Department of Energy
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

AUG 28 1985

In reply refer to: PJ

To Interested Parties:

In 1983, Bonneville Power Administration (BPA) commenced implementation of Columbia River Basin Fish and Wildlife Program Measure 704(e)(1)A, Enloe Dam Passage. Having completed this report, BPA is now ready to consult with the fish and wildlife agencies and Tribes, prior to funding implementation of passage at Enloe Dam. Enclosed with this letter is the fiscal year 1984 annual report for this project to comply with Program Consultation, Section 1304 (c)(2).

The annual report outlines BPA's implementation activities, addresses issues raised during consultations concerning passage, and reports the findings of a variety of technical investigations. Attention is particularly directed to sections of the report that deal with fisheries' considerations, passage alternatives, water quality, and baseline information for future compliance with the National Environmental Policy Act (NEPA).

To date, BPA has received varying recommendations from agencies, Tribes, and other interested groups regarding a "preferred" mode of passage at Enloe Dam have varied. After review and comment on the report by these entities, BPA will consult with interested parties to arrive at a concensus for a preferred passage alternative.

If you have any questions please call me at (503) 230-5496 or Larry Everson at (503) 230-5199 at your convenience.

Sincerely,

John R. Palensky, Director
Division of Fish and Wildlife

ENLOE DAM PASSAGE PROJECT
ANNUAL REPORT 1984
VOLUME I

Prepared For:

Larry P. Everson
Program Manager

BONNEVILLE POWER ADMINISTRATION
DIVISION OF FISH AND WILDLIFE
1002 N.E. Holladay Street
Portland, Oregon 97232

Project No. 83-477

Contract No. DE-AC79-83BP11902

Prepared By:

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3711.1 July, 1985

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ACKNOWLEDGEMENTS

IEC BEAK Consultants Ltd. would like to acknowledge the contributions of a number of individuals that have provided valuable input to this project. Mr. L.B. Everson, BPA Program Manager and M.L. Fanning, IEC BEAK Consultants Ltd. Project Manager provided overall study direction and review.

Special thanks to Washington Department of Game representatives S. Wright, A. Eldred, D. Guffer, K. Williams, J. Foster, S. Miller, B. Crawford, C. Morrill and S. Roberts; B.C. Fisheries Branch representatives D. Narver, C. Bull, G. Taylor, L. Sunde and P. Slaney; Washington Department of Fisheries representatives L. Phinney and K. Hopper; U.S. Fish and Wildlife representative D. Mulcahy; and Water Budget Centre representative C. McConnaha who provided valuable technical input to many fisheries aspects of the report which was prepared by M.L. Fanning, D. Hickey, B. Lister and J. Buell.

Our gratitude is expressed to OTT Water Engineers Inc. staff members R. Ott, G. Lamb, R. Eldridge, C. Smith and their special consultants M. Bell and K. DeRubertis for the conceptual design of passage alternatives.

We would also like to thank K. Ward of BPA who assisted staff members from BEAK Portland (J. Kiel), IEC BEAK Consultants Ltd. Vancouver (W. Morgan) and J. Buell in preparing the NEPA section of the report.

IEC BEAK Consultants Ltd. would also like to thank T. Griffing for his review and editorial contributions to the final report.

Plate 1: ENLOE DAM ON THE SIMILKAMEEN RIVER

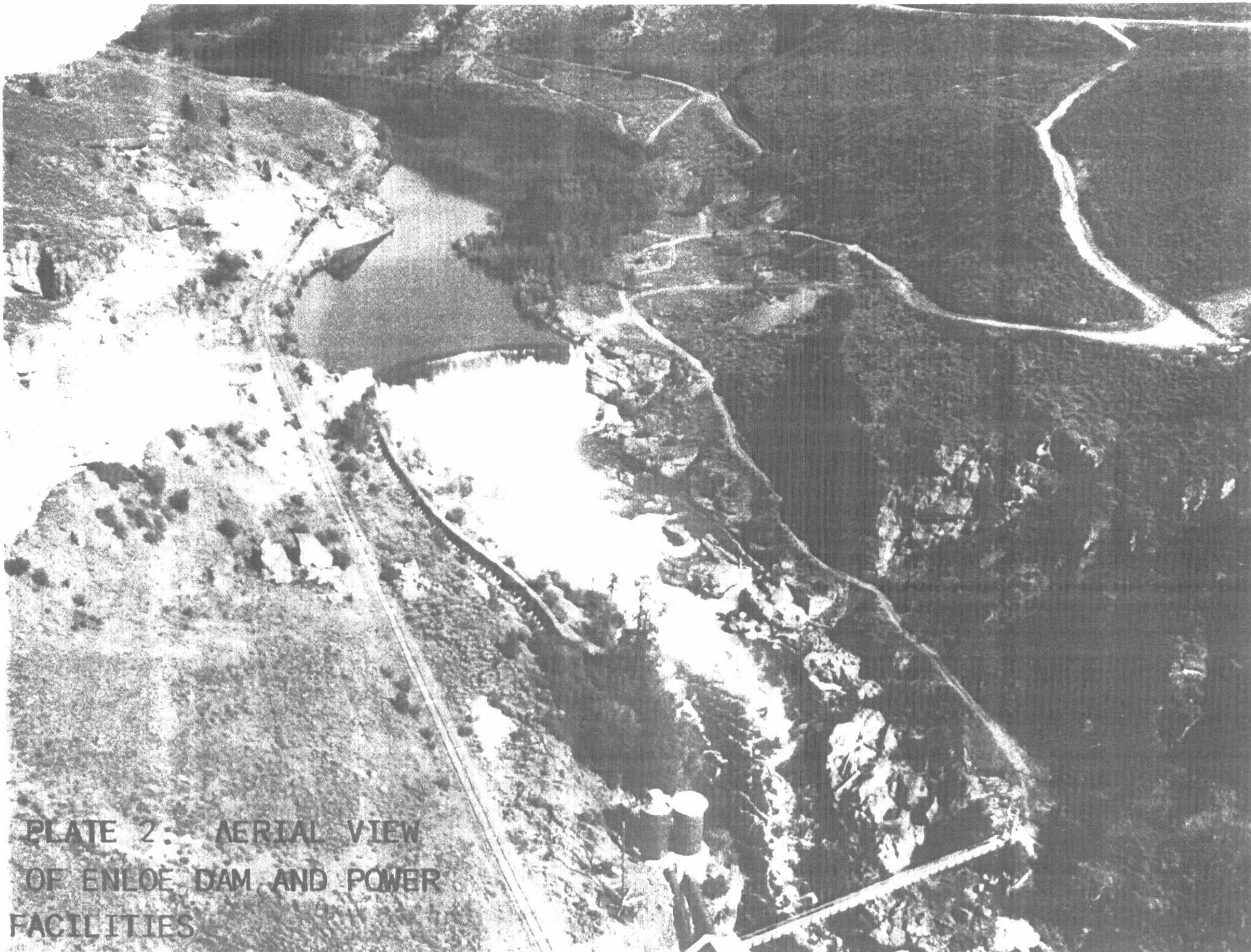


PLATE 2: AERIAL VIEW OF ENLOE DAM AND POWER FACILITIES

1.0 EXECUTIVE SUMMARY

The Northwest Power Planning Council's Columbia River basin Fish and Wildlife Program of 1982 commits measure 704 (e) (i), Table 5 (A) to passage of anadromous fish over Enloe Dam on the lower Similkameen River. Completion of passage and establishment of an anadromous salmonid fish run throughout the more than 320 linear miles of spawning and rearing habitat of the Similkameen basin would be considered as off-site mitigation for juvenile fish losses occurring on the mainstem of the Columbia River.

The Bonneville Power Administration (BPA) is conducting an extensive consultation program with agencies, Tribes and other organizations and groups in both the U.S. and Canada that have an interest in fish passage at Enloe Dam. Part of the response from this consultation program has been the identification of a broad array of issues relating to the feasibility of fish passage and the establishment of anadromous fish in the upper Similkameen basin. It is not the intention of this report to recommend a course of action among the several possible options for fish passage at Enloe Dam and the introduction of anadromous salmonid fish in the upper Similkameen River. Rather it is the intention to report the results of several investigations that address issues that have been raised and to provide an objective analysis of alternative means of fish passage. These issues are addressed in a manner that decision makers may have a more complete understanding of many of the complexities and ramifications that surround their decisions for a future course of action.

IEC BEAK Consultants Ltd. was engaged by BPA in 1983 for a multi-phased plan to conduct certain investigations and to collect information addressing these issues and report on the findings.

The only species of fish being considered for introduction at this time is a summer run of steelhead trout that is well adapted to the upper Columbia basin.

The Similkameen River basin drains an area of approximately 9,600 sq. km (over 3,600 sq. mi) of the eastern slope of the Cascade Mountains along both sides of the boundary between the U.S. and Canada. Of the total basin, 79%, including most of the water courses, lies within Canada. The river empties into the Okanogan River at Oroville, Washington, which in turn enters the Columbia River. Enloe Dam is located 8.8 miles upstream of the Similkameen River mouth and the international border is located at river mile 26.8. Figure 1-1 provides orientation.

Enloe Dam is 54 ft in height and was built of concrete between 1916 and 1923 as a hydroelectric facility but has not been in service since 1959. The dam and powerhouse are owned and were operated by the Okanogan Public Utilities District, who have plans for reactivating the facilities for power generation.

Within the Similkameen basin, most of the population lives in Canada where three communities (Princeton, Keremeos and Hedley) and their outlying agricultural areas represent most of the more than 8,000 residents. Principal economic activities include agriculture, forestry, mining and tourism. The valley of the Similkameen had a significant involvement in the historical development of British Columbia and remains as one of the major transportation corridors between the Pacific coast and the interior.

The hatchery at the Wells Dam on the Columbia River (river mile 515.6) established a stock of summer steelhead trout in the late 1960's from wild summer steelhead stocks that spawned in the mainstem and tributaries of the upper Columbia basin. This stock is the only reasonable choice for summer steelhead introduction into the upper Similkameen and already utilizes the stretch of river below Enloe Dam.

Wells stock adults return to Wells Dam on their upstream migration (passing over a total of 9 dams) between late August and early November with the peak of the run arriving in September and October. Adult size for a 1-ocean fish averages about 62 cm in length and 2.4 kg in weight with 73 cm and 4.0 kg being the average size for a 2-ocean fish. Depending on the year, the run is dominated by 1-ocean or 2-ocean fish. Females are slightly more abundant than males and produce on average about 5,500 to 6,500 eggs each. A small part of the run are captured at the Dam for broodstock each year, but the vast majority spawn freely, particularly in tributary systems. More than 1 million hatchery reared smolts are released annually in April or May and outmigrants move downstream to the estuary of the Columbia before the end of May. A

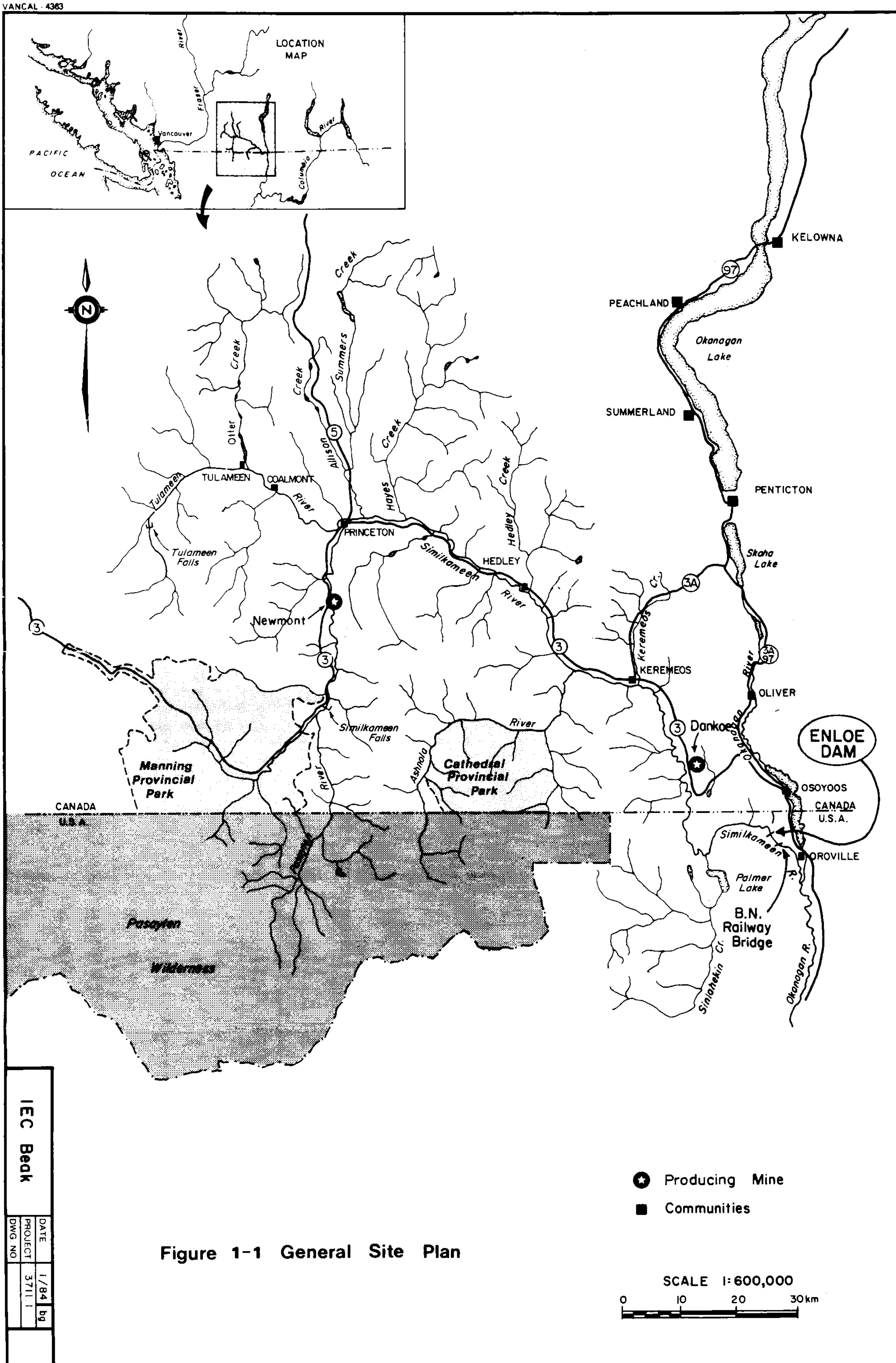


Figure 1-1 General Site Plan

substantial majority of the released smolts residualize in freshwater for periods of 1 to 3 years before undertaking outmigration. The Wells Hatchery stock is not distinguishable genetically from the wild stock spawners. Smolt to adult survival rates have been quite high compared to other upper Columbia basin stocks (in the range of 1.5% - 4.0%) and are improving in recent years. The run returning to Wells Dam has dramatically increased by more than an order of magnitude since 1978 reflecting the runs adaptation to the upper Columbia system, careful hatchery techniques, thorough disease monitoring and a good water source for the hatchery.

Spawning of steelhead at the Wells Hatchery takes place in January and February and rearing to smolt size occurs there as well as at other hatchery facilities in tributary systems. The smolts are released at a wide variety of locations in the upper Columbia basin. At present capacity the Wells Hatchery supplies about 100,000 smolts to the lower Similkameen River, and that capacity will increase to 250,000 with the hatchery expansion scheduled for 1985 or 1986. A vastly greater capacity exists if juvenile fish at younger life stages (ie. fry or parr) were to be the production stage targetted for planting.

The disease history of the Wells summer steelhead stock has been remarkably problem free for an upriver facility. No outbreak of either viral or bacterial diseases has ever occurred and only low and incidental diagnosis of such diseases has occurred while under the scrutiny of a rigorous disease monitoring program. Before fish could be transported into Canada, disease control certification is required as well as obtaining transport permits from appropriate Canadian agencies.

It is expected that the life history and general behaviour of steelhead planted in the upper Similkameen would be similar to that of other upper Columbia River runs; especially that of the Methow River which has very similar basin characteristics and receives Wells Hatchery stock.

Results of an extensive 1983 habitat assessment in the Similkameen River and its tributaries yielded estimates of the capacity of the system to produce steelhead smolts. These estimates ranged from about 400,000 to 700,000 smolts per year. Estimates were also derived of the adult steelhead that would return to the system to spawn using assumptions of average smolt to adult survival rates that have been observed in the upper Columbia River runs (1.5% and 4.0%). The estimates were between 9,100 and 24,000 adult fish. Not surprisingly, estimates of smolt production capacity were not uniform throughout the basin, and over 80% was estimated to originate in the mainstem of the river below Similkameen Falls. Given that adults are most likely to return to spawn in the area where they reared, this same section of the river could expect to receive 80% of the adults that return. The habitat study concluded that rearing habitat, not spawning habitat, was likely to be the factor that is limiting and would therefore establish the upper limit to steelhead trout production in the system.

Based on tests conducted at the falls at White River, Oregon, which have a vertical drop of 140 ft into a plunge pool, it is expected that juvenile mortality would not be excessive from passing over the 54 ft high Enloe Dam on their downstream migration.

An analysis of the existing mortality rates associated with the migration of steelhead was conducted. This addressed the concern that natural production in the Similkameen may have to be continuously supplemented by hatchery production in order to offset migratory mortalities experienced by the fish as they pass over the 9 mainstem Columbia dams plus Enloe Dam. The escapement of adults to the Similkameen River will be determined by the mortality rate per dam and by the rate of exploitation on returning adults. There is evidence that mortality rates are probably in the vicinity of 10% of the smolt population per dam and may have been as high as 15%. For there to be any excess adults available for harvest from a run dependent only on natural production (ie. without hatchery supplementation), the mortality rate must be less than 10% per dam, and in practice would probably have to be in the 5% to 8% range to allow even a modest harvest of 10% to 20% of the returning adults.

A series of projections have been prepared to illustrate how the run would react through time to different rates of exploitation between 0 and 40% and to different losses per dam of either 10% or 15%. A probable scenario for development of the Similkameen River summer steelhead run is presented. It would involve a juvenile loss of 10% per dam, and 10% exploitation below Wells Dam of adults entering the

Columbia River. If 250,000 smolts per year were supplied by the Wells Hatchery and no exploitation of adults occurred above Wells Dam, a spawning escapement of over 15,500 fish could be achieved in years 19 - 24, and natural spawning would be responsible for 71% of the returning adults. If, for the same period of time, an additional 10% harvest of adults (both wild and hatchery origin) were allowed above Wells Dam, the harvest would be about 1,350 fish in years 19 - 24 and the resulting spawning run would be about 12,000 adult fish. These projections serve to illustrate the degree to which harvest rates, mortality rates and rate of hatchery supplementation may be manipulated to achieve a desired run size and desired composition of wild and hatchery spawned fish.

Extending these projections over a fifty year period illustrates that an annual harvest including broodstock could be maintained at levels between 2,000 and 4,000 adult fish at exploitation rates ranging between 10% and 40%.

A benefit analysis was conducted to display the Enloe Dam passage project benefits in terms of present value over a 50 year project life. Monetary value of a sport-caught adult steelhead was placed at $144.00 U.S., and that of a commerical or Indian ceremonial harvested steelhead is $21.81 U.S., and the discount rate used was 3%. The passage project benefits for the three harvest scenarios, using an annual supplementation of 250,000 hatchery reared smolts are:

Harvest	Present Value - U.S. $
10%	$7,215,000
20%	$9,156,000
40%	$11,455,000

The capacity of the Similkameen River and its tributaries to provide suitable spawning substrate and water conditions was estimated from the habitat survey. The total estimated suitable spawning area for steelhead was 961,000 m^2. The spawner capacity was estimated to be about 98,000 steelhead trout for the entire system; of which 54,000 represents the mainstem; 30,000 represents the Tulameen River; 13,000 represents the Ashnola River and 1,000 represents the Pasayten River. The majority of the rearing area for juvenile steelhead was found to occur in roughly the same sections as the majority of the spawning area. Total estimated suitable rearing area for steelhead was in excess of 1.8 million m^2.

The species of resident sport fish with which introduced steelhead trout would most likely compete is the rainbow trout which occur naturally in the Similkameen River system. Several other sport fish species are also present in some sections including mountain whitefish, planted brook trout, cutthroat trout and squawfish. The total population of rainbow trout in the system in 1983 was estimated to be about 143,000, and observed densities were far lower than reported for other B.C. streams. Contrary to what may have been expected, the 1984 creel census indicates that fishing pressure is low and would not account for the very low density and small population size. Low primary and secondary productivity due to low nutrient availability is more likely the cause of observed slow growth, small size range of trout and low population density. Competition between steelhead and rainbow could be expected, but underutilized habitat seems to be available and would tend to lessen the effects of competition. Increased harvest regulations necessary to manage and protect the steelhead would also protect the resident trout and the residualization of steelhead smolts would probably also enhance the trout fishery.

An array of potential and accessable liberation sites for planting the steelhead smolts throughout the basin have been identified and catalogued. It is expected that a liberation strategy of releases throughout the upper Similkameen would enhance the natural homing tendencies of the fish and thus assist in providing a quality fall steelhead fishery by allowing a timely and well dispersed return of adults to the system, while they are still in their most desirable condition for angling. Comparisons of the river characteristics and the steelhead fisheries on other nearby upper Columbia River tributaries supports the notion that a quality fall steelhead fishery can be established on the Similkameen.

Stocking of life stages of steelhead younger than smolts (ie. fry or parr), or establishing low cost rearing facilities in the Similkameen headwaters may be strategies worthy of more in-depth consideration, both from the perspective of cost savings as well as a means of enhancing the quality of the steelhead fishery.

Expansion of the Wells Hatchery is planned, funds have been allocated by the Bureau of Reclamation for expansion and construction is scheduled to begin in 1985 or 1986. This expansion will readily permit the hatchery to provide 250,000 smolts annually for outplanting in the Similkameen system.

In order to assess present angling pressure, the sport fish catch, harvest and angler attitudes about a steelhead fishery, a comprehensive angler survey was conducted in 1984 throughout the Similkameen basin. It was found that angling pressure was light, both in terms of the number of anglers and in hours spent angling; the catch was small, both in numbers and in the size of the fish; the harvest was almost exclusively small sized rainbow and brook trout; the catch per unit effort and harvest per unit effort were discouragingly low; most of the anglers were B.C. residents but were travelling through the basin or were present for primary purposes other than angling; most anglers were in favour of steelhead introductions to the system and most would intensify their angling effort in the system in response to steelhead introductions.

The present harvest of steelhead returning to the Wells Dam is estimated to be divided among three Washington user groups; the recreational fishery is about 8%; the native harvest (mainly incidental) is about 1%; and the incidental commercial harvest is slightly less than 1%. The allocation and management of harvest of upper Similkameen steelhead will have to be designed to accommodate user groups and agency objectives in both B.C. and Washington. The returns and harvest of summer steelhead below Enloe Dam are dramatically increasing as a result of plantings there in recent years.

A profile of disease characteristics was developed for chinook and sockeye salmon which return to the Okanogan River and the lower Similkameen as well as the Wells Hatchery summer chinook stock to provide additional background information concerning the potential of fish disease transmission into the upper Similkameen.

The preferences expressed by agencies, Tribes and other interested organizations concerning the mode of fish passage at Enloe Dam were collected and summarized and reflect a diversity of opinions and considerations. The choices of trap and haul and dam removal were expressed more frequently than was the installation of fish ladders. Significant concern was expressed over the future of hydroelectric power generation on the lower Similkameen.

Six alternatives to provide upstream passage at Enloe Dam were developed to a conceptual level of design, including the categories of fishways, trap and haul systems and dam removal. The generalized layout and locations of these alternatives are diagrammed in Figure 1-2 and include:

1. Fishway from falls (not compatible with power production);

2. Fishway below powerhouse (compatible but some conflicts with power generation);

3. Trap and haul at falls (not compatible with power generation);

4. Trap and haul below powerhouse (compatible but some conflicts with power generation);

5. Trap and haul at railroad bridge (compatible and no conflicts with power generation); and

6. Dam removal (not compatible with power generation)

   a) after dredging trapped sediment; or
   b) natural scouring and release of sediments.

Alternatives 1 and 3 could not function compatibly with power generation because the fish could not be attracted to the fishway entrance. Alternative 6 would result in removal of the power generation option. Alternatives 2 and 4 would reduce the head available for power generation but could function simultaneously with power generation. Alternative 5 has no interaction with power generation. Construction of a barrier dam to deflect the fish would be required for alternatives 2, 4 and 5.

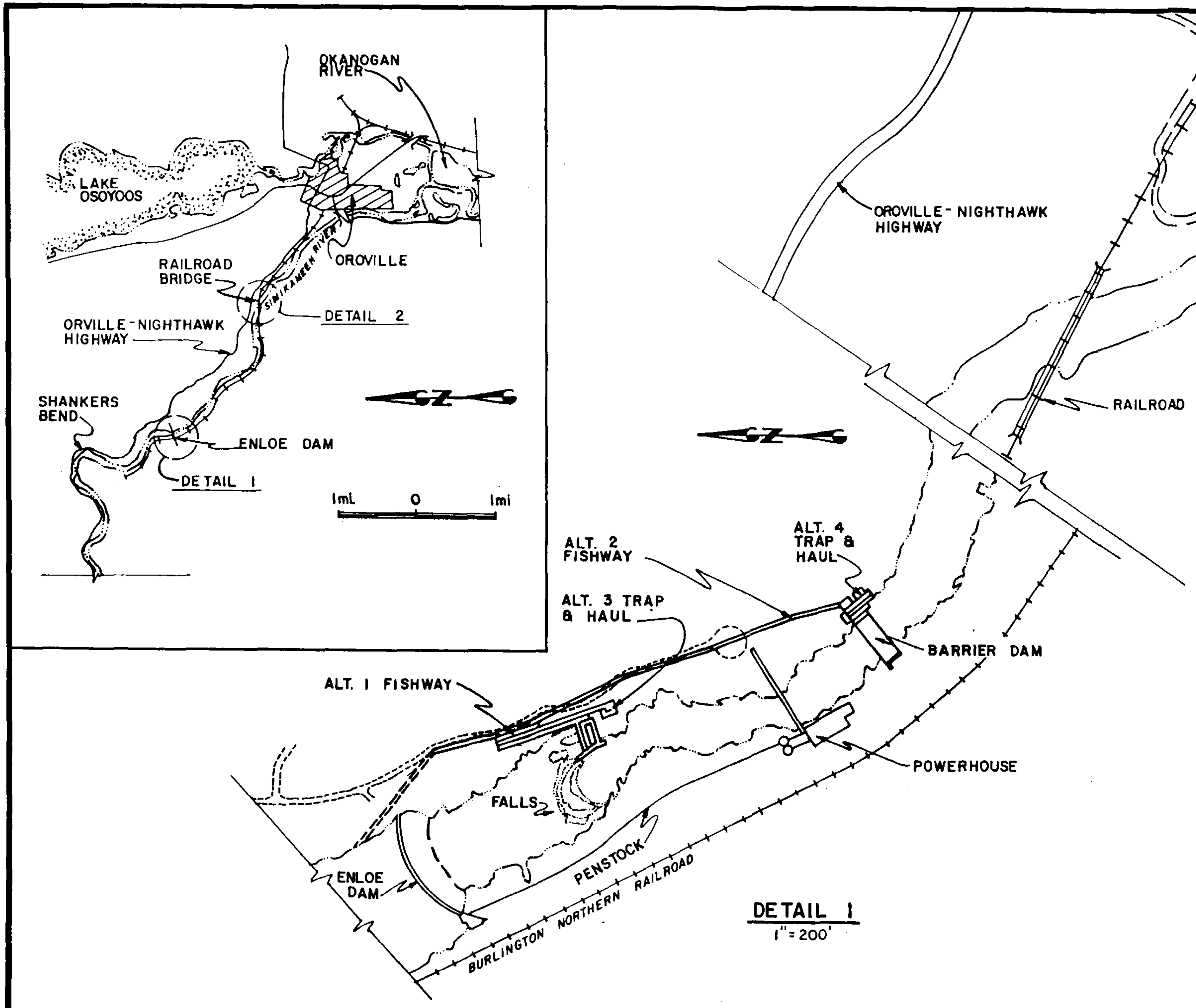


FIGURE 1-2

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVES

DATE JUNE 1985

JOB NUMBER S1030.01

OTT

The key consideration, other than power generation, for alternative 6 (dam removal) is how to deal with the accumulation of the 1.7 million cu yds of sediment deposited behind the dam. Serious hydraulic, flooding and environmental considerations of the downstream river sections are requisite if sediment release is contemplated, otherwise costs associated with dredging and disposal of the sediments are extreme. In either case, a small fishway would also be required to guarantee passage of the falls.

A brief summary of comparative costs of the various alternatives are presented. Annual costs are subjected to present value analysis and included in total costs.

Alternatives	Capital Costs	Total Costs Of Passage Facilities
1 - Fishway - Falls	$1,787,000	$2,096,000
2 - Fishway - Powerhouse	$2,347,000	$2,656,000
3 - Trap - Falls	$1,737,000	$3,611,000
4 - Trap - Powerhouse	$1,935,000	$3,809,000
5 - Trap - R.R. Bridge	$2,101,000	$3,973,000
6 - Dam Removal		
a) With dredging	$27,088,000	$27,371,000
b) Without dredging	$1,916,000	$2,199,000

The disbenefits arising from the loss of head for power production in alternatives 2 and 4 are estimated to be about 3.2 and 2.5 million dollars respectively. Detailed breakdowns of costs were developed and are presented in Section 5.2 of the report along with the conceptual designs and descriptions of operation.

A benefit cost analysis was conducted using the adult harvest scenarios of 10%, 20% and 40%, continued supplementation of smolts from Wells Hatchery, the total project costs for the alternative modes of passage, and a project life of 50 years.

The benefit cost ratios are summarized here:

Alternatives	Harvest Rate 10%	20%	40%
1 - Fishway - Falls	1.24	1.58	1.97
2 - Fishway - Powerhouse	0.75	0.95	1.19
3 - Trap - Falls	0.99	1.26	1.58
4 - Trap - Powerhouse	0.73	0.92	1.16
5 - Trap - R.R. Bridge	0.95	1.20	1.50
6a - Removal - dredge	0.23	0.29	0.37
6b - Removal - scour	1.22	1.55	1.94

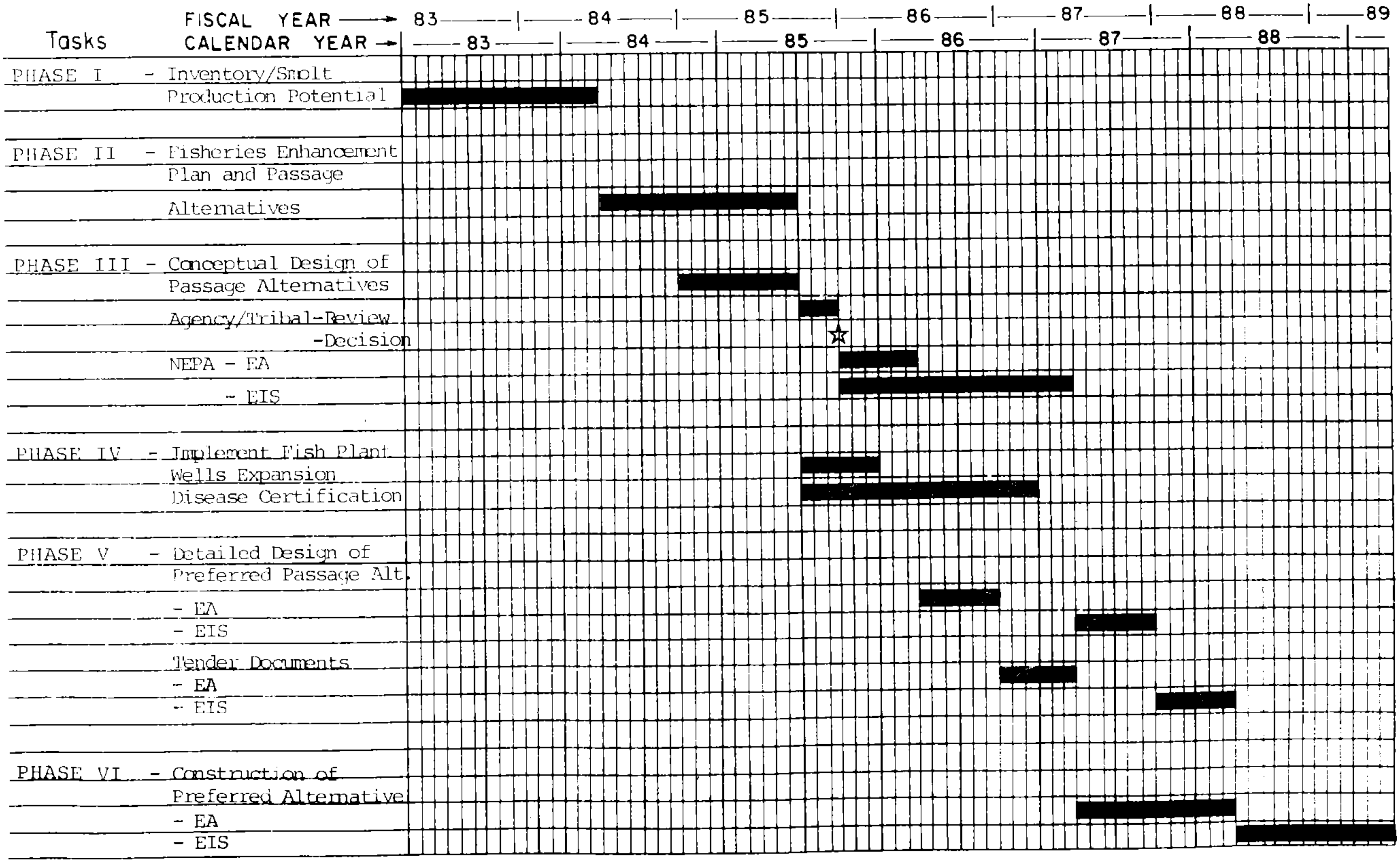
A preliminary schedule for the fish passage project is presented below (Figure 1-3). Several key milestone events are optimistically accounted for including a possible FERC hearing and the hydropower option, Wells Hatchery expansion and fish disease certification. The fall of 1985 is scheduled for arriving at the decision on the mode of passage.

To address concerns about the water quality in the Similkameen River and its tributaries, an extensive review and summary of existing water quality data from government monitoring agencies was conducted. The large volume of data for the system clearly demonstrates that there are no persistent physical, chemical or microbial characteristics that impose any constraints on introductions or survival of steelhead or other freshwater aquatic organisms to the system. Only occasional minor excursions outside of desirable ranges have occurred at some locations. Nutrient availability is low and may limit aquatic productivity.

A brief review is presented of the U.S., Canadian and international agencies with administrative responsibilities for water resource management in the Similkameen basin.

Figure 1.3

Proposed Project Schedule



As is the requirement for any significant U.S. government action, the NEPA process was begun to assess the potential environmental impacts that would arise from any of the six alternative modes of fish passage over Enloe Dam. At this stage the level of assessment is quite preliminary and is represented in Section 8.0 as basically a scoping document for either an environmental assessment or an environmental impact statement (depending on the severity of the impacts and the nature of the actions).

2.0 INTRODUCTION

In the fall of 1905, the Similkameen Falls Power and Development Company acquired the water rights to the Similkameen River (Bureau of Reclamation, 1976). However, it wasn't until between 1916 and 1923 that the 54 foot high Enloe Dam and hydroelectric facility were constructed by the Okanogan Valley Power Company (Eugene Enloe, President) at river mile 8.8. The rights of this company were subsequently transferred to the Okanogan Public Utility District, the present owner of the dam. Power was generated from the facility until 1959, at which time its operation was deemed economically unfeasible. In 1978, Enloe Dam and its powerhouse were listed on the National Register of Historic Sites (Bureau of Reclamation, 1979).

Since Enloe Dam was not provided with fish passage facilities, discussions among the various Canadian and U.S. agencies on providing passage have occurred since the 1920's without success (Wahle, pers. comm., 1983). The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (the Northwest Power Act) permitted the adoption of recommendations put forth by the U.S. federal and state fish and wildlife agencies, Indian Tribes and other interested parties intended "to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries" (Northwest Power Planning Council, 1982). The Act also gave the Bonneville Power Administration (BPA) the authority and responsibility to use its legal and financial resources "to protect, mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project on the Columbia River and its tributaries in a manner consistent with . . . the program adopted by the Council . . . and the purposes of this Act."

As a result of the recommendations requested by the Northwest Power Planning Council, the Council's Columbia River basin Fish and Wildlife Program (1982) commits Measure 704 (e) (i), Table 5(A) to removal or laddering of Enloe Dam, providing access for anadromous salmonids to many miles of spawning and rearing habitat in the upper Similkameen River watershed. Completion of Enloe Dam passage and establishment of an anadromous fish run in the Similkameen River basin would be considered as off-site mitigation for juvenile fish losses occurring on the mainstem Columbia River.

IEC BEAK Consultants Ltd. was engaged by BPA (Contract No. DE-AC79-83BP11902) in 1983 to conduct Phase I of a multi-phase program, intended to achieve the Council's goal of fish passage and anadromous salmonid production above Enloe Dam and fulfill Measure 704 (e) (i), Table 5(A) of the Fish and Wildlife Program.

The first phase, entitled "1983 Similkameen River Habitat Inventory for Enloe Dam Passage (Project 83-477)" is presented in two volumes, the main report (Volume I) and appendices (Volume II).

In fiscal years 1984 and 1985 IEC BEAK Consultants Ltd. was contracted to complete several additional project phases which include:

- o Fisheries enhancement plan;
- o Conceptual design of passage alternatives; and
- o NEPA baseline assessment of passage alternatives

The following report presents the results of studies completed in fiscal years 1984 and 1985. This draft will be submitted in July 1985 to the agencies and Tribes for their review and comments regarding the fisheries enhancement plan and passage alternatives. The final report will be completed by 31 December 1985.

3.0 THE SIMILKAMEEN RIVER BASIN, A PERSPECTIVE

3.1 Overview

The Similkameen River basin drains approximately 9600 sq km of the Pacific Northwest, of which 7600 sq km are located in Canada. Only statistics on the Canadian section of the basin have been used in this brief sketch. This was done for convenience as that data was readily available from Canadian sources, and no simplified and comparable data was equally accessable for the U.S. portion.

From the Cascade Mountains, the Similkameen River flows north through Manning Park to Princeton (Figure 3-1). At Princeton, the Similkameen meets its major tributary, the Tulameen River. It then flows southeasterly to its confluence with the Ashnola River. From this point the river continues to Keremeos and turns south to cross the international border near Nighthawk, Washington. The Similkameen on its final reach flows east for 40 km where it joins the Okanogan River at Oroville, Washington. In total the Similkameen traverses over 200 km from its source to its mouth.

The Similkameen River basin has had a prominent involvement in the historical development of British Columbia. As a consequence of the Oregon Treaty of 1846, all lands south of the 49th parallel came under the jurisdiction of the United States. In response to the need for an all-Canadian route to B.C.'s eastern interior fur trade, the Hudson's Bay Company established a route from Fort Langley to Kamloops in 1849. This new route incorporated the previously unknown headwaters of the Tulameen and Similkameen Rivers. Later in 1860, a route through Allison Pass to the Similkameen valley was developed which was to become the current route of Provincial Highway 3 (Sherwood, 1983).

The Similkameen basin experienced its first major influx of population during the 1850's as a consequence of American placer gold prospectors travelling through the basin to the gravel bars of Yale, Boston Bar and Lillooet on the Fraser River. Cattle ranching was also introduced to the Princeton area during this period while mixed agriculture was begun by the Hudson's Bay Company in Keremeos.

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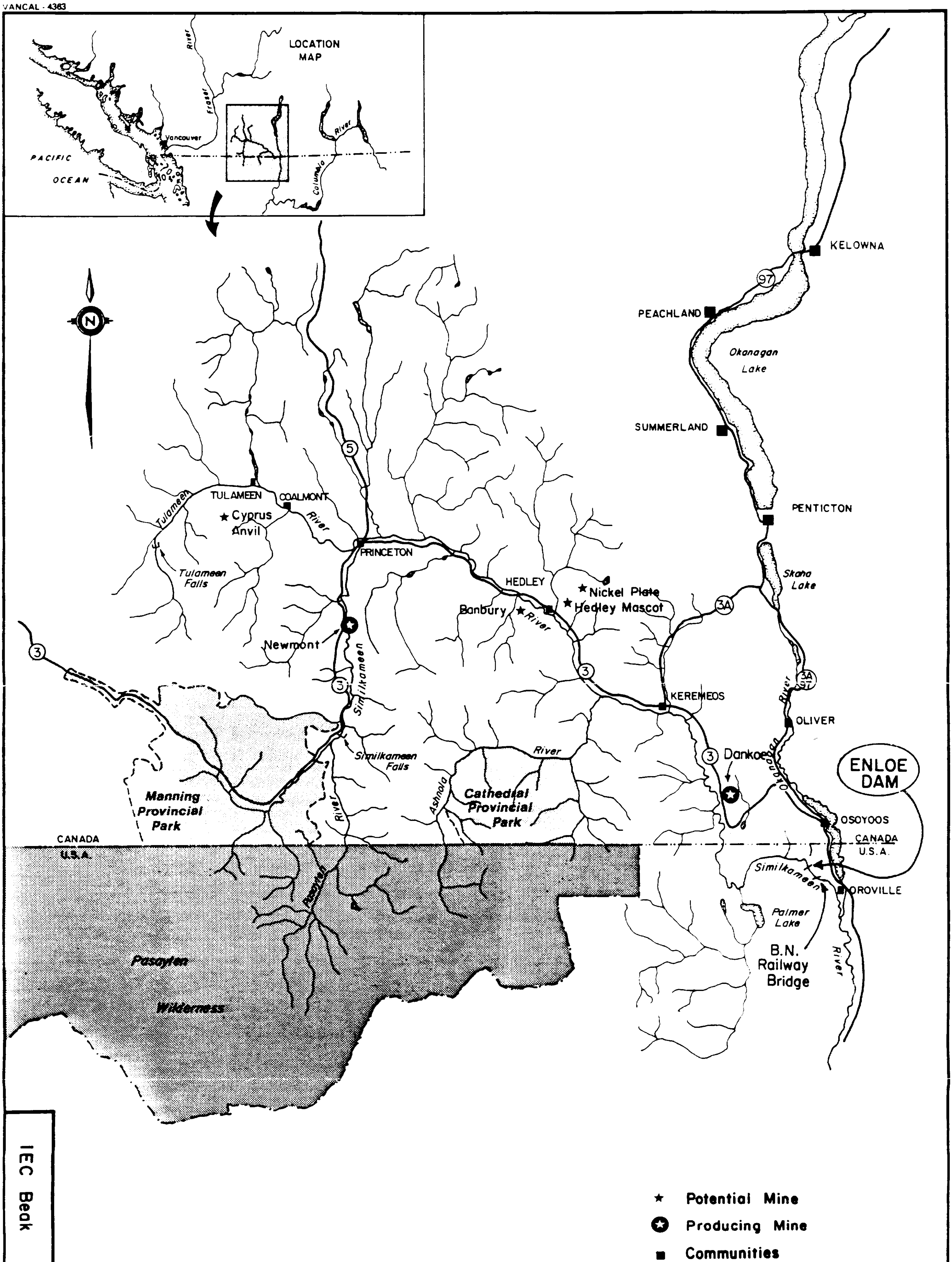

Figure 3-I General Site Plan

SCALE 1:600,000

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From 1860 to 1870, mining opportunities significantly increased in the area around Princeton. Placer gold was discovered in Granite Creek in 1885 and was later taken from gravel bars along the Similkameen, Tulameen and lesser tributaries. Later in the 1900's two major hard rock mines were established - Copper Mountain (copper) and Hedley (gold).

