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Walla Walla District

Reconnaissance Report
Palouse River Basin
Idaho and Washington

March 1989

RECONNAISSANCE REPORT
PALOUSE RIVER BASIN
IDAHO AND WASHINGTON

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I. PURPOSE.

This report presents results of a reconnaissance investigation of the feasibility of solving flooding and other water resource problems in the upper Palouse River Basin of Idaho and Washington. Flooding is a recurring problem in Moscow, Idaho; Pullman, Washington; Potlatch, Idaho; and Palouse, Washington. Moscow, Pullman, the University of Idaho, and Washington State University are very concerned about the water supply for the four entities. There are also community concerns regarding streamflow volumes and water quality, and recreational opportunities for water-based recreation.

II. STUDY AUTHORITY.

This study was authorized under resolutions by the Senate Committee on Public Works adopted 15 April 1949 and the House Committee on Public Works adopted 6 July 1949.

III. SCOPE OF STUDY.

A. General.

This reconnaissance investigation provides a preliminary evaluation of physical, economic, and environmental factors associated with various alternatives to reduce the impact of flooding in the basin, to enhance the municipal and industrial (M&I) water supply, to improve water quality, and to assess potential hydropower and recreation opportunities. The depth of detail used for this study is only that detail which was necessary to establish if further study is warranted on any of the alternatives under consideration. Use has been made of available topographic maps, photos, existing data, and information from prior reports and studies.

B. Flood Damage Reduction.

Because of time and funding limitations, this reconnaissance study used prior studies to the maximum extent possible in the evaluation of potential flood damages. The basin study conducted in the late 1960's provided information on potential flood damage on the North Fork Palouse River, and rural areas of the South Fork and Paradise Creek. This was supplemented by subsequent post flood surveys and recent aerial photography. The floodplain of the South Fork Palouse River through

Pullman has been studied several times for a local protection project, most recently in 1984. This information, updated by a field inventory of damageable property in downtown Pullman in the summer of 1988, was used to evaluate potential damage in Pullman. On the floodplain of Paradise Creek through Moscow and a portion of the South Fork Palouse River south of Moscow, development has taken place since the basin study of the late 1960's. Structures in these areas were counted in February 1989. Damages were calculated for typical structures and these damages were then applied to similar structures to compute damage throughout the floodplain for various floods.

IV. STUDY HISTORY.

The first Corps of Engineers study in the Palouse River Basin was a Preliminary Examination Report completed on 31 October 1938. An Interim Report was published on 10 August 1940 and a Survey Report on 15 January 1942. In 1950, a Detailed Project Report (DPR) on the Pullman channel was completed on 20 October 1950. A Letter Report updating this DPR was completed on 15 August 1963. A Design Memorandum on the channel was completed in FY 64. This study was reviewed again in 1984. A draft report was prepared, but not published due to lack of city support.

The Corps of Engineers studied the upper basin from 1966 to 1971. Phase I studies for the upper basin were completed and a Checkpoint I review conference was held in FY 68. A multipurpose reservoir project on the North Fork Palouse was considered to provide storage for municipal water supply, recreation, water quality control, flood control, and irrigation. Channel enlargement and diversion of Paradise Creek near Moscow, for flood control, was also considered. Floodplain information reports were completed for Paradise Creek from east of Moscow to Pullman and for the South Fork of the Palouse from Moscow through Pullman. Phase II studies for the upper basin were essentially complete when work was suspended in 1970 because restrictive legislation by Idaho precluded project feasibility on the North Fork Palouse River. Study of a multipurpose pumped storage project in the Union Flat-Almoto Creek area was initiated under the authority of the Columbia River and tributaries in FY 76. Due to local opposition, this study was terminated in March 1976. Pullman and Washington State University are interested in working out a channel improvement project through Pullman that will be aesthetically acceptable as well as provide flood protection. A study made in 1972 under Small Projects authority indicated that flood protection on Paradise Creek in Moscow was not economically feasible. However, a subsequent study by a University of Idaho graduate student, Johnny D. Johnson, in July 1980 entitled "An Application of the University of Kentucky Flood Control Planning Program III to the Flooding Problem of Moscow, Idaho;" indicates that flood reduction measures on Paradise Creek may be feasible.

The University of Idaho, Washington State University, U.S. Geological Survey (USGS), Soil Conservation Service, and the Pullman-Moscow Water Resources Committee have also conducted various studies relating to water supply for the Pullman-Moscow ground water basin. (See appendix J for a list of existing reports.)

V. STUDY PARTICIPANTS AND COORDINATION.

Study participants included city of Pullman, Pullman-Moscow Water Resources Committee (representing Pullman, Moscow, Washington State University, University of Idaho, Whitman County, and Latah County), Soil Conservation Service, Pullman Civic Trust, and the Pullman Palouse River Task Force.

The U.S. Fish and Wildlife Service (USFWS) provided a Planning Aid Letter and the University of Idaho made a Cultural Resources Survey. The Idaho Department of Water Resources was responsible for initiating the study and coordination has been maintained with their local representative.

VI. RESOURCES AND ECONOMY OF THE STUDY AREA.

The Palouse River Basin is located in eastern Washington and northern Idaho. The drainage basin covers over 2 million acres and includes parts of five counties in Washington and two in Idaho. Slightly over half the basin is in Whitman County, Washington. The headwaters of the river are in Idaho. The river flows some 124 miles to the Snake River after tumbling over the 185-foot Palouse Falls. The major tributaries are the North Fork, South Fork, Rebel Flat Creek, Rock Creek, Pine Creek, Union Flat Creek, and Cow Creek. The North Fork drains 15 percent of the basin and yields 41 percent of the runoff. Cow Creek drains 20 percent of the basin but contributes only 7 percent of the runoff.

Land use is as follows: Cropland--58 percent--1,231,000 acres; Rangeland--28 percent--597,000 acres; Forested Grassland--3 percent--62,000 acres; Mountain Forest--8 percent--163,000 acres; Other Lands--3 percent--61,000 acres.

Although the climate is variable from day to day and day to night, the region experiences rather consistent annual weather patterns. Hot, dry, and sunny days with cool nights are common with a maximum recorded temperature of 110 degrees F. Winters are cold with frequent periods of cloudy or foggy weather. During the winter, maximum temperatures may range from 30 to 40 degrees F. and minimums from 15 to 30. The lowest recorded temperature was -37 degrees F. Annual precipitation varies from 11 inches on the western border to 22 inches on the eastern border to 36 inches in the mountains in Idaho. Frost-free days range from 150 days in the cropland areas to 100 days or less in the Palouse Range. The prevailing winds are from the southwest, but winter storms may also come from the northeast.

The landscape has been formed by uplifting, vulcanism, erosion, and flooding. The mountains and basement rock are crystalline, including quartzite, schist, and granite. After the uplifting, more than 100 lava flows occurred with 1,000 to 10,000 years elapsing between flows during which sedimentary interbeds formed. These basalts and crystalline rocks were then covered with wind deposits of loessial materials which formed the rich soils of the Palouse cropland areas.

Most of the streams in the basin are intermittent, except for those originating in the eastern mountains. The western basin is channeled scabland and has numerous ponds and lakes, some of which contain water throughout the year. The ground water is correlated with the geology. The principal recharge areas are in the eastern mountains where the rainfall is the greatest and water can infiltrate the interfaces between the crystalline and basalt formations. The soils of the Palouse formation are relatively impermeable and recharge little water into deep aquifers. The scablands in the western area receive little rainfall. The principal aquifers of the basin are the basalt flows and the sedimentary interbeds.

The Palouse has been inhabited by people for at least 12,000 years. The first known non-Indians to visit the area were members of the Lewis and Clark Expedition in 1805. In 1811 fur traders entered the basin from Canada. Missionaries came in the 1830's and 1840's and gold prospectors in the 1860's. In 1853 Washington became a territory and in 1863 the first settlement began on Union Flat Creek. Virtually all the arable land was settled from 1870 to 1885. Agriculture is still the major industry of the basin, although logging and forest products are a major industry in the eastern mountains. The two land grant universities, Washington State University and the University of Idaho, are also major economic influences in the basin. About 70,000 people live in the Palouse River Basin with about 50 percent of them residing in Moscow, Pullman, and Colfax.

VII. PROBLEMS, NEEDS, AND OPPORTUNITIES.

A. Flooding.

Flooding is a recurring problem in the communities of Moscow, Pullman, Potlatch, and Palouse. Flooding usually occurs when rain falls on snow when the ground is frozen.

(1) Areas Studied for Flood Damage Reduction.

Three portions of the Palouse River Basin were evaluated for flood damage reduction: (a) the North Fork Palouse River from the upstream limits of the Colfax Channel Project to the Laird damsite; (b) the South Fork Palouse River from the downstream city limits of Pullman to the Robinson Lake damsite; and (c) Paradise Creek from its mouth to the Paradise Creek damsite. These are the areas where damage potential is significant and could be reduced by the reservoir projects under consideration.

(2) Extent and Character of Flood Damage.

The North Fork Palouse River from Colfax to the Laird damsite is approximately 60 river miles in length. It was broken down into reaches for damage analysis purposes, but is summarized in total here. The floodplain is relatively narrow, occasionally widening where creeks join the river. It is predominantly rural-agricultural in character, with the exception of small portions of the towns of Palouse, Potlatch, and Princeton. Total acreage in the floodplain is about 1,700 acres. Value of property subject to flooding is estimated at $10 million. Total damage estimated for the largest flood evaluated (ranging from 200- to 1,000-year flood, depending on the reach) was $6 million. Average annual damage, considering the probable frequency of flooding, is $75,000.

The South Fork Palouse River floodplain has two distinct characteristics: 16 river miles of rural-agricultural property and two areas of concentrated development; and the city of Pullman and a small area where U.S. Highway 95 crosses the South Fork, south of Moscow.

The rural-agricultural area floodplain contains approximately 690 acres (250-year flood), with estimated total value of damageable property of over $1 million, and damage by the largest flood evaluated, of approximately $182,000. Average annual damage was calculated at $13,000.

As noted, several studies have been made of the South Fork Palouse River, through Pullman for a local protection project. Potential damage is principally to commercial development typical of the business district of a small city. The upstream portion of this floodplain includes residences, mobile home courts, and a city park and swimming pool. There are approximately 186 acres in the Pullman floodplain. Total value of damageable property is approximately $33 million. Damage for the largest flood evaluated (in excess of 1,000-year flood) is $9.8 million, and average annual damage is $113,000. Damage in the most recent flood, that caused appreciable damage (January 1972), was $950,000 at 1988 price level. The city adopted floodplain regulations in the early 1970's and potential damage has decreased somewhat, compared to previous studies.

There are approximately 23 floodplain acres in an area of commercial and industrial development along U.S. Highway 95 south of Moscow, where it crosses the South Fork. Damage from a large flood (1,000-year flood) was estimated at $1,200,000 and average annual damages at $5,600. The flood of January 1972 put water around the buildings in this area, but caused negligible damage.

The floodplain of Paradise Creek is similar to that of the South Fork, in that it consists of a stretch of sparse development and two areas of fairly concentrated development. The sparse development is between the cities of Moscow and Pullman. There is a small area of concentrated development at the mouth of Paradise Creek on the edge of Pullman. The other area of concentrated development is the floodplain of Paradise Creek through Moscow.

From the mouth to the downstream city limits of Moscow, there are approximately 175 acres in the floodplain with the value of damageable property valued at $2.6 million. Damage for a large flood (500- to 1,000-year flood) would be about $835,000 and average annual damage is approximately $24,000. There is no historical flood damage information on this area.

Paradise Creek winds 4.5 miles through Moscow from the Paradise Creek damsite to the downstream city limits. The floodplain consists of residential development in the upstream reach, transitioning to commercial and industrial property as it skirts the downtown area and a portion of the University of Idaho campus before the creek exits the city. There are approximately 315 acres in the Paradise Creek floodplain in Moscow. Value of damageable property was estimated at almost $40 million. Damage from a large flood would be on the order of $8 million. Average annual damage was calculated at $187,000. The January 1972 flood caused about $500,000 damage at 1988 prices.

B. Municipal Water Supply.

Municipal water supply is a problem for Moscow, Pullman, and the two universities. A recent study by USGS indicates that the ground water level will continue to decline if pumping rates are increased. If pumping rates are stabilized at current withdrawal rates, there can be no further development in the two communities unless additional supplies can be developed from surface water sources or through conservation or reclamation of the present supply. At present the communities are using approximately 10,000 acre-feet per year. Projected requirements over the next 30 years are approximately 25,000 acre-feet per year.

C. Recreation Needs.

Water-based recreation is very limited in most of the basin and people from the larger population centers must travel considerable distances to find suitable recreation areas. The streams through Moscow and Pullman have little or no flow during the summer and water quality is very poor.

D. Water Quality.

Augmentation of streamflow in the North and South Forks of the Palouse and Paradise Creeks would enhance the water quality in those streams, particularly during the summer months.

E. Opportunities.

The opportunity exists to combine these needs in multipurpose development projects. Reservoirs to control flooding downstream could also be used to provide recreation facilities and streamflow enhancement and, in some cases, an alternative water supply for Moscow and Pullman. The Harvard and Laird sites on the North Fork could provide for all of these needs. Sites on the South Fork could provide flood control, streamflow enhancement, and possibly recreation. Channel improvements for flood control through Moscow and Pullman could also provide enhanced recreation and aesthetic development of the corridors if perennial streamflow could be provided. The Snake and Clearwater Rivers are possible sources of additional water supply.

VIII. ALTERNATIVE SOLUTIONS.

A. Flood Control. Alternatives which would provide flood protection are:

(1) Harvard or Laird Dams, which would control flooding in Potlatch and Palouse.

(2) Pullman channel improvement, which would decrease flood damages through the city of Pullman.

(3) Paradise Creek Dam, which would provide increased flood protection for both Moscow, Idaho, and Pullman, Washington.

(4) Robinson Lake Dam, which would provide some flood protection for both Moscow and Pullman.

B. M&I Water Supply.

(1) Harvard and Laird Dams could provide the minimum 25,000 acre-feet of storage for M&I water supply for Moscow, Pullman, University of Idaho, Washington State University, and Potlatch and Palouse, if required. Pipelines, 23.8 miles in length, with two pumping stations and a treatment facility near Palouse would be required.

(2) Dworshak Reservoir has storage that could be made available for M&I water. A 55-mile long pipeline would be required with two pumping stations and a water treatment plant.

(3) Another source of water is the Snake River near Wawawai, 3 miles upstream of Lower Granite Dam. This would require a pumping plant at the river, a treatment plant located 2 miles up Wawawai Canyon with another pumping station, and pipelines totaling 21.6 miles.

(4) There may be other potential sources of ground water in the South Palouse or Union Flat Creek drainages. However, it is beyond the scope of this study to explore the ground water potential of the basin.

C. Recreation and Streamflow Enhancement.

(1) The Harvard, Laird, and Robinson Lake Reservoirs all have potential for recreation storage and streamflow enhancement. The Paradise Creek Reservoir could provide some streamflow enhancement.

(2) Streamflow enhancement from the Paradise Creek or Robinson Lake sites would provide recreational opportunities for the cities of Moscow and Pullman, if channel improvements are made through the cities.

D. Multipurpose Projects.

Storage projects at the Harvard, Laird, Paradise Creek, and Robinson Lake sites have the potential for multipurpose developments. Projects at Harvard and Laird could include flood control, M&I storage, hydropower, recreation, irrigation, and streamflow enhancement. The Paradise Creek and Robinson Lake Reservoirs could combine flood control, recreation, and streamflow enhancement. All three dam and reservoir projects could also provide water-based recreation benefits and streamflow enhancement. These benefits have not been identified however, because no potential sponsors for these purposes were identified.

IX. SINGLE-PURPOSE PLANS.

A. Flood Damage Reduction.

Three reservoirs of various sizes and a channel project on the South Fork Palouse River through Pullman were considered for flood damage reduction. The reservoir projects are Laird on the North Fork, Robinson Lake on the South Fork, and Paradise Creek on Paradise Creek (which would also reduce damage on the South Fork downstream of the confluence). A tabulation of average annual remaining damage with the project and average annual benefits is shown on table 1.

Local flood protection measures were not evaluated for Paradise Creek and the South Fork Palouse River at Highway 95 crossing in Moscow, nor along the rural agricultural reaches of the North and South Forks Palouse River. Channel improvements in these reaches do not appear to be effective solutions without upstream reservoir control. The Harvard site was initially considered as an alternative. However, it was dropped from further study because of high cost site, environmental and sedimentation problems, and relocations required.

TABLE 1

AVERAGE ANNUAL REMAINING DAMAGES

Project	Average Annual Damage	Average Annual Remaining Damage by Reservoir Size (Flood Control Storage Capacity)				Average Annual Benefit by Reservoir Size (Flood Control Storage Capacity)			
		16,400 AF	30,900 AF	37,100 AF	51,400 AF	16,400 AF	30,900 AF	37,100 AF	51,400 AF
North Fork Palouse River, Reaches Affected by Laird Reservoir	$74,968	$39,147	$26,663	$563	$0	$35,821	$48,305	$74,405	$74,968
		1,200 AF	2,500 AF	3,200 AF	4,800 AF	1,200 AF	2,500 AF	3,200 AF	4,800 AF
South Fork Palouse River, Reaches Affected by Robinson Lake	$131,209	$104,210	$95,221	$0	$0	$26,999	$35,988	$131,209	$131,209
		1,200 AF	2,500 AF	3,100 AF	4,700 AF	1,200 AF	2,500 AF	3,100 AF	4,700 AF
South Fork Palouse River, and Paradise Creek, Reaches Affected by Paradise Creek Reservoir	$323,417	$180,909	$92,477	$3,800	$1,598	$142,508	$230,940	$319,617	$321,819

Project	Average Annual Damage	Average Annual Remaining Damage: Channel Improvement to 6,130 cfs	Average Annual Benefit: Channel Improvement to 6,130 cfs
South Fork Palouse River, Pullman	$45,827	$11,734	$34,093

B. M&I Water Supply.

Three projects were considered for M&I water supply: the Laird site on the North Fork Palouse River, the Snake River at Wawawai, and Dworshak Reservoir on the North Fork Clearwater River. All three alternatives can supply the water requirements. A comparison of the costs for single-purpose water supply projects is shown in the table below:

TABLE 2

COMPARISON OF M&I WATER SUPPLY ALTERNATIVES

PROJECT	CAPITAL COST	ANNUAL COST
Laird Dam	$36,913,000	$3,437,000
Pipeline	42,946,000	6,799,000
Total	$79,859,000	$10,236,000
Snake R.	$47,600,000	$8,946,000
Dworshak	$77,400,000	$12,433,000

In comparing these alternatives, the Snake River provides the least cost source of water. For 25,000 acre feet per year the cost per 1,000 gallons of potable water would be about $1.10.

X. PLAN SELECTION.

For M&I water supply, the Snake River alternative provides the least cost alternative. If ground water should no longer be available to the communities, this would be the least costly surface water supply.

See table 3 for a comparison of alternative projects. Multipurpose storage development at the Laird site on the North Fork has a benefit-to-cost ratio of 0.90. That project would prevent average annual flood damages of $75,000 along the North Fork, provide the Pullman-Moscow area future M&I water supply, and generate power. The M&I water supply benefits assigned to the storage project is the cost of the least-cost, single-purpose M&I water supply project (Snake River pumping plant).

XI. ECONOMICS OF THE PLANS.

A. M&I Water Supply.

The Snake River source of M&I water has a capital investment cost of $47,600,000 with an annual cost of $8,946,000. The cost for 1,000 gallons for the 25,000 acre-feet per year design requirement is $1.10.

TABLE 3

PALOUSE RIVER BASIN RECONNASSIANCE STUDY-ECONOMIC ANALYSIS

ALTERNATIVES ($1000)

	NORTH PALOUSE WATER SUPPLY LINE	LAIRD RESERVOIR 50,000 ACRE-FEET	LAIRD RESERVOIR 60,000 ACRE-FEET	LAIRD RESERVOIR 70,000 ACRE-FEET	ROBINSON LAKE 4,000 ACRE-FEET	PARADISE CREEK RESERVOIR 1,500 ACRE-FEET	SNAKE RIVER	DWORSHAK	PULLMAN CHANNEL 6075 CFS CAPACITY
AVERAGE ANNUAL DAMAGE REDUCTION BENEFIT		$75.0	$75.0	$75.0	$131.2	$156.1			$41.4 *
MUNICIPAL & INDUSTRIAL WATER SUPPLY		$8,946.0	$8,946.0	$8,946.0					
AVERAGE ANNUAL HYDROPOWER BENEFIT		$233.0	$245.0	$261.0					
TOTAL AVERAGE ANNUAL BENEFIT		$9,254.0	$9,266.0	$9,282.0	$131.2	$156.1			$41.4
PROJECT COST ($1000)									
LANDS,EASEMENTS,RIGHTS-OF-WAY	$270.0	$1,225.0	$1,225.0	$1,225.0	$1,419.0	$1,188.0	$247.0	$500.0	$120.0
CONSTRUCTION COST	$24,381.0	$20,895.0	$24,095.0	$28,695.0	$6,452.0	$6,757.0	$27,180.0	$44,106.0	$701.0
CONTINGENCIES	$6,095.0	$3,000.0	$3,000.0	$3,179.0	$1,504.0	$1,449.0	$6,773.0	$10,994.0	$165.0
SUBTOTAL	$30,746.0	$25,120.0	$28,320.0	$33,099.0	$9,375.0	$9,394.0	$34,200.0	$55,600.0	$986.0
E & D	$3,000.0	$3,280.0	$3,280.0	$3,280.0	$903.0	$892.0	$3,300.0	$5,100.0	$159.0
S & A	$2,300.0	$2,600.0	$2,600.0	$2,623.0	$722.0	$714.0	$2,500.0	$4,300.0	$66.0
INTEREST DURING CONSTRUCTION	$6,900.0	$5,913.0	$6,523.0	$7,439.0	$1,527.0	$1,527.0	$7,600.0	$12,400.0	$106.0
INVESTMENT COST	$42,946.0	$36,913.0	$40,723.0	$46,441.0	$12,527.0	$12,527.0	$47,600.0	$77,400.0	$1,317.0
AVERAGE ANNUAL COST									
INTEREST & AMORT.(8 7/8 %,100Y .088768)	$3,812.2	$3,276.7	$3,614.9	$4,122.5	$1,112.0	$1,112.0	$4,225.4	$6,870.6	$116.9
OPERATION & MAINTENANCE	$2,987.0	$160.0	$160.0	$160.0	$47.0	$32.0	$4,721.0	$5,562.0	$5.8
TOTAL ANNUAL COST	$6,799.2	$3,436.7	$3,774.9	$4,282.5	$1,159.0	$1,144.0	$8,946.4	$12,432.6	$122.8
TOTAL ANNUAL COST INCLUDING NORTH PALOUSE WATER SUPPLY LINE		$10,235.9	$10,574.1	$11,081.7					

B. Multipurpose.

Multipurpose storage development at the Robinson Lake and Paradise Creek sites is clearly not economically feasible.

Multipurpose development at the Laird site might be feasible if additional benefits for recreation and streamflow enhancement could be developed in addition to M&I, flood control, and hydropower. A 50,000 acre-foot reservoir was the smallest size evaluated for the Laird site in order to provide flood control and a conservation pool, in addition to the M&I water storage of 25,000 acre-feet. Benefits are essentially the same for the 50,000, 60,000, or 70,000 acre-foot sizes. The 50,000 acre-foot Laird Reservoir has an investment cost of $36,913,000 plus $42,946,000 for a water treatment plant, pumping station, and pipelines to Moscow and Pullman. The total cost would be $79,859,000 with annual costs of $10,236,000.

C. Flood Control.

The Pullman Channel Improvement alternative is the most viable economically of the various flood control alternatives. However, it does not provide positive net benefits and has a benefit-to-cost ratio of only 0.34. The investment cost is $1,317,000 with annual costs of $122,000. Benefits of $41,400 leave negative net benefits of $81,400. The channel project would prevent 75 percent of the damages in the downtown area for the 1,000-year flood and would prevent all damages up to the 100-year flood.

The city of Pullman and Washington State University communities are interested in improving the channel of the river through town and developing the river frontage into recreation and aesthetically pleasing area through beautification of the bank areas and adjoining properties. These are intangible benefits that are difficult to quantify and would provide substantial benefits to the development of the downtown area.

For these reasons, the project may still be attractive to the local people although it may be difficult to justify by strict economic criteria at this time.

XII. SOCIAL IMPACTS.

A. M&I Water Supply.

The cities of Pullman and Moscow, the University of Idaho, and Washington State University have reached a point where little additional development can take place without apparently jeopardizing the ground water supply. In order for the area to expand or attract new businesses, additional sources of water will be required. This might be accomplished through water conservation, locating additional ground water supplies, or importing water from a surface water source, such as the Snake River or the North Fork Palouse River.

Both the Idaho Department of Water Resources and Washington Department of Ecology are concerned with potential mining of the present ground water source and will impose restrictions on future withdrawals if some solution is not arrived at for future management of the ground water resource.

B. Flood Control.

Potential flooding of downtown Pullman from floods in excess of a 10-year flood are hindering further development and improvement of the downtown area and the stream channel corridor. Improving the channel to provide capacity for 100-year protection and beautifying the channel through the city would stimulate the city and property owners to develop the stream corridor. Properties would be improved and upgraded, additional parking facilities developed, and the river frontage developed into an attractive focal point for the city and the university. Trees, shrubs, and flowers would be planted, footpaths constructed, and benches and gathering places located to provide recreational amenities. This would provide foot access from the university campus directly to the downtown area.

The community is presently working with the Union Pacific and Burlington Northern Railroads to eliminate three Union Pacific Railroad river crossings in town and the Union Pacific Railroad tracks along the riverbank. This would improve channel hydraulics, reduce costs of construction and maintenance, and provide more riverbank area for plantings, recreation, and beautification projects.

XIII. CULTURAL RESOURCES.

A. M&I Water Supply. (Snake River Alternative.)

A detailed site location has not been made and no surveys have been conducted for cultural resources along the proposed pipeline routes. Surveys will need to be made at such time as a definite location of the project is made.

B. Flood Control. (Pullman Channel Improvement.)

Limited archaeological resources are known to occur in the project area. A survey conducted in 1976 by National Heritage, Inc. indicated that aboriginal quarry locations and habitation sites may exist in Pullman. The Washington Office of Archaeology and Historic Preservation has recommended that specific site areas be reassessed if a project was to be constructed. This survey should take place during the feasibility study.

XIV. ENVIRONMENTAL CONSIDERATIONS.

The USFWS has prepared a Planning Aid Report for the Palouse River Reconnaissance Study. (See appendix I.) The following summary of environmental concerns is based on an analysis of the USFWS report; an independent in-depth review by the Corps of Engineers has not taken place in this early stage of planning. The following discussion of environmental impacts is provided by alternative:

A. Paradise Creek Flood Control Reservoir.

Neither significant aquatic nor terrestrial impacts are anticipated. The project area is primarily agriculture land with only minimal streamside vegetation occurring along Paradise Creek. The operation of the project will largely determine the amount of either beneficial or adverse impacts. The project has the potential to provide improved downstream water quality and create wetland habitats if water releases are made over an extended period and a partial conservation pool is maintained.

B. Robinson Lake.

There appear to be no negative impacts to the aquatic environment other than those normally associated with construction activities. In fact, the potential exists to provide improved water quality and to provide recreational fishing if a conservation pool is maintained. Manns Lake and Winchester Lake are two lakes in the region that could be comparable to the proposed reservoir; they provided 20,313 and 44,548 angler hours in 1987, respectively.

Terrestrial impacts are also anticipated to be minimal. Loss of riparian and wetland habitats largely appear to be offset by new habitats that will be established with the project.

C. Palouse River Reservoir and Pipeline Proposal.

This proposal includes the construction of the Harvard and Laird Reservoirs and the construction of a pipeline to transport water from Palouse, Washington, to Pullman, Washington, and Moscow, Idaho. The lotic (river) environment of the project sites would be changed to a lentic (lake) environment with different aquatic values. Approximately 3,385 acres reservoir environment would be created which could provide a substantial increase in recreational fishing for the area. The existing streams are apparently small with limited access and fishery value. USFWS is concerned, however, with the loss of water from the Palouse River watershed and any potential downstream migratory impacts to the Snake River anadromous fish. An investigation of cumulative impact of water regime and volume changes in the Palouse watershed and its influence on the Snake River would need to take place.

Terrestrial impacts will occur to wetland, riparian, and upland habitats but these appear to be mitigatible. Many of the riparian and wetland habitats may be replaced by new similar habitats that develop around the shallow water edge of the reservoirs. A habitat evaluation would have to take place during the feasibility level study to determine the significant of the project impacts. Overall, it appears that considerable fishery values could be developed which would offset other environmental losses.

D. <u>Lower Granite to Pullman and Moscow Pipeline Proposal</u>.

USFWS is primarily concerned with the potential impact to anadromous fish migrating in the Snake River, as a result of reduced flows, and loss of fish in the pipeline. They feel that the cumulative impact of water withdrawal could potentially impact anadromous fish in the Snake River system. They realize that the amount overall is small, but they are concerned with the cumulative impact of similar projects in the future.

Terrestrial impacts are difficult to determine since the exact route of the pipeline has not been determined but the primary concern would be the significant wildlife habitats in the Snake River Canyon. The pipeline would impact riparian and canyon habitats that would require further analysis and the development of a mitigation plan.

E. <u>Palouse River Channel Alteration in Pullman</u>.

The aquatic and terrestrial resources in the project area are not considered substantial and could be mitigated. A primary concern would be the establishment of a low flow channel and energy deflectors to create pools or wet areas during low flows for aquatic resources.

XV. <u>CONCLUSIONS</u>.

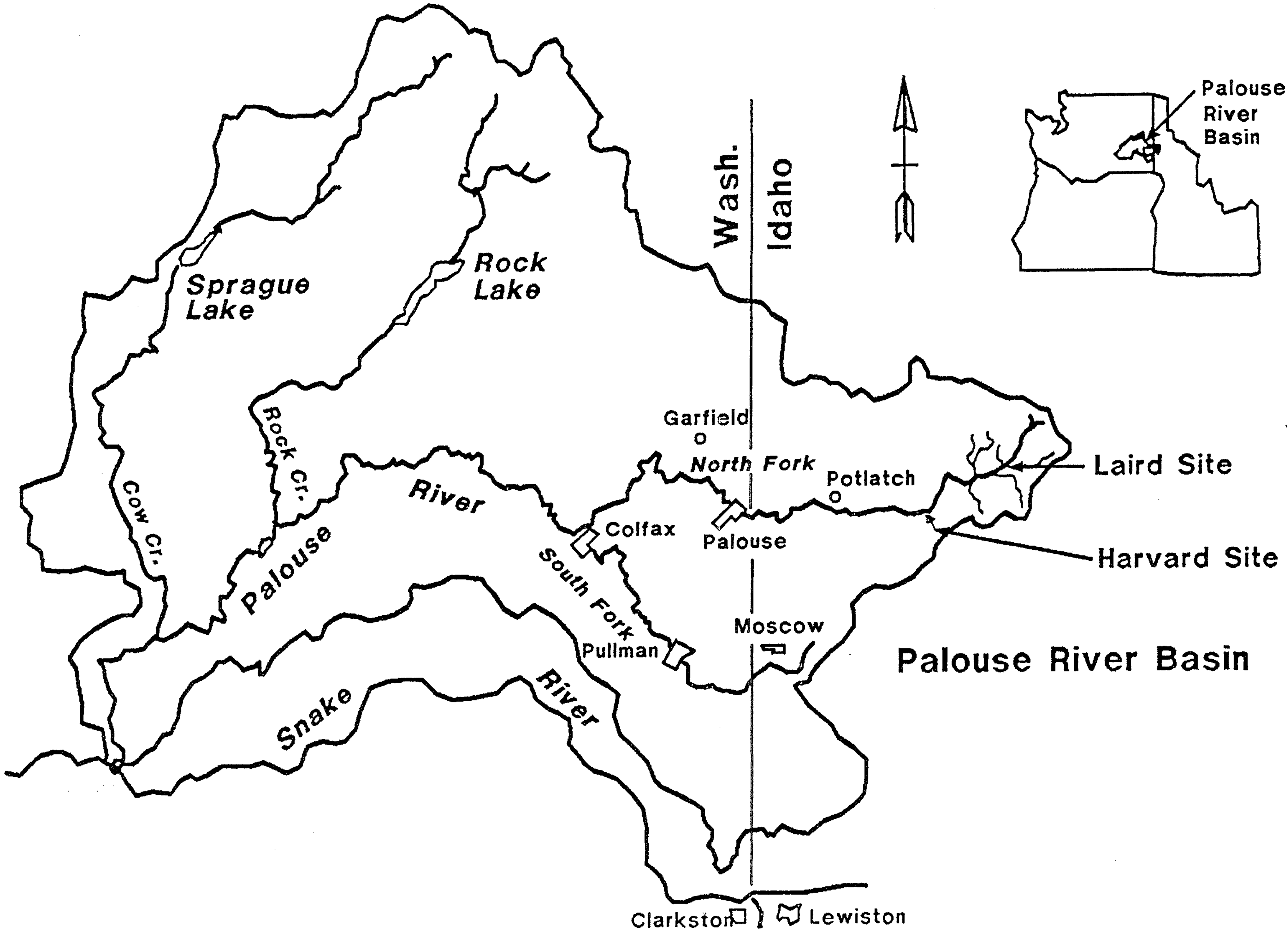
At the present, a local sponsor is not prepared to pursue M&I water supply alternatives under a feasibility study. However, the Pullman-Moscow Water Resources Committee, representing the two cities, two universities, and Whitman and Latah Counties, may wish to pursue the study at a later date. See appendix L for correspondence.

The Snake River pumping plan is the least-cost, single-purpose water supply project. However, the Laird site should definitely be considered for multipurpose development if a surface M&I water supply source is to be developed in the future. It would provide flood control, power generation, and possibly recreation and water quality benefits, as well as supply the communities with M&I water supply.

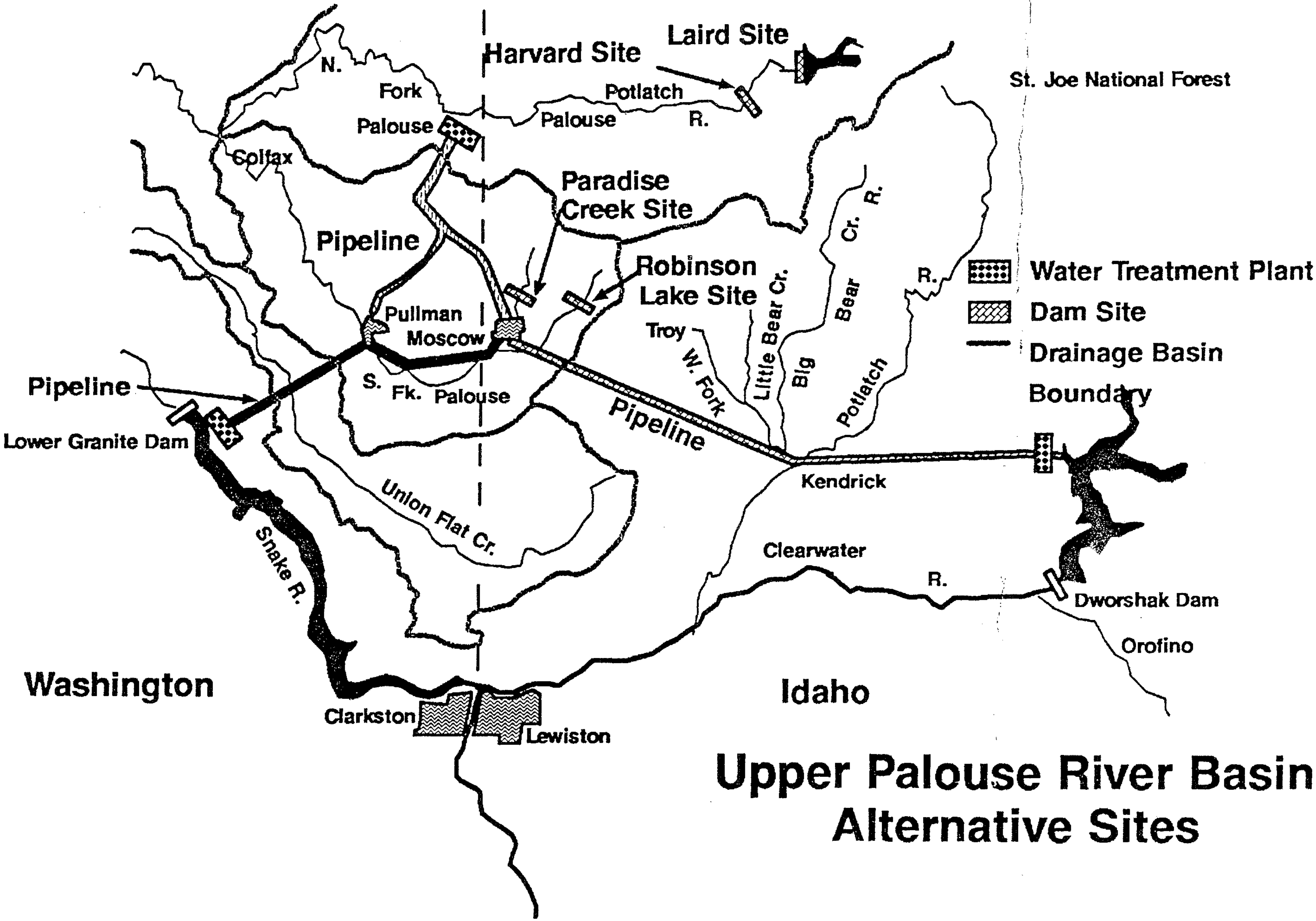
Channel improvement through the city of Pullman would provide flood protection and many intangible benefits, although it is not practical from a strict economic standpoint at this time. As a community asset, to promote development and civic pride, it could provide great benefit to the community.

XVI. RECOMMENDATIONS.

It is recommended that no further study be made of the Palouse River Basin at this time.

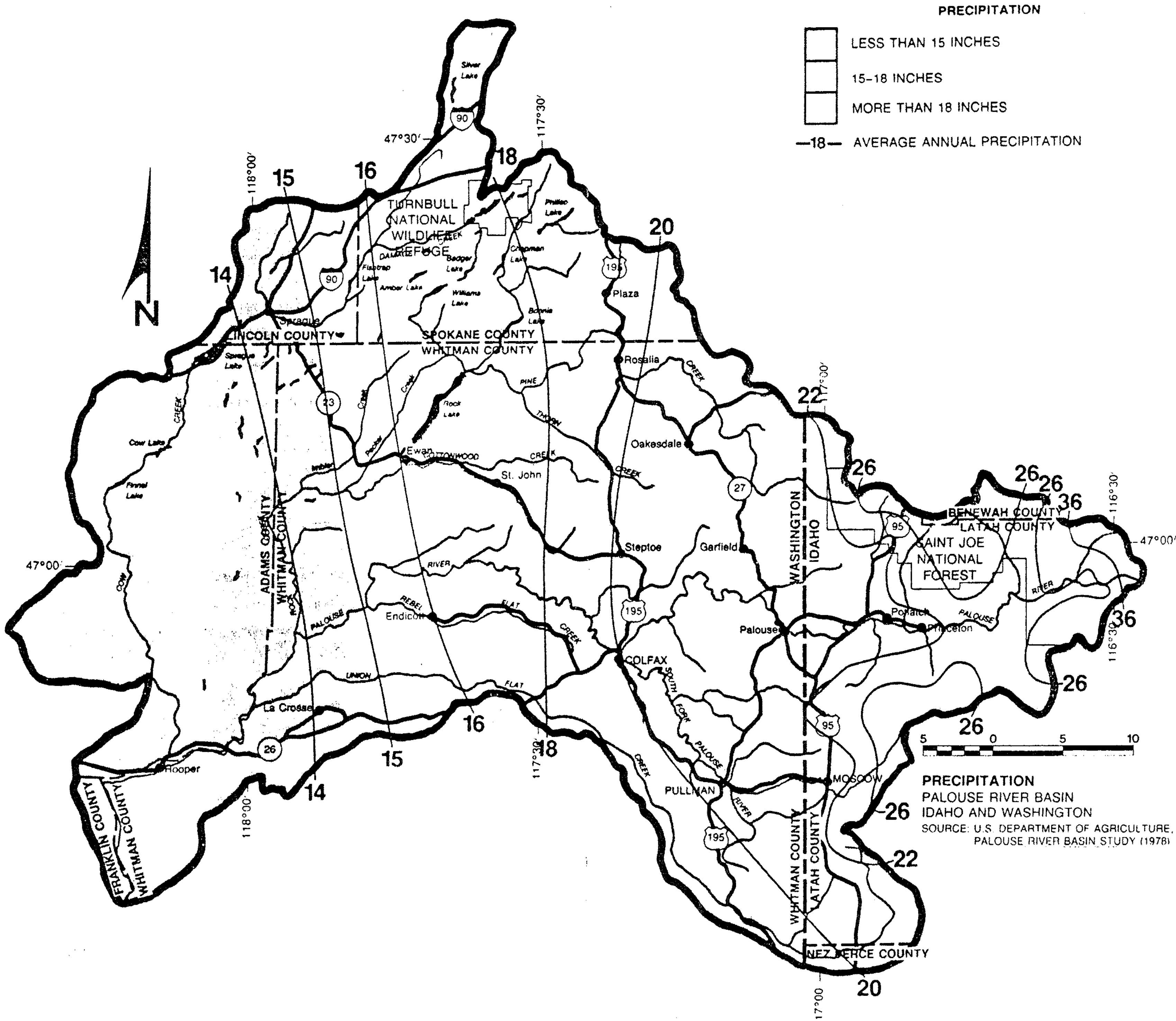


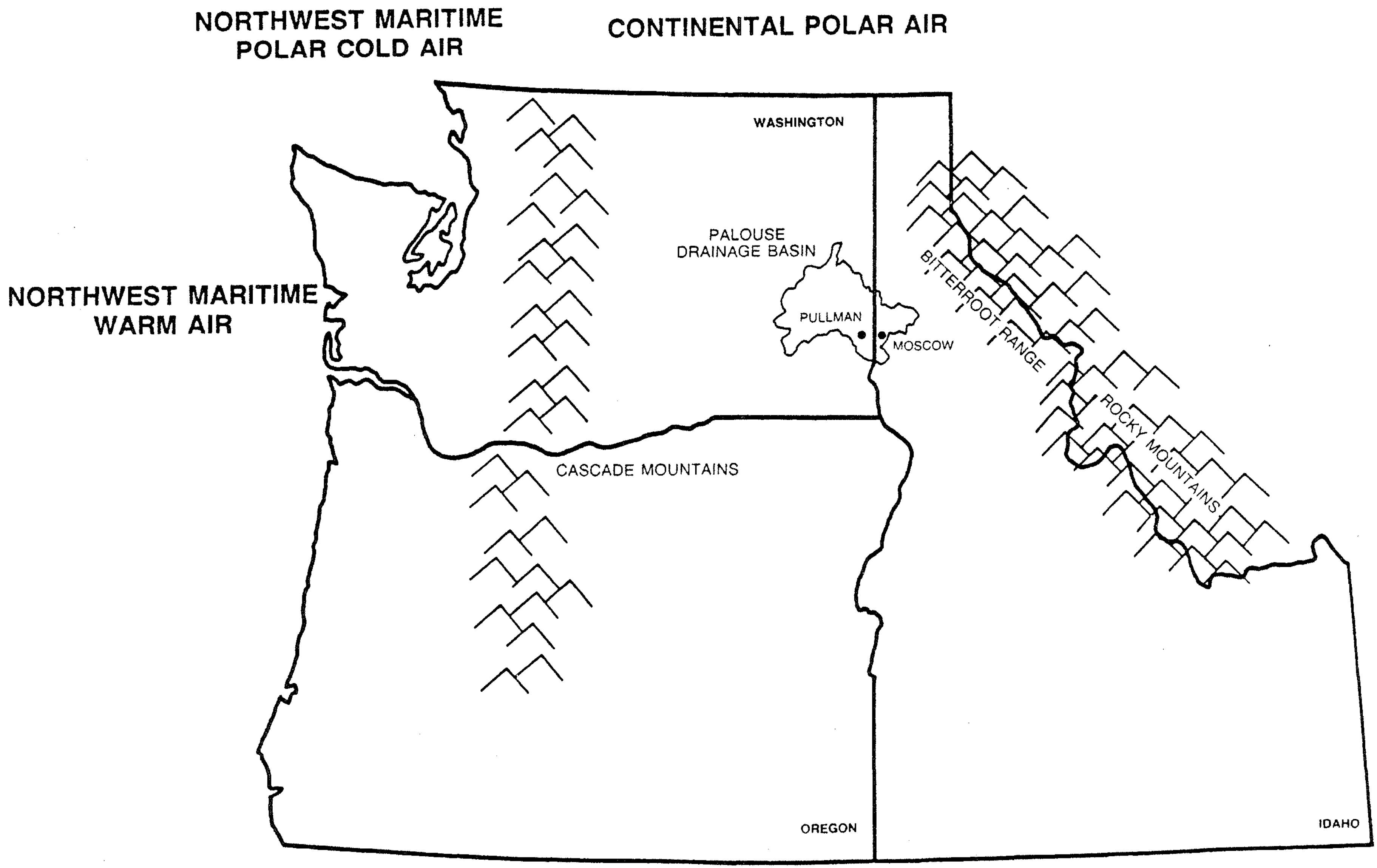
Palouse River Basin



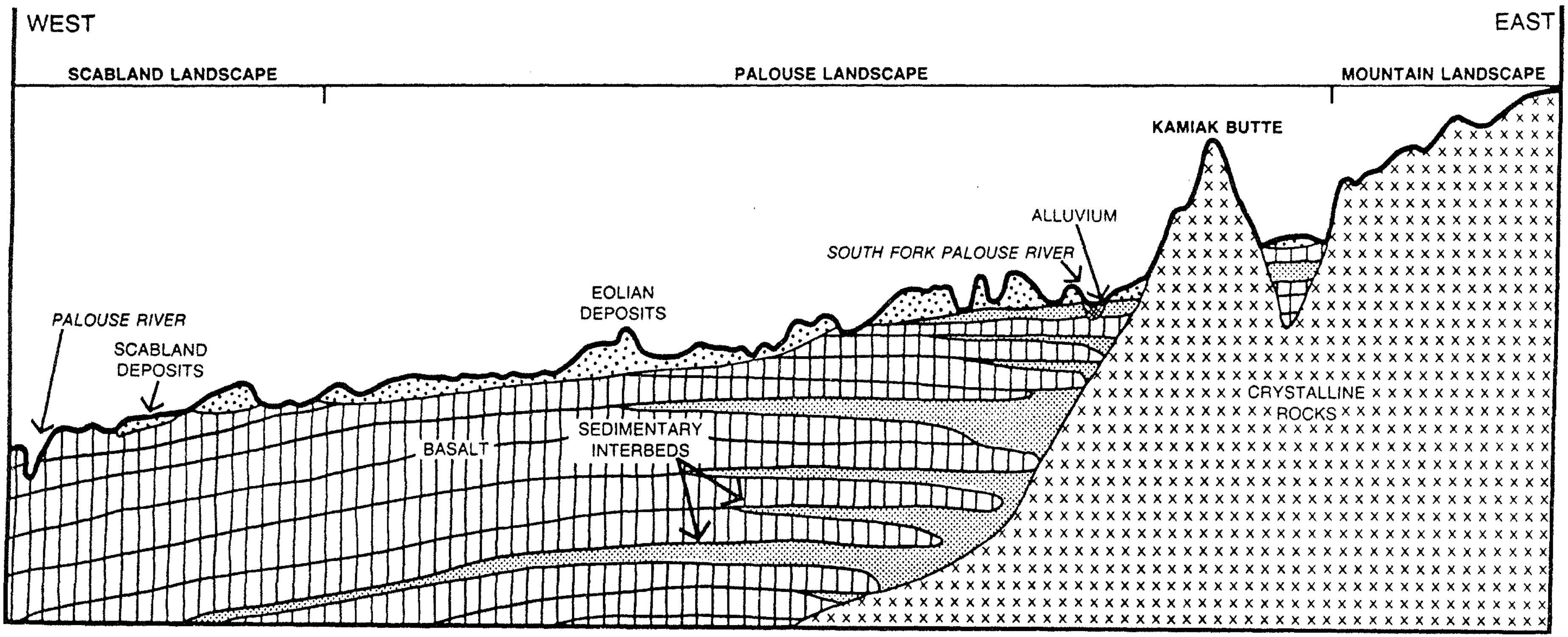
Upper Palouse River Basin Alternative Sites

Plate 2


PRECIPITATION
LESS THAN 15 INCHES
15-18 INCHES
MORE THAN 18 INCHES
—18— AVERAGE ANNUAL PRECIPITATION
N
TURNBULL NATIONAL WILDLIFE REFUGE
LINCOLN COUNTY
SPOKANE COUNTY
WHITMAN COUNTY
ADAMS COUNTY
FRANKLIN COUNTY
WASHINGTON
IDAHO
BENEWAH COUNTY
LATAH COUNTY
SAINT JOE NATIONAL FOREST
NEZ PERCE COUNTY
Sprague
Plaza
Rosalia
Oakesdale
Ewan
St. John
Steptoe
Garfield
Endicott
Palouse
Potlatch
Princeton
COLFAX
La Crosse
Hooper
PULLMAN
MOSCOW
47°30′
47°00′
118°00′
117°30′
117°00′
116°30′
5 0 5 10
PRECIPITATION
PALOUSE RIVER BASIN
IDAHO AND WASHINGTON
SOURCE: U.S. DEPARTMENT OF AGRICULTURE, PALOUSE RIVER BASIN STUDY (1978)



MACROCLIMATIC INFLUENCES



SCHEMATIC EAST-WEST GEOLOGIC SECTION THROUGH SOUTHERN WHITMAN COUNTY
ADAPTED FROM WALTERS AND GLANCY, RECONNAISSANCE OF GEOLOGY AND OF GROUNDWATER OCCURRENCE IN WHITMAN COUNTY, WASHINGTON (1969), p.4.

