; however, refuge personnel believe that little can be done locally to improve conditions for pintails (USFWS 1987). Duck production for 1987 was 21% below the past 10 years average (USFWS 1987). The production trend follows that of the flyway populations and trends in North American duck breeding populations for the last 30 years (USFWS unpub. data). Refuge personnel are concerned about the low production in mallards, redheads, and northern pintails (Anas acuta) over the last 2 years (Figure 7).

Goose use on the NWR has been on a slow upward trend since the late 1970's and early 1980's (Figure 7). This trend follows that of the Rocky Mountain populations. Canada goose production has been stable or on the increase for the past 10 years (Figure 8).

Table 1. Estimates of Canada goose production at Mud Lake WMA, Idaho from 1977-1987. Estimates are based on average number of eggs hatched in successful nests (taken from Will 1987).

Year	No. of Nests Found	Nests Successful No.	Nests Successful Percent	Ave. No. Eggs Hatched in Suc. Nests	Gosling Produced
1977	30	25	83.5	4.3	108
1978	21	16	76.2	4.6	74
1979	21	15	71.2	5.1	77
1980	32	17	53.1	4.4	75
1981	35	32	91.4	4.7	150
1982	53	36	67.9	4.7	169
1983	59	54	94.9	5.9	319
1984	58	NC	--	NC	---
1985	64	50	78.1	NC	---
1986	118	105	89.0	5.0	525
1987	104	91	87.5	4.8	437

Swan use on the NWR has vacillated over the past 10 years and is keyed to use by tundra swans (<u>Cygnus columbianus</u>) during spring and fall migrations (Figure 9). Three trumpeter swan (<u>C. buccinator</u>) cyngets were produced in 1987 bringing the total to 27 since nesting was first detected on Camas NWR in 1976.

Nongame Waterbirds

Wetlands in Jefferson County are an important resource for nesting and migratory waterbirds in Idaho (see Trost 1985). At Camas NWR production trends since 1983 show increases in most species, except sandhill cranes (<u>Grus canadensis</u>), black-necked stilts (<u>Himantopus mexicanus</u>), long-billed curlews (<u>Numenius americanus</u>), and killdeer (<u>Charadrius vociferus</u>) (Table 2). In 1987, cattle egret (<u>Bubulcus ibis</u>) use and production was at a record high for the NWR. Breeding in Idaho was first noted in 1978, and since that time cattle egrets have increased in numbers and distribution throughout the state. Numbers of sandhill cranes using the NWR and vicinity during fall staging continues to increase with about 700 birds noted in late October 1987. This is a noteworthy increase over peak numbers of 100-150 about 10 years ago.

Quantitative data on nongame waterbirds were not available for Mud Lake WMA (D. Wagner, IDFG, pers. commun.). Trost's (1985) colonial nesting waterbird study is being used as a base guidelines for populations status of waterbirds on the WMA. Waterbirds breeding at the WMA and Camas NWR are noted in the Appendix (Table A1).

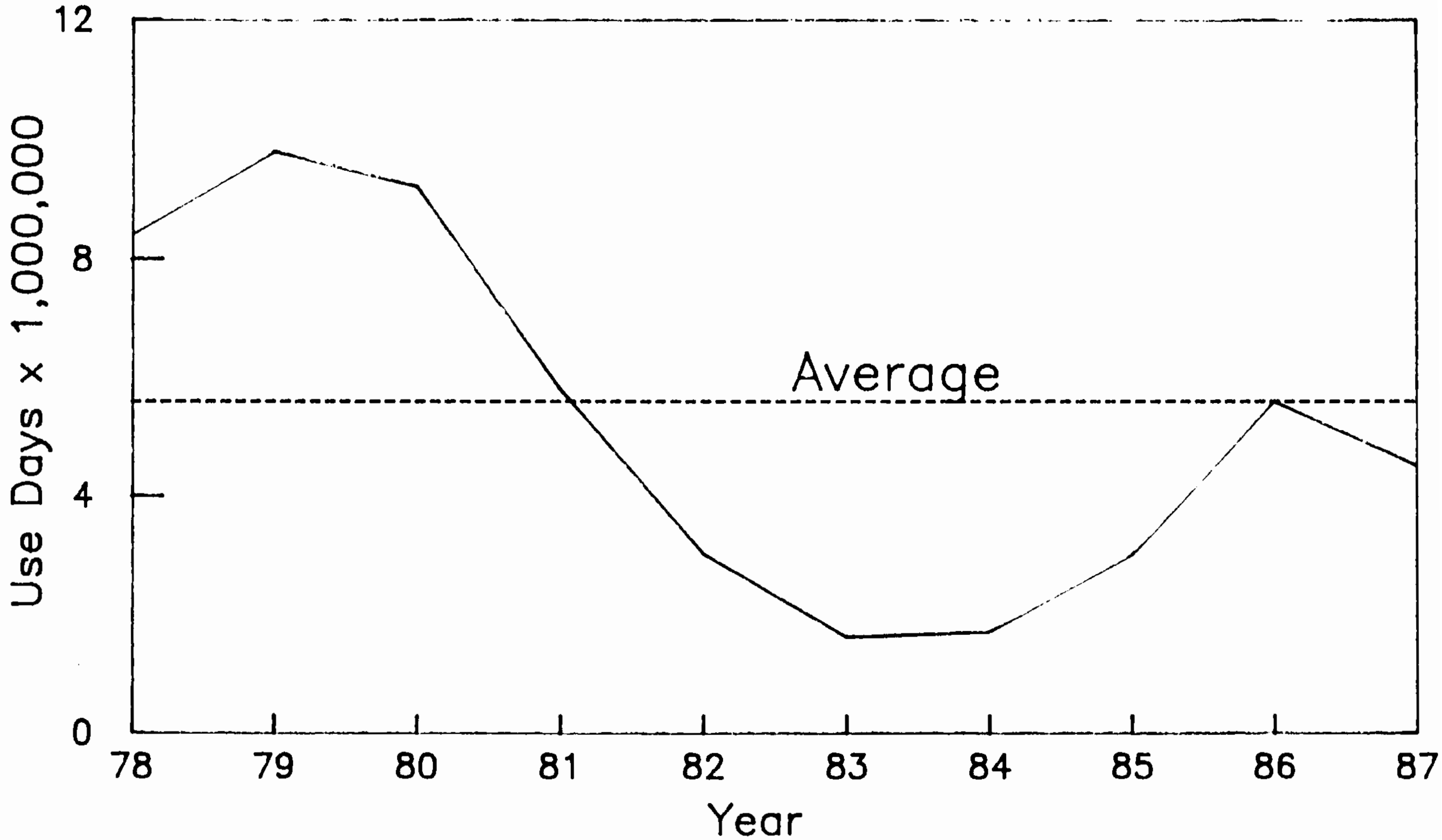

Figure 6. Duck use trends for a 10-year period at Camas NWR (taken from USFWS 1987).

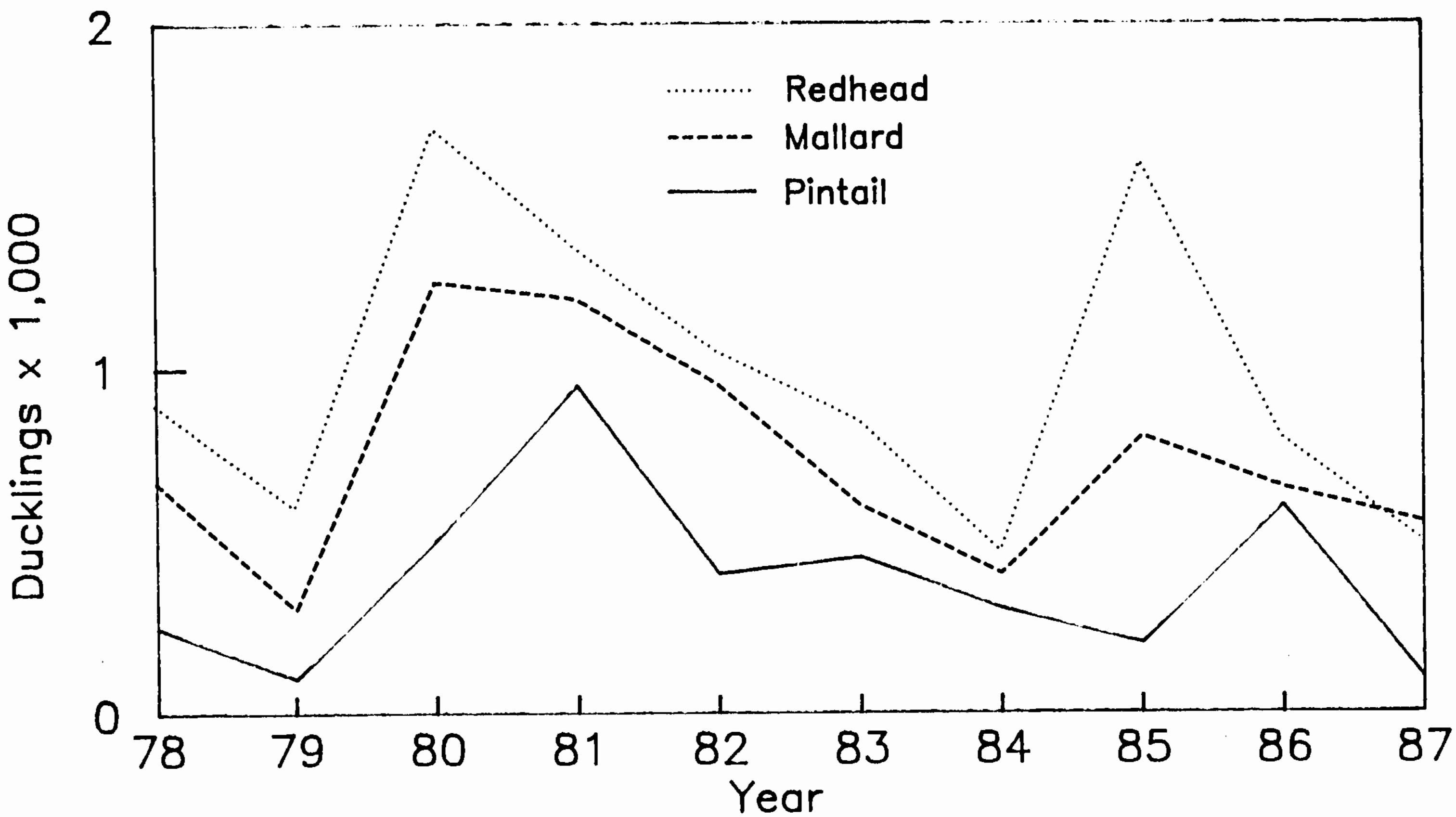

Figure 7. Ten year production trends for species of concern at Camas NWR (taken from USFWS 1987).