Since the culmination of World War II, forestry, ranching, agriculture and mining have increasingly developed. These activities complemented by recreation/tourism as a consequence of the opening of the Hope-Princeton Highway (Provincial Highway 3) in 1949 are the key determinants of land use in the Similkameen River basin today (Sherwood, 1983).

3.2 Population Characteristics

According to the report by the Ministry of Environment (1984), Statistics Canada established the 1981 interim population for the basin to be 8,160 people which is a 6.2 percent increase over 1976 compared to a general provincial increase of 10.1 percent. Within the basin those areas dependent on mining or forestry (Princeton and Hedley areas) show greater population fluctuations than those agricultural areas around Keremeos and Cawston which tend to be more stable (Sherwood, 1983). Growth in the Princeton area is projected at 1.1 percent per year compared to 1.5 percent in the Keremeos area.

The labour force in the Princeton area is over 2,000 people which is the largest in the basin. The chief sources of employment are: agriculture, forestry, mining, the provincial government and the Princeton School District. In Keremeos, the labour force is employed chiefly in agriculture related to fruit farming and ranching.

Two Indian Bands have a total of 22 reserves in the basin. The Upper Similkameen Band has an on-reserve population of 33 and the lower Similkameen Band has 179 individuals on-reserve and 31 off-reserve. The Bands are involved in a limited amount of ranching, farming and logging (Sherwood, 1983). Total reserve land for the two Bands is approximately 14,200 hectares. The majority of these lands are located downstream of Hedley.

3.3 Agriculture

Historically, fur trading, mining and the railway provided the original impetus for the development of agriculture in the Similkameen basin. By 1930, cattle ranching had developed in the Princeton area, while the Similkameen valley south of Hedley had become an important tree fruit producing region. Higher yields resulted after World War II with the introduction of intensified orchardry practices and other technological advances. Today, agriculture is ranked as one of the most important industries in the basin in terms of employment and value produced. In addition, agriculture provides important secondary economic activities including processing, packing, cold storage, shipping and service related industries (Sherwood, 1983). Between 1971 and 1981 there has been an increase in the number of farms from 284 to 350. The increase is due to growth in the number of fruit and vegetable, poultry and dairy farms. The number of farms classified as producing cattle have remained unchanged while field crop operations declined (Ministry of Environment, 1984).

The southern Similkameen valley is one of the hottest and driest areas in Canada. The valley produces such crops as apples, cherries, apricots, plums, peaches, melons, grapes, tomatoes, onions, sweet corn and cucumber. Vegetable production has recently declined due to high packaging and transportation costs, and a decline in the acreage of most fruit trees (except cherries and apricots).

Grape production has also become prominent during the 1970's in the Cawston-Keremeos-Oliver-Osoyoos region. The future promotion of small cottage wineries may provide an incentive to small growers to improve their stock and expand acreage. Five commercial vineyards currently operate.

The most significant limitations to agriculture in the basin are adverse topography, lack of rainfall, stoney soil as well as the low moisture-holding capacity of the soil. These limitations are however counter-balanced by the long frost-free growing seasons and warm summer temperatures which characterize the basin. Most of the arable land is found in valley bottoms (Ministry of Environment, 1984).

Ranching constitutes the second most important agricultural activity in the basin. The larger areas of open and semi-open grasslands found at lower elevations in the basin provide ideal range for cattle. As a consequence of logging at higher elevations, summer range lands are also expanding. The Hereford cattle and race horses raised in the Princeton area have a notable reputation in both B.C. and Alberta. The general outlook for the beef cattle industry is for higher prices which will provide incentives for producers to expand their herds. Such expansion opportunities will however, be moderated by a shortage of groundwater for irrigation and spring range (Ministry of Environment, 1984).

3.4 Forestry

Forestry has historically constituted a major element of the economy of the basin. Originally in the 1800's, local mills supplied rail ties for the construction of the Canadian Pacific Railway. As in the case of agriculture, World War II provided a major impetus for the technological advancement of small log harvesting and milling in southern B.C. Today forestry and related industries is the region's major employer (Sherwood, 1983).

The basin lies in the southwestern corner of the Kamloops Forest Region which contains two Public Sustained Yield Units (PSYU) - Similkameen and Ashnola. Approximately 80 percent of the Similkameen PSYU is forested and most of this forested land is productive. It should be noted that less than 20 percent is considered good site and 54 percent is considered medium site. Dominant species in the Similkameen PSYU are: spruce, lodgepole pine, Douglas fir and balsam. While 70 percent of the Ashnola PSYU is productive forest, less than 1 percent is classified good site and 28 percent is considered medium site. The major species logged in the Ashnola PSYU is lodgepole pine, and to a much lesser extent Douglas fir and balsam (Sherwood, 1983).

The largest employer in the region is Weyerhauser Canada Ltd. which operates a sawmill in Princeton with over 350 employees. This particular mill produces over 195 million board feet annually. Also, several smaller mills operate in the basin and supply assorted lumber products to local markets. There are no definite plans for construction of a pulp or groundwood mill in the basin over the next decade (Ministry of Environment, 1984).

3.5 Mining

The Similkameen basin is part of a highly mineralized area which contains several commercial deposits of copper, gold, silver, lead and zinc as well as reserves of low-sulphur thermal coal in the Tulameen area. Currently, there is only one major producing mine located at Copper Mountain and operated by Newmont Mines Limited. The re-activated Copper Mountain property is located on the east side of the Similkameen River while the existing concentrator is on the west side. Ore is now carried across the canyon by a suspension bridge to the concentrator. Mine tailings are slurried back to a pond on the east side. Water is reclaimed and pumped back for reuse at the concentrator. The present operation involves three open-pits with annual production of about 7 million tonnes. Reserves estimated at the end of 1980 are about 120 million tonnes which are adequate for approximately 20 additional years of production. The operation employed 225 people after a lay-off in 1982 (Sherwood, 1983).

The Norm Silver property, operated by Dankoe Mines Limited has historically been a small but notably producing mine. The mine was started over 80 years ago, producing silver, gold and some lead and zinc. The mine has been in production intermittently in recent years.

A mine that appears to be close to production is the gold property near Hedley held by Banbury Mines Limited. In addition, Mascot Gold Mines and GM Resources have undertaken considerable exploration and development work at their Nickel Plate Mountain property since the early 1970's. The Global/Cominco property near Summers Creek is reported to be a fairly significant deposit of copper. In the late 1970's exploration and planing was active on the Cyprus-Anvil Tulameen thermal coal project. Over the last several years this activity has subsided and nothing is known regarding future plans for the deposit.

3.6 Tourism, Recreation and Parks

Tourism in the Similkameen region was originally facilitated by the opening of the Hope-Princeton Highway in 1949. For many tourists, the Similkameen valley constitutes a route from the coast to other destination points in southern B.C. and Alberta. As a consequence, much of the tourist service industry caters primarily to the overnight trade. Summer tourist activities can now include hiking, camping, canoeing, nature observation, fishing, horse riding, hunting, rockhounding as well as visiting historical sites. In the winter, the basin offers such opportunities as alpine skiing, snowmobiling and nordic skiing (Sherwood, 1983).

The basin offers many wilderness campsites, commercial resorts, motels, trailer parks and private campgrounds along the highway. There are two lodges along the Hope-Princeton Highway, Manning Park Lodge and Gateway Lodge. Cathedral Lakes Resort Ltd. operates a lodge and cabins on Quiniscoe Lake in Cathedral Provincial Park. Provincial parks in the basin offer camping facilities for the vehicle camper while less developed facilities are provided by the Ministry of Forests in backroad areas (Sherwood, 1983). Manning Provincial Park has special facilities for visitors interested in nature observation during summer months (Outdoor Recreation Council of B.C., 1984). There are over 100 lakes in the Princeton area and over half are regularly stocked with rainbow trout (Outdoor Recreation Council of B.C., 1984).

Many of the ridges at upper elevations are ideal for horseback riding and a significant number of backcountry trails are available. The upper ridges surrounding Princeton also provide some good hunting terrain. Game animals in the basin include whitetailed deer, mule deer, elk, black bear, mountain goats, moose, grouse and ptarmigan (Outdoor Recreation Council of B.C., 1984).

There are ten provincial parks in the basin. Manning Park is the largest, most accessible and popular of the parks in the region with 70,000 hectares and is equipped for numerous tourist attractions. Cathedral Provincial Park is approximately half the size of Manning and is located in the Okanogan Range. The remaining parks are much smaller and are spread about the basin.

4.0 FISHERIES CONSIDERATIONS

It is not the intention of this report to choose among the several possible options for anadromous fish introductions to the upper Similkameen River. Rather it is the intention to report the results of several investigations that address issues of concern that were raised in the consultative program with the various agencies and Tribes with interests in these matters. The report attempts to address these issues in such a manner that decision makers may have a more complete understanding of some of the ramifications and complexities that surround their decisions regarding a future course of action.

In this section of the report information and analysis is presented on the Wells Hatchery summer steelhead stock, including its characteristics, availability and disease history as well as estimates of steelhead production potential in the river, juvenile mortality, adult return rates, harvest, escapement and supplemention with hatchery smolts, run strength projections and benefits. In addition, considerations are presented that deal with stocking strategy, adult migration timing and potential sport fishery, harvest management and a disease profile of other anadromous fish stocks in the area.

4.1 Description Of The Wells Hatchery Summer Steelhead Stock

When initial considerations were emerging for the introduction of steelhead trout to the Similkameen River above Enloe Dam it became apparent that the most promising source of a stock would be from the Wells Hatchery. The basic reasons were potential availability, general genetic history, present and historical distribution, and the absense of other stocks that met these general criteria in either the U.S. or Canada. This general impression was confirmed in consultation with specialists in the U.S. and Canadian agencies and thus a more detailed assessment of the Wells stock was undertaken. This section reports the findings of that assessment.

Relevant information on the Wells Hatchery summer steelhead stock is contained in a BPA publication entitled, "Columbia River Anadromous Salmonids, Volume III - Steelhead Trout", prepared by the Oregon Department of Fish and Wildlife, the

Washington Department of Fisheries, the Washington Department of Game and the Idaho Department of Fish and Game (1984a). For more detail on the information presented, please refer to the above publication.

4.1.1 History Of The Stock

The Wells stock was developed in the early 1960's at the Wells Hatchery located at Wells Dam on the Columbia River (RM515.6). Eggs were formerly collected at Priest Rapids Dam (RM397) and Wells Dam from wild summer steelhead stocks destined primarily for spawning areas above Priest Rapids Dam. Additional collections were made from Skamania and Yakima stocks (S. Roberts, pers. comm., 1983). Since 1974, fish have been collected at Wells Dam and spawned at Wells Hatchery.

4.1.2 Stock Characteristics

Wells stock adults migrate over Bonneville Dam from July through September, pass Priest Rapids Dam between mid-August and mid-October and reach Wells Dam between late August and early November. The peak of the run at Wells Dam occurs in September and October (K. Williams, pers. comm., 1984).

Wells stock summer steelhead return to the upper Columbia River predominantly as 1- and 2-ocean adults averaging 61.9 and 72.9 cm in length and 2.4 and 4.0 kg in weight, respectively. In several age composition studies conducted from 1978 to 1982, only 2 life history categories were identified. They were found to be age 1.1 and 1.2. A study by Williams (1984b) determined 14.5% of the returning hatchery adults had residulized in freshwater for at least 1 year following their release. He suggested the previous age analyses were incorrect in classifying all steelhead with freshwater ages of 2 or more years as wild-origin. He also noted that two 3-ocean fish he identified were the first observed in the Wells stock and were likely the product of abnormally low marine growth rates. No repeat spawners have ever been found among Wells steelhead sampled above Priest Rapids Dam.

The variable dominance of 1- versus 2-ocean return is characteristic of the Wells stock. The factors responsible for this variation are presently unknown but appear to be independent of flow conditions.

The male/female ratio of the Wells stock is 0.95 (47.5:52.5). In 1978, a 2-ocean dominant run, 139 females spawned at Wells Hatchery averaged 6,795 eggs per female while in 1979, a 1-ocean dominant run, 185 females averaged 5,458 eggs per female.

Wells stock juveniles are released in late April and early May at a size of 11-15 per kilogram. The peak movement of smolts over Priest Rapids Dam occurs in mid-May and Wells outmigrants typically arrive at the Columbia River estuary by the end of May.

Of the hatchery-origin adults returning in 1982, 86% reared in freshwater for one year while the remainder residualized in freshwater for an additional 1 to 3 years. The lower Methow River and Wells Reservoir are believed to be the principal areas utilized by residual Wells stock juveniles.

Loeppke et al. (1983) investigated eight enzyme systems of both hatchery and wild Wells stock spawners and guardedly concluded that the two stocks were genetically indistinguishable. Their conclusion is reasonable considering that some wild fish are used as broodstock at Wells Hatchery and that Wells stock steelhead likely interbreed with wild fish in the natural environment. It should be noted however, that tissue sampling for electrophoresis was biased toward the early portion of the run, and some fish identified as wild-origin may have been residual hatchery steelhead that had spent at least 2 years in freshwater prior to outmigrating. These factors, in addition to the fact that wild broodstock at Wells Hatchery tend to be brighter and later maturing than hatchery fish, indicate that the Wells Hatchery stock may differ in certain genetic characteristics from upriver wild stocks.

4.1.3 Present Status Of The Stock

The summer steelhead rearing and release program at Wells Hatchery has been extremely successful despite the nine mainstem dams that the fish must pass (K. Williams, pers. comm., 1984). A good water source, careful hatchery techniques, thorough disease monitoring and genetic adaptation to the remaining accessible portion of the upper Columbia River are major factors contributing to this stock's success.

The adult returns to Wells Dam have increased since 1978 from about 1600 to over 20,000 in 1983 and 17,000 in 1984 (Table 4-1). Because of the success at Wells Hatchery, it provides sufficient eggs to several Columbia River system facilities to annually release approximately 1,000,000 summer steelhead smolts.

Data for steelhead returns to Wells Dam from smolts released above Wells indicate that fishing rates of between 20 and 68 percent (of fish counted at Wells Dam) have occurred (Table 4-2). This harvest has not hindered hatchery acquisition of broodstock or the provision for increasing escapement. Smolt-to-adult survival rates of smolts planted upstream of Wells Dam presented in Table 4-3 are quite high (2.92 in 1978) in comparison to other upriver stocks, especially during recent years of favourable river flows in the Columbia River. Smolt to adult survival rates averaged 1.52% for the period 1972 to 1981. The percent return rate for 1982, based on the 16,443 1-ocean component returning in 1983 is expected to exceed 4.6%.

4.1.4 Hatchery Production

The spawning of summer steelhead at Wells Hatchery begins in early January, peaks in late January-early February and is completed by early March. Wild fish are often included as broodstock, but they tend to ripen later than hatchery fish.

Steelhead spawned at Wells are reared at Chelan Falls, Leavenworth, Naches and Lyons Ferry hatcheries in addition to Wells. Approximately 1.1 million Wells smolts are released annually.

4.1.5 Availability

The Wells Hatchery has planted summer-run steelhead trout in the Similkameen River in the early 1970's and in 1983, 1984 and 1985. The hatchery presently has the capability of supplying approximately 100,000 steelhead smolts annually for planting in the Similkameen River (K. Williams, pers. comm., 1984). Wells Hatchery also has the ability to provide a much greater number of juveniles at other life stages such as fry or parr if the rearing of the fish to smolt size is not required.

TABLE 4-1
Counts of Adult Steelhead at Wells Dam, Washington, 1978-1984

YEAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1978	177	32	12	399	432	528	---	1580
1979	72	2	22	1212	938	1040	355	3641
1980	202	24	15	382	1404	1358	413	3798
1981	139	23	107	623	1902	1401	513	4708
1982	149	7	67	1042	2766	3733	730	8494
1983	26	2	135	1891	11368	5294	1327	20043
1984	153	32	766	5024	7235	3298	778	17286

Note: Approximately 95 percent of the run over the Wells Dam is of hatchery origin.

Source: Unpublished data obtained from Ken Williams, Washington Department of Game (1985).

TABLE 4-2
Harvest, Escapement and Fishing Rate Above Wells Dam of Summer Steelhead Trout, 1967-1983

Year	Dam Count	Catch: Methow	Okanog.	Similk.	Wells Pool	Total	Escapement	Fishing Rate (%)
1967	1410	212	100	24	116	452	958	32
1968	2175	428	22	0	235	685	1440	32
1969	1464	199	0	0	109	308	1156	21
1970	1588	358	29	7	196	590	998	37
1971	3777	764	70	27	419	1280	2497	34
1972	1876	588	14	8	332	932	944	50
1973	1832	565	4	14	310	893	939	48
1974	479	62	2	0	34	98	381	20
1975	516	109	2	0	60	171	454	33
1976	4643	1616	8	0	886	2510	2133	54
1977	5324	1773	9	0	972	2754	2570	52
1978	1580	636	4	0	349	989	591	63
1979	3641	1170	10	0	641	1821	1820	50
1980	3426	1501	0	10	823	2334	1092	68
1981	4097	1674	3	0	265	1942	2155	47
1982	7929	1529	6	13	2124	3672	4257	46
1983	19413	5824	34	17	4640	10464	8949	54

Source: Unpublished data obtained from Ken Williams, Washington Department of Game (1985).

TABLE 4-3
Smolt-to-Adult Survival Rates of Wells Stock Steelhead Juveniles Planted Above Wells Dam, Washington, 1972 through 1981

Release Year	Smolts Released	1-Ocean Component	2-Ocean Component	Total Return	Percent Survival
1972	327,902	1,451 (1973)	569 (1974)	2,020	0.62
1973	146,880	170 (1974)	134 (1975)	304	0.21
1974	182,111	608 (1975)	1,046 (1976)	1,654	0.91
1975	249,279	3,934 (1976)	1,364 (1977)	5,298	2.13
1976	238,405	4,321 (1977)	1,665 (1978)	5,986	2.51
1977	172,978	271 (1978)	160 (1979)	431	0.25
1978	164,259	3,848 (1979)	950 (1980)	4,798	2.92
1979	268,252	2,848 (1980)	4,415 (1981)	7,263	2.71
1980	471,420	332 (1981)	7,412 (1982)	7,744	1.64
1981	358,234	1,107 (1982)	3,610 (1983)	4,717	1.32
1982	354,436	16,443 (1983)			
1983	494,784				
1984	492,558				
				Mean	1.52

1 Unpublished data obtained from K. Williams, Washington Department of Game (1985).

With a proposed expansion of the Wells Hatchery, slated for 1985 - 86, the number of smolts available to the Similkameen River could reach 250,000 (K. Williams, pers. comm., 1984). The programming of hatchery production to produce more fry or parr would also be possible.

4.1.6 Suitability

The Wells Hatchery summer steelhead stock has been successful since its development in the late 1960's. The original broodstock was from stocks that were destined to spawn upstream of Priest Rapids Dam and are therefore suitably adapted to the environmental conditions of the upper Columbia River.

The Wells Hatchery is the furthest upstream hatchery facility in the Columbia River (RM 515.6) and despite the travel distance and the eight other mainstem dams the fish must pass, the run has been building. It is obvious that the donor stock for the Similkameen River must have these traits if a Similkameen River run is to be successfully initiated.

The genetic composition and fitness for the upper Columbia River region and the exceptional disease history, along with the availability of juveniles for stocking, confirms that the Wells summer steelhead stock is the most suitable candidate to be the donor stock for the Similkameen River. In addition, the economics and logistics of transporting juveniles from Wells Hatchery are the most favourable since it is the closest hatchery facility to the Similkameen River basin.

4.2 Stocking History Of Wells Hatchery Steelhead Stock

Juveniles of Wells Hatchery summer steelhead trout are reared at Wells, Chelan Falls, Leavenworth, Naches and Lyons Ferry hatcheries in Washington State (ODFW, WDG, WDF and IDFG, 1984a). Approximately 1.1 million Wells smolts are released annually from these facilities. The Methow and Similkameen Rivers receive a total of 450,000 smolts from Wells Hatchery. The Wenatchee and Entiat Rivers receive 250,000 smolts from Chelan Falls Hatchery (RM 503). The Wenatchee River also periodically receives 100,000 fish from the Leavenworth National Fish Hatchery (on the Icicle River, a

Wenatchee River tributary). The Walla Walla, mainstem Snake, Tucannon and Grande Ronde Rivers and Asotin Creek receive a total of 300,000 smolts from Lyons Ferry Hatchery (Snake RM 63). Other tributaries to the Columbia River in Washington State which have received Wells stock smolts since 1970 include the Big White Salmon, Washougal and Yakima Rivers and Crab and Foster Creeks (ODFW, WDG, WDF and IDFG, 1984a). The Wells stock is, therefore, distributed in the Columbia River from the Big White Salmon River (Columbia RM 168.3) upstream to the Grande Ronde River (Snake RM 168.9) and in the Similkameen River, a tributary to the Okanogan River (Columbia RM 533.5).

A summary of the summer steelhead stock plantings from the Wells Hatchery since 1972 are presented in Table 4-4.

4.3 Disease History Of Wells Stock

The disease history of the Wells summer steelhead stock could be characterized as problem-free until 1983 and 1984 (Roberts, 1985, Appendix 3). Infectious pancreatic necrosis (IPN) virus has been detected at a low level (less than 1%) at the Wells Hatchery during the two-year period (ODFW, WDF, WDG and IDFG, 1984). Tag data suggests that the infected fish were not of Wells origin. All eggs from the infected fish were destroyed. Production fish at Wells Hatchery have never been diagnosed as carriers of IPN. In addition, no IPN outbreaks have ever occurred at the Wells Hatchery or any other Washington Department of Game hatchery (Roberts, 1985, Appendix 3). Bacterial kidney disease (BKD) has also been isolated from smolts at a low level. The spore stage of Ceratomyxa shasta has been observed in adult summer steelhead but the infective stage has not been found in the upper Columbia River system (Roberts, 1985). No outbreaks of bacterial diseases have ever been diagnosed at Wells Hatchery (Roberts, 1985, Appendix 3). Viral disease tests in 1985 on Wells summer steelhead were negative (Hopper, 1985).

TABLE 4-4
Summary of Wells Summer Steelhead Stock Plantings
From Wells Hatchery, 1972-1984

Year		Released	Stream
1972		197,745	Methow River
		12,334	Similkameen River
		117,823	Okanogan River
	Total	327,902	
1973		28,330	Columbia River (Chelan)
		118,550	Methow River
		47,666	Okanogan River
		4,386	Similkameen River
	Total	146,880	
1974		38,038	Columbia River
		144,073	Methow River
	Total	182,111	
1975		31,857	Columbia River
		2,110	Foster Creek
		215,072	Methow River
		20,050	Below Bonneville
		15,075	Washougal River
	Total	284,404	
1976		36,514	Columbia River
		201,891	Methow River
		23,825	Below Bonneville
		14,471	Washougal River
	Total	276,701	
1977		147,922	Methow River
		25,056	Ringold
	Total	172,978	
1978		60,903	Columbia River (Turbine Study)
		23,767	Columbia River
		59,145	Methow River
		20,444	Methow River (Control)
		19,295	Ringold
		20,056	Below Bonneville (Barge)
		19,466	Below Bonneville (Truck)
	Total	223,076	

TABLE 4-4 (Continued)
Summary of Wells Summer Steelhead Stock Plantings
From Wells Hatchery, 1972-1984

Year		Released	Stream
1979		64,884	Columbia River
		183,955	Methow River
		19,413	Methow River (Control)
		10,326	Bonneville (Truck)
		18,489	Bonneville (Barge)
	Total	297,067	
1980		268,371	Columbia River (Turbine Study)
		23,505	Columbia River
		179,544	Methow River
	Total	471,420	
1981		358,234	Methow River
1982		15,016	Chewack River (Methow system)
		299,414	Methow River
		25,004	Methow River (Test)
		25,036	Columbia River (Priest Rapids)
		15,002	Twisp River (Methow System)
	Total	379,472	
1983		16,368	Chewack River (Methow system)
		13,086	Columbia River
		20,259	Methow River (Control)
		328,444	Methow River
		16,988	Twisp River
		99,639	**Similkameen River**
		22,379	Columbia River (Priest Rapids)
	Total	517,163	
1984		19,995	Chewack River
		14,336	Twisp River
		356,134	Methow River
		76,080	**Similkameen River**
		24,923	Columbia River below Priest Rapids (Water Budget)
	Total	491,468	
1985		55,534	**Similkameen River**
		36,000	Columbia River (Priest Rapids)
		326,687	Methow River
		36,990	Columbia River (at Wells Hatchery)
	Total	455,211	

Source: Unpublished data obtained from Ken Williams, Washington Department of Game (1985).

4.4 Life Histories Of Other Upper Columbia River Summer Steelhead Stocks

The life histories and general behaviour of other upper Columbia River wild summer steelhead stocks may be useful in predicting how steelhead trout planted in the Similkameen River system might behave. The three river systems in the upper Columbia River drainage nearest to the Similkameen River are the Wenatchee, Entiat and Methow. The life histories of the wild steelhead runs to these systems is presented in a BPA publication entitled "Stock Assessment of Columbia River Anadromous Salmonids, Volume III - Steelhead Trout (ODFW, WDF, WDG and IDFG, 1984a). Table 4-5 presents a summary of the information available on these three stocks.

It is evident, from the data available, that the life histories of the upper Columbia River stocks are almost identical. Exceptions which occur include the variable dominance of 1- or 2- ocean returns and the larger percentage of age 3 and 4 juvenile outmigrants from the Methow River. The reason for the variable dominance of ocean residency is unknown (K. Williams, pers. comm., 1983). However, the additional freshwater rearing time may be attributable to the cold, unproductive water in the Methow River drainage (K. Williams, pers. comm., 1983).

It is reasonable to expect that the general behavior and life history of Similkameen River steelhead trout would follow closely those of other upper Columbia River runs, especially the Methow River whose physical characteristics most closely resemble portions of the Similkameen River. Further evidence for similar life histories stems from the origin of the Wells Hatchery stock which was developed in the late 1960's from wild summer steelhead stocks destined to spawn upstream of Priest Rapids Dam. Some of the original stock that were used to establish the Wells Hatchery stock could have been wild fish from any one or all three of these rivers and also likely from the Columbia mainstem. It is felt that these up-river stocks are most likely to be the best suited for the present conditions prevalent in the accessible upper Columbia River basin.

TABLE 4-5
Life History Summary for Upper Columbia River Wild Summer Steelhead Stocks

Stock	Entry Timing				Spawning Timing			Age at Maturity (%)			Juvenile Migration Timing			Age at Migration (%)			Length at Outmigration (mm)
	Columbia River	Home Stream Start	Home Stream Peak	Home Stream End	Start	Peak	End	1-Ocean	2-Ocean	3-Ocean	Start	Peak	End	2	3	4	
Wenatchee River (wild)	June-Aug.	mid-Aug.	late Sept.	early Nov.	Mar.	early May	June	65	32	3	early Apr.	early May	mid-June	87	13	-	170-200
Entiat River (wild)	June-Aug.	mid-Aug.	late Sept	early Nov.	Mar.	early May	June	88	12	-	mid-Apr.	-	early June	100	-	-	170-200
Methow River (wild)	June-Aug.	mid-Aug.	-	early Nov.	Apr.	-	May	-[a]	-[a]	-	Apr.	mid-May	early June	71	25	4	170-200

[a] 1-ocean/2-ocean dominance often occurs.

Source: ODFW, WDF, WDG and IDFG, 1984a.

4.5 Estimated Summer Steelhead Production For The Similkameen River

The intention of this assessment was to provide estimates of what the Similkameen River and its tributaries would be capable of producing in the way of summer steelhead smolts and returning adults.

Steelhead trout production estimates were determined following an extensive habitat assessment in 1983 (IEC BEAK Consultants Ltd., 1984) and by application of the Slaney Steelhead Production Model (Slaney, 1981). The model was used to predict both mean annual smolt yield/m^2 and mean adult steelhead return for each river reach within the study area. The rates of 1.5% mean and 4.0 % maximum smolt-to-adult survival rates were used to bracket the adult returns to be expected for the number of smolts produced. These survival values were derived from observed rates of Wells Hatchery stock in the Methow River by Washington Department of Game (K. Williams, pers. comm.,1983).

An additional method for calculating potential production estimates was utilized. This method involved using the spatial requirements of juvenile steelhead, ranging from 14.49 m^2 for age class 1+ to 26.14 m^2 for age class 2+ juveniles (Reiser and Bjornn, 1979). The spatial requirement was then divided into the total (gross) wetted stream area to obtain the number of smolts that could be produced from the system. Adult returns were also calculated using 1.5% and 4.0% smolt-to-adult survival rates.

The Slaney Steelhead Trout Model predicts that a total of 609,600 smolts would be produced by the Similkameen River study area. The main adult return, at 1.5% smolt-to-adult survival, would be 9,150 and at 4.0% survival, 24,400.

Slaney's model predicts that over 33% (205,021) of the steelhead smolts produced in the entire drainage would be produced in the mainstem Similkameen River, between Keremeos and Princeton, B.C. Almost 80% (475,347) of all the steelhead smolts produced in the system would emanate from the Similkameen River below Similkameen Falls. Of the remaining smolt production, a predicted 9% (55,337) would be produced from the Tulameen River, 4% (26,199) from the Ashnola River, 4% (21,842) from Sinlahekin Creek (Palmer Lake system), 3% (17,152) from the

Similkameen River above the falls and 2% (11,441) from the Pasayten River. A total production of 28,593 (5%) smolts is predicted from Similkameen River system above Similkameen Falls.

Adult steelhead escapement to the Similkameen River was estimated from the number of smolts determined by Slaney's model and using smolt-to-adult survival rates. Using the number of smolts predicted by Slaney's model, and applying a 1.5% smolt-to-adult survival rate, the estimated number of adults returning to the Similkameen River would be 9,150. Seventy-one hundred of these fish, almost 80% of the total run, would return to the area downstream of the Similkameen Falls. Of the approximately 830 steelhead adults predicted to return to the Tulameen River, almost half of these would return to the first reach, near Princeton, B.C. About 390 steelhead would return to the Ashnola River, with the majority of these moving up into the higher reaches. Sinlahekin Creek would have an estimated adult return of 328. A predicted 258 steelhead adults would return to the Similkameen River, above the falls, distributed evenly throughout all reaches. Of these only an estimated 171 adults are predicted to return to the Pasayten River.

During an exceptional year, with 4.0% smolt-to-adult survival, close to 20,000 adult steelhead would be expected to return from smolts produced in the Similkameen River below the falls. There would be an almost 167% increase in adult returns in the entire system if smolt-to-adult survival increased from 1.5% to 4.0%. A total of approximately 24,400 spawners would return to the whole system.

In addition to the steelhead model calculations, steelhead smolt production was estimated by dividing the spatial requirements of age class 1+ and 2+ smolts, 14.49 m^2 and 26.14 m^2, respectively (Reiser and Bjornn, 1978) into the total area of the Similkameen River system assessed (10,402,947m^2). The range of optimal production was calculated to be from 397,970 to 717,940 smolts. This range is based only on the habitat that was assessed during the 1983 field season, therefore, these calculations do not take into account the minimum 98 miles (160 km) of the Similkameen River system that has not be assessed.

The estimated range of adult returns using these smolt production estimates would be between 5,970 and 10,769 steelhead at 1.5% smolt-to-adult survival. At 4% smolt-to-adult survival, this range would be from 15,919 to 28,718.

It was estimated in the habitat study that rearing habitat is the limiting factor that will establish the upper limit to steelhead trout production in the Similkameen River (IEC BEAK Consultants Ltd., 1984a).

4.6 Estimated Juvenile Passage Mortality Over Enloe Dam

To date, no downstream migrant studies have been conducted to determine mortality of steelhead smolts passing over the 54 foot high Enloe Dam on the Similkameen River. In the absence of power generation at Enloe (it ceased in 1959), juvenile mortalities that would result from passing over the dam could be considered similar to passage over a natural falls. Results from tests for White River, Oregon during high flows (300 to 600 cfs) in 1983 and 1984 indicated juvenile steelhead had 100 percent survival after passing over White River Falls, a drop of 140 feet into a plunge pool. It is reasonable to assume that juvenile mortalities at Enloe Dam would not be excessive for similar conditions.

4.7 Adult Return Rate Estimates

During seaward migration as juveniles and their return as adults, Similkameen River steelhead would encounter a total of nine hydroelectric dams on the Columbia River mainstem, in addition to Enloe Dam on the Similkameen River. Because of the mortalities associated with fish passage at these dams and their associated reservoirs, it must be questioned whether or not natural production of steelhead in the Similkameen River could be be self-sustaining at this time. It is prudent, therefore, to consider supplementing natural production with plants of hatchery-reared juveniles. The purpose of this study, as requested by Washington Department of Game, was to determine through mortality analysis the probable requirement for hatchery supplementation of natural steelhead production.

The study utilized existing information provided by the Washington Department of Game and other agencies involved in fishery resource investigations on the Columbia River.

Requirements for hatchery supplementation are expressed throughout this report as the number of yearling hatchery smolts. Though under-yearling juveniles may be utilized to some extent for the Similkameen project, the lack of information on their survival to adult return precluded consideration of under-yearling stocking in this study.

The analysis required information on the following primary subjects:

1. survival of hatchery-reared smolts from release to adult escapement;

2. the potential productivity of steelhead spawning naturally in the Similkameen River, i.e. the expected number of adults produced per spawner without the influence of dams; and

3. the rates of loss attributable to dams, including losses incurred on both the juvenile and adult migrations.

Information on points (1) and (2) was available for the analysis, but data on losses attributable to dams were extremely limited, particularly for mid-Columbia steelhead. This data gap necessitated development of a range of possible scenarios concerning rates of loss per dam, and exploitation by sport and Indian fisheries.

The following sections explain the derivation of the above parameters and the principal calculations employed.

4.7.1 Adult Returns per Spawner

The starting point was the development of an expected average return rate for natural spawning without losses related to dams. The adult return rate per spawner was calculated from data for mid-Columbia summer steelhead prepared by Washington Department of Game for presentation to Federal Power Commission proceedings (A. Eldred, pers. comm., 1985). These data span the 1950 to 1973 brood years and include estimates of wild steelhead escapements over either Priest Rapids or Rock Island Dams, as well as estimates of commercial and sport fishery harvests of mid-Columbia steelhead in the lower Columbia River (Table 4-6). A graphical plot of adult return against parent escapement shows considerable variability and no clear relationship (Figure 4-1). This reflects, at least partly, the decline in returns per spawner after the 1958 brood year, when successive construction of the Priest Rapids, Rocky Reach, Wanapum and Wells dams affected an increasing portion of the steelhead spawning and rearing habitat in the Columbia River mainstem.

Spawning escapements to the mid-Columbia also increased in the 1960's. This increase in spawners combined with the loss of mainstem habitat likely caused the pronounced decline in return per spawner through the 1960's (Figure 4-2). For this reason, only adult return rates for the first 9 brood years (1950-1958) have been used to develop an average return per spawner for use in the Similkameen analysis.

Adult returns per spawner from the 1950-1958 broods averaged 3.2:1. The highest return rates, 4.5:1 and 7.0:1 from the 1950 and 1956 broods respectively, were produced by the lowest escapements. As these high values tend to skew the distribution of return rates, the median return rate (2.7:1) was considered to be a more appropriate measure of central tendency in the data. For this analysis, however, a conservative value of 2.5 adult returns per spawner was adopted. The rationale for this choice is discussed later in the section.

Return rates of mid-Columbia steelhead are somewhat lower than those reported for all Columbia River steelhead stocks above Bonneville Dam, most of which were destined for the Snake River system (Chapman et al., 1982). As with mid-Columbia stocks, no clear spawner/recruit relationship is apparant in Columbia summer steelhead data, especially when brood years affected by McNary and The Dalles Dams (1951-1958 broods) are removed. The average and median pre-McNary return rates for all Columbia stocks, i.e. 1938-1950 broods, were 3.3 and 3.4:1 respectively. In comparing these return rates to those of mid-Columbia stocks it should be noted that

TABLE 4-6
Spawning Escapements and Subsequent Adult Returns of Wild, Summer Steelhead to the Mid-Columbia River Area 1950-1973 Brood Years[a]

Brood Year	Spawning Escapement[b]	Adult Return[c]	Return per Spawner
1950	2261	10226	4.52
1951	3591	4671	1.29
1952	3693	8745	2.37
1953	4986	13349	2.68
1954	6614	9790	1.48
1955	4780	14567	3.05
1956	2180	15302	7.02
1957	4885	14070	2.88
1958	7498	17039	2.27
1959	5077	9008	1.77
1960	7614	12764	1.68
1961	8625	18665	2.16
1962	8401	11013	1.31
1963	8581	16067	1.87
1964	5422	8531	1.57
1965	8321	6989	0.84
1966	4960	14217	1.19
1967	6166	6959	1.13
1968	7978	8502	1.07
1969	5377	1677	0.31
1970	4475	148	0.03
1971	8938	6058	0.68
1972	4558	4796	1.05
1973	5322	1950	0.37

a Source: A. Eldred, Biologist, Washington Department of Game, Wenatchee.

b Number of adult steelhead passing Rock Island or Priest Rapids dams, minus sport fishery harvest upstream of these sites.

c Rock Island or Priest Rapids dam counts plus commercial and sport fishery harvest downstream from these sites 5 years after brood year.

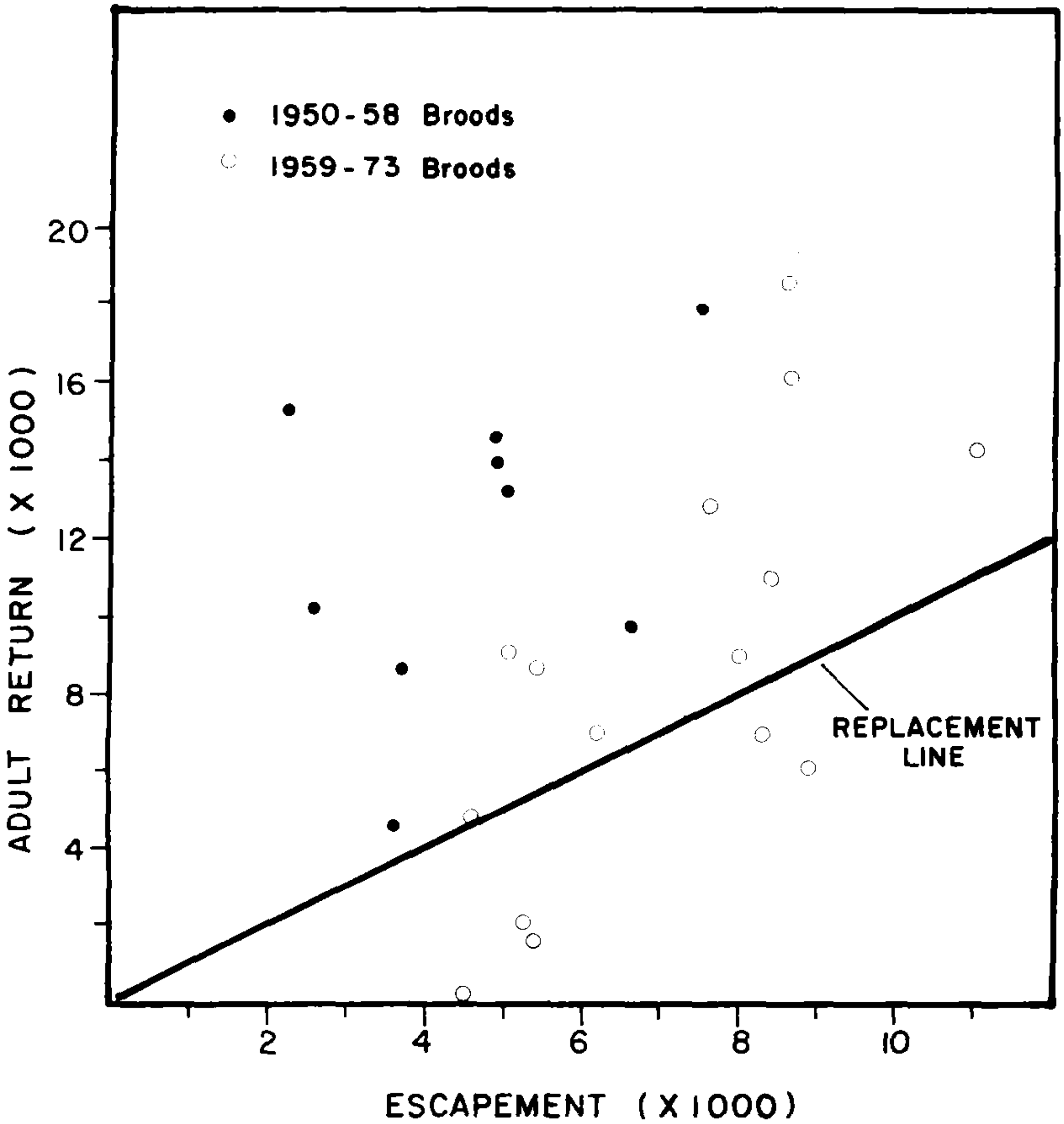

FIGURE 4-1 Relationship between parent escapement and adult return for mid-Columbia summer steelhead, 1950-1973 broods. Data from A. Eldred, Washington Department of Game, Wenatchee.