APPENDIX A

HYDROLOGY

APPENDIX A

HYDROLOGY

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CHARTS (Continued)

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APPENDIX A

HYDROLOGY

1. BASIN DESCRIPTION.

Palouse River Basin above Colfax, Washington, comprises 796 square miles in southeastern Washington and northwestern Idaho. As shown on the drainage basin map included as plate A-1, the basin is a roughly pear-shaped area. It has a general orientation of southwest to northeast, with the widest part of the basin near the southwestern end and the narrowest part at the northeastern or headwater end. The basin lies in two geologic provinces and is about evenly divided in the area between the provinces. The easterly half lies within the Northern Rocky Mountain province and has deeply dissected uplands with intermountain valleys and canyons. In this area the underlying geologic formations are principally basalts and granites and surface soil mantles are generally shallow with bedrock exposed in many places. Forests cover about 90 percent of this part of the area. The westerly half of the basin lies within the Columbia Plateau province and has young, incised valleys and rolling hills. The soil mantle covering basalt formations is generally several feet in depth and is clay and loam in composition. Native vegetation in this part was largely prairie grasses and brush. Most of the land that lies in the Columbia Plateau province is successfully farmed. This activity leaves large areas of ground bare for many months each year and the cultivated areas are very susceptible to erosion under certain circumstances. The soil is fairly stable, as evidenced by deep, nearly vertical banks which have stood many years in highway and railroad cuts. This stability, coupled with contour plowing, tends to alleviate erosion, but heavy warm rains on frozen ground will scour it very readily when the top few inches of earth thaw. The thawed layer tends to become soupy, sliding downhill and mixing with streamflow to be deposited elsewhere or carried off as suspended sediment.

The two principal streams in the area above Colfax are the Palouse and the South Fork of the Palouse Rivers which drain areas of 497 and 299 square miles, respectively, before they combine at Colfax. Both streams originate in timbered mountain slopes but also drain rolling farmland on the western edge of the mountains. Elevations of the Palouse River vary from 1,935 feet at the confluence at Colfax to 5,300 feet at the headwaters, and elevations of the South Fork of the Palouse River range from 1,935 feet at Colfax to 5,000 feet at the headwaters. From its source in the Hoodoo Mountains in Idaho, the Palouse River flows westerly for about 47 miles to Palouse, Washington, northwesterly about 17 miles to Elberton, Washington, and then southwesterly about 14 miles to Colfax. The South Fork of the Palouse River originates in the southern exposure of the Moscow Mountains in Idaho, a spur of the Palouse Mountain range, and flows southwesterly about 11 miles to the Washington-Idaho State line, then northwesterly about 7 miles to Pullman, Washington, thence about 22 miles northerly to Colfax. The following tabulation summarizes stream lengths, fall, and average slopes:

Stream	Drainage Areas (square miles)	Length (miles)	Fall (feet)	Average Slope (feet/mile)
Palouse River	497	78	3,365	43
South Fork of the Palouse River	299	40	3,065	77

2. CLIMATE.

a. General Features.

The climate of the Palouse River Basin is characterized by moderate mean annual temperatures but relatively large variations of temperature, low to moderate precipitation, moderate winds and sunshine, and low to moderate humidity. In general, the climate is subject to the moderating influence of the prevailing westerly flow of maritime air from the Pacific Ocean, but occasional influxes of polar air masses cause brief periods of extremely cold weather.

b. Temperature.

Large seasonal variations in temperature are experienced in the region and at times temperature differences inverse to elevation occur. Temperatures at Colfax, Washington, are typical of those at lower elevations in the area. The mean annual and mean January and July temperatures at Colfax are respectively 48.4 degrees, 29.2 degrees, and 67.8 degrees.

The lowest temperature of record for Colfax is -33 degrees and the highest is 113 degrees. At Pullman, Washington, 15 miles southeast of Colfax and about 600 feet higher in elevation, the extreme temperatures observed were -32 degrees and 110 degrees. Potlatch, Idaho, lying some 19 miles northeast of Pullman and at about the same elevation, has had observed temperature extremes of -48 degrees and 110 degrees. The intense cold periods in winter and hot periods in summer tend to be of short duration.

c. Precipitation.

Precipitation varies with elevation. Average precipitation in the Palouse River Basin varies from 10 inches to about 35 inches, and over the area above Colfax from 20 inches to about 35 inches. Moist Pacific maritime air masses moving from the Pacific Ocean eastward are predominant during the months of October through March, and the annual distribution of precipitation is generally determined by this 6-month period when approximately 70 percent of the annual precipitation falls. Convectional precipitation normally occurs during the summer months, although in occasional years orographic storms do occur during the summer. Much of the winter precipitation falls in the form of snow, and at higher elevations it accumulates until the spring runoff.

The following table shows the 1 April snow water content at three of the snow course sites within the basin.

Site	Elevation (feet msl)	1 April Snow Water Equivalent Average	Maximum	Minimum
Moscow Mountain, Idaho	4,410	16.8 in.	28.3 in.	4.3 in.
West Twin, Idaho	4,220	7.2 in.	17.4 in.	0.0 in.
East Twin, Idaho	4,130	8.4 in.	26.8 in.	0.0 in.

Although the average annual precipitation at Colfax is 20.97 inches, it has varied from 12.54 inches in 1924 to 30.34 inches in 1948. The station has a high mean monthly precipitation of 3.04 inches in December and a low mean monthly precipitation of 0.46 inches in July. Maximum 1-day precipitation at four locations within the basin are as follows: Potlatch, Idaho, 2.55 inches; Moscow, Idaho, 2.40 inches; Pullman, Washington, 2.45 inches; and Colfax, Washington, 2.00 inches.

d. Storms.

Storms in the upper Palouse River Basin are of two types: orographic or general storms and convective, or small areal storms. The general storms cover large areas and usually occur in the winter months and to a lesser degree in the spring and summer months. The precipitation from a general storm is associated with eastward moving, low-pressure areas accompanying frontal systems. Normally, the greater the intensity of the general storm, the smaller is the percentage of precipitation falling as snow, and snow accumulation is limited to the higher altitudes. Occasionally, the orographic or general storms occurring in midwinter are accompanied by warm winds and rain that extend to high levels. These storms last as long as several days, but seldom produce great total storm depths or high rainfall intensities. Convective storms generally occur in the spring and early summer. They may produce high intensities of rainfall but are limited to a few minutes duration and small areal extent. An example of this is a storm that occurred on 1 June 1923. Potlatch, Idaho, reported 2.55 inches of rain for that day.

3. <u>STREAMFLOW CHARACTERISTICS</u>.

Annual runoffs vary with annual precipitation received, and streamflows of the upper Palouse River Basin are largely governed by amounts of water in the snow pack. Normally, the annual high-water period occurs in early spring and the minimum low-water period occurs in the late summer and fall. This seasonal pattern can be seen in the summary hydrographs for the Palouse River near Potlatch, Idaho; the Palouse River at Colfax, Washington; and the South Fork of the Palouse River at Pullman, Washington, included as plates A-2, A-3, and A-4. Orographic storms occasionally produce high flows for a few days in midwinter. Also, when the weather moderates suddenly following a protracted period of very cold weather, ice flows jam at channel restrictions impeding streamflows and causing high stages. Early season loss of water from the snow pack tends to reduce the spring runoff somewhat in magnitude.

4. <u>WATER SUPPLY AND USE</u>.

Water supplies of the upper Palouse River Basin are limited in quantity and are not ideally distributed seasonally. Streamflow records are available for a number of locations within the basin, but record lengths are generally short and some stations are affected by irrigation withdrawals upstream of the gage location. Because streamflow records are too short to be representative, water supplies were estimated using longer records of surrounding streams correlated with shorter records in the Palouse River Basin. As a first step in this analysis, flows were adjusted to natural conditions by adding back in amounts estimated to have been lost to upstream irrigation. The Hydrologic Engineering Center's program HEC-4, "Monthly Streamflow Simulation," was used to correlate the data and generate any missing average monthly flow values for the period 1927-87 for a number of stream gages within the basin. Monthly discharges at ungaged sites were computed by multiplying the flows at the nearest gage site by a factor derived from a curve relating the basin mean elevation of a site to its observed annual runoff. Tables A-1 through A-12 show the average monthly discharge values for selected locations within the basin for the base period 1927-87.

Four of the monthly discharge tables were developed at sites being considered for dams in this reconnaissance study. Those four sites included the Palouse River at Laird damsite, the Palouse River at Harvard damsite, the South Fork of the Palouse River at Robinson Lake damsite, and the Paradise Creek above Moscow damsite. The locations of these four prospective damsites are shown on the basin map on plate A-1.

Annually, the main stem of the Palouse contributes about 80 percent and the South Fork of the Palouse the remaining 20 percent of the total surface water supply at Colfax. The main stem above Colfax drains over 60 percent of the area and produces about three times as much runoff per square mile as the South Fork. This occurs because about half of the drainage of the Palouse River above Colfax is a mountainous area having moderate to high annual precipitation while only about 10 percent of the South Fork drainage is a mountainous area. Water supplies of the upper part of the Palouse River are of good quality while supplies of the South Fork are annually silt-laden reflecting the effects of the extensive agricultural development within its basin.

The use of surface water supply is quite limited because water of suitable quality is not generally available when and where it is needed. A small amount of irrigation is practiced in lower valleys along the streams. Supplies for this purpose are obtained either from surface stream or deep wells. Most of the agricultural area depends on dry farming and conservation of natural locally received moisture by summer fallowing the lands.

Ground water supplies are deficient for needs in the lower part of the area above Colfax. Larger communities obtain ground water from deep wells and the water obtained is generally quite hard. The general ground water table has dropped considerably in recent years and further drop may result from increased future use. Some local water tables are distinctly separate from and above the general water table.

5. FLOODS.

Floods in Palouse River and tributaries result primarily from general rainstorms, but snowmelt or frozen ground conditions increase floodflows at times.

Major floods have occurred several times since the area was settled in the early 1870's. The earliest flood of historical record occurred in the year 1884. From testimony of early residents, this flood appears to be second in magnitude on the South Fork and about fourth on the main stem. One of the largest floods in the basin and largest known on the South Fork occurred in March 1910. Its peak discharges are estimated to have been 12,400 cfs in the Palouse River above the South Fork, approximately 11,500 cfs in the South Fork at Colfax, and 7,500 cfs in the South Fork at Pullman. In 1948, three floods of major proportions occurred within a period of 2 months in the upper Palouse River Basin. The South Fork at Pullman experienced discharges of 2,500, 3,400, and 5,000 cfs on 7 January, 22 February, and 26 February, respectively; while at Colfax on the South Fork below Spring Flat Creek, the estimated discharges were 7,500, 8,500, and 10,000 cfs. Maximum discharges for the same dates on the main stem above Colfax were approximately 8,000, 6,000, and 10,000 cfs. The highest known discharge on the Palouse River above Colfax occurred in December 1933 with a discharge of 13,000 cfs at Colfax.

Discharge was not particularly high on the South Fork in this flood. The February 1963 flood, while not of exceptional magnitude in the upper Palouse River Basin, produced the highest known flood peak on the Palouse River at Hooper with a discharge of 33,500 cfs on 4 February. Damaging floods have occurred at 2- to 5-year intervals since the settlement of the basin, with the exception of the period 1934-47, during which time the peak discharges were unusually low.

6. FLOOD FREQUENCIES.

Frequencies of the annual flood peaks for various locations within the basin were computed with a regional frequency analysis due to the short records of most of the gages. Attempts were made to correlate the annual peak data with longer record stations outside of the basin, but due to poor correlations, these attempts were abandoned. A regional analysis of the stations within the basin yielded a period of record of 67 years which was judged to be sufficient for a frequency study. The HEC program "Regional Frequency Analysis" was used to correlate the existing data and estimate any missing peaks in the following time period:

Frequency Study Base Period: 1898-99, 1901-07, 1909-19, 1933-42, 1948, and 1951-86.

Once the regional program generated a full set of annual peak data for each gage site, another HEC program, "Flood Flow Frequency Analysis," was used to generate the frequency curves and statistics for each site. This program uses the methods outlined in USGS Bulletin 17B, "Guidelines for Determining Flood Flow Frequency." At stations where discharge estimates were available for the years 1910, 1934, and 1948, and where these discharges were larger than the rest of the flows in the record, they were treated as historical flows.

A graphical method was used to determine the curve statistics of ungaged sites and sites with less than 10 years of data. Using data from the gage sites, curves were drawn relating the 10-, 50-, 100-, and 500-year flows to the basin characteristic, drainage area times normal annual precipitation. This set of curves then yielded four annual peak flows for each ungaged site and a frequency curve was computed that most closely fit those four points. The resulting frequency curves and statistics are shown on charts A-1 through A-16.

The new frequency curve for the South Fork of the Palouse River at Pullman, Washington, shows a significant deviation from an earlier frequency curve dated February 1977 prepared for that location. A comparison of the statistics associated with each of the curves indicates that the mean logarithms and standard deviations computed are nearly the same for both curves as shown below.

Date of Frequency Curve	Mean Logarithm	Standard Deviation	Adopted Skew
1977	3.0468	0.2912	0.5
1988	3.0695	0.2857	0.2

The adopted skew values are, however, quite different and are the major reason for the difference between the two curves, especially in the lower exceedence probability range.

The skew value used to generate the 1977 curve was a positive 0.5. That value was a station skew value based on the 30-year actual period of record. It was not adjusted with a generalized skew as suggested in the "Guidelines for Determining Flood Flow Frequency," Bulletin 17B, published by the USGS.

In contrast, the skew value used to generate the 1988 curve was a positive 0.2. That value was an adopted skew value based on a 67-year extended period of record and a generalized skew of 0.2. The extended record was the result of the regional analysis described above. The computed correlations and the overlap period among the stations were considered to be sufficient for the program to generate extended data sets that were reasonable estimates of the actual discharges at the stations involved. The generalized skew value of 0.2 was the result of a regional skew study that involved six stations within the basin, considering the station skew values and the actual period of record at each station. The adopted skew value of 0.2 used by the "Flood Flow Frequency" program appears to be a more reasonable skew value for a station in the Palouse River Basin.

7. FLOODPLAIN AREAS AND DEPTHS.

Preliminary estimates of floodplain areas and depths of flooding were made for definition of flood damages for various sizes of floods. Floodplain information derived for previous flood insurance studies was applicable to this study with adjustments made to the frequencies associated with the various floodplains and water surface profiles. The frequencies were modified so that the discharges used to compute the floodplain information originally were associated with frequencies taken from updated frequency curves.

8. PROBABLE MAXIMUM FLOOD.

a. Purpose, Definition, and General Basis.

The probable maximum flood is used as the basis for sizing the capacity of the spillways for the proposed Laird, Harvard, Paradise Creek, and Robinson Lake Dams. This use is intended to prevent downstream catastrophe which could otherwise result from a dam failure caused by extreme flows. Standard 1 of the Office of the Chief of Engineers, Engineer Circular 1110-2-27, dated 1 August 1966, is assumed to be the applicable guide to use in developing the spillway design flood for both dams. The standard: "Design dam and spillway large enough to assure that the dam will not be overtopped by floods up to the probable maximum categories," is deemed to be the most reasonable for design because of the large volumes of impounded water that could cause the loss of many lives and high property damage should major failure occur. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The probable maximum flood is defined and discussed in more detail in Civil Engineer Bulletin 52-8 and subsequent engineer manuals and guides from the Office of the Chief of Engineers. For the damsites considered in this study, the floods were developed using probable maximum precipitation (PMP) and other hydrologic conditions optimized for maximum amount and concentration of runoff and streamflows. Studies were made of the largest floods that could occur from general rain plus snowmelt or thunderstorm floods. The following paragraphs discuss and summarize details of development of the probable maximum floods.

b. Precipitation.

The general rainstorm PMP was derived using criteria and procedures presented in the U.S. Weather Bureau Hydrometeorological Report #43 and supplement. The supplement is contained in a letter dated 20 September 1967 from the U.S. Weather Bureau to the Office of Chief of Engineers. The month of May was selected as the most critical period for the occurrence of a probable maximum flood principally for three reasons: full reservoir at start of storm, maximum precipitation amounts, and high temperatures for snowmelt. The precipitation, plus snowmelt, was arrayed according to figure B of the U.S. Weather Bureau Hydrometeorological Report #43. The pattern consisted of small incremental amounts of precipitation, plus snowmelt at the start of the storm increasing to the maximum amounts at midstorm, then reducing to small amounts at the end of the storm. The thunderstorm PMP was derived using criteria and procedures described for computing "Lower Limit Thunderstorms" presented on page 4 of a letter from the Weather Bureau, Hydrometeorological Branch, Office of Hydrology, to A. L. Cochran, Civil Works, Office of the Chief of Engineers, Corps of Engineers, dated 20 September 1967. The resulting 6-hour thunderstorms were broken into incremental precipitation amounts and arrayed according to figure B of the U.S. Weather Bureau Hydrometeorological Report #43.

c. Snowmelt.

Snowmelt was considered for the 72-hour general rainstorm events only. It was not considered for the thunderstorm events since they would occur during snow-free periods of the year. For the Harvard and Laird damsites, snowmelt was computed using equation 21 of EM 1110-2-1406, dated 5 January 1960. This equation was deemed applicable because of the heavy timber cover of both drainage areas. For the Paradise Creek and Robinson Lake damsites, equation 20 of the reference sited above was used due to the large open areas in both of these drainage basins. Average snow course measurements from several sites within the basin were used to determine the available snow water content that would contribute toward runoff during the probable maximum storm.

d. Excesses.

Runoff excesses are difficult to define since they vary due to a number of different conditions within the basin. Soil moisture content, type of soil, amount of ground cover, and average slope of terrain are just a few of the factors that would determine the runoff excesses. Table 12-6 in Chow's "Handbook of Applied Hydrology" suggests that a minimum infiltration rate of 0.30 inches per hour should be reasonable for a shallow loess soil type such as that found in the Palouse River Basin. Since the probable maximum flood is based on the most severe conditions that are reasonably possible, the infiltration rate of 0.30 inches per hour was used as the maximum rate occurring during the PMP. Loss rates assigned to the 72-hour PMP storm were as shown in the table below.

Storm Period	Loss Values
1st 6-hour period	70% of precipitation
2nd & 3rd 6-hour periods	50% of precipitation
4th & 5th 6-hour periods	30% of precipitation
6th through 12th 6-hour periods	10% of precipitation

The schedule outlined above was used in all cases for the general rainstorm events except where the resulting loss value would have exceeded the limit rate of 0.30 inches per hour discussed previously. Note that loss percentages decrease as the storm progresses assuming that the soil moisture conditions will be increasing steadily causing the loss percentages to taper off.

The excess amounts during the thunderstorm PMP events were assumed to be 70 percent of the precipitation values since the thunderstorm is a 6-hour event. Again the losses were not allowed to exceed 0.30 inches per hour as described above.

spillway design discharge for the Laird, Paradise Creek, and Robinson Lake damsites. At the Harvard damsite, the general rainstorm PMP peak flow becomes the spillway design discharge.

TABLE A-1

PALOUSE RIVER BASIN

LAIRD DAM SITE
SECTION 31, T42N, R2W

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	144	146	292	421	147	70	13	6	8	18	112	432
1928	88	98	400	580	140	21	2	2	3	7	15	9
1929	19	2	59	101	39	15	7	2	1	2	6	17
1930	6	96	121	91	44	19	9	3	4	8	8	3
1931	2	46	262	241	44	9	1	1	1	3	4	5
1932	11	52	371	536	314	50	9	4	5	4	15	27
1933	56	27	326	412	205	84	12	6	7	12	49	54
1934	173	140	263	259	12	11	2	2	2	8	8	22
1935	30	76	91	120	198	39	10	4	5	3	7	17
1936	6	26	109	148	133	36	12	2	4	0	4	11
1937	2	7	78	187	144	32	9	4	3	5	9	32
1938	81	92	128	121	87	17	7	4	5	4	10	19
1939	33	32	355	265	55	18	7	2	1	2	4	9
1940	35	203	387	272	56	9	1	2	3	7	8	36
1941	51	76	93	80	35	25	10	4	7	14	95	191
1942	114	112	237	200	67	27	9	4	5	5	18	43
1943	117	166	259	285	128	68	15	6	6	7	17	32
1944	22	30	91	122	23	9	2	1	1	2	3	6
1945	145	110	221	270	121	20	10	2	4	4	8	28
1946	43	99	224	179	139	32	12	4	4	6	21	125
1947	151	489	434	628	72	31	8	2	6	12	18	80
1948	175	284	169	85	497	73	16	10	7	10	21	31
1949	33	135	311	254	253	23	5	4	2	5	11	18
1950	19	209	273	230	289	148	16	7	6	11	25	60
1951	93	372	166	242	77	36	12	4	4	9	11	45
1952	23	108	324	464	139	27	7	5	4	3	7	10
1953	137	229	275	182	159	68	12	5	7	5	19	63
1954	53	209	116	148	76	47	9	6	8	9	14	21
1955	28	23	139	215	187	47	14	5	5	13	36	345
1956	174	102	370	448	258	50	11	6	4	9	12	60
1957	16	165	309	326	384	55	11	5	5	7	11	58
1958	109	560	204	456	107	25	8	4	5	5	37	155
1959	364	149	378	270	152	45	12	4	8	13	61	32
1960	34	142	265	276	102	35	6	4	4	6	21	31
1961	65	535	179	176	142	30	7	3	3	6	6	38
1962	45	112	193	200	89	33	6	4	5	9	19	47
1963	7	211	142	170	53	16	3	3	3	3	27	10
1964	14	19	168	365	250	76	12	7	6	7	16	372
1965	337	470	316	381	91	42	7	6	4	4	9	10
1966	28	16	260	130	34	12	3	1	2	2	12	44
1967	189	114	192	188	233	50	8	2	1	5	7	30
1968	29	373	86	60	21	10	3	2	8	16	50	94
1969	128	83	420	622	165	27	9	2	2	5	5	17
1970	276	352	268	203	152	33	10	4	5	9	20	22
1971	248	277	237	256	149	155	21	6	9	11	18	28
1972	252	492	849	310	259	44	12	6	5	7	12	76
1973	99	32	113	61	33	12	2	1	1	2	59	411
1974	843	358	375	562	233	100	12	4	3	3	7	8
1975	48	81	311	400	445	56	14	11	6	11	19	174
1976	242	187	250	561	185	33	11	9	5	6	7	8
1977	18	19	29	52	25	11	3	2	4	6	21	166
1978	131	228	212	145	82	20	11	6	7	4	6	9
1979	5	122	383	394	272	18	6	3	2	6	7	29
1980	70	127	173	112	91	77	13	5	5	5	11	111
1981	86	398	93	199	92	78	20	5	4	7	15	51
1982	98	685	427	362	116	25	12	5	7	9	20	60
1983	180	348	372	154	91	20	13	5	7	8	48	60
1984	216	171	455	262	110	110	18	6	7	9	33	26
1985	18	37	198	492	107	50	7	5	9	9	14	12
1986	63	400	364	111	63	15	7	2	5	7	39	36
1987	22	151	160	79	29	15	8	2	4	3	4	5

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.
2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. near Potlatch, ID.

   D. The Laird Dam site is located approximately twenty-two miles upstream of the gage on the Palouse R. near Potlatch. To generate average monthly streamflows at the dam site, the flows for the gage near Potlatch were multiplied by the factor 0.389, which was taken from a curve relating the annual runoff to the basin mean elevation of the gage sites along the Palouse River. This adjustment produced the natural average monthly discharges for the Laird Dam site for the period 1927-1987.

TABLE A-2

PALOUSE RIVER BASIN

HARVARD DAM SITE
SECTION 9, T41N, R3W

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	243	247	494	712	248	118	22	10	14	31	190	731
1928	149	166	677	981	236	36	3	4	5	12	26	15
1929	32	3	99	170	66	25	12	3	2	3	11	28
1930	11	162	205	155	74	32	15	5	6	13	13	5
1931	3	78	443	408	75	16	1	1	2	5	7	9
1932	18	88	628	907	532	84	15	7	9	7	25	46
1933	95	45	552	697	347	143	21	10	11	20	82	91
1934	292	238	445	438	20	18	4	3	3	14	14	37
1935	51	129	153	203	334	65	17	6	9	5	12	28
1936	10	43	185	250	226	61	20	4	6	1	6	18
1937	3	11	132	316	243	54	14	6	5	8	16	55
1938	136	155	217	205	147	29	13	7	9	6	17	32
1939	55	53	601	447	93	31	11	4	2	4	7	15
1940	59	344	655	460	94	15	2	4	5	13	14	61
1941	86	128	158	136	59	42	17	7	12	23	161	324
1942	192	189	400	338	114	46	16	7	9	8	30	72
1943	199	282	438	482	216	115	26	10	11	12	28	53
1944	37	51	155	207	39	15	3	1	2	3	5	11
1945	245	187	374	457	205	34	16	3	7	7	13	47
1946	72	167	378	303	236	53	21	6	7	11	36	211
1947	255	827	734	1063	121	52	13	4	10	20	31	136
1948	297	480	286	143	840	124	27	16	13	16	35	52
1949	56	228	526	430	428	38	8	7	3	8	19	30
1950	33	354	463	389	490	251	26	13	10	19	42	101
1951	157	629	280	410	131	61	21	7	7	16	19	76
1952	39	183	549	785	236	45	11	9	7	5	11	16
1953	232	388	465	308	269	116	20	9	11	9	32	107
1954	89	353	196	251	128	80	14	11	14	15	24	36
1955	48	39	236	363	316	79	24	9	9	22	61	584
1956	294	173	626	757	436	84	18	10	6	14	21	102
1957	28	279	523	551	649	93	18	9	9	13	18	98

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1958	184	947	345	772	181	42	14	6	8	9	63	262
1959	615	253	640	456	257	76	20	7	14	22	103	53
1960	58	240	448	467	173	59	11	7	7	10	35	52
1961	111	905	303	298	240	51	11	5	5	11	10	64
1962	76	190	326	338	150	57	11	7	9	15	32	79
1963	13	357	241	288	89	28	5	5	5	5	45	17
1964	24	33	285	618	423	129	20	13	11	12	28	630
1965	570	796	534	644	155	71	13	10	7	7	14	16
1966	48	28	440	220	58	21	5	1	3	3	20	74
1967	319	192	325	318	395	84	13	3	1	9	11	51
1968	49	631	145	102	36	17	5	3	13	27	85	159
1969	217	140	711	1051	278	45	15	3	3	8	9	28
1970	467	596	453	343	258	55	17	7	9	14	34	38
1971	419	469	400	433	253	262	35	11	14	18	30	47
1972	426	832	1436	524	439	74	20	11	8	12	20	128
1973	168	55	191	103	56	21	3	1	1	3	99	696
1974	1425	605	635	951	395	168	20	7	5	5	13	14
1975	82	136	526	677	753	95	23	19	11	18	33	295
1976	409	316	423	949	313	57	18	15	9	10	12	13
1977	30	33	49	88	41	18	5	3	7	10	36	281
1978	221	386	359	245	138	34	19	11	12	7	10	15
1979	9	207	648	667	459	30	11	5	3	11	12	49
1980	119	215	293	190	154	131	22	8	9	8	18	188
1981	145	673	158	336	156	132	34	9	6	13	25	86
1982	165	1159	722	612	196	41	20	9	11	14	34	101
1983	305	588	630	261	153	34	22	9	11	13	81	101
1984	366	290	769	443	187	186	30	11	12	16	56	45
1985	30	63	336	832	182	84	13	9	15	15	23	20
1986	107	676	617	188	106	25	12	3	9	13	66	61
1987	38	256	271	134	49	26	14	4	7	5	6	9

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.
2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.
   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.
   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. near Potlatch, ID.
   D. The Harvard Dam site is located approximately sixteen miles upstream of the gage on the Palouse R. near Potlatch. To generate average monthly streamflows at the dam site, the flows for the gage near Potlatch were multiplied by the factor 0.658, which was taken from a curve relating the annual runoff to the basin mean elevation of the gage sites along the Palouse River. This adjustment produced the natural average monthly discharges for the Harvard Dam site for the period 1927-1987.

TABLE A-3

PALOUSE RIVER BASIN

PALOUSE R. NEAR POTLATCH, IDAHO
USGS GAGE #13345000; SECTION 10, T41N, R5W

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	370	376	751	1082	377	180	34	15	21	47	289	1111
1928	226	253	1029	1491	359	54	5	6	7	18	39	23
1929	49	4	151	259	101	38	18	5	3	5	16	43
1930	16	246	311	235	113	49	23	7	9	20	20	8
1931	5	119	674	620	114	24	2	2	3	7	11	14
1932	27	134	954	1379	808	128	23	11	13	11	38	70
1933	144	69	839	1059	527	217	32	15	17	31	125	139
1934	444	361	676	666	30	28	6	4	4	21	21	56
1935	77	196	233	308	508	99	26	9	13	7	18	43
1936	15	66	281	380	343	92	30	6	9	1	9	27
1937	5	17	200	481	369	82	22	9	8	12	24	83
1938	207	236	330	312	224	44	19	10	14	9	26	48
1939	84	81	913	680	141	47	17	6	3	6	10	23
1940	90	523	996	699	143	23	3	6	7	19	21	92
1941	130	195	240	206	90	64	26	11	18	35	245	492
1942	292	287	608	513	173	70	24	10	14	12	46	110
1943	302	428	665	732	329	175	39	15	16	18	43	81
1944	56	78	235	314	59	23	4	2	3	5	8	16
1945	373	284	569	694	311	52	25	5	11	11	20	72
1946	110	254	575	461	358	81	32	9	10	16	54	321
1947	387	1257	1116	1615	184	79	20	6	15	31	47	206
1948	451	730	434	218	1277	188	41	25	19	25	53	79
1949	85	346	799	653	651	58	12	10	4	12	29	46
1950	50	538	703	591	744	381	40	19	15	29	64	154
1951	239	956	426	623	199	92	32	10	10	24	29	115
1952	60	278	834	1193	358	69	17	14	10	7	17	25
1953	353	589	706	468	409	176	30	14	17	13	48	163
1954	136	536	298	381	195	121	22	16	21	23	37	54
1955	73	59	358	552	480	120	37	13	14	33	93	888
1956	447	263	951	1151	663	128	28	15	9	22	32	155
1957	42	424	795	837	987	141	27	14	13	19	28	149
1958	279	1439	524	1173	275	64	21	9	12	14	96	398
1959	935	384	973	693	391	116	30	10	21	33	156	81
1960	88	364	681	709	263	89	16	10	11	15	53	79
1961	168	1376	461	453	365	78	17	8	7	16	15	98
1962	115	289	496	514	228	86	16	11	13	23	48	120
1963	19	543	366	437	135	42	8	7	7	7	69	26
1964	37	50	433	939	643	196	30	19	16	18	42	957
1965	867	1209	812	979	235	108	19	15	10	10	22	25
1966	73	42	669	335	88	32	8	2	4	5	31	112
1967	485	292	494	484	600	128	20	4	2	13	17	78
1968	75	959	221	155	54	26	7	5	20	41	129	241
1969	330	213	1080	1598	423	69	23	4	5	12	14	43
1970	709	906	688	522	392	84	26	10	13	22	51	57
1971	637	713	608	658	384	398	53	16	22	27	46	71
1972	648	1264	2182	796	667	113	31	16	12	18	30	195
1973	255	83	291	157	85	32	4	2	2	4	151	1057
1974	2166	920	965	1446	600	256	31	10	7	8	19	21
1975	124	207	800	1029	1144	145	35	29	16	28	50	448
1976	621	480	643	1442	476	86	27	23	13	15	18	20
1977	46	50	74	133	63	28	7	4	10	15	55	427
1978	336	586	545	373	210	51	29	16	18	11	15	23
1979	14	314	985	1013	698	46	16	7	5	16	18	74
1980	181	326	446	288	234	199	33	12	14	12	27	286
1981	221	1023	240	511	237	201	51	14	9	19	38	131
1982	251	1761	1097	930	298	63	31	14	17	22	52	153
1983	463	894	957	397	233	52	33	14	17	20	123	153
1984	556	440	1169	673	284	283	45	16	18	24	85	68
1985	46	96	510	1265	276	128	19	13	23	23	35	30
1986	162	1027	937	286	161	38	18	5	14	19	100	92
1987	57	389	412	204	75	39	21	6	10	7	9	14

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.
2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.
   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.
   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. near Potlatch, ID.

TABLE A-4

PALOUSE RIVER BASIN

PALOUSE R. AT PALOUSE, WASHINGTON
USGS GAGE #13345300; SECTION 6, T16N, R46E

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	425	578	820	1082	382	198	34	16	25	52	289	1111
1928	384	495	1029	1491	376	54	5	6	7	21	39	25
1929	49	4	151	292	103	38	18	5	3	8	16	44
1930	21	246	363	274	119	50	23	7	9	20	20	8
1931	17	119	787	674	146	24	2	2	3	7	13	14
1932	50	161	954	1379	808	128	24	11	13	14	38	80
1933	144	145	839	1059	550	219	33	18	17	34	125	139
1934	791	536	845	666	37	28	6	4	6	21	21	61
1935	86	369	233	355	508	99	26	9	13	12	28	47
1936	26	66	299	455	343	99	32	6	9	7	22	27
1937	9	18	200	486	369	82	22	9	8	13	24	87
1938	207	260	330	337	240	44	19	10	14	16	30	48
1939	92	132	913	680	166	50	17	6	3	10	20	23
1940	90	557	1015	699	160	23	4	6	7	19	27	93
1941	170	208	240	206	111	64	26	17	18	40	245	492
1942	292	557	656	552	173	81	24	10	14	18	46	113
1943	324	428	672	732	329	175	43	22	16	24	43	81
1944	65	114	307	354	68	23	4	2	3	7	17	16
1945	388	443	606	721	364	54	25	5	11	14	20	75
1946	110	254	575	475	358	81	32	11	10	16	54	356
1947	517	1432	1116	1615	199	79	20	6	15	31	47	206
1948	451	873	434	225	1277	205	43	28	21	27	53	79
1949	215	715	799	693	657	58	12	10	4	12	37	46
1950	50	538	707	666	751	381	40	21	17	32	64	154
1951	286	1068	438	689	212	92	32	12	10	24	39	115
1952	85	560	854	1193	358	69	19	14	10	16	17	25
1953	365	589	706	518	409	176	30	16	22	24	48	188
1954	192	698	323	457	254	121	22	16	21	26	38	54
1955	91	101	358	642	523	138	39	17	22	33	93	888
1956	767	263	951	1195	663	128	30	16	10	23	34	155
1957	58	634	823	899	987	141	27	14	13	19	28	149
1958	495	1672	524	1173	325	64	22	11	12	19	96	398
1959	1506	649	973	729	399	125	30	11	22	37	156	81
1960	176	364	727	709	269	89	16	11	12	17	53	79
1961	436	1376	850	461	420	81	17	8	7	17	20	98
1962	115	289	551	598	232	86	19	11	13	26	48	120
1963	19	543	393	468	137	42	14	7	7	11	69	26
1964	90	67	529	1007	643	196	34	19	16	19	42	957
1965	1689	1216	812	980	266	108	23	19	10	15	22	25
1966	73	48	669	360	104	32	9	2	4	7	31	112
1967	485	292	494	484	600	128	20	4	3	15	17	80
1968	106	959	221	157	69	26	7	5	20	41	129	241
1969	670	369	1080	1612	451	72	29	4	5	19	15	43
1970	1244	1160	698	522	392	99	33	12	13	22	51	57
1971	637	713	721	658	387	398	53	22	22	27	46	71
1972	1840	1264	2182	796	674	115	31	16	12	18	40	195
1973	351	128	298	168	78	21	3	1	3	7	51	1001
1974	1934	902	948	1378	579	254	34	9	6	12	23	28
1975	136	206	793	961	1039	141	33	28	16	28	53	393
1976	610	488	641	1343	473	97	27	21	10	21	27	27
1977	68	55	73	134	59	20	5	4	12	15	51	417
1978	369	589	546	375	214	56	28	17	21	14	17	26
1979	19	331	913	870	597	45	15	6	5	18	22	69
1980	204	340	437	280	235	218	40	12	20	20	28	286
1981	221	1023	240	511	266	201	51	19	9	19	38	131
1982	522	1761	1097	1034	300	70	31	14	17	30	52	153
1983	463	894	957	534	287	58	34	22	17	27	123	153
1984	819	745	1169	715	314	283	45	25	29	27	85	76
1985	56	96	711	1265	284	128	21	13	23	23	41	34
1986	162	1027	937	368	214	46	18	5	14	21	100	95
1987	77	389	439	240	100	39	21	8	10	12	16	17

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.
2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. at Palouse, Washington.

TABLE A-5

PALOUSE RIVER BASIN

PALOUSE RIVER AT COLFAX, WASHINGTON
USGS GAGE #13346100; SECTION 11, T16N, R43E

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	500	1189	972	1197	403	199	43	15	31	82	544	1378
1928	540	495	1174	1491	386	60	5	6	7	27	103	38
1929	63	17	194	407	152	53	19	5	3	8	27	48
1930	50	257	431	354	139	65	23	7	9	20	34	13
1931	29	212	878	884	154	27	3	3	3	7	25	21
1932	50	232	1161	1409	816	128	27	11	13	14	65	112
1933	328	145	968	1158	550	336	39	18	17	55	235	173
1934	791	568	1031	789	42	34	6	4	6	21	37	93
1935	154	463	279	448	508	99	26	9	13	12	37	54
1936	32	224	404	659	380	127	36	6	9	7	26	33
1937	16	42	291	652	389	82	24	9	8	13	53	105
1938	225	580	330	465	260	77	19	10	14	18	51	66
1939	114	169	1170	824	196	62	17	6	3	10	20	34
1940	90	557	1459	806	160	53	6	6	7	19	33	138
1941	233	280	240	241	111	76	26	17	24	67	544	492
1942	305	559	656	697	193	93	26	10	14	19	75	140
1943	426	428	768	890	363	280	49	22	16	29	64	88
1944	100	191	364	466	84	44	5	2	3	7	23	22
1945	653	443	751	923	364	72	27	5	12	14	38	95
1946	204	296	575	613	383	103	32	11	10	19	108	376
1947	517	1680	1235	1615	212	108	21	6	15	31	72	212
1948	682	919	483	229	1277	205	47	28	21	39	99	106
1949	218	715	853	831	657	58	13	10	4	12	85	54
1950	135	538	735	807	751	399	44	21	17	48	79	203
1951	286	1068	700	864	249	122	32	12	10	24	59	136
1952	89	560	1274	1278	413	109	24	16	10	22	24	31
1953	643	777	766	645	409	218	35	16	22	25	98	188
1954	271	965	421	577	276	121	22	17	21	35	65	55
1955	164	312	358	849	564	138	42	17	22	50	189	725
1956	695	310	1286	1404	617	151	34	15	13	31	54	169
1957	54	407	1116	1021	863	146	23	10	4	18	41	174
1958	412	1536	451	1167	323	72	25	7	11	22	140	346
1959	1449	579	837	817	416	126	30	10	28	68	168	100
1960	126	668	814	801	293	86	13	10	9	17	119	106
1961	197	1996	1038	543	422	81	14	4	6	18	29	96
1962	156	346	695	786	237	113	21	10	11	37	67	162
1963	81	702	350	542	131	48	16	4	7	10	470	39
1964	128	171	535	1196	704	189	37	22	27	25	79	1123
1965	1175	1109	532	1178	241	90	27	19	19	16	26	33
1966	142	125	660	507	105	26	12	1	2	6	31	116
1967	532	370	521	490	664	135	19	4	1	13	25	117
1968	147	998	235	150	54	27	7	2	25	46	139	276
1969	728	340	1410	1674	424	83	26	4	9	23	25	44
1970	769	1046	781	529	386	91	35	12	14	25	56	62
1971	694	746	719	670	397	422	54	18	20	34	63	106
1972	871	1535	2329	783	666	112	21	20	13	16	40	319
1973	413	132	335	188	92	28	4	1	4	7	150	1041
1974	1934	1412	1184	1521	632	332	42	10	6	12	38	47
1975	247	424	1214	1065	1039	141	37	44	22	33	69	531
1976	756	608	713	1411	491	107	34	28	19	22	36	32
1977	46	61	93	153	82	40	5	2	12	17	75	460
1978	419	706	625	451	247	66	29	17	21	14	31	42
1979	21	763	1131	974	677	53	15	6	5	18	26	85
1980	204	437	437	330	282	223	41	14	20	23	45	286
1981	221	1023	295	633	266	201	51	19	9	19	51	137
1982	522	1761	1247	1179	314	105	32	14	20	52	63	195
1983	516	914	1118	682	314	78	39	22	22	36	149	175
1984	819	745	1233	872	368	294	55	25	29	36	167	85
1985	86	178	939	1341	318	191	21	13	23	31	74	41
1986	344	1219	946	519	234	51	18	7	14	28	428	114
1987	100	393	530	284	100	53	21	8	10	12	24	22

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. at Colfax, Washington.