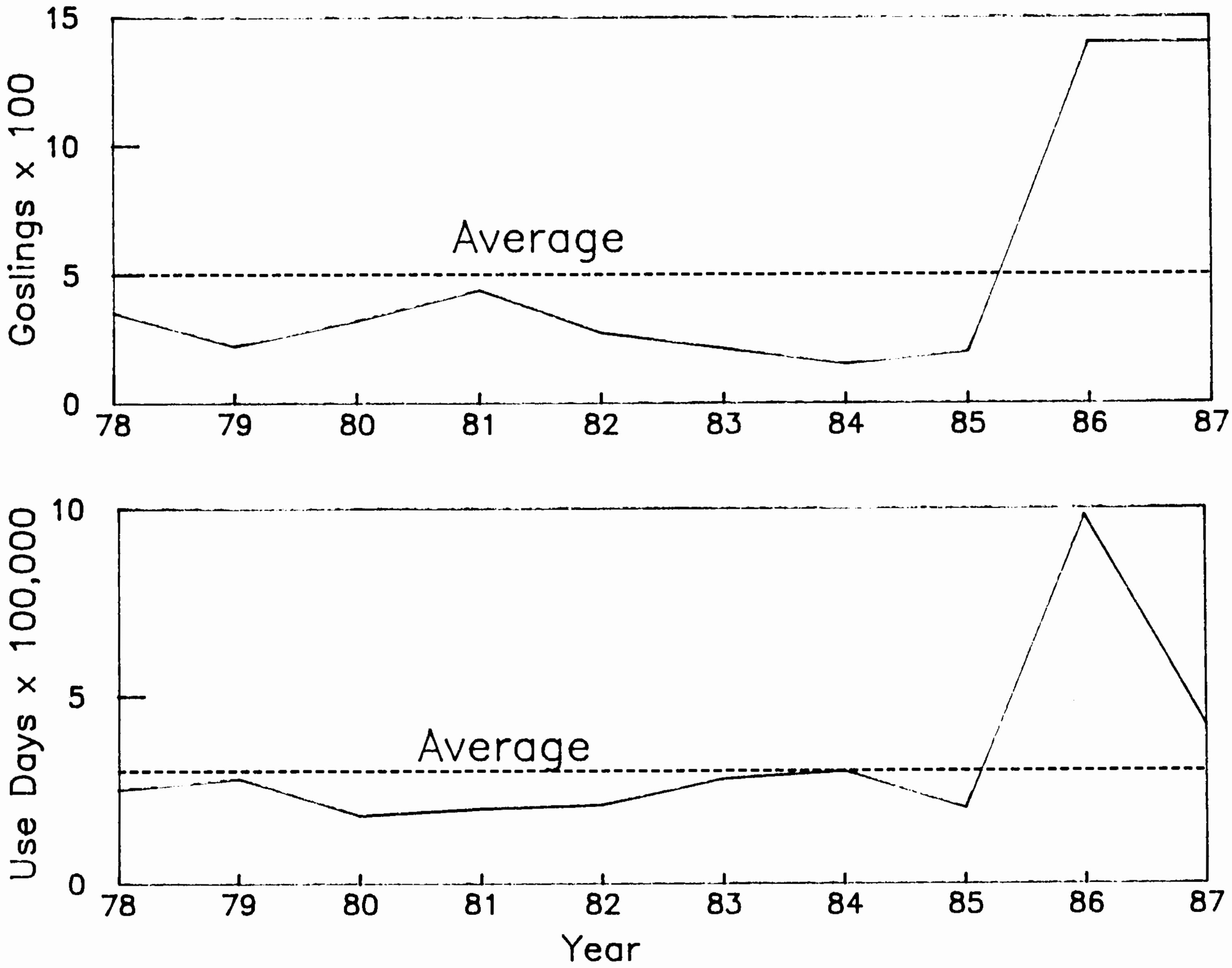

Figure 8. Canada goose production and use trends for a 10-year period at Camas NWR (taken from USFWS 1987).

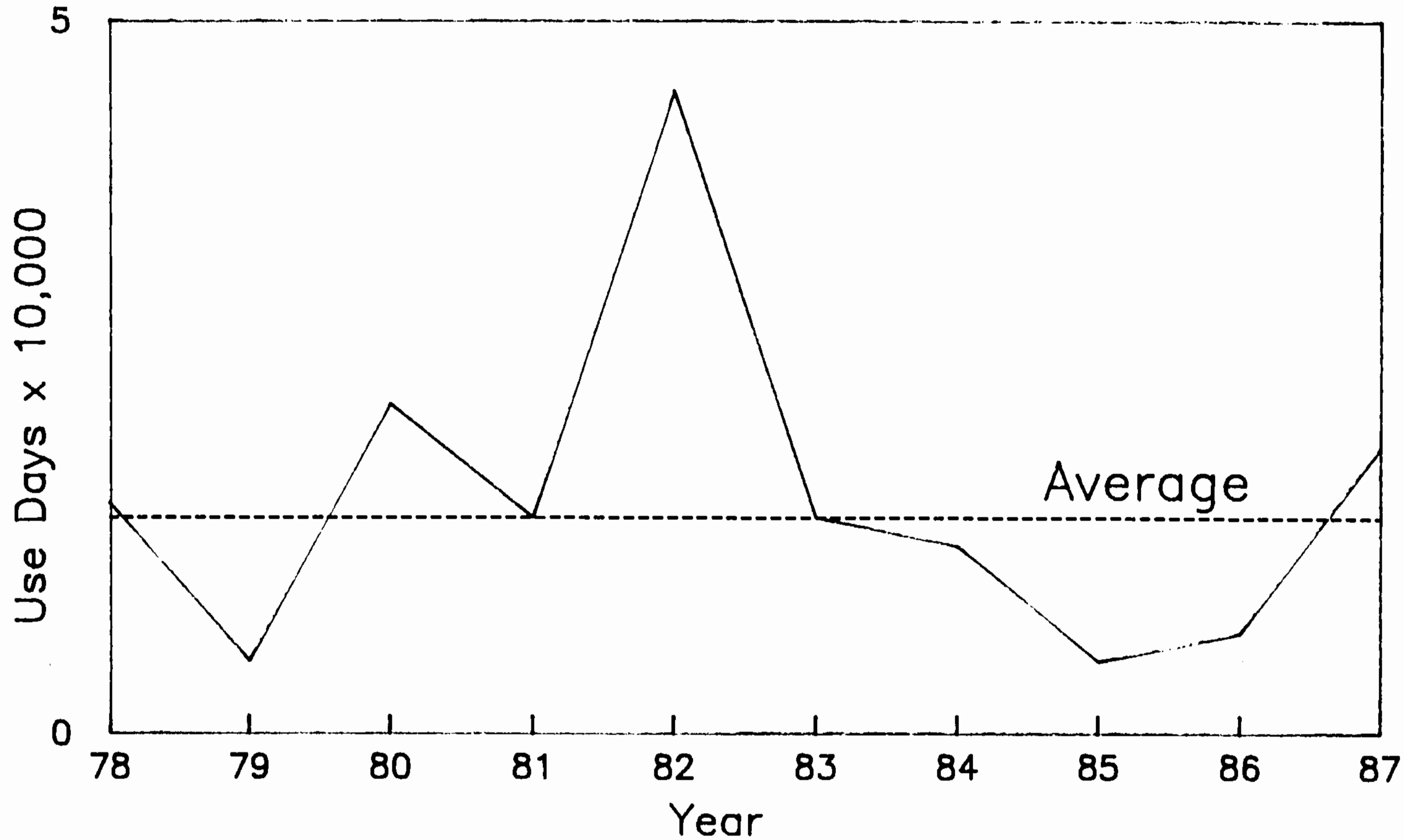

Figure 9. Tundra and trumpeter swan use trends for a 10-year period at Camas NWR (taken from USFWS 1987).

Table 2. Estimated use days and production of nongame waterbirds at Camas NWR, Idaho. Production data are not available for all years and species (taken from USFWS 1987).