DATE	
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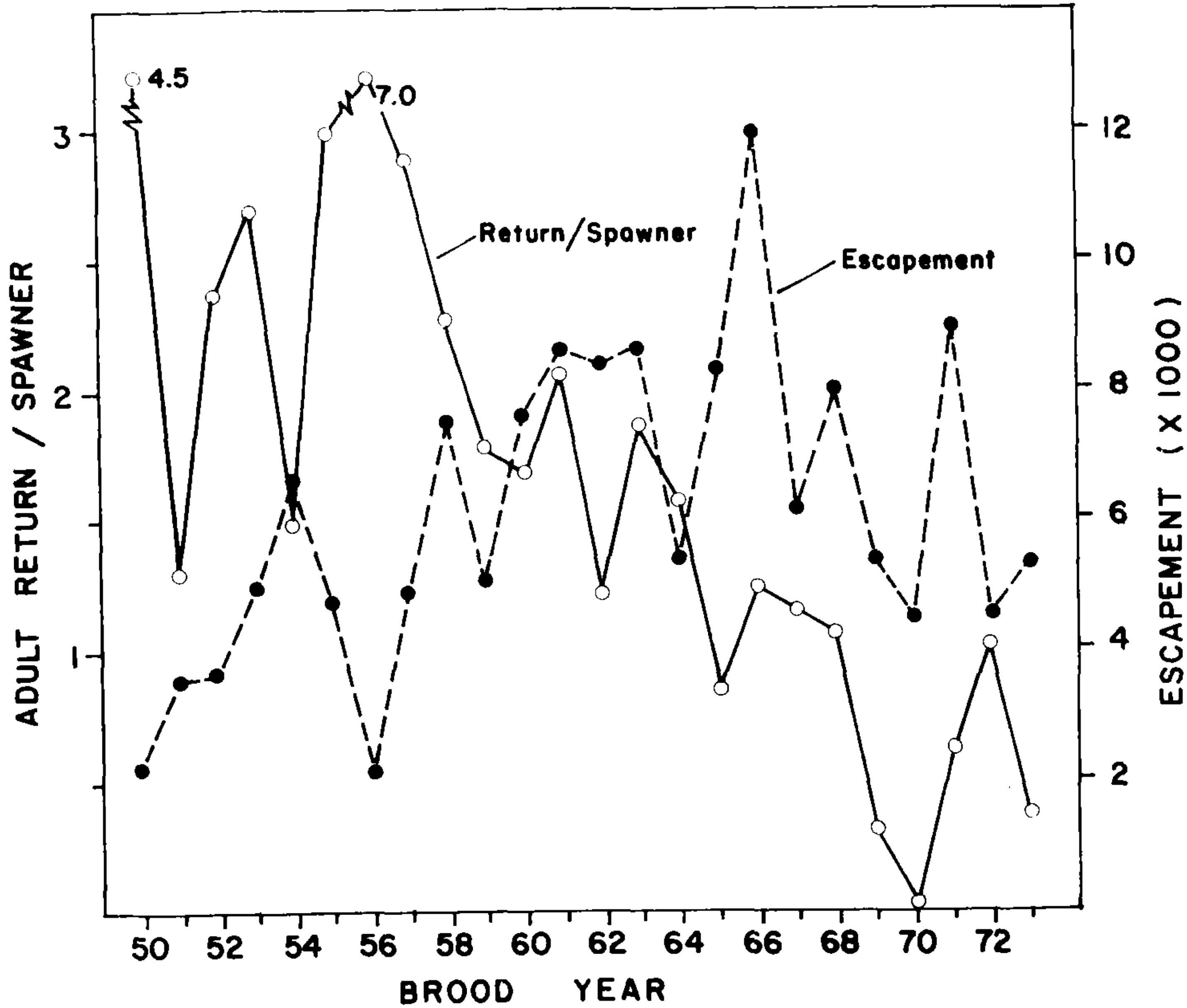

FIGURE 4-2 Trend in escapement and subsequent adult return per spawner for mid-Columbia summer steelhead, 1950-1973 broods. Data from A. Eldred, Washington Department of Game, Wenatchee.

DATE	
PROJECT	3711.1
DWG. NO	

the data base for the latter group came from the post-McNary period (1950-1958 broods).

Selection of a conservative return rate (2.5:1.) for natural spawning in the Similkameen reflects the fact that:

1. Initial returns to the river will not be fully adapted to the new spawning and nursery conditions;

2. Productivity or fitness of Wells stock, which has been subjected to hatchery propagation for 3 generations, will probably be lower than that of a comparable wild stock (Reisenbichler and McIntyre, 1977); and

3. Fry-to-smolt mortality may be higher than normal, because the relatively short growing season in the Similkameen will likely result in an average 3 years rearing before smolt migration, compared to the 2 year average in more southerly mid-Columbia tributaries.

With respect to point (2) there is already evidence of selection for early spawning timing, perhaps inadvertant, in the Wells steelhead stock (K. Williams, pers. comm., 1984). It is this characteristic which is believed to be largely responsible for reduced fitness of hatchery steelhead stocks in the Kalama River (Chilcote et al., 1984).

Initial returns of steelhead to the Similkameen River will experience relatively low spawning and juvenile rearing densities. The positive effects of low density on egg-to-smolt survival will offset, to some extent, the influence of the factors discussed above.

4.7.2 Hatchery Smolt Survival

The average smolt-to-adult survival rate was derived from Wells Hatchery data for the release years 1972 to 1981 (K.Williams, pers. comm., 1985). Over this period, returns of 1-ocean and 2-ocean steelhead to Wells Dam averaged 1.51% of smolts released (Table 4-7). These returns to Wells Dam are not the total returns to the upper Columbia River as they do not include interceptions by the Indian or sport fisheries downstream of Wells Dam.

In Section 4.7.3 below it is estimated that a smolt survival rate of 1.5% represents a loss per dam of approximately 12%. To calculate the smolt survival rates corresponding to losses of 10% and 15% per dam, the scenarios used later in this report, the following relationship was used:

$$\text{Smolt Survival Rate} = \frac{\text{Total survival rate at X\% loss/dam}}{\text{Total survival rate at 12\% loss/dam}} \times 1.51$$

The calculated smolt-to-adult survival rates for losses of 10% and 15% per dam are therefore as follows:

$$\text{10\% Loss Per Dam} \quad \frac{0.387}{0.326} \times 1.51 = 1.79\%$$

$$\text{15\% Loss Per Dam} \quad \frac{0.230}{0.326} \times 1.51 = 1.07\%$$

4.7.3 Losses Related To Dams

No data are available on total dam-related losses of mid-Columbia steelhead, including both the smolt and adult migrations. However, limited data have been obtained on steelhead smolt losses attributable to the 5 mid-Columbia dams (Wells, Rocky Reach, Rock Island, Wanapum and Priest Rapids). Preliminary results from a 1984 investigation by the Water Budget Centre with Wells Hatchery smolts indicated an average loss of 9.4% per dam for the 5 dams in the mid-Columbia reach (C. McConnaha, pers. comm., 1985). Conditions for smolt migration were considered to be relatively good in 1984. A steelhead smolt transport study (C. Morrill. pers. comm., 1985), comparing survival to adult return from Wells Hatchery smolts released below Priests Rapids Dam (transport group) and in the Methow River (control group), indicated losses per dam of 7% and 20% in 1982 and 1983 respectively (Table 4-8).

TABLE 4-7
Adult Returns and Survival Rates of Hatchery-Reared Summer Steelhead Smolts Released from Wells and Skamania Hatcheries, 1972-1981

Smolt Release Year	Wells Hatchery[a] No. of Smolts Released	Adult Returns[c] 1-ocean	Adult Returns[c] 2-ocean[d]	Adult Returns[c] Total	Survival (%)	Skamania Hatchery[b] No. of Smolts Released	Adult Returns (2-ocean)	Survival (%)
1972	327,902	1451	518	1969	0.60	129,250	4095	3.17
1973	146,880	170	122	292	0.20	100,200	4402	4.39
1974	182,111	608	952	1560	0.86	103,740	4897	4.72
1975	249,279	3934	1241	5175	2.08	99,320	6399	6.44
1976	238,405	4321	1515	5836	2.45	100,045	6072	6.07
1977	172,978	271	146	417	0.24	116,349	3989	3.43
1978	164,259	3848	865	4713	2.87	115,110	5662	4.92
1979	268,252	2848	4018	6866	2.56	114,896	7911	6.89
1980	471,420	332	6745	7077	1.50	98,434	5041	5.12
1981	258,234	1107	3285	4392	1.70	127,407	1573	1.23
				Mean	1.51		Mean	4.63

a Source: K. Williams, Biologist, Washington Department of Game, Brewster.

b Source: B. Crawford, Biologist, Washington Department of Game, Vancouver.

c Returns to Wells Dam. Total does not include contributions to sport and native fisheries downstream of Wells Dam.

d Annual return equals total 2-ocean fish minus 9% to account for estimated portion of wild 2-ocean fish.

e Annual total return to Washougal River, including returns to hatchery and sport catch, minus 6.6% to account for estimated portion of wild fish. All Skamania stock return after 2-ocean years.

TABLE 4-8
Adult Returns from Releases of Wells Hatchery Steelhead Smolts to Determine Effects of Truck Transport on Survival, and Indicated Rates of Loss Per Dam[a]

Release Year	Release Site [b]	Adult Returns To Bonneville Dam [c]	
1982	Below Priest Rapids (Transport Group)	308	Survival ratio (Control/Transport) = 216/308 = 0.70 Indicated survival per dam (5 dams) = $\sqrt[5]{0.70} = 0.93$ Loss per dam = 1 - 0.93 = 0.07
	Methow River (Control Group)	216	
1983	Below Priest Rapids (Transport Group)	210[d]	Survival ratio (Control/Transport) = 67/210 = 0.32 Indicated survival per dam (5 dams) = $\sqrt[5]{0.32} = 0.80$ Loss per dam = 1 - 0.80 = 0.20
	Methow River (Control Group)	67[d]	

a Adult return data were provided by C. Morrill, Washington Department of Game, Olympia.

b Equal numbers of smolts were released in each group.

c Returns to points upstream of Bonneville Dam were excluded from the calculations because of the possible effect of straying on recoveries from Transport Groups.

d Returns include only the 1-ocean fish in 1984.

For purposes of this analysis, an estimate of average loss per dam was derived by comparing the smolt-to-adult survival rate of Wells Hatchery stock with that of a lower Columbia River summer steelhead stock (Skamania Hatchery on the Washougal River) not directly affected by mainstem dams. During the 10-year period of comparison, the 1972 to 1981 release years, smolt-to-adult survival rates of the Wells and Skamania stocks averaged 1.51% and 4.63% respectively (Table 4-7). The basic assumption was that the difference in average survival rates for the 2 hatchery stocks represented the effect of dams on the smolt and adult migrations. Based on this assumption, average survival rate and loss per dam may be calculated as follows:

Proportionate loss related to dams = $\frac{0.463 - .0151}{.0463} = 0.67$

Proportion surviving the effects of all dams = 1 - 0.67 = 0.33

Indicated survival per dam (9 dams) = $\sqrt[9]{0.33}$ = 0.88

Estimated loss per dam = 1 - 0.88 = 0.12

An important underlying assumption is that Wells and Skamania Hatchery smolts are of similiar quality, i.e. have the same survival potential under comparable conditions. There are apparently no comparative data on quality of Wells and Skamania Hatchery smolts (S. Roberts, pers. comm., 1985). However, it is conceivable that the 2 groups could differ in quality, considering that Wells fish are reared in earthen ponds at lower densities than the raceway-reared Skamania fish. If Wells smolts are of higher quality, the difference in survival of the two stocks is not solely attributable to the effects of dams. Loss per dam would therefore be underestimated. For example, if Wells smolts were of 50% higher quality than Skamania smolts, the survival rate should be 0.22 rather than 0.33 as calculated above. The estimated average loss per dam would consequently increase to 0.16.

4.7.4 Indian Fishery

Before 1977, catches of summer steelhead in the Columbia River Indian fishery (Zone 6 - Bonneville to McNary Dam) were incidental. Since that time Indian catches of steelhead have increased, particularly in 1983 and 1984. Recoveries of tagged 1-ocean steelhead adults in that fishery indicate that the 1982 and 1983 smolt releases from

Wells Hatchery contributed approximately 1% of Indian catches totalling 15,100 and 71,200 steelhead in 1983 and 1984 respectively (C. Morrill, pers. comm., 1985). The Wells Hatchery contribution of 1-ocean fish in 1983, for example, would be estimated at 151 fish, 0.9% of the 1-ocean steelhead escapement (16,443) to Wells Dam in that year (K. Williams, pers. comm., 1985).

It appears unlikely that the Indian fishery had a significant effect on steelhead escapements to Wells Dam during the period considered in this study (1973 to 1983).

4.7.5 Detailed Calculations

Estimates of adult steelhead escapements to the Similkameen River were developed for several scenarios, including 10% and 15% rates of loss per dam and fishery exploitation rates ranging from 0 to 40%. Assumptions made to simplify development of these estimates were as follows:

Saltwater age at return of hatchery-produced adults	1-ocean
Saltwater age at return of wild adults	2-ocean
Freshwater rearing period of wild smolts	3 years
Total age of returning wild adults	6 years
Adult return per spawner from wild (2-ocean) fish	2.5
Adult return per spawner from hatchery-produced (1-ocean) fish	2.2
Incidence of repeat spawning	0
Smolt mortality at Enloe Dam	0

The lower production rate used for returning hatchery produced adults was based on the lower average fecundity of 1-ocean (5,100 eggs) compared to 2-ocean (5,800 eggs) females (K. Williams, pers. comm., 1985). An additional assumption was that wild and hatchery- produced adults would have the same sex ratio.

The basic return rates for naturally-spawning steelhead were corrected downward to account for the effect of dams. Return rates of 2.5 or 2.2:1 were multiplied by a factor of either 0.387 or 0.23, corresponding to total survival rates at respective losses of 10% and 15% per dam.

The production rates used to estimate escapements under each scenario are listed in Table 4-9.

4.8 Surplus Adult Production

In a steelhead population with an average production rate of 2.5 adults per spawner the theoretical average surplus amounts to 1.5 adults or 60% of total production. However, this theoretical surplus does not generally represent the actual harvestable surplus, as some provision must be made for the fact that production rates and subsequent adult returns may vary considerably from year to year. A more conservative harvest rate is normally established to achieve adequate spawning escapements in years of below average survival.

The 9 mainstem Columbia dams would obviously place a significant demand on available surplus production from a naturally-spawning steelhead population in the Similkameen River. The relationship between harvestable surplus and loss per dam is presented in the following table, using a production rate of 2.5 adults per spawner.

	Loss per Dam			
	10%	8%	5%	2%
Total loss related to dams[a]	.60	.53	.37	.17
Surplus Production[b]	0	.15	.37	.52

[a] Total of 9 dams.
[b] Expressed as a portion of the returning adult run.

It is evident that loss per dam must be under 10% before any harvestable surplus would be available from a population which depended solely on natural production. In

TABLE 4-9
Adult Steelhead Production Rates Used to Estimate Spawning Escapements to the Similkameen River at Selected Rates of Exploitation and Loss Per Dam [a]

	Exploitation Rate			
Loss Per Dam	0	10%	20%	40%
No Loss[b]				
Adult escapement per:				
2-ocean wild spawner	2.50	2.25	2.00	1.50
1-ocean hatchery spawner	2.20	1.98	1.80	1.32
10% Loss Per Dam				
Adult escapement per:				
2-ocean wild spawner	0.97	0.87	0.78	0.58
1-ocean hatchery spawner	0.85	0.77	0.68	0.51
Adult escapement from hatchery smolts	1.79%[c]	1.61%	1.43%	1.07%
15% Loss Per Dam				
Adult escapement per:				
2-ocean wild spawner	0.58	0.52	0.46	0.35
1-ocean hatchery spawner	0.51	0.46	0.41	0.31
Adult escapement from hatchery smolts	1.07%[c]	0.96%	0.86%	0.64%

a The term "escapement" refers here to fish which spawn naturally in the Similkameen River after escaping fisheries, other sources of mortality and the collection of brood stock.

b Return rates at 0 loss per dam are shown here for comparison. Only the 10% and 15% loss per dam scenarios were included in the analysis.

c Derivation of smolt-to-adult survival rates for 10% and 15% loss per dam is explained in Section 2.2.

practise, loss per dam would probably have to be in the order of 5-8% for natural production to sustain even a modest harvest of 10-20% of the returning adults.

4.9 Projected Escapements And Smolt Requirements

The expected escapements from natural production supplemented by annual plantings of 100,000 hatchery smolts in the Similkameen River have been estimated for a range of scenarios, including exploitation rates of 0 to 40% and losses per dam of either 10% or 15% (Figure 4-3). The 100,000 smolt figure was selected simply to illustrate the escapements which could be achieved by a consistent level of hatchery smolt planting, combined with natural production, over a 24 year period. Respective contributions of hatchery and natural production to escapement are tabulated for each scenario in Table 4-10. By year 19, for example, the contribution of natural production to escapement would range from 71% in the best case (10% loss/dam and 0 exploitation) to 31% in the worst case (15% loss/dam and 40% exploitation).

The estimated requirement for supplemental plants of hatchery smolts was also estimated (Figure 4-4). For example, the number of hatchery smolts needed to produce an escapement of 1,000 fish in year 19 could range from 2,000 to 106,000, depending on the scenario for exploitation and loss per dam (Table 4-11).

4.10 Run Strength Projections - A Probable Scenario

The prospects for reducing smolt losses at dams would appear to be promising, considering the programs of smolt collection/transport and controlled dam spillage being implemented on the Columbia River. Survival of steelhead smolts from Wells Hatchery also appears to have improved in recent years, with return rates of the 1978 to 1982 releases ranging from 1.5 to 6.5% and averaging 3.0% (K. Williams, pers. comm., 1985). The use of river water rather than well water during the spring smoltification period is thought to have contributed to better smolt quality at Wells Hatchery since 1978 (S. Miller, pers. comm., 1985). These factors indicate that a loss per dam of 10% or less may be a more realistic assumption for planning than the 15% rate.

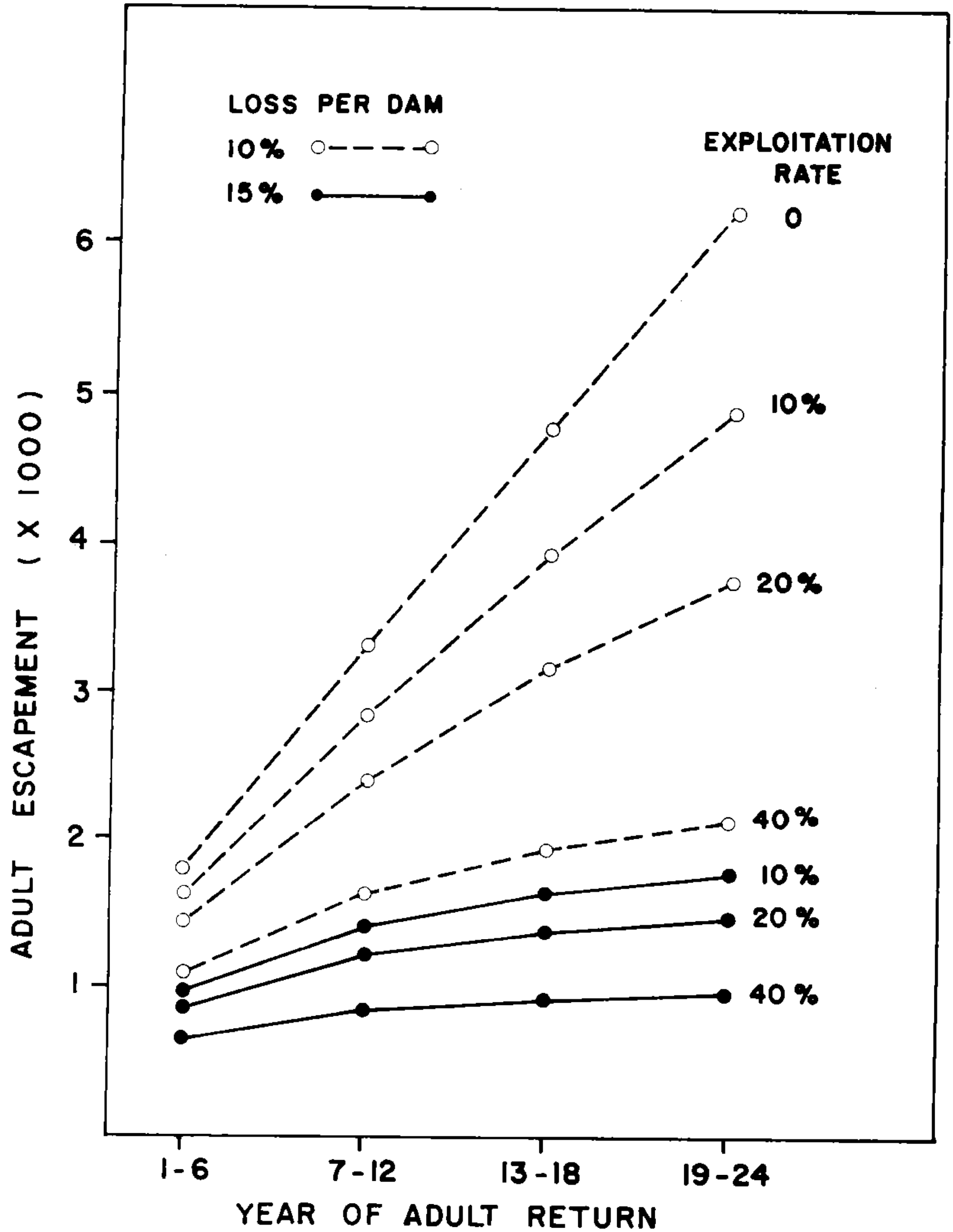

FIGURE 4-3 Estimated adult steelhead spawning escapements to the Similkameen River from annual releases of 100,000 hatchery-reared smolts and natural production, at selected rates of fishery exploitation and loss per dam.

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TABLE 4-10

Estimated Spawning Escapements of Adult Steelhead to the Similkameen River and Respective Contributions of Hatchery and Natural Production From Annual Releases of 100,000 Hatchery-Reared Smolts, at Selected Rates of Exploitation and Loss Per Dam

Exploitation Rate	Return Years	Adult Escapement by Source[a]: Hatchery Smolts	Natural Production by Generation: First	Second	Third	Total Run
		10% Loss Per Dam				
0	1-6	1790	--	--	--	1790
	7-12	1790	1522	--	--	3312
	13-18	1790	1522	1476	--	4788
	19-24	1790	1522	1476	1432	6220
10%	1-6	1610	--	--	--	1610
	7-12	1610	1240	--	--	2850
	13-18	1610	1240	1079	--	3929
	19-24	1610	1240	1079	938	4867
20%	1-6	1430	--	--	--	1430
	7-12	1430	972	--	--	2402
	13-18	1430	972	758	--	3160
	19-24	1430	972	758	592	3752
40%	1-6	1070	--	--	--	1070
	7-12	1070	546	--	--	1616
	13-18	1070	546	317	--	1933
	19-24	1070	546	317	184	2117
		15% Loss Per Dam				
0	1-6	1070	--	--	--	1070
	7-12	1070	546	--	--	1616
	13-18	1070	546	317	--	1933
	19-24	1070	546	317	184	2117
10%	1-6	960	--	--	--	960
	7-12	960	442	--	--	1402
	13-18	960	442	230	--	1632
	19-24	960	442	230	119	1751
20%	1-6	860	--	--	--	860
	7-12	860	353	--	--	1213
	13-18	860	353	162	--	1375
	19-24	860	353	162	75	1450
40%	1-6	640	--	--	--	640
	7-12	640	198	--	--	838
	13-18	640	198	69	--	907
	19-24	640	198	69	24	931

a Refers to fish which escape fisheries and other sources of mortality to spawn.

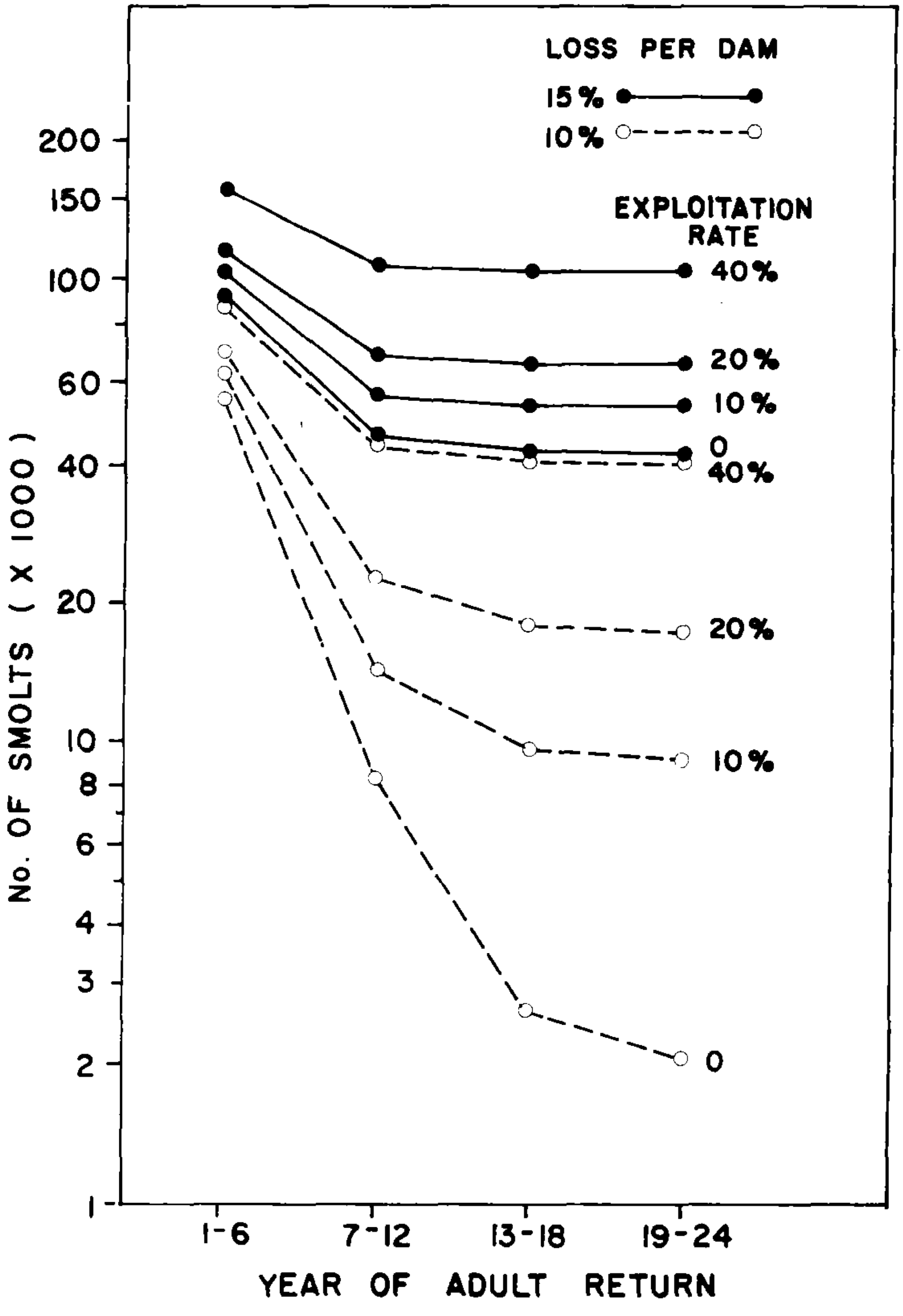

FIGURE 4-4 Estimated hatchery smolt plants required to supplement natural production and achieve escapements of 1,000 adult steelhead to Similkameen River, at selected rates of fishery exploitation and loss per dam.

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TABLE 4-11

Estimated Plants of Hatchery-Reared Smolts Required to Produce Spawning Escapements of 1,000 Adult Steelhead to the Similkameen River and Respective Contributions of Hatchery and Natural Production to Escapement, at Selected Rates of Exploitation and Loss Per Dam

Exploitation Rate	Return Years	Adult Escapement by Source[a] Hatchery Smolts	Natural Production by Generation First	Second	Third	Total Run
		10% Loss Per Dam				
0	1-6	55,900	1,000	--	--	--
	7-12	8,400	150	850	--	--
	13-18	2,600	47	128	825	--
	19-24	2,000	36	40	124	800
10%	1-6	62,100	1,000	--	--	--
	7-12	14,300	230	770	--	--
	13-18	9,500	153	177	670	--
	19-24	9,000	145	118	154	583
20%	1-6	69,900	1,000	--	--	--
	7-12	22,400	320	680	--	--
	13-18	17,600	252	218	530	--
	19-24	17,200	246	171	170	413
40%	1-6	93,500	1,000	--	--	--
	7-12	45,800	490	510	--	--
	13-18	42,400	454	250	296	--
	19-24	42,200	451	232	145	172
		15% Loss Per Dam				
0	1-6	93,500	1,000	--	--	--
	7-12	45,800	490	510	--	--
	13-18	42,400	454	250	296	--
	19-24	42,200	451	232	145	172
10%	1-6	104,200	1,000	--	--	--
	7-12	56,300	540	460	--	--
	13-18	53,400	513	248	239	--
	19-24	53,200	511	236	129	124
20%	1-6	116,300	1,000	--	--	--
	7-12	68,600	590	410	--	--
	13-18	66,200	569	242	189	--
	19-24	66,200	569	233	111	87
40%	1-6	156,300	1,000	--	--	--
	7-12	107,800	690	310	--	--
	13-18	105,800	677	214	109	--
	19-24	105,800	677	210	75	38

[a] Refers to fish which escape fisheries and other sources of mortality to spawn.

Estimates by Washington Department of Game from 1982 punchcard returns indicate that the sport fishery in the Columbia mainstem below Wells Dam intercepted approximately 8% of the steelhead returning to Wells Dam. Taking into consideration the relatively low contribution (approximately 1%) of Wells steelhead to the 1983 and 1984 Indian fisheries, it may be quite possible to achieve 90% escapement to Wells Dam and, consequently, to the Similkameen River.

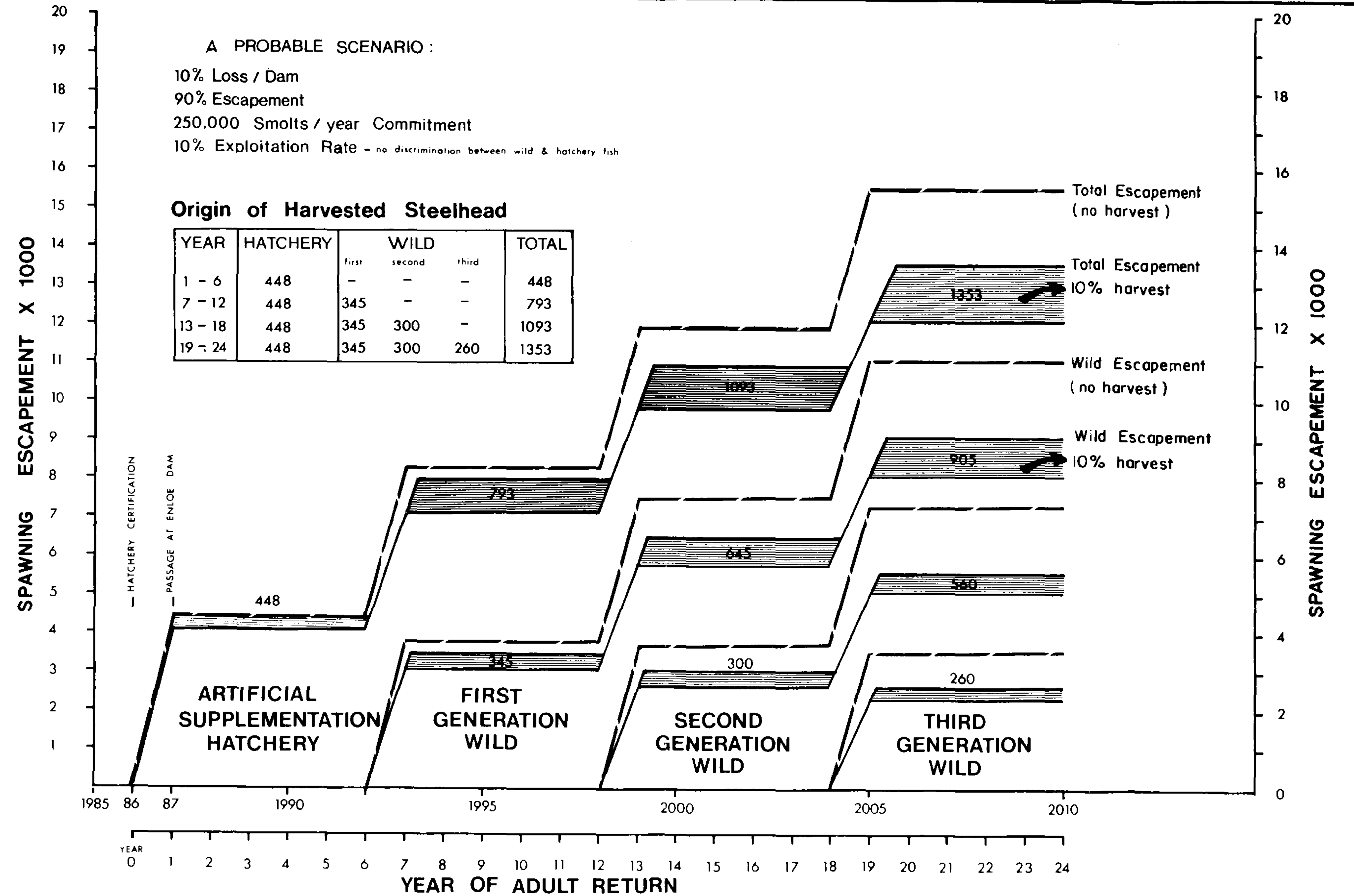
A probable scenario for development of the Similkameen River summer steelhead run would therefore involve 10% loss per dam and 10% exploitation below Wells Dam of adults entering the Columbia River. With a commitment of 250,000 Wells Hatchery smolts per year and no exploitation of returning adults, a spawning escapement of 15,550 could be achieved by years 19-24 (Figure 4-5). This total also includes the broodstock requirement. At that time, the wild component of the run will represent 71.2 percent of the returning adults.

If an additional 10% exploitation is permitted annually above Wells Dam on both wild and hatchery stocks, in years 19-24, 1,353 steelhead could be harvested (including broodstock) and spawning escapement to the Similkameen River would be reduced to 12,168.

In Figure 4-6 the total run, harvest and escapement of steelhead above Wells Dam is presented illustrating the effect of 10%, 20% and 40% exploitation of the run over a 50 year period. As the harvest (including broodstock requirement) increases from 2,228, 3,278 and 3,923 for the 10%, 20% and 40% exploitation rates respectively, the total run is reduced from 22,273 to 9,808.

4.11 Benefits Analysis

Expected run strength of steelhead returning to the Similkameen River as a consequence of providing passage over Enloe Dam, with Wells Hatchery produced smolt supplementation of 250,000 annually is projected to year 50 in order to determine benefits for a reasonable project lifetime.



Origin of Harvested Steelhead

YEAR	HATCHERY	WILD first	WILD second	WILD third	TOTAL
1 - 6	448	–	–	–	448
7 - 12	448	345	–	–	793
13 - 18	448	345	300	–	1093
19 - 24	448	345	300	260	1353

FIGURE 4-5 FORECAST TREND IN SIMILKAMEEN RIVER STEELHEAD ESCAPEMENT UNDER 0% AND 10% EXPLOITATION RATES

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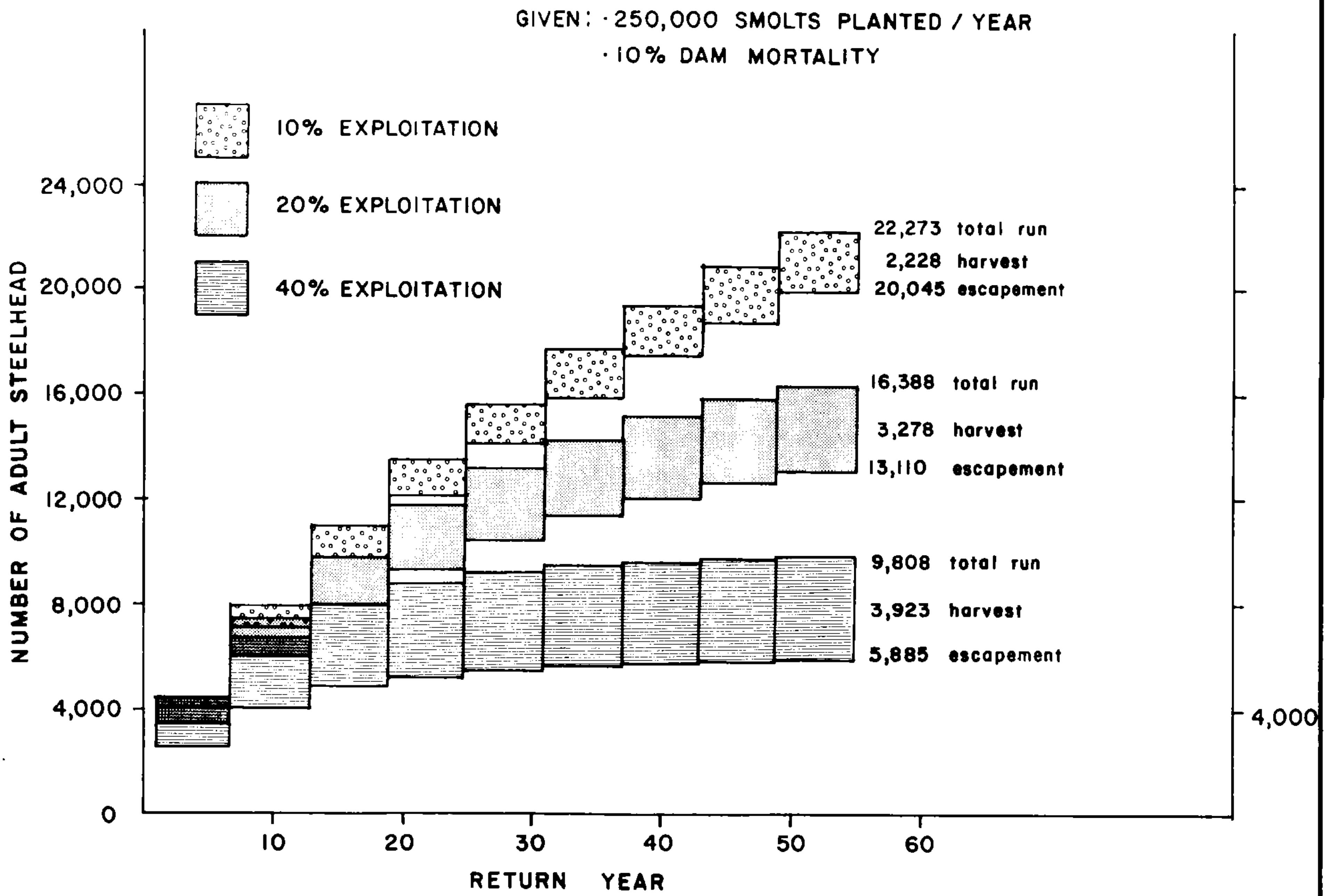

Figure 4-6 Similkameen River Escapement & Harvest

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The previous analysis projects staged increases in run strength at six year intervals, reflecting increases in numbers of returning adults from naturally reproducing parents. Since the rate of increase in run strength is a function of harvest, run strength over time was determined for four assumed harvest intensities: 0%, 10%, 20% and 40% (spawning escapements of 100%, 90%, 80% and 60% of the total run). In order to project benefits from the harvest of returning adult fish, this analysis calculates expected catch over time for each of the four harvest intensities. Naturally, no catch results from a 0% harvest intensity.

This analysis also assumes 115 adult fish are removed as broodstock for eggs and milt to support the 250,000 smolt supplementation program. This assumption is based on the average fecundity of 2-ocean adult females of 5,800 eggs, approximately equal numbers of males and females taken and an egg-to-smolt hatchery mortality of 25% (S. Miller, pers. comm., 1985).

The adult return rates from hatchery smolt plants presented in Table 4-9 are based on returns to Wells Dam, after some harvest by sport, Indian and commercial fisheries in the Columbia River downstream of Wells Dam. These return rates therefore do not represent the total adult steelhead return to the Columbia River. The annual harvest downstream of Wells Dam appears to be in the order of 10%. For purposes of forecasting benefits, adult return rates from hatchery smolt plants shown in Table 4-9 have to be corrected by a factor of 1.11 (100/90). The net result is that total harvest and benefits increase by 11.1% over those predicted with the more conservative return rates used to generate the adult return projections in Table 4-10 and Figures 4-5 and 4-6.

In Table 4-12 projected sport, commercial and Indian harvest above and below Wells Dam is presented. Also included in this table is the spawning escapement which refers to the number of adult steelhead returning to the Similkameen River after escaping all sport, commerical and Indian fisheries and other sources of mortality. Benefits of project implementation are calculated based on these projected catch statistics for each management scenario. Calculations assume realization of annual harvest of adult steelhead trout as presented in the table above with 22% of the catch allocated to the Indian fishery and 78% to the freshwater sport fishery (NMFS, 1984). The

TABLE 4-12
Projected Sport, Commercial And Indian Fishery Harvest Based On 10%, 20% And 40% Fishery Exploitation Rates

Project Years	Spawning Escapement	Brood Stock Requirement	Total Harvest Above Wells Dam	Total Harvest Below Wells Dam	Total Harvest	Sport Fishery 78%	Commerical & Indian Fishery 22%
10% Harvest							
1 - 6	4,025	115	333	497	830	647	183
7 - 12	7,125	115	678	879	1,557	1,214	343
13 - 18	9,823	115	978	1,212	2,190	1,708	482
19 - 24	12,168	115	1,238	1,501	2,739	2,136	603
25 - 30	14,210	115	1,465	1,753	3,218	2,510	708
31 - 36	15,985	115	1,660	1,971	3,631	2,832	799
37 - 42	17,530	115	1,833	2,162	3,995	3,116	879
43 - 48	18,875	115	1,983	2,328	4,311	3,363	948
49 - 50	20,045	115	2,113	2,472	4,585	3,576	1,009
20% Harvest							
1 - 6	3,575	115	780	496	1,276	995	281
7 - 12	6,005	115	1,388	833	2,221	1,732	489
13 - 18	7,900	115	1,860	1,096	2,956	2,306	650
19 - 24	9,380	115	2,233	1,302	3,535	2,757	778
25 - 30	10,533	115	2,518	1,461	3,979	3,104	875
31 - 36	11,433	115	2,743	1,586	4,329	3,377	952
37 - 42	12,135	115	2,920	1,684	4,604	3,591	1,013
43 - 48	12,683	115	3,055	1,760	4,815	3,756	1,059
49 - 50	13,110	115	3,163	1,819	4,982	3,886	1,096
40% Harvest							
1 - 6	2,675	115	1,668	496	2,164	1,688	476
7 - 12	4,040	115	2,578	747	3,325	2,594	731
13 - 18	4,833	115	3,108	894	4,002	3,122	880
19 - 24	5,293	115	3,413	979	4,392	3,426	966
25 - 30	5,558	115	3,590	1,028	4,618	3,602	1,016
31 - 36	5,713	115	3,693	1,057	4,750	3,705	1,045
37 - 42	5,803	115	3,753	1,073	4,826	3,764	1,062
43 - 48	5,855	115	3,788	1,083	4,871	3,799	1,072
49 - 50	5,885	115	3,808	1,089	4,897	3,820	1,077

analysis also assumes a project life of 50 years and realization of first project benefits one year after implementation.