TABLE A-6

PALOUSE RIVER BASIN

PALOUSE RIVER BELOW S.F. AT COLFAX, WASHINGTON
USGS GAGE #13349210: SECTION 11, T16N, R43E

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	736	1189	1201	1474	424	253	60	28	42	82	544	1378
1928	872	695	1742	2028	494	69	16	15	17	38	103	52
1929	93	126	237	462	169	60	35	9	11	19	39	76
1930	53	378	580	427	153	69	32	15	19	28	40	29
1931	39	301	1194	884	165	37	13	5	6	15	33	25
1932	88	282	1509	1558	903	150	39	23	19	26	92	233
1933	447	186	1148	1172	607	336	56	30	32	55	235	975
1934	944	593	1382	918	54	38	16	8	19	30	68	201
1935	277	463	344	448	516	138	41	16	15	25	51	70
1936	58	384	579	659	380	130	53	9	9	12	32	47
1937	22	127	406	652	453	92	39	14	11	27	77	203
1938	408	667	330	561	280	77	39	15	22	30	57	124
1939	185	308	1287	874	210	73	31	12	9	27	34	74
1940	159	637	2027	806	212	53	9	11	12	28	58	247
1941	404	550	263	282	111	88	37	21	36	67	544	646
1942	454	798	853	697	220	93	45	24	28	34	120	242
1943	678	783	947	958	394	287	70	35	27	36	64	123
1944	125	191	508	497	86	44	6	7	7	16	29	67
1945	753	600	1013	923	364	83	34	12	30	27	79	220
1946	278	599	732	662	396	119	47	22	27	33	108	459
1947	783	2191	1717	2143	239	124	32	13	23	50	102	296
1948	823	1323	761	229	1388	206	83	44	38	46	106	135
1949	356	715	1333	831	657	80	31	15	9	24	85	96
1950	157	754	951	876	818	431	71	38	35	48	174	328
1951	453	1124	1131	864	256	124	47	18	22	44	81	249
1952	150	959	1669	1410	443	115	35	28	22	38	43	71
1953	781	980	883	722	473	230	58	28	30	40	98	188
1954	392	1001	626	577	307	181	38	28	37	41	65	85
1955	238	394	574	897	576	174	63	24	33	50	189	834
1956	887	474	2057	1420	710	175	51	33	23	36	55	181
1957	111	802	1476	1140	935	188	44	26	22	32	66	174
1958	663	1575	702	1458	323	91	38	19	31	36	190	368
1959	1488	890	1193	828	428	141	49	15	43	68	229	156
1960	335	689	970	801	299	110	24	22	29	33	119	119
1961	490	2109	1517	543	439	117	30	15	11	29	42	111
1962	284	355	761	786	239	115	33	17	19	45	79	184
1963	97	1061	350	609	177	65	25	10	16	21	63	65
1964	183	284	817	1276	735	210	40	27	34	36	89	1377
1965	1636	1449	658	1314	283	116	34	28	25	22	38	39
1966	222	203	780	540	130	41	17	3	6	12	48	164
1967	756	479	668	661	839	170	25	7	5	21	33	217
1968	200	1343	298	172	78	35	10	8	32	49	168	349
1969	985	483	2114	1878	501	98	29	7	14	28	31	66
1970	1155	1485	1053	650	481	115	44	19	27	35	78	99
1971	1056	936	1082	806	471	568	72	28	35	47	77	173
1972	1364	2210	2959	958	742	133	39	38	27	36	58	410
1973	598	208	389	229	120	38	8	6	10	17	150	1427
1974	1934	1605	1656	1892	674	467	47	30	15	26	52	74
1975	364	741	1722	1136	1162	199	66	53	37	50	114	765
1976	1157	902	1167	1719	582	150	40	39	29	36	50	64
1977	119	108	134	159	89	37	10	9	27	25	89	596
1978	733	911	713	546	314	77	42	32	39	29	35	77
1979	28	1439	1467	1070	740	70	30	10	10	36	54	130
1980	288	558	633	361	322	270	57	26	30	34	51	362
1981	303	1342	389	632	296	250	80	28	18	39	76	229
1982	660	2926	1729	1315	406	106	52	19	32	51	93	245
1983	673	1316	1414	571	326	84	68	33	30	42	211	292
1984	978	674	1484	839	374	348	66	36	42	45	129	219
1985	108	321	1222	1286	367	190	29	20	40	41	56	45
1986	478	1550	1176	404	234	61	32	16	30	37	129	117
1987	163	488	719	216	95	62	41	19	14	15	30	61

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.
   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.
   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. blw S. F. at Colfax, WA.

TABLE A-7

PALOUSE RIVER BASIN

PALOUSE RIVER AT HOOPER, WASHINGTON
USGS GAGE #13351000: SECTION 27, T15N, R37E

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	1199	1400	2018	1525	750	377	179	107	116	133	544	1378
1928	1207	1287	2763	2290	847	118	58	30	17	56	109	119
1929	169	126	463	740	202	122	64	9	11	28	84	158
1930	179	698	933	535	242	152	32	15	19	56	103	86
1931	81	601	1903	1499	320	60	15	5	7	52	62	87
1932	166	674	2076	2257	1163	286	131	72	29	37	123	287
1933	802	321	1741	1869	892	417	131	68	92	89	334	2130
1934	1748	1174	2179	1272	74	57	16	8	19	96	101	333
1935	422	985	540	696	867	228	107	48	40	62	94	136
1936	129	1062	1008	1006	564	241	123	54	14	27	82	130
1937	81	306	678	1107	643	193	99	44	27	48	132	399
1938	779	1584	402	723	451	124	65	42	73	75	121	227
1939	303	396	2070	1298	378	153	88	44	26	46	78	132
1940	230	1707	2882	1300	412	79	9	11	18	83	102	356
1941	586	1390	463	382	229	167	117	94	108	109	544	646
1942	657	1634	1234	1070	340	193	132	28	72	64	185	359
1943	1231	1761	1394	1550	691	397	174	98	40	62	103	245
1944	394	538	918	827	120	82	12	12	8	32	63	113
1945	1473	1550	1898	1082	748	124	73	27	55	49	100	327
1946	610	1040	1202	776	593	214	114	50	50	67	129	682
1947	1433	3488	2773	2345	489	212	64	32	49	120	260	460
1948	1460	2651	1134	327	1537	455	160	101	82	94	142	236
1949	559	1528	2005	1402	1049	153	33	62	9	87	151	153
1950	325	1819	1284	1520	1146	571	181	101	78	101	210	516
1951	658	2380	1845	1112	460	287	105	43	40	123	158	354
1952	329	2791	2634	2353	744	226	181	96	61	48	64	118
1953	1960	2029	1291	798	765	411	122	72	43	49	99	392
1954	675	1809	1135	978	446	289	116	72	88	78	120	153
1955	513	754	896	1536	927	258	116	33	31	99	349	2101
1956	2145	1181	3488	2059	990	317	135	68	56	81	119	283
1957	146	1469	2191	1459	1364	354	103	60	30	65	89	311
1958	862	2687	1036	2050	677	199	92	25	27	63	224	723
1959	3014	1707	1844	1212	701	293	90	56	100	157	319	251
1960	270	1324	1273	1260	521	208	50	31	52	64	206	237
1961	514	3627	2125	985	731	239	70	33	43	70	98	218
1962	344	626	1296	1215	487	235	54	31	34	91	130	308
1963	166	2933	599	888	325	135	43	21	25	39	99	132
1964	321	499	1182	1528	860	309	89	56	67	64	130	1752
1965	2590	2782	1157	1644	540	228	105	60	67	58	83	100
1966	434	382	1060	720	204	75	27	2	6	26	72	214
1967	873	800	790	785	977	285	62	8	6	32	69	274
1968	306	1561	484	294	134	58	6	0	41	73	186	410
1969	1226	903	3682	2990	949	253	112	39	44	76	86	141
1970	1749	2329	1672	961	657	231	96	56	55	82	139	194
1971	1997	1271	1472	1040	588	706	163	54	91	96	128	329
1972	1979	3317	3754	1362	1072	289	112	89	61	82	114	596
1973	1203	443	603	325	185	70	14	2	7	46	233	2198
1974	4602	3353	2387	2543	1015	503	174	95	68	77	119	179
1975	879	1233	2944	1830	1589	395	196	135	118	128	199	1090
1976	1884	1543	1634	2099	803	309	136	117	92	91	111	122
1977	149	169	216	211	141	75	9	8	47	66	138	740
1978	890	1378	1143	816	514	168	149	60	87	63	80	147
1979	63	3441	2358	1384	1021	169	76	39	49	63	97	195
1980	427	986	1023	580	511	498	162	66	81	69	108	452
1981	513	1783	627	924	485	375	162	56	39	78	120	323
1982	958	4174	2563	1957	685	249	158	85	84	105	172	514
1983	1283	1914	2318	1174	596	214	186	106	99	103	346	508
1984	2157	1332	2113	1438	679	548	195	122	105	107	213	401
1985	238	814	2006	2109	572	325	89	85	102	103	130	124
1986	1122	2456	1782	748	462	191	115	68	93	101	179	215
1987	257	878	936	361	187	107	72	48	31	44	70	129

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.
2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse River at Hooper, Washington.

TABLE A-8

PALOUSE RIVER BASIN

PARADISE CR. AT UNIVERSITY OF IDAHO AT MOSCOW, IDAHO
USGS GAGE #13346800; SECTION 12, T39N, R6W

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	24	22	13	24	4	3	1	0	1	0	5	7
1928	21	28	74	15	4	1	1	1	0	0	3	2
1929	0	10	17	6	3	1	1	0	2	0	0	2
1930	0	19	40	4	3	1	1	0	1	0	0	1
1931	0	7	47	5	2	0	1	1	0	0	0	1
1932	0	6	57	12	5	2	1	0	1	0	3	5
1933	15	7	46	13	4	3	1	1	1	0	4	8
1934	32	12	17	5	2	1	1	0	0	0	1	5
1935	24	11	18	16	3	1	1	1	1	0	1	2
1936	6	6	28	9	3	1	0	0	1	0	0	1
1937	0	4	41	19	3	1	0	0	1	0	2	4
1938	15	13	30	11	3	1	1	1	0	0	1	3
1939	1	10	55	5	2	1	1	0	1	0	0	1
1940	0	21	22	8	2	1	1	2	0	0	1	4
1941	15	9	5	11	4	3	1	1	0	0	5	8
1942	12	17	10	4	3	1	1	1	1	0	3	5
1943	16	19	23	18	4	2	1	1	0	0	1	2
1944	5	8	25	9	2	1	1	1	0	0	0	2
1945	23	7	28	11	4	1	1	0	3	0	2	4
1946	6	16	28	4	3	1	1	1	1	0	3	6
1947	19	44	28	9	3	1	1	2	0	0	3	5
1948	34	30	10	3	6	2	0	1	0	0	3	4
1949	6	21	27	9	5	2	1	1	1	0	2	2
1950	8	11	15	20	6	4	1	0	3	0	3	4
1951	24	34	36	9	3	2	0	0	1	0	2	5
1952	2	16	58	15	5	2	1	2	1	0	1	2
1953	9	24	20	7	3	1	0	1	0	0	2	4
1954	10	23	7	19	3	2	0	0	3	1	1	2
1955	5	15	15	6	3	2	1	0	1	0	4	7
1956	18	19	66	9	5	1	0	0	1	0	1	4
1957	11	23	38	20	5	2	1	1	4	0	2	3
1958	7	47	8	11	5	4	1	0	0	1	5	6
1959	39	15	41	8	3	2	0	0	1	0	4	4
1960	3	20	17	10	3	1	1	1	1	0	3	3
1961	9	31	39	9	5	1	0	0	0	0	1	2
1962	6	9	21	7	3	1	1	0	0	0	2	4
1963	0	34	3	7	2	1	1	0	0	0	1	1
1964	9	12	33	11	3	3	1	0	0	0	3	10
1965	27	24	11	10	4	2	1	2	0	0	0	1
1966	10	2	14	3	2	1	1	1	0	0	0	3
1967	26	16	7	9	4	2	1	0	3	0	0	3
1968	3	46	3	4	2	1	1	0	1	0	4	5
1969	33	8	93	17	5	1	1	1	1	1	0	1
1970	30	20	22	6	4	2	1	0	2	0	2	3
1971	29	23	25	8	3	6	1	1	2	0	2	3
1972	39	23	107	13	7	1	1	1	2	0	1	6
1973	16	5	6	4	2	1	1	0	3	0	3	9
1974	36	32	47	20	4	4	0	0	1	0	1	2
1975	17	37	70	16	6	2	1	2	1	0	3	8
1976	27	30	50	19	4	3	1	0	0	0	1	2
1977	1	3	1	3	2	1	1	0	2	0	2	7
1978	16	24	13	14	3	2	1	1	0	0	0	2
1979	0	45	38	10	7	1	1	1	0	1	1	3
1980	8	19	14	5	5	2	0	0	1	0	1	5
1981	4	32	6	9	3	4	1	0	1	1	1	3
1982	16	67	23	17	2	1	1	1	1	1	2	6
1983	17	23	20	7	3	1	1	1	1	1	4	5
1984	22	12	18	10	3	3	1	1	0	1	3	3
1985	2	7	49	16	3	3	1	1	2	1	1	1
1986	20	54	15	4	4	1	1	1	1	0	4	3
1987	1	10	13	2	2	1	1	2	0	0	0	1

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. below S. F. at Colfax, WA.

   D. That extended data set was input back into the HEC4 program as a long record station along with the actual gage data for the following gages in the S.F. Palouse R. basin; gage #13346800, Paradise Cr. at U of I at Moscow, Id. for Oct 1978 - Oct 1986; gage #13348000, S.F. Palouse R. at Pullman, Wa. for Feb 1934 - Sep 1942 & Jan 1960 - Sep 1981, and gage #13348500, Missouri Flat Cr. at Pullman, Wa. for Feb 1934 - Sep 1940 & Jan 1960 - Sep 1979. The HEC4 program generated missing streamflow data for the above gages in the period 1927 - 1987 producing the set of natural average monthly streamflows for the Paradise Cr. at U of I at Moscow, Id. gage site.

TABLE A-9

PALOUSE RIVER BASIN

S. F. PALOUSE RIVER ABOVE MISSOURI FLAT CREEK AT PULLMAN, WA
USGS GAGE #13348000; SECTION 6, T14N, R45E

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	116	46	75	126	32	13	8	4	3	4	14	85
1928	104	111	241	80	28	11	5	3	3	6	14	22
1929	4	384	89	40	12	4	3	4	3	3	7	4
1930	5	384	169	23	10	5	3	3	5	4	6	6
1931	3	370	191	43	7	1	1	2	1	6	3	4
1932	7	407	219	96	36	17	5	3	5	5	18	27
1933	65	61	175	84	31	17	5	5	6	2	9	59
1934	263	44	94	25	6	7	2	1	1	3	4	23
1935	109	64	92	124	18	4	2	1	1	1	2	4
1936	50	53	140	35	12	3	1	1	1	1	2	3
1937	2	14	177	122	15	7	2	1	1	2	3	17
1938	52	89	135	55	11	3	1	1	1	2	3	4
1939	7	47	218	26	6	2	1	1	1	1	1	3
1940	7	87	90	42	7	2	1	1	1	4	20	70
1941	115	61	36	42	27	19	4	1	2	2	7	65
1942	40	89	62	21	18	8	2	1	0	1	3	17
1943	66	60	119	102	23	10	2	2	2	2	7	10
1944	19	25	100	43	8	2	1	1	1	3	3	5
1945	115	29	127	68	25	7	4	6	6	7	9	47
1946	36	96	118	21	14	3	2	3	4	5	10	34
1947	111	194	123	65	14	5	5	2	0	1	4	28
1948	251	71	57	14	56	16	7	3	4	5	6	16
1949	20	162	132	59	42	11	3	3	3	5	10	12
1950	40	67	82	104	49	28	8	5	6	12	22	37
1951	116	62	162	52	20	10	3	1	3	3	10	28
1952	19	315	226	91	31	24	8	6	5	7	6	8
1953	29	95	120	36	16	5	4	2	3	4	12	42
1954	61	147	52	91	19	13	3	3	5	6	7	10
1955	34	77	73	31	25	7	2	3	4	4	24	107
1956	74	63	240	64	33	8	5	3	4	5	16	30
1957	60	102	165	118	38	16	8	8	6	9	15	26
1958	56	213	44	82	32	32	10	4	5	6	17	99
1959	525	51	171	42	16	8	3	1	3	4	11	24
1960	20	100	91	54	20	6	2	2	2	3	16	18
1961	50	288	163	45	26	8	2	2	2	3	8	28
1962	30	37	110	45	19	6	2	2	3	5	5	12
1963	7	127	22	35	10	5	2	2	2	3	5	9
1964	30	49	149	76	28	13	4	3	3	3	7	113
1965	247	158	56	72	19	9	3	2	3	3	4	4
1966	41	40	70	20	7	4	3	2	2	3	5	16
1967	75	37	40	41	42	12	3	2	2	4	3	48
1968	18	101	22	14	6	3	2	3	5	5	17	45
1969	160	91	313	137	36	8	4	3	4	6	6	11
1970	168	149	103	39	23	9	6	3	4	5	10	13
1971	152	80	122	45	22	41	8	5	5	7	14	40
1972	268	360	305	70	53	16	7	9	6	7	9	65
1973	85	33	37	21	10	4	3	4	5	5	41	219
1974	401	298	184	123	38	23	7	4	4	5	8	14
1975	87	115	234	95	58	15	8	7	6	9	15	85
1976	165	133	187	136	40	19	7	7	5	7	8	9
1977	12	10	14	8	8	4	3	4	5	5	16	55
1978	81	128	73	63	25	8	6	5	5	5	7	16
1979	7	332	161	67	57	9	4	4	4	6	8	17
1980	46	103	72	28	28	17	6	4	6	5	9	23
1981	21	123	42	65	23	18	6	3	5	6	14	56
1982	79	104	111	105	11	6	2	1	3	6	15	36
1983	75	72	103	33	14	7	3	5	6	6	18	44
1984	111	105	99	64	20	20	9	10	4	6	6	20
1985	15	145	180	114	20	15	7	7	6	6	6	9
1986	73	65	94	24	23	6	2	1	0	5	7	9
1987	7	98	67	7	4	2	1	2	1	2	2	4

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. below S. F. at Colfax, WA.

   D. That extended data set was input back into the HEC4 program as a long record station along with the actual gage data for the following gages in the S.F. Palouse R. basin: gage #13346800, Paradise Cr. at U of I at Moscow, Id. for Oct 1978 - Oct 1986; gage #13348000, S.F. Palouse R. at Pullman, Wa. for Feb 1934 - Sep 1942 & Jan 1960 - Sep 1981, and gage #13348500, Missouri Flat Cr. at Pullman, Wa. for Feb 1934 - Sep 1940 & Jan 1960 - Sep 1979. The HEC4 program generated missing streamflow data for the above gages in the period 1927 - 1987 producing the set of natural average monthly streamflows for the S. F. of the Palouse R. above Missouri Flat Creek at Pullman Washington gage site.

TABLE A-10

PALOUSE RIVER BASIN

MISSOURI FLAT CREEK AT PULLMAN, WASHINGTON
USGS GAGE #13348500; SECTION 6, T14N, R45E

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	22	44	18	24	4	2	0	0	0	1	13	36
1928	27	34	62	13	4	1	0	0	0	0	2	7
1929	1	99	29	4	1	0	0	0	0	0	3	0
1930	1	103	57	1	2	1	0	0	0	0	0	0
1931	0	95	68	2	0	0	0	0	0	0	0	0
1932	0	98	64	13	3	1	0	0	0	0	2	4
1933	14	17	41	13	3	1	2	0	0	1	5	23
1934	60	8	14	3	1	1	0	0	0	0	0	5
1935	32	18	23	24	1	0	0	0	0	0	0	0
1936	13	11	35	4	1	0	0	0	0	0	0	0
1937	0	2	46	22	1	1	0	0	0	0	0	3
1938	13	24	31	7	1	0	0	0	0	0	0	0
1939	1	9	52	3	0	0	0	0	0	0	0	0
1940	1	23	19	7	0	0	0	0	0	0	3	12
1941	16	11	8	9	3	3	0	0	0	0	5	13
1942	18	22	9	2	2	0	0	0	0	0	0	3
1943	26	12	25	18	3	1	0	0	0	0	2	1
1944	3	3	13	7	0	0	0	0	0	0	0	0
1945	21	5	23	7	2	1	0	1	0	0	0	15
1946	5	31	26	3	1	0	0	0	0	1	2	7
1947	29	37	23	9	1	0	0	0	0	0	1	5
1948	51	24	13	1	8	3	0	0	0	0	2	2
1949	6	34	35	8	5	1	0	0	0	0	2	1
1950	6	17	20	17	3	6	0	0	0	1	2	9
1951	27	12	33	10	1	1	0	0	0	0	4	6
1952	3	107	56	21	4	2	0	0	0	2	0	0
1953	10	15	24	6	1	0	0	0	0	0	2	13
1954	14	34	12	16	1	1	0	0	0	1	0	2
1955	4	15	12	5	2	0	0	1	0	1	26	42
1956	26	24	58	8	4	0	0	0	0	0	3	6
1957	9	26	38	20	3	3	0	1	0	2	3	5

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1958	8	26	11	12	4	4	1	0	0	0	7	32
1959	74	21	40	5	1	1	0	0	0	1	7	4
1960	4	29	19	8	2	1	0	0	0	1	2	2
1961	10	85	44	6	3	1	0	0	0	0	1	4
1962	5	5	24	5	3	1	0	0	0	1	1	2
1963	1	40	3	6	1	0	0	0	0	0	1	1
1964	4	9	37	8	2	1	0	0	0	0	1	28
1965	57	32	7	8	2	1	0	0	0	0	0	0
1966	6	6	11	1	0	0	0	0	0	0	1	3
1967	27	8	6	7	7	1	0	0	0	1	0	13
1968	4	25	3	1	0	0	0	0	0	1	3	9
1969	45	22	93	21	2	1	0	0	0	0	0	1
1970	46	31	19	5	2	1	1	0	0	0	1	2
1971	42	15	39	5	2	9	1	0	0	1	2	8
1972	72	89	57	11	8	1	0	3	0	1	1	21
1973	22	8	5	1	1	1	1	1	1	0	9	46
1974	81	61	35	18	5	3	1	0	0	1	1	2
1975	18	28	63	17	4	1	1	1	0	1	2	18
1976	36	29	38	20	4	2	0	1	0	1	1	1
1977	1	1	2	1	1	0	0	1	1	0	2	15
1978	21	35	15	12	3	1	1	0	0	0	1	2
1979	0	81	34	10	6	1	0	0	0	4	1	2
1980	9	27	9	4	4	1	0	0	0	1	3	3
1981	9	35	10	10	2	3	0	0	0	0	1	15
1982	20	33	29	17	0	0	0	0	0	0	3	7
1983	17	7	19	3	1	0	0	2	0	0	3	9
1984	38	30	28	13	2	3	0	1	0	5	1	4
1985	1	45	62	13	1	3	0	0	0	0	0	0
1986	17	15	17	2	3	0	0	0	0	0	1	1
1987	2	24	10	0	0	0	0	0	0	0	0	0

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse R. below S. F. at Colfax, WA.

   D. That extended data set was input back into the HEC4 program as a long record station along with the actual gage data for the following gages in the S.F. Palouse R. basin: gage #13346800, Paradise Cr. at U of I at Moscow, Id. for Oct 1978 - Oct 1986; gage #13348000, S.F. Palouse R. at Pullman, Wa. for Feb 1934 - Sep 1942 & Jan 1960 - Sep 1981, and gage #13348500, Missouri Flat Cr. at Pullman, Wa. for Feb 1934 - Sep 1940 & Jan 1960 - Sep 1979. The HEC4 program generated missing streamflow data for the above gages in the period 1927 - 1987 producing the set of natural average monthly streamflows for the Missouri Flat Cr. at Pullman, WA. gage site.

TABLE A-11

PALOUSE RIVER BASIN

S. F. PALOUSE RIVER DAMSITE AT ROBINSON LAKE, IDAHO
SECTION 1, T39N, R5W

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	17	7	11	18	5	2	1	1	0	1	2	12
1928	15	16	34	11	4	2	1	0	0	1	2	3
1929	1	55	13	6	2	1	0	1	0	0	1	1
1930	1	55	24	3	1	1	0	0	1	1	1	1
1931	0	53	27	6	1	0	0	0	0	1	0	1
1932	1	58	31	14	5	2	1	0	1	1	3	4
1933	9	9	25	12	4	2	1	1	1	0	1	10
1934	38	6	13	4	1	1	0	0	0	0	1	3
1935	16	9	13	18	3	1	0	0	0	0	0	1
1936	7	8	20	5	2	0	0	0	0	0	0	0
1937	0	2	25	17	2	1	0	0	0	0	0	2
1938	7	13	19	8	2	0	0	0	0	0	0	1
1939	1	7	31	4	1	0	0	0	0	0	0	0
1940	1	12	13	6	1	0	0	0	0	1	3	10
1941	16	9	5	6	4	3	1	0	0	0	1	9
1942	6	13	9	3	3	1	0	0	0	0	0	2
1943	9	9	17	15	3	1	0	0	0	0	1	1
1944	3	4	14	6	1	0	0	0	0	0	0	1
1945	16	4	18	10	4	1	1	1	1	1	1	7
1946	5	14	17	3	2	0	0	0	1	1	1	5
1947	16	28	18	9	2	1	1	0	0	0	1	4
1948	36	10	8	2	8	2	1	0	1	1	1	2
1949	3	23	19	8	6	2	0	0	0	1	1	2
1950	6	10	12	15	7	4	1	1	1	2	3	5
1951	17	9	23	7	3	1	0	0	0	0	1	4
1952	3	45	32	13	4	3	1	1	1	1	1	1
1953	4	14	17	5	2	1	1	0	0	1	2	6
1954	9	21	7	13	3	2	0	0	1	1	1	1
1955	5	11	10	4	4	1	0	0	1	1	3	15
1956	11	9	34	9	5	1	1	0	1	1	2	4
1957	9	15	24	17	5	2	1	1	1	1	2	4
1958	8	30	6	12	5	5	1	1	1	1	2	14
1959	75	7	24	6	2	1	0	0	0	1	2	3
1960	3	14	13	8	3	1	0	0	0	0	2	3
1961	7	41	23	6	4	1	0	0	0	0	1	4
1962	4	5	16	6	3	1	0	0	0	1	1	2
1963	1	18	3	5	1	1	0	0	0	0	1	1
1964	4	7	21	11	4	2	1	0	0	0	1	16
1965	35	23	8	10	3	1	0	0	0	0	1	1
1966	6	6	10	3	1	1	0	0	0	0	1	2
1967	11	5	6	6	6	2	0	0	0	1	0	7
1968	3	14	3	2	1	0	0	0	1	1	2	6
1969	23	13	45	20	5	1	1	0	1	1	1	2
1970	24	21	15	6	3	1	1	0	1	1	1	2
1971	22	11	17	6	3	6	1	1	1	1	2	6
1972	38	51	44	10	8	2	1	1	1	1	1	9
1973	12	5	5	3	1	1	0	1	1	1	6	31
1974	57	43	26	18	5	3	1	1	1	1	1	2
1975	12	16	33	14	8	2	1	1	1	1	2	12
1976	24	19	27	19	6	3	1	1	1	1	1	1
1977	2	1	2	1	1	1	0	1	1	1	2	8
1978	12	18	10	9	4	1	1	1	1	1	1	2
1979	1	47	23	10	8	1	1	1	1	1	1	2
1980	7	15	10	4	4	2	1	1	1	1	1	3
1981	3	18	6	9	3	3	1	0	1	1	2	8
1982	11	15	16	15	2	1	0	0	0	1	2	5
1983	11	10	15	5	2	1	0	1	1	1	3	6
1984	16	15	14	9	3	3	1	1	1	1	1	3
1985	2	21	26	16	3	2	1	1	1	1	1	1
1986	10	9	13	3	3	1	0	0	0	1	1	1
1987	1	14	10	1	1	0	0	0	0	0	0	1

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse River below South Fork at Colfax, Wa.

   D. That extended data set was input back into the HEC4 program as a long record station along with the actual gage data for the following gages in the S.F. Palouse R. basin: gage #13346800, Paradise Cr. at U of I at Moscow, Id. for Oct 1978 - Oct 1986; gage # 13348000, S. F. Palouse R. at Pullman, Wa. for Feb 1934 - Sep 1942 & Jan 1960 - Sep 1981; and gage #13348500, Missouri Flat Cr at Pullman, Wa. for Feb 1934 - Sep 1940 & Jan 1960 - Sep 1979. The HEC4 program generated missing streamflow data for the above gages in the period 1927 - 1987 producing the set of natural average monthly streamflows for the S. F. Palouse R. above Missouri Flat Creek at Pullman, Wa. gage site.

   E. The Robinson Lake damsite is located approximately seventeen miles upstream of the gage on the S. F. Palouse R. at Pullman. To generate average monthly streamflows at the dam site, the flows for the gage at Pullman were multiplied by the factor 0.143, which was taken from a curve relating the annual runoff to the basin mean elevation of the gage sites in the S. F. Palouse R. basin. This adjustment produced the natural average monthly discharges for the Robinson Lake damsite for the period 1927 - 1987.

TABLE A-12

PALOUSE RIVER BASIN

PARADISE CREEK DAM SITE ABOVE MOSCOW, IDAHO
SECTION 4, T39N, R5W

NATURAL AVERAGE MONTHLY DISCHARGE (CFS)

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1927	17	16	9	17	3	2	1	0	1	0	4	5
1929	0	7	12	4	2	1	1	0	1	0	0	1
1928	15	20	53	11	3	1	1	1	0	0	2	1
1930	0	14	29	3	2	1	1	0	1	0	0	1
1931	0	5	34	4	1	0	1	1	0	0	0	1
1932	0	4	41	9	4	1	1	0	1	0	2	4
1933	11	5	33	9	3	2	1	1	1	0	3	6
1934	23	9	12	4	1	1	1	0	0	0	1	4
1935	17	8	13	12	2	1	1	1	1	0	1	1
1936	4	4	20	5	2	1	0	0	1	0	0	1
1937	0	3	30	14	2	1	0	0	1	0	1	3
1938	11	9	22	8	2	1	1	1	0	0	1	2
1939	1	7	40	4	1	1	1	0	1	0	0	1
1940	0	15	16	6	1	1	1	1	0	0	1	3
1941	11	6	4	8	3	2	1	1	0	0	4	6
1942	9	12	7	3	2	1	1	1	1	0	2	4
1943	12	14	17	13	3	1	1	1	0	0	1	1
1944	4	6	18	5	1	1	1	1	0	0	0	1
1945	17	5	20	8	3	1	1	0	2	0	1	3
1946	4	12	20	3	2	1	1	1	1	0	2	4
1947	14	32	20	6	2	1	1	1	0	0	2	4
1948	25	22	7	2	4	1	0	1	0	0	2	3
1949	4	15	19	6	4	1	1	1	1	0	1	1
1950	6	8	11	14	4	3	1	0	2	0	2	3
1951	17	25	26	6	2	1	0	0	1	0	1	4
1952	1	12	42	11	4	1	1	1	1	0	1	1
1953	6	17	14	5	2	1	0	1	0	0	1	3
1954	7	17	5	14	2	1	0	0	2	1	1	1
1955	4	11	11	4	2	1	1	0	1	0	3	5
1956	13	14	48	6	4	1	0	0	1	0	1	3
1957	8	17	27	14	4	1	1	1	3	0	1	2
1958	5	34	5	8	4	3	1	0	0	1	4	4
1959	28	11	30	6	2	1	0	0	1	0	3	3
1960	2	14	12	7	2	1	1	1	1	0	2	2
1961	6	22	28	6	4	1	0	0	0	0	1	1
1962	4	6	15	5	2	1	1	0	0	0	1	3
1963	0	25	2	5	1	1	1	0	0	0	1	1
1964	6	9	24	8	2	2	1	0	0	0	2	7
1965	19	17	8	7	3	1	1	1	0	0	0	1
1966	7	1	10	2	1	1	1	1	0	0	0	2
1967	19	12	5	6	3	1	1	0	2	0	0	2
1968	2	33	2	3	1	1	1	0	1	0	3	4
1969	24	6	67	12	4	1	1	1	1	1	0	1
1970	22	14	16	4	3	1	1	0	1	0	1	2
1971	21	17	18	6	2	4	1	1	1	0	1	2
1972	28	17	77	9	5	1	1	1	1	0	1	4
1973	12	4	4	3	1	1	1	0	2	0	2	6
1974	26	23	34	14	3	3	0	0	1	0	1	1
1975	12	27	50	12	4	1	1	1	1	0	2	6
1976	19	22	36	14	3	2	1	0	0	0	1	1
1977	1	2	1	2	1	1	1	0	1	0	1	5
1978	12	17	9	10	2	1	1	1	0	0	0	1
1979	0	32	27	7	5	1	1	1	0	1	1	2
1980	6	14	10	4	4	1	0	0	1	0	1	4
1981	3	23	4	6	2	3	1	0	1	1	1	2
1982	12	48	17	12	1	1	1	1	1	1	1	4
1983	12	17	14	5	2	1	1	1	1	1	3	4
1984	16	9	13	7	2	2	1	1	0	1	2	2
1985	1	5	35	12	2	2	1	1	1	1	1	1
1986	14	39	11	3	3	1	1	1	1	0	3	2
1987	1	7	9	1	1	1	1	1	0	0	0	1

NOTES:

1. Monthly discharges are based on United States Geological Survey gage data at stations #13345000, "Palouse R. nr Potlatch, ID" for Nov 1966-Nov 1986; #13345300, "Palouse R. at Palouse, WA" for May 1973-Sep 1980; #13346000, "Palouse R. nr Colfax, WA" for Oct 1955-Sep 1963; #13346100, "Palouse R. at Colfax, WA" for Oct 1963-May 1979; #13349210, "Palouse R. blw S.F. at Colfax, WA" for Oct 1963-Nov 1987; #13351000, "Palouse R. at Hooper, WA" for Feb 1951-Dec 1987; #13341400, "E.F. Potlatch R. nr Bovill, ID" for Sep 1959-Sep 1971; #13332500, "Grande Ronde R. at Rondowa, OR" for Jan 1927-Aug 1987; #13326000, "Wallowa Lake nr Joseph, OR" for Jan 1927-Aug 1987; and #12415000, "St. Maries R. at Lotus, ID" for Jan 1927-Sep 1966. Flow data for gages #13346000 & #13346100 were combined into one record since the gage sites are within four miles of each other and the drainage areas differ by only 6 square miles.

2. Monthly discharges were computed as follows:

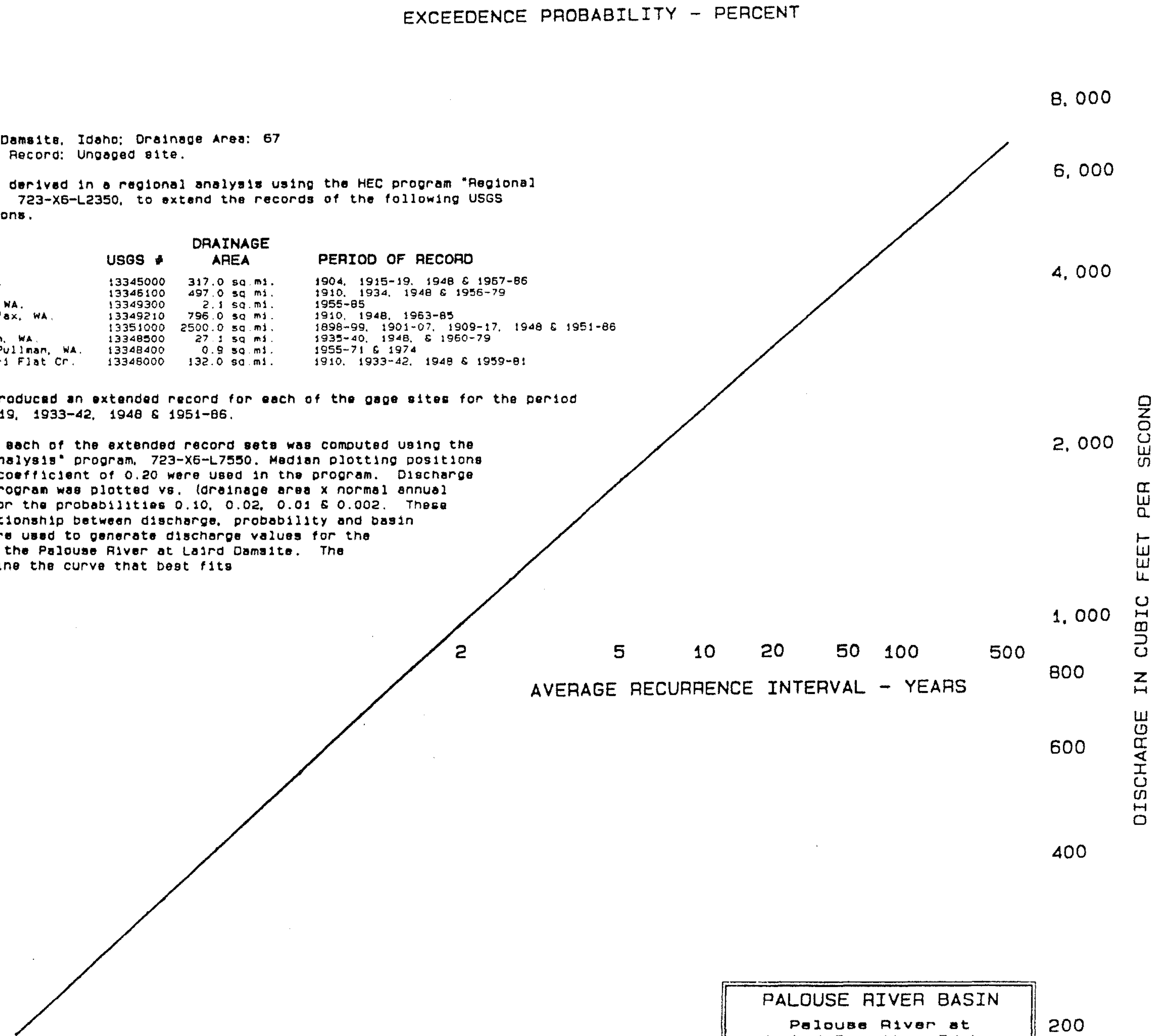
   A. Monthly flow data for the Grande Ronde R. at Rondowa, Or. was adjusted for storage and evaporation at Wallowa Lake to obtain an unregulated condition. Evaporation loss rates for Wallowa Lake were computed based on the information found in NOAA Technical Reports NWS 33 & 34.

   B. Irrigated acreage upstream of each gage was determined from information provided by the Washington State Dept. of Ecology and the Soil Conservation Service. Using this information and assumed monthly consumptive use rates, the gage data was adjusted to remove the effects of irrigation withdrawals upstream of the gage sites.

   C. The resulting natural discharges were correlated using the Hydrologic Engineering Center's program HEC4, "Monthly Streamflow Simulation." This program generated any missing average monthly flow values from the period 1927-1987 for the gage on the Palouse River below South Fork at Colfax, Wa.

   D. That extended data set was input back into the HEC4 program as a long record station along with the actual gage data for the following gages in the S.F. Palouse R. basin: gage #13346800, Paradise Cr. at U of I at Moscow, Id. for Oct 1978 - Oct 1986; gage # 13348000, S. F. Palouse R. at Pullman, Wa. for Feb 1934 - Sep 1942 & Jan 1960 - Sep 1981; and gage #13348500, Missouri Flat Cr. at Pullman, Wa. for Feb 1934 - Sep 1940 & Jan 1960 - Sep 1979. The HEC4 program generated missing streamflow data for the above gages in the period 1927 - 1987 producing the set of natural average monthly streamflows for the Paradise Cr. at U of I at Moscow, Id. gage site.

   E. The Paradise Creek damsite is located approximately five miles upstream of the gage on Paradise Creek at the University of Idaho at Moscow. To generate average monthly streamflows at the dam site, the flows for the gage at Moscow were multiplied by the factor 0.721, which was taken from a curve relating the annual runoff to the basin mean elevation of the gage sites in the S. F. Palouse River basin. This adjustment produced the natural average monthly discharges for the Paradise Creek damsite for the period 1927 - 1987.



NOTES:

1. Palouse River at Laird Damsite, Idaho; Drainage Area: 67 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Palouse River at Laird Damsite. The computed statistics define the curve that best fits the four data points.

COMPUTED STATIBTICS	
Mean Logarithm	2.9964
Standard Deviation	0.2957
Optimized Skew	-0.0437

PALOUSE RIVER BASIN

Palouse River at Laird Damsite, Idaho

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

NOTES:

1. Palouse River at Harvard Damsite, Idaho; Drainage Area: 148 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq.mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq.mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-85
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq.mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Palouse River at Harvard Damsite. The computed statistics define the curve that best fits the four data points.

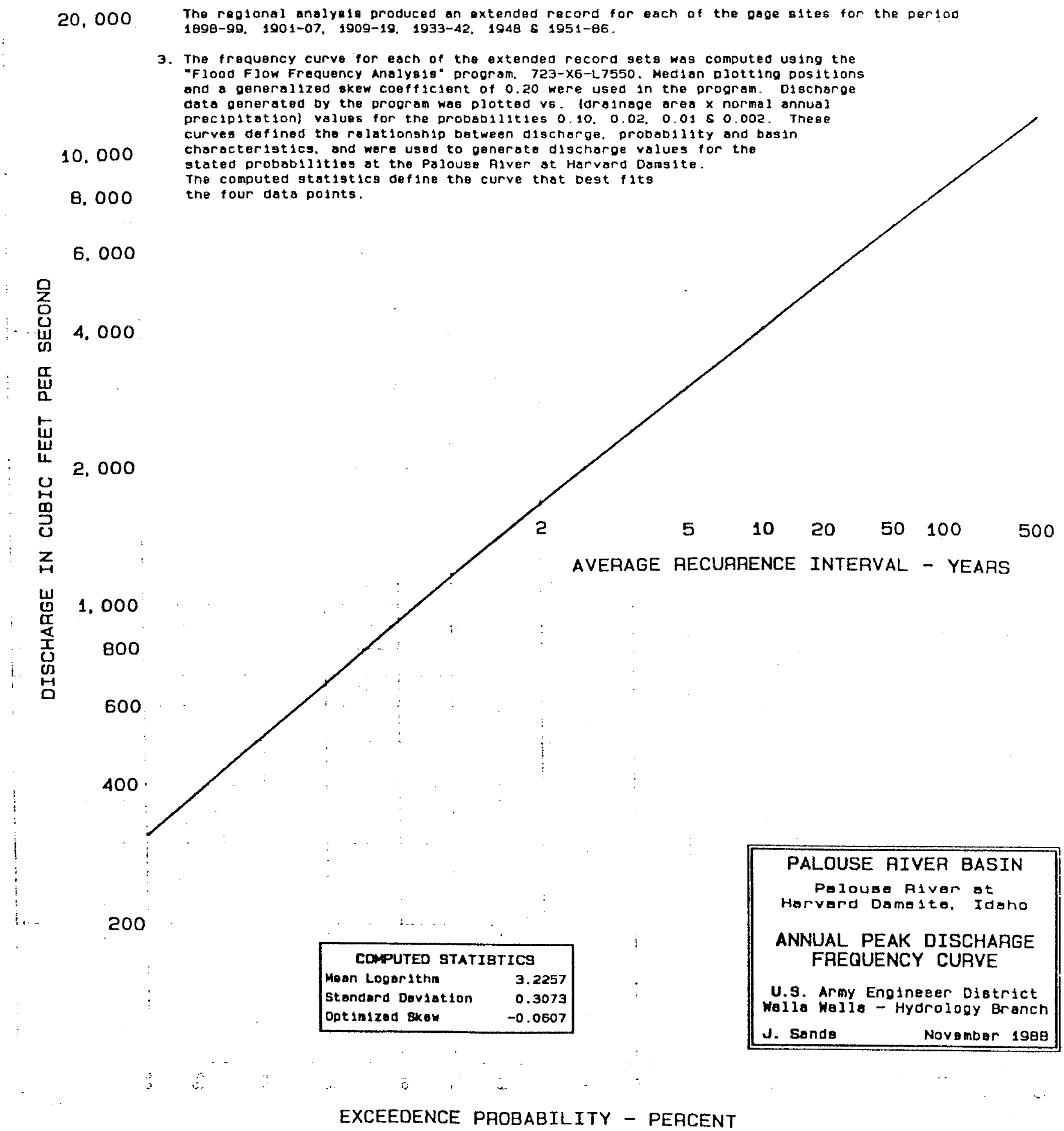


CHART A-2

NOTES:

1. Palouse River near Potlatch, Idaho: USGS Station Number 13345000; Drainage Area: 317 square miles; Period of Record: 1904, 1915-19, 1948 & 1967-86.