Species	1987		1986		1985		1984		1983	
	Use Days	Prod	Use Days	Prod	Use Days	Prod	Use Days	Prod	Use Days	Prod
Western grebe	26,400	250	7,500	75	13,500	50	9,500	50	6,100	20
Eared grebe[a]	7,300		39,000		12,000	25	69,000	50	18,000	30
Pied-billed grebe	15,650	125	10,600	100	9,000	25	6,525	25	8,100	20
Common loon	60		90		45		30		150	
Double-crested cormorant	8,800		5,700		15,000	6	7,000		3,250	
White pelican	4,350		3,600		5,400		4,200		5,200	
American bittern[a]	1,600		2,400		5,400		2,700		1,100	
Great blue heron	8,950	60	9,750	30	25,500	60	16,050	30	9,640	30
Great egret	1,470	15	180		660		1,100		750	8
Snowy egret	9,750	90	8,100	80	10,500	30	3,450	20	5,100	20
Cattle egret	2,950	30	180		690	4			970	2
Black-crowned night-heron	9,250	60	9,900	50	25,500	50	7,050	20	9,800	30
Sandhill crane	47,050	15	20,000		13,600	25	21,075	15	27,650	40
Sora[a]			3,000		4,800		2,625			
California gull	4,850		6,100		15,000		15,750		10,400	
Ring-billed gull	4,500		4,450		15,000		15,900		8,250	
Franklin's gull	19,500		8,000		7,500		15,000		10,500	
Common tern					1,700		450		1,300	
Black tern	24,750	150	37,500	150	15,000	50	12,750	75	13,500	75
Forster's tern[a]	2,400									
Wilson's phalarope[a]	2,400		2,000		22,500		18,000		12,500	
American avocet	4,400		6,750	30	4,125	25	4,050	25	6,500	25
Black-necked stilt	5,075	15	150		4,500	30	2,700	20	4,800	20
Common snipe[a b]	10,500		5,500		7,500		7,500		7,500	
Willet	7,200	40	15,000	25	18,000	30	15,000	25	9,500	25
Long-billed curlew	8,250	25	22,000	60	9,900	60	7,500	50	10,250	50
Killdeer	7,950	25	12,600	60	10,500	50	15,075	75	10,900	50

[a] Breeds in the area, production data not available.
[b] Hunted species.

Raptors

The most common breeding raptors are northern harriers (Circus cyaneus), American kestrels (Falco sparverius), and short-eared owls (Asio flammeus) (Table 3). Wintering raptors include rough-legged hawks (Buteo lagupus), short-eared owls, northern harriers, golden eagles (Aquila chrysaetos), and bald eagles (Haliaeetus leucocephalus) (IDFG 1984). Eagle numbers fluctuate in winter with the largest concentrations occurring during population explosions of black-tailed jackrabbits (Lepus californicus).

Peregrine falcons have been released at Camas NWR as an effort to reintroduce the falcons to this area. Wild peregrines are most frequently observed during spring and fall migrations, although they may be seen any time of year.

Table 3. Estimated use days and production of raptors at Camas NWR, Idaho (taken from USFWS 1987).

	1987		1986		1985		1984		1983	
Species	Use days	Prod.	Use days	Prod.	Use days	Prod.	Use days	Prod.	Use days	Prod.
Northern harrier	9,100	30	8,100	25	10,000	70	9,450	45	11,000	30
Northern goshawk			120		200		720		240	
Red-tailed hawk	1,110	4	1,050	4	810	6	1,180	4	1,500	4
Swainson's hawk	3,085	9	3,150	12	2,700	11	7,050	15	6,600	20
Rough-legged hawk	3,150		900		1,620		3,600		180	
Ferruginous hawk	150		150		300		300		420	
Golden eagle	280		300		900		1,500		1,640	
Bald eagle	1,080		510		2,760		6,150		5,375	
Prairie falcon	390		490		330		540		660	
Peregrine falcon	1,035		370		740		810		630	
American kestrel	5,600	20	5,775	15	15,000	35	10,800	45	6,250	20
Long-eared owl	1,020	4	850		1,800	7	2,760	9	430	2
Short-eared owl	3,540	15	5,250	20	7,400	30	4,150	30	2,780	15
Great horned owl	4,680	9	3,550	12	2,900	9	3,430	12	4,090	12

Upland Gamebirds

Gray partridge (Perdix perdix) and sage grouse (Centrocercus urophasianus) are found in low numbers and produce limited hunting (IDFG 1984). At Camas NWR, the gray partridge population was estimated at a minimum of 100 with approximately 75 young produced in 1987. The area is known summer range for sage grouse. Sage grouse appeared to be more numerous in the area during 1987; however, no more that 100 birds were observed at any on time on Camas NWR and no breeding or wintering occurs on the refuge (USFWS 1987). Ring-necked pheasants (Phasianus colchicus) appear to be recovering from severe winters during the mid 1980's (USFWS 1984). On the refuge, estimated maximum numbers have increased from about 200 in 1985 to 600 in 1987 (USFWS 1986, 1987).

Gamebirds are relatively scarce compared to areas of similar habitat elsewhere in Idaho. Agricultural chemicals (i.e., organophosorous insecticides) used in southeastern Idaho may be causing declines in gamebird populations (L. Blus, USFWS, pers. commun.). Organophosphorous insecticides are responsible for sage grouse die offs in the Mud Lake area. (**reference - from Vicki**)

Other Nongame birds

Some of the conspicuous nongame birds using the sagebrush habitat are horned larks (Eremophia alpestris), Brewer's sparrows (Spizella breweri), vesper sparrows (Pooecetes gramineus), sage sparrows (Amphispiza belli), sage thrashers (Oreoscoptes montanus), and loggerhead shrikes (Lanius ludovicianus). Refer to the appendix for other nongame birds using the area.

Mammals

Pronghorn antelope (Antilocapra americana) are the most abundant and conspicuous big game species in the area. Pronghorn and mule deer (Odocoileus hemionus) use of Mud Lake WMA has increased in the last 10 years, with about 50 mule deer and 400 pronghorn observed during severe winters. At Camas NWR mule deer numbers reached 150 during 1987, while pronghorn use continued to be low with counts of 20 on the refuge. A small herd of about 20 white-tailed deer (O. Virginianus) are present on the NWR. Some moose (Alces alces) production occurs on the NWR (4 calves in 1987) and limited numbers of elk (Cervus elaphuss) use the area.

Beavers (Castor canadensis) are abundant and frequently cause problems at Camas NWR. Muskrats (Ondatra zibethica) are common and often cause damage by burrowing in dikes. Mink (Mustela vison), raccoon (Procyon lotor), red fox (Vulpes vulpes), coyote (Canis latrans), and bobcat (Felis rufus), are present in small numbers.

Nuttall's cottontail (Sylvilagus nuttallii) and pygmy rabbits (S. idahoensis) are common in the sagebrush habitat of the area (Reynolds et al. 1986). Numbers of black-tailed jackrabbits are variable because the population is cyclic (Reynolds et al. 1986). Deer mice (Peromyscus maniculatus) are probably the most abundant small rodent. Some of the other common rodents in the area include least chipmunks (Tamias minimus), Great Basin pocket mice (Thomomys talpoides) and montane voles (Microtus montanus).

Herptiles

Reptiles expected to be common include short-horned lizards (Phrynosoma douglassi), sagebrush lizards (Sceloporus graciosus), gopher snakes (Pituophis melanoleucus), and western rattlesnakes (Crotalus viridis), all of which are found in shrubsteppe habitat. The Great Basin spadefoot toad (Scaphiophus intermontanus), found in wetlands, has been recorded for the area (Reynolds et al. 1986). Rana spp. also occurs on Camas NWR but is extremely rare (J. Richardson, USFWS, pers. commun.).

THREATENED, ENDANGERED, AND SPECIES OF CONCERN

Several vertebrate species that regularly occur in the study area have been given special status by state and federal agencies because of the species' restricted range, specific habitat requirements, and/or low numbers (Table 4). One plant species, Astragalus ceramicus var. apus, occurring within the project area is endemic to Idaho and has been given candidate status (Category 3C under the Endangered Species Act). The plant is found in sandy soils of shrub steppe habitat and is often associated with big sagebrush (Artemesia tridentata var. tridentata) (Cholewa and Henderson 1984, D. Henderson, Univ. of Idaho, pers. commun.)

Federally endangered bald eagles and peregrine falcons are found at both Mud Lake WMA and Camas NWR. Bald eagles are regular winter visitors. Eagle numbers (85) peaked at Camas NWR in 1983 when jackrabbit populations were at their highest (USFWS 1987).

Fourteen peregrine falcons have been released successfully at Camas NWR during 1983 - 1985 and 1987 (Bechard and Levine 1988). In spring 1988, a subadult male and subadult female, both banded, occupied the hack tower at Camas. The pair made no breeding attempt.

Table 4. Wildlife species occurring within the Mud Lake/Camas NWR area that have been given state and/or federal status because of restricted range, specific habitat requirements, and/or low numbers.

	U.S. Fish and Wildlife Service Candidate (C), Threatened (T), and Endangered (E) species	Idaho Department of Fish and Game Species of Concern (SC), and Threatened or Endangered (T/E)	U.S. Bureau of Land Management Sensitive Species (SS)
White-faced Ibis (<u>Plegadis chihi</u>)	C	SC	SS
Trumpeter Swan (<u>Cygnus buccinator</u>)		SC	SS
Swainson's Hawk (<u>Buteo swainsoni</u>)	C		SS
Ferruginous Hawk (<u>Buteo regalis</u>)	C	SC	SS
Bald Eagle (<u>Haliaeetus leucocephalus</u>)	E	T/E	
Peregrine Falcon (<u>Falco peregrinus anatum</u>)	E	T/E	
Long-billed Curlew (<u>Numenius americanus</u>)	C	SC	SS

FUTURE WITHOUT PROJECT

Flood damages in the Mud Lake area and Camas Creek drainage are expected to continue in the future without the project. High run-off would continue to cause seasonal flooding of lands surrounding Mud Lake. Floods would continue to damage cropland, roads, buildings, and other structures. Nesting habitat of waterfowl and other birds would continue to be adversely affected by floods. Erosion damage due to flood flows in Camas and Beaver creeks would continue. This would limit fish habitat suitability in these drainages, particularly the lower sections. Grazing in the future would also continue to erode streambanks and damage riparian vegetation along Camas and Beaver creeks.