The net monetary value per unit (sport-caught adult steelhead) is placed at $144. This is the interim compensatory value for an adult sport-caught steelhead in an enhanced fishery as simulated by Meyer (1984) and has been adjusted downward signficantly since earlier values were published by the National Marine Fisheries Service (Meyer, 1982). Further revisions are presently being made and NMFS anticipates publication of new revised values in October of this year. The value of commercial or Indian ceremonial steelhead harvest is placed at $21.81 (Meyer, 1984) for purposes of calculating project benefits.

The discount rate chosen for this analysis is 3%. This is the risk-free rate of time preference used by BPA for power system analysis and projected evaluation. It is felt that the choice of this discount rate is consistent with the very conservative assumptions in the model to project run strength.

The present value of projected benefits from the Enloe Dam Fish Passage Project, with supplementation, for 10%, 20% and 40% harvest scenarios in six year cycles and a 50 year project life is summarized in Table 4-13. For calculating the values in Table 4-13 the following formulation by Grant, Ireson and Leavenworth (1976) was used:

$$\text{Present worth} = \sum_{i=1,6}^{50} (P/A, 3\%, N \text{ yrs}) \times (P/F, 3\%, (N\text{-}6) \text{ yrs}) \times \$144/\text{fish} \times \#\text{ of fish}$$

where: present worth of year groups $= (P/A) = \dfrac{(1+i)^N - 1}{i\,(1+i)^N}$

and: present worth of each year group at year zero $= (P/F) = \dfrac{1}{(1+i)^N}$

and: N = # of years (50)
i = discount rate (3%)

(NOTE: The Commercial/Indian harvest, valued at $21.81/fish is included in the total.)

TABLE 4-13
Projected Benefits From The Sport, Commercial And Indian Fishery Harvest Based On 10%, 20% And 40% Fishery Exploitation Rates

Project Years	Harvestable Fish Sport	Harvestable Fish Commercial/Indian	P/A 3%, N YRS	P/F 3%, N YRS	Benefit In Dollars Sport	Benefit In Dollars Commerical/Indian	Benefit In Dollars Total
10% Harvest							
1 - 6	647	183	5.417	1.000	504,691	21,620	526,311
7 - 12	1,214	343	5.417	0.8375	793,094	33,939	827,033
13 - 18	1,708	482	5.417	0.7014	934,491	39,942	974,433
19 - 24	2,136	603	5.417	0.5874	978,716	41,847	1,020,563
25 - 30	2,510	708	5.417	0.4919	963,101	41,146	1,004,247
31 - 36	2,832	799	5.417	0.4120	910,148	38,892	949,040
37 - 42	3,116	879	5.417	0.3450	838,567	35,828	874,395
43 - 48	3,363	948	5.417	0.2890	758,134	32,368	790,502
49 - 50	3,576	1,009	1.913	0.2420	238,392	10,187	248,579
				TOTAL	**6,919,334**	**295,769**	**7,215,103**
20% Harvest							
1 - 6	995	281	5.417	1.000	776,148	33,199	809,347
7 - 12	1,732	489	5.417	0.8375	1,131,498	48,385	1,179,883
13 - 18	2,306	650	5.417	0.7014	1,261,672	53,863	1,315,535
19 - 24	2,757	778	5.417	0.5874	1,263,258	53,992	1,317,250
25 - 30	3,104	875	5.417	0.4919	1,191,022	50,851	1,241,873
31 - 36	3,377	952	5.417	0.4120	1,085,300	46,339	1,131,639
37 - 42	3,591	1,013	5.417	0.3450	966,398	41,290	1,007,688
43 - 48	3,756	1,059	5.417	0.2890	846,730	36,158	882,888
49 - 50	3,886	1,096	1.913	0.2420	259,057	11,066	270,123
				TOTAL	**8,781,083**	**375,143**	**9,156,226**
40% Harvest							
1 - 6	1,688	476	5.417	1.000	1,316,721	56,237	1,372,958
7 - 12	2,594	731	5.417	0.8375	1,694,635	72,330	1,766,965
13 - 18	3,122	880	5.417	0.7014	1,708,126	72,923	1,781,049
19 - 24	3,426	966	5.417	0.5874	1,569,794	67,039	1,636,833
25 - 30	3,602	1,016	5.417	0.4919	1,382,108	59,045	1,441,153
31 - 36	3,705	1,045	5.417	0.4120	1,190,712	50,866	1,241,578
37 - 42	3,764	1,062	5.417	0.3450	1,012,956	43,287	1,056,242
43 - 48	3,799	1,072	5.417	0.2890	856,423	36,602	893,025
49 - 50	3,820	1,077	1.913	0.2420	254,657	10,874	265,531
				TOTAL	**10,986,131**	**469,203**	**11,455,334**

The total project benefit for the three harvest scenarios is calculated to be:

Harvest	Present Value
10%	$7,215,100
20%	$9,156,225
40%	$11,455,335

The present value figures given above represent a first estimate of benefits expected to accrue from the Enloe Dam fish passage project. A variety of harvest management production/allocation decisions incorporated in this analysis will allow refinements in the production costs and benefits calculations. The production estimates in our opinion are extremely conservative, as they should be at this stage of analysis.

4.12 Stocking Strategy Considerations

This section of the report contains information that could be useful in developing a specific strategy for stocking steelhead in the Similkameen River above Enloe Dam.

4.12.1 Spawning Area Locations

An extensive amount of spawnable area, that portion of the area within a particular reach which meets the criteria for the parameters of depth, velocity and substrate for steelhead trout spawning, was found to be present throughout the Similkameen River system during a thorough habitat assessment conducted by IEC BEAK Consultants Ltd. (1984). A summary of the percentage of spawning substrate area, spawnable area and spawner capacity by stream section is reproduced from that report and is presented in Table 4-14 and Figure 4-7.

The mainstream of the Similkameen River was found to contain an estimated 55.2% or 529,600 m^2 of the available spawnable area in the entire system (961,000 m^2). The majority of spawnable area, 38% or 365,000 m^2, is present in the stream section between Keremeos and Princeton, B.C. Of the remaining area (17.2%), the percentage distributions were from Enloe Dam to Palmer Creek (0%), Palmer Creek to Keremeos (4.7%), Princeton to Similkameen Falls (1.0%) and above the falls (11.5%).

TABLE 4-14
Summary of Similkameen River System Steelhead Trout Spawning Substrate, Spawnable Area and Spawner Capacity by Stream Section

Stream	Stream Section	% of Similkameen River System[1]: Area of Spawning Substrate	% of Similkameen River System[1]: Spawnable Area/Spawner Capacity[2]	Spawner Capacity: No.	Spawner Capacity: % Within Stream
Similkameen River	Enloe Dam to Palmer Ck.	0 (0)	0 (0)	0	0
	Palmer Ck. to Keremeos	40.8 (2,168,000)	4.7 (45,000)	4,572	8
	Keremeos to Princeton	31.7 (1,684,000)	38.0 (365,000)	37,228	69
	Princeton to Similkameen Falls	0.7 (38,800)	1.0 (9,600)	976	2
	Above Similkameen Falls	6.4 (340,000)	11.5 (110,000)	11,228	21
	TOTAL	**79.6** (4,231,200)	**55.2** (529,600)	**54,004**	
Ashnola River	Near Mouth	0.6 (32,200)	0.9 (8,400)	856	6
	Near Mouth to above Lakeview Ck.	L 0.1[3] (1,800)	L 0.1 (30)	2	L 1
	Above Lakeview Ck. to Duruisseau Ck.	4.8 (253,000)	12.9 (124,000)	12,628	94

TABLE 4-14 (Continued)
Summary of Similkameen River System Steelhead Trout Spawning Substrate, Spawnable Area and Spawner Capacity by Stream Section

Stream	Stream Section	% of Similkameen River System[1] Area of Spawning Substrate	% of Similkameen River System[1] Spawnable Area/Spawner Capacity[2]	Spawner Capacity No.	Spawner Capacity % Within Stream
Ashnola River (Continued)					
	Above Duruisseau Ck.	0 (0)	0 (0)	0	0
	TOTAL	**5.4** (287,000)	**13.8** (132,430)	**13,486**	
Tulameen River	Princeton to River Mi. 6.5	6.5 (343,600)	12.2 (117,400)	11,984	41
	River Mi. 6.5 to Lawless Ck.	7.1 (375,500)	17.4 (167,300)	17,072	58
	Lawless Ck. to Falls	0.3 (14,200)	0.4 (4,100)	420	1
	TOTAL	**13.9** (733,300)	**30.0** (288,800)	**29,476**	
Pasayten River	Mouth to River Mi. 3.5	0.8 (44,000)	0.7 (6,800)	698	68
	Above River Mi. 3.5	0.4 (21,200)	0.3 (3,200)	326	32
	TOTAL	**1.2** (65,200)	**1.0** (10,000)	**1,024**	

TABLE 4-14 (Continued)
Summary of Similkameen River System Steelhead Trout Spawning Substrate, Spawnable Area and Spawner Capacity by Stream Section

Stream	Stream Section	% of Similkameen River System[1] Area of Spawning Substrate	% of Similkameen River System[1] Spawnable Area/Spawner Capacity[2]	Spawner Capacity No.	Spawner Capacity % Within Stream
Similkameen River System Above Similkameen Falls	Similkameen River	6.4 (340,000)	11.5 (110,000)	11,228	92
	Pasayten River	1.2 (65,200)	1.0 (10,000)	1,024	8
	TOTAL	**7.6** (405,200)	**12.5** (120,000)	**12,252**	
Similkameen River System	**TOTAL**	**(5,316,800)**	**(960,830)**	**97,990**	

1 Approximate area (m^2) in brackets.

2 Percent spawnable area and percent spawner capacity are equal since spawnable area divided by 19.6, the suggested average area (m^2) required for each spawning pair (Reiser and Bjornn, 1979) times two, equals spawner capacity.

Values for spawnable area (m^2) are in brackets and spawner capacity (no.) in the next column.

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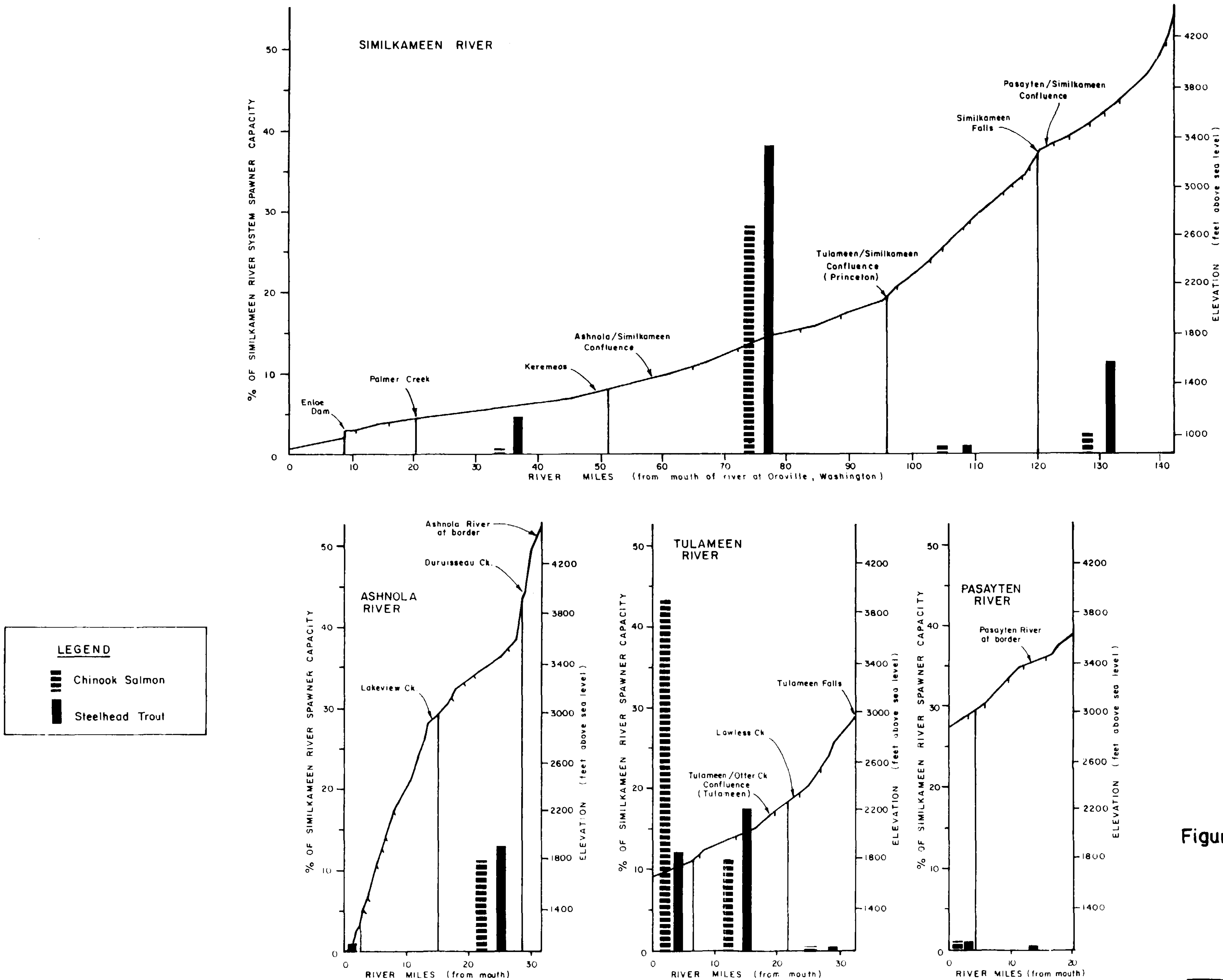

Figure 4-7 : Steelhead Trout and Chinook Salmon Spawner Capacity Distribution Within the Similkameen River System.

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A qualification should be noted regarding the stream section between Palmer Creek and Keremeos. The field habitat sampling criteria used (average depth and velocity) may have seriously underestimated the total spawnable area present in this section. This section has the greatest concentration of spawning gravel of any part of the entire basin (over 2 million m^2). It has been estimated that perhaps as much as 542,000 m^2 of additional spawnable area may exist in that section, and if true that would escalate the spawner capacity of the basin by an additional 50,500 adult fish (IEC BEAK Consultants Ltd., 1984).

The spawner capacity calculated for the entire Similkameen River system was about 98,000 steelhead trout. Of this total, approximately 54,000 would utilize the Similkameen River mainstem, mainly between Keremeos and Princeton (37,000). The other main spawning areas would be above Similkameen Falls (11,000) and between Palmer Creek and Keremeos (4,600). As previously noted, the actual spawner capacity of the latter stream section could increase to 60,000 if the vast areas of potentially suitable spawning area, unaccounted for by the general field sampling techniques, were included.

The Ashnola River has the spawning capacity for nearly 13,500 adult steelhead trout with the majority, 12,600, utilizing the area above Lakeview Creek to Duruisseau Creek. A small number (900) could also use the area just upstream of the Similkameen River confluence.

Approximately 30,000 spawners, or one-third of the basin total, could utilize the Tulameen River, virtually all between Princeton and Lawless Creek.

The Pasayten River contains an area for approximately 1,000 spawners, with the majority (700) located within the first 3.5 river miles. This represents less than 9% of the combined spawner capacity of 12,000 for the river system above Similkameen Falls.

4.12.2 Rearing Area Locations

Potential rearing area for steelhead trout was estimated at about 1,802,600 m^2 for the entire Similkameen River study area (Table 4-15) (IEC BEAK Consultants Ltd., 1984). Figure 4-8 depicts the distribution of potential rearing area in the Similkameen River system, with reference to streambed profile. Sixty-seven percent (1,217,200 m^2) of the entire rearing area is located in the mainstem Similkameen River below Similkameen Falls, with 33% (594,700 m^2) in the portion of the Similkameen River between Keremeos and Princeton, B.C.

The Tulameen River contains a total of 18% (319,400 m^2) of the potential rearing area, with the majority present in the lower reaches.

Of the 3.5% (63,600 m^2) in the Ashnola River, 2.2% (40,200 m^2) is contained in the upper middle reaches between Lakeview and Duruisseau creeks. The limiting factors to potential rearing area in the Ashnola River are the high water velocities and low temperatures.

Above Similkameen Falls, there is a calculated 11% (202,400 m^2) the total potential rearing area in the system of which 3% (47,300 m^2) is in the Pasayten River and 8% (155,100 m^2) in the Similkameen River.

By comparing Figures 4-7 and 4-8 it can be seen, especially in the Similkameen River, that the majority of rearing area is found in the same sections as the majority of spawning area. It should also be mentioned that the spawning and rearing area figures were based on only the sections of the Similkameen River drainage that were habitat inventoried. There is an estimated 98 miles of additional stream that was not inventoried. Therefore, the calculated estimates for spawning and rearing area in the system are probably conservative.

4.12.3 Resident Fish Populations And Potential Competition

Rainbow trout (Salmo gairdneri), which occur naturally in the Similkameen River system, are the main sport species. Their distribution and abundance varies

TABLE 4-15
Summary of Similkameen River System Juvenile Steelhead Trout Potential Rearing Area

Stream	Stream Section	Potential Rearing Area (m^2)	% of Similkameen River System
Similkameen River	Enloe Dam to Palmer Creek	186,647	10.3
	Palmer Creek to Keremeos	314,055	17.4
	Keremeos to Princeton	594,715	33.0
	Princeton to Similkameen Falls	121,791	6.7
	Above Similkameen Falls	155,119	8.6
	TOTAL	**1,372,327**	**76.0**
Ashnola River	Near Mouth	409	0.02
	Near Mouth to Above Lakeview Creek	11,940	0.7
	Above Lakeview Creek to Duruisseau Creek	40,167	2.2
	Above Duruisseau Creek	11,055	0.6
	TOTAL	**63,571**	**3.5**

TABLE 4-15 (Continued)
Summary of Similkameen River System Juvenile Steelhead Trout Potential Rearing Area

Stream	Stream Section	Potential Rearing Area (m^2)	% of Similkameen River System
Tulameen River	Princeton to River Mi. 6.5	94,971	5.3
	River Mi. 6.5 to Lawless Creek	165,300	9.2
	Lawless Creek to Falls	59,137	3.3
	TOTAL	**319,408**	**17.8**
Pasayten River	Mouth to River Mi. 3.5	22,786	1.3
	Above River Mi. 3.5	24,472	1.4
	TOTAL	**47,258**	**2.7**
Similkameen River System Above Similkameen Falls	Similkameen River	155,119	8.6
	Pasayten River	47,258	2.7
	TOTAL	**202,377**	**11.3**
SIMILKAMEEN SYSTEM TOTAL		**1,802,564**	**100.0**

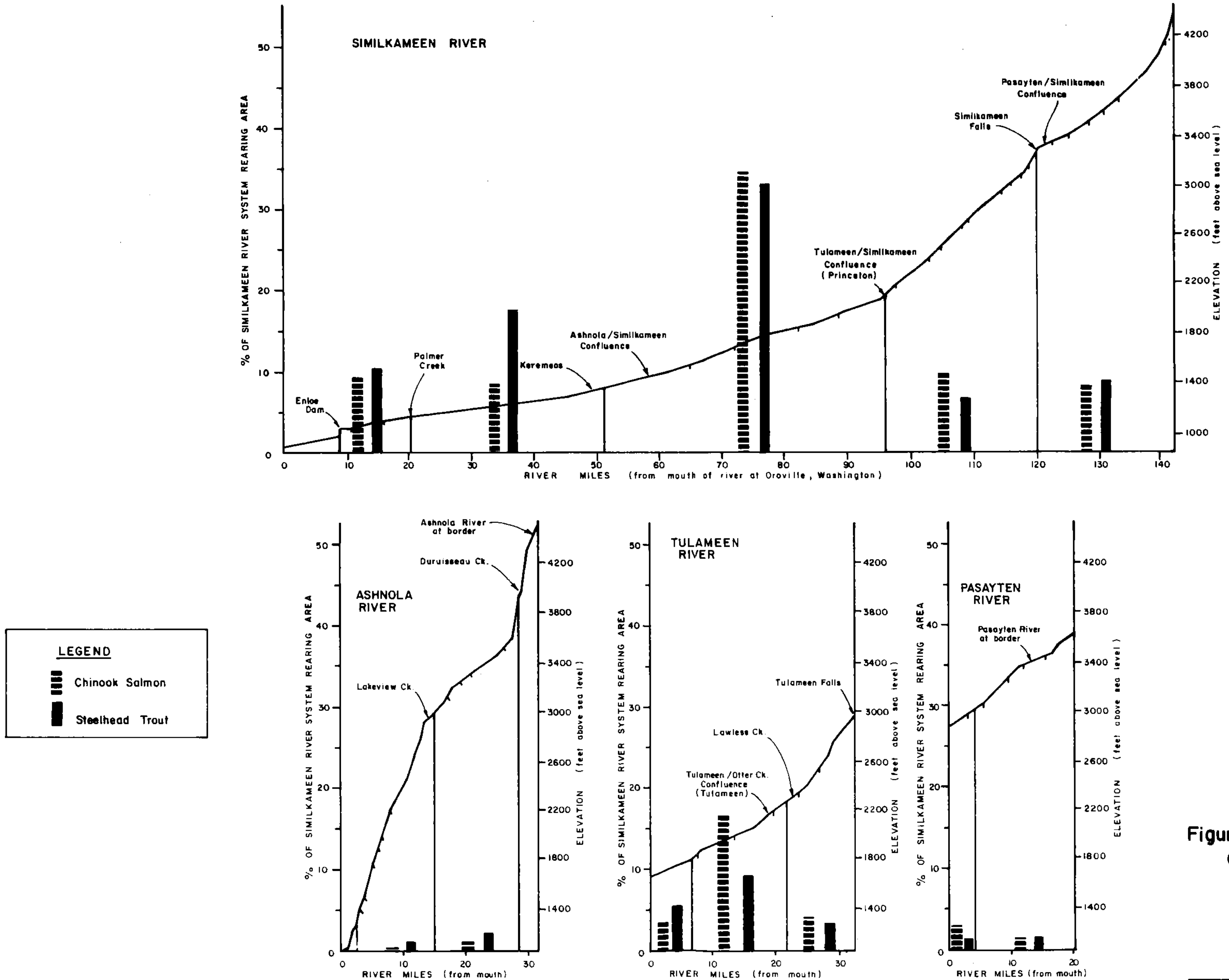

Figure 4-8 Steelhead Trout and Chinook Salmon Rearing Area Distribution Within the Similkameen River System.

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throughout the system with a possible limitation south of the Canada/U.S. border to the Enloe Dam, where none were observed (IEC BEAK Consultants Ltd., 1984). Other fish caught or observed included mountain whitefish (Prosopium williamsoni), bridgelip suckers (Catostomus columbianus), longnose dace (Rhinichthys cataractae), sculpins (Cottus sp.), northern squawfish (Ptychocheilus oregonensis), and black crappie (Pomoxis nigromaculatus). In addition, a small number of kokanee salmon (Oncorhynchus nerka), either dead or spawned out, was observed in Sinlahekin Creek (IEC BEAK Consultants Ltd., 1984). Brook trout (Salvelinas fontinalis) have been stocked in Summers and Allison Creeks and are common there. Cutthroat trout (Salmo clarki) have been captured in the Ashnola River.

The Similkameen River below Similkameen Falls supports the largest diversity of fish but predominated by mountain whitefish and bridgelip suckers. In contract, the Similkameen River above Similkameen Falls and the Pasayten River, supports only two species, rainbow trout and longnose dace.

The most numerous of the species in the main tributary streams of the basin above Enloe Dam was found to sculpins followed in declining order by mountain whitefish, longnose dace, bridgelip suckers and lastly, rainbow trout (IEC BEAK Consultants Ltd., 1984).

Based on densities calculated from the fisheries inventory (IEC BEAK Consultants Ltd., 1984), a total population of rainbow trout in the Similkameen River system was calculated to be 142,318 (Table 4-16).

Densities of rainbow trout throughout the Similkameen River system varied from 0 to 0.20 fish/m^2 (0 to 5.78 g/m^2). The densities of rainbow trout in the Similkameen River system were far lower than those found in other British Columbia streams. Nuaitch Creek in the Nicola River stream (a tributary of the Thompson River which flows into the Fraser River) had average rainbow densities of 2.13 fish/m^2 (10.93 g/m^2) (Tredger, 1980). Ptolemy (1982) found in Louis Creek, a tributary of the North Thompson River, rainbow densities ranged up to 1.95 fish/m^2 (2.28 g/m^2). He also found that these latter values compared favourably with other productive rainbow streams such as 2.89 fish/m^2 (10.4 g/m^2) in Deadman River/Criss Creek (Thompson River tributaries) and 3.2 fish/m^2 (19.5 g/m^2) in the Nicola River mainstem.

TABLE 4-16
Summary of Standing Crop, Fish Population and Density of Rainbow Trout in the Similkameen River System

Stream	Stream Section	Density Range (no./m^2)	Standing Crop Range (kg/ha)	Population Estimate (no.)	Total Standing Crop (kg)
Similkameen River	Enloe Dam to Palmer Creek	0	0	0	0
	Palmer Creek to Keremeos	0-0.0005	0-1.7	408	168.3
	Keremeos to Princeton	0-0.20	0-52.1	42,621	1,393.5
	Princeton to Similkameen Falls	0-0.10	0-57.8	13,047	386.1
	Above Similkameen Falls	0-0.11	0.5-13.8	11,382	206.1
	TOTAL			**67,458**	**2,154**
Ashnola River	Near Mouth	0.01-0.02	0.1-0.1	894	0.5
	Near Mouth to Above Lakeview Creek	0.01-0.19	4.1-33.7	22,675	498.5
	Above Lakeview Creek to Durisseau Creek	0.003-0.11	0.8-19.6	12,546	275.2
	Above Duruisseau Creek	0.16	15.5	11,819	114.5
	TOTAL			**47,934**	**888.7**

TABLE 4-16 (Continued)
Summary of Standing Crop, Fish Population and Density of Rainbow Trout in the Similkameen River System

Stream	Stream Section	Density Range (no./m^2)	Standing Crop Range (kg/ha)	Population Estimate (no.)	Total Standing Crop (kg)
Tulameen River	Princeton to River Mi. 6.5	0	0	0	0
	River Mi. 6.5 to Lawless Creek	0.001-0.01	0.2-3.9	3,061	144.9
	Lawless Creek to Falls	0.02-0.13	4.7-13.4	16,044	276.9
	TOTAL			**19,105**	**421.8**
Pasayten River	Mouth to River Mi. 3.5	0.01	3.1	1,353	41.9
	Above River to Mi. 3.5	0.004-0.04	0.2-6.5	6,468	90.8
	TOTAL			**7,821**	**132.7**
	SIMILKAMEEN RIVER SYSTEM TOTAL			**142,318**	**3,597.2**

The low densities of rainbow trout in the Similkameen River system could be due to several factors. It was felt that perhaps the main one was high fishing pressure (P. Slaney, pers. comm., 1983). Low densities of rainbow were usually found in areas where there was easy access to a stream from a highway. The Ashnola River, which has limited access over most of its length, has higher densities than the rest of the Similkameen River system. The 1984 creel census does not bear this out however (see Appendix 2). It is more likely the case that the primary and secondary productivity in the stream is so low that fish production cannot keep pace with the angling pressure that is exerted. Fishing pressure on catchable-sized (200+ mm) rainbow trout could be reflected in low juvenile recruitment. Other factors contributing to the low density observed may include interspecies competition, low nutrient concentrations in the streams and anchor ice (C. Bull, pers. comm., 1983).

The highest densities of rainbow trout in the mainstem Similkameen River, below Similkameen Falls, were found between Keremeos and Princeton, B.C. (Table 4-16). An estimated population of 42,621 rainbow trout was calculated for this stretch of river. This represents 30% of the population of rainbow in the entire system. Of the total population for the system, 40% (56,076) is in the Similkameen River below the falls. The majority of the remaining fish (13,047) in the Similkameen River, below the falls, were estimated to be in the Similkameen River from Princeton to the falls. Only 408 rainbow trout were estimated from Keremeos, B.C. to the Enloe Dam in Washington.

The second largest estimated population of rainbow trout in the system was in the Ashnola River, where rainbow population densities ranged from 0.01 to 0.19 fish/m^2. This population makes up 34% (47,934) of the total rainbow trout population for the Similkameen River system. The vast majority of the trout in the Ashnola River are found above the lower two reaches of the river. In the Tulameen and Pasayten Rivers, trout densities or a small proportion of the rainbow trout population are also found at or near the mouths of the rivers.

Within the Similkameen River basin, upstream of Enloe Dam, the main fish species with which introduced steelhead would compete is rainbow trout. The population of this species in the system as a whole is depressed (P. Slaney, pers. comm., 1983). We conclude that the rainbow trout habitat in the Similkameen River system is presently underutilized with the possible exception of the Ashnola River. Competition between the steelhead and rainbow is likely to occur, however, due to the habitat presently available, the effect should be minimal. If steelhead were introduced there would probably also be increased fishing regulations implemented such as a 20 cm (8 in) minimum size limit. This regulation exists in British Columbia where both steelhead and rainbow are present (C. Bull, pers. comm., 1985) and would serve to protect the smolts as well as reduce the harvest of resident rainbow trout. More than 57% of the harvested rainbow trout measured during the 1984 creel survey of the Similkameen River system were under 20 cm (IEC BEAK Consultants Ltd., 1985, see Appendix 2). Another effect of steelhead trout introduction would be the indirect enhancement of the resident trout population by the residualization of some percentage of the stocked steelhead smolts. Residualization of some smolts for at least 1 year following release has been noted for the Wells Hatchery summer steelhead stock (K. Williams, pers. comm., 1984). This residualization would, however, tend to increase steelhead/rainbow trout competition.

4.12.4 Potential Liberation Sites, Access And Transportation Considerations

Steelhead smolts, once imprinted to a particular stretch of stream, will usually return as adults to the same section of stream. Lister et al. (1981) in a review of the effects of enhancement strategies on salmonid homing/straying found that the further upstream in a river system the juveniles were planted, the stronger their homing to that stream was. In addition, the tendency to stray into other streams and/or stray back to the facility where they were reared was also signficantly reduced.

The likely planting situation in the Similkameen River system is one in which the returning adults, on their way back to the Similkameen River, would have to pass Wells Hatchery where they have been reared. It is crucial that the adults proceed to the Similkameen River directly, and not stop at the hatchery, in order to provide the optimal angling time on the run and maximum spawner contribution to the Similkameen River system. A tendency has been noted with the Methow River steelhead to remain near the mouth of the Methow River and in the Columbia River until they are ready to move upstream to spawn (K. Williams, pers. comm., 1983).

However, the majority of steelhead smolts are planted in the Methow River between the mouth and 8 miles upstream (S. Miller, pers. comm., 1984). The intension of planting smolts in the lower river is to create a good sport fishery on the hatchery fish in this accessible lower portion (K. Williams, pers. comm., 1984). This planting strategy may explain, to a large extent, the tendency for the returning adults to remain in the lower river.

The objectives of introducing steelhead trout in the Similkameen system would be to produce a quality steelhead fishery (with or without harvest) throughout the majority of the system in both the fall and spring, and to allow the maximum contribution of the returning adults to steelhead propagation. Between 100,000 and 250,000 summer steelhead smolts would likely to be liberated annually in the Similkameen basin for a number of years. In order that the steelhead contribute both to the fishery and to propagation it seems prudent that the smolts be liberated in the upper portions of the watershed. This would allow additional time for the fish to imprint on the system and bring the returning adults far upstream in the Similkameen system. The smolts could be distributed in such a way as to minimize competition with resident rainbow trout as well as utilize the extensive rearing habitat present in the system.

Potential liberation sites were identified on the basis of access for a tanker truck or helicopter and the premise of planting in the upper reaches of the system to better facilitate homing. Also, the sites tend to be upstream of the major areas suitable for spawning and the areas in the vicinity have ample rearing area available with fairly low rainbow trout densities. The portion of the Similkameen River system above Similkameen Falls was not considered for smolt planting due to the partial or complete velocity barrier to upstream migration it poses.

The location of these potential steelhead liberation sites are indicated in Figure 4-9. River mile distances are summarized in Table 4-17. The sites on the Similkameen River are measured on the basis of their distance from the confluence with the Okanogan River. The sites on the Tulameen and Ashnola Rivers are measured in terms of their distance from their confluence with the Similkameen River. The river mile distances provide an indication of how far planted juvenile steelhead would swim within the system on their downstream migration.

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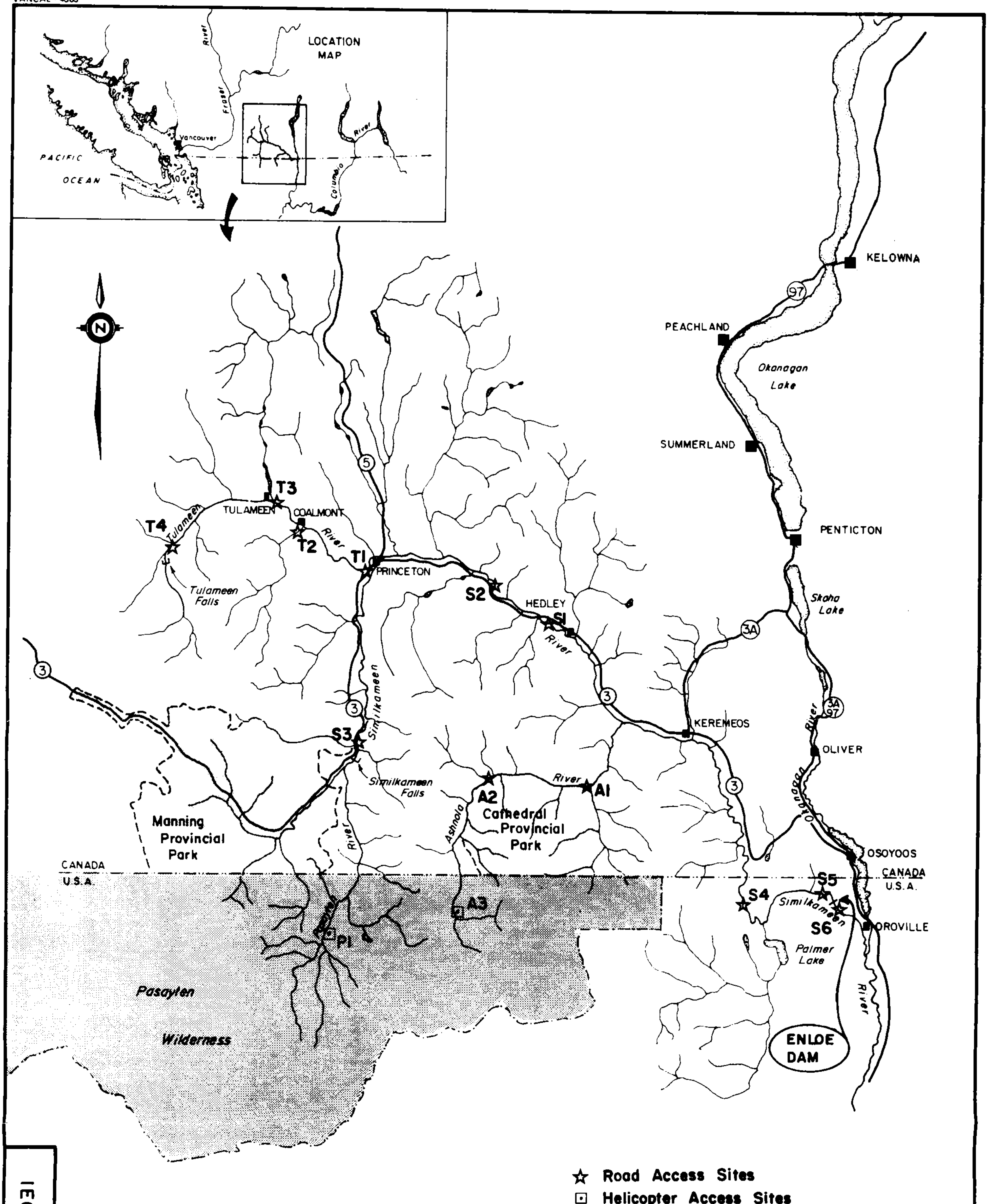

FIGURE 4 – 9 PRELIMINARY STEELHEAD SMOLT LIBERATION SITES

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0 10 20 30 km

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TABLE 4-17
Location of Potential Steelhead Smolt Liberation Sites in the Similkameen River System

Liberation Site	River Mile Distance From Confluence of the Similkameen and Okanogan Rivers	
	Miles	Kilometres
S1	52	84
S2	60	97
S3	96	155
S4	21	35
S5	12	20
S6	5	8
	River Mile Distance From Confluence of the Similkameen and Tulameen Rivers	
	Miles	Kilometres
T1	0.5	0.8
T2	12	19
T3	16	26
T4	28	45
	River Mile Distance From Confluence of the Similkameen and Ashnola Rivers	
	Miles	Kilometres
A1	16	26
A2	28	45
A3	36	60
	River Mile Distance From Confluence of the Similkameen and Pasayten Rivers	
	Miles	Kilometres
P1	18	30

It may become desirable to consider the stocking of other juvenile stages of steelhead such as fry in all or part of the system. Such options may have certain benefits and could utilize these same liberation sites or other sites depending on the strategy being employed.

The location of the potential liberation sites was also measured in relation to its proximity to the Wells Hatchery. Distances and travel times were calculated for tanker truck as well as helicopter modes of transportation and are presented in Table 4-18.

4.12.5 Life Stage Stocking Alternatives

The proposed steelhead smolt stocking program outlined in Sections 4.7 to 4.10 of this report assumes an annual commitment of 250,000 smolts transported to the Similkameen River. The operating and maintenance costs of rearing smolts to a size averaging six fish per pound (S. Miller, pers. comm., 1985) is estimated at $125,000. The smolts are loaded at a density of 0.75 pounds per gallon of truck capacity (2,000 gallons estimated) and transported a relatively long distance (60 miles) from the Wells Hatchery to the closest release points in the lower Similkameen River. The estimated capital, operating, maintenance and transportation costs of producing these high quality smolts is presented in Section 5.3, Table 5-10.

The alternatives for reducing the high costs of production and transport are to:

1. Produce larger numbers of fry or parr which could be transported at much higher densities and lower costs for outplanting taking advantage of natural rearing; or

2. Consider construction of a low cost rearing facility in the lower Similkameen River which would significantly reduce the transportion costs.

A third alternative which was explored at a meeting 7 February 1984 with the B.C. Fish and Wildlife Branch was operation of a rearing facility in the B.C. portion of the

TABLE 4-18
Distance and Travel Time From the Wells Hatchery to Potential Liberation Sites

Liberation Site	Approximate # of Miles/Kilometres From Wells Hatchery by Road		Approximate # of Hours From Wells Hatchery by Road (Tanker Truck/ 40 mph)	Approximate # of Miles/Kilometres From Wells Hatchery by Air		Approximate # of Hours From Wells Hatchery by Air (Helicopter/ 40 mph)a
	Miles	Kilometres		Miles	Kilometres	
S1	136	219	3.5	96	155	2.5
S2	144	232	3.5	104	167	3.0
S3	180	290	4.5	114	184	3.0
S4	95	152	2.5	780	128	2.0
S5	89	142	2.0	73	117	2.0
S6	87	139	2.0	67	107	1.5
T1	156	251	4.0	116	187	3.0
T2	168	270	4.0	124	199	3.0
T3	172	276	4.5	128	206	3.0
T4	184	296	5.0	136	219	3.5
P1[b]				79	122	2.0
A1	126	203	3.0	82	132	2.0
A2	138	222	3.5	90	145	2.0
A3[b]				60	96	1.5

a This assumes 40 mph. However, the actual mph is contingent on the type of helicopter chosen, method of transportation (cargo on board or in a sling) and size of load.

b Not accessable by road.

Similkameen River (see IEC BEAK Consultants Ltd. Progress Report, September, 1984). At the present time, the B.C. government representatives are concerned about the long term commitment to funding the operation of such a facility and would prefer stocking and natural rearing in the Similkameen River and its tributaries.

4.12.6 Stock Availability

The most suitable stock for introduction to the Similkameen River above Enloe Dam appears to be the Wells Hatchery summer steelhead stock which has shown excellent returns to the lower river from the 100,000 and 76,000 smolt plants respectively in 1983 and 1984. In 1985, an additional 55,500 smolts were planted in the lower Similkameen River. At the present time the Wells Hatchery expansion, funded by the Bureau of Reclamation (Appendix 1, minutes of meeting 7 May 1985) appears to be proceeding on schedule with construction planned for late 1985 or early 1986. This facility will provide the capacity to produce 250,000 smolts for outplanting in the Similkameen River system. The Bureau of Reclamation's funding commitment, however, is for a period of five years (Appendix 1, minutes of meeting 7 May 1985) at which time another funding source to cover the future operation and maintenance costs will be required.

4.12.7 Preliminary Stocking Strategy

Summer steelhead smolts have been transported from Wells Hatchery annually in 1983, 1984 and 1985 for outplanting in large numbers below Enloe Dam on the Similkameen River. To date no additional investigations have been undertaken to determine other alternative stocking strategies. Our preliminary evaluations have included the location of potential liberation sites, consideration of other life stage stocking alternatives and discussion of potential rearing facility options for the Similkameen River. The final stocking strategy will be the ultimate responsibility of B.C. Fisheries Branch and Washington Department of Game representatives to initiate after the achievement of fish passage at Enloe Dam.

4.13 Adult Migration Timing

Concern has been expressed by the B.C. Fisheries Branch and Washington Department of Game representatives regarding the expected timing of summer steelhead movement into the Similkameen River as that timing would have a bearing on the expected quality of the sport fishery. The preferred fishery is in the fall when the summer steelhead are recent arrivals and are bright silvery in colour. Overwintering steelhead which pass Wells Dam in the fall and remain in the Okanogan River until early spring, and enter the Similkameen to spawn are usually dark coloured fish which are regarded as less desirable to anglers. This section attempts to address that concern by summarizing information available on timing for upper Columbia River summer steelhead stocks.

One indication of the likelihood that adult summer steelhead would enter the upper Similkameen in time to provide a quality fall fishery can be seen by examining the pattern of their passage over Wells Dam on their return to the Methow, Okanogan and lower Similkameen Rivers. That historical pattern is presented in Table 4-19 in the form of monthly counts during the period from 1967 through 1984. The pattern is consistent in that the vast majority of fish pass the dam in August, September and October. Since 1970 nearly 90% of each year's run passed Wells Dam in these three months. It is also apparent from the data for the most recent 6 years that the summer steelhead run above Wells Dam is increasing dramatically.