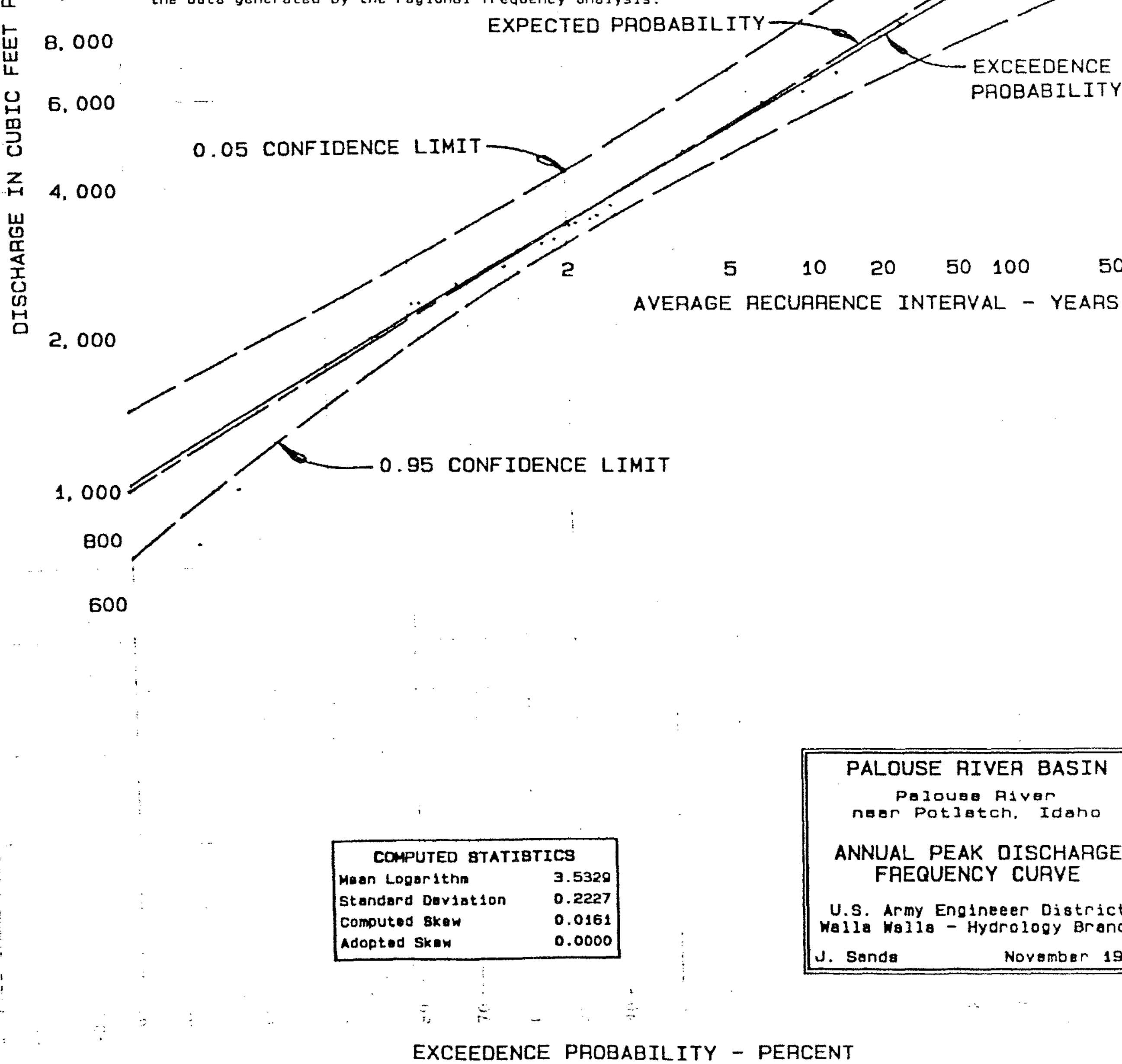
2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA	13349210	796.0 sq mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq mi.	1910, 1933-42, 1948 & 1959-81

This analysis produced an extended record for the Palouse R. nr. Potlatch gage site for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve and statistics were computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions, a historic period of 89 years, and a generalized skew coefficient of 0.20 were used in the program.

4. The confidence limits shown were computed based on the 26 years of systematic record and one historic event recorded at the Palouse R. near Potlatch gage site for a historic period of 58 years. They do not reflect the data generated by the regional frequency analysis.



COMPUTED STATISTICS	
Mean Logarithm	3.5329
Standard Deviation	0.2227
Computed Skew	0.0161
Adopted Skew	0.0000

PALOUSE RIVER BASIN

Palouse River near Potlatch, Idaho

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

CHART A-3

NOTES:

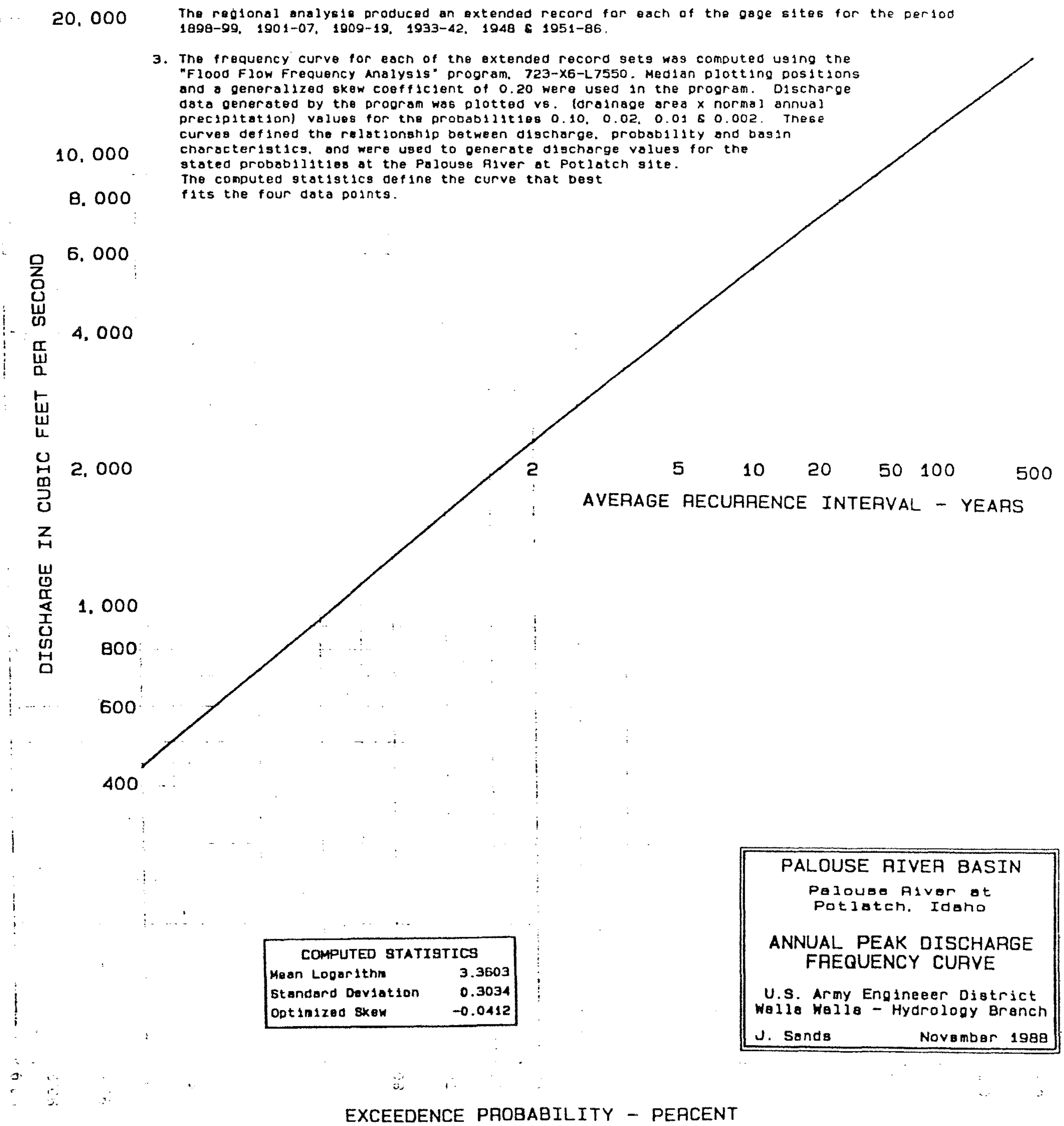
1. Palouse River at Potlatch, Idaho: Drainage Area: 250 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA	13346100	497.0 sq mi	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA	13349210	796.0 sq mi.	1910, 1948, 1953-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1946 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1946 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Palouse River at Potlatch site. The computed statistics define the curve that best fits the four data points.



NOTES:

1. Palouse River at Palouse, Washington; Drainage Area: 360 square miles; Period of Record: 1974-80; USGS station number: 13345300.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1946 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1945 & 1951-55
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA	13348000	132.0 sq mi.	1910, 1933-42, 1946 & 1959-81

Since the Palouse R. at Palouse gage had less than ten years of data it was treated as an ungaged location and was not included in the regional frequency computations. The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Palouse River at Palouse, Washington gage site. The computed statistics define the curve that best fits the four data points.

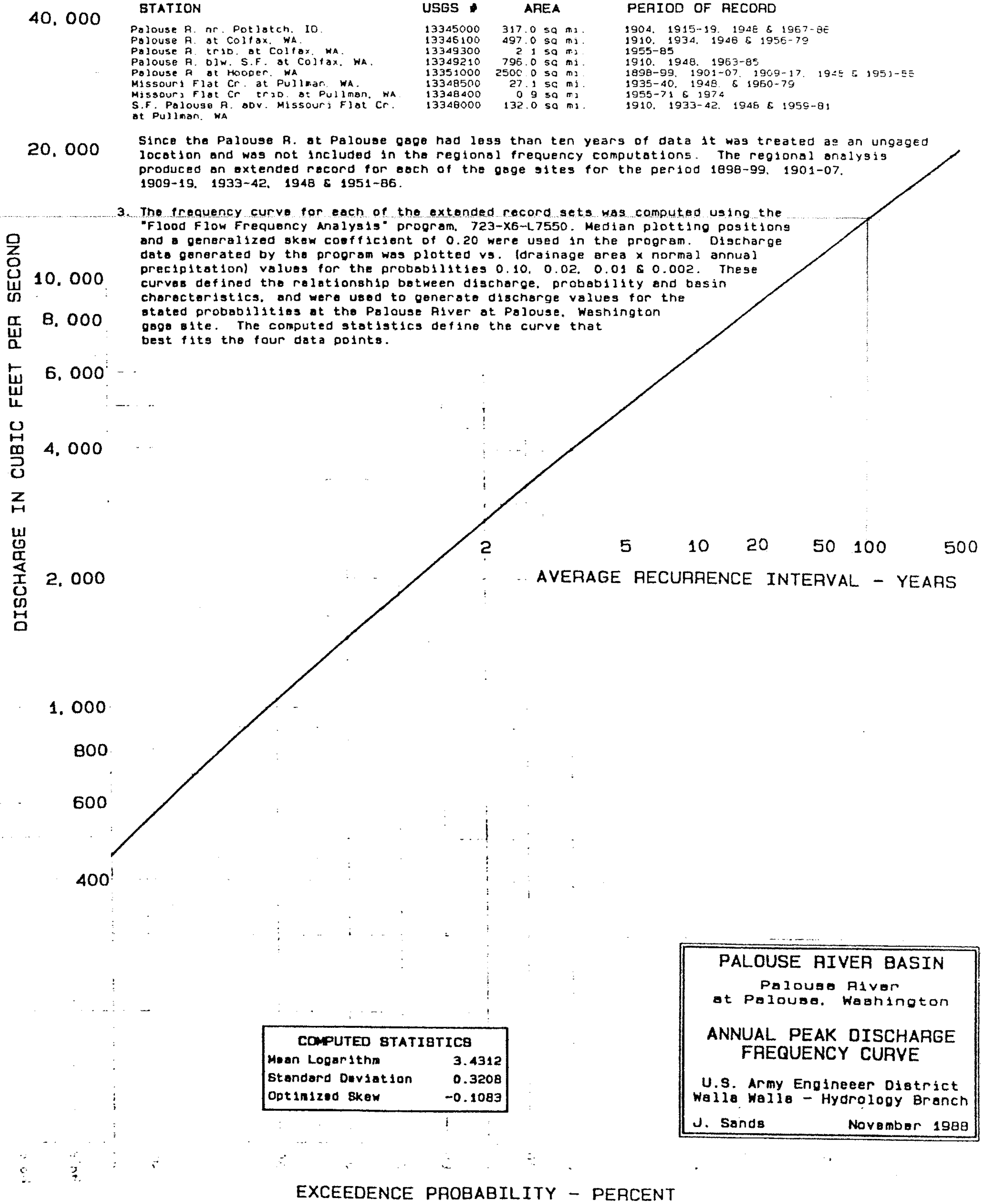


CHART A-5

NOTES:

1. Palouse River at Colfax, Washington; Drainage Area: 497 square miles; Period of Record: 1910, 1934, 1948, & 1956-79; USGS Gaging Station: 13346100.

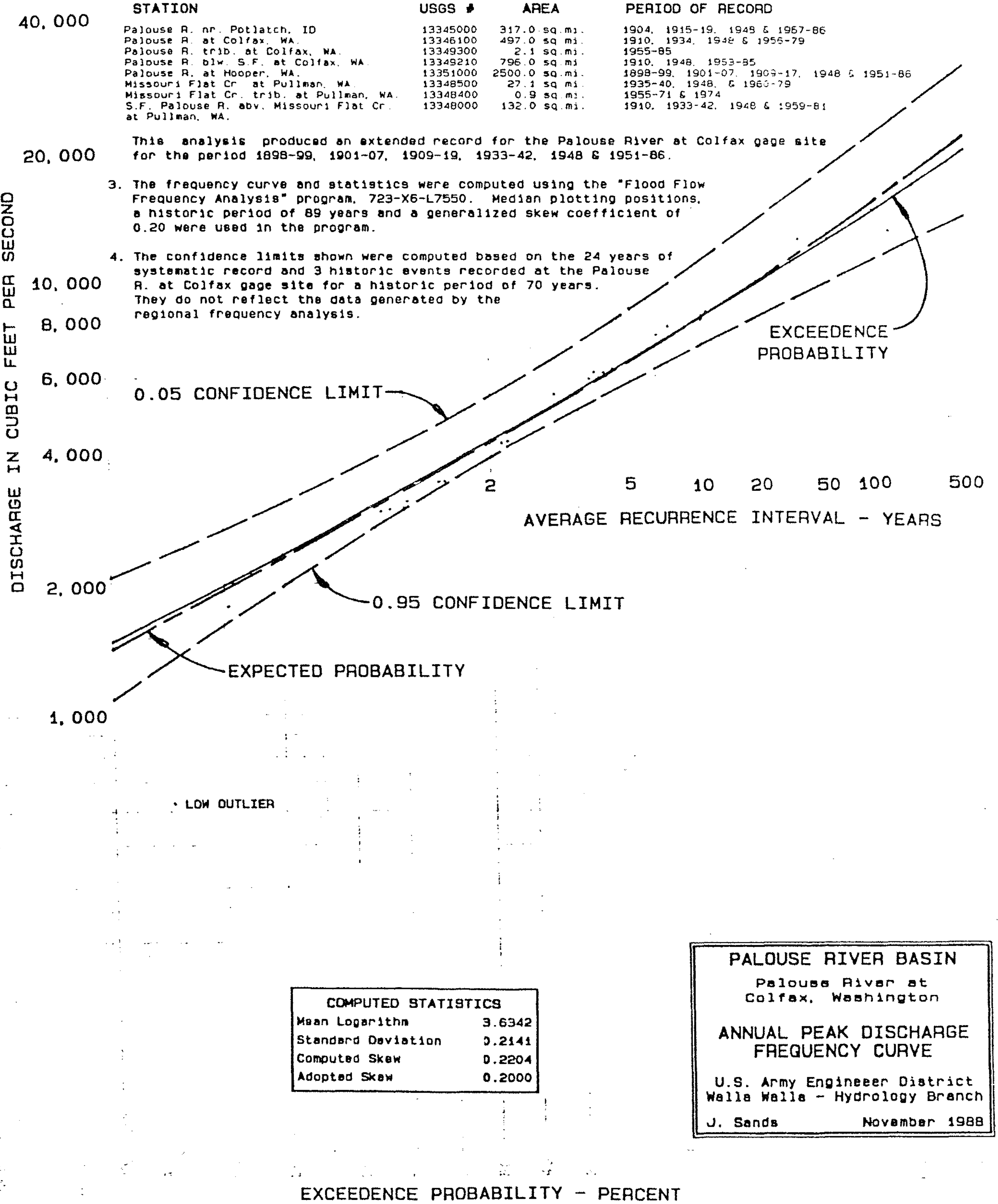
2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi	1910, 1948, 1953-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

This analysis produced an extended record for the Palouse River at Colfax gage site for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve and statistics were computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions, a historic period of 89 years and a generalized skew coefficient of 0.20 were used in the program.

4. The confidence limits shown were computed based on the 24 years of systematic record and 3 historic events recorded at the Palouse R. at Colfax gage site for a historic period of 70 years. They do not reflect the data generated by the regional frequency analysis.



COMPUTED STATISTICS	
Mean Logarithm	3.6342
Standard Deviation	0.2141
Computed Skew	0.2204
Adopted Skew	0.2000

PALOUSE RIVER BASIN

Palouse River at Colfax, Washington

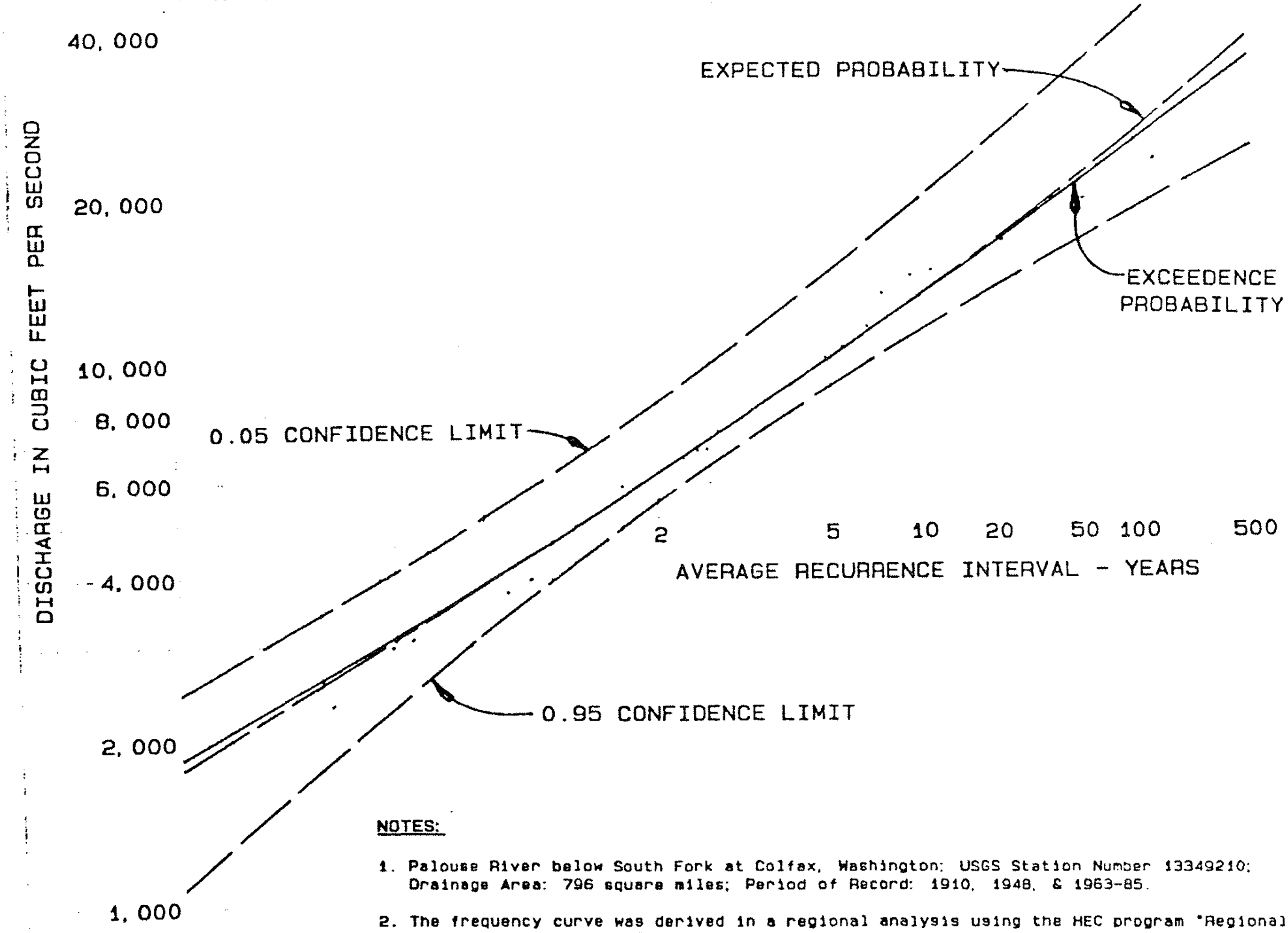
ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

CHART A-6

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1957-86
Palouse R. at Colfax, WA.	13346100	497.0 sq.mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq.mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1946 & 1951-85
Missouri Flat Cr. at Pullman, WA	13348500	27.1 sq.mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81



NOTES:

1. Palouse River below South Fork at Colfax, Washington; USGS Station Number 13349210; Drainage Area: 796 square miles; Period of Record: 1910, 1948, & 1963-85.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the USGS streamflow gaging stations shown above. This analysis produced an extended record for the Palouse R. below South Fork at Colfax gage site for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve and statistics were computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions, a historic period of 89 years, and a generalized skew coefficient of 0.20 were used in the program.

4. The confidence limits shown were computed based on the 23 years of systematic record and two historic events recorded at the Palouse River below South Fork at Colfax gage site for a historic period of 76 years. They do not reflect the data generated by the regional frequency analysis.

COMPUTED STATISTICS	
Mean Logarithm	3.8018
Standard Deviation	0.2440
Computed Skew	0.1782
Adopted Skew	0.2000

PALOUSE RIVER BASIN

Palouse River below South Fork at Colfax, Washington

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

CHART A-7

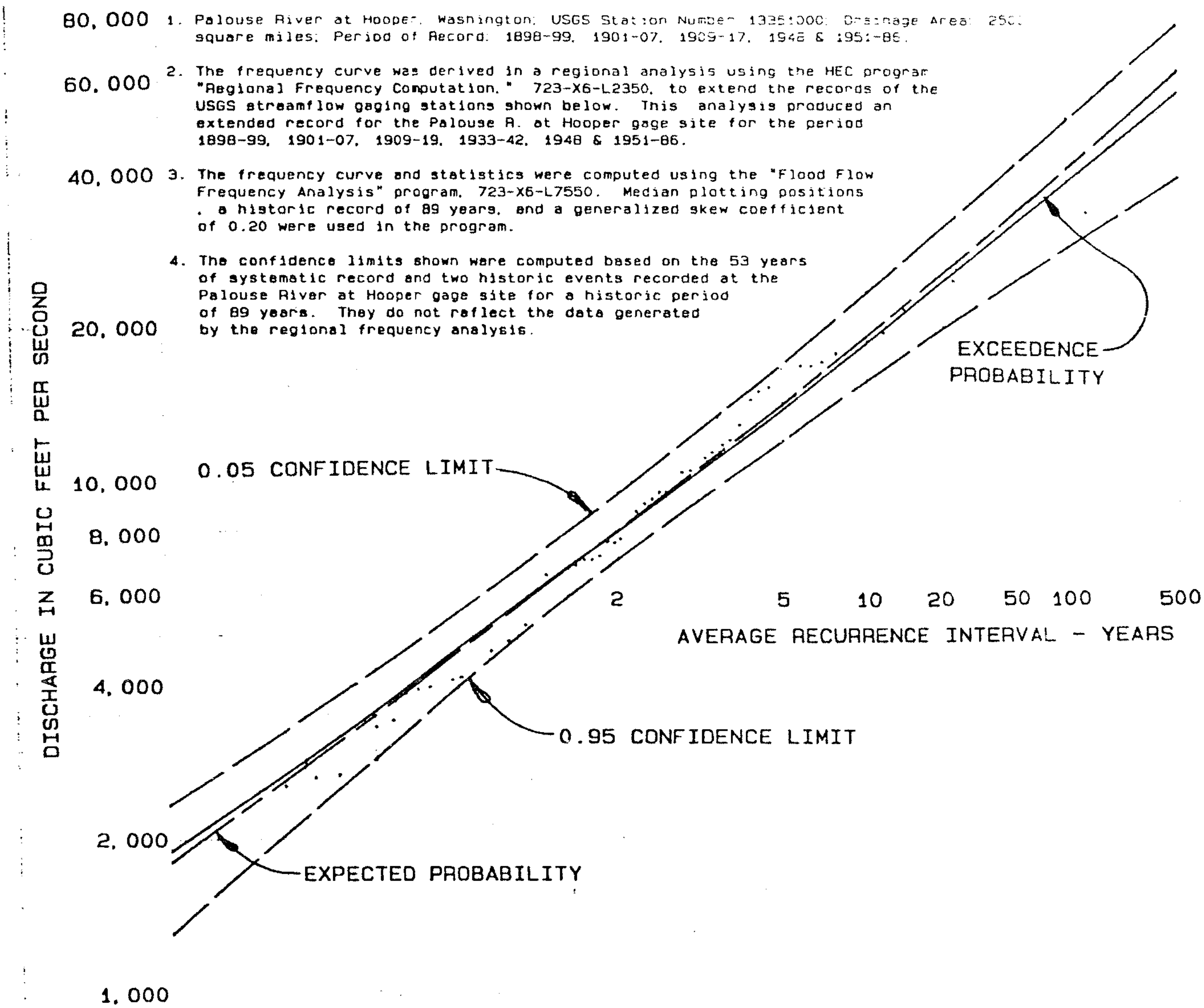
NOTES:

1. Palouse River at Hooper, Washington; USGS Station Number 13351000; Drainage Area: 2500 square miles; Period of Record: 1898-99, 1901-07, 1909-17, 1948 & 1951-86.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the USGS streamflow gaging stations shown below. This analysis produced an extended record for the Palouse R. at Hooper gage site for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve and statistics were computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions , a historic record of 89 years, and a generalized skew coefficient of 0.20 were used in the program.

4. The confidence limits shown were computed based on the 53 years of systematic record and two historic events recorded at the Palouse River at Hooper gage site for a historic period of 89 years. They do not reflect the data generated by the regional frequency analysis.



• LOW OUTLIER

• LOW OUTLIER

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1957-66
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1948 & 1955-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1950-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.'NOTENW	13348000	132.0 sq mi.	1910, 1933-42, 1948 & 1959-81

COMPUTED STATISTICS	
Mean Logarithm	3.9126
Standard Deviation	0.2815
Computed Skew	0.0922
Adopted Skew	0.1000

PALOUSE RIVER BASIN

Palouse River
at Hooper, Washington

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

EXCEEDENCE PROBABILITY - PERCENT

CHART A-8

NOTES:

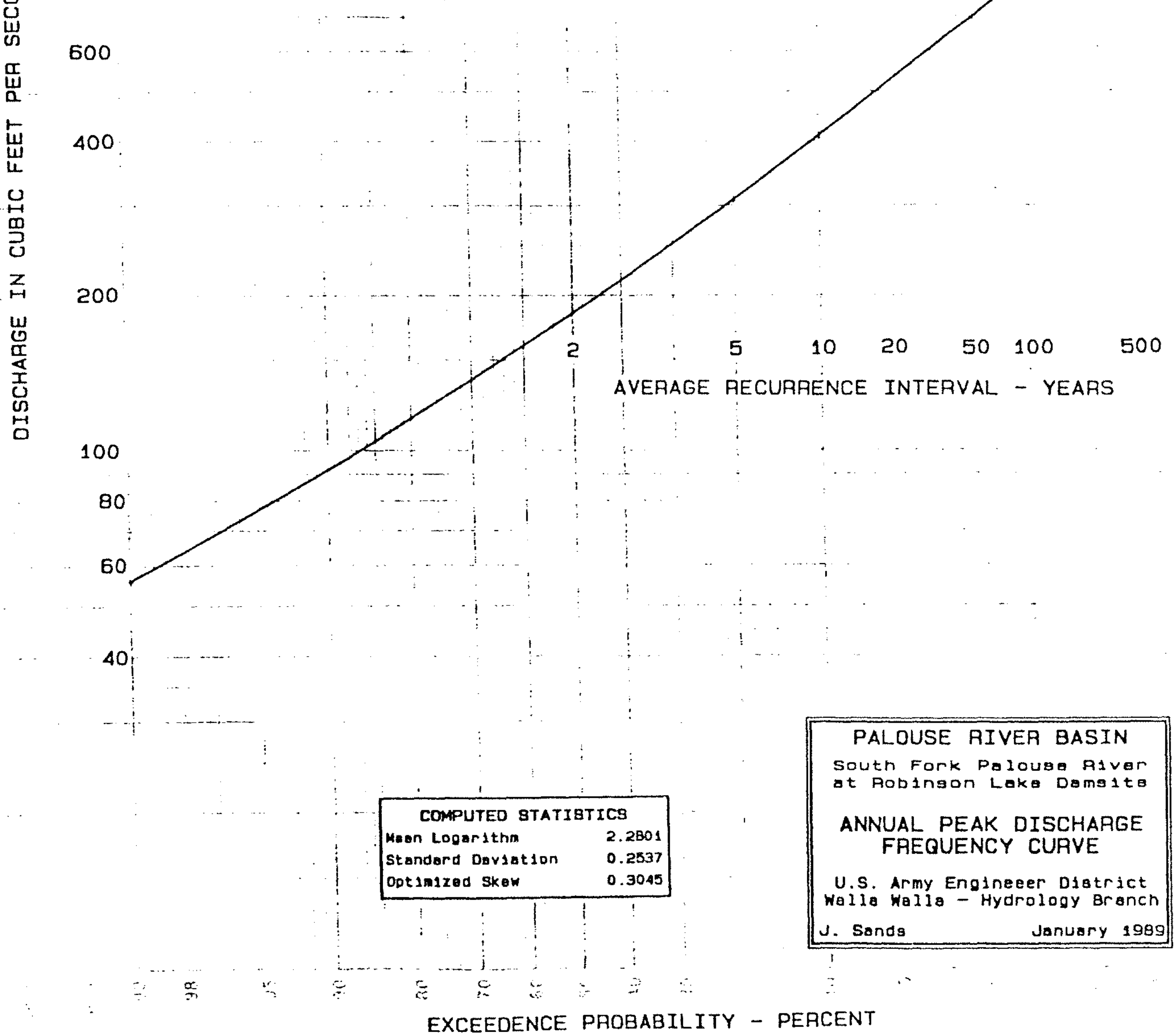
1. South Fork Palouse River at Robinson Lake, Idaho Damsite: Drainage Area: 8.3 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1957-66
Palouse R. at Colfax, WA	13346100	497.0 sq mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R. blw. S.F at Colfax, WA.	13349210	796.0 sq mi.	1910, 1948, 1953-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1946 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq mi.	1910, 1933-42, 1948 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the South Fork Palouse River at Robinson Lake Damsite. The computed statistics define the curve that best fits the four data points.



COMPUTED STATISTICS	
Mean Logarithm	2.2801
Standard Deviation	0.2537
Optimized Skew	0.3045

PALOUSE RIVER BASIN

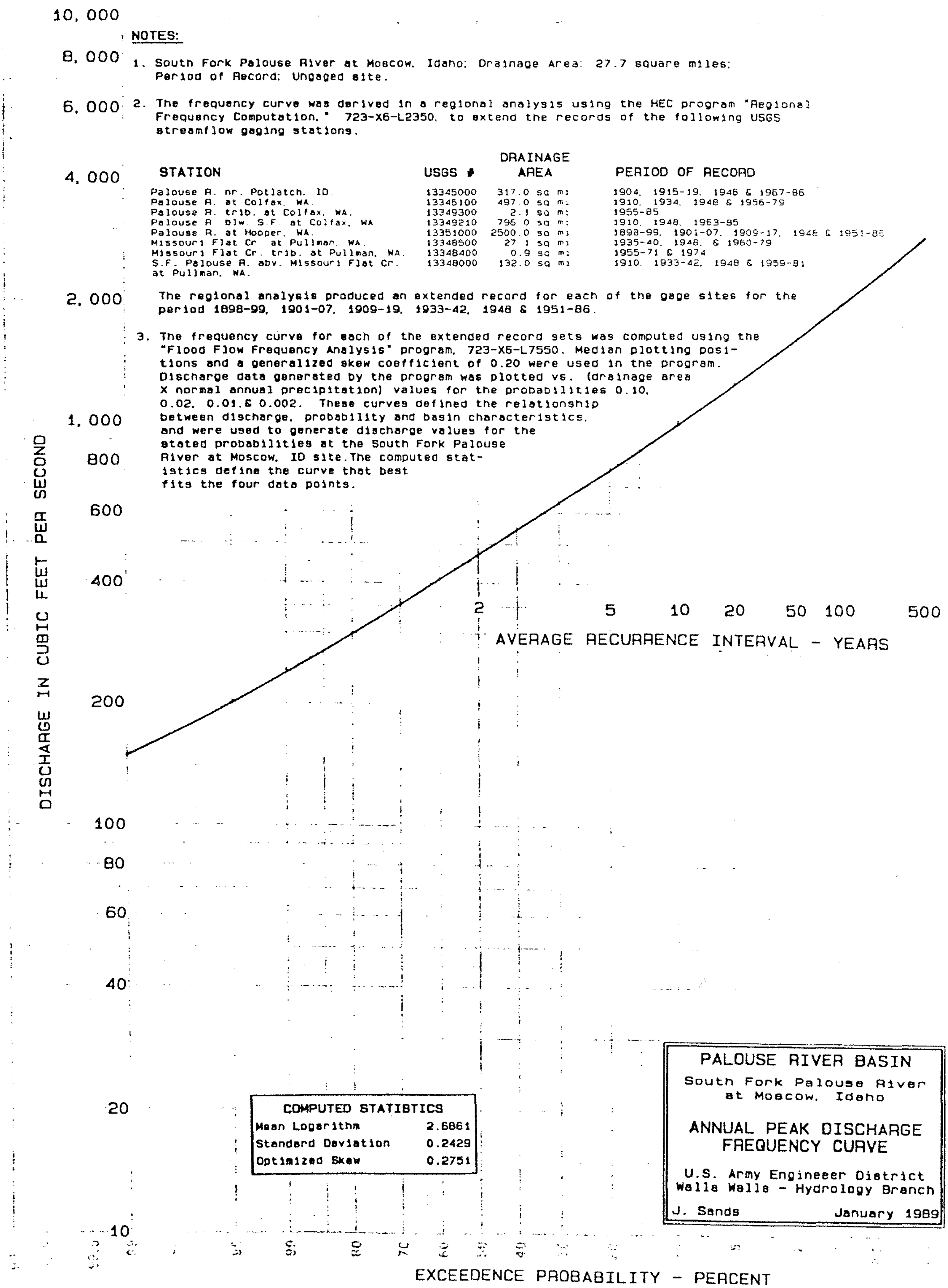
South Fork Palouse River at Robinson Lake Damsite

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands January 1989

CHART A-9



NOTES:

1. South Fork Palouse River at Moscow, Idaho; Drainage Area: 27.7 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq mi	1904, 1915-19, 1946 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi	1898-99, 1901-07, 1909-17, 1946 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi	1935-40, 1946, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq mi	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq mi	1910, 1933-42, 1948 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area X normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01, & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the South Fork Palouse River at Moscow, ID site. The computed statistics define the curve that best fits the four data points.

COMPUTED STATISTICS

Mean Logarithm	2.6861
Standard Deviation	0.2429
Optimized Skew	0.2751

PALOUSE RIVER BASIN

South Fork Palouse River at Moscow, Idaho

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands January 1989

NOTES:

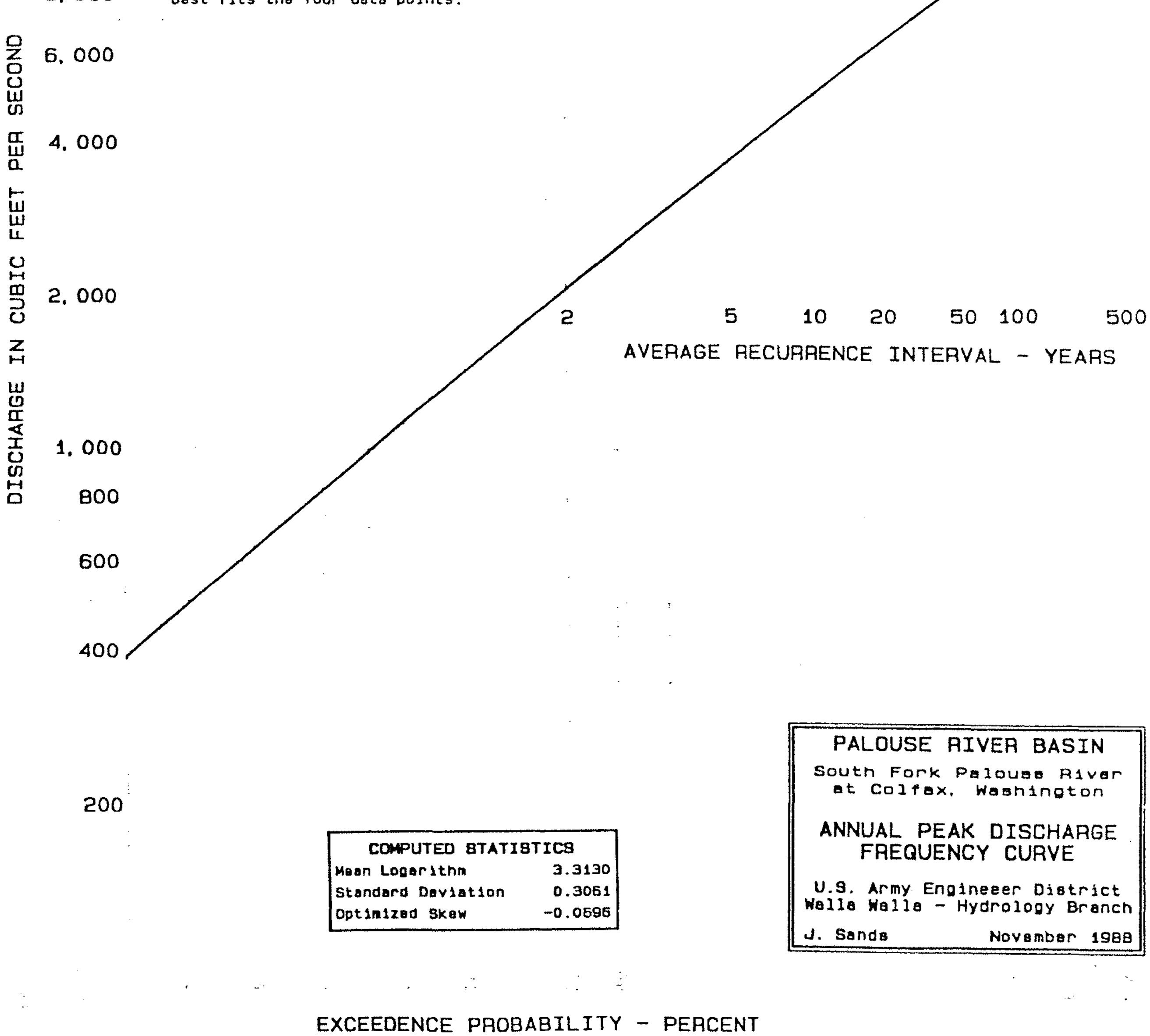
1. South Fork Palouse River at Colfax, Washington; Drainage Area: 308 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1967-86
Palouse R at Colfax, WA	13346100	497.0 sq mi	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R. blw. S.F at Colfax, WA	13349210	796.0 sq mi	1910, 1948, 1953-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-[illegible]
Missouri Flat Cr at Pullman, WA	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the South Fork Palouse River at Colfax site. The computed statistics define the curve that best fits the four data points.



COMPUTED STATISTICS	
Mean Logarithm	3.3130
Standard Deviation	0.3061
Optimized Skew	-0.0596

PALOUSE RIVER BASIN

South Fork Palouse River at Colfax, Washington

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

CHART A-11

NOTES:

1. South Fork Palouse River above Missouri Flat Creek at Pullman, Washington; Drainage Area: 132 square miles; Period of Record: 1910, 1933-42, 1948 & 1959-81; USGS station number: 13348000.

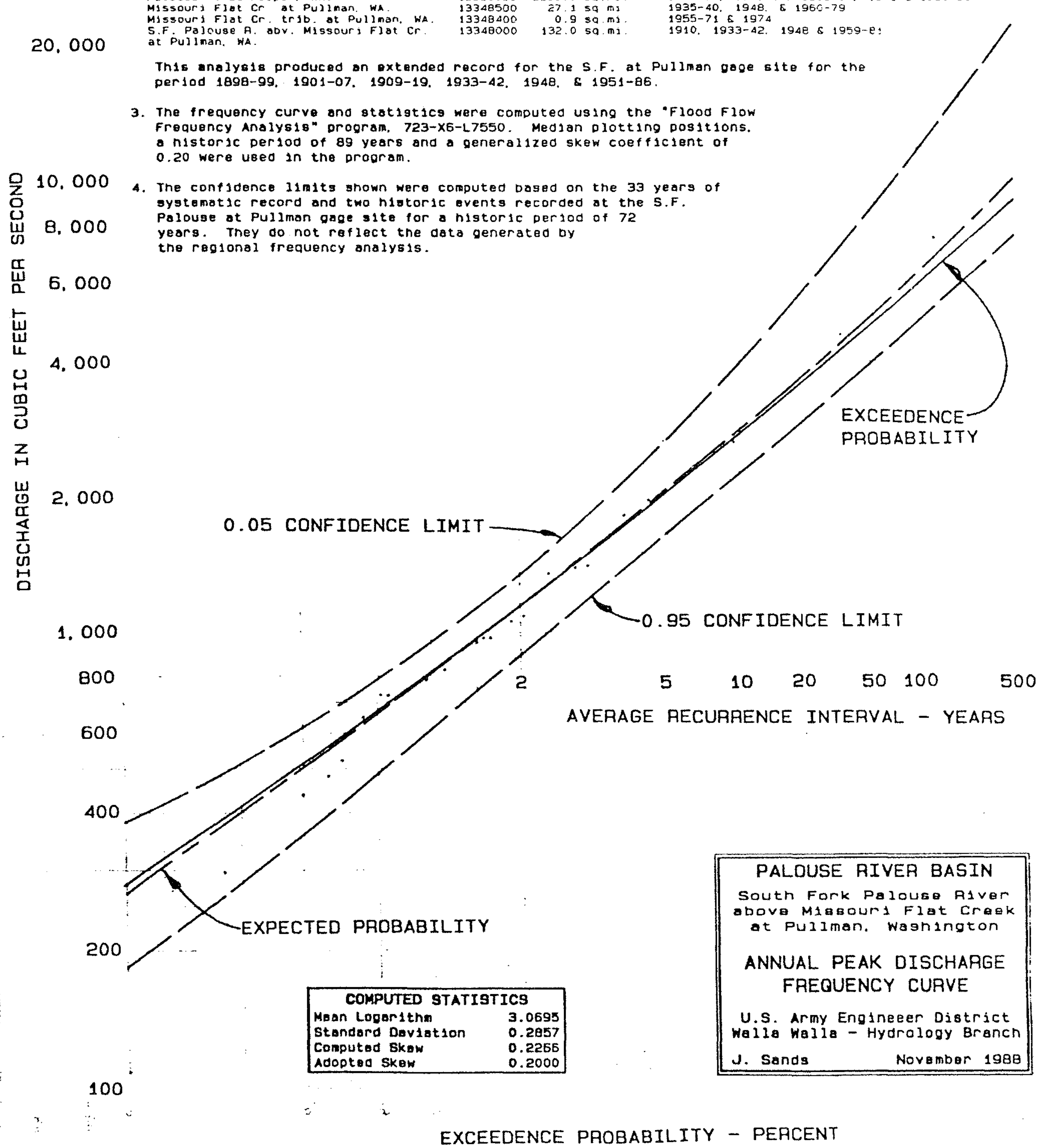
2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq.mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw S.F. at Colfax, WA.	13349210	796.0 sq.mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq.mi.	1898-99, 1901-07, 1909-17, 1945 & 1951-85
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq.mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

This analysis produced an extended record for the S.F. at Pullman gage site for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948, & 1951-86.