FUTURE WITH THE PROJECT

ALTERNATIVE 1

This alternative would enlarge the wildlife refuge and use that expanded area to store excess flood water. This alternative would involve construction a dike connecting Camas NWR and Mud Lake WMA (Figure 2). The future with the project conditions for fish and wildlife in the project area are based on the following assumptions:

1. Use of the southern alignment (Camas Creek) would convert approximately 3,120 acres of farmland pasture to a mosaic of wetlands, cropland, and rangeland.

2. Use of northern alignment (county road) would convert approximately 1,920 acres of farmland/pasture to wetlands, rangeland, and cropland.

3. These areas as well as portions of Camas NWR and Mudlake WMA would be flooded to an elevation between 4,785 and 4,790 feet msl on the average every three years (Figure 9).

Hydrology

The project would provide flood damage reduction. During years of high run-off, water would be diverted from Camas Creek into the nearby diked area connecting Camas NWR and Mud Lake WMA. The ground water table could be raised as a result of the diking and low areas (< 4,785 feet) would probably be flooded annually. Even under current conditions low areas are flooded most years between Camas Creek and the county road. If either alignment is used, we would expect that the ground water table above the county road would be raised. Pothole-like depressions in the rangeland above the county road would be intermittently flooded. There may also be some change in groundwater levels in Camas NWR and Mud Lake WMA as a result of the project.

At this time we do not know at what elevation the project would be operated at for flood control. However, we assume that is would be between 4,785 feet msl, the elevation at which water starts to overtop the dikes around Mud Lake, and 4,790 feet msl. Because of the flat topography around Mud Lake, the area flooded at these two elevations are quite different. On Camas NWR this difference is quite apparent (Figure 9). At 4,785 feet flooding on the refuge is limited to the Rays Lake area in the southern portion of the refuge. On the other hand, at elevation 4,790 feet a large portion of the refuge would be flooded.

Vegetation

The project area is currently composed of a mosaic of wetlands, marginal cropland and rangeland. With the project the water table is expected to remain the same or even rise making hay the only cultivated crop that would be possible to grow. We anticipated that there would be some increase in the amount and quality of wetlands in the project area due to mostly a change in farming practices. However, there would be little if any opportunity for wetland enhancement using supplemental water (extending water retention in these wetlands into the summmer) since these lands have a low priority date for water rights and construction of additional wells in the Mud Lake area is being contested by the Service due to a dropping water table. The wetlands would be seasonally flooed in the spring and dry or nearly so during the rest of the year.

The project could also change the vegetation on the Camas NWR by increasing the flood frequency and duration in the area. Upland areas that are dry most years could become flooded on a more frequent basis depending on the operation of the project (Figure 10).

Fish

We would expect no benefits or impacts to fish as a result of this alternative.

Wildlife

The effects of this project alternative on wildlife is difficult to ascertain based on the data provided. In the project area a general improvement of habitat conditions would be expected if the area were managed for wildlife. We would anticipate that the amount and quality of wetland habitat would increase as a result of a change in farm and grazing management. However, wetland habitat enhanced by creating more permanently flooded wetlands using acquired water rights or wells would not be possible due to reasons stated previously. This greatly limits the enhancement potential for wetland-dependent species. In addition, we would expect more frequent and greater flooding in project area with this alternative. Upland areas that now provide important nesting habitat would be flooded with a corresponding loss of nests.

The effects of this alternative on the habitat in Camas NWR and Mud Lake WMA are of even greater concern. Even if flooding were held to an elevation of 4,785 msl there would be considerable flooding in the Rays Lake area (Figure 9). This degree of flooding would makes it impossible to manage water levels

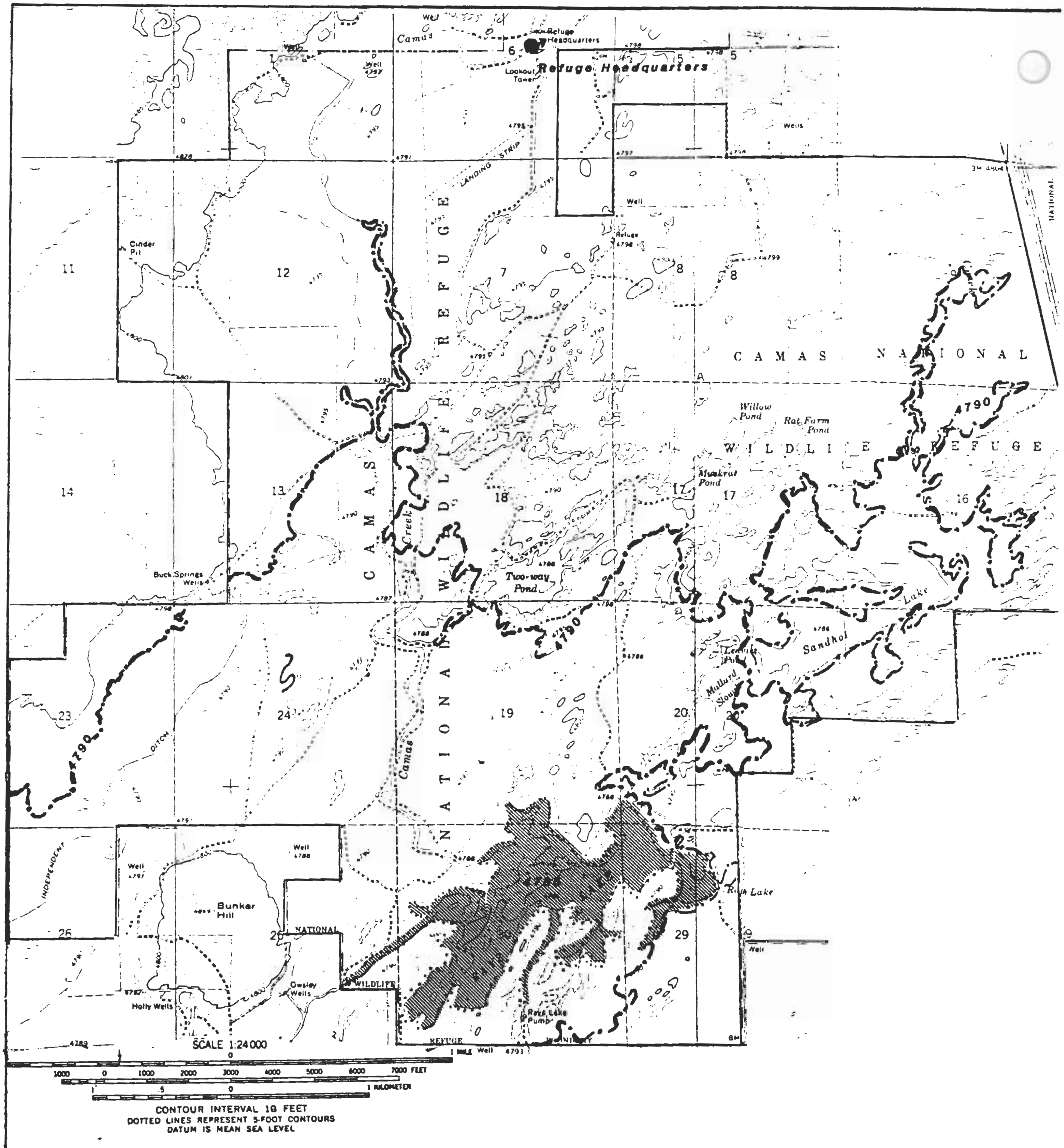

Figure 10. Flooded area on Camas NWR for project operation elevations of 4,785 feet (shaded area) and 4,790 feet (a dashed line).

in some refuge impoundments and further increase nest losses on the refuge due to flooding (C. Peck, USFWS, pers. commun.).

It is the Service's biological opinion that any wildlife habitat gains realized by acquisition and management of the project area (land between Camas NWR and Mud Lake WMA) would likely be offset by habitat losses resulting from increased flooding in the refuge and Mud Lake WMA. This is based on assuming that this alternative would not be feasible if flooded area were held below elevation 4,785 msl.

ALTERNATIVE 2

This alternative involves pumping water from Mud Lake to a sump area on the INEL. The future with the project conditions for fish and wildlife are based on the following assumptions:

1. Use of this sump area would convert approximately 640 acres of shrubsteppe into herbaceous vegetation tolerant of periodic flooding.

2. This area would be flooded on the average every five to seven years.

Hydrology

The project would provide flood damage protection. A temporary pool in the shrublands would be created about every five to seven years. Soils in this area have low permeability because there is clay at the root zone (McBride et al. 1978). Water in the pool might persist through the summer because of the soil characteristics. There would be increased flows in the canal during the flood years, which could eliminate wetlands in and along the canal.

Vegetation

The sagebrush, winterfat, rabbitbrush and other desert shrubs occupying the sump area would eventually be eliminated by periodic flooding. Annual forbs and grasses that can tolerate periodic flooding would be expected to invade the site.

Fish

We expect no benefits or impacts to fish as a result of this alternative.

Wildlife

This project could provide resting habitat for waterfowl during spring and summer when the area is temporarily flooded. Migratory shorebirds would also use the area for resting and feeding.

Flooding the area would destroy native shrublands used by sage grouse and pronghorn; however, the site could provide a water source for these species during dry summer months. Elimination of the shrubsteppe by flooding would destroy habitat for several small mammals and reptiles. Some of the species expected to be impacted include Nuttall's cottontails, pygmy rabbits, black-tailed jackrabbits, least chipmunks, short-horned lizards, and sagebrush lizards.