An additional indication of a quality fall fishery comes from the monthly sport catch of adult steelhead and thus the relative size of the runs for 5 rivers in the upper Columbia basin as reported in Table 4-20. These data are summarized from Washington Department of Game punchcard returns for the two most recent seasons of available data. The steelhead in all five rivers represent Wells Hatchery stock.

In the rivers with a substantial steelhead fishery (Methow, Entiat and Wenatchee), very significant catches are reported in the fall months. This lends additional credability to the expectation that adults would return to the upper Similkameen River in sufficient numbers to provide a quality fall fishery there.

TABLE 4-19
Monthly Steelhead Count Summaries for Wells Dam[1]

1967, 1968 and 1969

Month	1967	1968	1969	Total	%
April	-	-	73	73	1.38
May	53	671	727	1451	27.33
June	121	29	31	181	3.41
July	53	11	28	92	1.73
August	208	119	186	513	9.66
September	368	777	137	1282	24.15
October	744	566	186	1496	28.18
November	30	95	96	221	4.16
				5309	

1970 to 1979

Month	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total	%
April	-	3	6	6	-	-	-	-	-	-	15	0.05
May	105	184	299	142	162	55	44	37	177	72	1277	4.48
June	31	12	6	31	19	12	37	22	32	2	204	0.72
July	18	5	2	48	43	21	56	38	12	22	265	0.93
August	132	284	286	339	120	128	530	1034	399	1212	4464	15.68
September	630	1771	766	1006	75	254	2301	1173	788	1180	9944	34.92
October	723	1690	724	782	278	273	1856	2849	528	1165	10868	38.16
November	87	186	88	N/C	42	N/C	156	526	N/C	355	1440	5.06
											28477	

1980 to 1984

Month	1980	1981	1982	1983	1984	Total	%
April	-	-	-	-	-		
May	202	139	149	26	153	669	1.23
June	24	23	7	2	32	88	0.16
July	15	107	67	135	766	1090	2.01
August	382	623	1042	1891	5024	8962	16.50
September	1404	1902	2766	11368	7235	24675	45.42
October	1358	1401	3733	5294	3298	15084	27.76
November	413	513	730	1327	778	3761	6.92
	3798	4708	8494	20043	17286	54329	

[1] Unpublished data obtained from Ken Williams, Washington Department of Game (1985).

TABLE 4-20
Monthly Steelhead Trout Sport Catch[1]

Month	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
Methow River													
1982	0	0	3	9	193	544	145	16	41	313	262	3	1529
1983	0	2	6	65	1075	1769	753	47	45	512	1550	0	5824
Entiat River													
1982	0	0	0	0	3	9	13	3	13	9	19	0	69
1983	0	0	0	0	17	37	30	0	0	0	90	0	174
Wenatchee River													
1982	0	6	0	16	117	278	104	41	114	63	41	0	780
1983	4	0	0	0	0	0	0	637	400	368	252	0	1661
Similkameen River													
1982	0	0	0	0	0	0	0	0	0	0	13	0	13
1983	0	0	0	0	0	0	0	2	0	0	15	0	17
Okanagan River													
1982	0	0	0	0	0	3	3	0	0	0	0	0	6
1983	0	0	0	0	0	4	13	0	2	6	9	0	34

[1] Data presented for 1982-83 and 1983-84 seasons collated by Washington Department of Game from punchcard returns.

In 1983 the Washington Department of Game planted 100,000 summer steelhead smolts in the lower Similkameen and 76,000 were planted there in 1984, all from the Wells Hatchery. The information available at this time does not allow a fall fishery evaluation comparable to other rivers such as the Methow, Entiat or Wenatchee. Returns from the 1984-85 and 1985-86 seasons, when they become available, should allow such an assessment.

To assist in the interpretation of the preceeding information about the arrival times of adult steelhead in neighboring river systems in the Upper Columbia basin, a comparison of some of their physical characteristics (drainage area, flow and water temperature) of those rivers is presented in Table 4-21. The location and basin configuration is shown in Figure 4-10.

The data indicates that the Similkameen River has the largest drainage area of 9190 km^2 compared with 4589 km^2 for the Methow River. Mean annual discharge is 66.2 m^3/s compared with 45.1 m^3/s. Mean discharge during the peak migration period August-October ranges from 17.4-25.0 m^3/s for the Similkameen compared with 13.9-15.0 m^3/s for the Methow River. Mean monthly discharge as a percent of annual discharge during the peak migration period is similar for all the river systems.

A comparison of mean annual water temperatures indicates the Similkameen River is slightly warmer at 7.9°C than the Methow (7.6°C), Wenatchee (7.4°C), and Entiat Rivers (5.4°C). During the expected period of peak upstream migration, August to October, the mean monthly water temperature declines from 15.4-10.0°C on the Similkameen River, 14.3-9.3°C on the Methow River and 13.9-8.7°C on the Wenatchee River.

A comparison of the physical characteristics of these Upper Columbia River tributaries with the Similkameen River indicates that there are more similarities than differences between the drainages. This is supportive of the expectation that adult summer steelhead would return to the Okanogan-Similkameen River system during the same migration period as the other river systems, and would therefore be the basis of a quality fall fishery.

TABLE 4-21
Physical Comparison of the Wenatchee, Entiat, Methow and Similkameen Rivers[1]

	Drainage Area (km^2) At Gauge	Elevation (m) At Gauge	Mean Annual Unit Runoff ($l/s/km^2$)
Wenatchee River	3370	207	28.4
Entiat River	526	475	20.7
Methow River	4589	274	9.8
Similkameen River	9190	347	7.2

MEAN DISCHARGE IN m^3/s

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wenatchee River	51.5	53.7	61.0	93.1	230.1	290.6	148.8	51.5	27.2	31.3	48.7	58.5	95.6
Entiat River	2.9	3.1	3.9	7.8	29.7	44.5	19.1	6.5	3.5	3.0	3.2	3.5	10.9
Methow River	11.8	12.1	15.8	38.7	138.0	187.3	64.2	20.6	13.9	15.0	15.0	13.8	45.1
Similkameen River	17.1	18.7	19.4	54.7	227.4	259.7	86.1	26.1	17.4	20.5	25.0	21.7	66.2

MEAN DISCHARGE IN PERCENT OF AVERAGE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wenatchee River	4.5	4.7	5.3	8.1	20.1	25.4	13.0	4.5	2.4	2.7	4.3	5.1	100.0
Entiat River	2.2	2.4	3.0	6.0	22.7	34.0	14.6	5.0	2.6	2.3	2.5	2.7	100.0
Methow River	2.2	2.2	2.9	7.1	25.3	34.3	11.8	3.8	2.5	2.8	2.7	2.5	100.0
Similkameen River	2.2	2.4	2.4	6.9	28.6	32.7	10.8	3.3	2.2	2.6	3.2	2.7	100.0

MEAN WATER TEMPERATURE (^oC)*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wenatchee River	0.6	1.0	3.0	6.2	9.7	12.6	14.1	13.9	11.9	8.7	5.2	2.3	7.4
Entiat River	0.0	0.5	2.2	4.8	7.5	9.7	10.7	10.4	8.7	6.1	3.4	1.2	5.4
Methow River	0.8	1.0	2.9	6.1	9.7	12.7	14.4	14.3	12.4	9.3	5.7	2.6	7.6
Similkameen River	0.3	0.3	2.4	5.9	9.9	13.4	15.4	15.4	13.4	10.0	6.0	2.5	7.9
Okanogan River	1.0	1.3	4.0	8.2	13.0	16.9	19.1	18.8	16.2	12.0	7.3	3.2	10.0

1 Sources: Water Survey of Canada
USGS - Water Resources Division

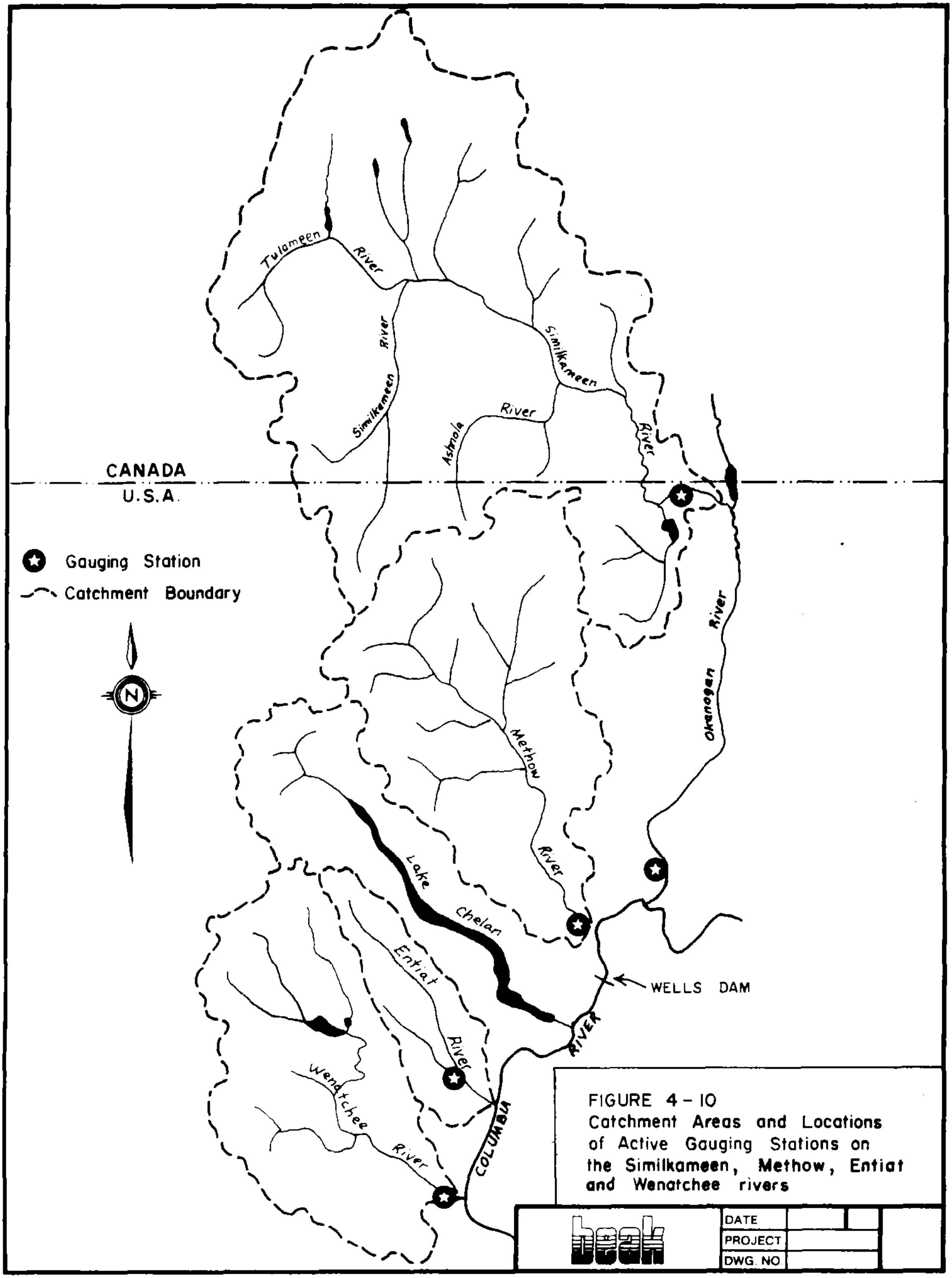

FIGURE 4 - 10
Catchment Areas and Locations of Active Gauging Stations on the Similkameen, Methow, Entiat and Wenatchee rivers

4.14 Potential Sport Fishery

In order to more fully address the various considerations of establishing a sport fishery based on steelhead trout in the Similkameen basin above Enloe Dam, it is instructive to examine the existing fishery there. This section addresses the present fishery based on non-anadromous trout species above Enloe Dam and the growing steelhead fishery below the dam and summarizes some of the features of a potential steelhead fishery above the dam.

4.14.1 Present Resident Sport Fishery Upstream Of Enloe Dam

As part of BPA's program of consultation with the various agencies, Tribes and organizations with interest in potential fish passage of Enloe Dam, significant contact has been ongoing with the B.C. Fisheries Branch. Following from a suggestion by representatives of that agency (C.J. Bull, personal communication, 1984), a detailed survey of Similkameen anglers was conducted in the summer season of 1984 to document several aspects of angling pressure, sport fish harvest and angler attitudes. The census method employed was basically that described by Malvestuto et. al. (1978) with slight modifications. The full report of this effort including the objectives, methods, results and analysis are contained in Appendix 2. Only a brief summary of some of the salient findings are presented here.

The method employed relies on non-uniform probability sampling techniques and stream-side interviews to gather the base data on anglers, their catch and their harvest. This allows statistical extrapolation from the base data to estimates covering both time and distance throughout the basin. A trained field crew, augmented by periodic counts from a spotter aircraft, surveyed approximately 400 km (240 miles) of stream. Interviews were conducted on 62 days, within defined sampling units of the stream, which included weekdays, all weekends and all statutory holidays (to enhance sample size) during the period from 23 June through 8 September 1984.

A total or 336 anglers were interviewed and they reported a total catch of 631 fish with only 229 of those kept (harvested). The breakdown of the catch and harvest by species and size was:

Species	Catch	Harvest			
		Number	% of Catch	x Fork Length	x Weight
Rainbow trout	475	155	32%	19.7 cm	77.5 gr.
Brook trout	138	62	45%	19.0 cm	72.3 gr.
Cutthroat trout	1	1	100%	--	--
Mountain whitefish	10	8	80%	30.7 cm	--
Squawfish	7	3	43%	--	--
Total	**631**	**229**	**36%**		

All of the brook trout came from the tributary system composed of Allison and Summers Creeks, where that species has been stocked.

The origin of the anglers was determined to be 16% from the local area, 71% from elsewhere in B.C., 6% from other provinces and 6% from other countries. Of the local residents, nearly 90% had come to the river specifically to fish, contrasted with only 39% of the non-residents (61% had other primary reasons, mainly family camping and just travelling past, for being on the river). The local residents seem to prefer fishing the headwater lakes that have been stocked. These results reflect the rather poor capability of the Similkameen River to draw anglers despite its extensive stretches of easy access from the highway. The small size of the fish catchable in the system probably has a great deal to do with the poor drawing power.

Effort by anglers was also reported to be low, averaging less than two hours for an angler day. This average varied on a monthly basis between 0.8 and 2.5 hours, and again reflects that the principal recreational activities were other than fishing.

The mean daily catch per unit effort was highest in June at 2.2 fish/hour and declined to below 1 for the remainder of the season (0.4 fish/hour in September). These discouragingly low rates of yield are probably the other major reason for the low power the system has for attracting anglers.

Extrapolations of the base data to the entire system for the four month period resulted in the following average estimates.

Total angler effort = 7,518 days (13,410 hours)
Total catch = 10,791 fish (harvest of 4,619 fish)
Total catch of rainbow trout = 7,554 (harvest 2,493)
Total catch of brook trout = 3,237 (harvest 1,457)
Total catch per unit effort = 1.4 fish/day (0.8 fish/hour)
Total harvest per unit effort = 0.6 fish/day (0.3 fish/hour)

Quite obviously the distribution of effort, catch or harvest was not uniform amongst all sections of the basin. The following estimates were calculated for the four month summer period.

Stream Section	Effort (Angler Days)	Catch (Number)	Harvest (Number)
Allison/Summer Creeks	2,781	5,557	1,879
Old Hedley Road Bridge to Princeton	2,201	840	375
Ashnola River	1,732	7,063	2,405
Above Similkameen Falls	1,723	2,038	648
Tulameen River	449	329	149
Old Hedley Road Bridge to Keremeos	354	87	87
Similkameen Falls to Princeton	Approx. 0	N/A	N/A
U.S. Border - Enloe Dam	Approx. 0	N/A	N/A

During the interviews anglers were asked for their opinions concerning steelhead introductions to the system and how they would respond to such introduction. A total of 88% were in favour of the introductions, 9% were undecided, and only 3% were opposed. In response to the question if they would make a special trip to the Similkameen to fish for steelhead, 49% said yes, 48% said no and 3% were undecided. Of those anglers who said they would spend more time if steelhead were introduced, 46% indicated they would spend at least a weekend, 16% said a week or more and 38% said a day or less. Overall, 30% of the interviewed anglers felt that steelhead introductions would not effect their angling effort and 70% would make a special trip or expend more effort fishing.

4.14.2 Present Sport Fishery Below Enloe Dam

As indicated in Section 4.14.1 above the IEC BEAK Consultants Ltd., 1984 summer creel survey did not include the U.S. portion of the Similkameen River below Enloe Dam or Palmer Lake. In general fishing effort for resident species on the mainstem Similkameen River between Enloe Dam and the confluence with the Okanogan River is relatively light. Major sport fish captured below Enloe Dam include rainbow trout (*Salmo gairdneri*), mountain whitefish (*Prosopium williamsoni*), lingcod (*Lota lota*), smallmouth bass (*Micropterus dolomieui*) and carp (*Cyprinus carpio*).

Angler effort and harvest for summer-run chinook salmon which enter the Similkameen River in August and September is presently light. The small harvest is mainly restricted to avid anglers who are local residents of the area.

The summer steelhead sport fishery which has recently been introduced by the Washington Department of Game 1983 and 1984 smolt stocking program in the Similkameen River seems to have produced excellent results during the 1984-85 season, representing the 1-ocean adult return of the 1983 smolt plant. The Washington Department of Game punchcard data for the 1984-85 season which will provide information on angler effort and harvest will not be available until mid-summer 1985 (K. Williams, pers. comm., 1985).

4.14.3 Potential Steelhead Sport Fishery On Similkameen River

The success of Wells Hatchery summer steelhead returning from smolts planted in the Methow River is indicative of the potential to produce a similar quality sport fishery in the Similkameen River. Preliminary indications from the 1983 and 1984 smolt plants in the Similkameen River are that the 1-ocean year class returned in good numbers providing the best fall and spring steelhead fishery on record (since 1967, Table 4-2) for the Okanogan and Similkameen Rivers. The expansion at Wells Hatchery to provide 250,000 smolts annually for planting in the Similkameen River and achievement of fish passage at Enloe Dam will provide access to extensive spawning and rearing habitat available in the upper watershed. The continued supplementation of artificial production combined with natural production is projected to provide a total steelhead run of 22,300 and harvest of 2,228 in years 49 and 50 based on a 10% annual harvest (Section 4-10). In contrast, at a 40% allowable harvest per year the total run size would be 9,800 in years 49 and 50 with a harvest of 3,923 steelhead.

At the present time the potential for a viable sport fishery on the Similkameen River appears to be excellent. However, many fisheries management decisions are required regarding such issues as the ultimate stocking strategy; harvest allocation among users in Washington, B.C. Tribes and sport fishermen; and protection of wild fish. All of these factors are factors which will influence the eventual size of the run. In addition, many factors relating to the behavior of Wells Hatchery smolts planted in the Similkameen River are still unknown.

4.15 Harvest Management Considerations

In order to assess the potential benefits to be realized from the establishment of a summer steelhead fishery in the Similkameen River by developing a natural run of wild fish with artificial supplementation as outlined in Section 4.10, the most appropriate method of maximizing natural production while controlling the commercial (native and domestic) and recreational harvest in British Columbia and Washington must be determined. The resource user groups which should be considered in development of a unified harvest management strategy and their present estimated harvest of the Wells

Hatchery - Methow River/Okanogan River/Similkameen River stocks in the Columbia River below Wells Dam is as follows:

User Group (1983 and 1984 estimated)	Washington %	B.C. %
Commercial Fishery - domestic - incidental	0 - 1	0
Commercial Fishery - Native - incidental	1	0
Recreational Fishery (1982 WDG punchcard)	8	0

A comparison of the current sport fishing regulations in British Columbia and Washington is presented to illustrate the variety of freshwater fishery management strategies employed in the Pacific Northwest with respect to steelhead and rainbow trout.

4.15.1 British Columbia Fisheries Branch

In British Columbia, the 1985/86 Synopsis provides an annual province wide catch quota of 10 steelhead (rainbow trout greater than 50 cm fork length) for all waters. A maximum daily catch of 0 wild and 2 hatchery steelhead in Vancouver Island Region 1 rivers is permitted where a catch and release fishery has been employed to protect wild stocks. Other general restrictions include use of single barbless hooks, a general bait ban (May 1 - November 30) and a new requirement that after an individual's daily quota is reached, no further fishing is permitted. For the Thompson River in Region 3 only 2 steelhead per month may be harvested. Two daily possession quotas of 1 steelhead or trout over 50 cm are permitted. Aggregate trout for all streams in the Region is set at 4. The annual closure occurs January 1 to May 31 to protect spawners.

The B.C. portion of the Okanogan-Similkameen River system is located in Region 8. The catch quota for trout over 30 cm (Fl) for all streams is 2 and for trout over 50 cm (Fl) for all waters is 1. The aggregate trout daily catch quota (all species, all sizes) is 4 for all streams, 6 for all lakes and 6 for all waters in the Region. A possession limit of 2 daily quotas is in effect. The Okanogan Region is currently considering a minimum size limit for rainbow trout (C. Bull, pers. comm., 1985) of 10 inches in an attempt to improve the quality of the sport fishery. The Similkameen River and its tributaries are exempt from the general spring stream closure which is in effect for other river systems in the Region.

4.15.2 Washington Department Of Game

Washington Department of Game Region II regulations for 1985 which apply to the Okanogan and Similkameen Rivers indicate an annual catch quota of 30 steelhead over 20", with a maximum of 20 captured above Bonneville Dam. In general no distinction is made between wild and hatchery steelhead in Washington State with a maximum daily catch of 2 fish over 20" and a possession limit of 4 fish over 20". In Region II catch quotas for trout are no more than 8, 3 over 14", and 2 over 20". A possession limit is set at 1 catch limit, only 2 steelhead over 20", with a minimum rainbow size limit of 6".

Special regulations include no annual closure in the Okanogan River with closures January 1 to March 31 and May 25 to December 31 for both the Similkameen and Methow Rivers. More restrictive regulations apply to the Wenatchee and Entiat Rivers. For the Entiat River closures occur May 25 to November 30, January 1 to March 31 (trout minimum length 10") and December 1 to December 31. The Wenatchee River from its mouth to the Icicle River Road Bridge is closed May 25 to November 30 (trout minimum length 8", all steelhead over 20" must be released unharmed), January 1 to March 31, and December 1 to December 31 (trout minimum length 10", steelhead daily catch limit of 2 over 20").

4.15.3 Tribes - B.C. And Washington

At the present time, Tribes in British Columbia and Washington support passage at Enloe Dam and development of a summer steelhead fishery in the Similkameen River. Native harvest in Washington State however is generally targetted on chinook salmon with steelhead captured incidentally during their Fall and Winter Treaty fisheries. As mentioned in Section 4.7 Native catches of steelhead have increased in recent years to 151 and 712 in 1983 and 1984 respectively with Wells Hatchery returns representing approximately 1% of their total harvest.

British Columbia Natives have indicated their support for steelhead trout and salmon introduction into the Canadian portion of the Similkameen River. At the present time the Osoyoos Band from Oliver in the Okanogan Region are allocated an annual harvest of sockeye salmon (10% of the run) from the Okanogan River below McIntyre Dam (B. Kurtz, DFO, pers. comm., 1985) by spear and gaff fishing. In 1984, approximately 2000 sockeye were taken from a run estimated at 40,000.

4.15.4 Sport Fishing Associations

Sport fishing organizations in British Columbia (B.C. Wildlife Federation, Penticton Flyfishers, Ospreys, Steelhead Society) are generally supportive of creating a new sport fishery on the Similkameen River, however they rely on the B.C. Fisheries Branch technical representatives to assess the merits and risks of the proposal. Concerns expressed to date include possible disease transfer, requirement for additional management in the Region, harvest allocation and harvest of a less desirable late running steelhead rather than the more preferable fall run.

4.16 Disease Profile Of Other Upper Columbia River Fish Stocks

Although the main emphasis of an anadromous salmonid stocking program in the Similkameen River system upstream of Enloe Dam is presently on summer steelhead, the possibility exists that other anadromous species may be introduced or stray into the upper Similkameen River once passage is achieved. For this reason, a description of the fish diseases documented in other upper Columbia River anadromous stocks has been compiled below.

4.16.1 Wells Hatchery Summer Chinook

The upper Columbia River summer chinook run is currently the dominant component of the Columbia River summer chinook population with the other main component being the Snake River run destined primarily for the Salmon River in Idaho. The present upper Columbia River run is a remnant of a much larger run that was severely impacted by the construction of the Grande Coulee Dam and to a lesser extent, the other mainstem Columbia River dams (ODFW, WDF, WDG and IDFG, 1984b).

Wells Dam Hatchery is presently the primary production facility for upper Columbia River summer chinook.

No viral diseases have been diagnosed at Wells Hatchery however bacterial kidney disease (BKD) was diagnosed in 1984 (K. Hopper, pers. comm., 1985), and eye fluke has also been identified (ODFW, WDF, WDG and IDFG, 1984b).

4.16.2 Similkameen River Summer Chinook

Between October 28 and 31, 1984, IEC BEAK Consultants Ltd. fisheries biologists collected 52 fresh Similkameen River summer chinook carcasses and 16 ovarian fluid samples to be examined for evidence of furnunculosis (Aeromonas salmonicida), enteric redmouth (Yersinia ruckeri), bacterial kidney disease (BKD) (Renibacterium salmoninarum, ceratomyxosis (Ceratomyxa shasta), the proliferative kidney disease etiologic agent (PKD), infectious hematopoietic necrosis (IHN) virus and infectious pancreatic necrosis (IPN) virus.

The salmon carcasses and ovarian fluid samples were shipped the same day they were collected to Bio Med Research Laboratories Inc., Seattle. Bio Med examined the carcasses for non-viral disease agents and along with the ovarian fluid samples, removed tissue samples (spleen and kidney) and delivered them to the National Fishery Research Center in Seattle for viral disease determinations.

The opportunity existed to collect more than 16 ovarian fluid samples however, during the latter part of the sampling period the unusually cold weather (-10°C) caused any fluids collected to freeze thus precluding their use in disease analysis. The tissue samples from all the carcasses were utilized to provide additional information.

The results from the non-viral analyses showed no apparent evidence of furunculosis, enteric redmouth, BKD, KD, or PKD. However, 62 percent of the carcasses had ceratomyxosis infections and all fish had high levels of non- R. salmoninarum bacteria in kidneys and liver (Appendix 3). No viruses were isolated from the 16 ovarian fluid and 52 kidney/spleen samples examined (Appendix 3).

4.16.3 Okanogan River Sockeye

Sixty-five ovarian fluid samples were collected by IEC BEAK Consultants Ltd. from spent sockeye salmon females in the Canadian portion of the Okanagan River near Oliver, B.C. on October 18 and 19, 1984.

The samples were shipped to the National Fishery Research Center, Seattle for infectious hematopoietic necrosis (IHN) virus determination.

The infection rate was found to be 94 percent (61/65 samples). The results were felt to be typical of sockeye salmon populations in general (Appendix 3).

5.0 PASSAGE ALTERNATIVES

5.1 Review Of Agencies And Tribes Preferred Mode Of Passage

BPA has conducted an extensive consultation program with government agencies, Tribes and organizations in both the U.S. and Canada that have an interest in the question of fish passage over Enloe Dam. An indication of that consultation effort is the wide distribution that was given to the progress report (IEC BEAK Consultants Ltd., September 1984). That distribution list is reproduced in Appendix 1 of this report.

One function of that consultation program was to solicit comments from the various groups about their preferred mode of fish passage over Enloe Dam. Probably for a variety of reasons, many groups chose not to identify a preference. Of those that did, there was a diversity of opinion. This section attempts to summarize those opinions and draws heavily on the written communications that are reproduced in Appendix 1 of this report, as well as those in the progress report of September 1984.

The B.C. Fisheries Branch were generally receptive to the proposal to introduce summer steelhead, but indicated several areas of concern. The reader is directed to the letter dated September 4, 1984 from David W. Narver to John Palensky reproduced in Appendix 1. It is this agency's position that the only acceptable passage at this time would be by trap and haul as that would allow full control of escapement, opportunity for disease assessment, full evaluation of the project and appropriate distribution of fish within the system. Should the program be judged as successful, in terms of adult returns, dam removal or a fishway could be considered at some point in the future.

The Colville Confederated Tribes responded in a letter by Al Aubertin to BPA dated December 17, 1984 restating their earlier position that their preference is removal of Enloe Dam, and that they are opposed to hydroelectric development on the river. They cited the reasons of preserving existing runs of salmon and other fish in the Similkameen River and to allow for effective rehabilitation and utilization of the river for fishery purposes (Appendix 1).

In letters to BPA dated December 21, 1984 and January 4, 1985 signed by Donald W. Moos, Director, the Washington State Department of Ecology expressed qualified support for fish passage at Enloe Dam (Appendix 1). Their qualifications were that survival of downstream migrants at mainstem Columbia River dams should be improved first and secondly that the mode of passage should not preclude the restoration of hydroelectric power production at Enloe Dam.

The National Marine Fishery Service, in a letter from Dale R. Evans, Division Chief to L.W. Lloyd of the Bureau of Reclamation dated January 22, 1985, reiterate their support for fish passage at Enloe Dam and identify dam removal as probably the most feasible and cost-effective alternative (Appendix 1). They also note that the Bureau of Reclamation had earlier identified dam removal as the preferred passage alternative in the December 1976 Environmental Impact Statement on the Oroville-Tonasket Unit Extension.

In a Memorandum for Record dated March 14, 1985 which summarized an inter-agency meeting on 26 February 1985, the Army Corps of Engineers outline their feasibility study plan of alternative hydroelectric developments on the lower Similkameen River. They point out on page 6 that the trap and haul alternative for Enloe Dam might be the most easily adaptable passage alternative to the large dam, should it be built, and that laddering may be inconsistent with the large dam depending on the economic life of the passage facilities (Appendix 1).

The Washington Department of Game are on record, via a letter dated June 8, 1984 to John Palensky of BPA from Frank R. Lockard, Director, as favouring dam removal as their first preference for the long term, but recognize the difficulties of accomplishing that. Their second choice is a trap and haul facility which they point out would have several advantages over a ladder, namely:

1. It could be used for collecting and transporting broodstock;
2. It could limit passage of some species;
3. It could trap wild spawners if the dam were removed; and

4. It would allow capture and selection of wild fish for use as hatchery broodstock, (see Appendix A of IEC BEAK Consultants Ltd., 1984 progress report).

The Okanogan Public Utilities District have applied to the Federal Energy Regulatory Commission for a license to reactivate Enloe Dam for hydroelectric power generation and would therefore obviously be opposed to any passage alternative which would infringe upon that possibility or detract from its economic viability, and have not stated a preference for a passage alternative.

5.2 Description Of Passage Alternatives

5.2.1 Introduction

Six alternatives to provide upstream passage at Enloe Dam have been developed to a conceptual level of design. These six alternatives fall into three general categories:

- Fishways;
- Trap and Haul Systems; and
- Dam Removal

These passage schemes were applied to the project site and six conceptual alternatives were developed:

- Alternative 1 - Fishway From Falls;
- Alternative 2 - Fishway Below Powerhouse;
- Alternative 3 - Trap And Haul At Falls;
- Alternative 4 - Trap And Haul Below Powerhouse;
- Alternative 5 - Trap And Haul At Railroad Bridge; and
- Alternative 6 - Dam Removal

The alternatives were developed to provide optimum passage effectiveness, while considering cost, operation and site constraints.

Alternatives 1 through 4 and 6 are located at the Enloe Dam site. Alternative 5 is located further downstream. Figure 5-1 shows the existing Enloe Dam site. The Enloe Dam site is characterized by a 54 ft high gravity arch dam, a 20 ft high natural water fall below the dam and an unused powerhouse and penstock on the right bank. Terrain along the right bank and downstream of the dam is steep and has poor access, it therefore, is less suitable than the left bank for fish passage construction. The left bank has good access and more gradual slopes. To the extent possible, all construction schemes at the Enloe site are located along the left bank.

Alternative 5 is located approximately 2 miles downstream of Enloe Dam. This site is shown in Figure 5-2. Good access is presently available to the left bank of the Alternative 5 site.

In 1981, Public Utility District No. 1 of Okanogan County (PUD) filed a Federal Energy Regulatory Commission license application (Project No. 2062) for redevelopment of hydropower at Enloe Dam. The PUD's proposal has been considered in the development of passage alternatives. Alternatives 2, 4 and 5 are designed to be compatible with hydropower development at Enloe Dam. Alternatives 1, 3 and 6 are not compatible with the PUD's plans. Although Alternatives 2 and 4 were developed to be compatible with hydropower, some conflicts still exist. These are discussed in the following sections.

5.2.2 Alternative 1 - Fishway From Falls

Physical Description

Alternative 1 is a fishway which would be constructed on the left bank of the Similkameen River between Enloe Dam and the falls downstream of the dam. The alignment and details of the fishway are shown in Figures 5-3 through 5-5. Entrances would be located at the base of the falls, and the 78-pool, vertical slot fishway would continue upward along the left bank and exit above the dam. The vertical drop between the entrances and exit is approximately 79 ft.

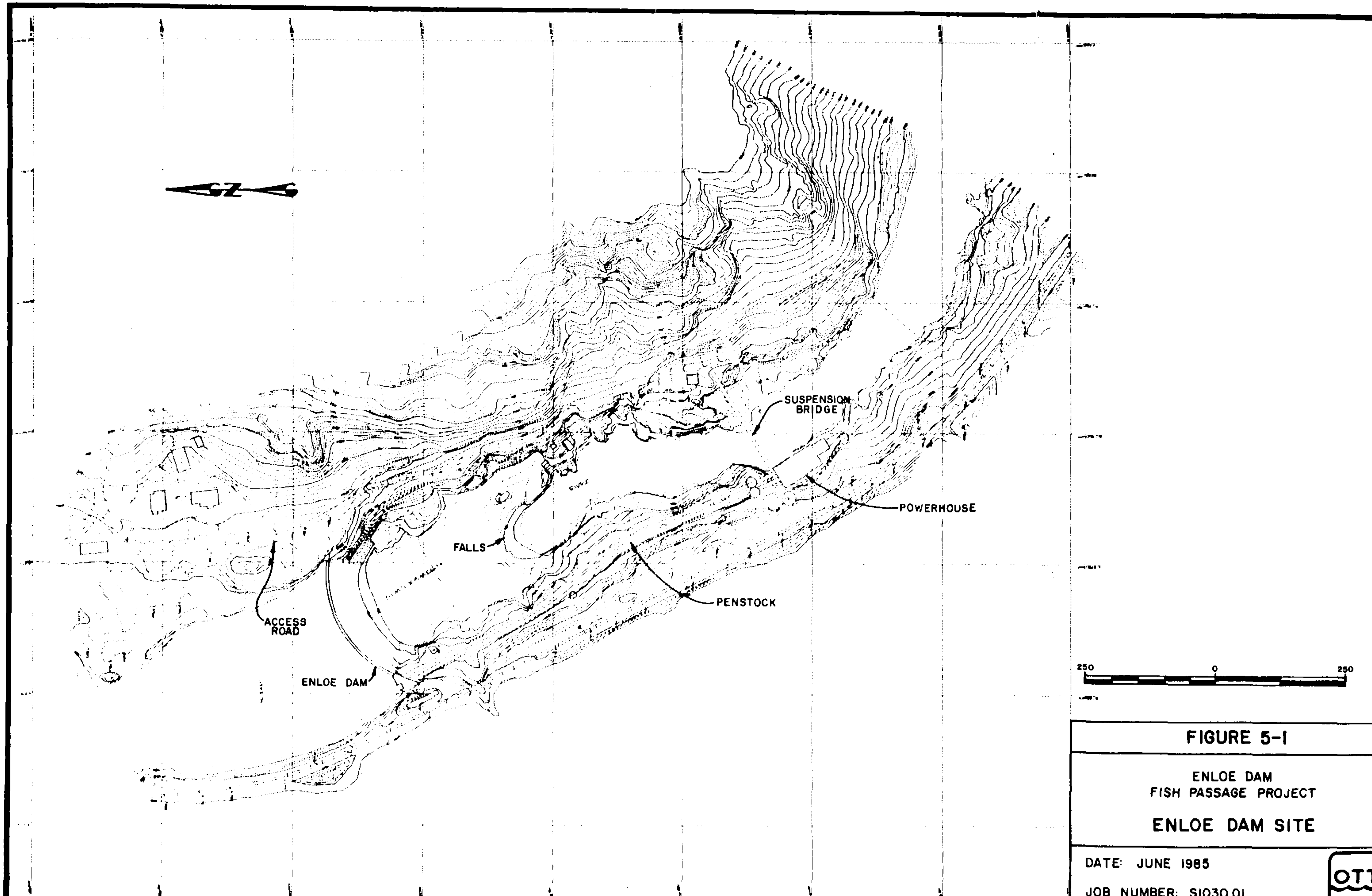

FIGURE 5-1

ENLOE DAM
FISH PASSAGE PROJECT

ENLOE DAM SITE

DATE: JUNE 1985

JOB NUMBER: S1030.01

OTT

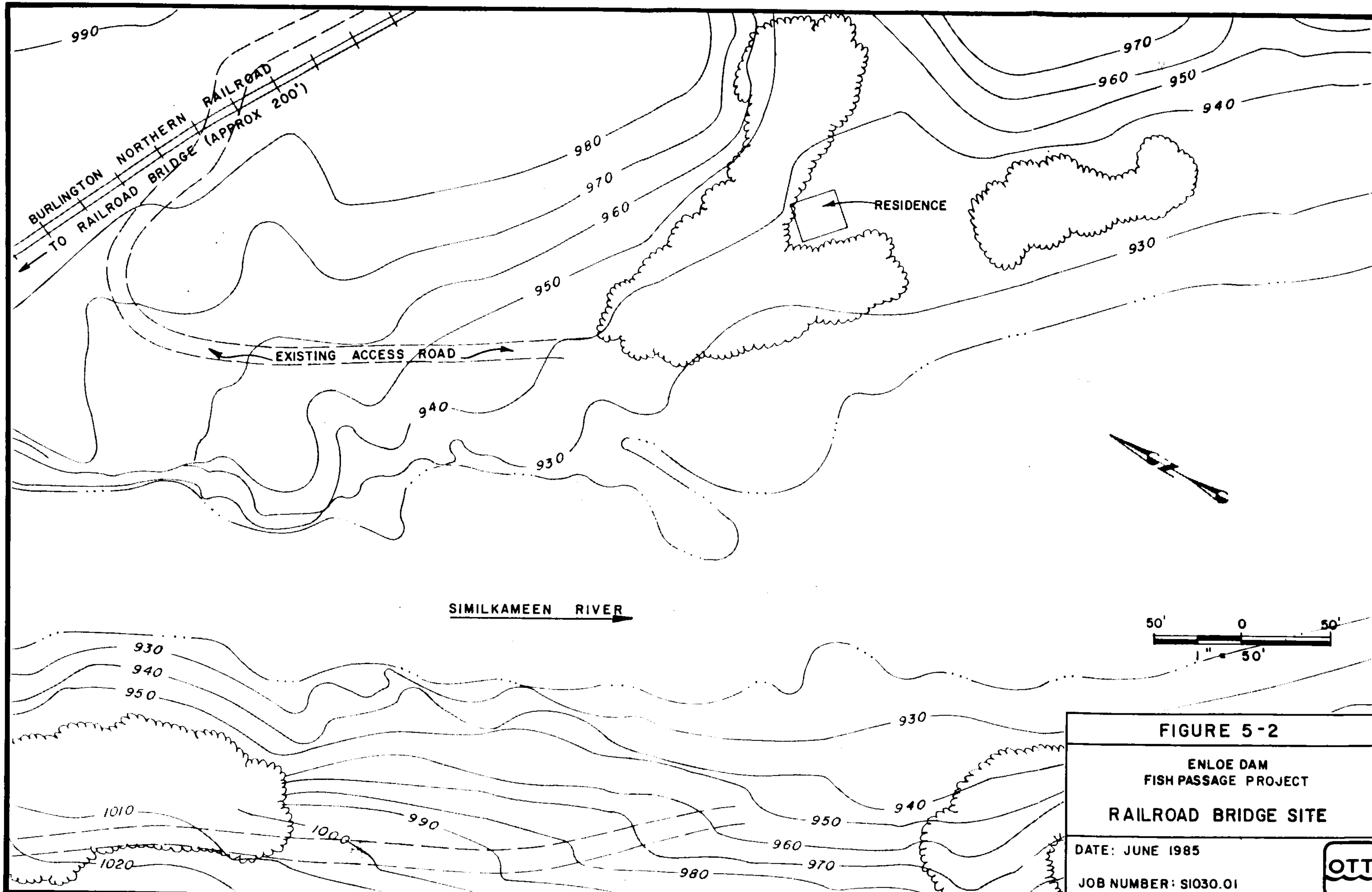

FIGURE 5-2

ENLOE DAM
FISH PASSAGE PROJECT

RAILROAD BRIDGE SITE

DATE: JUNE 1985

JOB NUMBER: S1030.01

OTT

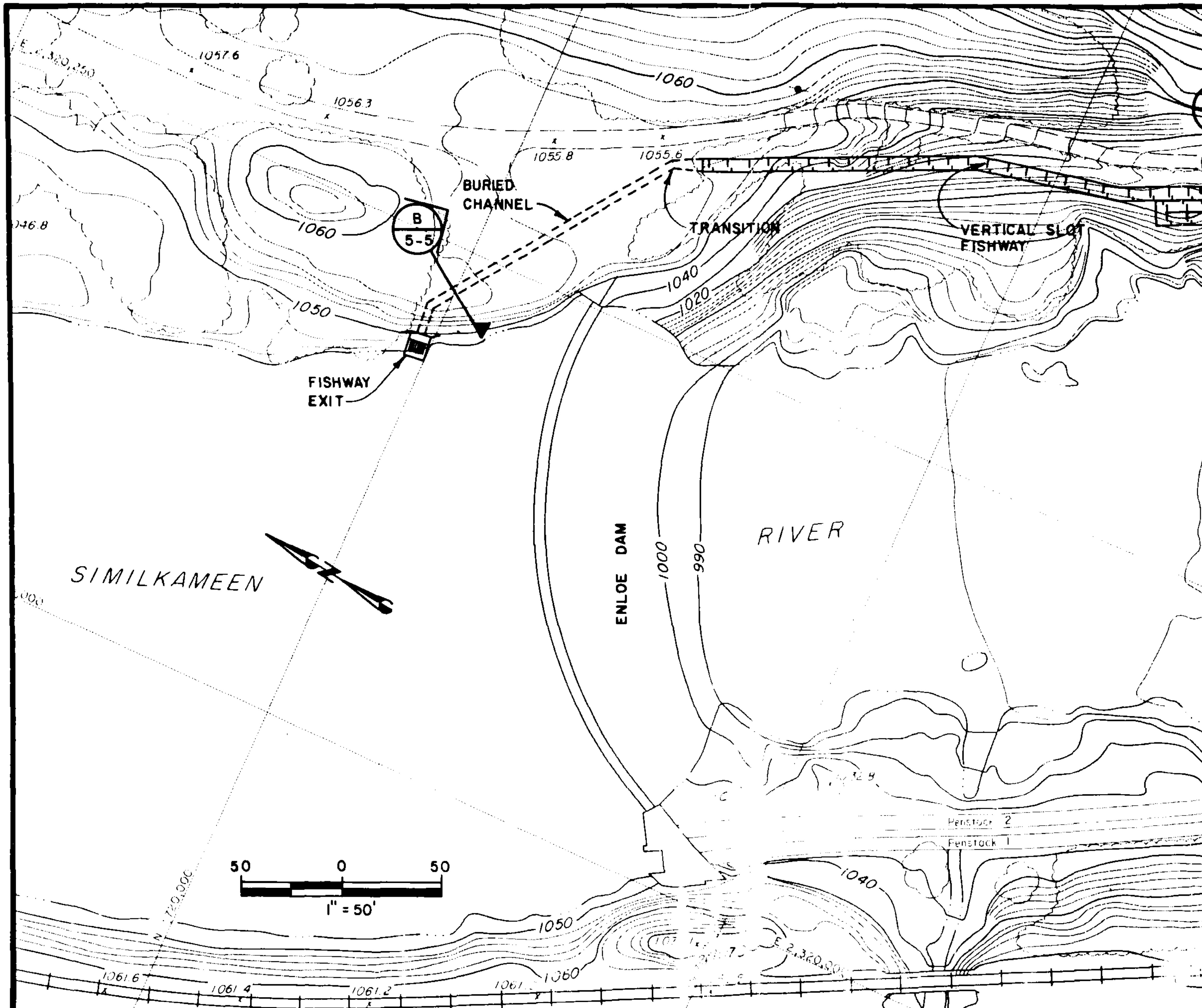

FIGURE 5-3

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 1 SITE PLAN

DATE: JUNE 1985

JOB NUMBER: S1030.01

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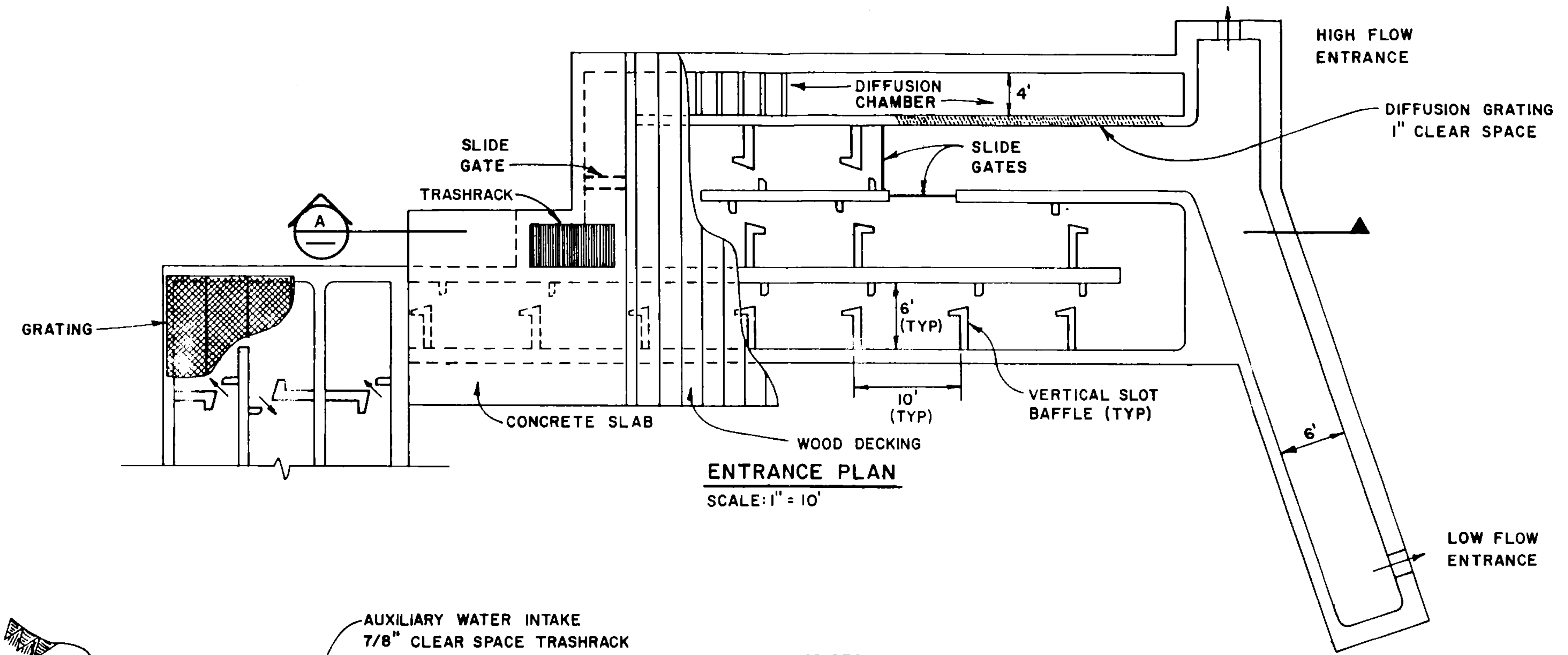