3. The frequency curve and statistics were computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions, a historic period of 89 years and a generalized skew coefficient of 0.20 were used in the program.

4. The confidence limits shown were computed based on the 33 years of systematic record and two historic events recorded at the S.F. Palouse at Pullman gage site for a historic period of 72 years. They do not reflect the data generated by the regional frequency analysis.



COMPUTED STATISTICS	
Mean Logarithm	3.0695
Standard Deviation	0.2857
Computed Skew	0.2266
Adopted Skew	0.2000

PALOUSE RIVER BASIN

South Fork Palouse River above Missouri Flat Creek at Pullman, Washington

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

CHART A-12

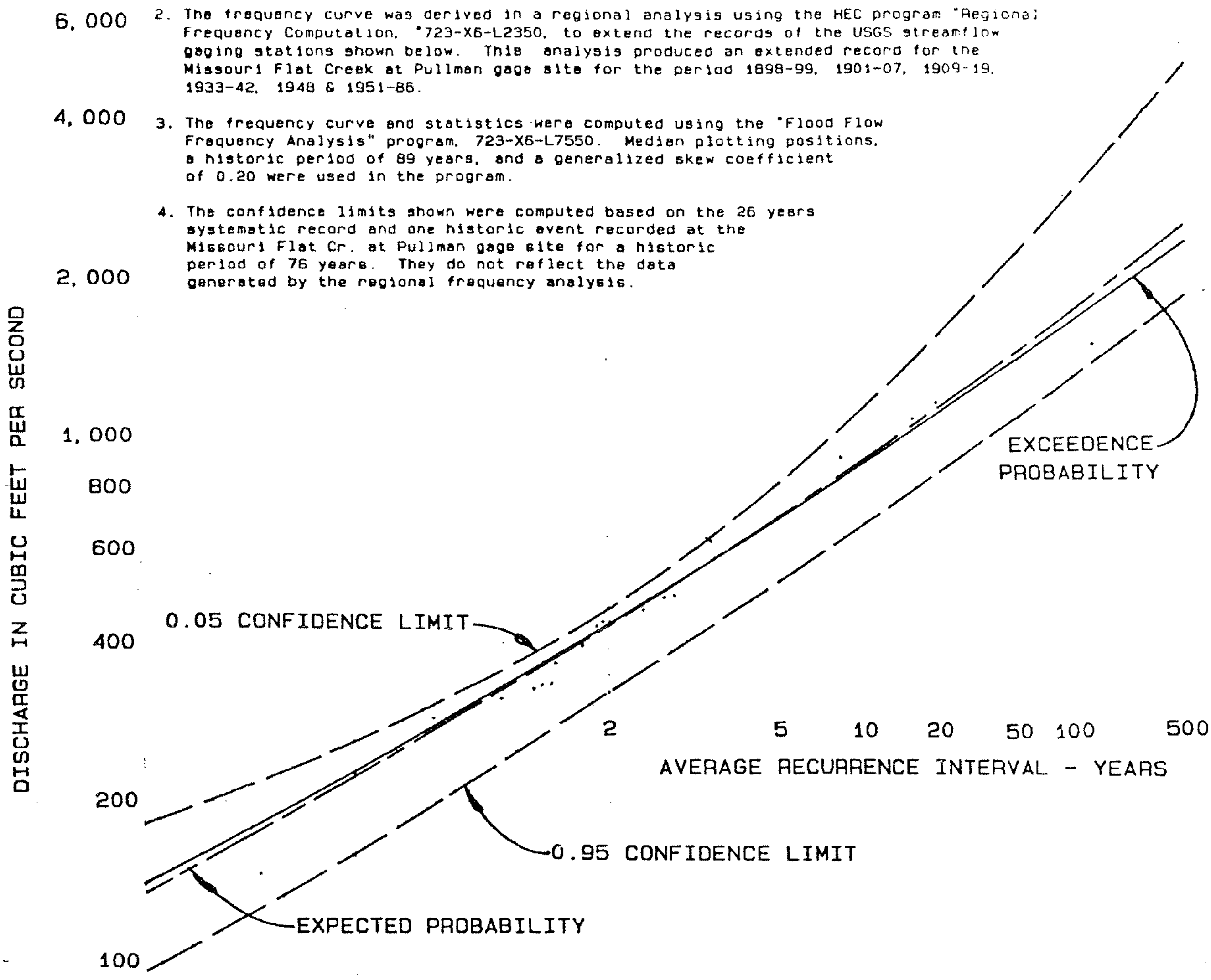
NOTES:

1. Missouri Flat Creek at Pullman, Washington; USGS Station Number 13348500; Drainage Area: 27.1 square miles; Period of Record: 1935-40, 1948 & 1960-79.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation, "723-X6-L2350, to extend the records of the USGS streamflow gaging stations shown below. This analysis produced an extended record for the Missouri Flat Creek at Pullman gage site for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve and statistics were computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions, a historic period of 89 years, and a generalized skew coefficient of 0.20 were used in the program.

4. The confidence limits shown were computed based on the 26 years systematic record and one historic event recorded at the Missouri Flat Cr. at Pullman gage site for a historic period of 76 years. They do not reflect the data generated by the regional frequency analysis.



* LOW OUTLIER

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq.mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi.	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

COMPUTED STATISTICS

Mean Logarithm	2.6496
Standard Deviation	0.2318
Computed Skew	0.1661
Adopted Skew	0.2000

PALOUSE RIVER BASIN

Missouri Flat Creek at Pullman, Washington

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988

EXCEEDENCE PROBABILITY - PERCENT

NOTES:

1. Paradise Creek above Moscow, Idaho Damsite; Drainage Area: 11.7 square miles; Period of Record: Ungaged site.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1967-85
Palouse R at Colfax, WA.	13346100	497 0 sq mi	1910, 1934 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA	13349210	796 0 sq mi	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr at Pullman, WA	13348500	27.1 sq mi	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr at Pullman, WA.	13348000	132.0 sq mi.	1910, 1933-42, 1948 & 1959-81

The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Paradise Creek above Moscow, ID Damsite. The computed statistics define the curve that best fits the four data points.

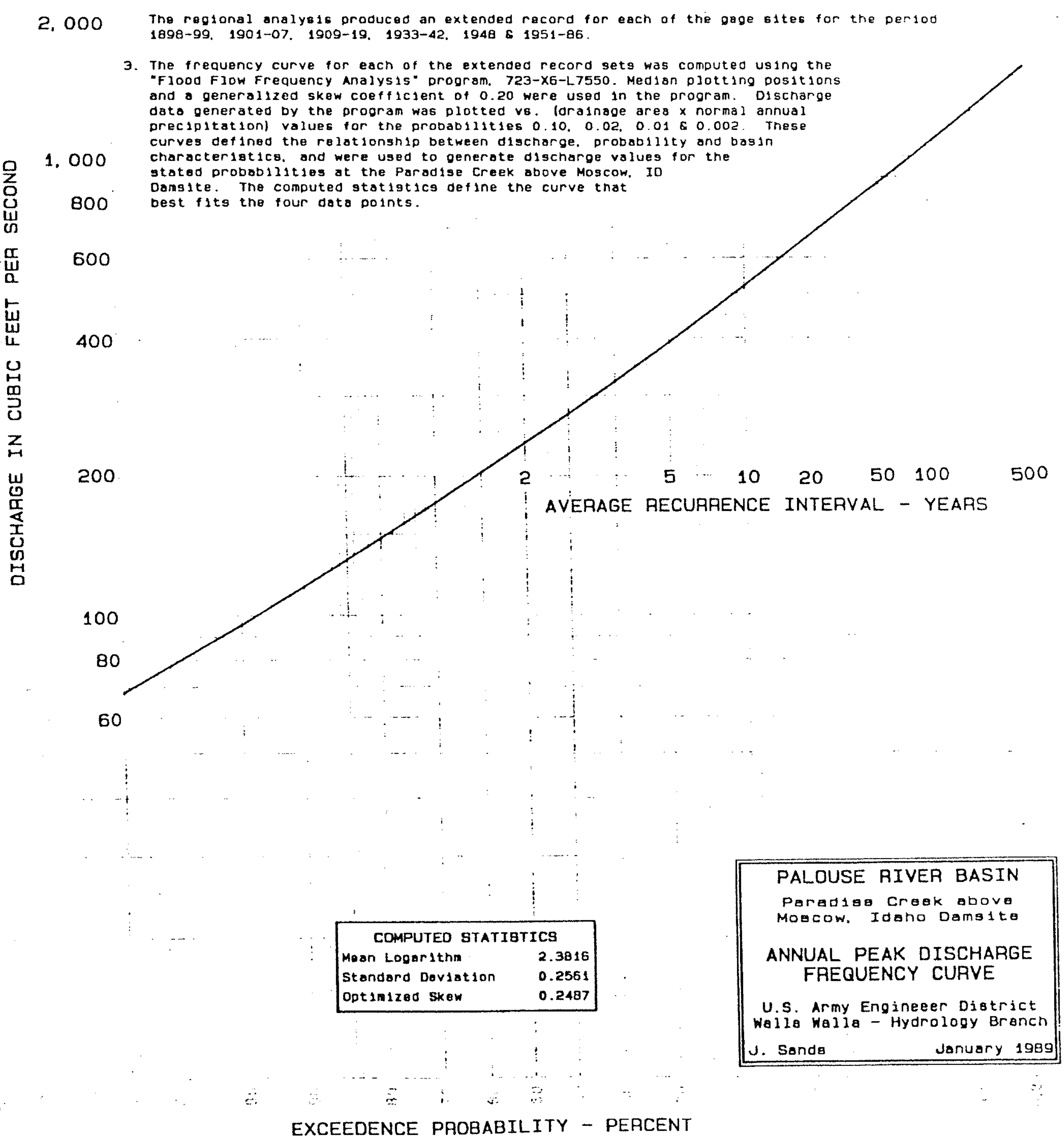


CHART A-14

NOTES:

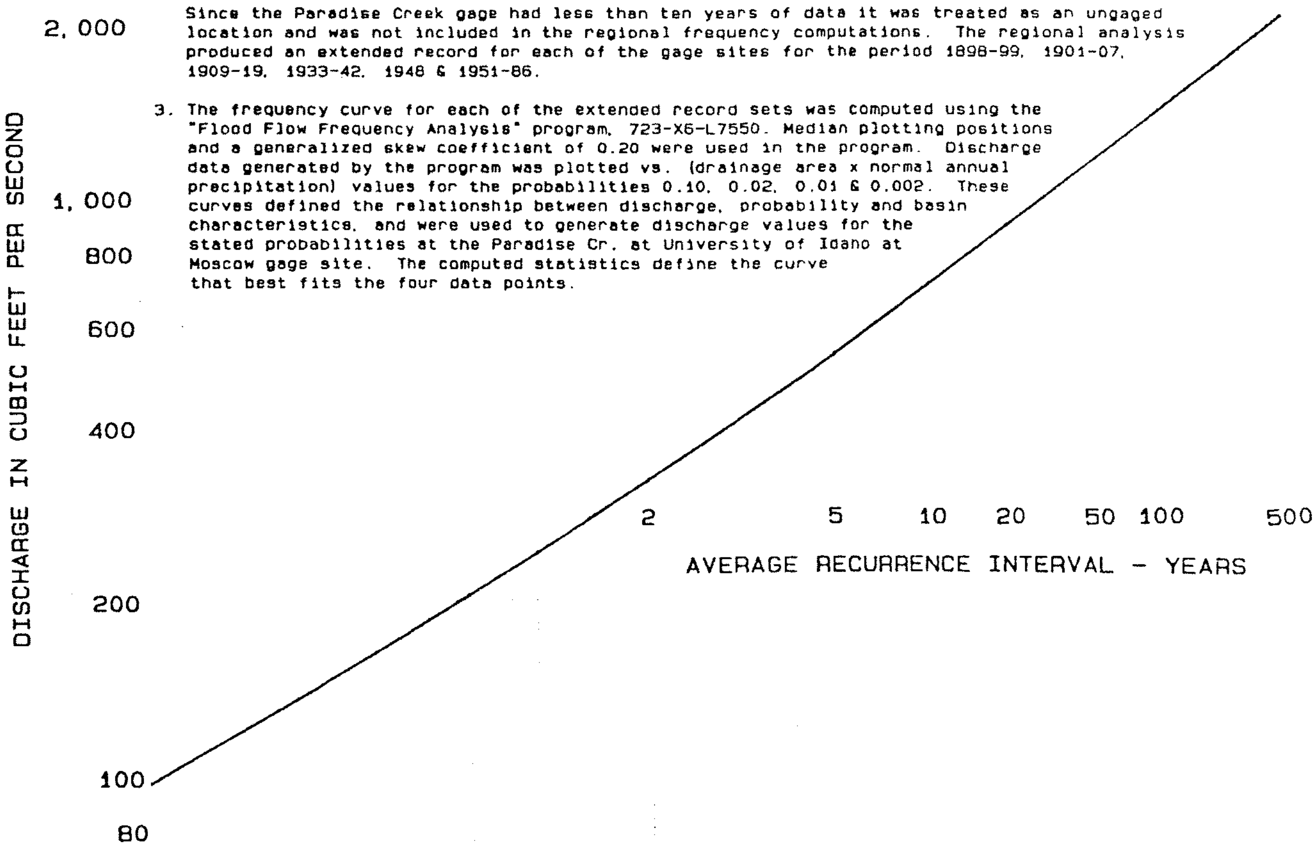
1. Paradise Creek at University of Idaho at Moscow, Idaho; Drainage Area: 17.7 square miles; Period of Record: 1979-86; USGS station number: 13346800.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA	13346100	497.0 sq mi	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq mi.	1955-85
Palouse R blw S F at Colfax, WA.	13349210	796 0 sq mi	1910, 1946, 1953-85
Palouse R. at Hooper, WA	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr at Pullman, WA	13348500	27 1 sq mi	1935-40, 1946, & 1960-79
Missouri Flat Cr trib. at Pullman, WA.	13348400	0.9 sq mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq mi.	1910, 1933-42, 1948 & 1959-81

Since the Paradise Creek gage had less than ten years of data it was treated as an ungaged location and was not included in the regional frequency computations. The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Paradise Cr. at University of Idaho at Moscow gage site. The computed statistics define the curve that best fits the four data points.



COMPUTED STATISTICS	
Mean Logarithm	2.5237
Standard Deviation	0.2507
Optimized Skew	0.2479

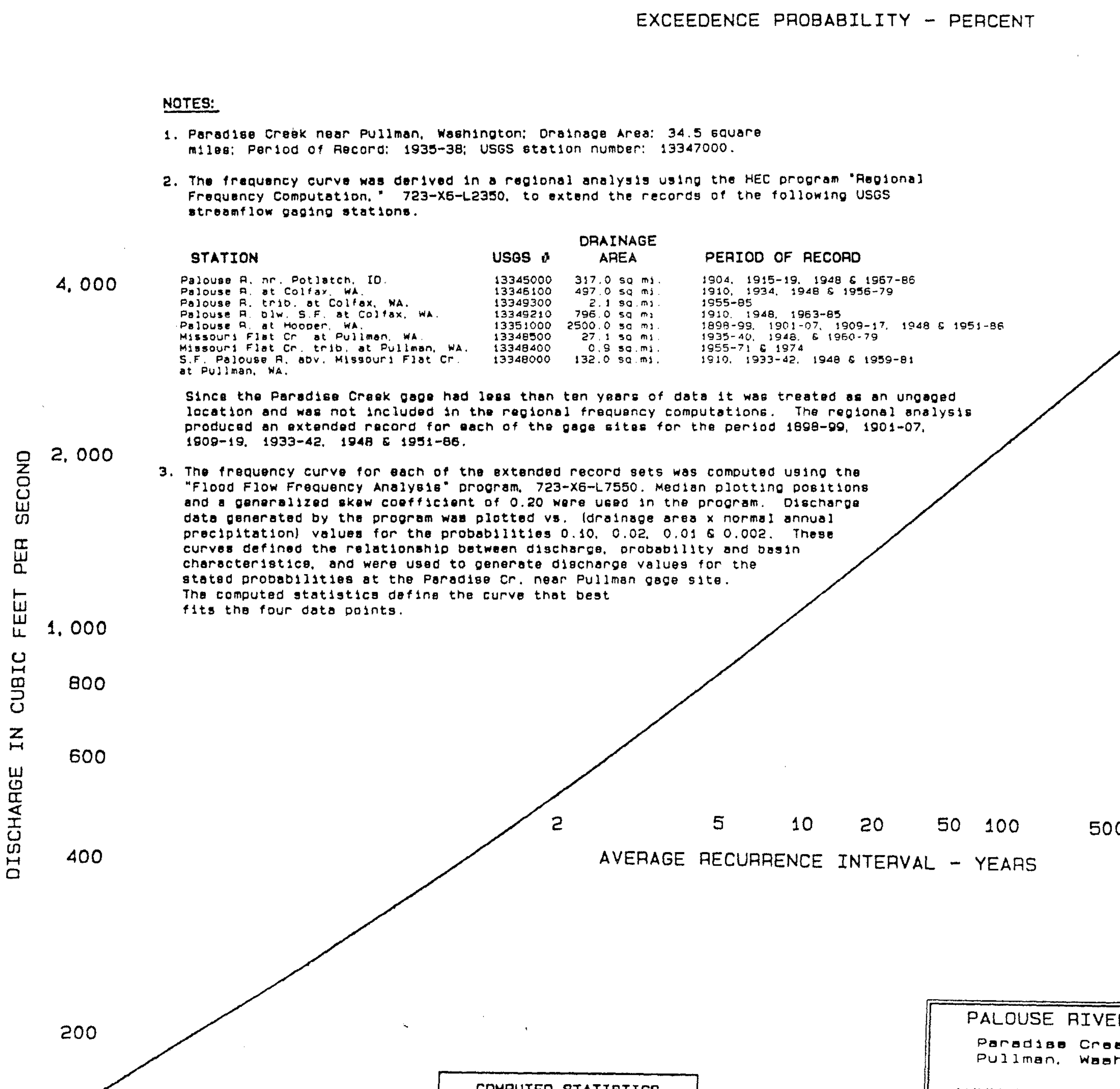
PALOUSE RIVER BASIN

Paradise Creek at Univ. of Idaho at Moscow, Idaho

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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

J. Sands November 1988



NOTES:

1. Paradise Creek near Pullman, Washington; Drainage Area: 34.5 square miles; Period of Record: 1935-38; USGS station number: 13347000.

2. The frequency curve was derived in a regional analysis using the HEC program "Regional Frequency Computation," 723-X6-L2350, to extend the records of the following USGS streamflow gaging stations.

STATION	USGS #	DRAINAGE AREA	PERIOD OF RECORD
Palouse R. nr. Potlatch, ID.	13345000	317.0 sq mi.	1904, 1915-19, 1948 & 1967-86
Palouse R. at Colfax, WA.	13346100	497.0 sq mi.	1910, 1934, 1948 & 1956-79
Palouse R. trib. at Colfax, WA.	13349300	2.1 sq.mi.	1955-85
Palouse R. blw. S.F. at Colfax, WA.	13349210	796.0 sq mi	1910, 1948, 1963-85
Palouse R. at Hooper, WA.	13351000	2500.0 sq mi.	1898-99, 1901-07, 1909-17, 1948 & 1951-86
Missouri Flat Cr. at Pullman, WA.	13348500	27.1 sq mi.	1935-40, 1948, & 1960-79
Missouri Flat Cr. trib. at Pullman, WA.	13348400	0.9 sq.mi.	1955-71 & 1974
S.F. Palouse R. abv. Missouri Flat Cr. at Pullman, WA.	13348000	132.0 sq.mi.	1910, 1933-42, 1948 & 1959-81

Since the Paradise Creek gage had less than ten years of data it was treated as an ungaged location and was not included in the regional frequency computations. The regional analysis produced an extended record for each of the gage sites for the period 1898-99, 1901-07, 1909-19, 1933-42, 1948 & 1951-86.

3. The frequency curve for each of the extended record sets was computed using the "Flood Flow Frequency Analysis" program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of 0.20 were used in the program. Discharge data generated by the program was plotted vs. (drainage area x normal annual precipitation) values for the probabilities 0.10, 0.02, 0.01 & 0.002. These curves defined the relationship between discharge, probability and basin characteristics, and were used to generate discharge values for the stated probabilities at the Paradise Cr. near Pullman gage site. The computed statistics define the curve that best fits the four data points.

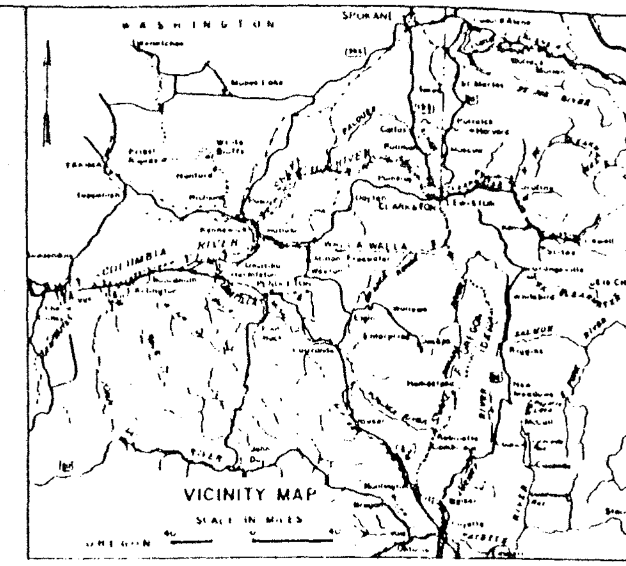
COMPUTED STATISTICS	
Mean Logarithm	2.7305
Standard Deviation	0.2442
Optimized Skew	0.2335

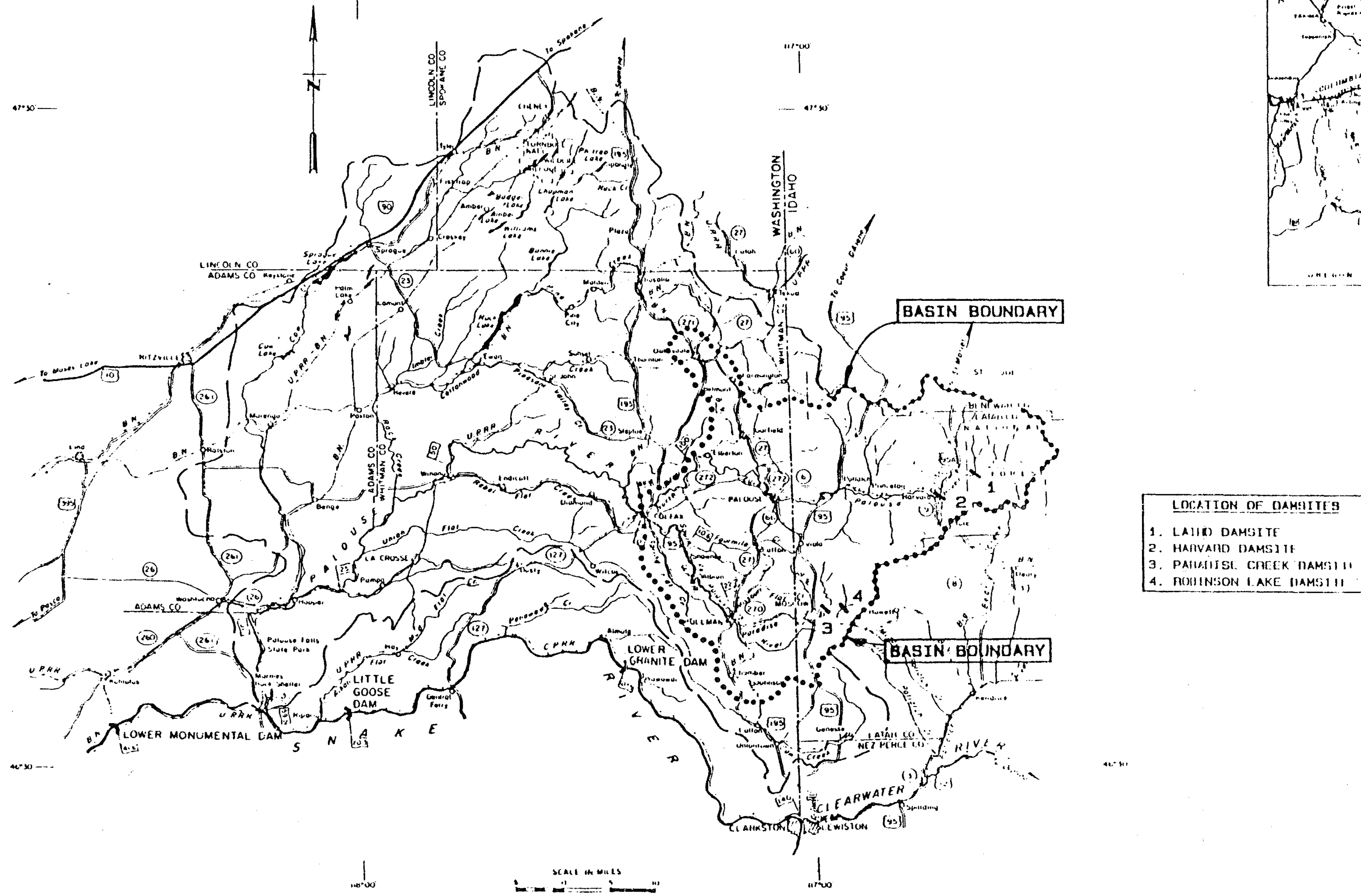
PALOUSE RIVER BASIN

Paradise Creek near Pullman, Washington

ANNUAL PEAK DISCHARGE FREQUENCY CURVE

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





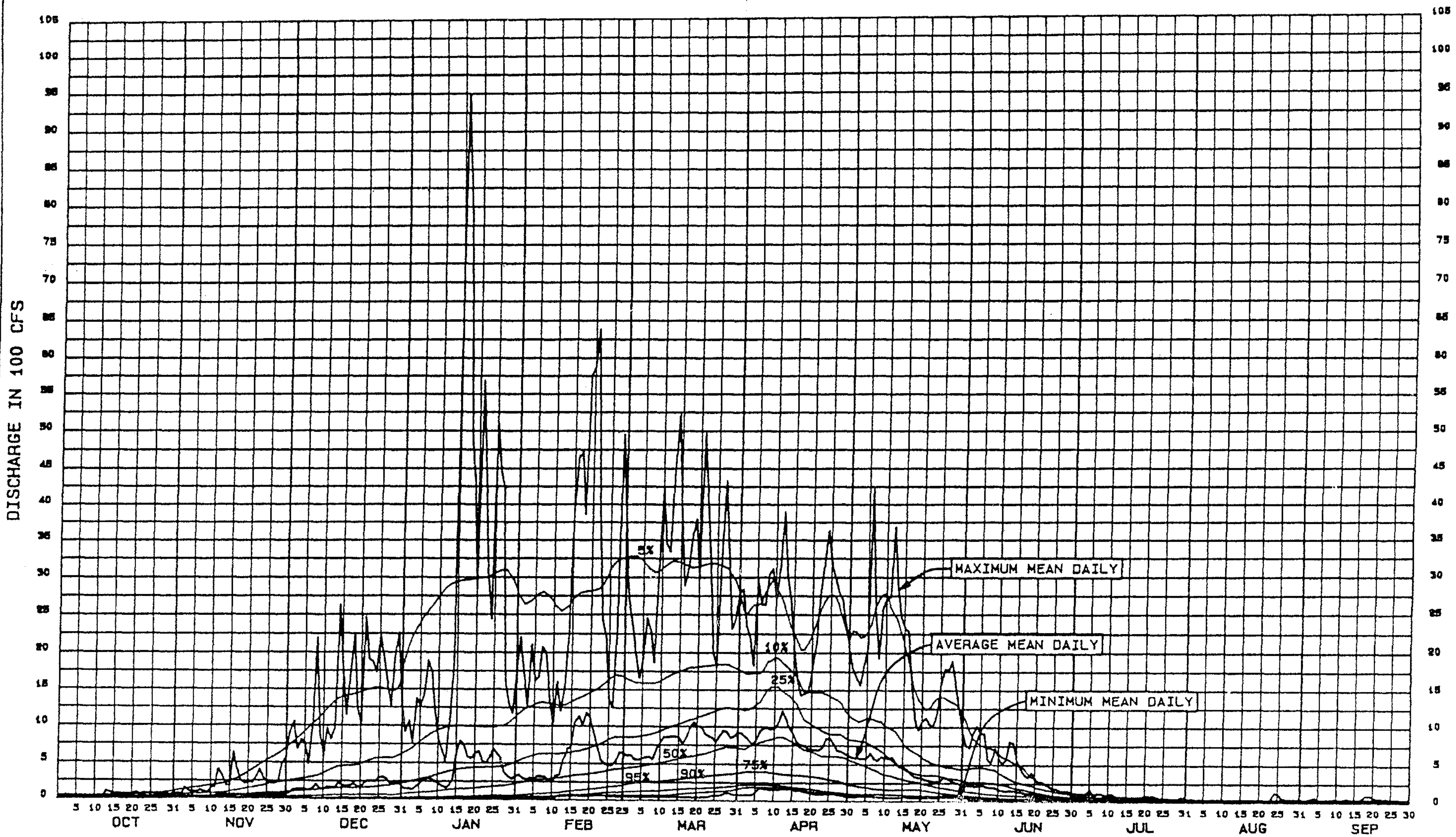
PALOUSE RIVER BASIN
ABOVE COLFAX, WASHINGTON

BASIN MAP

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

J. Sands March 1989

PLATE A-1



NOTES:

1. USGS GAGING STATION NUMBER = 13345000.
2. PERIOD OF RECORD = 1916-1919, 1968-1985.
3. DRAINAGE AREA = 397 SQUARE MILES.
4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

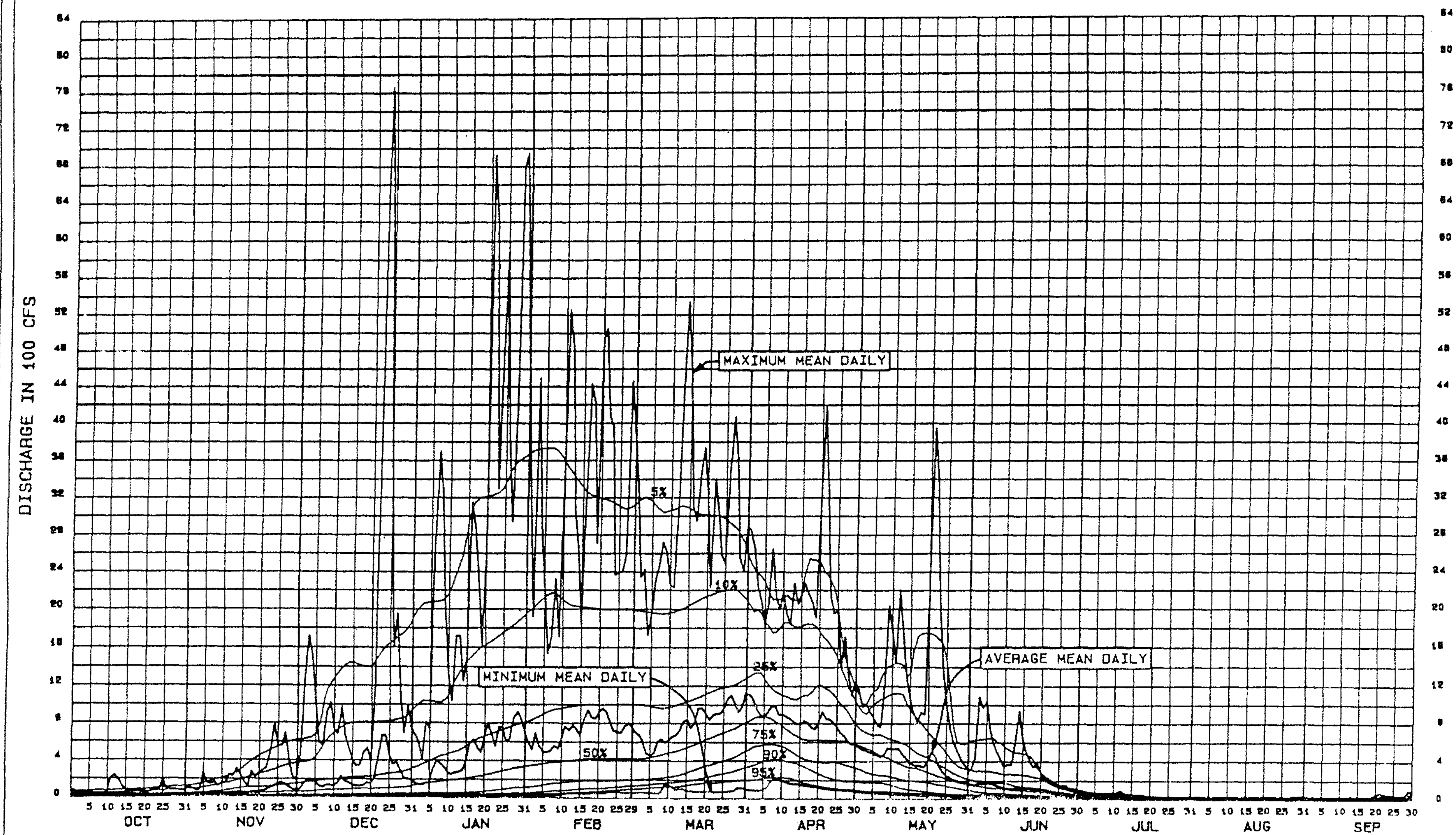
PALOUSE RIVER
NEAR POTLATCH, IDAHO

SUMMARY HYDROGRAPHS

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

SCHUSTER MARCH, 1989

13345000



NOTES:

1. USGS GAGE #13346000, PALOUSE R. NEAR COLFAX USED FOR PERIOD SEPT 1955 THROUGH OCT 1963. USGS GAGE #13346100, PALOUSE R. AT COLFAX USED FOR PERIOD SEPT 1963 THROUGH OCT 1977.

2. DRAINAGE AREAS:
PALOUSE R. NR. COLFAX = 491 SQUARE MILES.
PALOUSE R. AT COLFAX = 497 SQUARE MILES.

3. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

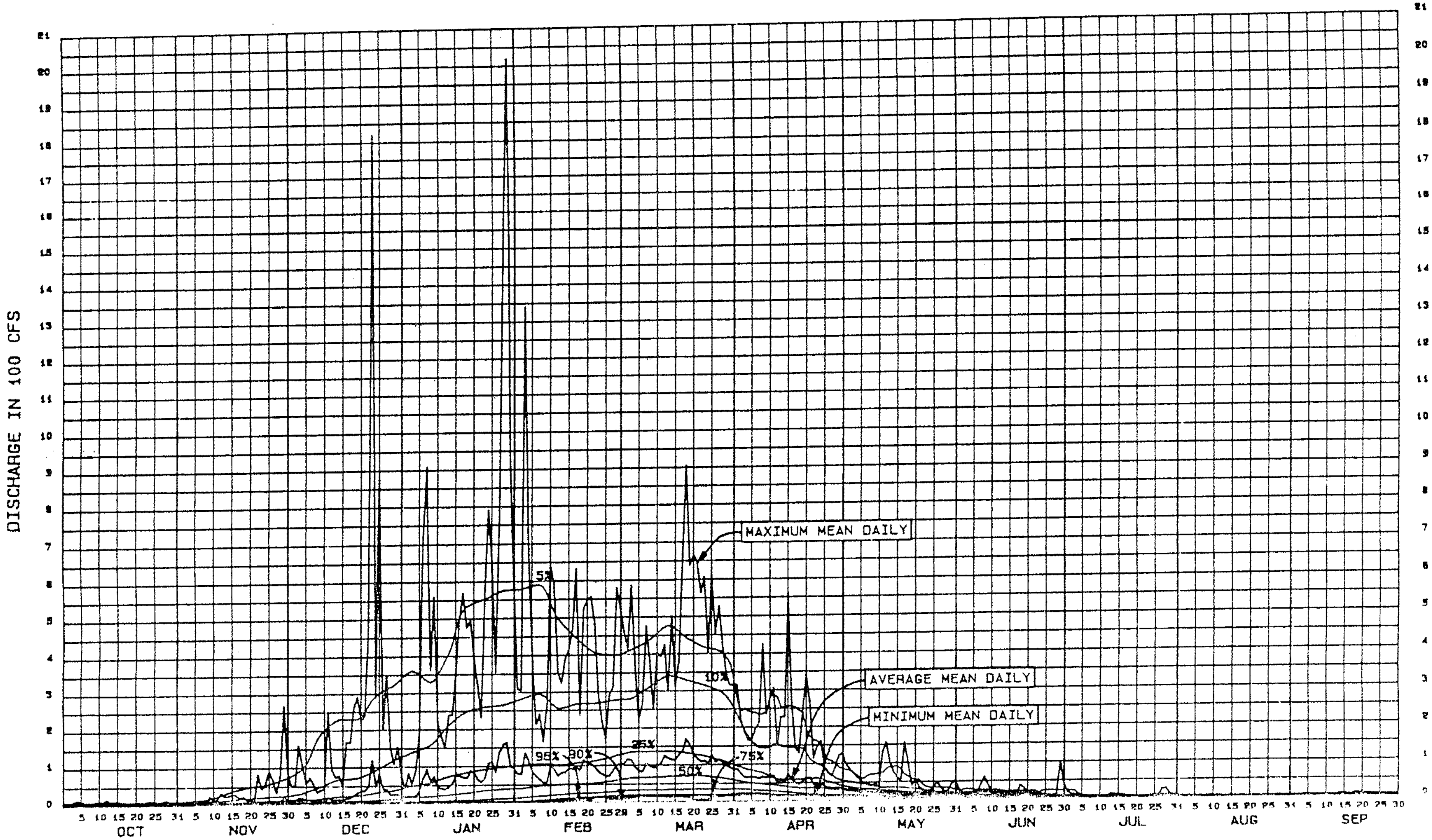
PALOUSE RIVER
AT COLFAX, WASHINGTON

SUMMARY HYDROGRAPHS

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

SCHUSTER MARCH, 1989

13346100



NOTES:

1. USGS GAGING STATION NUMBER = 13348000.
2. PERIOD OF RECORD = 1935-1942, 1961-1981.
3. DRAINAGE AREA = 132 SQUARE MILES.
4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

SOUTH FORK PALOUSE RIVER
AT PULLMAN, WASHINGTON

SUMMARY HYDROGRAPHS

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

SCHUSTER MARCH, 1989

13348000

APPENDIX E

<u>PARADISE CREEK DAMSITE</u>

APPENDIX E

PARADISE CREEK DAMSITE

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APPENDIX E

PARADISE CREEK DAMSITE

1. LOCATION.

The project is located less than a mile northeast of Moscow, Idaho, Section 4 and 9, Range 5 West, Township 39 North, on Paradise Creek (see figure E-1).

2. SITE DESCRIPTION.

a. Hydrology.

The spillway design flood of 14,550 cfs is based on the probable maximum precipitation occurring when the reservoir is full.

b. Geology.

Geological data and knowledge of the specific damsite is extremely limited. Based on the study, Preliminary Earth-Resistivity Studies in the Moscow Basin, Idaho, Richard E. Cavin, Washington State University, the basalt at the Paradise Creek damsite was judged to be about 100 feet below the ground surface and covered with gravels and Palouse silt.

3. PROPOSED FEATURES.

a. Reservoir and Relocations.

Inactive reservoir storage would be about 300 acre-feet. Active flood control storage would be about 1,500 acre-feet. Total gross reservoir storage would be about 1,800 acre-feet at a maximum reservoir elevation of 2,630 feet msl. The reservoir water surface area would be about 168 acres. The top of inactive storage (conservation pool) would be at elevation 2,620 feet msl with a water surface area of about 40 acres. Area and capacity curves are shown on figure E-2.

One structure is shown on the quadrangle map within the reservoir and about 1.7 miles of light duty road would be relocated.

b. Diversion and Care of Water.

Diversion and care of Paradise Creek during construction is assumed to be minimal. Diversion of the creek would be through the permanent outlet works.

c. Dam.

The top of the main dam embankment would be at elevation 2,645 feet msl which is 37 feet above the streambed. The creek bed is estimated to be at elevation 2,608 feet msl. Top width of the dam would be 30 feet and the axis length would be 2,850 feet. The upstream face slope would be 1V to 6H and the downstream face slope would be 1V to 4H. The embankment section as shown on figure E-3 would be composed of impervious clay fill. A central filter of sand, 10 feet wide, would connect to a 5-foot-thick horizontal gravel filter drain extending to the downstream toe. The upstream face would be covered with a protective layer of rockfill and the downstream face would be protected with gravel. Total fill volume of the main dam is estimated to be 408,000 cubic yards.

d. Spillway and Outlet Works.

A preliminary design for the spillway, outlet works, and stilling basin was based on the design of similar facilities at the Mill Creek Diversion structure near Walla Walla, Washington. Spillway and outlet works would be constructed as adjacent structures located near the existing creek channel. The spillway would be an uncontrolled spillway with a design capacity of 14,550 cfs. The overflow ogee section would be 300 feet long and the reservoir would be surcharged about 5.5 feet above the spillway crest to pass the design flood. Energy would be dissipated in a conventional concrete hydraulic jump stilling basin.

The outlet works would have a capacity of 400 cfs controlled by slide gates. Discharge would be to a riprap channel connecting to the existing Paradise Creek channel.

4. CONSTRUCTION COSTS.

Derivation of construction, investment, and annual costs is described below. A summary of annual costs is shown on table E-1. Engineering estimate sheets are shown on table E-2.

USGS quadrangle maps were used extensively in the development of cost estimates.

Total cost for lands and damages is based on the estimated land value and the estimated administrative cost for land acquisition.

Road relocations were estimated on a cost per mile basis. The length of roadways were estimated based on USGS quadrangle maps.

Embankment quantities are estimated based on a valley cross section drawn from the USGS quadrangle map having a contour interval of 20 feet.

A contingency factor of 20 percent is included in the estimate.

The cost of engineering and supervision and administration was estimated based on curves relating government costs on civil works projects to direct construction costs. The estimated construction cost is $11 million (see table E-1).

5. INVESTMENT COST.

Interest during construction was estimated assuming a 3-year construction period, equal payments at midyear, compounded at 8.875 percent interest rate. The investment cost is $12,527,000.

6. ANNUAL COSTS.

Annual interest and amortization cost was estimated assuming a 100-year service life at 8.875 percent interest rate.

O&M cost is based on experience curves. Estimated O&M for Paradise Creek Dam and Reservoir (1,500 acre-feet total storage) is $32,000.