ALTERNATIVE 3

This alternative involves the reconstruction of Lone Tree Reservoir along Camas Creek and modification of an existing canal 1.2 miles upstream from the dam site to divert flows away from Camas Creek. The future with the project conditions for fish and wildlife are based on the following assumptions:

1. Reconstruction of this reservoir would convert about 200 acres of grazed sagebrush, pasture, and riparian habitat into a reservoir with extreme water fluctuations.

2. This area would be flooded annually.

3. Erosion of dikes at Mud Lake would be reduced.

Hydrology

The project would provide some flood damage protection during some years. With this alternative there would be reduced spring flows in Camas Creek during some years resulting in less scouring and reduced streambank erosion. The site would provide some water storage annually, although we anticipate that much water would percolate into the underlying lava tubes. The reservoir would be managed for flood control with little storage in spring before runoff, increased storage during runoff, and release of water during summer months.

Vegetation

Reduced streambank erosion would allow greater development of riparian vegetation along Camas Creek downstream of the reservoir; however, improvements would be limited unless land management agencies reduce or eliminate grazing. Weedy herbaceous annuals would probably invade those areas of the reservoir that are periodically flooded.

Fish

Camas Creek is usually dry most years a short distance below the dam site. There would be little if any effect on fish due to the water percolation characteristics of the area. There would be some loss of fish into the canal although the significance of the loss is unknown at this time.

Wildlife

The reconstructed reservoir could provide resting habitat for waterfowl. Flooded shallow areas would receive use by migrating shorebirds for resting and feeding. There could be some gains for migratory and resident birds if an area around the reservoir were fenced and riparian vegetation planted along the shoreline.

Some sagebrush-steppe would be lost due to flooding, resulting in a loss of habitat for those mammals and reptiles associated with sagebrush. The sagebrush habitat that would be lost appears to be in poor condition as a result of heavy livestock grazing, (D. Wagner, IDFG, pers. commun.) so the area may not receive much use by wildlife. These losses could be compensated by fencing an area around the reservoir to exclude livestock. The canal could pose a hazard to mammals if water velocities are swift and/or slopes steep such that animals are trapped and drown.

ALTERNATIVE 4

This alternative would enlarge an existing canal system to divert flood water south of Mud Lake to one existing sump area and a newly created sump area. The future with the project conditions for fish and wildlife are based on the following assumptions:

1. Use of the new sump area would convert approximately 90 acres of cropland and 45 acres of shrubsteppe into herbaceous annuals tolerant of periodic flooding.

2. Existing sump area would not be enlarge.

3. These areas would be flooded on the average every five to seven years.

Hydrology

The project would provide flood damage reduction. During years of high runoff, water would be diverted from Mud Lake into the sump areas. The existing sump area is an old playa that usually holds water through most of the summer during flood years (K. Dows, SCS, pers. commun.). Soils in this area have low permeability because of clay at the root zone (McBride et al. 1978). Water in the newly created sump might persist through the summer because of these soil characteristics.

Vegetation

No change in vegetation is expected to occur at the existing sump area. Weedy herbaceous annuals will continue to dominate the area. Periodic flooding at the newly created sump area will eventually convert the shrubsteppe and farmland to weedy herbaceous annuals, like those found at the existing sump area.

Fish

We expect no benefits or impacts to fish as a result of this alternative.

Wildlife

Waterfowl and shorebirds are expected to continue use of the existing pump during flood years. The newly created sump should also provide resting and feeding habitat for migratory waterbirds. If water tends to persist through the summer months, these sumps would provide a valuable source of water for many species of resident wildlife including sage grouse and pronghorn. Elimination of shrubsteppe is minimal and is not expected to adversely affect those wildlife species associated with sagebrush habitat.

ALTERNATIVE 5

This alternative involves replacing an existing diversion and control structure with larger structures. A canal, approximately five miles long would be constructed with a 400-acre drainage basin. The future with the project conditions for fish and wildlife are based on the following assumptions:

1. The Lee-Egbert Ditch would be enlarged to an average width of 770 feet. Approximately 470 acres of shrub-steppe vegetation would be converted into a canal and dike.

2. Use of the drainage basin would convert 400 acres of shrub-steppe into herbaceous vegetation tolerant of periodic flooding.

3. This area would be flooded on the average every five to seven years.

Hydrology

Up to 500 cfs would be diverted from Camas Creek into the proposed canal. Percolation characteristics of the channel would determine how much if any of the diverted water would reach the drainage basin.

Vegetation

Shrubsteppe vegetation occupying the canal route and drainage basin would be converted. Vegetation tolerant of periodic flooding would be expected to exist at the drainage site.

Fish

There would be some loss of fish into the canal when water is being diverted though amount and significance is unknown at this time.

Wildlife

Resident wildlife associated with the shrub-steppe vegetation community would be affected although this is not thought to be a significant impact. If water velocities are swift or canal slopes steep there could be a significant loss of wildlife by drowning.

FISH AND WILDLIFE RESOURCE UTILIZATION

ANGLER USE

Mud Lake is primarily a local fishery with most anglers from Jefferson or adjacent counties (Corsi and Elle 1986). Data collected from 1982 through 1988 indicate that the lake is primarily a perch fishery with other species making up a small percentage of the total catch (Table 5). These data also indicate that catch rates appear to vary significantly between years with a total catch rate high of 3.4 fish per hour in 1984-85 to 0.3 fish per hour in 1987-88. Drought conditions during 1987 and 1988 probably significantly reduced angler accessibility and low water levels may have adversely affected fish populations.

Table 5. Creel census data for Mud Lake from period 1982 to 1988 (taken from IDFG 1987.)a

	Effort (hours)	Catch/Catch Rates				
		Trout	Perch	Bass	Otherb	Total
1982-83	288	0/0	115/0.4	9/0.03	0/0	124/.43
1983-84	78	0/0	74/0.95	41/0.52	2/0.03	117/1.5
1984-85	3,067	5/<0.01	10,273/3.3	37/0.01	13/<0.01	10,328/3.4
1985-86	4,656	19/<0.01	5,641/1.2	163/0.4	20/<0.01	5,843/1.3
1986-87	3,461	44/0.01	1,839/0.5	348/	74/0.1	2,231/0.6
1987-88	2,032	0/0	481/0.24	88/0.04	5/<0.01	574/0.3

a These are estimated using data from anglers filling out questionnaires at check-out boxes and extrapolating over all anglers observed on the lake. IDFG (1987) notes that estimates should be considered low.

b Includes only other game fish (i.e., black crappie, bluegill, and bull heads).

Creel census taken during the ice fishery season from December 14, 1985 to February 21, 1986 had an average catch rate of 1.6 fish per hour but only a harvest rate of 1.3 fish per hour due to the small size of perch caught (Table 6). Catch and harvest rate varied considerably during the census period. It is primarily a perch fishery during winter.

Table 6. Catch, harvest, and effort statistics for the Mud Lake ice fishery during 1985-1986 (taken from Corsi and Elle 1986).

Interval[a]	Effort (hours)	Catch/rate	Harvest rate	Estimated harvest Perch	Estimated harvest Bass
1	1,039.5	2.3	1.5	1,538	14
2	1,489.5	2.4	1.8	2,664	11
3	1,477.3	1.1	0.8	1,219	4
4	1,525.0	1.3	1.2	1,911	--
5	698.0	2.0	2.0	698	--
Total	6,229.3	1.6	1.3	8,030	29

a Intervals represent two-week time periods during the census (December 14 - February 21).

There are little angler use or harvest data available for the Beaver and Camas creek drainages. However, spot creel checks during 1980-85 showed average catch rates of 0.86 trout per hour in some tributaries (Moore 1986). Some tributaries had catch rates up to 1.8 trout per hour with the majority of catch being wild rainbow trout.

We do not anticipate that there will be any significant losses of gains to the fisheries in the area as a result of the alternatives under consideration. The alternatives should not affect Mud Lake operations. The lower portion of Camas Creek has no fishery in some areas and limited fishery in other areas when water is present.

HUNTER/TRAPPING USE

Waterfowl hunting is the primary hunting activity on Mud Lake WMA and Camas NWR with mallards and gadwalls the most common ducks harvested (Table 7). In 1987 waterfowl hunter activity at Camas NWR was low with 380 hunters spending

1,430 hours, down from 810 and 2,970 hours spent hunting in 1986 (USFWS 1987). The Service also noted that 35 Canada geese were harvested in 1987.

Table 7. Summary of waterfowl harvest data at Camas NWR for 1979-1987 (taken from USFWS 1983, 1987).

Species	Average Number of Ducks Harvested 1979-1983	1984-1987
Mallard	479	371
Gadwall	133	88
Northern pintail	169	35
Green-winged teal	39	42
Cinnamon/blue-winged teal	42	15
American wigeon	93	49
Northern shoveler	83	16
Redhead	1	14
Canvasback	34	1
Lesser scaup	7	10
Bufflehead	11	9
Common goldeneye	2	10
Total	1,093	660

Upland gamebird hunting is also popular in the vicinity of Mud Lake. The Service estimated that 75 hunters spent 200 hours pheasant hunting on the refuge (USFWS 1987). IDFG (1984) estimates 600 pheasants, 10 gray partridge, 5 sage grouse and 20 mourning doves are annually harvested at Mud Lake WMA.

A few mule deer and pronghorn antelope are harvested each year on the Mud Lake WMA. The IDFG (1984) estimates that six mule deer and 2 pronghorn antelope are harvested each year.

Muskrats are the most common furbearer at Mud Lake. Little data exist on actual harvest rates but IDFG (1984) estimates that 350 muskrats are harvested each year. In addition, they estimate that 5 beaver, 5 coyotes, and 1 red fox are also harvested annually.