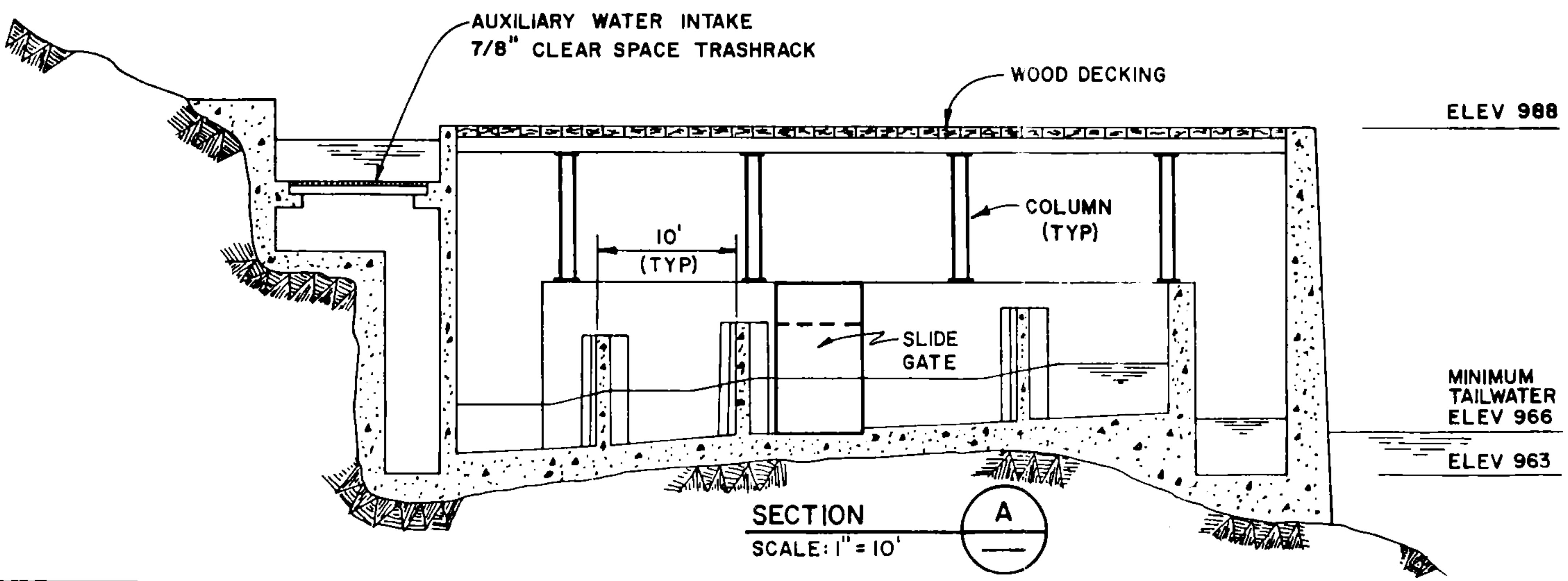

FIGURE 5-4

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 1
FISHWAY DETAILS

DATE: JUNE 1985
JOB NUMBER: S1030.01

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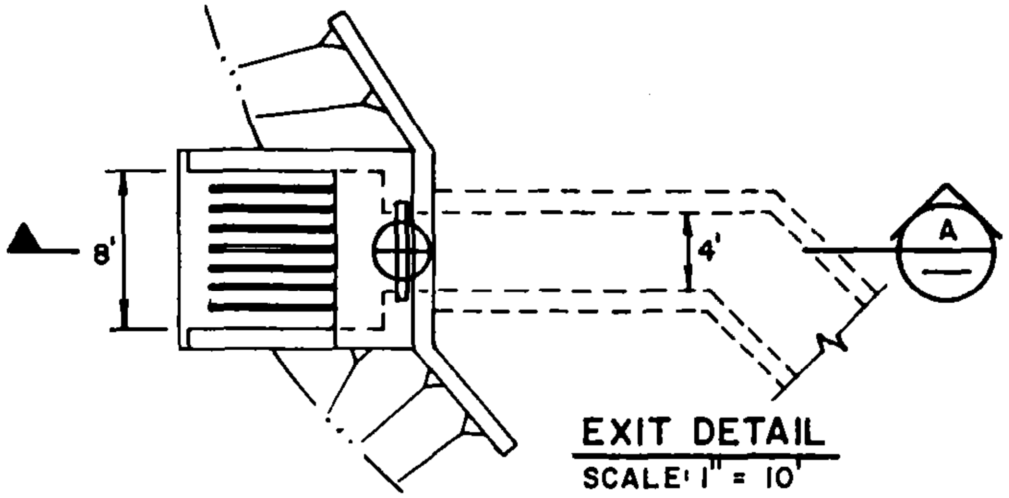
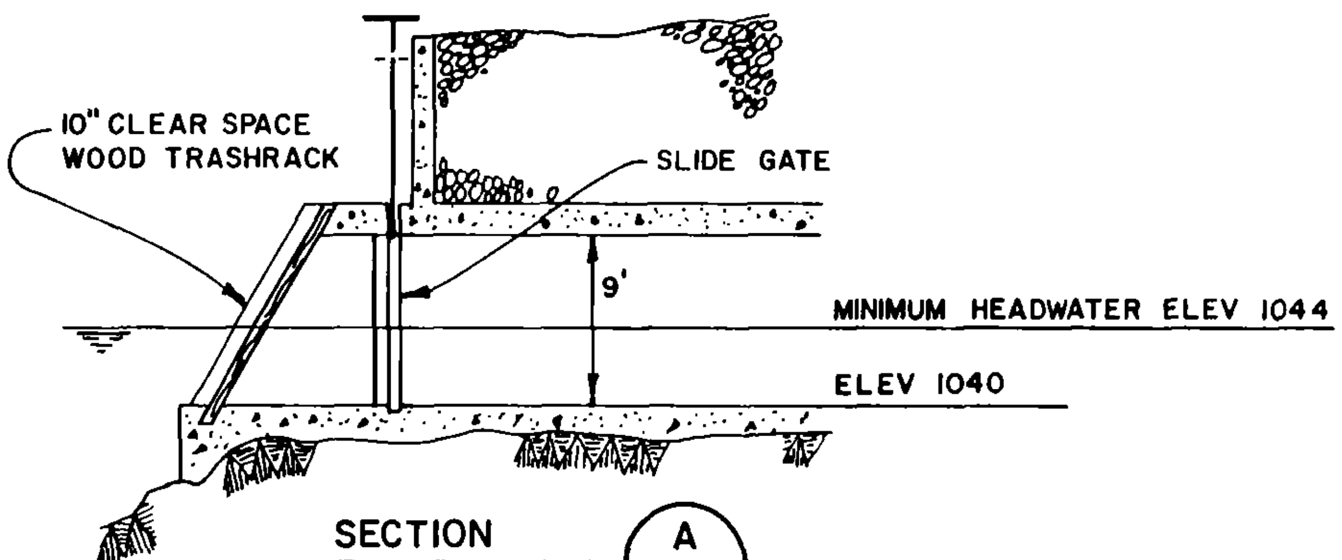
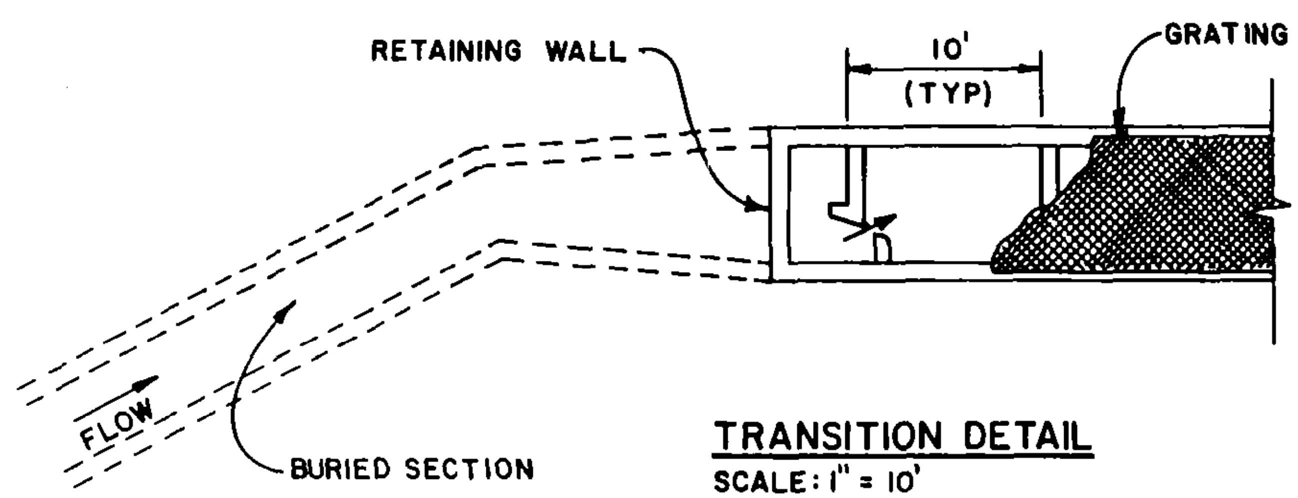


EXIT DETAIL
SCALE: 1" = 10'



SECTION A
SCALE: 1" = 10'



TRANSITION DETAIL
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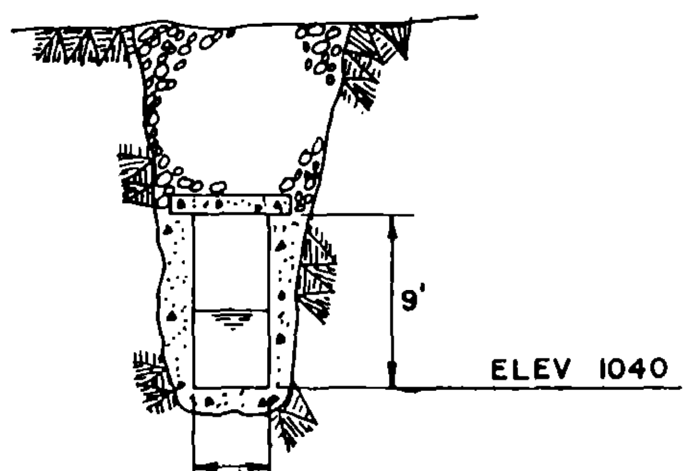
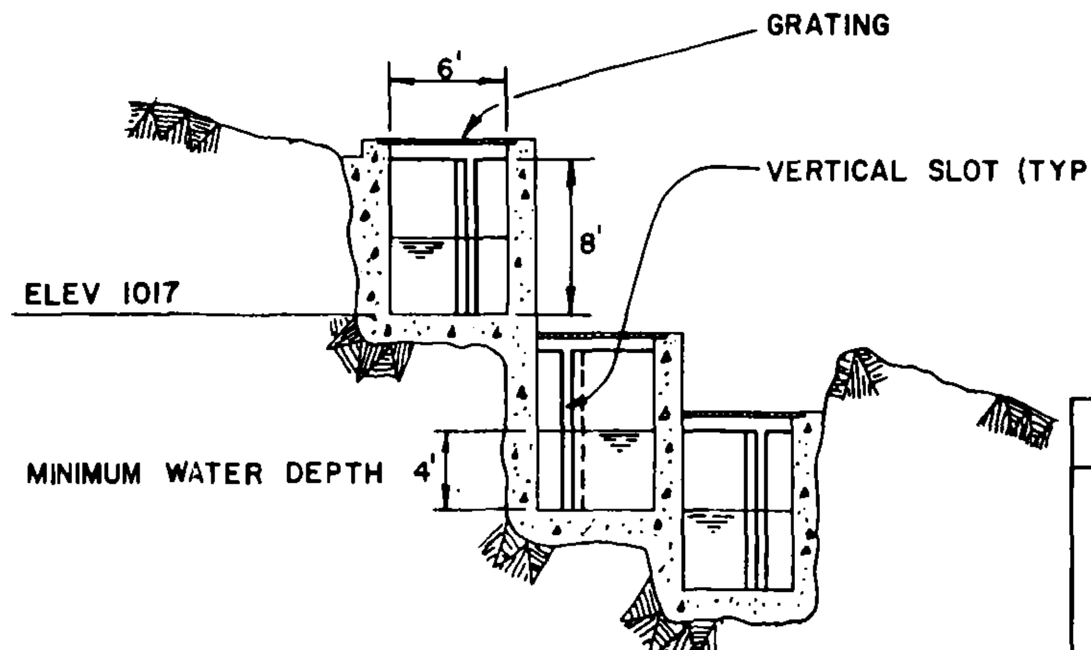


SECTION B 5-3
SCALE: 1" = 10'



SECTION C 5-3
SCALE: 1" = 10'

FIGURE 5-5

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 1 DETAILS

DATE: JUNE 1985

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OTT

Fish approaching the falls would enter one of two entrances located at the base of the falls. The upstream entrance would be constructed to provide low to mid-flow passage; the downstream entrance would provide mid- to high flow passage. Pools above the entrance pool would be 6 ft wide by 10 ft long with a minimum water depth of 4 ft. Baffles between pools would be the vertical slot type with a 1 ft slot. The maximum drop between pools would be 1 ft. The lower section of the fishway would be twice folded with common walls. This arrangement would provide an economical design through savings in concrete and rock excavation. Two additional folded sections would be required above the falls to maintain a uniform hydraulic gradient.

From the entrance pool to a point approximately adjacent to the dam crest, the fishway slope is 10H:1V (ten horizontal to one vertical). Beyond this point, site characteristics and economical design dictate the fishway be buried and set on a nearly horizontal slope. The width of the buried section would be decreased from 6 ft to 4 ft to maintain sufficiently high transport velocities. The fishway exit would be located at the end of the buried section. The exit would be protected with a 10 in clear space trashrack, sloped 60° from the horizontal.

The entire fishway, including walls, slabs and baffles would be constructed of reinforced concrete. The lower portion of the fishway would be covered by a wood deck to prevent uncontrolled flow from entering the fishway. The remaining fishway section would be covered with a galvanized grating to prevent poaching. The exit trashrack would be constructed of wood to minimize ice formation. The auxiliary water intake trashrack would be submerged approximately 2 ft to prevent ice formation.

Steelhead are estimated to arrive at Enloe Dam in their upstream migration during the period of October through November and February through May, when flows in the Similkameen River vary between 400 cfs and 5,500 cfs. Under these flow conditions, tailwater on the fishway will fluctuate about 7 ft. To compensate for the wide fluctuation in tailwater, the lower four pools would operate with the low flow entrance between flows of 400 cfs to 3,000 cfs. Above 3,000 cfs, the lower four pools would be shunted by slide gates and fish would enter the fifth pool directly from the entrance pool. This operation requires only 4 ft of freeboard beyond the minimum water depth of 4 ft and eliminates the need to construct approximately 3 ft of wall and baffle height over the entire fishway length.

As the flow in the Similkameen rises, flow through the fishway will increase from 30 cfs (at low flow) to 55 cfs (at the peak design flow of 5,500 cfs). Flow in the fishway would be controlled by the vertical slots and the water surface fluctuations of entrance and exit. Since the ladder flow of 30 cfs to 55 cfs would not attract fish under all flow conditions, auxiliary water would be added to the entrance pool. Up to 50 cfs of auxiliary attraction flow would be provided through the intake at the lower ladder section. The trashrack on the intake would have a 7/8 in clear space, with flow controlled by a slide gate. Auxiliary water would be diffused into the entrance pool through a diffusion grating with 1 in clear space. Maximum velocity through the grating would be 0.5 ft/sec.

Operation

Alternative 1 would be capable of effectively passing the estimated fish runs that may be established in the Similkameen River. If fish arrive at the site later than the mid-May estimate, however, the confined area at the site and high flows would make passage very difficult.

This alternative requires a substantial capital investment, but little operation and maintenance cost. Periodic adjustment of gates and clearing of trashracks are the principal maintenance requirements.

5.2.3 Alternative 2 - Fishway Below Powerhouse

Physical Description

Like Alternative 1, Alternative 2 is a vertical slot fishway located on the left bank of the Similkameen River. The 80-pool fishway would begin at a barrier dam located downstream of the old powerhouse, and would continue upstream along the left bank to exit 90 ft upstream of the dam. Alignment and details of Alternative 2 are shown in Figures 5-6 through 5-9.

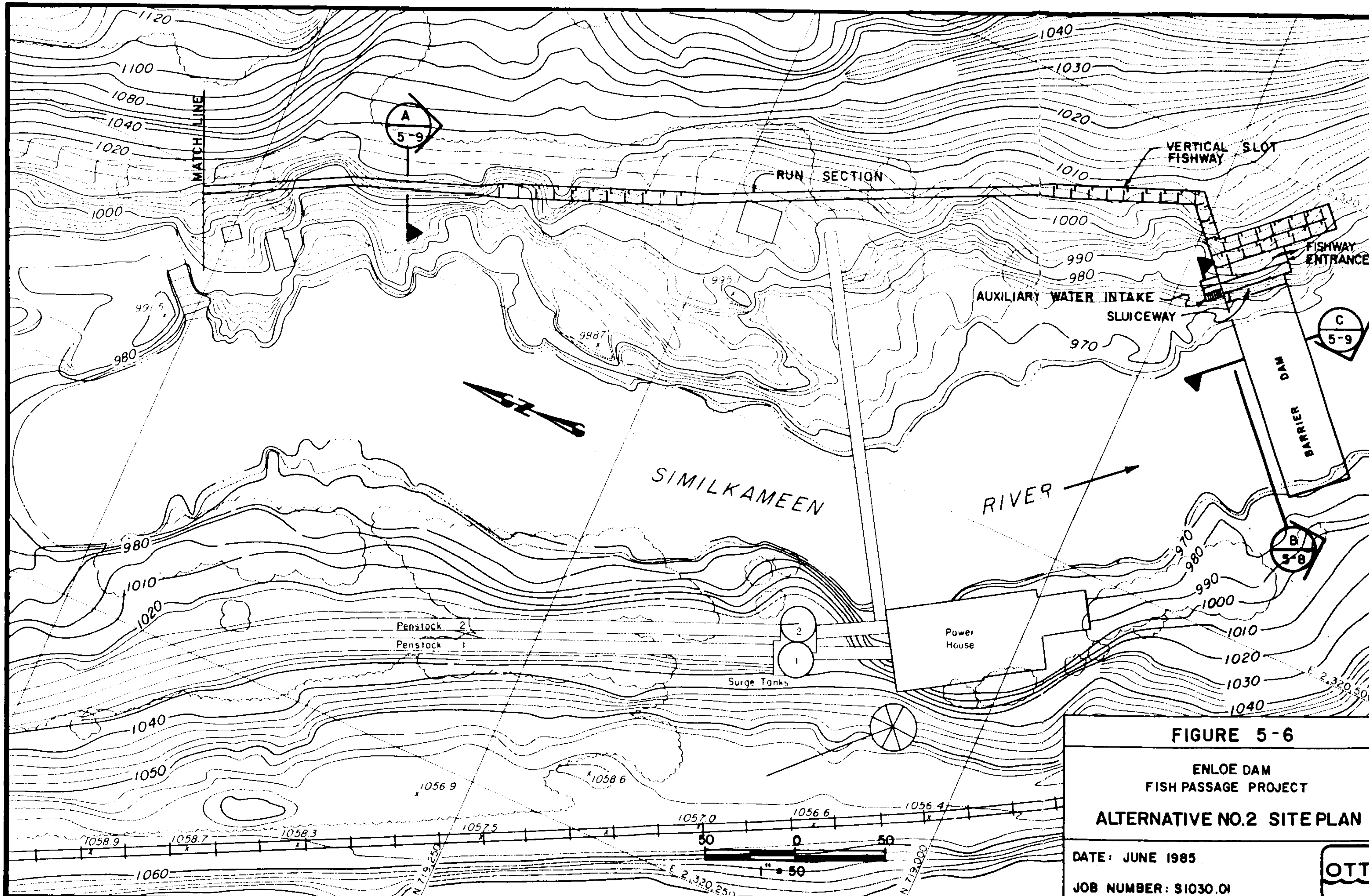

FIGURE 5-6

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO.2 SITE PLAN

DATE: JUNE 1985

JOB NUMBER: S1030.01

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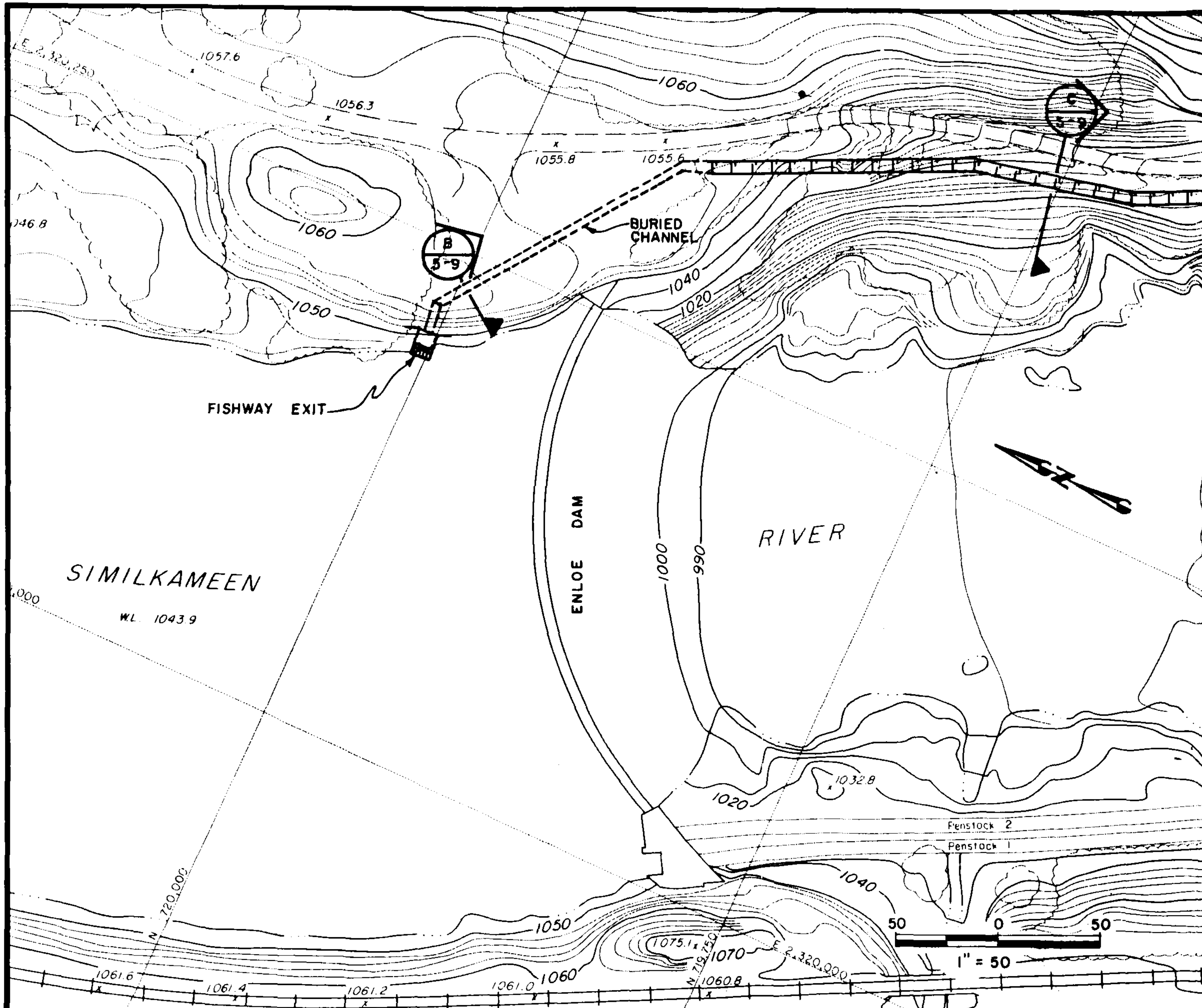

FIGURE 5-7

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 2 SITE PLAN

DATE: JUNE 1985

JOB NUMBER: S1030.01

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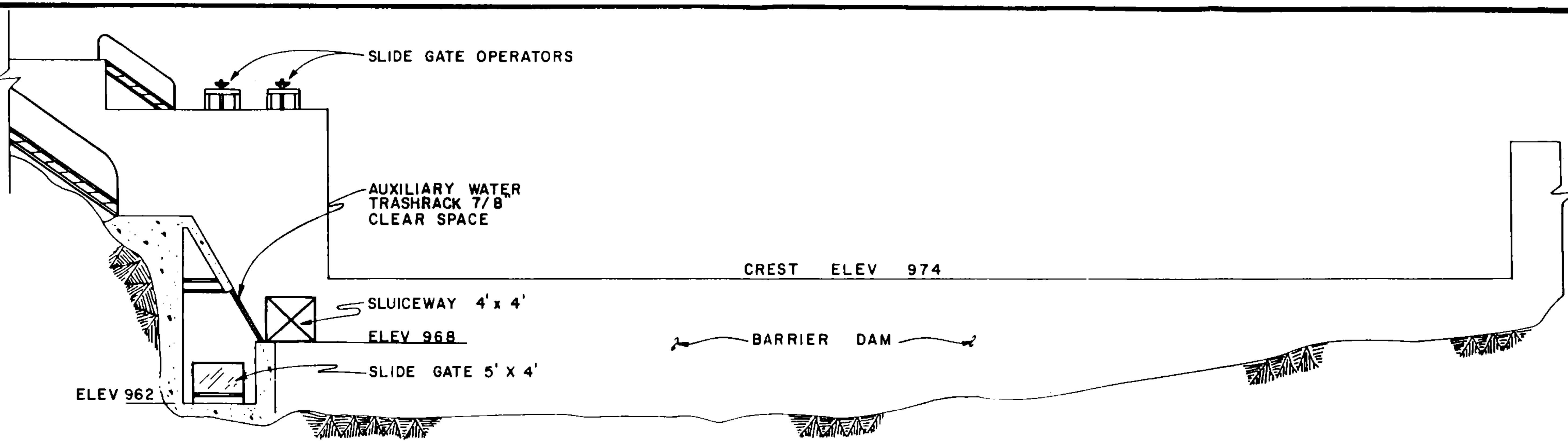
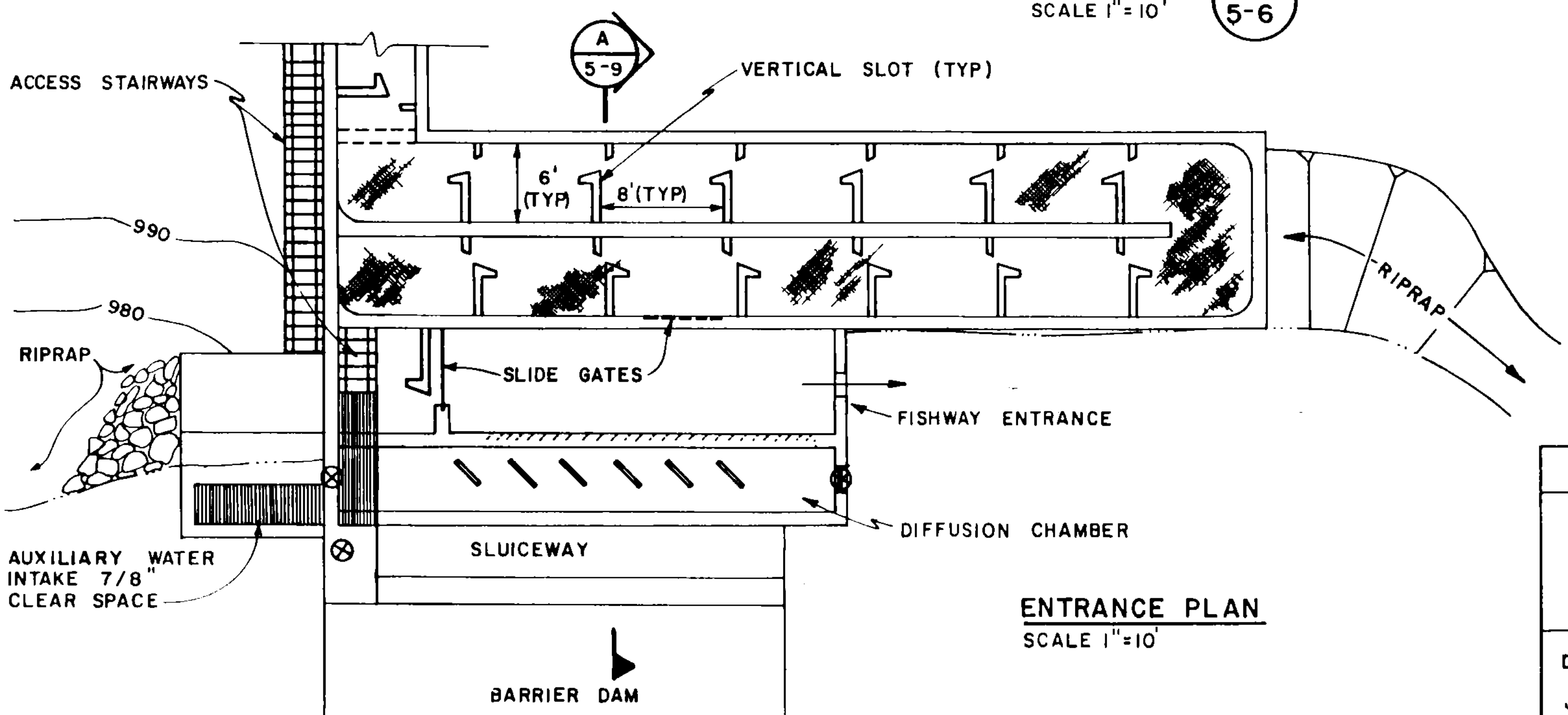


SECTION B 5-6
SCALE 1"=10'



ENTRANCE PLAN
SCALE 1"=10'

FIGURE 5-8

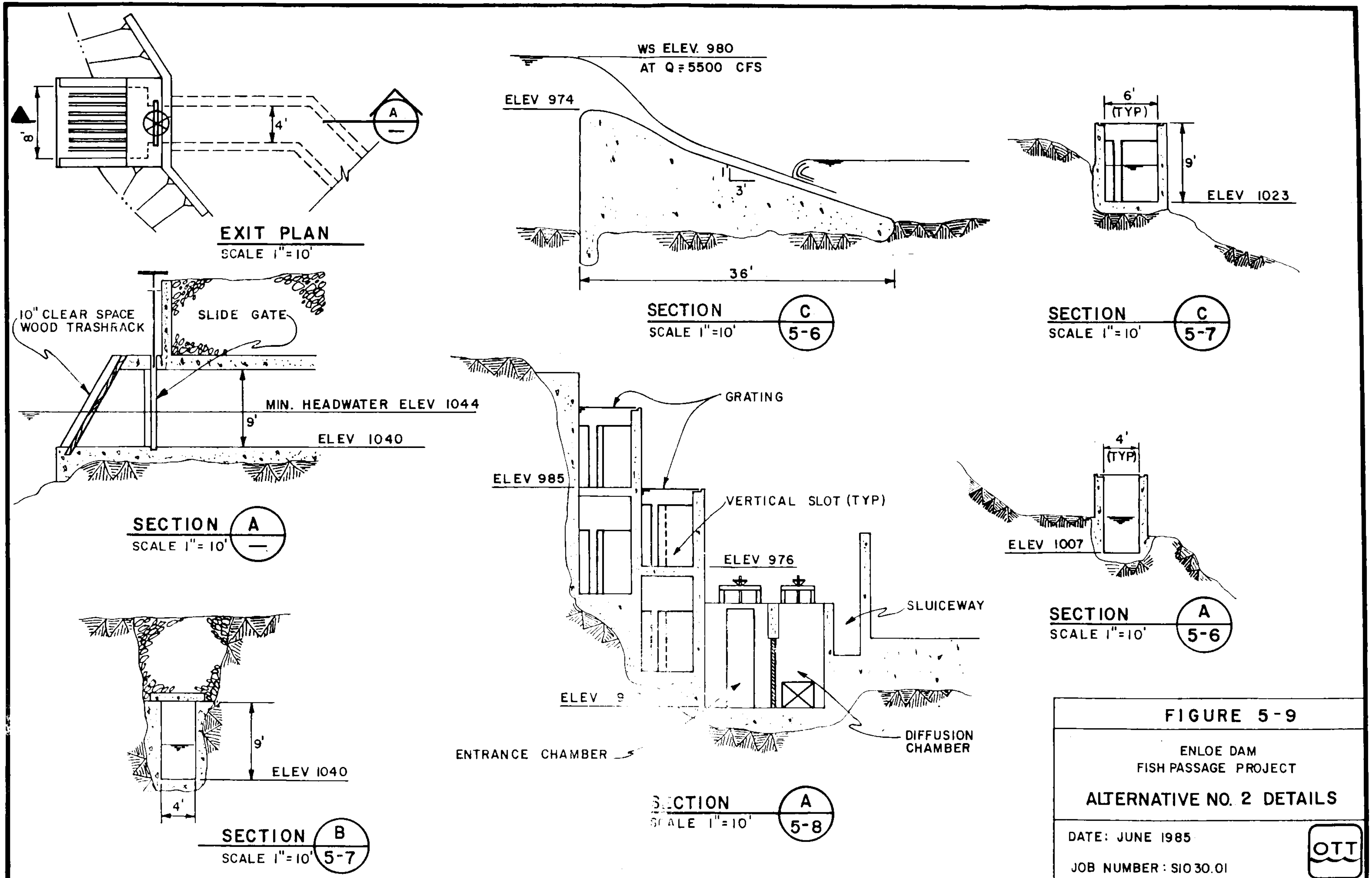
ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 2 DETAILS

DATE: JUNE 1985

JOB NUMBER: S1030.01

OTT


EXIT PLAN
SCALE 1"=10'
8'
4'
A
WS ELEV. 980
AT Q = 5500 CFS
ELEV 974
1
3'
36'
SECTION C 5-6
SCALE 1"=10'
6' (TYP)
9'
ELEV 1023
SECTION C 5-7
SCALE 1"=10'
10" CLEAR SPACE
WOOD TRASHRACK
SLIDE GATE
MIN. HEADWATER ELEV 1044
9'
ELEV 1040
SECTION A
SCALE 1"= 10'
GRATING
ELEV 985
VERTICAL SLOT (TYP)
ELEV 976
SLUICEWAY
ELEV 9
ENTRANCE CHAMBER
DIFFUSION
CHAMBER
SECTION A 5-8
SCALE 1"=10'
4' (TYP)
ELEV 1007
SECTION A 5-6
SCALE 1"=10'
9'
ELEV 1040
4'
SECTION B 5-7
SCALE 1"=10'
FIGURE 5-9
ENLOE DAM
FISH PASSAGE PROJECT
ALTERNATIVE NO. 2 DETAILS
DATE: JUNE 1985
JOB NUMBER: S10 30.01
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Fish migrating upstream toward Enloe Dam would be stopped by a swimming barrier located normal to the course of the stream. The hydraulic height of the barrier would be approximately 9 ft. The crest of the barrier would be ogee in shape, with a sloped apron (3H:1V). Fish would enter the ladder at the left abutment of the barrier through a single entrance. Auxiliary attraction flow would be added by a wall diffuser to the entrance pool. Like Alternative 1, fishway pools would be 6 ft wide and 10 ft long with 1 ft of head loss per pool. Depth of flow in the fishway would vary from a minimum of 4 ft to a maximum of 8 ft. The fishway slope would be 10H:1V.

Pools in the lower section of the fishway would be "stacked" in two levels, similar to a parking garage. The lower 16 pools would be founded on rock; the next layer of 16 pools would be set above the bottom 16 pools and supported by common walls. This concept is used to accommodate the steep surrounding slopes. Run or "flat" sections of the fishway with 4 ft widths, as discussed in Alternative 1, would also be used in this alternative.

The barrier dam would be constructed of mass concrete, and the fishway would be constructed of reinforced concrete, with slabs, walls and baffles cast-in-place. Buried sections of the fishway near the exit could be covered with precast concrete. All exposed areas of the fishway would be covered by galvanized grating. The exit trashrack would be constructed of wood to minimize ice formation, and sloped 60° from the horizontal to facilitate raking. Also, the auxiliary water intake would be submerged for ice protection.

Run timing and design flows in the Similkameen River for Alternative 2 are the same as those discussed in Alternative 1. Like Alternative 1, slide gates would be provided in this alternative to control the fluctuation of tailwater and decrease the wall and baffle heights. Auxiliary water requirements for this alternative are the same as those for Alternative 1.

Operation

Alternative 2 is capable of passing fish during the design range of flow in the Similkameen system. It may also be possible to pass fish at much higher flows than the 5,500 cfs that typically occurs in mid-May. The principal advantage of this fishway scheme is its compatibility with hydropower at Enloe Dam. If hydropower is developed in conjunction with this alternative, head would be lost for generation due to the construction of the barrier dam. Loss of head for generation is costly; however, this alternative does not preclude hydropower development. In contrast, Alternative 1 could not reasonably be developed with the proposed hydropower project, since the fishway entrances would lie well upstream of the turbine discharges. This would result in fish being attracted to the turbine discharge rather than to the ladder.

5.2.4 Alternative 3 - Trap And Haul At Falls

Physical Description

Alternative 3 is a trap and haul system that operates at the falls downstream of Enloe Dam. The trap system would include a fishway section leading up to a holding pool, and a trapping and loading facility. The configuration and details of the trap facility are shown in Figure 5-10 through 5-12.

The lower fish ladder section of the trap facility would be similar in location and layout to the Alternative 1 fishway. Two entrances, one for high flow and one for low flow, would be provided in the first pool. The remaining fishway pools would be 6 ft wide by 10 ft long. Weirs between pools would be half Ice Harbor type; notched, with a bottom orifice. Fish may either pass through orifices or jump over the "notched" area in the crest of the weir. The depth of flow in pools would be 7 ft.