TABLE E-1

ANNUAL COSTS

Total Construction Cost		
(Including Contingencies, E&D, and S&A)		$11,000,000
Interest During Construction		
3-year construction, compound interest at:	8.875%	1,527,000
TOTAL INVESTMENT COST		$12,527,000
Annual Costs		
Interest and Amortization		
Service Life @ 100 years	8.875%	$1,112,000
Operation and Maintenance		
Dam and Reservoir		32,000
TOTAL ANNUAL COSTS		$1,144,000

TABLE E-2

FILENAME: PALOUSE\PDCEST88 — ENGINEER'S ESTIMATE — RECONNAISSANCE

PROJECT: PARADISE CREEK DAMSITE — SHEET 1 OF 5

LOCATION: East of Moscow, ID, Paradise Creek — ESTIMATED BY: PORTER/CLAUSEN

FEATURES: Embankment Dam — DATE: 10-Jan-89

PERTINENT DATA:

OCTOBER 1988 PRICE LEVEL

CLAUSEN, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
01 - LANDS AND DAMAGES					
					Based on
Project Lands Incl. Contingency	L.S.	1	681,000.00	681,000	Real Estate
(720 Ac, assume 3 Owners)					Land Value
Highway Right of Way	L.S.	1	34,000.00	34,000	& Adm. Cost
(20.6 Ac, assume 3 Owners)					

TOTAL COST LANDS AND DAMAGES				$715,000	
02 - RELOCATIONS					
Light Duty Roads	MI	1.7	222,700.00	378,600	
(Gravel)					

			Subtotal	$378,600	
CONTINGENCIES	25%			94,400	

TOTAL COST RELOCATIONS			USE---->	$473,000	
03 - RESERVOIR					
Reservoir Clearing	AC	5	2,000.00	10,000	
Buildings & Improvements	EA	1	500.00	500	
(Demolition & Removal)					
Boundary Survey	MI	3.6	5,000.00	18,000	
Boundary Survey	MI	3.6	10,000.00	36,000	

			Subtotal	$64,500	
CONTINGENCIES	25%			16,500	

TOTAL COST RESERVOIR			USE---->	$81,000	

FILENAME: PALOUSE\PDCEST88	ENGINEER'S ESTIMATE	RECONNAISSANCE
PROJECT: PARADISE CREEK DAMSITE		SHEET 2 OF 5
LOCATION: East of Moscow, ID, Paradise Creek		ESTIMATED BY: PORTER/CLAUSEN
FEATURES: Embankment Dam		DATE: 10-Jan-89
PERTINENT DATA: OCTOBER 1988 PRICE LEVEL		CLAUSEN, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
04 - DAM					
Embankment					
Key Trench Excavation					
(Common)	CY	65956	3.00	197,870	
Stripping	CY	31168	1.60	49,870	
Sand/Gravel Drain	CY	54028	14.00	756,390	
Clay Random Fill	CY	261556	4.00	1,046,220	
Rock Bedding	CY	11936	16.00	190,980	
Rock Fill	CY	80645	26.00	2,096,770	
			Subtotal	$4,338,100	
CONTINGENCIES	25%			1,084,900	
Cost of Embankment			USE---->	$5,423,000	
Outlet Works					
Concrete	CY	455	350.00	159,250	
Slide Gates					
(2'x 4'H, 20'head to sill)	EA	2	15,000.00	30,000	
(With operators)					
Trashracks	LB	28875	1.00	28,880	
Handrailing	LF	60	40.00	2,400	
			Subtotal	$220,530	
CONTINGENCIES	25%			55,470	
Cost of Outlet Works			USE---->	$276,000	

TABLE E-2 (Continued)

FILENAME: PALOUSE\PDCEST88	ENGINEER'S ESTIMATE	RECONNAISSANCE
PROJECT: PARADISE CREEK DAMSITE		SHEET 3 OF 5
LOCATION: East of Moscow, ID, Paradise Creek		ESTIMATED BY: PORTER/CLAUSEN
FEATURES: Embankment Dam		DATE: 10-Jan-89
PERTINENT DATA: OCTOBER 1988 PRICE LEVEL		CLAUSEN, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Spillway					
Concrete	CY	4916	[illegible]50.00	1,720,600	
Cement	CWT	24088	incl.		
Reinforcing	LB	614500	incl.		
Excavation for Riprap	CY	24800	3.00	74,400	
Riprap Bedding	CY	2665	16.00	42,640	
Riprap	CY	5330	26.00	138,580	
			Subtotal	$1,976,220	
CONTINGENCIES	25%			493,780	
Total Cost Spillway			USE---->	$2,470,000	
TOTAL COST DAM Embankment, Outlet, and Spillway				$8,169,000	
20 - Permanent Operating Equipment					
Hydrologic Sta. & Gages	JOB	1	80,000.00	80,000	See Harvard Es
Reservoir Operating Manual	EA	1	45,000.00	45,000	Project Planni
					Est 3/4 man-yr
			Subtotal	$125,000	
CONTINGENCIES	25%			31,000	
TOTAL COST PERMANENT OPERATING EQUIPMENT			USE---->	$156,000	

FILENAME: PALOUSE\PDCEST88 — ENGINEER'S ESTIMATE — RECONNAISSANCE

PROJECT: PARADISE CREEK DAMSITE — SHEET 4 OF 5

LOCATION: East of Moscow, ID, Paradise Creek — ESTIMATED BY: PORTER/CLAUSEN

FEATURES: Embankment Dam — DATE: 10-Jan-89

PERTINENT DATA:

OCTOBER 1988 PRICE LEVEL

CLAUSEN, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
50 - CONSTRUCTION FACILITIES					
Mobilization	JOB	1	5,000.00	5,000	
Office/Laboratory Trailer	EA	2	9,000.00	18,000	
Temporary Utilities	JOB	1	5,000.00	5,000	
6'high Chain Link Fence	LF	400	8.00	3,200	Tel. Estimate
12' wide Gate	EA	1	600.00	600	Tel. Estimate
			Subtotal	$31,800	
CONTINGENCIES	25%			8,200	
TOTAL COST CONSTRUCTION FACILITIES			USE---->	$40,000	
TOTAL CONSTRUCTION COST ROBINSON LAKE DAM (Less Lands)			USE---->	$8,919,000	
30 - ENGINEERING & DESIGN	10.00%			$892,000	
31 - SUPERVISION & ADMINISTRATION	8.00%			$714,000	

TABLE E-2 (Continued)

FILENAME: PALOUSE\PDCEST88 ENGINEER'S ESTIMATE RECONNAISSANCE

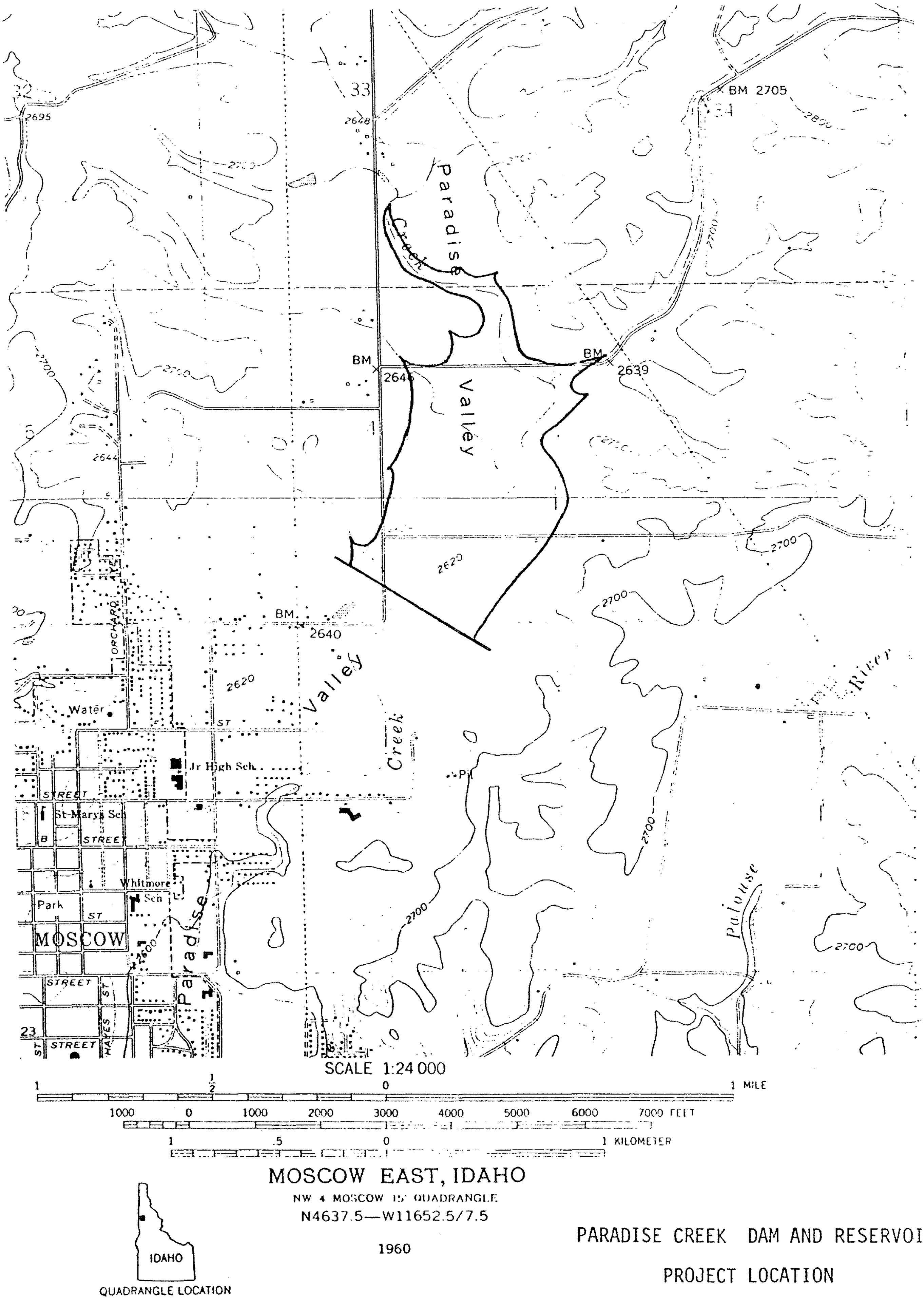
PROJECT: PARADISE CREEK DAMSITE SHEET 5 OF 5

LOCATION: East of Moscow, ID, Paradise Creek ESTIMATED BY: PORTER/CLAUSEN

FEATURES: Embankment Dam DATE: 10-Jan-89

PERTINENT DATA:
OCTOBER 1988 PRICE LEVEL
CLAUSEN, NPWPL-PP, 6592

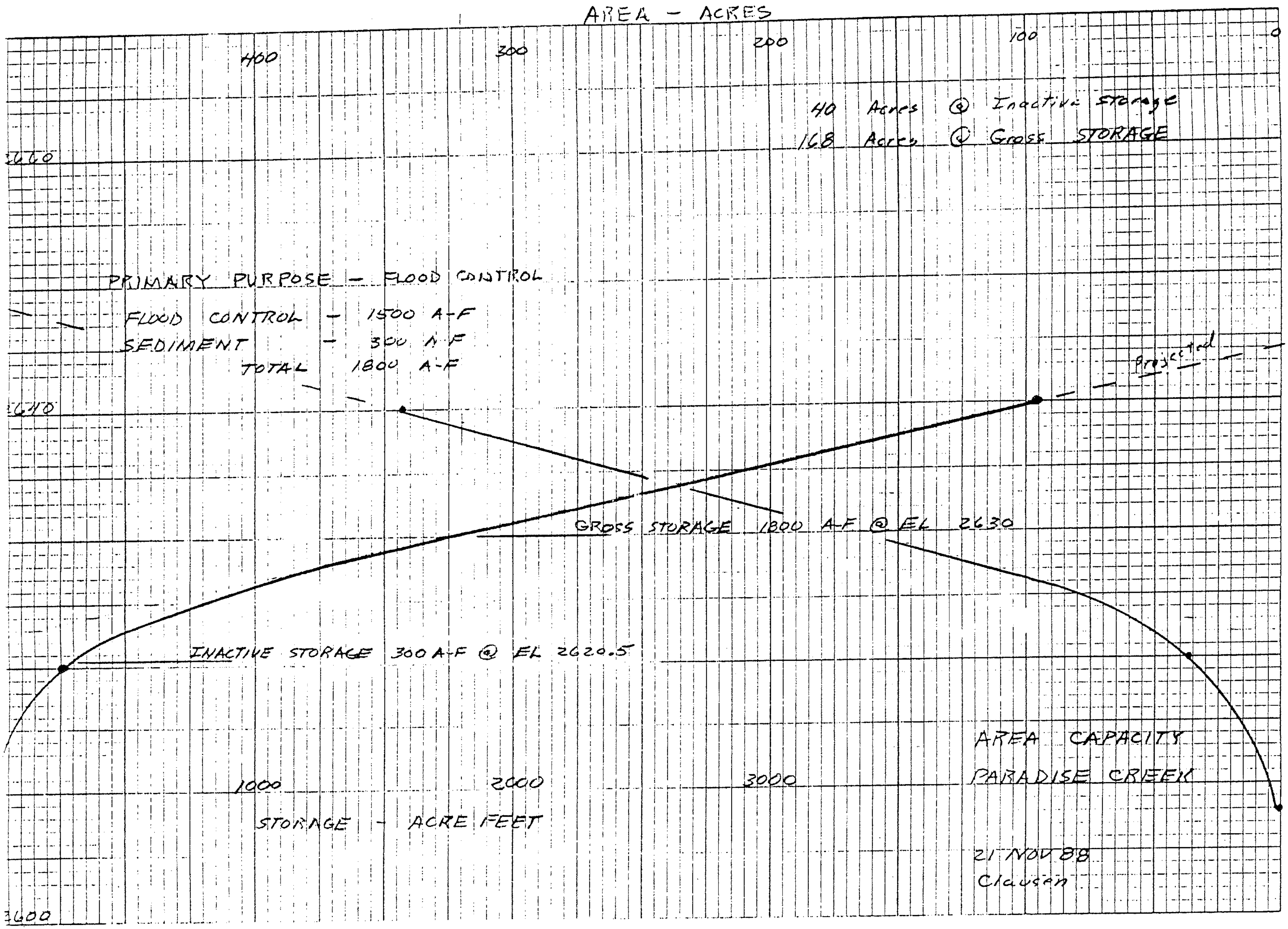
ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
SUMMARY COST ESTIMATE					
(Including Contingencies)					
01 - LANDS AND DAMAGES				$715,000	
02 - RELOCATIONS				$473,000	
03 - RESERVOIR				$81,000	
04 - DAM				$8,169,000	
20 - Permanent Operating Equipment				$156,000	
50 - CONSTRUCTION FACILITIES				$40,000	
30 - ENGINEERING & DESIGN				$892,000	
31 - SUPERVISION & ADMINISTRATION				$714,000	
TOTAL PROJECT COST				$11,240,000	(ROUNDED)



PARADISE CREEK DAM AND RESERVOIR

PROJECT LOCATION

Figure F-1



AREA - ACRES
400
300
200
100
0
40 Acres @ Inactive Storage
168 Acres @ Gross STORAGE
2660
PRIMARY PURPOSE - FLOOD CONTROL
FLOOD CONTROL - 1500 A-F
SEDIMENT - 300 A-F
TOTAL 1800 A-F
Projected
2640
GROSS STORAGE 1800 A-F @ EL 2630
INACTIVE STORAGE 300 A-F @ EL 2620.5
AREA CAPACITY
PARADISE CREEK
1000
2000
3000
STORAGE - ACRE FEET
21 NOV 88
Clausen
2600

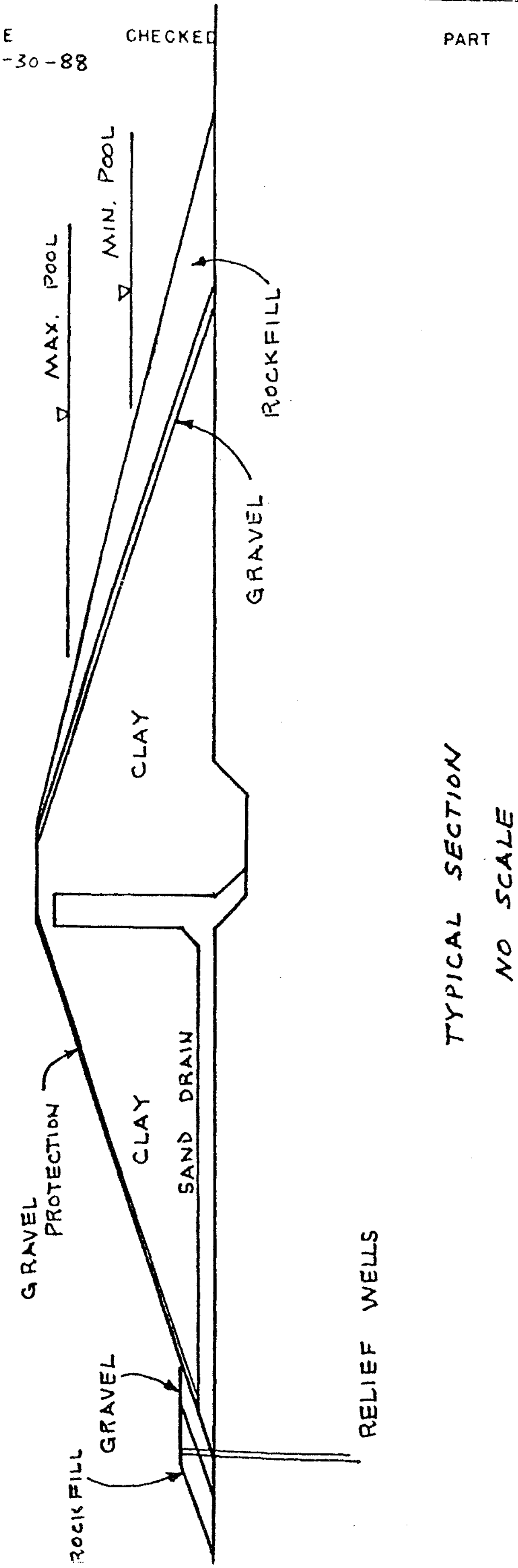
CORPS OF ENGINEERS, U.S. ARMY WALLA WALLA DISTRICT

ENGINEERING DIV. BRANCH SECTION

PROJECT

SUBJECT *TYPICAL EMBANKMENT*

BY	DATE	CHECKED	PART	PAGE	OF
Gmc	12-30-88				



NPD Form 7A
June 1962

Clearprint
10th Grid - RP
Translucent Grid

Figure F-3

APPENDIX F

ROBINSON LAKE DAMSITE

APPENDIX F

ROBINSON LAKE DAMSITE

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APPENDIX F

ROBINSON LAKE DAMSITE

1. LOCATION.

The project is located approximately 4 miles east northeast of Moscow, Idaho, Section 1, Range 5 West, Township 39 North, on the South Fork of the Palouse River, about 700 feet downstream from the existing Robinson Lake Dam (see figure F-1). The proposed project would inundate the existing dam and lake.

2. SITE DESCRIPTION.

a. Hydrology.

The spillway design flood of 14,450 cfs is based on the probable maximum precipitation occurring when the reservoir is full.

b. Geology.

Geological data and knowledge of the specific damsite is extremely limited. It is generally known that the Columbia River Basalt rises to the surface east of Moscow, Idaho. This study assumes an adequate foundation for construction of an embankment dam. Overburden depths were assumed to be 10 feet on the left abutment, 20 feet deep on the right abutment, and 30 feet deep in the valley floor.

3. PROPOSED FEATURES.

a. Reservoir and Relocations.

Inactive reservoir storage would be 1,000 acre-feet. Active flood control storage would be 4,000 acre-feet. Total gross reservoir storage would be 5,000 acre-feet at a maximum reservoir elevation of 2,745 feet msl. The reservoir water surface would be about 160 acres. The inactive storage (conservation pool) would be at elevation 2,710 feet msl with a water surface area of 65 acres. Area and capacity curves are shown on figure F-2.

Fourteen structures are shown on the quadrangle map within the reservoir and about 3.6 miles of light duty roads would be relocated.

About 16.5 acres of wooded lands within the inactive storage area would be cleared for the reservoir.

b. Diversion and Care of Water.

Facilities for diversion and care of the South Fork Palouse River during construction would include an upstream cofferdam and diversion through the project outlet works. The cofferdam would be incorporated into the main dam embankment.

c. Dam.

The dam would be an embankment dam with a central impervious core, upstream and downstream filters, random fill, and riprap protection on the face slopes. Overburden would be removed under the central core and filters. The upstream face slope would be 1V to 2.5H and the downstream face slope would be 1V to 2.0H. Top of dam would be 15 feet above the spillway crest and top width would be 40 feet. The dam would be 1,175 feet long at elevation 2,760 feet msl. Total volume of material placed in the embankment is estimated to be 537,000 cubic yards. A typical embankment section is shown on figure F-3.

d. Outlet Works.

A low level outlet facility with a capacity of 400 cfs is estimated to control releases from the project. A small intake tower is assumed to be adequate for the project. The outlet would discharge to a small concrete impact type stilling basin to dissipate the energy head.

e. Spillway.

The spillway would be uncontrolled spillway and located on the left abutment (looking downstream). Spillway design capacity would be 14,450 cfs. The overflow ogee section would be 200 feet long and the reservoir would be surcharged about 11 feet above the spillway crest to pass the design flood. The spillway chute would discharge to a conventional concrete hydraulic jump stilling basin.

4. EXISTING PROJECT DESCRIPTION.

There is an existing dam at the proposed location owned by Latah County (Storage Right #874008). However, the project is no longer operational and water is allowed to flow freely through the dam. The dam and original reservoir would be inundated by the new dam and reservoir.

5. CONSTRUCTION COSTS.

Derivation of construction, investment, and annual costs is described below. A summary of annual costs is shown on table F-1. Engineering estimate sheets are shown on table F-2.

USGS quadrangle maps were used extensively in the development of cost estimates.

Total cost for lands and damages is based on the estimated land value and the estimated administrative cost for land acquisition.

Road relocations were estimated on a cost per mile basis using costs from similar type of construction.

Reservoir clearing and the boundary survey quantities were estimated using USGS quadrangle maps. Fourteen buildings and improvements would be removed from the reservoir area.

Embankment quantities are estimated based on a valley cross section drawn from the USGS quadrangle map having a contour interval of 20 feet. A preliminary design for the outlet works is based on the design of similar facilities at Mill Creek Lake near Walla Walla, Washington. Spillway quantities were determined from sections based on the USGS quadrangle map.

Permanent operating equipment was assumed to include a hydrologic station and gages.

Temporary construction facilities would include an office and construction laboratory within a fenced compound.

A contingency factor of 20 percent is included in the estimate.

The cost of engineering and design and supervision and administration was estimated based on curves relating government costs on civil works projects to direct construction costs. The estimated construction cost is $11,109,200.

6. INVESTMENT COST.

Interest during construction was estimated assuming a 3-year construction period, equal payments at midyear, compounded at 8.875 percent interest rate. The investment cost is $13,164,000.

7. ANNUAL COSTS.

Annual interest and amortization cost was estimated assuming a 100-year service life at 8.875 percent interest rate.

O&M costs are based on experience curves. Estimated O&M for Robinson Lake Dam and Reservoir (5,000 acre-feet) is $47,000.

TABLE F-1

ANNUAL COSTS

Construction Cost		
(Including Contingencies, E&D, and S&A)		$11,000,000
Interest During Construction		
3-year construction, compound interest at:	8.875%	1,527,000
TOTAL INVESTMENT COST		$12,527,000
Annual Costs		
Interest and Amortization		
Service Life @ 100 years	8.875%	$1,112,000
Operation and Maintenance		
Dam and Reservoir		47,000
TOTAL ANNUAL COSTS		$1,159,000

TABLE F-2

FILENAME: PALOUSE\ROBEST88	ENGINEER'S ESTIMATE	RECONNAISSANCE
PROJECT: ROBINSON LAKE DAMSITE		SHEET 1 OF 5
LOCATION: East of Moscow, ID, South Fork Palouse River		ESTIMATED BY: PORTER/CLAUSEN
FEATURES: Embankment Dam		DATE: 10-Jan-89
PERTINENT DATA: OCTOBER 1988 PRICE LEVEL		Clausen, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
01 - LANDS AND DAMAGES					
					Based on
Project Lands Incl. Contingency	L.S.	1	386,400.00	386,400	Real Estate
(277 Ac, assume 18 Owners)					Land Value
Highway Right of Way	L.S.	1	70,800.00	70,800	& Adm. Cost
(44 Ac, assume 6 Owners)					

TOTAL COST LANDS AND DAMAGES				$457,200	
02 - RELOCATIONS					
Light Duty Roads (Gravel)	MI	4	222,700.00	801,700	

			Subtotal	$801,700	
CONTINGENCIES	20%			160,300	

TOTAL COST RELOCATIONS			USE---->	$962,000	
03 - RESERVOIR					
Reservoir Clearing (Vegetation & etc.)	AC	17	2,000.00	33,000	
Buildings & Improvements (Demolition & Removal)	EA	14	500.00	7,000	
Boundary Survey	MI	3	5,000.00	17,000	
Boundary Fencing	MI	3	10,000.00	34,000	

			Subtotal	$91,000	
CONTINGENCIES	20%			18,000	

TOTAL COST RESERVOIR			USE---->	$109,000	

FILENAME: PALOUSE\ROBEST88 ENGINEER'S ESTIMATE RECONNAISSANCE

PROJECT: ROBINSON LAKE DAMSITE SHEET 2 OF 5

LOCATION: East of Moscow, ID, South Fork Palouse River ESTIMATED BY: PORTER/CLAUSEN

FEATURES: Embankment Dam DATE: 10-Jan-89

PERTINENT DATA:
OCTOBER 1988 PRICE LEVEL
Clausen, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
04 - DAM					
Embankment					
Clearing and Grub	SY	33900	1.00	33,900	
Foundation Preparation	SY	9900	20.00	198,000	
Common Excavation	CY	103000	3.00	309,000	
Random Fill	CY	326000	2.50	815,000	
Impervious Core	CY	68500	6.00	411,000	
Filter 1	CY	22400	14.00	313,600	
Filter 2	CY	22400	14.00	313,600	
Filter 3	CY	22400	14.00	313,600	
Filter Drain	CY	61000	13.00	793,000	
Riprap	CY	14200	26.00	369,200	
Grout Curtain	SF	79500	2.00	159,000	

			Subtotal	$4,028,900	
CONTINGENCIES	20%			806,100	

Cost of Embankment			USE---->	$4,835,000	
Outlet Works					
Intake Tower	JOB	1	183,000.00	183,000	Based on Mill
Discharge Conduit					Crk IFB 80-B-0
(48" dia ccp)	LF	520	165.00	85,800	
Stilling Basin					
Excavation	CY	502	3.00	1,510	
Concrete	CY	64	350.00	22,400	
Riprap Bedding	CY	77	16.00	1,230	
Riprap	CY	230	26.00	5,980	

			Subtotal	$299,920	
CONTINGENCIES	20%			60,080	

Cost of Outlet Works			USE---->	$360,000	

TABLE F-2 (Continued)

FILENAME: PALOUSE\ROBEST88	ENGINEER'S ESTIMATE	RECONNAISSANCE
PROJECT: ROBINSON LAKE DAMSITE		SHEET 3 OF 5
LOCATION: East of Moscow, ID, South Fork Palouse River		ESTIMATED BY: PORTER/CLAUSEN
FEATURES: Embankment Dam		DATE: 10-Jan-89

PERTINENT DATA:

OCTOBER 1988 PRICE LEVEL

Clausen, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Spillway					
Excavation, Common	CY	38533	3.00	115,600	
Excavation, Rock	CY	31454	8.00	251,630	
Concrete	CY	4834	350.00	1,691,900	
Cement	CWT	23687	Incl.		
Reinforcing	LB	604250	Incl.		
Excavation for Riprap	CY	2963	3.00	8,890	
Riprap Bedding	CY	741	16.00	11,850	
Riprap	CY	2222	26.00	57,780	
Backfill	CY	4259	2.50	10,650	
			Subtotal	$2,148,300	
CONTINGENCIES	20%			429,700	
Total Cost Spillway			USE---->	$2,578,000	
TOTAL COST DAM Embankment, Outlet, and Spillway				$7,773,000	
20 - Permanent Operating Equipment					
Hydrologic Sta. & Gages	JOB	1	80,000.00	80,000	See Harvard Es
Reservoir Operating Manual	EA	1	45,000.00	45,000	Project Planni
					Est 3/4 man-yr
			Subtotal	$125,000	
CONTINGENCIES	20%			25,000	
TOTAL COST PERMANENT OPERATING EQUIPMENT			USE---->	$150,000	

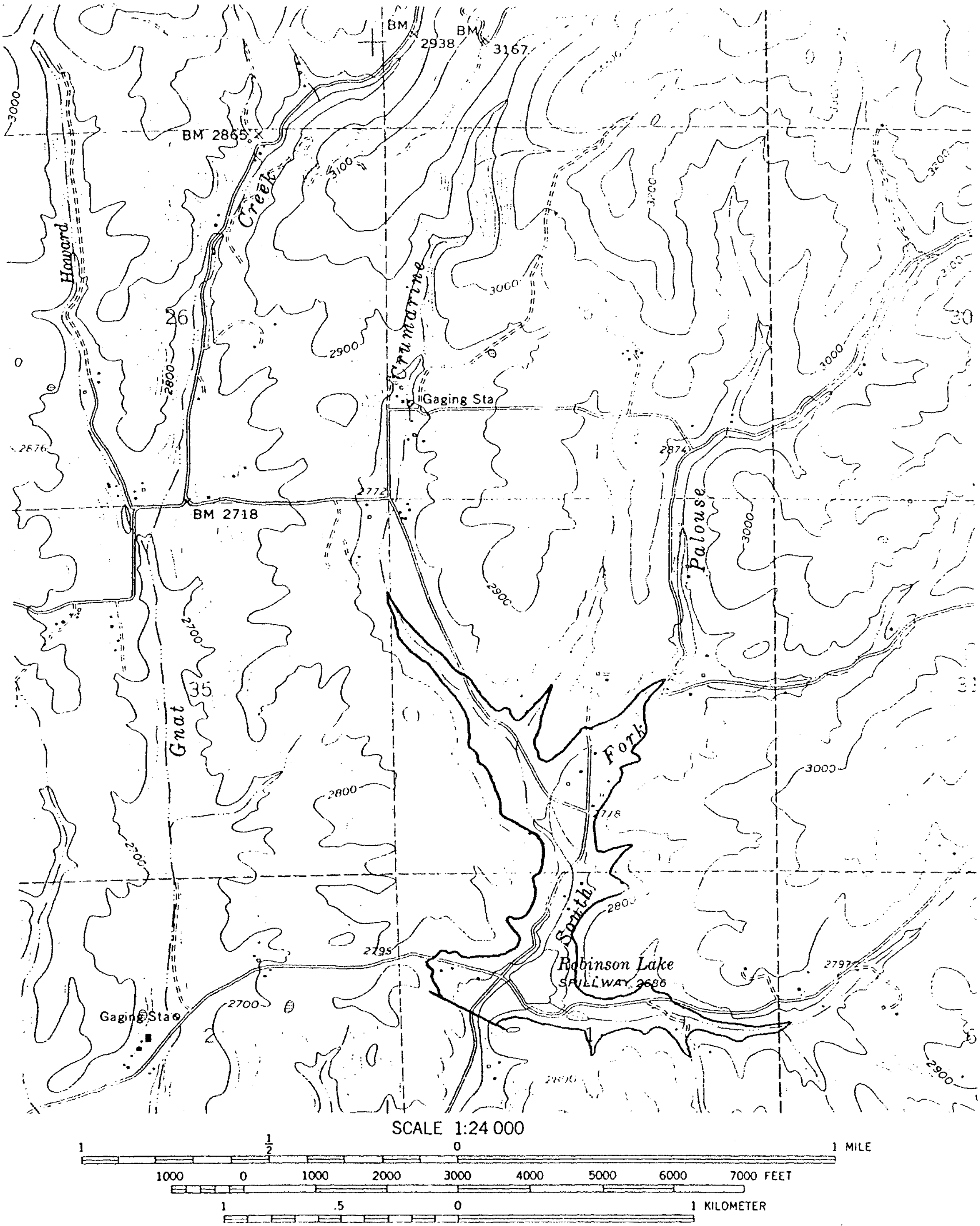
TABLE F-2 (Continued)

FILENAME: PALOUSE\ROBEST88	ENGINEER'S ESTIMATE	RECONNAISSANCE
PROJECT: ROBINSON LAKE DAMSITE		SHEET 4 OF 5
LOCATION: East of Moscow, ID, South Fork Palouse River		ESTIMATED BY: PORTER/CLAUSEN
FEATURES: Embankment Dam		DATE: 10-Jan-89
PERTINENT DATA: OCTOBER 1988 PRICE LEVEL		Clausen, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
50 - CONSTRUCTION FACILITIES					
Mobilization	JOB	1	5,000.00	5,000	
Office/Laboratory Trailer	EA	2	7,000.00	14,000	
Temporary Utilities	JOB	1	5,000.00	5,000	
6'high Chain Link Fence	LF	400	8.00	3,200	Tel. Estimate
12' wide Gate	EA	1	600.00	600	Tel. Estimate
			Subtotal	$27,800	
CONTINGENCIES	20%			5,200	
TOTAL COST CONSTRUCTION FACILITIES			USE---->	$33,000	
TOTAL CONSTRUCTION COST ROBINSON LAKE DAM (Less Lands)			USE---->	$9,027,000	
30 - ENGINEERING & DESIGN	10.00%			$903,000	
31 - SUPERVISION & ADMINISTRATION	8.00%			$722,000	

FILENAME: PALOUSE\ROBEST88	ENGINEER'S ESTIMATE	RECONNAISSANCE
PROJECT: ROBINSON LAKE DAMSITE		SHEET 5 OF 5
LOCATION: East of Moscow, ID, South Fork Palouse River		ESTIMATED BY: PORTER/CLAUSEN
FEATURES: Embankment Dam		DATE: 10-Jan-89
PERTINENT DATA: OCTOBER 1988 PRICE LEVEL		Clausen, NPWPL-PP, 6592

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
SUMMARY COST ESTIMATE					
(Including Contingencies)					
01 - LANDS AND DAMAGES				$457,200	
02 - RELOCATIONS				$962,000	
03 - RESERVOIR				$109,000	
04 - DAM				$7,773,000	
20 - Permanent Operating Equipment				$150,000	
50 - CONSTRUCTION FACILITIES				$33,000	
30 - ENGINEERING & DESIGN				$903,000	
31 - SUPERVISION & ADMINISTRATION				$722,000	
TOTAL PROJECT COST				$11,109,200	(ROUNDED)



ROBINSON LAKE, IDAHO

SW/4 POTLATCH 15' QUADRANGLE

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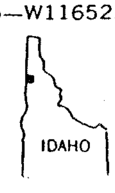
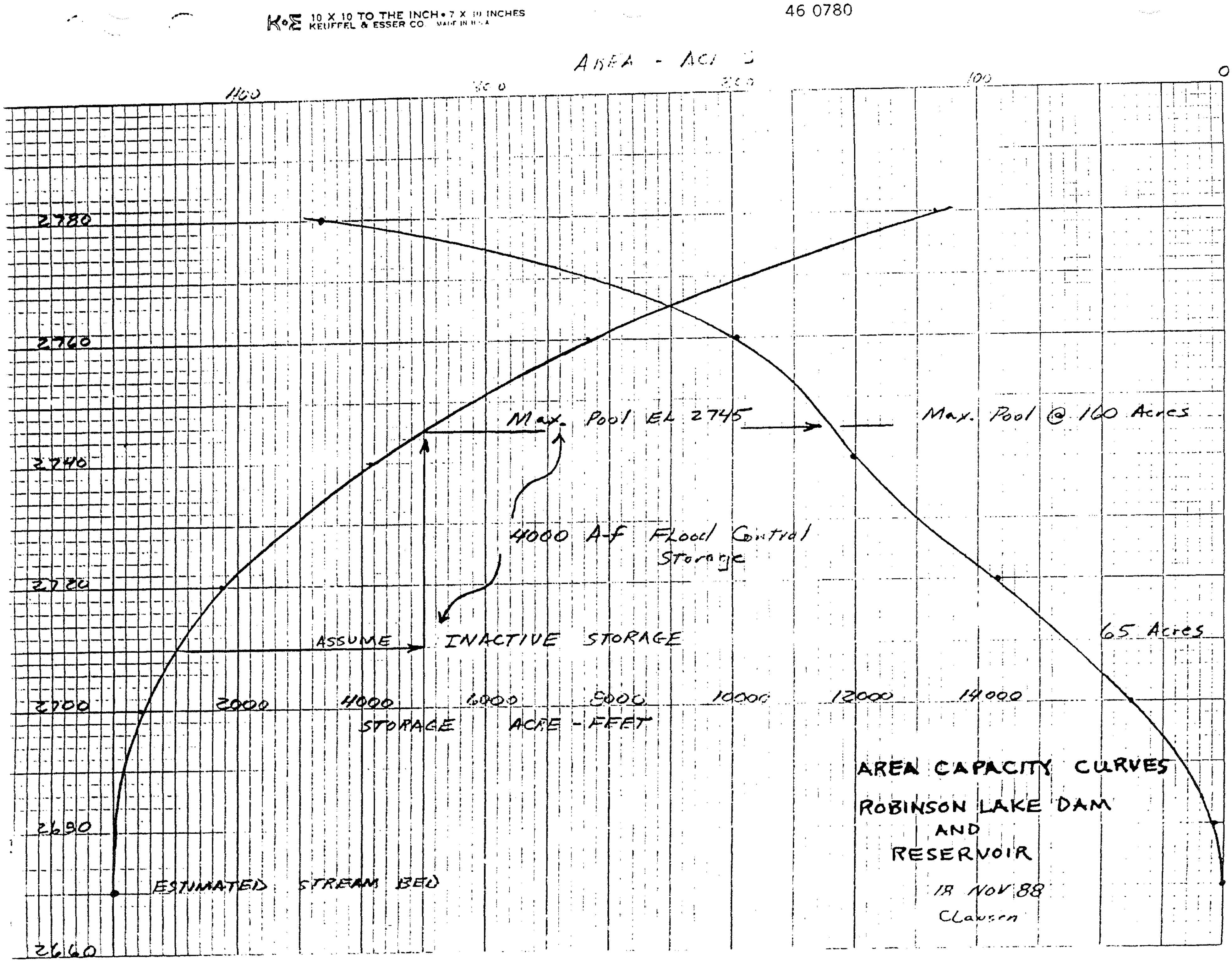


ROBINSON LAKE DAM AND RESERVOI

PROJECT LOCATION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KEUFFEL & ESSER CO.
46 0780
AREA - ACRES
0
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400
2780
2760
2740
2720
2700
2690
2660
Max. Pool EL 2745
Max. Pool @ 160 Acres
4000 A-F Flood Control Storage
ASSUME
INACTIVE STORAGE
65 Acres
2000
4000
6000
8000
10000
12000
14000
STORAGE ACRE - FEET
ESTIMATED STREAM BED
AREA CAPACITY CURVES
ROBINSON LAKE DAM
AND
RESERVOIR
18 NOV 88
Clausen

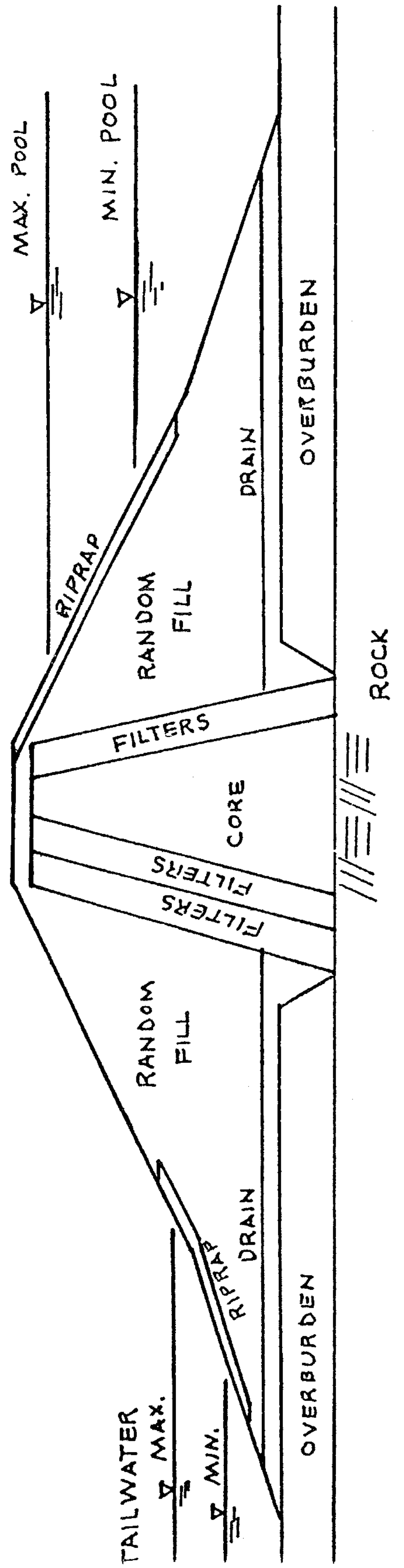
CORPS OF ENGINEERS, U.S. ARMY — WALLA WALLA DISTRICT

ENGINEERING DIV. BRANCH SECTION

PROJECT

SUBJECT *TYPICAL EMBANKMENT SECTION*

BY	DATE	CHECKED	PART	PAGE	OF
gmc	12-30-88				



TYPICAL SECTION
NO SCALE

NPD Form 7A
June 1962

Clearprint
10th Grid - RP
Translucent Grid

APPENDIX I

PLANNING AID LETTER

United States Department of the Interior

FISH AND WILDLIFE SERVICE
BOISE FIELD OFFICE
4696 Overland Road, Room 576
Boise, Idaho 83705

March 23, 1989

Lieutenant Colonel James A. Walter
District Engineer
Attn: Mr. William MacDonald
Walla Walla District, Corps of Engineers
Bldg. 602, City-County Airport
Walla Walla, Washington 99362

Re: Palouse River Planning Aid Report
file #351.6300

Dear Colonel Walter:

Thank you for your comments on our draft Planning Aid Report for the Palouse River Reconnaissance Study. We have incorporated your comments into the final report whenever possible. We are sending five copies of the final report, as specified in the scope of work, under separate cover. If you have any questions concerning the report, contact Ralph Myers at (208) 334-1931.

Sincerely yours,

Charles H. Lobdell
Field Supervisor

UNITED STATES DEPARTMENT OF THE INTERIOR

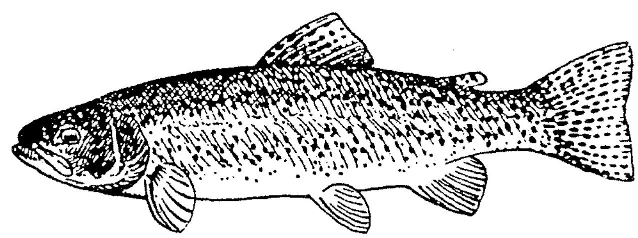
FISH AND WILDLIFE SERVICE

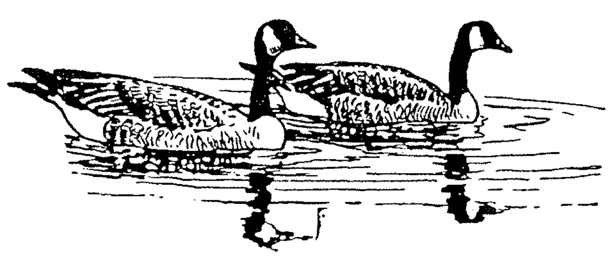
PALOUSE RIVER BASIN

RECONNAISSANCE STUDY

IDAHO

PLANNING AID REPORT





REGION ONE

MARCH 1989

PLANNING AID REPORT

PALOUSE RIVER BASIN RECONNAISSANCE STUDY

PREPARED FOR
THE U.S. ARMY CORPS OF ENGINEERS
WALLA WALLA DISRICT

PREPARED BY
U.S. FISH AND WILDLIFE SERVICE
BOISE FIELD OFFICE
CHARLES H. LOBDELL, FIELD SUPERVISOR
RALPH E. MYERS, FISHERY BIOLOGIST

MARCH 1989

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INTRODUCTION

The U.S. Army Corps of Engineers (Corps), Walla Walla District is conducting a Palouse River Basin, Idaho/Washington Reconnaissance Study. Several water development alternatives are being investigated. The study was initiated in response to concerns about water supply and flooding. Population centers of primary concern include the town of Pullman, Washington, and Moscow, Palouse, and Potlatch, Idaho.

The Corps has requested that the U. S. Fish and Wildlife Service (Service) prepare a Planning Aid Report as part of the Reconnaissance study. The purpose of this Planning Aid Report is to identify potential fish and wildlife resource impacts, needs, and opportunities related to five proposed developments. The report is based primarily on existing information. The Service has relied on the Corps to provide all available descriptions of the alternative, including maps, photographs, and engineering, hydrologic, survey, and land use data. Information from the Planning Aid Report will be used as a framework for detailed Fish and Wildlife Coordination Act investigations should feasibility-level studies be required. The report has been prepared in accordance with the Fish and Wildlife Coordination Act and the National Environmental Policy Act, as amended.

Several previous investigations have been conducted by the Bureau of Reclamation and the Corps to address similar concerns as identified in the present study. Specific engineering plans and designs are not available for all of the current proposals. For this reason, our report relies heavily on past design proposals and is necessarily general in description of potential fish and wildlife impacts.