Hunter use data for Camas NWR can be used to provide a general indication of possible recreational benefits associated with Alternative 1 (Table 8). The project area would provide hunting access to the area between Camas NWR and Mud Lake WMA. Most of the hunting would be for upland gamebirds since there would be little water left in the seasonally flooded wetlands during the fall in the project area. The increase would be at least proportional to hunter use documented for Camas NWR. We estimate that at a minimum the area would provide hunting opportunity to additional 22 or 14 hunters depending on the dike alignment (Table 8). This would not be a significant gain in recreational benefits.

We do not anticipate any significant recreational gains for the other alternatives. Alternative 3 may provide some additional opportunities if recommended mitigation features are implemented.

Table 8. Estimated hunting benefits associated with Alternative 1. Data for 1987 for Camas NWR were used as basis. Estimates are for upland gamebirds only.

	Camas NWR (10,578 acres)	Alternative 1 s. alignment (3,120 acres)	Alternative 1 n. alignment (1,920 acres)
No. of hunters	75	22	14
Effort (hours)	200	59	36

NONCOMSUMPTIVE USES

Wildlife observation is the most popular visitor activity at Camas NWR. Visits went from 700 in 1986 to 1,170 in 1987. A total of 2,250 hours were spent observing wildlife in 1987. In 1980, IDFG (1984) recorded 4,900 visits at Mud Lake WMA that were associated with activities such as photography, wildlife observation, sightseeing, education trips, and picnicing. Alternative 1 could enhance the opportunities for some of these activities.

DATA GAPS AND INFORMATION NEEDS

This report represents a very cursory assessment of possible impacts and benefits associated with the project alternatives. It relied solely on existing data and personal observations and communications with biologists familiar with the Mud Lake area. There are many data gaps and information needs associated with the project that would be necessary to collect during feasibility level investigations. This is particularly true for Alternative 1 and 3, the larger, more complicated project alternatives.

The following is a list of information and/or study needs for each project alternative:

Alternative 1.

1. Determine the flood capacity of the project area that would not adversely affect current operations and waterfowl (and other waterbirds) production on the Camas NWR and Mud Lake WMA.

2. Obtain additional hydrologic data to assess water conditions in the project area (i.e., flood water duration and volume, groundwater characteristics).

3. Conduct a detailed vegetation survey and map existing cover types in project area.

4. Survey project area for Astragalus ceramicus var apus.

5. Assess current wildlife habitat conditions in the project area using the Habitat Evaluation Procedure (HEP).

6. Survey wildlife populations in project area and in area that would represent conditions in the project area with habitat development (conversation with Dave Wagner, IDFG, indicates that such an area does exist on Mud Lake WMA).

7. Evaluate contaminant problem in the Mud Lake area associated with pesticide and herbicide applications.

8. Assess wildlife losses and benefits associated with the project using the HEP and wildlife population data.

9. Evaluate any potential recreational use and benefits associated with the project.

10. Investigate potential funding sources for habitat enhancement if wildlife would benefit from project.

Alternative 2 and 4 - Sump areas west and south of Mud Lake.

1. Conduct vegetation survey and map cover types in the project areas.

2. Survey project areas for Astragalus ceramicus var. apus.

3. Obtain additional hydrologic data (i.e., flood frequency and duration).

4. Assess existing and future habitat conditions in the project areas with and without the projects.

5. Develop mitigation/enhancement plan for wildlife resources if project alternatives prove feasible.

Alternatives 3 and 5 - Lone Tree Reservoir and canal systems

1. Conduct vegetation survey and map cover types in the project area.

2. Survey project area for Astragalus ceramicus var. apus.

3. Obtain additional hydrologic data for Camas Creek in the project area and downstream. This should include percolation rates into aquifer.

4. Obtain detailed project description information including reservoir operations for flood control purposes.

5. Survey fish populations in the project area as well as upstream and downstream.

6. Assess existing fish habitat conditions in the project area and downstream.

7. Survey wildlife populations in the project area.

8. Assess existing wildlife habitat conditions in the project area.

9. Assess potential contaminant problems (associated with pesticide and herbicide applications) in Camas Creek and in general vicinity of the project area.

10. Assess future fish and wildlife habitat conditions and populations with and without the project.

11. Evaluate and design modifications to Camas Creek Canal and Lee-Egbert Canal to allow for safe wildlife crossing.

FISH AND WILDLIFE ENHANCEMENT/MITIGATION OPPORTUNITIES AND RECOMMENDATIONS

The four project alternatives being investigated have different fish and wildlife enhancement opportunities or mitigation needs. In this section we will discuss each alternative separately itemizing enhancement/mitigation opportunities and needs.

ALTERNATIVE 1 - REFUGE EXPANSION

At this time our recommendations include the following:

1. Project design should ensure that existing facilities and wetlands at Camas NWR and Mud Lake WMA are not adversely affected by increased flooding in the project area. Chuck Peck, refuge manager for the Service's Southeast Refuge Complex, has expressed concerns about the possibility that this alternative could cause additional flooding on the refuge with subsequent loss of waterfowl production. No proposed solution to the Mud Lake flooding problem that would adversely affect existing facilities at NWR is acceptable to the Service. At this time we doubt if Alternative 1 can provide the flood control without adversely affecting refuge operations and wildlife habitat on the refuge.

2. Private property should be purchased in fee title and ownership transferred to either federal government managed by the Service under the refuge system.

3. Water rights associated with the subject private property should also be transferred to the Service.

4. Dikes should be aligned to avoid significant impacts to wetlands or other important habitat.

5. Use of flood waters diverted into the project area should be at the management discretion of the Service. The water should not be considered as supplementary water for irrigation or other consumptive water uses.

6. Portions of the project area could be contoured to increase the wetland area and improve the habitat by increasing the interspersion of wetland and upland cover types.

ALTERNATIVE 2 - SUMP AREA WEST OF MUD LAKE

This alternative would alter the vegetation from a shrubsteppe community composed of species tolerant of periodic flooding. Mitigation for loss of shrubsteppe habitat may be necessary if the area proves valuable to sage grouse and other resident wildlife. In addition, if the area supports a significant population of Astragalus ceramicus var. apus then avoidance may be a prudent mitigation action.

Some enhancement values for wildlife may be accrued with this alternative by providing seasonally foraging habitat for shorebirds and other migratory water birds. If water persisted into the summer months then the area could also provide some habitat value to resident wildlife as a water source in a xeric environment if water availability is limited in the area.

Recommended mitigation actions that could avoid or off-set habitat losses associated with this alternative include the following:

1. Avoid use of the area if significant populations of Astragalus ceramicus var. apus exist.

2. Fence an area larger than that which would be flooded to protect shrub-steppe habitat from livestock grazing. Fence design should allow antelope and mule deer crossing.

3. Depending on range conditions interseeding of native shrubs, forbs and grasses would improve habitat conditions within fenced area.

ALTERNATIVE 3 - LONE TREE DAM

There are several mitigation actions that would be necessary to help off-set potential impacts associated with building a reservoir on Camas Creek. Whether some of these actions would constitute enhancement features is unknown until a more thorough project description and assessment are completed. In addition, based on identified information needs some of these actions may prove unnecessary or infeasible.

The mitigation/enhancement opportunities associated with these alternatives assume that (1) there would be a loss of terrestrial habitat due to inundation, (2) there would be a loss of stream habitat with a corresponding gain in lacustrine-reservoir habitat, (3) operation of the reservoir would control streamflows in Camas Creek downstream of the dam and (4) Camas Creek Canal would be restructured. We recognize that the quality of fish and wildlife habitat in the project area and in Camas Creek downstream of the site is poor to moderate due to livestock grazing and other land uses. The following represents a partial list of opportunities available with this alternative:

1. Reservoir operations would reduce flood flows in Camas Creek during spring run-off in some years. This could reduce erosion of streambanks. However, possible riparian habitat benefits derived from this action would be minimal unless there were corresponding major changes in land use along the creek.

2. Fence areas along Camas Creek to improve riparian habitat.

3. Plant riparian vegetation along stream and use other techniques to stabilize shoreline.

4. Fence large area around Lone Tree Reservoir to exclude livestock. Fence should allow mule deer and antelope crossing.

5. Plant riparian vegetation around shoreline of the reservoir.

6. Interseed native shrubs, forbs, and grasses in fenced area around the reservoir to improve wildlife habitat conditions.

7. Provide for downstream fish passage at Camas Creek diversion.

8. Screen Camas Creek Canal to avoid unnecessary fish loss into the canal.

9. Contour Camas Creek Canal to allow easy big game crossing.

We note that the Bureau of Land Management does have a riparian restoration program that could be used to help improve the stream and riparian habitat along Camas Creek. Without their support and contribution to the effort, we would assume little benefit to fish and wildlife resulting from reduced spring flows in Camas Creek.

ALTERNATIVE 4 - SUMP AREAS SOUTH OF MUD LAKE

There would be no mitigation needs for the existing sump area. Possible impacts and benefits associated with new the sump area would be similar to those already described for Alternative 2. Refer to that alternative for a list of possible mitigation/enhancement actions.

ALTERNATIVE 5 - LEE-EGBERT CANAL AND DRAINAGE BASIN

There would be limited impacts to fish and wildlife resources in the area. However, the following measures should be investigated:

1. Screen Lee-Egbert Canal to avoid unnecessary fish loss into the canal.

2. Contour the canal to allow easy crossing by big game and other wildlife.

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Appendix

Table A1. Bird species list for Mud Lake Wildlife Management Area (M) and Camas National Wildlife Refuge (C).