Auxiliary water would be added to seven of the lower pools through chimney type overflows. Auxiliary water would be gravity fed from an intake above the falls and controlled by a valve. Auxiliary water would be added to the seven pools to maintain a sufficiently high transport velocity through pools as the tailwater rises and floods the lower pools. A transport, or average, velocity of 1 to 2 ft/sec would be maintained to attract fish through the ladder. Auxiliary flow would be split evenly between pools; total flow would vary between 25 and 50 cfs.

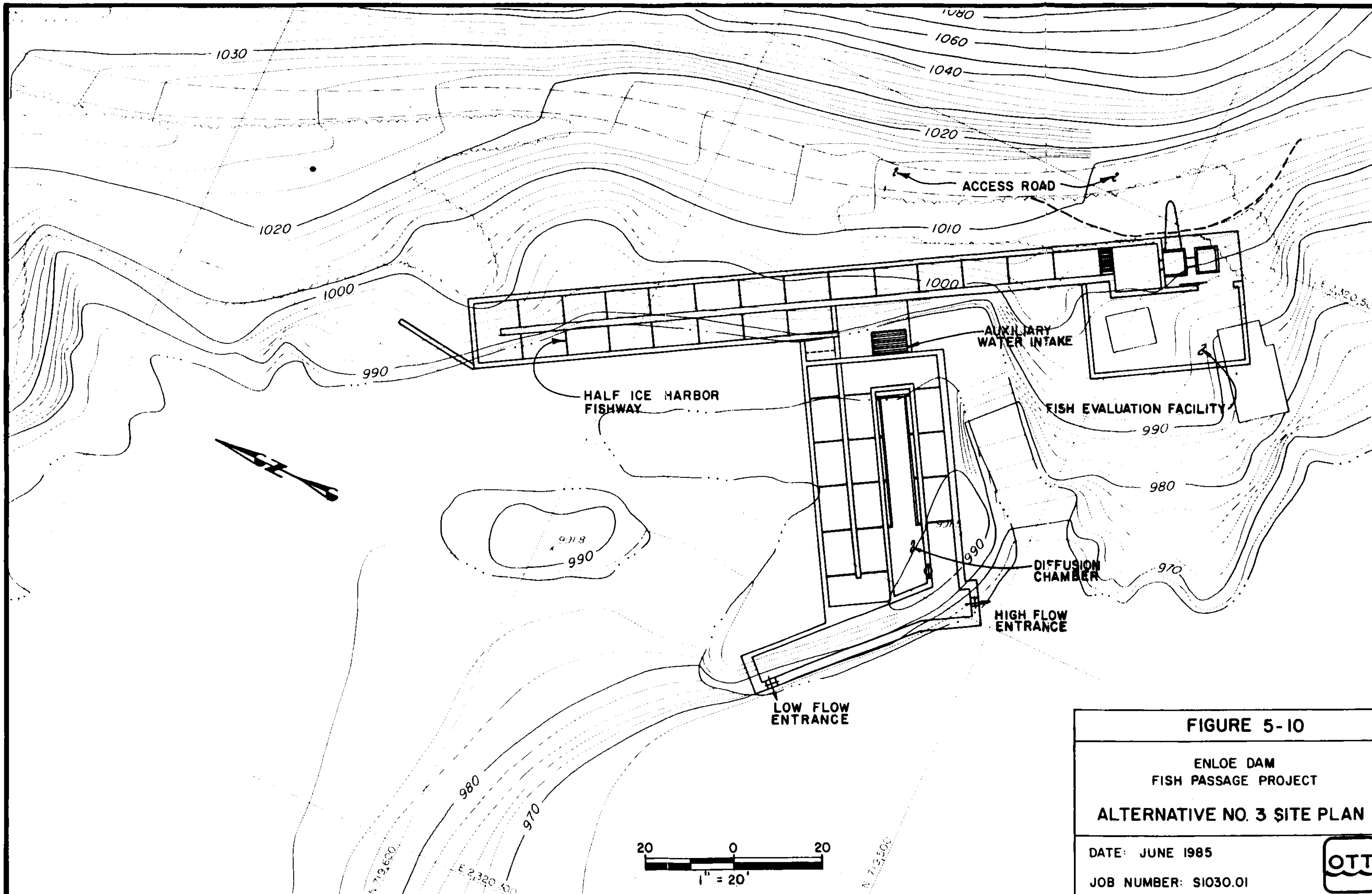

FIGURE 5-10

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 3 SITE PLAN

DATE: JUNE 1985

JOB NUMBER: S1030.01

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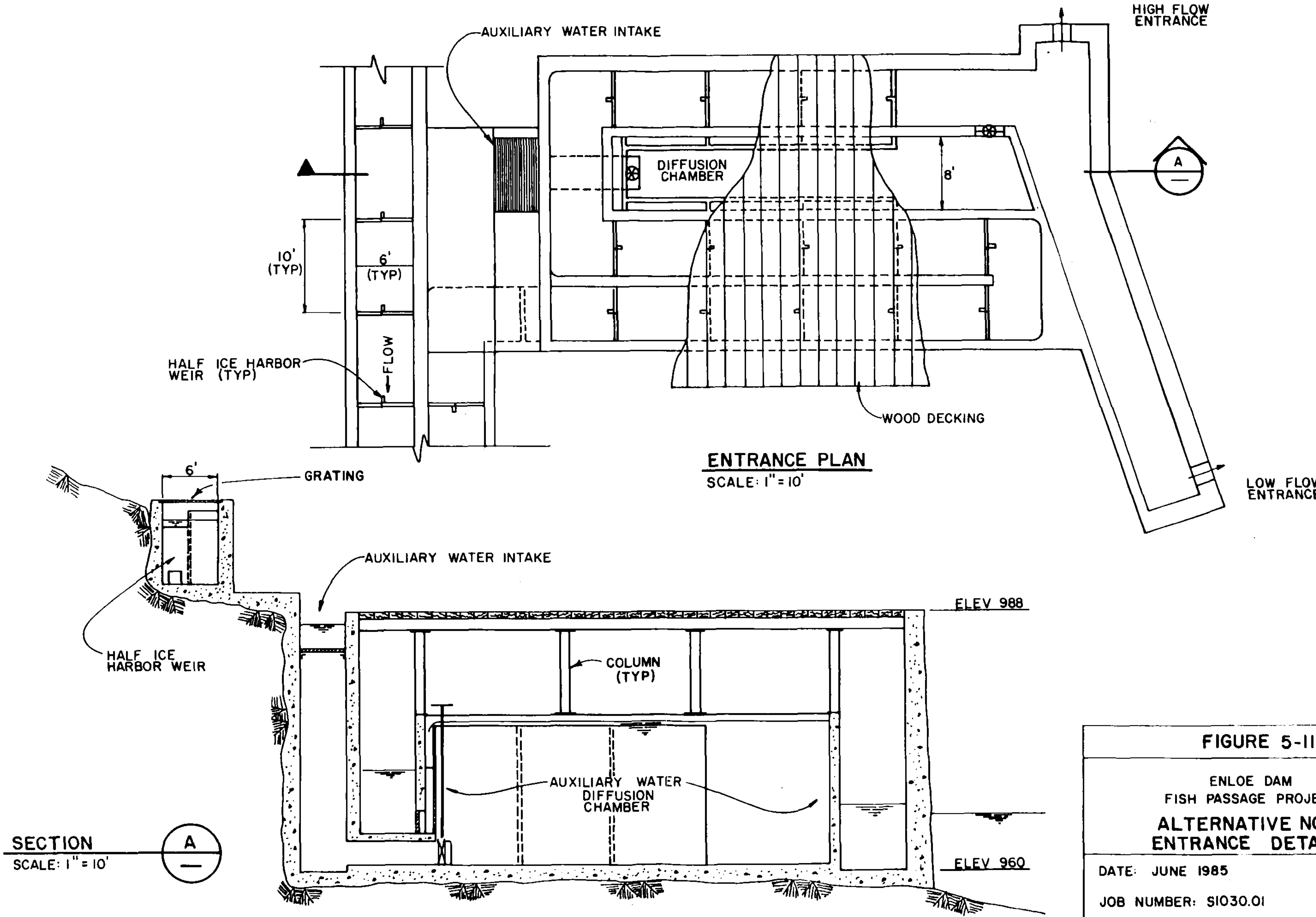

FIGURE 5-11

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 3 ENTRANCE DETAILS

DATE: JUNE 1985

JOB NUMBER: S1030.01

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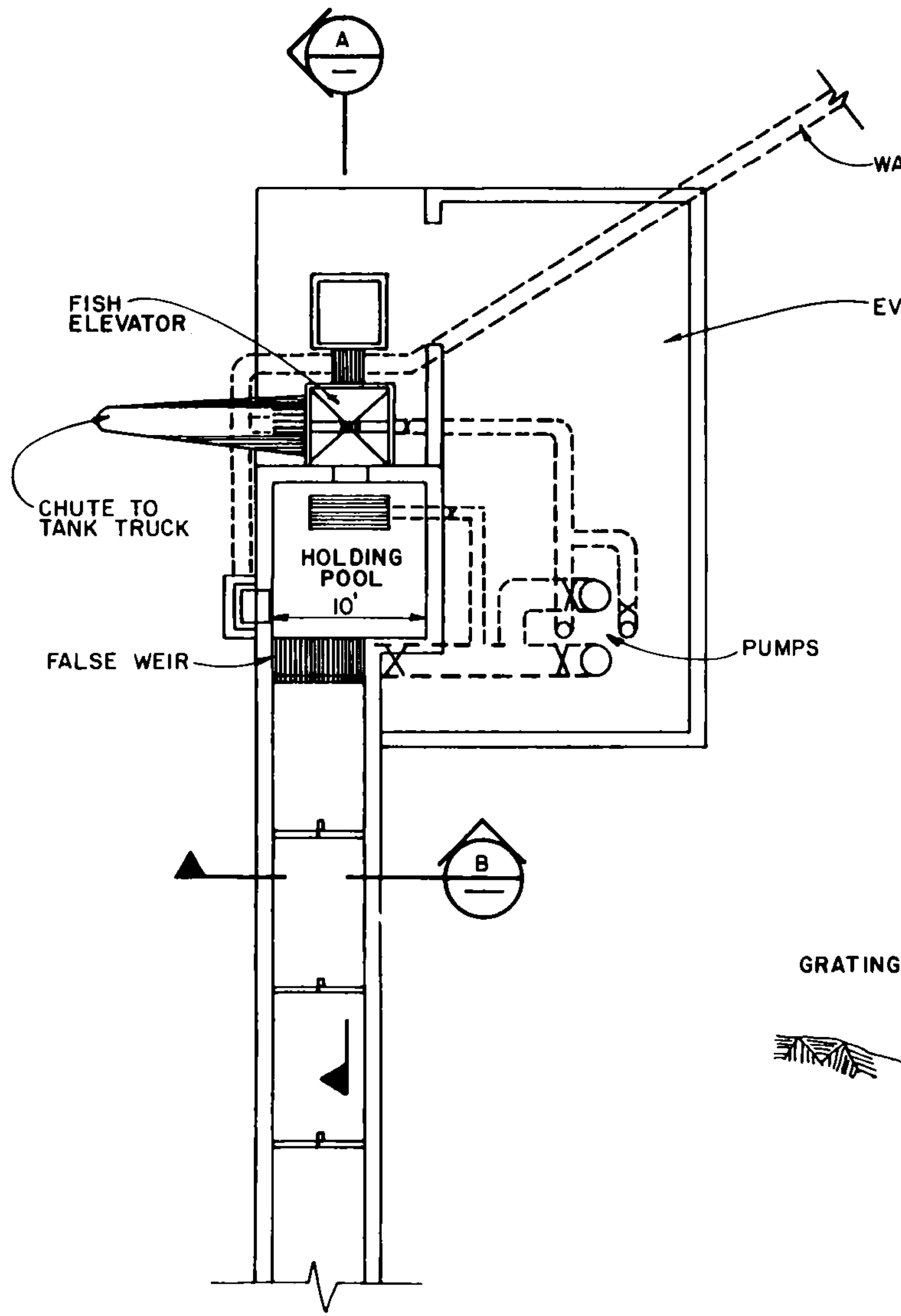
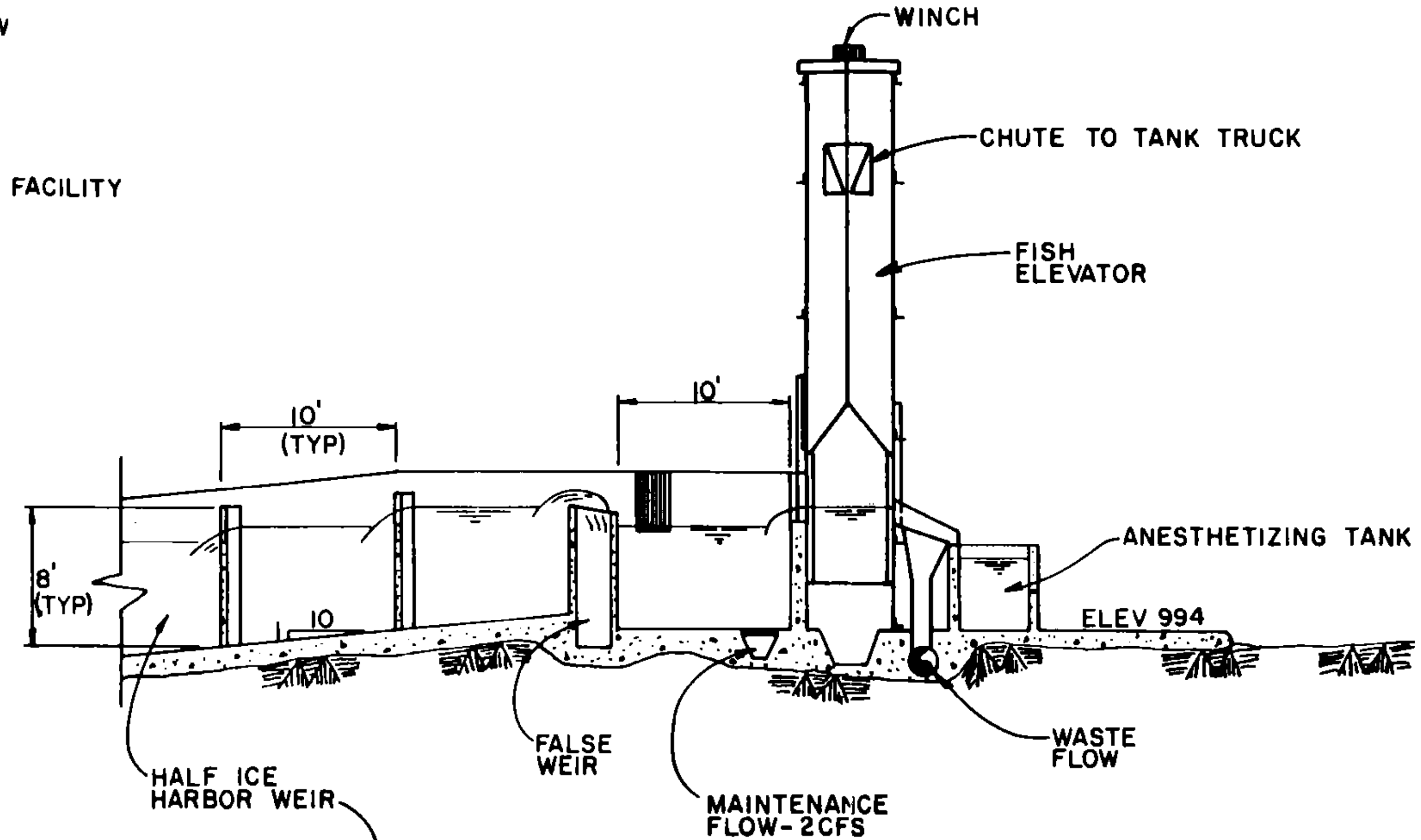


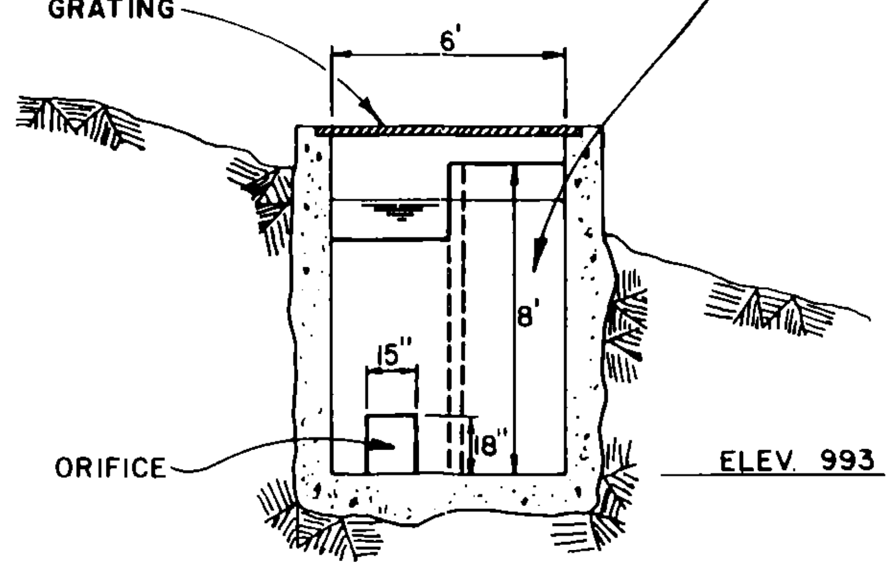
FISH TRAP PLAN

SCALE: 1" = 10'



SECTION A

SCALE: 1" = 10'



SECTION B

SCALE: 1" = 5'

FIGURE 5-12

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 3
FISH TRAP DETAILS

DATE: JUNE 1985

JOB NUMBER: S1030.01

OTT

A false weir would be provided at the upstream end of the fishway to supply approximately 25 cfs along the fishway. The false weir would supply "fresh" flow to the fishway, separate from the water in the holding pool. Water would be pumped to the false weir from a source above the falls and would be directed downstream by vanes.

The holding pool would be 10 ft wide by 10 ft long with a depth of 6 ft, and would have the capacity to hold approximately 200 adult fish. A flow of 2 cfs of fresh water would be supplied to the holding pool by a floor diffuser to meet the oxygen requirements of 200 adult fish. Excess flow from the holding pool would be released into the stream.

Fish in the holding pool would be crowded toward the elevator with a vertical aluminum punched plate. Fish would move from the holding pool to the elevator by jumping over a weir. Water pumped into the elevator would then raise the fish to the elevation of the loading chute. Once loaded into the 2,000 gallon tank truck, fish would be hauled from the trap facility to the upper watershed.

Access to the trap site is currently available by an irrigation canal road along the left bank of the stream. Improvements, however, would be required along the 1-1/2 miles of canal road. The minimum haul distance for fish off-loading would be approximately four miles per round trip. The average haul distance for the early years of the project is assumed to be 60 miles per round trip.

Operation

In order to pass steelhead, the fish trap would be required to operate for approximately six months. It is estimated that one and one-half full-time employees would be necessary to operate the trap and perform routine facility maintenance.

This alternative is not compatible with the PUD's plans for power generation for the same reason discussed in Alternative 1.

5.2.5 Alternative 4 - Trap And Haul Below Powerhouse

Physical Description

Alternative 4 is a trap and haul facility located at a barrier dam that would be constructed immediately downstream of the existing powerhouse. The entrance to the trap facility would be located at the left abutment of the barrier dam. Details of the trap facility are shown on Figures 5-13 and 5-14.

The fishway section below the holding pool and elevator would use the "stacked" design discussed in Alternative 2. The fishway pools would be the half Ice Harbor design discussed in Alternative 3. The auxiliary water, holding pool and fish elevator would be similar in design and operation to those discussed in Alternative 3.

The pool upstream of the barrier dam would eventually fill with sediment and plug the 7/8 in auxiliary water trashrack. To prevent this, a sluiceway would be provided to clear the immediate area upstream of the intake. A sluice gate would be used to control flow in the sluiceway. The sluiceway would be operated only to clear material; it would not operate continuously.

Access for fish hauling is available along the irrigation canal road to the county road, and from the county road to selected off-loading sites in the upper watershed. A section of new road would be necessary between the trap facility and the suspension bridge to the old powerhouse. Slope failures have occurred in two locations on the old access road between the suspension bridge and the dam. These slopes could be rehabilitated with fill and the toe of the slopes protected from high river flows. The access road should be graded, drained and surfaced with crushed rock prior to project construction.

Operation

Alternative 4 is designed to pass fish effectively through the steelhead migration period of October through November and February through May. For these six months of operation, a labor requirement of one and one-half full-time employees is

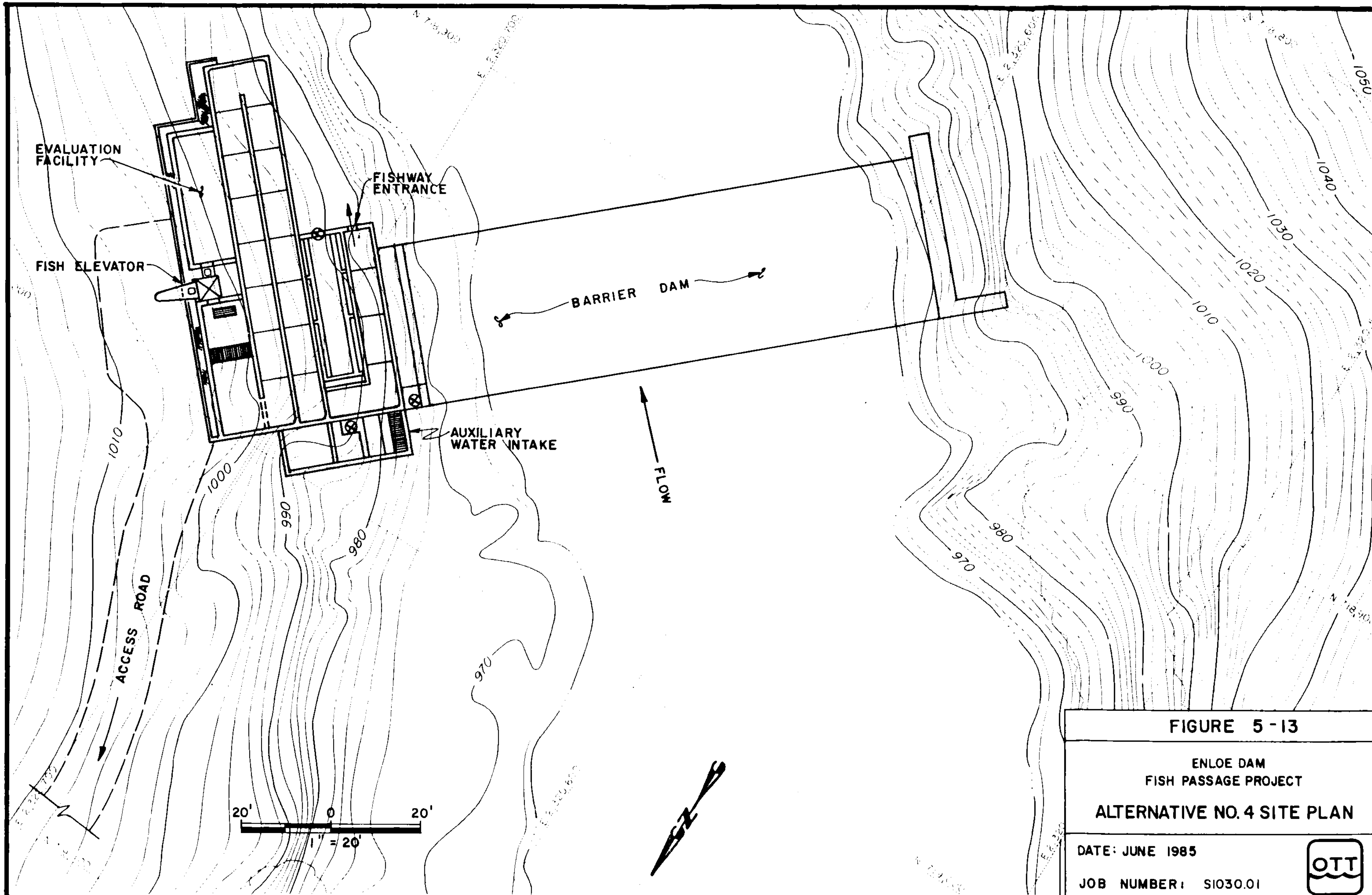
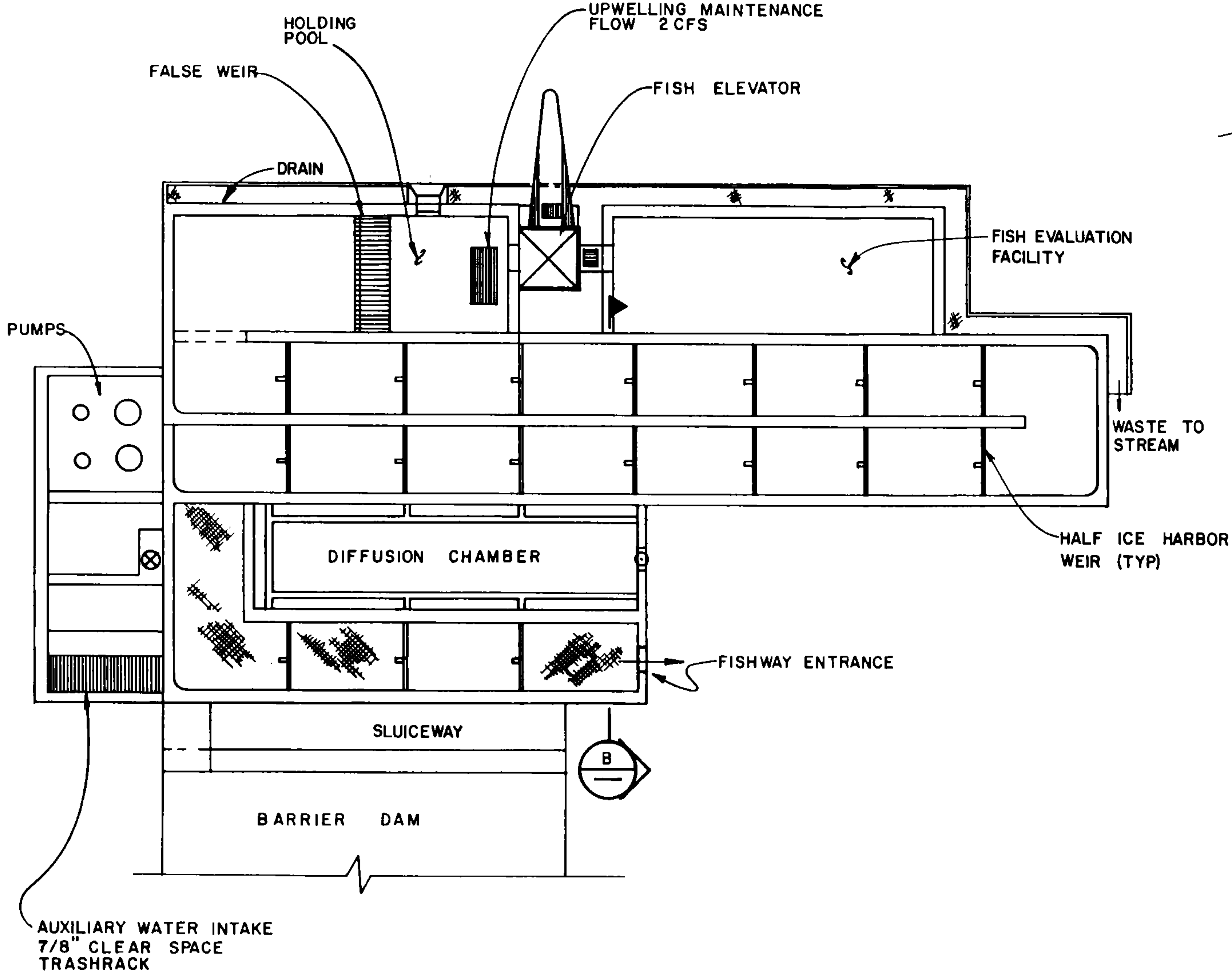


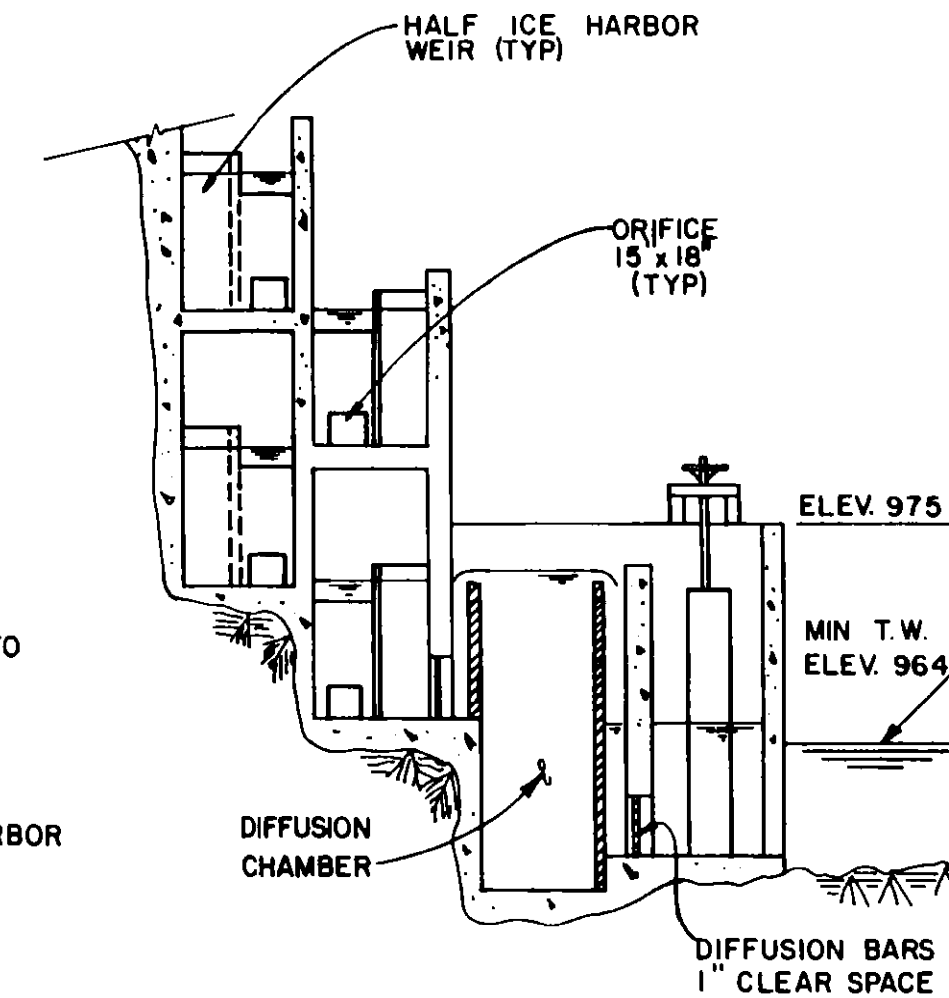
FIGURE 5-13

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 4 SITE PLAN



ENTRANCE PLAN
SCALE: 1" = 10'



SECTION B
SCALE 1"=10'

FIGURE 5-14

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 4
FISH TRAP DETAILS

DATE: JUNE 1985

JOB NUMBER: S1030.01

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estimated. If species other than steelhead are stocked in the Similkameen River, labor requirements would increase.

Like Alternative 2, this trap and haul alternative is compatible with hydropower redevelopment at Enloe Dam. The barrier dam would, however, decrease the available head at the proposed powerhouse.

5.2.6 Alternative 5 - Trap And Haul At Railroad Bridge

Sitings for the four previous alternatives were based on considerations of operation, constructability, cost and hydropower redevelopment at Enloe Dam. Redevelopment of hydropower at Enloe Dam is a serious issue. The PUD believes they can rehabilitate the Enloe facility and produce power at a competitive cost in the near future. From the perspective of the PUD, any alternative that would substantially reduce the hydraulic head of their project, Alternatives 2 and 4, is unacceptable. In response to the PUD's concerns, Alternative 5 has been developed. This alternative has no effect on redevelopment of hydropower at Enloe Dam.

Physical Description

Alternative 5 is a trap and haul facility located approximately two miles downstream of Enloe Dam, and approximately 200 ft downstream of the Burlington Northern Railroad bridge. Facilities would include a barrier dam, short ladder section, holding pool, fish elevator and evaluation facilities. Details of Alternative 5 are shown in Figures 5-15 through 5-17.

The barrier dam would be oriented normal to the flow of the Similkameen River. The crest would be ogee in shape and the downstream face would be sloped 3H:1V. The hydraulic height of the structure would be approximately 9 ft. The maximum height of the structure would be roughly 35 ft due to the deep stream channel in that location. The crest length of the barrier dam would be approximately 125 ft. A sluiceway would be constructed at the left abutment of the barrier to clear the auxiliary water intake.

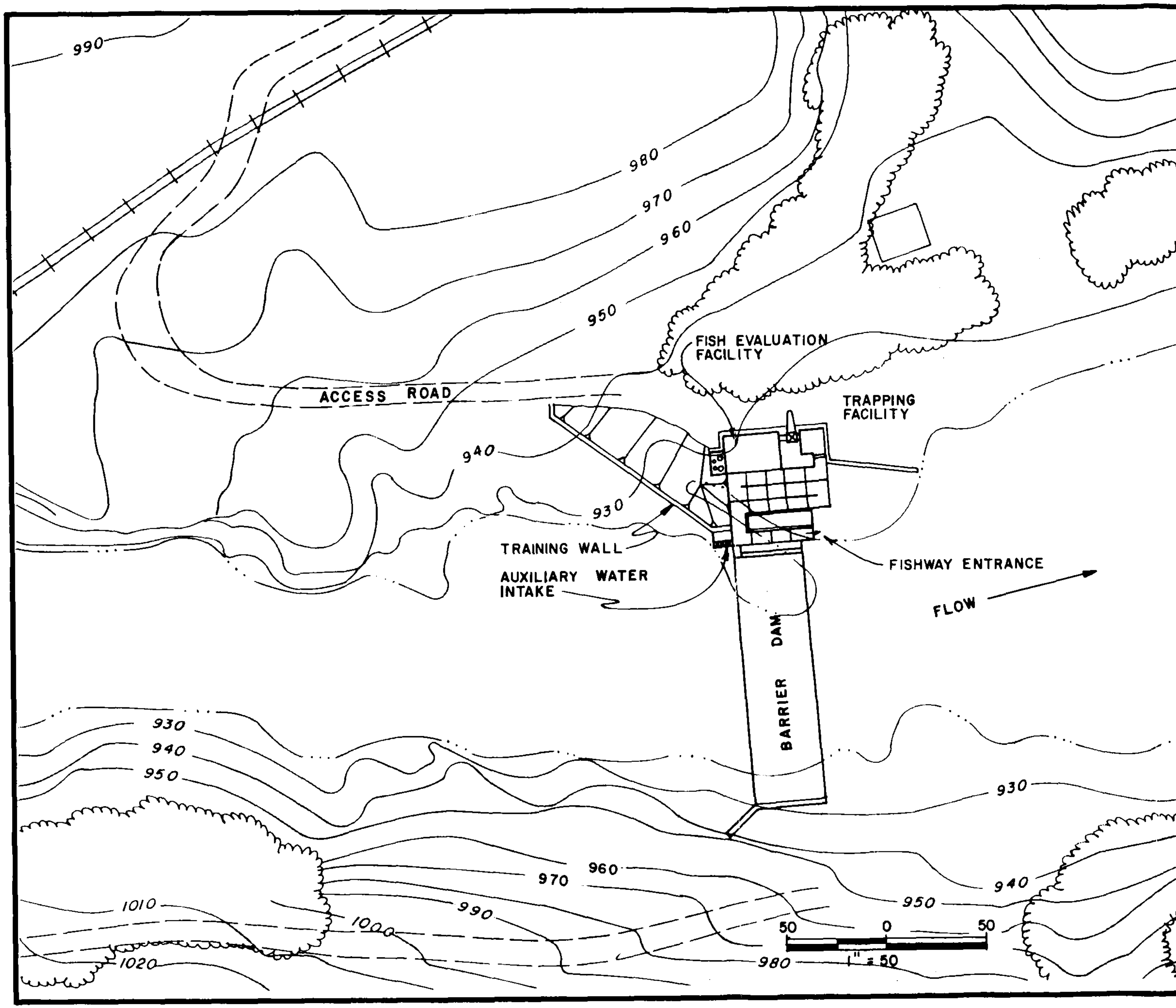


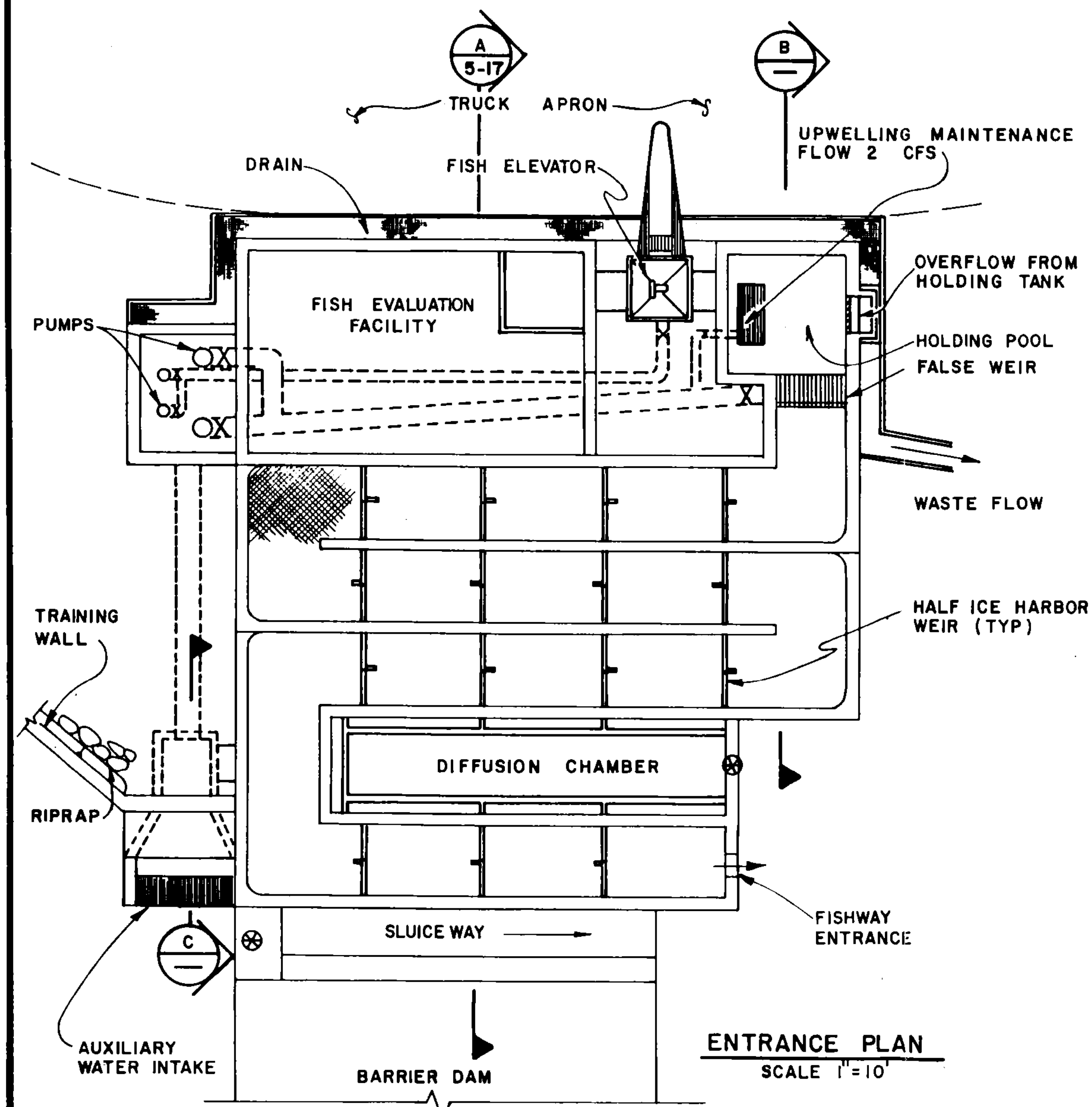
FIGURE 5-15

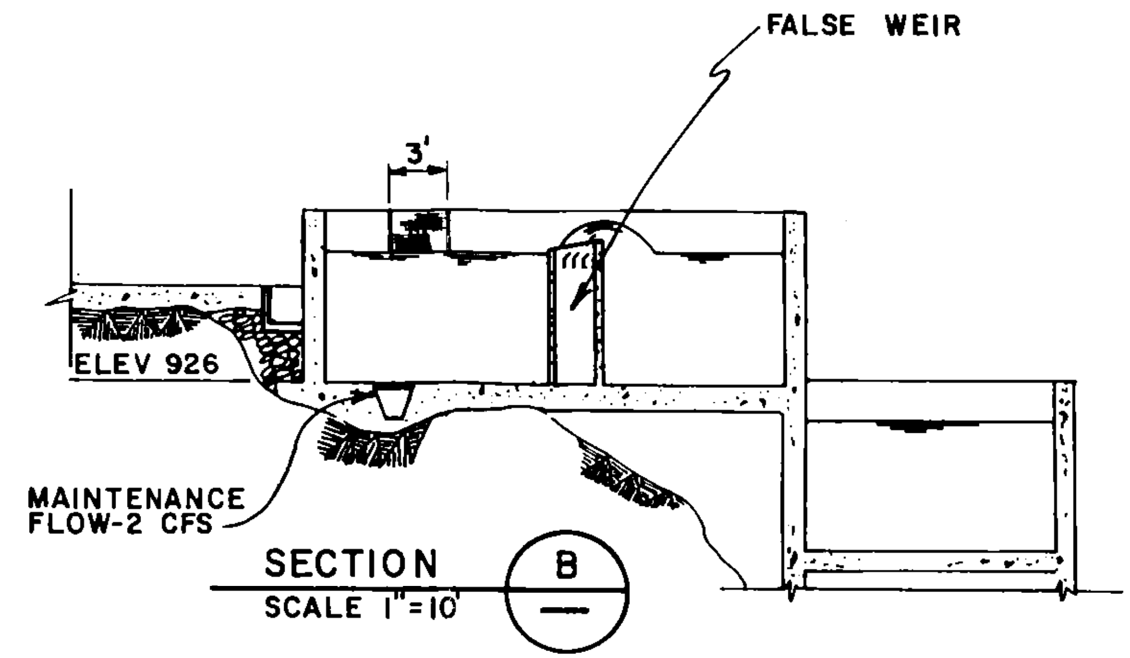
ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 5 SITE PLAN