ALTERNATIVES ANALYSIS

Five potential developments are being considered for the Palouse River area of northwestern Idaho and southwestern Washington (Figure 1). We are presenting a summary list of the alternatives followed by a more in-depth evaluation of each alternative. The analysis includes a description of existing fish and wildlife resources in the proposed project area, a projection of anticipated impacts and potential mitigation/enhancement measures, identification of data gaps and study needs, and the Service's reconnaissance level recommendation on each alternative.

Specific engineering plans for all alternatives have not yet been developed. The exact route for the proposed pipelines, and management of water levels for the proposed reservoirs are presently undefined. Specific plans on the locations and methodology of channel alterations at Pullman, Washington are lacking. We anticipate the development of specific construction, operation, and management plans should any of the alternatives be evaluated at the feasibility level.

SUMMARY OF ALTERNATIVES

1. A flood control reservoir on Paradise Creek upstream from Moscow, Idaho (Figure 2 and Table 1).

2. A storage reservoir at Robinson Lake, Idaho (Figure 3 and Table 1).

3. Storage reservoirs on the Palouse River, Idaho at Harvard and Laird. The proposal includes a pipeline from Palouse, Idaho to Moscow, Idaho and Pullman, Washington (Figures 4 and 5, and Table 1).

4. A pipeline from Lower Granite Reservoir to the towns of Pullman, Washington, and Moscow, Idaho (Figure 6).

5. Channel alterations through the town of Pullman, Washington.

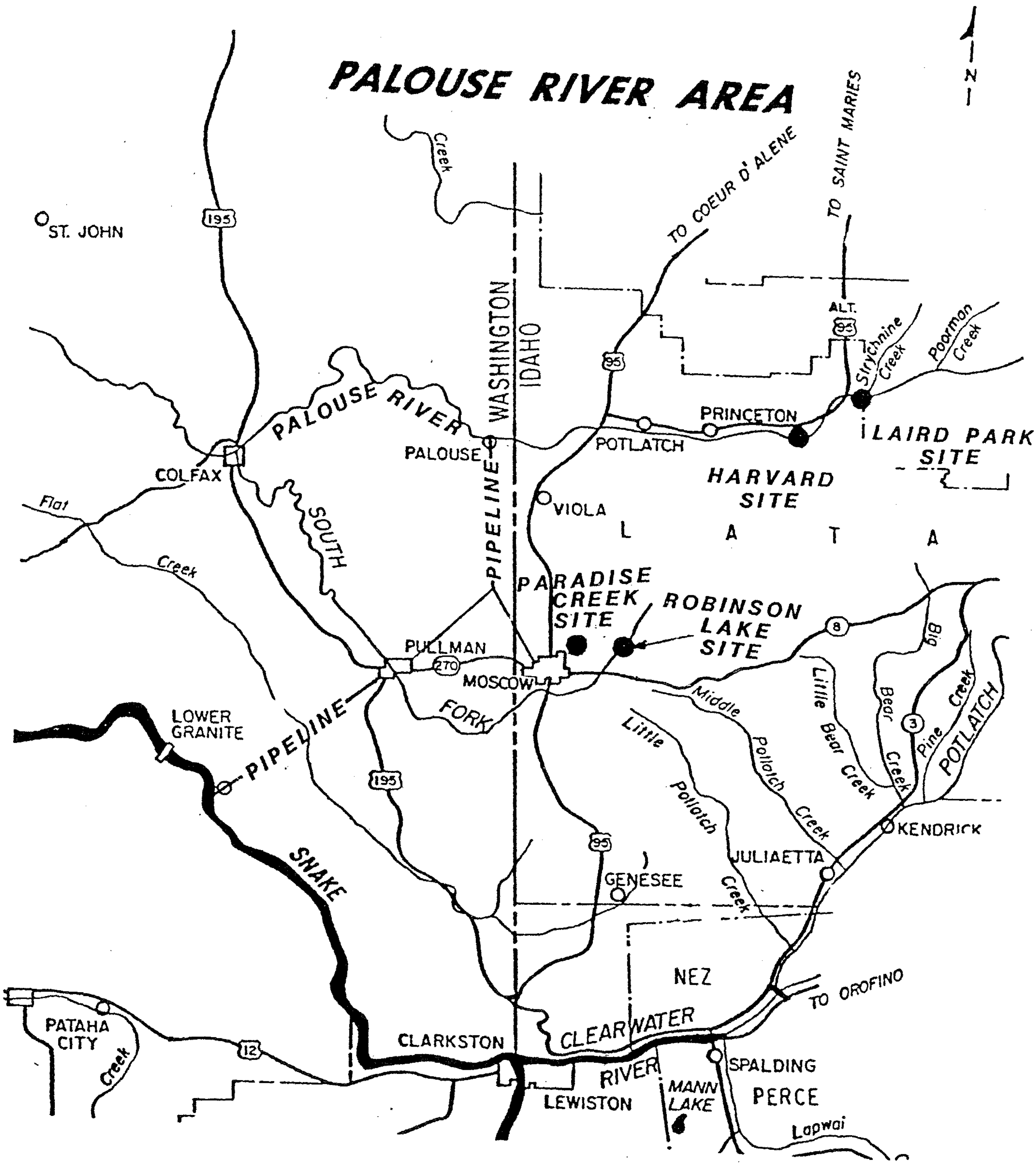

Figure 1. Map of the geographic location of the five development alternatives being studied in eastern Washington and western Idaho.

Table 1. Physical characteristics of proposed reservoirs in Latah County, Idaho.

	Harvard	Laird	Paradise Creek	Robinson Lake
Normal pool elevation (msl)	2,673	2,874	2,635	2,732
Storage capacity (acre-feet)	110,000	70,000	1,768	---
Surface area (acres)	2,310	1,075	240	130
Mean depth (feet)	48	65	7	---
Mean annual inflow (acre-feet)	199,200	149,400*	5,350	---
Expected water retention time (days)	203	171	121	---

* Estimated by taking 75% of Harvard flow.

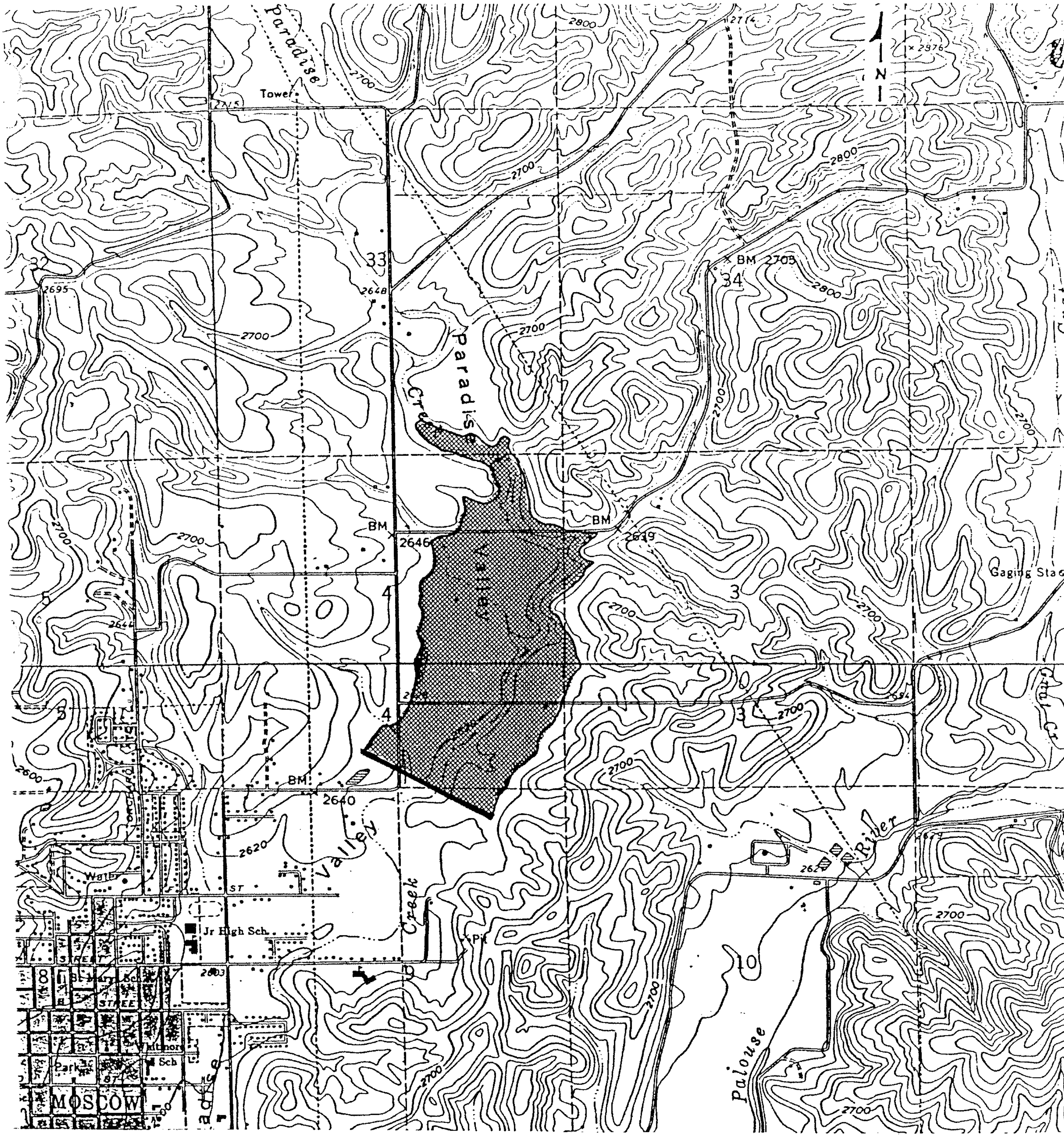

Figure 2. Map depicting the location and inundated area for the proposed Paradise Creek Reservoir.

Figure 3. Map depicting the location and inundated area for the proposed Robinson Lake Reservoir.

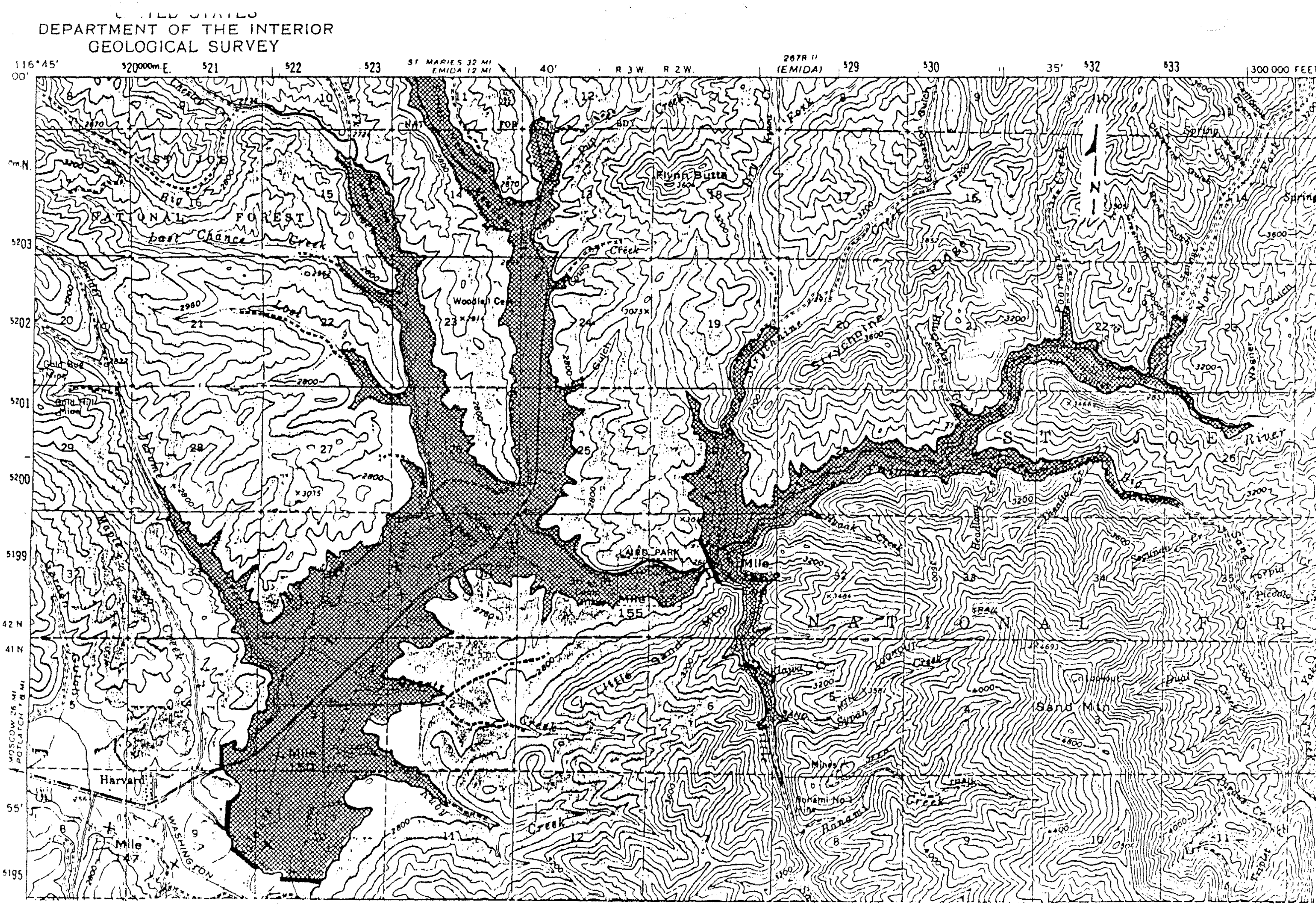

Figure 4. Map depicting the location and inundated area for the proposed Harvard and Laird Reservoirs.

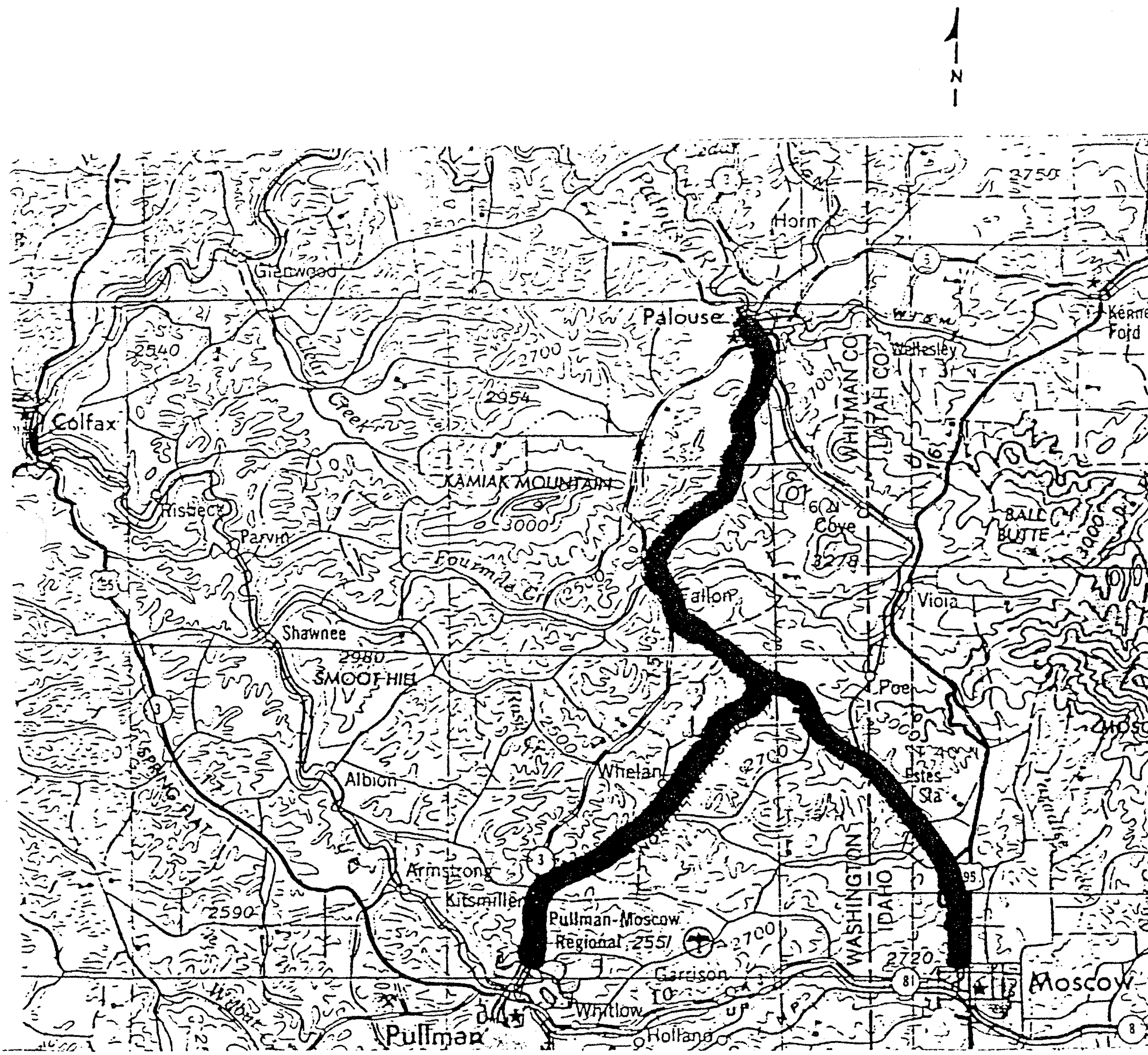

Figure 5. Map depicting the route of the proposed pipeline from Palouse, Washington to Pullman, Washington and Moscow, Idaho.

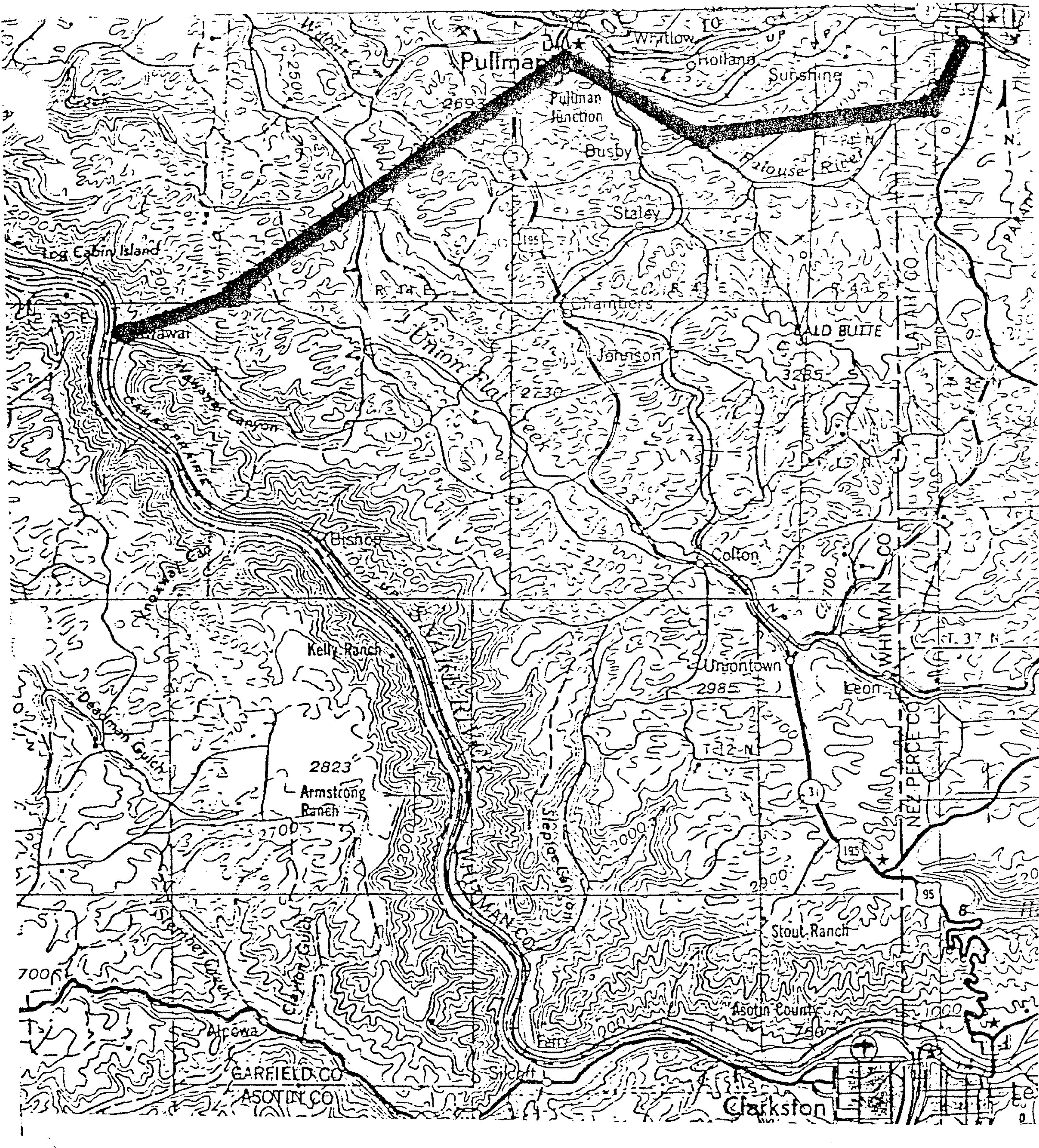

Figure 6. Map depicting the route of the proposed pipeline from Lower Granite Reservoir, Washington to Pullman, Washington and Moscow, Idaho.

The reservoir would be located approximately one mile east of Moscow, Idaho in Paradise Valley (Figure 2). The project location is within the Palouse, an area well known for its dryland wheat production, at north latitude 46° 45' and west longitude 116° 57'. The topography of the project area is generally rolling hills. Paradise Creek is a small stream (average annual discharge of 5,350 acre-feet) which drains a relatively small watershed (17.7 square miles). The watershed has been extensively logged and tilled, and the Palouse region is well known for its extremely high erosion rates. Flows in Paradise Creek are extremely variable, averaging less than 1 cubic feet per second (cfs) from July through October, while peaking in excess of 400 cfs during spring runoff (Table 2). During high flows, Paradise Creek typically carries a large suspended sediment load.

The proposed reservoir would be small and shallow (Table 1), inundating approximately 1.5 miles of Paradise Creek. At full pool (elevation 2,635), approximately 3.8 miles of reservoir shoreline would exist.

To date, we have no additional information on how the water levels in the reservoir would have to be managed to provide flood control benefits. We anticipate the reservoir water levels could fluctuate dramatically, and that the reservoir would typically be drained by September or October to maximize potential floodwater storage.

Table 2. Summary of hydrologic data for Paradise Creek at the University of Idaho for 1979-1988. Data provided by the U.S. Geological Survey.

Month	Mean Discharge (cfs)	Variance	Standard Deviation
January	9.86	63.97	8.00
February	27.56	449.77	21.21
March	19.75	199.36	14.12
April	8.57	23.52	4.85
May	3.35	2.02	1.42
June	1.94	0.96	0.98
July	0.98	0.16	0.40
August	0.75	0.12	0.35
September	0.87	0.30	0.54
October	0.81	0.15	0.38
November	1.71	1.47	0.38
December	2.96	2.96	1.72

The soils in the proposed project area include Westlake-Latahco silt loams at slopes of 0-3%, Palouse-Latahco silt loams at 0-3% slopes, Thatuna silt loam at 3-7% slopes, Naff-Palouse silt loams at 7-25% slopes, and Naff-Thatuna silt loams at 7-25% slopes (Barker 1981). The ability of the soil types to produce tree and understory plant species has not been identified. Potential limits to recreational development on soil types in the study area include severe slope and erodability of the soils.

Existing Fish and Wildlife Resources

Aquatic resources

The aquatic habitats within the proposed project area in Paradise Creek have limited fishery values. We are aware of no evidence to indicate that the proposed project area has fishery values of local, regional, or national significance.

Instream substrate in the project area is predominantly silt and sand. We expect the dominant benthic communities in the creek would be oligochaetes and dipterans. Benthic communities are likely limited by the annual scouring and deposition during spring run-off, and low summer flows.

Wildlife resources

Existing wildlife habitat in the proposed reservoir site is limited. The characterization is based on a site visit on December 1, 1988 by Bill MacDonald (Corps) and Ralph Myers (Service), and consultation with local Idaho Department of Fish and Game (Department) biologists. Upland areas within the project site are primarily tilled cropland. Several acres of the project area are pastureland that are heavily grazed. Narrow strips of riparian wetland vegetation (approximately 6 - 10 feet wide) exist along the current stream channel. This zone appeared to be predominantly grasses and cattails (*Typha latifolia*). The cattails provide winter cover for pheasants, as evidenced by sets of pheasant tracks in snow that had fallen 2 days prior to the site visit.

The project area provides year-round foraging habitat for raptors. The value of the habitat for raptors is likely reduced by the lack of cover currently in the project area.

No population data are available for furbearers in the project area. We observed no evidence of furbearers use of the project area, and expect that use is limited to small numbers of muskrats (*Ondatra zibethica*).

Threatened or endangered species

The proposed project is within the range of the bald eagle (*Haliaeetus leucocephalus*). At the present time, we have no information to indicate that the proposed development would impact critical habitat. No candidate species, or species designated for special management by the state of Idaho are known to occur in the project area.

Angler/hunter use

No hunter or angler data are available for the proposed reservoir area, however, we expect that the area supports little or no hunting activity and no fishing activity.

Anticipated Impacts

This section of the report is designed to identify anticipated negative and positive impacts to existing fish and wildlife resources resulting from the Paradise Creek Reservoir proposal. Actual impacts that would occur with construction of the project will depend on final designs and operations of the project. For the purpose of impact assessment, we are assuming that the existing condition of fish and wildlife resources in the project area will not significantly change in the forseeable future if the project is not constructed.

Acquatic resources

Negative impacts to aquatic resources are not expected if the project is constructed. Similarly, we expect insignificant fishery benefits as a result of the project. Specific project operations are not available, however, we anticipate that the reservoir would be dewatered in the fall and winter. High levels of turbidity are expected during periods of high runoff. The reservoir could result in improvements in downstream water quality. Settling of sediment would occur in the reservoir, making the outflow less turbid than the inflow. Also, water releases from the reservoir could maintain higher minimum streamflows, thereby improving the quantity and quality of downstream aquatic habitats.

Wildlife resources

Wetland vegetation could increase in the project area with construction of the reservoir. The extent and quality of the habitat created would depend on management of the water levels in the reservoir, and management of project lands. Areas that are inundated would likely experience high rates of sedimentation. High levels of sedimentation and water level fluctuations could preclude establishment of submerged vegetation, and also inhibit plant growth in seasonally flooded areas. Seasonally flooded areas could support emergent vegetation such as reed canary grass (*Phalaris arundinacea*), cattail (*Typha* spp.), and bulrush (*Scirpus* spp.). Cattails and rushes could establish in areas that are flooded or saturated through most of the year though this would be dependent on reservoir operations in relation to water level management. Grasses would probably dominate less frequently flooded areas. Survey data are not available to quantify the expected acreages of different habitats. Gross estimates from the relationship of maximum water surface elevation to pool surface area indicates that an average of 16 acres could be flooded for every one-foot vertical rise in water surface elevation.

Waterfowl production could occur in the project area, depending on water management. If water levels were maintained at a relatively constant level from April through August, waterfowl nesting could occur in the project area. It appears that holding the reservoir level at water depths of three to four feet maximum could provide maximum nesting habitat and also provide brood rearing habitat. Approximately 50 acres of water could exist at three to four foot of depth, with the receiving 190 acres of dry project lands being dewatered. We assume that the seasonally flooded areas would only be flooded for a short period of time in February or March, and could support vegetation for nesting cover. Under good nesting conditions such as occur on the Bear Lake National Wildlife Refuge, duck nest densities average 0.69 nests/ha

(Bjornn et al. 1987). We expect potential for nesting at the proposed project site would be considerably lower than at Bear Lake. Assuming a potential duck nest density of 0.25/ha, 19 nests/year could occur on project lands if 190 acres of unflooded habitat is maintained from April to August. Klett et al. (1988) found mallard nest success rates ranged from lows of 1-3% in cropland, to highs of 18-27% in idle grasslands. Talent et al. (1983) reported that generally, duck brood size at flight stage is five or six. Using these data, we expect that no waterfowl will be produced if project lands are used as cropland, and 25 ducks could potentially be produced if project lands were managed to provide duck nesting and rearing habitat.

Goose nesting platforms could result in the reservoir producing geese. Geese could use surrounding agricultural areas for feeding. We estimate that potentially, 25 geese could be produced per year with nesting platforms and maintenance of water in the reservoir through August.

Pheasant production could increase by up to 114 birds per year with project construction. Our estimate is based on 190 acres of the 240 acre reservoir remaining unflooded throughout the nesting and brooding season (spring and summer). We assumed a potential nest density of one nest per five acres with a 50% success rate and six chicks per nest (Brad Compton, Id. Dept. of Fish and Game, Lewiston, Id., pers. commun.) We are assuming that flood flows would normally occur in February, prior to the pheasant nesting season, and by April, water levels in the reservoir would be receding or relatively low. We are also assuming that the water fluctuation zone would support vegetation suitable for pheasant nesting. Intensive agricultural practices on the project lands could eliminate any pheasant benefits.

Angler/hunter use

The reservoir is not expected to provide increased angling or waterfowl hunting opportunity in the project area. The reservoir would likely be dewatered between October and January, which is when the waterfowl hunting season occurs. Even under optimum conditions, the reservoir would likely provide less than five hunter days of opportunity per year. This represents an estimated economic value of $132 at a value rate of $26.41/day (Sorg and Nelson 1987).

We estimate that pheasant hunting opportunities could increase as a result of the project. If the project area produced 114 pheasants per year, 95 hunter days may be gained as a result of the project. The estimate is based on a 50% cock to hen relationship for birds produced, and current pheasant hunting in Region 2 where 3,360 hunters expended 18,415 days to kill 11,069 cock pheasants. (Brad Compton, Dept. of Fish and Game, Lewiston, Id., pers. commun.) Using the hunt data, one cock pheasant provides 1.7 hunter days, so a maximum of 97 hunter days could be gained if all cocks produced were harvested. Using Young et al. (1987), 97 hunter days for pheasants in the project area is valued at $2,370.

Potential Mitigation/Enhancement Opportunities

The proposed project would impact aquatic and terrestrial habitat which currently is of limited occurrance (riparian wetlands) or value for fish and wildlife. The following are potential options or strategies for mitigating losses, or enhancing fish and wildlife habitat. The potential mitigation and enhancement measures will be re-evaluated should the project be elevated to the feasibility level, and specific project plans become available.

1. Maintain stable water levels in the reservoir from April 1 - August 31, with a minimum 3-foot deep conservation pool.

Justification

Maintaining stable water levels during the waterfowl nesting and brooding season could maximize waterfowl production. Maintaining three feet of water in the reservoir would provide shallow brood rearing areas for waterfowl.

2. Manage project lands surrounding the reservoir for the purpose of providing wildlife habitat.

Justification

Use of project lands for agricultural activities such as cropping or grazing would reduce the value of the land for waterfowl and upland game bird habitat. Managing all non-flood control related aspects of the reservoir for wildlife habitat would maximize wildlife benefits.

Information Gaps and Study Needs

1. Sedimentation rates, and expected functional life of the project have not been identified for the proposed reservoir.

Study recommendation

Conduct a study to identify sediment transport dynamics of Paradise Creek to identify the expected rate and pattern of sediment deposit in the reservoir, and the expected period for which the reservoir would be functional.

2. No data are available to describe potential water management and releases for the proposed reservoir.

Study recommendation

Conduct a study to identify the range of potential water management scenarios that are practical for maintaining flood control benefits. The study should identify the effectiveness of the management alternative in providing flood benefits, as well as the value provided for fish and wildlife resources.

3. Quantitative data describing the wildlife habitat within the proposed project area are not available. Qualitative data are very limited.

Study recommendation

Conduct a Habitat Evaluation Procedures (HEP) study in the project area to quantify the existing wildlife habitat, and evaluate the value of the habitat for wildlife species in the area. The existing riparian habitat is extremely limited, however, assuming a 5-foot band of vegetation on both sides of 1.5 miles of Paradise Creek, the project would inundate approximately 2 acres of wetland habitat.

4. Quantitative data on wildlife use of the study area does not exist.

Study recommendation

Conduct seasonal surveys to determine use of the area by wildlife species. The survey should provide quantitative data.

5. Detailed topographic survey data for the study are does not exist.

Study recommendation

Conduct a survey of the proposed project area to delineate morphometric characteristics of the proposed reservoir and surrounding project lands at one-foot intervals.

Reconnaissance-Level Recommendation

Our preliminary assessment of the project indicates losses of valuable fish and wildlife habitat is not likely to occur as a result of the project. Significant wildlife enhancement opportunites associated with the project may be available. Based on preliminary project information, we would support elevating the project to the feasibility level for further evaluation. The feasibility-level evaluations should include conducting the studies recommended in this report.

ROBINSON LAKE RESERVOIR PROPOSAL

The proposed reservoir would be located on the South Fork of the Palouse River approximately three miles east of Moscow, Idaho, at north latitude $46^{o}45'$ and west longitude $116^{o}55'$ (Figure 3). The reservoir would inundate approximately 1.3 miles of stream habitat. Approximately 0.5 miles of the existing stream habitat is surrounded by Robinson Lake Park. The proposed reservoir area contained a small, shallow reservoir prior to the 1960's with a spillway elevation of approximately 6-10 feet. The old reservoir experienced high levels of siltation. Today, no water is retained and Robinson Lake Park is located on the old reservoir area. The remaining 0.8 miles of stream flows through private land.

The median average monthly discharge in the South Fork of the Palouse River over the past twenty years has been one cfs for six months of the year (Table 3). The Corps has identified a normal pool surface elevation of 2,732 for the proposed reservoir. The proposed reservoir would be small (130 acres) but relatively deep (maximum depth approximately 50 feet). Information on the expected storage capacity of the reservoir is not available at this time.

Table 3. Median average monthly discharges for 1968-1987 in the South Fork of the Palouse River at the proposed Robinson Lake damsite. Data were provided by the Corps.

Month	Discharge (cfs)
January	12
February	16
March	15
April	9
May	3
June	1
July	1
August	1
September	1
October	1
November	1
December	6

The reservoir would be surrounded by relatively steep slopes (Figure 3). The watershed land uses are similar to those in the Paradise Creek watershed. The soil types in the project area include Crumarine silt loam at 0-3% slopes, Spokane loam at 15-35% slopes, and Tarey silt loam at 25 35% slopes (Barker 1981). The relatively steep areas surrounding the reservoir would provide poor to fair potential for wildlife habitat development. Recreational development is limited by severe slope and erodability of the soil.

Existing Fish and Wildlife Resources

Aquatic resources

The aquatic habitats within the proposed project area in the South Fork of the Palouse River have limited fishery values. No data are available to quantify the fish populations in the project area. We have no indication that significant game fish populations exist in the project area. Water quality and low flows are probably limiting for fish populations.

Wildlife resources

Wildlife values are moderate (Nellis and Allen 1987). No data are available to quantify wildlife use of the area. Most of the land use in the project area is grazed pastureland. The proposed reservoir area also contains a public park. The stream has a narrow band of riparian vegetation in some areas, although much of the riparian vegetation has been heavily impacted by livestock grazing. It is likely that the existing riparian vegetation provides cover for game species including pheasants, and possibly white-tailed deer. We expect use to be relatively minor. Common tree species in the project area include ponderosa pine and Douglas fir (Table 4).

Table 4. Common tree species and woodland understory vegetation that are characteristic of the soil types found in the Robinson Lake project area. Data adapted from Barker (1981).

Common Trees	Understory
Ponderosa pine (*Pinus ponderosa*)	Bluebunch wheatgrass (*Agropyron spicatum*)
Douglas fir (*Pseudotsuga menziesii*)	Idaho fescue (*Festuca idahoensis*)
	Pine reedgrass (*Calamagrostio sp.*)
	Heartleaf arnica (*Arnica cordifolia*)
	Common snowberry (*Symphoricarpos albus*)
	Elk sedge (*Carex geyeri*)
	White spirea (*Spirae sp.*)
	Blue wildrye (*Elymus glaucus*)
	Herbaceous cinquefoil (*Potentilla sp.*)
	Silky lupine (*Lupinus sericeus*)
	Rose (*Rosa sp.*)

Threatened or endangered species

The proposed project area is within the range of the bald eagle. On December 1, we observed a bald eagle flying over the proposed Robinson Lake Reservoir area. At the present time, we have no information to indicate that any of the proposed developments would impact critical habitat.

Angler/hunter use

No hunter or angler data are available for the proposed reservoir area, however, we expect that the area supports no fishing activity, no waterfowl hunting, and little or no big game or upland game bird hunting activity.

Anticipated Impacts

Aquatic resources

Negative impacts to aquatic resources are not expected if the project is constructed. The reservoir could act as a sedimentation basin, thereby improving the downstream water quality. The project may also improve aquatic habitat downstream by maintaining higher instream flows throughout the year below the project. The nature and quantity of benefits from improved water quality and increased instream flow would depend on the actual reservoir operations.

Fishery benefits, as a result of the project, would depend largely on water level fluctuations in the proposed reservoir. If the reservoir is operated in a manner where large water level fluctuations occur, fishery benefits could be limited. Conversely, substantial fishery benefits could result from the project if relatively stable water levels are maintained. If a conservation pool at least 20 feet in depth were maintained, a substantial trout and bass fishery could probably be established and maintained by annual stocking.

Wildlife resources

Some loss of riparian wetland habitat would occur with construction of the reservoir. The existing habitat is currently of limited quality, so the loss is expected to be relatively small. Subsequent establishment of riparian vegetation on the shore of the proposed reservoir would depend largely on water level fluctuations and land use management. If water level fluctuations are relatively small, small areas of emergent and/or submerged wetland vegetation could establish in the seasonally flooded areas of the reservoir, and permanently flooded, shallow areas. Due to the steep slopes surrounding the reservoir area, shallow areas and riparian zones would be very limited.

High quality waterfowl nesting and brooding habitat would not likely be associated with the project. We estimate that one or two duck broods (5-10 ducks) could potentially be produced per year. If several goose nesting platforms were constructed, 5-10 geese may also be produced per year. We expect no increased upland game bird production associated with project construction.

Angler/hunter use

We estimate angler use in the proposed reservoir could be 20,000 angler hours annually, based on Department estimates for angler use of Manns Lake (a similar lake in Region 2). Using data from Sorg et al. (1985) we estimate the economic value of the potential angler use at $87,490 annually. The estimate assumes a value of $22.52 per trip, with 4.4 hours per day and 1.17 days per trip. Waterfowl and upland game bird hunting are not expected to be significant in the project area.

Potential Mitigation/Enhancement Opportunities

The fish and wildlife habitat that would be lost in the proposed inundation area is generally of low quality. Following are potential options or strategies for mitigating losses or enhancing fish and wildlife habitat. The potential mitigation and enhancement measures will be re-evaluated should the project be elevated to the feasibility level, and specific project plans and operations become available.

1. Minimize water level fluctuations in the reservoir.

Justification

Large water level fluctuations could severely limit the development of littoral and riparian wetland vegetation. Both littoral and riparian vegetation are extremely valuable fish and wildlife habitats. Maximum fish and wildlife benefits could be realized by providing conditions conducive to development of quality littoral and riparian wetland habitat.

2. Stock the reservoir with catchable trout.

Justification

A significant fishery could be established with an annual stocking program. A self-sustaining trout population capable of supporting the expected fishing pressure would not be likely in the reservoir.

3. Unavoidable loss of riparian and wetland habitat would occur with project construction. Compensation of the losses by enhancement of similar currently degraded habitats in close proximity to the project could offset the losses.

Information Gaps and Study Needs

1. Sedimentation rates, and expected functional life of the project have not been identified for the proposed reservoir.

Study recommendation

Conduct sediment transport dynamics of the South Fork of the Palouse River to identify the expected rate of sedimentation of the reservoir, and the expected period for which the reservoir would be functional.

2. Quantitative data on wildlife use of the study area does not exist.

Study recommendation

Conduct seasonal surveys to determine use of the area by wildlife species. The survey should provide quantitative data.

3. Quantitative data describing the wildlife habitat within the proposed project area are not available. Qualitative data are very limited.

Study recommendation

Conduct a Habitat Evaluation Procedures (HEP) study in the project area to quantify the existing wildlife habitat, and evaluate the value of the habitat for wildlife species in the area.

Reconnaissance-Level Recommendation

Our preliminary assessment of the project indicates unmitigable losses of valuable fish and wildlife habitat is not likely to occur as a result of the project. Significant fish enhancement opportunites associated with the project may be available. Based on preliminary project information, we would support elevating the project to the feasibility level for further evaluation. Feasibility-level evaluations should include conducting the studies recommended in this report to evaluate project impacts on fish and wildlife.

PALOUSE RIVER RESERVOIRS AND PIPELINE PROPOSAL

This alternative includes the construction of two reservoirs on the Palouse River at approximately river miles (RM) 148 and 157, coupled with a pipeline to transport water from Palouse, Washington (RM 116) to Pullman, Washington and Moscow, Idaho (Figure 4). The primary purpose of the reservoirs would be to provide municipal water for the towns of Pullman and Moscow.

Mean monthly flows in the project area range from 11.5 cfs in August to 764 cfs in March (Table 5). Spring flows are extremely variable. Both reservoirs would be relatively large and deep, with the Harvard Reservoir being the shallower and larger of the two (Table 1). Most lands in the Harvard site are privately owned, while the Laird site would be on lands of the Panhandle National Forests. The primary land use in the Harvard site is agricultural (grazed and cropped), and the primary use of the Laird site is silvicultural. The topography of the Laird site is relatively steep compared to the Harvard site.

The normal pool elevation for the Harvard reservoir would be 2,673 and 2,874 for the Laird pool. Neither reservoirs are expected to have extensive littoral areas. Projected water level fluctuations have not been identified, so we are unable to identify the amount of littoral habitat that would be periodically dewatered.

Table 5. Summary of hydrologic data for the Palouse River near Potlatch, Idaho for 1916-1919 and 1967-1988. Data provided by the U.S. Geologic Survey.

Month	Mean Discharge (cfs)	Variance	Standard Deviation
January	357.60	192532.47	438.79
February	545.43	186309.53	431.64
March	764.34	252079.72	502.08
April	753.11	267471.63	517.18
May	393.07	136219.47	369.08
June	117.02	10117.16	100.58
July	27.01	209.78	14.48
August	11.42	42.37	6.51
September	11.81	40.62	6.37
October	16.78	64.46	8.03
November	45.90	1540.23	39.25
December	164.44	49241.45	221.90

In addition to the reservoirs, a pipeline would be constructed to transport approximately 20 million gallons/day from Palouse, Washington (downstream of the proposed reservoirs) to Pullman, Washington and Moscow, Idaho. The pipeline would follow an existing railroad bed along most of the route.

Soil types in the proposed project area includes Hampson silt loam at 0-3% slopes, Crumarine silt loam at 0-3% slopes, Santa silt loam at 2-35% slopes, and Minaloosa loam at 35-65% slopes (Barker 1981). The potential for wildlife habitat in these soil types is fair to good. Recreational development potential is limited by severe slope and soil erodability.

Existing Fish and Wildlife Resources

Aquatic resources

Water quality above the proposed Laird damsite (RM 157) is relatively good. Conditions rapidly degrade through the proposed Harvard site. The proposed Harvard Reservoir reach is characterized by unstable, eroding stream banks. Water temperatures through the reach increase more than in any other part of the drainage (Buettner 1973).

The value of the Palouse River between the proposed Harvard Reservoir (RM 148) and the proposed Palouse, Washington pipeline intake (RM 116) is limited by water quality (Von Lindern 1986). Reduced water quality seems to be a result of non-point source activities in the watershed. Water quality in the river downstream of Potlatch, Idaho, is of sufficient qualtiy to be used for agricultural water, habitat for warmwater fish, and secondary recreational contact.

Water quality downstream of Palouse, Washington is also relatively poor. If the project would result in reductions of flow during low flow periods, water quality could become more degraded. Also, any reduction in flow in the Palouse River has the potential for cumulative impacts on anadromous fish migrating in the Snake River. Spring flows in the project area can exceed 2,000 cfs, and an extreme flow of 10,000 cfs occurred in 1972. If high flows are stored in the reservoirs, a corresponding decrease in flow could occur in the Snake River during periods of smolt outmigration. The extent of the impact could depend on reservoir water management as well and other development projects in the Snake River drainage (cumulative impacts).