Common Name	Occurrence
LOONS	
Common Loon	M C
GREBES	
Pied-billed Grebe	M* C*
Horned Grebe	M C
Eared Grebe	M* C*
Western Grebe	M* C*
PELICANS AND CORMORANTS	
American White Pelican	M C
Double-crested Cormorant	M* C*
BITTERNS, HERONS, AND EGRETS	
American Bittern	M* C*
Great Blue Heron	M* C*
Great Egret	M* C*
Snowy Egret	M* C*
Cattle Egret	M* C*
Black-crowned Night-Heron	M* C*
IBISES	
White-faced Ibis	M* C*
WATERFOWL	
Tundra Swan	M C*
Trumpter Swan	M C*
Great White-fronted Goose	M C
Snow Goose	M C
Canada Goose	M C
Wood Duck	M* C*
Green-winged Teal	M* C*
Mallard	M* C*
Northern Pintail	M* C*
Blue-winged Teal	M* C*
Cinnamon Teal	M* C*
Northern Shoveler	M* C*
Gadwall	M* C*
American Wigeon	M* C*
Canvasback	M* C*
Redhead	M* C*
Ring-necked Duck	C*
Greater Scaup	M C
Lesser Scaup	M* C*
Common Goldeneye	M C
Barrow's Goldeneye	M C
Buffehead	M* C
Hooded Merganser	M C
Common Merganser	M C
Red-breasted Merganser	M C*
Ruddy Duck	M* C*

Common Name	Occurrence
VULTURES	
Turkey Vulture	M C
OSPREY, EAGLES, AND HAWKS	
Osprey	M C
Bald Eagle	M C
Northern Harrier	M* C*
Sharp-shinned Hawk	M* C
Cooper's Hawk	M* C
Northern Goshawk	M C
Swainson's Hawk	M* C*
Red-tailed Hawk	M* C*
Ferruginous Hawk	M* C*
Rough-legged Hawk	M C
Golden Eagle	M* C
FALCONS	
American Kestrel	M* C*
Merlin	M C
Peregrine Falcon	M C
Prairie Falcon	M C
GALLINACEOUS BIRDS	
Gray Partridge	M* C*
Ring-necked Pheasant	M* C*
Sage Grouse	M* C*
RAILS	
Virginia Rail	M C
Sora	M* C*
American Coot	M* C*
CRANES	
Sandhill Crane	M* C*
PLOVERS	
Semipalmated Plover	C
Killdeer	M* C*
STILTS AND AVOCETS	
Black-necked Stilt	M* C*
American Avocet	M* C*

* Breeding

Common Name	Occurrence
SHOREBIRDS	
Greater Yellowlegs	M C
Lesser Yellow legs	M C
Solitary Sandpiper	C
Willet	M* C*
Spotted Sanpiper	M C
Long-billed Curlew	M* C*
Marbled Godwit	M C
Western Sandpiper	M C
Least Sandpiper	M C
Baird's Sandpiper	M C
Pectoral Sandpiper	M C
Long-billed Dowitcher	M C
Short-billed Dowitcher	M
SNIPE	
Common Snipe	M* C*
PHALAROPES	
Wilson's Phalarope	M* C*
Red-necked Phalarope	M C
GULLS AND TERNS	
Franklin's Gull	M* C
Ring-billed Gull	M* C
California Gull	M* C
Caspian Tern	M C
Common Tern	C
Forster's Tern	M* C*
Black Tern	M* C*
DOVES	
Rock Dove	M* C
Mourning Dove	M* C*
OWLS	
Western Screech-Owl	M* C
Great Horned Owl	M* C*
Burrowing Owl	M* C*
Great Gray Owl	C
Long-eared Owl	M* C*
Short-eared Owl	M* C*
Northern Saw-whet Owl	M* C
GOATSUCKERS	
Common Nighthawk	M C*
HUMMINGBIRDS	
Calliope Hummingbird	M C
Rufous Hummingbird	M C
KINGFISHERS	
Belted Kingfishers	M C

Common Name	Occurrence
WOODPECKERS	
Lewis's Woodpecker	M C
Yellow-bellied Sapsucker	M
Downy Woodpecker	M C
Hairy Woodpecker	M C
Northern Flicker	M* C*
FLYCATCHERS	
Western Wood-Pewee	M C*
Willow Flycatcher	M C
Olive-sided Flycatcher	M
Say's Phoebe	M C
Western Kingbird	M* C
Eastern Kingbird	M* C*
LARKS	
Horned Lark	M* C*
SWALLOWS	
Tree Swallow	M* C*
Violet-green Swallow	M C*
Northern Rough-winged Swallow	M* C
Bank Swallow	M* C*
Cliff Swallow	M* C*
Barn Swallow	M* C*
JAYS, MAGPIES, AND CROWS	
Gray Jay	C
Stellar's Jay	M
Clark's Nutcracker	M C
Black-billed Magpie	M* C*
American Crow	M* C*
Common Raven	M C
CHICKADEES	
Black-capped Chickadee	M* C
Mountain Chickadee	M
NUTHATCHES	
Red-breasted Nuthatch	C
White-breasted Nuthatch	M C
Brown Creaper	M
WRENS	
House Wren	M* C*
Marsh Wren	M* C*

* Breeding

Common Name	Occurrence
KINGLETS, BLUEBIRDS AND THRUSHES	
Golden-crowned	M C
Ruby-crowned	M C
Western Bluebird	C
Mountain Bluebird	M C
Veery	C
Swainson's Thrush	C
Hermit Thrush	C
American Robin	M* C*
Townsend's Solitaire	M
MOCKINGBIRDS AND THRASHERS	
Gray Catbird	C
Sage Thrasher	M* C*
Northern Mockingbird	M
PIPITS	
Water Pipit	C
WAXWINGS	
Bohemian Waxwing	M C
Cedar Waxwing	M C
SHRIKES	
Northern Shrike	M C
Loggerhead Shrike	M C
STARLINGS	
European Starling	M* C*
VIREOS	
Warblin Vireo	C
WARBLERS	
Yellow Warbler	M* C*
Yellow-rumped Warbler	M C
MacGillivray's Warbler	C
Common Yellowthroat	M C*
Wilson's Warbler	M C
Yellow-breasted Chat	M C
Americn Redstart	M
TANAGERS	
Western Tanager	M* C
GROSBEAKS AND BUNTINGS	
Black-head Grosbeak	M C
Evening Grosbeak	M C
Lazuli Bunting	M

Common Name	Occurrence
TOWHEES AND SPARROWS	
American Tree Sparrow	M C
Chipping Sparrow	M C
Brewer's Sparrow	C
Vesper Sparrow	M* C*
Lark Sparrow	M C
Sage Sparrow	M* C*
Savannah Sparrow	M C*
Song Sparrow	M* C
Lincoln's Sparrow	C
White-crowned Sparrow	M C
Dark-eyed Junco	M C
Lapland Longspur	C
BLACKBIRDS, MEADOW LARKS AND ORIOLES	
Red-winged Blackbird	M* C*
Western Meadowlark	M* C*
Yellow-headed Blackbird	M* C*
Brewer's Blackbird	M* C*
Brown-headed Cowbird	M* C*
Northern Oriole	M* C
FINCHES	
House Finch	M* C*
American Goldfinch	M* C*
Evening Goldfinch	
WEAVER FINCHES	
House Sparrow	M* C*

* Breeding

APPENDIX I

PREVIOUS STUDIES

APPENDIX I

PREVIOUS STUDIES

1925 Preliminary Report on the Geology and Water Resources of the Mud Lake Basin, Idaho. Water Supply Paper 560-D. (U.S. Geological Survey (USGS)).

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1975 Groundwater levels and well records for current observation wells in Idaho, 1974. IDWR, August 1975.

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1982 Mud Lake Dam, Phase I Inspection Report, National Dam Safety Program. (IDWR and USACE).

1982 Groundwater Flow Characteristics in Mud Lake Area, Southeast Idaho, Thesis--S. A. Luttrell, University of Idaho, April 1982.

1984 31 January meeting, Corps of Engineers, State Bureau of Disaster Services, IDWR, and local officials. Discussion of current flooding situation and adoption of contingency measures.

1984 Application of Numerical ground water Flow Model to the Mud Lake Area in S.E. Idaho (USGS).

1987 Egin Bench Sprinkler Irrigation Evaluation Report, Verl King, IDWR (draft).

There are also a number of other USGS, State of Idaho, and University of Idaho studies of the Snake River plain that relate to the Mud Lake area.

APPENDIX J

SOIL CONSERVATION SERVICE SOIL EROSION INVENTORY AND CROP WATER REQUIREMENTS

United States
Department of
Agriculture

Soil
Conservation
Service

Room 124
3244 Elder Street
Boise, Idaho 83705

February 2, 1989

Dale Smelcer
U.S. Army Corps of Engineers
Walla Walla District
Building 603, City-County Airport
Walla Walla, Washington 99362-9265

Dear Dale,

As a result of our meeting with you this last summer, we agreed to supply certain resource inventory data for your Reconnaissance Study of Mud Lake.

Enclosed is an erosion inventory of the irrigated cropland in the vicinity of Mud Lake. Sheet, rill, wind and streambank erosion were addressed.

Crop water requirements were determined for the irrigated cropland acreage primarily influenced by the operation of Mud Lake. Additional back-up data is available and on file here at our office.

I hope this data is both timely and useful to you in the development of your study report.

Sincerely,

PAUL H. CALVERLEY
State Conservationist

Enclosure

cc: (w/o enclosure)
Robert Zinszer, AC, Pocatello AO
Mike Somerville, ASTC, Boise SO
Paul Malone, SRC, Boise SO
LeRoy Zollinger, SCE, Boise SO
J. Kent Foster, RPS, Boise SO

SOIL EROSION INVENTORY

MUD LAKE RECONNAISSANCE STUDY

Soil Erosion Inventory

Erosion By Water

A soil erosion inventory was developed for all the irrigated cropland within the vicinity of Mud Lake. Some 28,800 acres are located upstream from the Reservoir and approximately 26,000 acres are located below the Reservoir.

The irrigated cropland was divided into treatment units representing differences in soil textures, percent slope and crop rotation.

Sheet and rill erosion was calculated using the Universal Soil Loss Equation (USLE) as defined in USDA Agriculture Handbook Number 537 entitled, "Predicting Rainfall Erosion Losses," dated December 1978. The USLE is an erosion model designed to predict the long-time average soil losses in runoff from specific field areas in specified cropping and management systems. Technical values used in the USLE are based on Pacific Northwest (PNW) research developed by Dr. Don McCool, ARS, Pullman and the PNW USLE Technical Committee. This data is located in the SCS Field Office Technical Guides.

The USLE Equation is:

$A = R\ K\ L\ S\ C\ P$ where:

A = soil loss in tons/acre/year

R = the rainfall and runoff factor

K = the soil erodibility factor

L = the slope-length factor

S = the slope-steepness factor

C = the cover and management factor

P = the support practice factor

Erosion By Wind

Wind erosion estimates were calculated using the Wind Erosion Equation (WEQ). This equation is an empirical mathematical formula used to model soil losses under various management conditions for any given location. The equation uses numerical factors representing local soils, climate, length of unprotected distance and vegetative conditions.

The Wind Erosion Equation is:

$E = f\,(I\ K\ C\ L\ V)$ where:

- E = the potential average soil loss in tons/acre/year
- f = a function of
- I = the erodibility of soil
- K = the surface roughness factor
- C = the climate factor
- L = the unsheltered distance across the field along the direction of the prevailing wind
- V = the vegetative cover factor

Technical values for the WEQ have been developed by the ARS Wind Erosion Research Station located in Garden City, Kansas and are contained in the Field Office Technical Guide.

Streambank Erosion

A sample study was made to identify streambank erosion on the three tributary streams to Mud Lake (Camas, Beaver and Medicine Lodge Creeks) using aerial photography. A summary of our procedures and findings are included within this section of our report.

MUD LAKE RECONNAISSANCE STUDY

Treatment Unit Descriptions

Critical Area Upstream from the Reservoir

Treatment Units	Soils	Crop Rotations
1	Loam & silt loams (0-3% slope)	Alfalfa - 8 yrs. Small grain - 2 yrs.
2	Loamy sand & sandy loams (0-3% slope)	Alfalfa - 8 yrs. Small grain - 2 yrs.
3	Sand, loamy sand & sandy loams (3%)	Potatoes - 1 yr. Small grain - 1 yr.
4	Loam & silt loams (1% slope)	Potatoes - 1 yr. Small grain - 1 yr.
5	Sandy loam & fine sandy loams (2%)	Potatoes - 1 yr. Small grain - 1 yr.
6	Sands (3% slope)	Potatoes - 1 yr. Small grain - 1 yr.
7	Sands (5% slope)	Potatoes - 1 yr. Small grain - 1 yr.

Cropland Area Downstream from the Reservoir

Treatment Units	Soils	Crop Rotations
A	Silty clay loams	Alfalfa - 8 yrs. Small grain - 2 yrs.
B	Loam sands	Alfalfa - 8 yrs. Small grain - 2 yrs.

MUD LAKE RECONNAISSANCE STUDY

Upstream Soil Erosion Inventory

Erosion Summary: Cropland Area Upstream from the Reservoir

Present Condition:

Treatment Unit	Acres	USLE (Sheet& Rill)		WEQ (Wind)		**Total Tons**
		T/Ac/Yr	Total Tons	T/Ac/Yr	Total Tons	
1	18,200	2.0	36,400	.4	7,280	43,680
2	2,000	2.0	4,000	1.6	3,200	7,200
3	1,000	3.0	3,000	11.0	11,000	14,000
4	100	3.0	300	3.0	300	600
5	6,750	3.0	20,250	11.0	74,250	94,500
6	375	3.0	1,125	11.0	4,125	5,250
7	375	3.0	1,500	11.0	4,125	5,625
TOTALS	28,800		66,575		104,280	170,855

MUD LAKE RECONNAISSANCE STUDY

Downstream Soil Erosion Inventory

Erosion Summary: Cropland Area Downstream from the Reservoir

Present Condition:

Treatment Unit	USLE (Sheet & Rill)			WEQ (Wind)		
	Acres	Annual T/Ac./Yr.	Total Tons	T/Ac./Yr.	Total Tons	**Total Tons**
A. Silty Clay Loams	16,000	0.5	8,000	1.5	24,000	32,000
B. Loamy Sands	10,000	0.25	2,500	5.5	55,000	57,500
TOTAL	26,000		10,500		79,000	89,500

MUD LAKE RECONNAISSANCE STUDY

Streambank Erosion Analysis

Objective:

To determine if significant changes have occurred (over time) in stream channel corridors tributary to Mud Lake using aerial photography.

Methods Used:

Six sites were selected on three stream channels tributary to Mud Lake. Two representative sites were located (in the field) on Beaver, Camas and Medicine Lodge Creeks. Channel cross-sections were also determined at each site.

Stream channel corridors were identified on 1960 black-and-white and 1980 color-infrared, aerial photos. Representative channel sections for each site were isolated and scanned (digitized). Sections from the 1960 photos were compared to the 1980 photos for changes. Stream section distance and area measurements were taken and compared using a video-image analysis method. Changes in stream segments were identified by overlapping each digitized stream segment.

Results:

Limitations in the resolution (level of detail) of the available aerial photos made true comparisons (overlay) somewhat difficult and subject to an estimated 5 to 7 percent error.

The six sites analyzed represent a very small sample of the total channel length of these three streams. Results of our analysis of these six sites indicate that very little change has occurred relative to channels and riparian corridors between 1960 and 1980. However, some channel modifications were noted where channels were relocated to accommodate for the installation of on-farm irrigation systems.

It is our opinion that streambank erosion, within the area of our analysis, is insignificant. We do, however, recognize that there could be some areas of severe active streambank erosion (most likely in the upper watershed) which were not represented in our analysis.

If at a later date a more detailed assessment of stream channel change and streambank erosion is undertaken, it is recommended that a photo base at a scale of 1:6,000 (500 ft./in.) be used.

CROP WATER REQUIREMENTS

MUD LAKE RECONNAISSANCE STUDY

Crop Water Requirements

A decision was made to evaluate the crop water requirements for only those cropland acres which are irrigated and influenced by the operation of Mud Lake itself. As a result, crop water requirements were determined for the 26,000 acres located downstream from the Reservoir. Requirements were not determined for the 28,800 acres (included in the erosion inventory) in the vicinity and located upstream from the Reservoir. These upstream irrigated cropland areas will be evaluated as part of the Mud Lake Cooperative River Basin Study at a later date.

Crop water requirements of the Mud Lake area, Jefferson County, Idaho, were determined by existing SCS data in the Idaho Irrigation Guide, Title 210 - Chapter VI. The concern is for crop water use on lands serviced by the Owsley, Jacket, and Independent Canal Companies which store water in Mud Lake and deliver water to users south of Mud Lake.

Typically, due to insufficient storage capacity, early season water must be dumped out into the desert; mid-season storage is used; and late season water is largely pumped from wells.

Two major soil groups have been identified within the area: deep silty clay loams and deep loamy sands. Each group is managed essentially the same. Crop rotation consists of 16,900 acres of alfalfa and 9,100 acres of grain. Alfalfa is managed as the highest priority crop.

Canal distribution and application efficiencies were estimated on a once-only seasonal basis. Typically, efficiencies vary in relation to, or as a function of, the management required to supply water to meet crop water demand. Usually efficiencies are lower at the ends of the irrigation season than in mid-season as long as supply exceeds need. Short water supply periods are generally managed for the highest possible water efficiencies. The efficiency values used in this brief study were derived by SCS field personnel acquainted with the Mud Lake area, hence, considered reliable.

Camas Creek and Beaver Creek converge at Camas, Idaho, and supply the surface inflow to Mud Lake. Other water into the area is from natural precipitation.

Considerable ground water is pumped from a bank of well pumps along the north side of Mud Lake for irrigation. High ground water levels (early in the season), cause these wells to flow under artesian pressure. Maximum pumping lifts at lowered ground water levels do not exceed 20 feet. Total capacity of the pump and canal systems is about equal to each other. Ground water contributes little to direct consumptive use needs.

Crop water requirements are summarized in Tables 1-3. Table 1 is the normal consumptive use by month in inches, Table 2 is the seasonal water requirement in acre feet, and Table 3 is the monthly water requirement in acre feet.

MUD LAKE CROP WATER REQUIREMENT
Climatic Area III

Table 1, Normal Consumptive Use (inches)

Crop	Apr	May	Jun	Jul	Aug	Sep	Oct	Seasonal
Alfalfa	0.63	3.53	4.94	6.51	5.19	3.01	0.79	24.60
Grain	0.69	2.78	5.79	5.04	0.88	----	----	15.18

Table 2, Seasonal Water Requirement (acre-feet)

Crop	Acres	Estimated Efficiencies			Seasonal	
		Canal	Distribution	Application	Cu (in)	Requirement (Ac-Ft)
Alfalfa	16,900	90%	90%	75%	24.60	57,029
Grain	9,100	90%	90%	75%	15.18	18,949
					Total	75,978

Table 3, Monthly Water Requirement (acre-feet)

Crop	Apr	May	Jun	Jul	Aug	Sep	Oct	Seasonal
Alfalfa	1,460	8,183	11,452	15,092	12,032	6,978	1,831	57,029
Grain	861	3,470	7,228	6,291	1,098	0	0	18,949
Totals	2,321	11,653	18,680	21,383	13,130	6,978	1,831	75,978