The aquatic habitats within the proposed project area in the Palouse River and tributaries have from limited to moderate fishery values (Table 6). Fishery values are generally of local significance rather than of statewide or national significance (Pacific Northwest River Basins Commission 1971). The Department annually stocks the proposed project area with trout. Stocked fish include catchable (6+ inches) rainbow trout (*Salmo gairdneri*), and fingerling (3-6 inches) and catchable brown trout (*Salmo trutta*). In 1986, the Department stocked 3,819 catchable rainbow trout, 10,727 catchable brown trout, and 4,300 fingerling brown trout in the Palouse River. Fish survey sampling conducted in July of 1986 by Department personnel indicated most of the fish in the Palouse River downstream of the proposed project area are dace (*Rhinichthys spp.*) and red-side shiners (*Richardsonius balteatus*), followed in numbers by suckers (*Catostomus spp.*) and northern squawfish (*Ptychocheilus oregonensis*). No game fish were collected (Von Lindern 1986). This is consistent with Buettner (1973) who found no trout below the proposed Laird damsite (RM 157).

Table 6. Summary of the fish and wildlife resource values associated with the existing aquatic habitats that the proposed Harvard and Laird reservoirs would inundate. Adapted from Nellis and Allen (1986).

	Fish Values	Wildlife Values
Palouse River (above Harvard)	limited	substantial
Big Creek	unknown	moderate
Meadow Creek	moderate	substantial
Palouse River (above Laird)	moderate	substantial
Strychnine Creek	moderate	substantial
Little Sand Creek	limited	substantial
Big Sand Creek	limited	substantial

Wildlife resources

Existing wildlife values of the proposed project area range from moderate to substantial (Table 6). The Palouse River provides year-round habitat for substantial numbers of white-tailed deer, elk, and black bear. Quantified use data are not available, however, the Department characterizes use as high. The area provides habitat for upland game birds (primarily pheasants), and limited production of waterfowl. No data are available to quantify upland game bird or waterfowl use.

The area proposed for inundation contains narrow, willow dominated riparian areas along the Palouse River, and tributaries. Most of the riparian habitat has been heavily grazed by livestock. Our survey of riparian vegetation in the proposed Harvard reservoir site indicates that much of the riparian habitat is limited in quality for wildlife species due to current land use practices. We did observe pheasant use of scattered areas of riparian vegetation that were not as heavily impacted. The isolated patches of higher quality riparian vegetation could be extremely valuable to upland game birds given the degraded nature most of the surrounding habitats.

No population data are available for furbearers in the proposed Harvard or Laird Park project areas. We observed indications of beaver (*Castor canadensis*) activity in Meadow Creek, but expect that existing furbearers use of the project area is relatively low. We expect less use of the proposed Laird Park project area than the proposed Harvard site, and observed no indications of furbearers presence during our October 30 site visit.

Most of the riparian and upland habitat in the proposed Harvard reservoir site is heavily grazed. The transition of land use from grazed pasture to forested land occurs at approximately the same elevation as the proposed water surface elevation (2,673). Upland habitats in the proposed Laird Park reservoir site are primarily forested, dominated by fir, pine, and larch species (Table 7). The terrain is relatively steep and heavily wooded. The proposed Laird Park reservoir site currently supports a narrow band of riparian vegetation. The stream bank rises quickly, providing little area for riparian vegetation. The stream is also bordered by an unpaved road on one side. The riparian cover consists mainly of trees and shrubs that overhang the stream.

Table 7. Common tree species and woodland understory vegetation that are characteristic of the soil types found in the Harvard and Laird project sites. Data adapted from Barker (1981).

Common Trees	Understory
Grand fir (*Abies grandis*)	Mallow ninebark (*Physocarpus malvaceus*)
Douglas fir (*Pseudotsuga menziesii*)	Creambrush oceanspray (*Holodiscus discolor*)
Ponderosa pine (*Pinus ponderosa*)	Columbia brome (*Bromus vulgaris*)
Western larch (*Larix occidentalis*)	Blue wildrye (*Elymus glaucino*)
Lodgepole pine (*Pinus contorta*)	Elk sedge (*Carex geyri*)
	Gland cinquefoil (*Potentilla gladulosa*)
	Willow (*Salix sp.*)
	Queencup beadlily (*Clintonia uniflora*)
	Common snowberry (*Symphoricarpos albus*)
	Sedge (*Carex sp.*)
	Pachystima (*Pachistima myrsinites*)
	Baldhip rose (*Rosa gymnocarpa*)
	Longtube twinflower (*Linnaea borealis*)
	American trailplant (*Adenocaulon bicolor*)
	Piper anemone (*Anenome piperi*)
	Goldthread (*Coptis sp.*)

Threatened or endangered species

The proposed project areas are within the range of the bald eagle. At the present time, we have no information to indicate that any of the proposed developments would impact critical habitat.

We are including information on candidate species, and species designated for special management considerations by the states of Washington and Idaho (Table 8). Candidate species, and state designated species receive no protection under the Endangered Species Act, as amended. We are including them in the early phase of planning because the species could possibly be petitioned for listing in the future.

Table 8. Plant and animal candidate species or species of state concern that may be found in the proposed Harvard and Laird Reservoirs, and associated Palouse, Washington to Pullman, Washington and Moscow, Idaho pipeline project areas.

Township	Range	Sections	Species (status)
14 N	45 E	5	*Astragalus arrectus* (SPS) *Astragalus riparius* (SPS) *Chalochortus nitidus* (C2 SPX) *Mimulus pulsiferae* (SPS) *Silene spaldingii* (C2 SPT)
15 N	45 E	32	*Haplopappus liatriformis* (C2 SPT)

SPS = designated by the State of Washington as a sensitive species
SPT = designated by the State of Washington as a threatened species
SPX = designated by the State of Washington as possibly extinct
C2 = Taxa for which information now in the possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules.

Angler/hunter use

Despite annual trout stocking by the Department, no data on angler use of the proposed project areas are available. Angler use is thought to be relatively low. The factors that limit angler use of the project areas probably include lack of access due to private land holdings, and the river's inability to support large fish.

Data on hunter use of the specific project areas are lacking. The lack of effort by the Department to identify hunter use of the areas indicates the low use that the area receives. We expect that limited hunting of upland game birds, waterfowl, and deer occurs in the proposed project areas. On a regional basis, 125 goose permits, and 137 duck permits were issued in 1987. The hunters expended 264 days to kill 38 geese, and 131 days to kill 73 ducks. The project are is contained within big game management units 8 and 8A, and black bear management units 1B and 1C. Substantial numbers of black bear, elk and deer are harvested annually in these units (Table 9). In the general project area, estimated black bear harvest is less than one bear per 100 square miles (Johnson 1986).

Table 9. Summary of harvest data for hunting units containing the proposed project area. Data were taken from McNeill et al. 1988a, McNeill et al. 1988b, and McNeill et al. 1988c.

Species	Period of Record	Average Annual Harvest
black bear	1983-1987	118
deer	1975-1987	683
elk	1974-1987	150

The proposed pipeline route probably receives limited hunting pressure, mainly from upland game bird hunters. No specific project area data are available, however, Whitman County and Region 1 data indicate that the area could be relatively important on a local basis for upland game bird hunting (Table 10).

Table 10. Summary of 1987 - 1988 hunting season hunter use and harvest data for eastern Washington.

Species	Total Harvest		No. of hunters		Hunter days	
	Whitman County	Region 1	Whitman County	Region 1	Whitman County	Region 1
Pheasant	24,599	55,135	6,679	15,910	33,463	87,295
Quail	4,017	22,543	1,564	4,924	6,614	22,584
Chukar	6,018	21,556	1,513	4,299	6,308	18,241
Gray partridge	4,506	11,361	2,051	4,582	9,755	23,324
Ruffed grouse	484	68,231	280	13,227	681	80,288
Blue grouse	16	18,377	182	7,932	372	44,609
Spruce grouse	0	2,916	116	1,751	120	17,078
Duck	3,709	48,834	856	5,490	3,742	34,368
Goose	409	8,013	515	3,967	1,816	22,969
Snipe	107	464	212	302	935	6,824
Dove	1,342	5,691	277	1,190	818	4,287
Rabbit	285	4,505	233	1,743	803	14,969
Raccoon	0	109	0	317	0	3,856
Deer	931	12,632	3,949	45,538	12,463	241,516

Anticipated Impacts

Aquatic resources

The existing lotic aquatic habitat would be replaced with approximately 3,385 acres of lentic aquatic habitat created by the two reservoirs. Dominant benthic invertebrate populations would shift from lotic species to lentic species. The total biomass of aquatic invertebrates would be greater in the reservoir than the existing stream due to the greater wetted area of the reservoir, and the establishment of a plankton community in the reservoir. The reservoir could provide substantially more, and better quality habitat for game fish species than the existing river. The reservoir would probably maintain a trout population if supported by annual stocking efforts.

Wildlife resources

The proposed reservoir would result in loss of riparian habitat that currently exists along the river course. The establishment of riparian areas around the proposed reservoirs would depend on shoreline soils and topography, and water level management. Loss of riparian habitat would negatively impact wildlife species. Given the limited extent of the riparian areas, and current poor quality of the surrounding upland habitat, the impact to wildlife species currently using the riparian areas could be severe. The overall impact is lessened by the relatively low existing use of the area by wildlife.

Waterfowl production in the project area would likely remain relatively unchanged with the project. Substantially more resting habitat would be available with reservoir creation, however, nesting habitat availability would remain relatively unchanged.

Impacts to furbearers and large mammals are expected to be relatively minor, however, the Department has concerns about the loss of deer, elk, and black bear habitat that would occur.

Angler/hunter use

Angler use of both reservoirs would be substantially higher than current use of the river. Most of the river in the Harvard Reservoir reach does not support viable game fish populations and is currently bordered by private land, which limits angler access. The reservoir would provide better angler access, as well as larger game fish populations.

We estimate that the Harvard Reservoir could support 60,000-80,000 hours of fishing pressure per year (Bert Bowler, Id. Dept. Fish and Game, Lewiston, ID, pers. commun.). We estimate that Laird Reservoir could receive approximately one half (30,000-40,000) the angler hours as Harvard Reservoir. The lower use is atrributable to less accessibility and the expected lower productivity of Laird Reservoir. Using data from Sorg et al. (1988) we estimate that the economic value of the 120,000 angler hours with a value of $22.52 per trip (assumes 4.4 hours are fished per day, and each trip averages 1.17 days). gained by the project would be $524,942.

Waterfowl hunter use of the reservoirs would likely occur. We estimate that waterfowl hunting effort could increase by 50% in Region 2 with construction of the reservoirs. This translates into 130 additional days of goose hunting and 115 additional days of duck hunting, with an estimated economic value of $7,724.

We expect no substantial change in big game hunting or upland game bird hunting with reservoir construction.

Potential Mitigation/Enhancement Opportunities

The fish and wildlife habitat that currently exists in the proposed inundation area would be lost as a result of the project. The following are potential options or strategies for mitigating losses or enhancing fish and wildlife habitat. The potential mitigation and enhancement measures will be re-evaluated should the project be elevated to the feasibility-level, and specific project plans and operations become available.

1. Minimize annual water level fluctuations in the reservoirs.

Justification

Large and frequent water level fluctuations reduce the opportunity for establishment of littoral and riparian vegetation. Littoral habitat enhances the fishery value of the reservoirs. Riparian habitat would be valuable for wildlife.

2. Stock the reservoir with fingerling or catchable trout

Justification

The fishery potential could be greatly enhanced by stocking of game fish.

3. Move location of the proposed Harvard damsite downstream closer to the Idaho-Washington state line.

Justification

The topography of the reservoir area and surrounding land downstream of the proposed damsite would have more waterfowl and upland game bird benefits associated with the reservoir than the currently proposed area. Locating the reservoir downstream would provide increased littoral habitat for waterfowl as well as proximity to upland and waterfowl nesting areas. This action could create the potential for production of 500 additional waterfowl (100 broods at 5 individuals per brood). We estimate that hunting could increase 100% over existing conditions in Region 2 resulting in 264 additional goose hunter days and 131 additional duck hunter days.

4. Equip the Harvard Dam with the capability to withdrawl hypolimnetic water from the reservoir.

Justification

Hypolimnetic withdrawals from the Harvard Reservoir during summer months could help establish a coolwater fishery in the river below the dam. The success of establishing the downstream fishery would depend on water quality in the proposed reservoir, and water releases from the reservoir.

5. Schedule water releases from the Harvard Dam to ensure that flows in the Palouse River both above and below Palouse, Washington do not fall below existing conditions.

Justification

Water quality in the Palouse River is currently degraded below the proposed dams. Any reduction in flow below the existing conditions could further reduce water quality by reducing dilution flows from upriver.

Information Gaps and Study Needs

1. Sedimentation rates, and expected functional life of the project have not been identified for the proposed reservoir.

Study recommendation

Conduct sediment transport dynamics of the Palouse River to identify the expected rate of sedimentation of the reservoir, and the expected period for which the reservoirs would be functional.

2. Instream flows that would be necessary to maintain a sport fishery below the proposed Harvard dam are undefined.

Study recommendation

Conduct a study using methodologies such as Instream Flow Incremental Methodologies (IFIM) to identify minimum flows necessary to maintain a viable sport fishery below the proposed Harvard Dam.

3. Quantitative data on fish populations within the proposed project area are lacking.

Study recommendation

Conduct a survey of fish populations in the area of impact for the proposed project. Data collected should be quantitative.

4. The cumulative impacts related to anadromous fish migration of this proposal, and other federal project proposals in the Snake River drainage have not been assessed.

Study recommendation

Conduct a cumulative impacts study to determine if alteration of flow magnitude and timing in the Palouse River, along with other federal projects, would have a cumulative impact on Snake River flow timing and magnitude. Development of expected discharges on a monthly basis at the mouth of the Palouse River with and without the project would be helpful in assessing potential impacts. The study should be designed to determine if cumulative impacts to anadromous fish could result from project flow alterations.

5. Quantitative data on wildlife use of the specific project area does not exist.

Study recommendation

Conduct seasonal surveys, with emphasis on the proposed project area, to determine use of the area by wildlife species. The survey should provide quantitative data.

6. Quantitative data describing the wildlife habitat within the proposed project area are not available. Qualitative data are very limited.

Study recommendation

Conduct a HEP study in the project area to quantify the existing wildlife habitat, and evaluate the value of the habitat for wildlife species in the area.

7. The feasibility of placing the proposed dams further downstream near the Idaho-Washington border is unknown. Substantial wildlife benefits could result from such a reservoir.

Study recommendation

Conduct a study to evaluate the feasibility of constructing the reservoir(s) downstream of the proposed site(s).

Reconnaissance-Level Recommendation

Our preliminary assessment of the project indicates unmitigable losses of valuable fish and wildlife habitat are not likely to occur as a result of the project. The potential exists for cumulative impacts to anadromous fish resulting from this and other projects. Resident fish enhancement opportunites associated with the project may be available. Based on preliminary project information, we would support elevating the project to the feasibility level for further evaluation.

LOWER GRANITE TO PULLMAN AND MOSCOW PIPELINE PROPOSAL

The purpose of the proposed pipeline would be to transport water from Lower Granite Reservoir to Pullman, Washington and Moscow Idaho for municipal use. The intake would be located upstream of the Lower Granite Dam (near Wawawai), and the pipeline would follow a fairly direct route to Pullman (Figure 6.) A line running east from Pullman to Moscow would also be required. The exact route of the pipeline has yet to be determined.

The topography in the immediate area of Lower Granite Reserovir is relatively steep, while most of the pipeline route is dominated by rolling hills (Figure 6). The dominant land use in the Lower Granite canyon is for cattle grazing, while cropland dominates most of the pipeline route.

Existing Fish and Wildlife Resources

Aquatic resources

The main aquatic habitat within the proposed project area is in Lower Granite Reservoir. The pipeline proposal would likely require some in-water activity during construction. During operation, water would be drawn from out of the reservoir for transport to Pullman and Moscow. Lower Granite Reservoir has high fishery values. The reservoir is the sole migration route for anadromous fish in Idaho, with high levels of activity from late March through November. In addition the anadromous fish use of the reservoir, an array of resident game and nongame fish occur in the reservoir (Table 11).

Table 11. List of resident fishes (age 1 and older) collected with gill nets, trap nets, beach seine, and electro-fishing gear in lower Snake reservoirs. Adapted from Bennett et al. (1983) and Bennett and Shrier (1986). Native or introduced status was identified from Simpson and Wallace (1982).

Family	Scientific Name	Common Name
Acipenseridae	*Acipenser transmontanus*	White sturgeon (N)
Salmonidae	*Prosopium williamsoni*	Mountain whitefish (N)
	Salmo gairdneri	Rainbow trout (N)
	Salmo trutta	Brown trout (I)
	Salmo clarki	Cutthroat trout (N)
Cyprinidae	*Acrocheilus alutaceus*	Chiselmouth (N)
	Cyprinus carpio	Carp (I)
	Mylocheilus caurinus	Peamouth (N)
	Notemmigonus crysoleucas	Golden shiner
	Ptychocheilus oregonesis	Northern squawfish (N)
	Rhinichthys osculus	Longnose dace (N)
	Rhinichthys cataractae	Speckled dace (N)
	Richardsonius balteatus	Redside shiner (N)
Catostomidae	*Catostomus columbianus*	Bridgelip sucker (N)
	Catostomus macrocheilus	Largescale sucker (N)
Ictaluridae	*Ictalurus natalis*	Yellow bullhead (I)
	Ictalurus nebulosus	Brown bullhead (I)
	Ictalurus punctatus	Channel catfish (I)
	Noturus gyrinus	Tadpole madtom (I)
	Pylodictis olivaris	Flathead catfish (I)
Centrarchidae	*Lepomis gibbosus*	Pumpkinseed (I)
	Lepomis gulosus	Warmouth (I)
	Lepomis macrochirus	Bluegill (I)
	Micropterus dolomieui	Smallmouth bass (I)
	Micropterus salmoides	Largemouth bass (I)
	Pomoxis annularis	White crappie (I)
	Pomoxis nigromaculatus	Black crappie (I)
Percidae	*Perca flavescens*	Yellow perch (I)
Cottidae	*Cottus* sp. (3 species)	Sculpin (N)

(N) = Native
(I) = Introduced

The proposed pipeline route contains numerous small tributaries. We are not aware that any of the streams within the proposed route contain significant fishery values. The streams are relatively small, and drain crop and pasture lands.

Wildlife resources

The proposed pipeline project area contains narrow bands of riparian vegetation along the tributary streams. The riparian areas are probably of relatively low quality due to the impacts of current land use practices. Despite the relatively low quality of the riparian areas, the value of the areas may be disproportionately high due to the scarcity of wildlife cover in the surrounding areas.

Wildlife population data for most of the project area are unavailable. Survey data for selected species in the immediate area of Lower Granite pool are available (unpublished Corps data). Winter mule deer counts for 1978-1988 on the north side of the reservoir averaged 302, while an average of 22 white-tailed deer were counted on the north shore during the same time period. Winter upland game bird counts at Wilma, a Habitat Managment Unit on Lower Granite Reservoir, indicate low use of the pool area by wintering upland game birds. Eight pheasants, and eight California quail were counted in January of 1985 at Wilma. Nest site densities for raptor species in the Lower Granite pool area (Table 12) are relatively low in comparison to upstream areas of the Snake River in Idaho (U.S. Bureau of Land Management 1987).

Table 12. Nest site densities for selected raptors from 1978 - 1980 on Lower Granite Reservoir. Adapted from unpublished data provided by the Corps.

Species	River Miles per Nest Site
Western barn owl (*Tyto alba*)	3.30
Northern harrier (*Circus cyaneus*)	19.85
Common raven (*Corvus corax*)	39.70
American kestrel (*Falco sparverius*)	4.41
Red-tailed hawk (*Buteo jamaicensis*)	3.05
Prairie falcon (*Falco mexicanus*)	13.23
Great-horned owl (*Bubo virginianus*)	13.23
Short-eared owl (*Asio flammeus*)	39.70

Threatened or endangered species

The proposed project area is within the range of the bald eagle, and occasional winter use of the Lower Granite pool area occurs (Corps unpublished data). At the present time, we have no information to indicate that any of the proposed developments would impact critical habitat.

We are including information on candidate species, and species designated for special management considerations by the states of Washington and Idaho (Table

13). Candidate species, and state designated species receive no protection under the Endangered Species Act, as amended. We are including them in the early phase of planning because the species could possibly be petitioned for listing in the future.

Table 13. Plant and animal species which may be found in the proposed Lower Granite-Pullman-Moscow pipeline project area and have been designated as candidate species or species of state concern.

Township	Range	Sections	Species (status)
13 N	43 E	1,2	*Astragalus arrectus* (SPS) *Astragalus riparius* (SPS) *Githopsis specularioides* (SPS) *Bufo woodhousei* (SPM) *Diadophis punctatus* (SPM)
14 N	44 E	14,22,23	*Buteo swainsoni* (SPS)
14 N	45 E	5,6	*Astragalus arrectus* (SPS) *Astragalus riparius* (SPS) *Chalochortus nitidus* (C2 SPX) *Mimulus pulsiferae* (SPS) *Silene spaldingii* (C2 SPT) *Aster jessicae* (C2 SPT) *Anbystoma tigrinum* (SPM) *Polites sonora* (SPM) *Polygonia oreas* (SPM)

SPS = designated by the State of Washington as a sensitive species.
SPT = designated by the State of Washington as a threatened species.
SPX = designated by the State of Washington as possibly extinct.
SPM = designated by the State of Washington for population monitoring.
C2 = Taxa for which information now in the possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules.

Angler/hunter use

With the exception of the Snake River, angler use of the proposed project area is relatively inconsequential, as evidenced by the lack of data on angler use. The Snake River (Lower Granite Reservoir) supports a significant steelhead fishery. During a good steelhead return year such as 1984 - 1985, an estimated 8,797 angler hours can be expended in Lower Granite Reservoir (Mendel and Aufforth 1985). Hunter data for Washington Department of Wildlife's Region 1 and Whitman County, Washington indicates that hunter use of the proposed project area is limited mainly to upland game bird and deer hunting (Table 10). No project site specific hunter data are available. The county provides a disproportionate part (46%) of the total pheasant harvest in Region 1. A qualitative assessment of the project area indicates the project area provides excellent deer hunting and is an important deer wintering area. (Bill MacDonald, Corps of Engineers, Walla Walla, WA, pers. commun.).

Anticipated Impacts

Aquatic resources

The primary potential for impacts to aquatic resources could be to anadromous fish migrating in the Snake River. The project could reduce flows in the Snake River below the intake of the pipeline. No specific values are available for how much water would be withdrawn, however, we anticipate the amount would be relatively small in comparison to Snake River flows (possibly 30-40 cfs). Impacts directly related to any reduced flows as a result of the project are not expected to be significant in themselves, however, the cumulative impact of this activity and other activities in the Snake River watershed could have significant cumulative impacts.

The pipeline would intersect some small streams, although the exact route is currently not known. Minor aquatic impacts are expected from the temporary disturbance that would occur when the pipeline is installed.

Wildlife resources

The project could impact riparian vegetation at the point of withdrawal from the Snake River and along the pipeline route. Specific impact assessment cannot be conducted until specific project plans and locations are identified. We expect that most impacts would be temporary in nature, and would probably not impact large areas of high quality habitat.

Angler/hunter use

Based on information currently available, we expect little or no impact to angler or hunter use as a result of the project.

Potential Mitigation/Enhancement Opportunities

Fish and wildlife habitat that currently exists in the project area could be degraded as a result of the project. The following are potential options or strategies for mitigating losses. The potential mitigation and enhancement measures will be re-evaluated should the project be elevated to the feasibility level, and specific project plans and operations become available.

1. Locate intake and pumping facilities in areas that do not have high quality riparian wetland habitat.

Justification

By locating structures in areas of little or no riparian or wetland habitat, avoidance of loss of valuable fish and wildlife habitat would occur.

2. Develop a pipeline route that avoids and minimizes construction activites in riparian or wetland areas.

Justification

Avoiding construction in riparian or wetland habitat, which are limited and of high value to local wildlife, would avoid and minimize loss of valuable wildlife habitat.

3. Implement management practices on existing riparian habitat in the vicinity of the pipeline route to enhance their value for wildlife.

Justification

We expect that some loss of riparian habitat would be unavoidable during project construction. Enhancement of the value of habitat that is currently of decreased value to wildlife would provide in-kind conpensation for unavoidable losses.

4. Minimize withdrawals from the Snake River from mid-March through July. Any withdrawals should be compensated by providing a similar amount of water from an alternate source.

Justification

Mid-March - July is the period of high outmigration of steelhead and salmon smolts. The success of outmigration is related to the presence of high flows during this period to aid the smolts in moving quickly to the ocean. Any activity that alters flow timing or magnitude in the Snake River could have a direct or cumulative impact on smolt migration success. Any reduction in spring and early summer flows below existing conditions is unacceptable.

Information Gaps and Study Needs

1. Quantitative data on fish populations within the proposed project area are lacking.

Study recommendation

Conduct a survey of fish populations throughout the proposed project area. Data collected should be quantitative.

2. Quantitative data on wildlife use of the study area exist only for selected species within the canyon area of Lower Granite Reservoir. Wildlife data for other potential impact areas are lacking.

Study recommendation

Conduct seasonal surveys to determine use of the potentially impacted areas by wildlife species. The survey should provide quantitative data.

3. Quantitative and qualitative data describing the wildlife habitat within much of the proposed project area are not available.

Study recommendation

Conduct a Habitat Evaluation Procedures (HEP) study in the project area to quantify the existing wildlife habitat, and evaluate the value of the habitat for wildlife species in the area.

Reconnaissance-Level Recommendation

Our preliminary assessment of the project indicates the project has potential to negatively impact anadromous fish. Anadromous fish are a unique resource of regional and national significance. Significant fish and wildlife enhancement opportunites are not associated with the project. Based on preliminary project information, we would not support elevating the project to the feasibility level for further evaluation.

PALOUSE RIVER CHANNEL ALTERATION IN PULLMAN

No specific plans on the extent or design of the channel alterations are available at this time. We assumed the activity would be limited to within the city limits. Most of the natural stream channel and riparian areas have already been altered by urban development. The stream channel runs directly through the town of Pullman, Washington. Median average monthly flows through the project reach range from 4 cfs to 103 cfs (Table 14).

Table 14. Median average monthly discharge for 1968 - 1987 in the South Fork of the Palouse River at Pullman, Washington. Data provided by the Corps.

Month	Discharge
January	80
February	104
March	103
April	64
May	23
June	9
July	6
August	4
September	5
October	5
November	9
December	22

Existing Fish and Wildlife Resources

Aquatic resources

The aquatic habitats in the Palouse River within the proposed project area have limited fishery values. Most of the expected project area has already experienced some degree of channelization. Water quality and low flows are probably limiting the value of the stream for fishery values. We are not aware of the existence of game fish populations in the project area.

Wildlife resources

Wildlife values are limited due to the proximity of the area to human population and development. Much of the area adjacent to the stream in the project area has been developed. Narrow bands of riparian vegetation are present on the banks of the stream outside the town of Pullman. Little or no riparian vegetation exists through much of the expected project reach. We expect that the project area is used by passerine birds. The stream is a source of water and could also provide limited cover.

We observed a muskrat using the stream on December 1 in a stream segment on the outskirts of Pullman. We expect that limited muskrat use occurs throughout the proposed project area.

Threatened or endangered species

The proposed project areas are within the range of the bald eagle. At the present time, we have no information to indicate that any of the proposed developments would impact critical habitat.

We are including information on candidate species, and species designated for special management considerations by the states of Washington and Idaho (Table 15). Candidate species, and state designated species receive no protection under the Endangered Species Act, as amended. We are including them in the early phase of planning because the species could possibly be petitioned for listing in the future.

Table 15. Plant and animal candidate species or species of state concern that may be found in the proposed Pullman channel alternative project area.

Township	Range	Sections	Species (classification*)
14 N	45 E	5,6	*Astragalus arrectus* (SPS)
			Astragalus riparius (SPS)
			Chalochortus nitidus (C2 SPX)
			Mimulus pulsiferae (SPS)
			Silene spaldingii (C2 SPT)
			Aster jessicae (C2 SPT)

SPS = designated by the State of Washington as a sensitive species
SPT = designated by the State of Washington as a threatened species
SPX = designated by the State of Washington as possibly extinct
C2 = Taxa for which information now in the possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules.

Angler/hunter use

We expect no angler use of the project area due to the lack of game fish populations, and no hunter use of the area due to the urban nature of the project area.

Anticipated Impacts

Aquatic resources

The project is expected to have no substantial negative impacts in the immediate project area due to the lack of existing resource values. Altering the hydraulic characteristics of the stream could result in increased hydraulic energy over existing conditions downstream of the project area. The increased hydraulic energy could cause increased erosion and streambank destabilization downstream of the project area.

Wildlife resources

The project is expected to have no substantial negative impacts to wildlife resources due to the lack of existing resources in the project area. Likewise, the project is not expected to have any positive impacts on terrestrial resources.

Angler/hunter use

We expect no impact to angler or hunter use of the project area as a result of the project.

Potential Mitigation/Enhancement Opportunities

Fish and wildlife habitat that currently exists in the project area could be impacted as a result of the project. The following are potential options or strategies for mitigating losses. The potential mitigation and enhancement measures will be re-evaluated should the project be elevated to the feasibility level, and specific project plans and operations become available.

1. Construct the channel modification with a low flow channel to maintain surface flow through the channel year-round.

Justification

We are concerned that low flows in the river could result in insignificant surface flows if porous material is used to stabilize the streambed and no low flow channel is constructed. Surface flows are important as a water source for wildlife species and also aquatic invertebrate production.

2. Avoid unnecessary disturbance of existing riparian vegetation. Compensation will be required for any loss resulting from the project. In-kind replacement of riparian vegetation could be accomplished through enhancement of currently degraded habitat.

Justification

Riparian habitat is of high value for wildlife. Avoidance of an impact wherever practical is required for consistency with NEPA, and in-kind replacement of any unavoidable loss is required for consistency with the Service's mitigation policy.

Information Gaps and Study Needs

1. The impacts of channel alterations on downstream channel integrity have not been identified.

Study recommendation

Conduct a study to determine the impacts of the proposed channel alterations on downstream channel integrity.

2. Quantitative data on fish populations within the proposed project impact area are lacking.

Study recommendation

Conduct a survey of fish populations in the area of impact for the proposed project. Data collected should be qualitative and quantitative.

3. Quantitative data on wildlife use of the study area does not exist.

Study recommendation

Conduct seasonal surveys to determine use of the potentially impacted areas by wildlife species. The survey should provide qualitative and quantitative data.

4. Quantitative and qualitative data describing the wildlife habitat within the the proposed project area are not available.

Study recommendation

Conduct a Habitat Evaluation Procedures (HEP) study in the project area to quantify the existing wildlife habitat, and evaluate the value of the habitat for wildlife species in the area.

Reconnaissance-Level Recommendation

Our preliminary assessment of the project indicates unmitigable losses of valuable fish and wildlife habitat are not likely to occur as a result of the project. Enhancement opportunites associated with the project seem limited. Based on preliminary project information, we would support elevating the project to the feasibility-level for further evaluation.

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APPENDIX J

PREVIOUS REPORTS

APPENDIX J

PREVIOUS REPORTS

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2. Interim Report, Palouse River and Tributaries, CENPW, 10 August 1940.

3. Survey Report, Palouse River and Tributaries, CENPW, 15 January 1942.

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13. Special Flood Hazard Information, Paradise Creek, Pullman and Vicinity, Washington, CENPW, 1970.

14. Water Supply Study, Stevens, Thompson and Runyan, Inc., for Pullman-Moscow Water Resources Committee, August 1970.

15. South Fork Palouse River, Special Flood Hazard Information, Moscow, Idaho and Vicinity, CENPW, January 1973.

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APPENDIX K

SCS CORRESPONDENCE ON EROSION AND SEDIMENTATION POTENTIAL

United States Department of Agriculture

Soil Conservation Service

Date: February 13, 1989

Subject: Clearwater RC&D Measure for Palouse River Study
Assistance to U.S. Corps of Engineers

To: Dale Smelcer
Civil Engineer
U.S. Corps of Engineers
Walla Walla, WA

Enclosed is a report from the Clearwater RC&D Council on general soils characteristics within potential reservoir site watersheds at Paradise Creek and Robinson Lake. Although sites at Harvard and Laird were originally meant to be included in this report, substantial difficulties in locating and correlating data in multiple surveys required a modification of that objective.

The topographic maps provided me for assistance in developing this report will be returned under a separate cover.

Michael J. Neubeiser

Michael J. Neubeiser
RC&D Coordinator

cc:Don Heath, RC&D Council President	w/enclosure
Harry Lee, RC&D Natural Resources Comm.	w/enclosure
Latah County SCD Board of Supervisors	w/enclosure
RC&D Council Officers	w/o enclosure

PALOUSE RIVER BASIN STUDY ASSISTANCE

TO U.S.CORPS OF ENGINEERS

Prepared By

Clearwater Resource Conservation And Development Council

Under Measure No. 16-6003-057-108

With Assistance From USDA-Soil Conservation Service

Sponsored By

Latah County Soil Conservation District

INTRODUCTION

The Clearwater RC&D Council, at the request of the Latah Soil Conservation District Board of Supervisors, agreed to provide general soils information to the Corps of Engineers, relative to the Corps reconnaissance survey of the Palouse River Basin.

The Corps is conducting the survey at the request of the Idaho Department of Water Resources. The main purpose is to identify alternative sources of developing/enhancing the domestic water supply for the Moscow/Pullman area. This area faces a potential shortage of water in the future due to depletion of the Moscow/Pullman aquifer.

One of the alternatives under consideration by the Corps is the development of additional surface storage impoundment structures. Four potential sites are being studied. They are referred to as the Harvard, Laird, Paradise Creek, and Robinson Lake sites.

General soils data has been assimilated for this report for the Paradise Creek and Robinson Lake sites. Due to time constraints and unforeseen difficulties similar data is not included in this report for the Laird and Harvard sites. A brief explanation of those difficulties is offered later in the report.

SOIL MAP UNITS 1/

Soil map units consist of one or more major soils and some minor soils. The extent, in acres, of each soil within a map unit defines wether it is a major or minor soil type. The map unit is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The soil map units occurring in the Paradise Creek and Robinson Lake watersheds are listed below, with a brief description.

3 - Palouse-Naff

Very deep, well drained, gently sloping to moderately steep soils that formed in loess.

Slopes are 2 to 20 percent. The native vegetation was grasses. Elevation is about 2,700 feet. The average annual precipitation is about 21 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is about 140 days.

This unit is made up of about 30 percent Palouse soils and 22 percent Naff soils. The remaining 48 percent is components of minor extent.

Palouse soils are on uplands. These soils are very deep and well drained. The surface layer and the upper part of the subsoil are medium textured. The lower part of the subsoil is moderately fine textured.

Naff soils are on uplands. Texture, depth, and drainage characteristics are very similar to the Palouse soils.

Of minor extent in this unit are Thatuna, Tilma, Garfield, and Athena soils and the somewhat poorly drained Latahco soils.

Most areas of this unit are used for cropland. A few areas are used for hayland and pastureland.

The main limitation of this unit for agricultural use is the hazard of erosion. The main limitation for recreational development are a dusty surface layer and slope. The main limitations for homesite development are slope, moderate and moderately slow permeability, and frost action. Thatuna and Tilma soils have a perched water table early in spring. Latahco soils have a seasonal high water table and are subject to flooding.

Wildlife habitat is limited by the use of clean tilled farming practices. Hungarian partridge, ring-necked pheasant, hawks, owls, coyote, and ducks are in this unit.

4 - Southwick-Larkin

Very deep, moderately well drained and well drained, gently sloping to moderately steep soils that formed in loess.

Slopes are 3 to 25 percent. The vegetation in uncultivated areas is mainly coniferous trees. Elevation is 2,600 to 2,700 feet. Average annual precipitation is about 23 inches. Average annual air temperature is about 46 degrees F, and the average frost-free season is about 130 days.

This unit is made up of about 44 percent Southwick, and 35 percent Larkin soils. The remaining 21 percent is components of minor extent.

Southwick soils are on uplands. These soils are very deep and moderately well drained. The surface layer, subsoil, and layer immediately below the subsoil are medium textured. The lower part of the profile is an older, buried subsoil of moderately fine texture.

Larkin soils are on uplands. These soils are very deep and well drained. They are medium textured throughout.

Of minor extent in this unit are Driscoll soils and the somewhat poorly drained Latahco and Lovell soils.

This unit is used mainly for cropland. It is also used for hayland, pastureland, and woodland.

The main limitation of the unit for agricultural use is the development are slope, a dusty surface layer, and slow and moderately slow permeability. The main limitations for homesite development are slope, a seasonal perched water table, slow and moderately slow permeability, and frost action. The minor Latahco and Lovell soils are subject to flooding.

The main wildlife species in this unit, particularly in areas adjacent to cultivated fields, are ring-necked pheasant, Hungarian partridge, valley quail, hawks, and owls. Some white-tailed deer, coyote, ducks, and black bear are also present.

5. - Taney-Joel

Very deep, moderately well drained and well drained, gently sloping to moderately steep, cool soils that formed in loess.

This map unit occurs east and west of Troy and north and south of Potlatch. Slopes are 3 to 35 percent. The vegetation in uncultivated areas is mainly coniferous trees. Elevation is 2,600 to 2,800 feet. Average annual precipitation is about 25 inches, average annual air temperature is about 45 degrees F, and the average frost-free season is about 110 days.

This unit is made up of about 65 percent Taney, and 12 percent Joel soils. The remaining 23 percent is components of minor extent.

Taney soils are on uplands. These soils are very deep and moderately well drained. The surface layer, subsoil, and layer immediately below the subsoil are medium textured.

Joel soils are on uplands. These soils are very deep and well drained. The surface layer is medium textured. The subsoil is medium, grading to fine, texture.

Of minor extent in this unit are Klickson soils and the somewhat poorly drained Crumarine soils.

This unit is used mainly for cropland, hayland, and pastureland, with minor areas of woodland.

The main limitations of this unit for agricultural uses are the hazard of erosion and a seasonal perched water table. The main limitations for woodland are the hazard of erosion, wetness, and plant competition. The main limitations for recreational development are slope, a dusty surface layer, a seasonal high water table, slow and moderately slow permeability. The main limitations for homesite development are slope, a seasonal perched water table, slow and moderately slow permeability, and frost action. The minor Crumarine soils are subject to flooding.

The main wildlife species in this unit, particularly in areas adjacent to cultivated fields, are Hungarian partridge and valley quail. Some grouse, hawks, owls,coyote, black bear, ducks, and beaver are also present. This unit provides prime habitat for white-tailed deer.

8. - Vassar-Uvi

Deep and very deep, well drained soils that formed in volcanic ash, loess, and granitic residuum.

This map unit occurs extensively in the Moscow Mountain area. Slopes are 35 to 65 percent. Elevation is 2,800 to 5,000 feet. Average annual precipitation is 28 to 45 inches, average annual air temperature is 40 to 44 degrees F, and the average frost-free season is about 75 to 110 days.

This unit is made up of about 39 percent Vassar, and 30 percent Uvi soils. The remaining 31 percent is components of minor extent.

Vassar soils are on mountains. These soils are deep and well drained. They formed in volcanic ash overlying residuum derived dominantly from granite. The surface layer is medium textured. Below this, to an average depth of 54 inches, the soils are moderately coarse and coarse textured. Weathered granite is at an average depth of 54 inches.

Uvi soils are on mountains. These soils are very deep and well drained. They formed in loess and residuum derived dominantly from granite. The soils are medium textured throughout.

Of minor extent in this unit are Spokane and Molly soils and Rock Outcrop.

This unit is used for woodland.

The main limitations of this unit for woodland are the hazard of erosion, slope, and plant competition. This unit is poorly suited to recreational and homesite development.

This unit provides prime habitat for white-tailed deer. Other wildlife in this unit include grouse, hawks, owls, coyote, black bear, elk, beaver, bobcat, and cougar.

HYDROLOGIC SOIL GROUPS 1/

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow rate of infiltration when thoroughly wet. These consist chiefly of clayey soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

MAP UNIT SOILS/HYDROLOGIC GROUPS 1/

3. Palouse-B Naff-B
   Athena-B Garfield-C Latahco-C Thatuna-C Tilma-C

4. Southwick-C Larkin-B
   Driscoll-C Lovell-C

5. Taney-C Joel-B
   Crumarine-B Klickson-B

8. Vassar-B Uvi-B
   Molly-B Spokane-B

Relative percent of hydrologic groups in each map unit (estimated).

3.	Palouse-Naff	B - 60%	C - 40%
4.	Southwick-Larkin	B - 35%	C - 65%
5.	Taney-Joel	B - 35%	C - 65%
8.	Vassar-Uvi	B - 100%	

Paradise Creek Watershed

Map Unit	Estimated Acres	Hydrologic Group (Acres)	
3	1,264	B 758	C 506
4	3,506	B 1,227	C 2,279

5	805	B 516	C 289
8	1,925	B 1,925	C 0
	7,500	B 4,426	C 3,074

Robinson Lake Watershed

Map Unit	Estimated Acres	Hydrologic Group (Acres)	
5	2,300	B 805	C 1,495
8	2,700	B 2,700	C 0
	5,000	B 3,505	C 1,495

Laird and Harvard Watersheds

In the course of developing this report it was discovered the Laird and Harvard watersheds fall within portions of four separate soil surveys, with two sets of criteria and evaluations, making even general assumptions a challenge beyond the scope of this report. Attempting to correlate the data and arrive at comparable evaluations is certainly not impossible, but far more time consuming than the Council staff had anticipated.

The soils information is available in the Benewah County Area Soil Survey and Latah County Area Soil Survey, which are published surveys. Another portion of the data is included in the ongoing Benewah County-St. Joe National Forest Soil Survey. The remainder of the data is available in the Land Systems Inventory of the Palouse District, Clearwater National Forest.

SUMMARY

Watersheds with greater amounts of soils in the C and D hydrologic groups possess high erosion hazard potential. Naturally occurring soil erosion in itself should not pose a serious threat of premature siltation, and thus a higher than normal operation and maintenance cost.

Agricultural activity within the watershed has altered this natural order. However, it was not intended in this brief report to attempt to quantify the potential erosion hazard. That is an effort requiring considerably more staff time, and computer assisted methodology.

The threat of siltation is greatest where agricultural activity, especially tillage, is high, and conservation implementation is low.

Without conservation the reservoir sites surrounded by the most cropland, and least amount of uncultivated acres, could reasonably be expected to be at the most risk of premature siltation.

A variety of soil conservation practices are well defined. Assistance in design and implementation is provided at no cost by the Soil Conservation Service, U.S. Forest Service, and Idaho Dept. of Lands.

There are several conservation programs available which offer cost-share assistance for conservation practice implementation. Among these are the Conservation Reserve Program (CRP), Agricultural Conservation Program (ACP), Idaho State Water Quality Program (ISWQP), and the Forest Incentive Program (FIP). Attempting to identify the extent of these programs within the study sites is again outside the intent of this report. These programs are dynamic, and would therefore exert varying degrees of influence on erosion control efficiency, and siltation, during the lifetime of any water impoundment.

1/ Extracted from Soil Survey of Latah County, USDA-SCS, April, 1981

APPENDIX L

PULLMAN-MOSCOW WATER RESOURCES COMMITTEE CORRESPONDENCE

Washington
State University

Office of the Vice President -- Business and Finance, Pullman, Washington 99164 1045

February 16, 1989

Mr. Dale Smelcer
Corps of Engineers
Walla Walla, WA 99362

Dear Mr. Smelcer:

Subject: Pullman/Moscow Water Resources Committee

As was discussed at your attendance at a recent meeting of the Pullman/Moscow Water Resources Committee, the Committee is not prepared at this time to indicate additional studies or areas of interest where we feel the Corps of Engineers involvement would be advantageous. You had indicated at the meeting that it might be desirable for the Committee to indicate such studies, with the letter to be included as an appendix to the alternative surface water supply study which is being completed by the Corps of Engineers, expected to be forwarded to Portland on about March 31st.

On the other hand, the involvement of the Corps of Engineers in the ground and surface water studies for this Pullman/Moscow basin has been extremely helpful, if not essential, in past years in support of the Committee. While we are not able to be specific at this point, it is our opinion that the Corps of Engineers is an essential participant with the Committee as further study progresses. At this time, however, it is essential that the Committee turn its attention to the formulation of a "ground water management plan". Until this plan is completed, not only will the attention and the efforts of the Committee be dedicated in this direction, but completion of that study is necessary before we can be more specific with the Corps of Engineers about their involvement.

In short, the Pullman/Moscow Water Resources Committee is appreciative of the past and current efforts of the Corps of Engineers, and it is necessary that involvement continue, but it is premature to indicate specific areas which we feel the Corps should pursue at this time.

Very truly yours,

Kenneth E. Abbey
Chair
Pullman/Moscow Water Resources Committee

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