DATE JUNE 1985

JOB NUMBER S1030.01





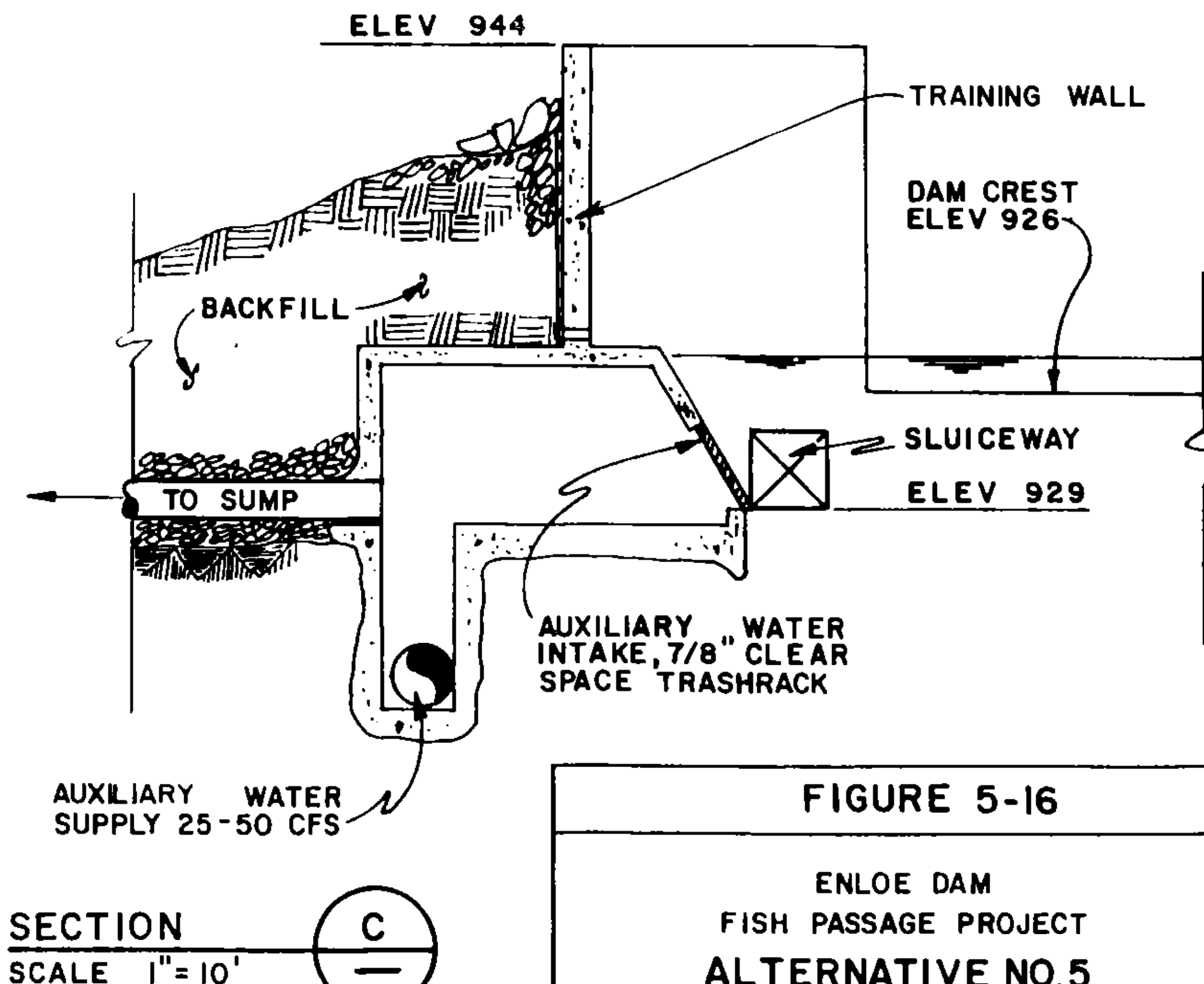


FIGURE 5-16

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO.5
FISH TRAP DETAILS

DATE: JUNE 1985

JOB NUMBER: S1030.01

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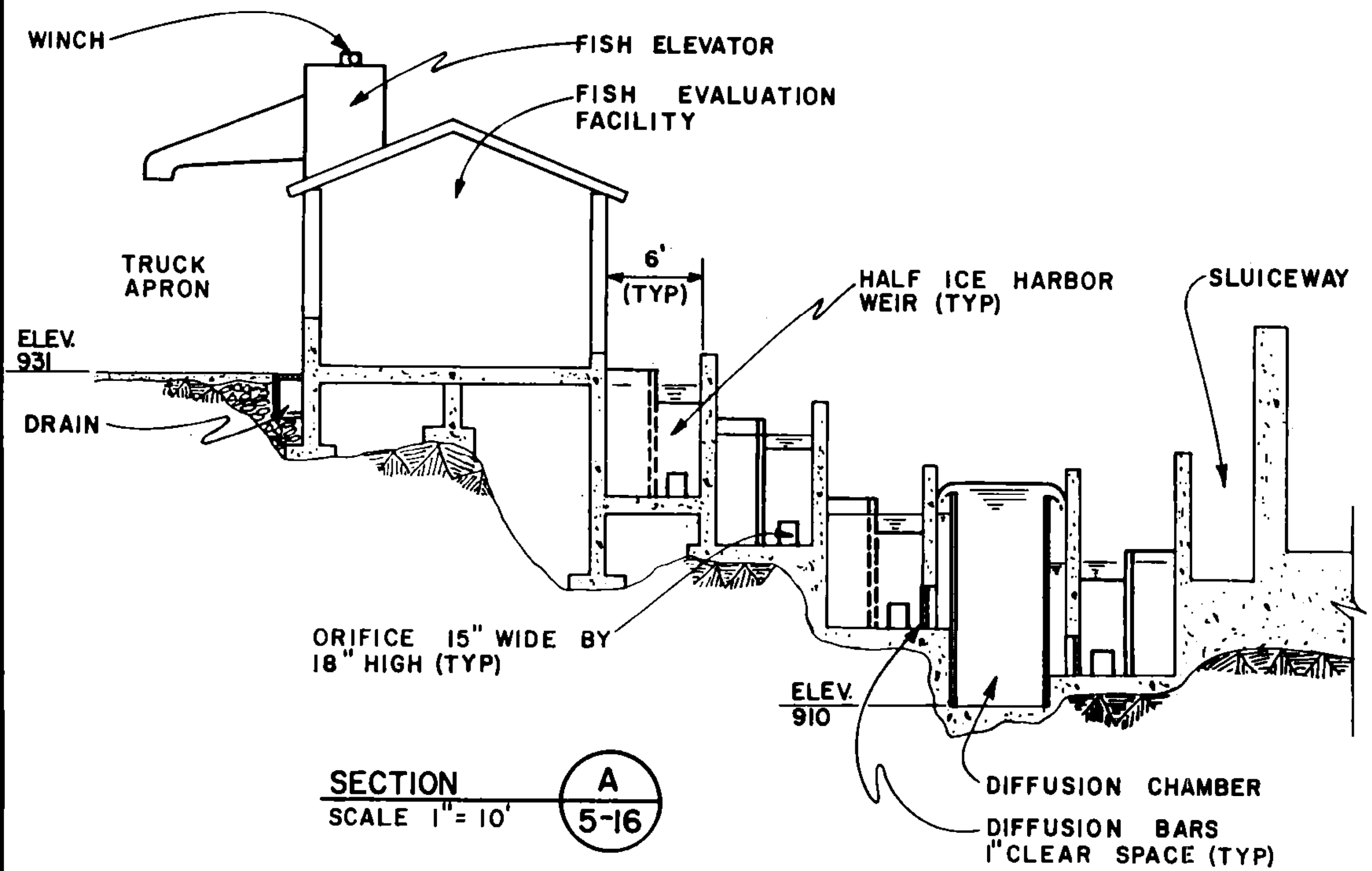
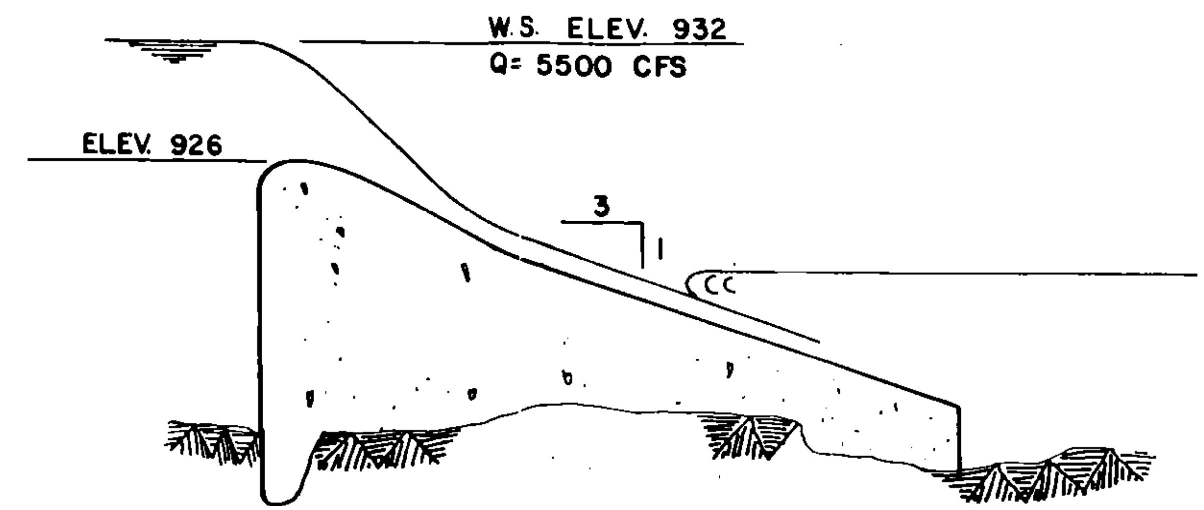
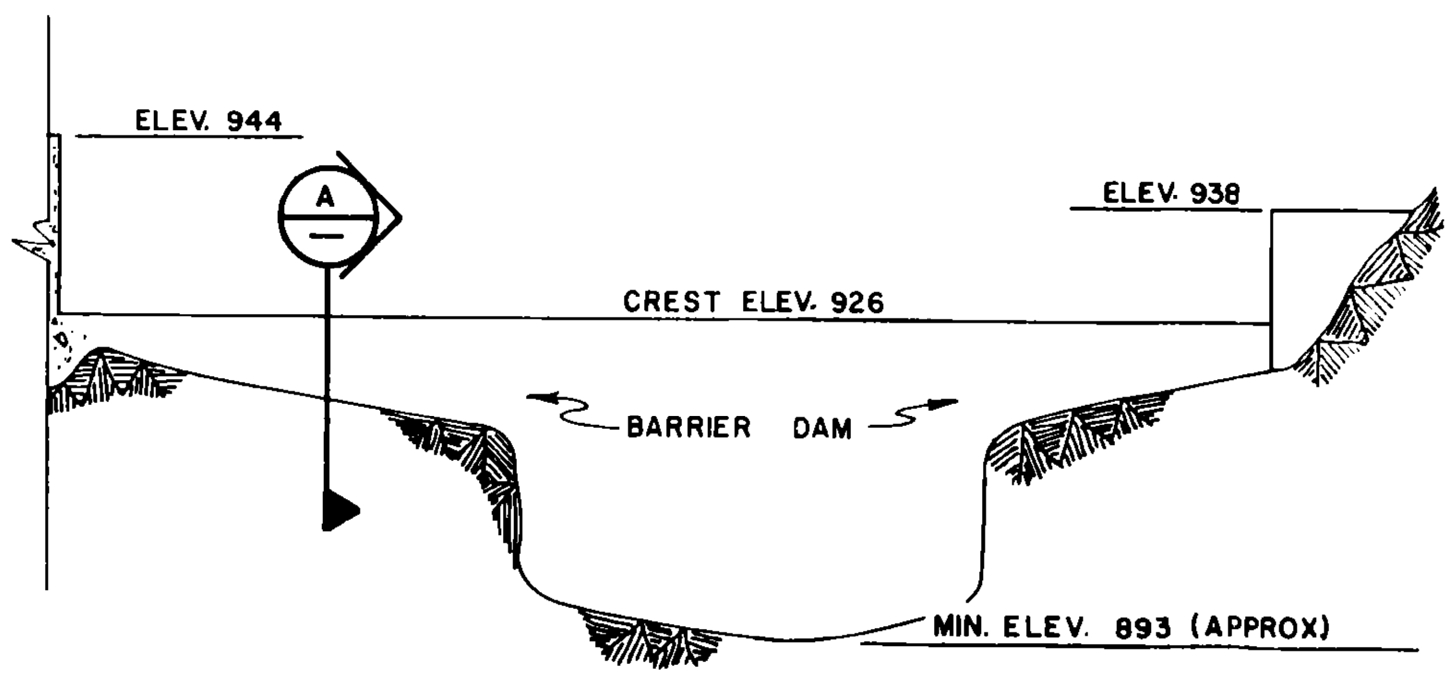


SECTION A 5-16
SCALE 1" = 10'



TYPICAL SECTION A
SCALE 1" = 10



BARRIER DAM ELEVATION
SCALE 1" = 10'

FIGURE 5-17

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO.5 DETAILS

DATE: JUNE 1985
JOB NUMBER: S103.Q01

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A single fishway entrance would be located at the left bank, adjacent to the sluiceway. Fishway pools would be half Ice Harbor type, sized 6 ft wide by 10 ft long. Auxiliary water would be gravity fed from an intake upstream of the barrier dam. The auxiliary water, between 25 cfs and 50 cfs, would be split evenly between the lower seven pools. Flow to the upper ladder would be provided by a false weir at the head of the last pool. The operation of the trap facility would be the same as Alternatives 3 and 4.

Truck access to the trap facility is favorable for this alternative. An existing 1,300 ft access road connects the site to the county road. Although several grades of the road are steep and one curve has a short radius, regrading and alignment do not pose significant problems. The road should also be surfaced with crushed rock. Easement across the private land should not be difficult to acquire.

Operation

Performance of Alternative 5 is comparable with all the upstream alternatives (1 - 4), but has the advantages of better access and complete compatibility with hydropower redevelopment at Enloe Dam.

5.2.7 Alternative 6 - Dam Removal

Physical Description

Enloe Dam presents a 54 ft barrier to fish passage. Alternative 6 proposes the removal of Enloe Dam with subsequent laddering of the falls below the dam to provide upstream passage for fish.

Blasting of pools into the falls has been considered to provide passage at the falls. During low flows in the Similkameen River, this would be an effective means of passage. However, as flows increase toward the peak design flow of approximately 5,500 cfs, passage would be difficult, and weaker fish could be substantially delayed. A second consideration is the nature of the rock that forms the falls. This rock is a joint-controlled conglomerate that may not blast in a predictable manner. Therefore, preliminary planning assumes passage at the falls would be provided with a vertical slotted fishway similar to that discussed in Alternative 1. The principal difference is the location of the ladder exit. The Alternative 6 ladder exit would be located upstream of the falls and below Enloe Dam. Figures 5-18 and 5-19 show the fishway location and configuration.

Two considerations in the dam removal portion of Alternative 6 include:

1. Demolition of the structure; and

2. Disposal of the sediment that has accumulated upstream of the dam.

The key consideration is the disposal of sediment. Enloe Dam reservoir is approximately 1.5 miles long and contains approximately 1.70 million cubic yards of sediment (Nelson, 1972). Sediment in the upstream portion of the reservoir is graded between cobbles and sands. Sediment in the lower portion of the reservoir is graded between sands and fines. This volume and composition of sediment cannot be released in an uncontrolled manner without severe environmental consequences, including: increased flooding, water quality degradation and deposition of sediments upon spawning gravels. In an effort to lessen the environmental consequences associated with dam removal, two alternative schemes for removal have been investigated:

1. Dredging of sediments in the Enloe reservoir and subsequent demolition of the dam; and

2. Sequential removal of horizontal sections of the dam crest and release of sediment through natural scour.

Dredging

The dredging scheme could be accomplished by use of a suction-dredge that is supported on floats. Dredged material would be placed on-site for a sufficient length of time to dehydrate before hauling off-site. If a 20 in suction-dredge is used, with a

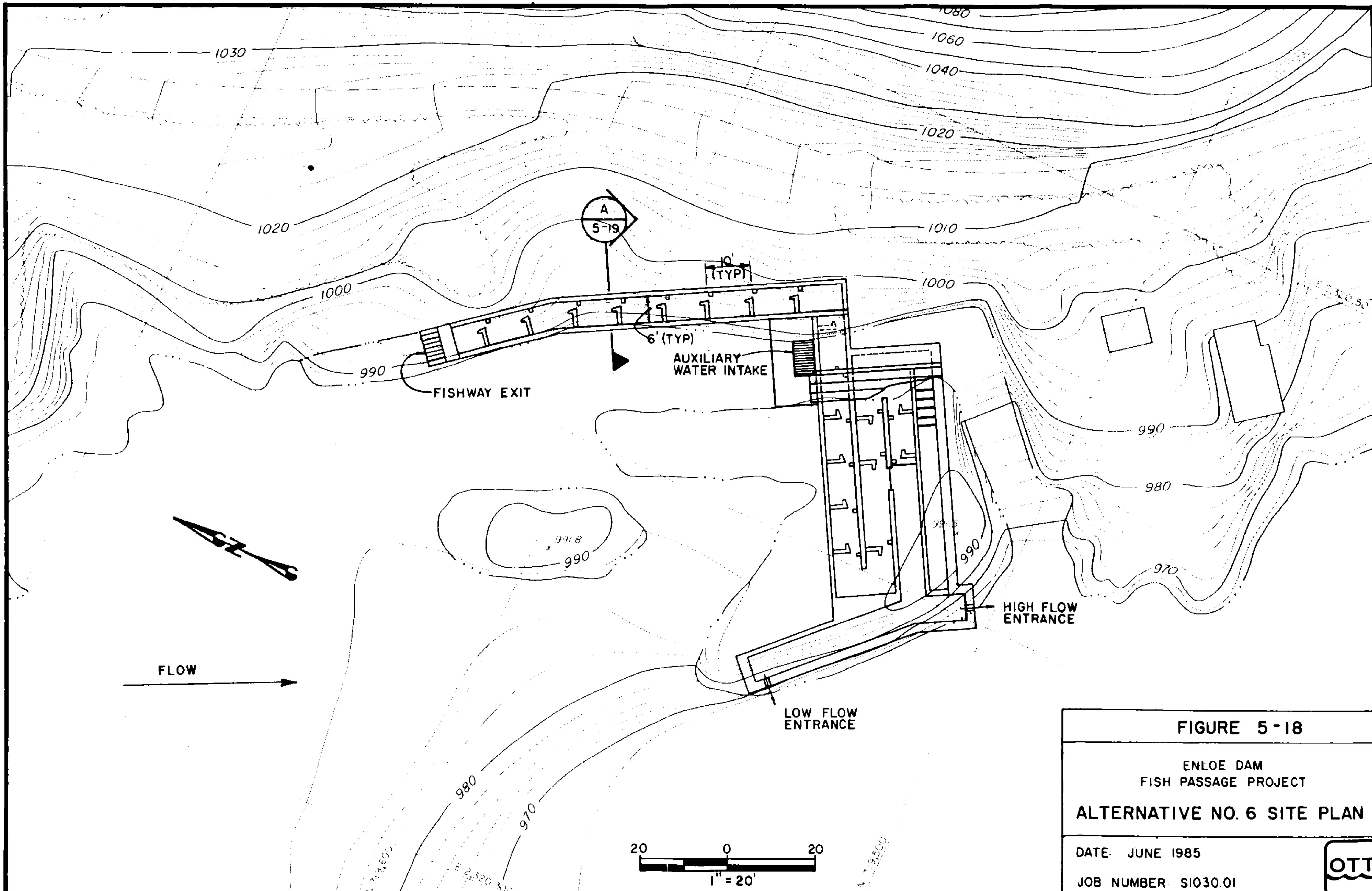

FIGURE 5-18

ENLOE DAM
FISH PASSAGE PROJECT

ALTERNATIVE NO. 6 SITE PLAN

DATE: JUNE 1985

JOB NUMBER: S1030.01

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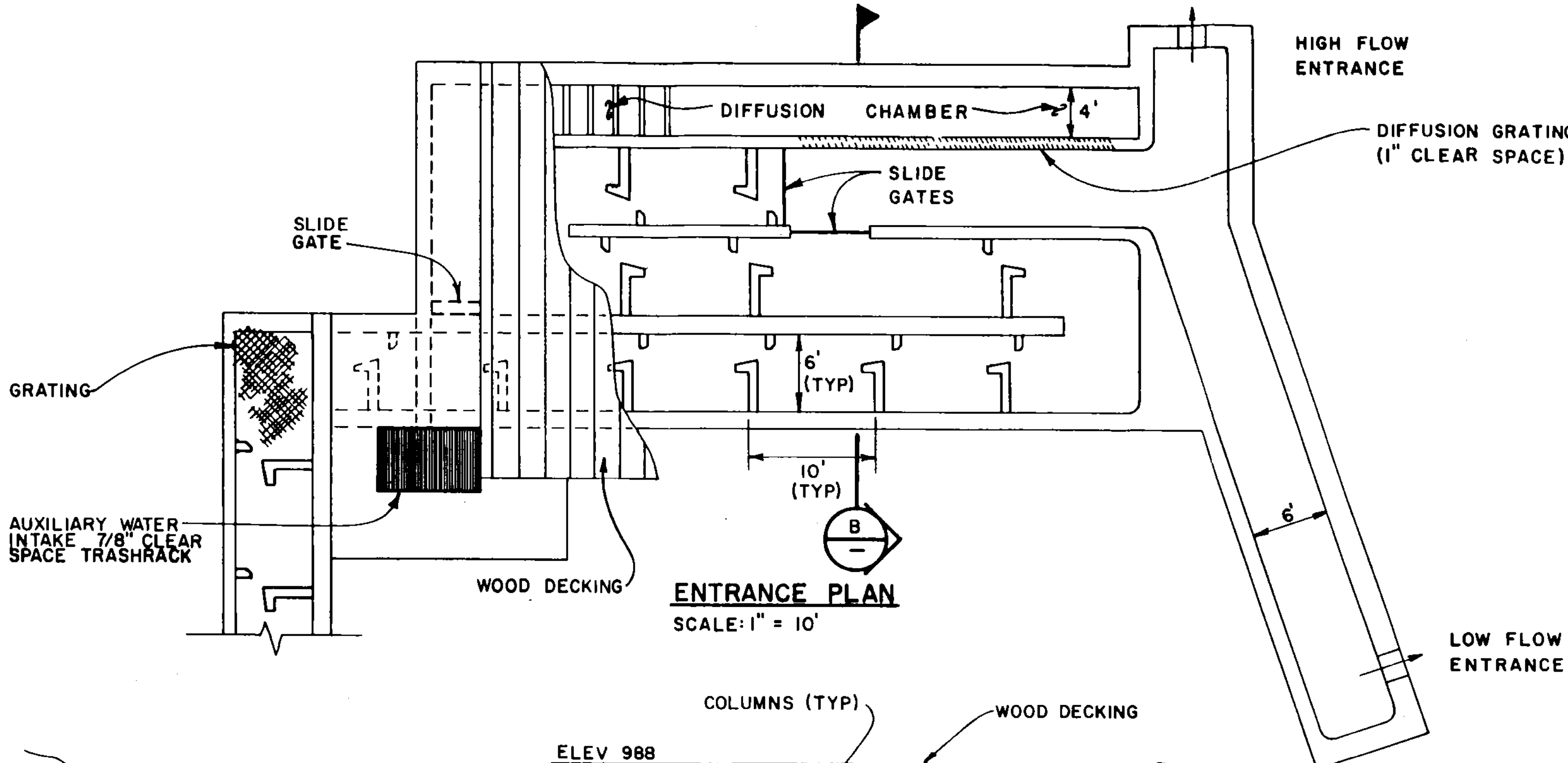
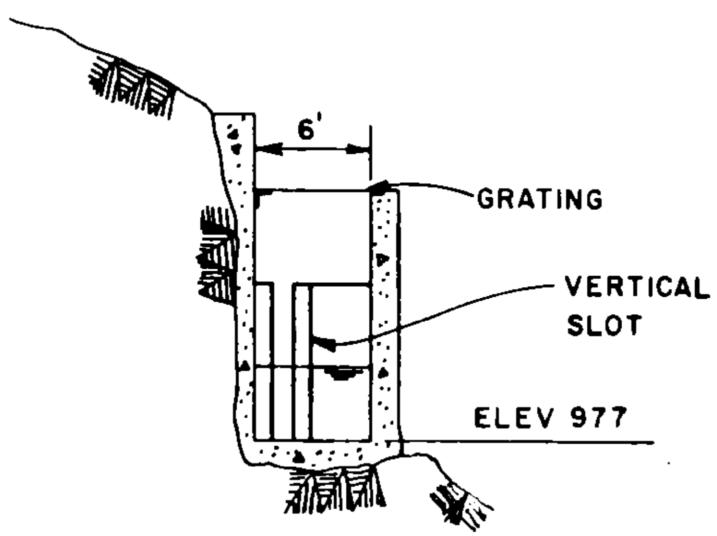
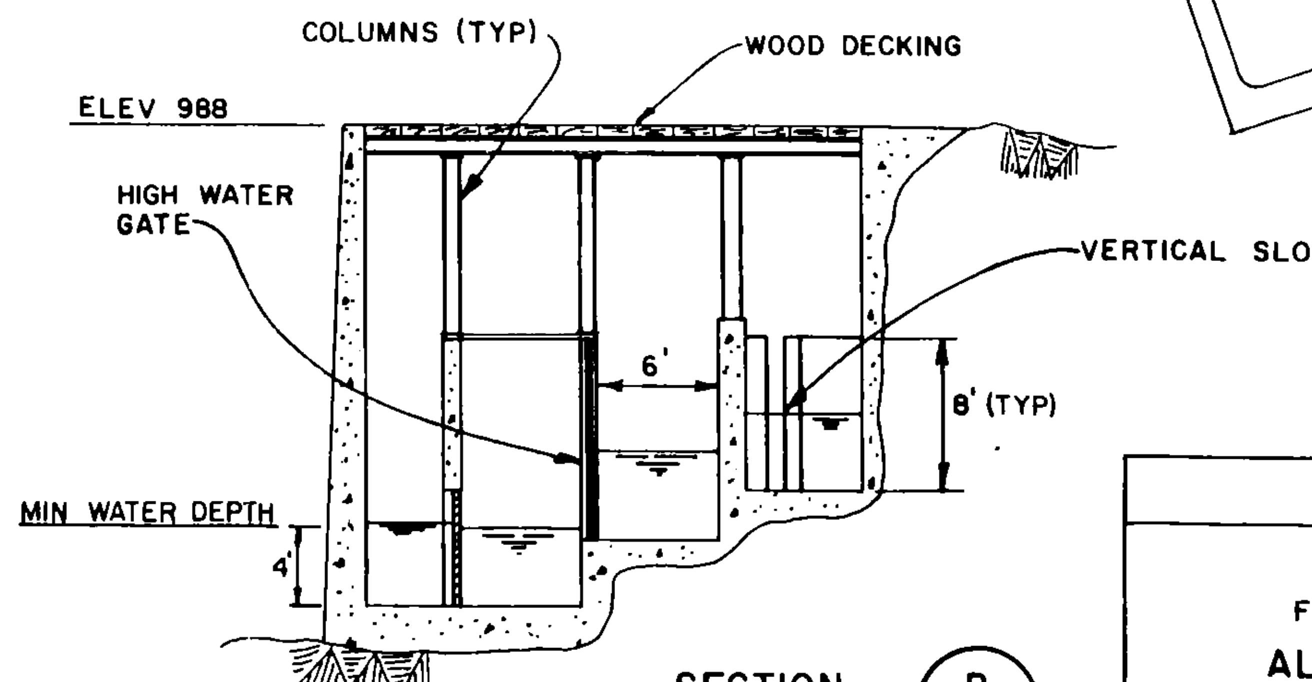


ENTRANCE PLAN
SCALE: 1" = 10'



SECTION A 5-18
SCALE: 1" = 10'



SECTION B
SCALE: 1" = 10'

FIGURE 5-19

ENLOE DAM
FISH PASSAGE PROJECT

**ALTERNATIVE NO. 6
FISHWAY DETAILS**

DATE: JUNE 1985

JOB NUMBER: S1030.01

OTT

capacity of approximately 15,000 cubic yards per day, the 1.79 million cubic yards of sediment could be removed in approximately four months. Demolition of the dam could be undertaken after the dredging operation. The dam crest could be removed in horizontal lifts; each lift spanning one-half of the crest length. This would simplify dewatering substantially.

Sediment would be hauled to a waste area near the site and graded for stability. Slopes of the waste pile could be revegetated by hydroseeding. Because the sediment may contain high concentrations of toxic metals and/or compounds, due to past mining and agricultural activities in the watershed, careful sediment disposal and removal may be necessary. Preliminary analysis of toxic/hazardous materials performed by IEC BEAK Consultants Ltd. in 1984, however, suggests that sediment composition will not control disposal.

Sediment Release

Dam removal by the second scheme involves blasting horizontal lifts of the dam and allowing sediment to be scoured from the reservoir by high flows. The Similkameen River has the capacity of carrying approximately 320,000 cubic yards of the reservoir sediment in an average water year. If the entire volume, 1.79 million cubic yards, of sediment is assumed to be released downstream, it would take approximately six years to flush the reservoir.

This method of dam removal would involve approximately six separate mobilizations of a blasting crew. A monitoring program to determine the extent of the sediment after each high water event would also be necessary. The actual rate of degradation will depend upon the stream flows and may vary significantly from the six year estimate. The controlling consideration in the release of sediment downstream is the carrying capacity of the lower Similkameen River and the Okanogan River below its confluence with the Similkameen. Accelerated deposition of alluvial material in these low gradient areas could dramatically increase the flooding in the Oroville-Tonasket areas. The U.S. Bureau of Reclamation (1975) and U.S. Army Corps of Engineers (1978) indicate that flooding is a significant problem in the area, even on an annual basis. Before sediment is released from the Enloe reservoir, a comprehensive analysis should be performed to determine the extent of flooding and flood damages that could result.

Costs have been estimated for both dam removal schemes and are presented in Section 5.3.2. It is possible that a combination of sediment release and sediment removal would yield the most economic and environmentally sound solution, if the BPA and other State and Federal agencies elect to remove the dam to provide fish passage into the upper Similkameen watershed.

5.3 Benefit Cost Analysis

A Benefit Cost Analysis was performed for the Enloe Dam Passage project to determine the benefit cost ratios (B/C) for the six passage alternatives. The analysis consists of identifying and quantifying project benefits and costs, and determining the B/C ratios. The analysis was performed on a present worth basis. A Federal discount rate of 3 percent and a project life to 50 years were assumed. This is consistent throughout the economic analysis in the project.

There are four components to the Benefit Cost Analysis, including a determination of:

- Benefits;
- Disbenefits;
- Costs; and
- B/C Ratios

These are explained in the following sections.

5.3.1 Benefits

Benefits of the project are assumed to be realized only from the harvest of steelhead trout. Three harvest scenarios have been investigated in the analysis, including a 10, 20 and 40 percent harvest of returning adult fish. It is interesting to note that as the harvest of returning adults increases, the run builds at a slower rate; however, the catch is still greater and the project benefit increases.

In an effort to place a monetary value on fish, Meyer's (1984) estimate of $144.00 per adult sport caught and $21.81 for commercial/Indian caught steelhead trout was used. Table 5-1 shows the number of harvestable steelhead trout for the 10, 20 and 40 percent harvest scenarios. A brood stock of 115 fish has been removed from the harvest estimates. Since these fish are not caught, they are assumed to have no economic value.

Using the 3 percent discount rate, the present worth of project benefits was determined. Results are given in Table 5.2.

5.3.2 Disbenefits

Of the six upstream passage alternatives, three were developed assuming the PUD would not redevelop hydropower at the Enloe site (Alternatives 1, 3 and 6). Alternative 5 was developed without regard for hydropower redevelopment; since it has no impact on the PUD's proposal. Alternatives 2 and 4, however, were developed to be compatible with hydropower. As mentioned in previous sections, Alternatives 2 and 4 cause the PUD to lose head for power generation and thereby reduce the economic benefit of their proposed project. Also, Alternative 2 would require the PUD to bypass flow for fishway operation. Since the loss of power would be caused by the Enloe Dam Passage project, it is considered a project disbenefit.

In conjunction with the PUD staff, the potential economic loss was calculated for Alternatives 2 and 4. The present worth of losses were determined to be:

- $3,259,000 - Alternative 2; and
- $2,467,000 - Alternative 4

TABLE 5-1
Number Of Harvestable Steelhead For 10%, 20% and 40% Harvest Scenarios By Project Year[1]

Project Years	10% Harvest	20% Harvest	40% Harvest
1 - 6	830 (183)	1,276 (281)	2,164 (476)
7 - 12	1,557 (343)	2,221 (489)	3,325 (731)
13 - 18	2,190 (482)	2,956 (650)	4,002 (880)
19 - 24	2,739 (603)	3,535 (778)	4,392 (966)
25 - 30	3,218 (708)	3,979 (875)	4,618 (1,016)
31 - 36	3,631 (799)	4,329 (952)	4,750 (1,045)
37 - 42	3,995 (879)	4,604 (1,013)	4,826 (1,062)
43 - 48	4,311 (948)	4,815 (1,059)	4,871 (1,072)
49 - 50	4,585 (1,009)	4,982 (1,096)	4,897 (1,077)

1 Numbers represent estimated total harvest by sport, commercial and Indian fisheries. Numbers in brackets represent the Indian harvest only.

TABLE 5-2
Present Worth Of Project Benefits For 10%, 20% And 40% Harvest Scenarios

Harvest Scenario	Present Worth
10%	$7,215,100
20%	$9,156,225
40%	$11,455,335

5.3.3 Costs

Project costs were estimated for each of the six passage alternatives. The total project costs include estimates for:

- o Capital Costs;
- o Annual Costs; and
- o Replacement Costs.

Capital costs are those costs incurred at the beginning of the project, including: construction, engineering services and equipment. Annual costs include costs of labor and facility maintenance. Replacement costs are incurred periodically for replacement of mechanical equipment.

A present value analysis was performed to place capital, annual and replacement costs on a consistent basis. A 50 year project life and a 3 percent discount rate were used in the analysis. Tables 5-3 through 5-9 show the detailed cost summaries for the six alternatives. This information is an estimate based on the level of detail completed to date.

Cost estimates made by the U.S. Bureau of Reclamation for smolt production and outplanting were used in the analysis. The Bureau of Reclamation has committed $425,000 for expansion of the Wells Hatchery, $125,000 per year for operation and maintenance of the Wells Hatchery expansion and outplanting and $65,000 for the purchase of a fish hauling truck (Appendix 1, MOM - 7 May 1985). After 5 years of operation, the Bureau of Reclamation intends to give ownership of the Wells expansion to Douglas County PUD. It is assumed that if the BPA were to construct a smolt production facility, for the period after Douglas County PUD takes ownership of the Wells expansion, it would not cost any more to operate than the Bureau's estimate. In estimating the fish hauling requirements of Alternatives 3, 4 and 5, the purchase of a fish hauling truck was included. Therefore, the cost of the Bureau of Reclamation truck is not included in the Alternative 3, 4 and 5 estimates.

TABLE 5-3
Capital And Annual Costs For Construction, Engineering, Operation And Maintenance For Alternative 1 - Fishway From Falls

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	$ --	$25,000
Dewatering	LS	--	--	$60,000
Earthwork				$154,000
Excavation, Rock	CY	7200	20	144,000
Backfill	CY	1100	8	9,000
Riprap	CY	40	25	1,000
Reinforced Concrete				$578,000
Slabs	CY	310	225	70,000
Walls	CY	1380	350	483,000
Precast	CY	110	225	25,000
Metals				$182,000
Trashracks	LS	--	--	4,000
Diffusers	LS	--	--	6,000
Valves & Gates	LS	--	--	55,000
Grating	LS	--	--	117,000
Wood				$15,000
Exit Trashracks	LS	--	--	1,000
Decking	LS	--	--	14,000
Miscellaneous				$67,000
Drainage	LS	--	--	4,000
Access Road	LS	--	--	63,000
Civil Site Work				$15,000
Subtotal				$1,096,000
10% Contractor O & P				110,000
20% Contingency				241,000
TOTAL				$1,447,000

TABLE 5-3 Continued
Capital And Annual Costs For Construction, Engineering, Operation And Maintenance For Alternative 1 - Fishway From Falls

Item	Unit	Quantity	Unit Cost	Total Cost
Engineering Services				
Permits				$30,000
Design				
Basic Services				160,000
Surveying				15,000
Geotechnical Investigation				25,000
Testing				20,000
Inspection				90,000
TOTAL				$340,000
TOTAL CAPITAL COSTS				$1,787,000
Annual Costs				
Labor, 1/4 FTE @ 32,000/Year				$8,000
Maintenance/Year				4,000
TOTAL ANNUAL COSTS				$12,000
Present Value				
Annual Costs				$309,000
TOTAL PROJECT COST				**$2,096,000**

TABLE 5-4
Capital And Annual Costs For Construction, Engineering, Operation And Maintenance For Alternative 2 - Fishway Below Powerhouse

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	$ --	$25,000
Dewatering	LS	--	--	$135,000
Earthwork				$163,000
Excavation, Rock	CY	7450	20	149,000
Backfill	CY	1600	8	13,000
Riprap	CY	40	25	1,000
Reinforced Concrete				$862,000
Slabs	CY	620	225	140,000
Walls	CY	1580	350	553,000
Mass	CY	1120	135	151,000
Precast	CY	80	225	18,000
Metals				$192,000
Trashracks	LS	--	--	9,000
Diffusers	LS	--	--	6,000
Valves & Gates	LS	--	--	45,000
Grating	LS	--	--	132,000
Wood				$1,000
Exit Trashracks	LS	--	--	1,000
Miscellaneous				$81,000
Drainage Facility	LS	--	--	7,000
Access Road	LS	--	--	74,000
Civil Site Work				$20,000
Subtotal				$1,479,000
10% Contractor O & P				148,000
20% Contingency				325,000
TOTAL				$1,952,000

TABLE 5-4 Continued
Capital And Annual Costs For Construction, Engineering, Operation And Maintenance For Alternative 2 - Fishway Below Powerhouse

Item	Unit	Quantity	Unit Cost	Total Cost
Engineering Services				
Permits				$30,000
Design				
Basic Services				180,000
Surveying				15,000
Geotechnical Investigation				45,000
Testing				25,000
Inspection				100,000
TOTAL				$395,000
TOTAL CAPITAL COSTS				$2,347,000
Annual Costs				
Labor, 1/4 FTE @ 32,000/Year				$8,000
Maintenance/Year				4,000
TOTAL ANNUAL COSTS				$12,000
Present Value				
Annual Costs				$309,000
TOTAL PROJECT COST				**$2,656,000**

TABLE 5-5
Capital, Annual And Replacement Costs For Construction, Engineering, Operation And Maintenance For Alternative 3 - Trap And Haul At Falls

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	$ --	$25,000
Dewatering	LS	--	--	$60,000
Earthwork				$111,000
Excavation, Rock	CY	5400	20	108,000
Backfill	CY	350	8	3,000
Reinforced Concrete				$332,000
Slabs	CY	209	225	47,000
Walls	CY	790	350	277,000
Precast	CY	36	225	8,000
Metals				$110,000
Trashracks	LS	--	--	4,000
Diffusers	LS	--	--	30,000
Piping	LS	--	--	4,000
Valves & Gates	LS	--	--	59,000
Elevator	LS	--	--	11,000
Fencing	LS	--	--	2,000
Wood				$14,000
Decking	LS	--	--	14,000
Equipment				$229,000
Generator	LS	1	16,000	16,000
Winches	LS	2	1,000	2,000
Truck	LS	1	140,000	140,000
Pumps	LS	--	--	61,000
Miscellaneous	LS	--	--	10,000
Miscellaneous				$167,000
Evaluation Facility	LS	--	--	63,000
Drainage	LS	--	--	2,000
Access Road	LS	--	--	102,000

TABLE 5-5 Continued
Capital, Annual And Replacement Costs For Construction, Engineering, Operation And Maintenance For Alternative 3 - Trap And Haul At Falls

Item	Unit	Quantity	Unit Cost	Total Cost
Civil Site Work	LS	--	--	$10,000
Subtotal				$1,058,000
10% Contractor O & P				106,000
20% Contingency				233,000
TOTAL				$1,397,000
Engineering Services				
Permits				$30,000
Design				
Basic Services				160,000
Surveying				15,000
Geotechnical Investigation				25,000
Testing				20,000
Inspection				90,000
TOTAL				$340,000
TOTAL CAPITAL COSTS				$1,737,000
Replacement Costs				
Tractor - Replace @ Year 10, 20, 30 & 40				$80,000
Pumps - Replace 2 @ Year 25				30,000
Annual Costs				
Truck Maintenance/Year				$ 4,500
Labor, 1/4 FTE @ 32,000/Year				48,000
Maintenance/Year				8,000
Power				5,500
TOTAL ANNUAL COSTS				$66,000
Present Value				
Replacement Costs				$ 176,000
Annual Costs				1,698,000
TOTAL PROJECT COST				**$3,611,000**

TABLE 5-6
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 4 - Trap And Haul Below Powerhouse

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	--	$25,000
Dewatering	LS	--	$ --	$135,000
Earthwork				$80,000
Excavation, Rock	CY	3850	20	77,000
Backfill	CY	350	8	3,000
Reinforced Concrete				$352,000
Slabs	CY	120	225	27,000
Walls	CY	480	350	168,000
Mass	CY	1110	135	150,000
Precast	CY	30	225	7,000
Metals				$141,000
Trashracks	LS	--	--	9,000
Diffusers	LS	--	--	30,000
Piping	LS	--	--	9,000
Valves & Gates	LS	--	--	63,000
Elevator	LS	--	--	10,000
Fencing	LS	--	--	2,000
Grating	LS	--	--	18,000
Equipment				$229,000
Generator	LS	1	16,000	16,000
Winches	LS	2	1,000	2,000
Truck	LS	1	140,000	140,000
Pumps	LS	--	--	61,000
Miscellaneous	LS	--	--	10,000
Miscellaneous				$187,000
Evaluation Facility	ls	--	--	63,000
Drainage	LS	--	--	2,000
Access Road	LS	--	--	122,000

TABLE 5-6 Continued
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 4 - Trap And Haul Below Powerhouse

Item	Unit	Quantity	Unit Cost	Total Cost
Civil Site Work				$10,000
Subtotal				$1,159,000
10% Contractor O & P				116,000
20% Contingency				255,000
TOTAL				$1,530,000
Engineering Services				
Permits				$30,000
Design				
Basic Services				190,000
Surveying				15,000
Geotechnical Investigation				45,000
Testing				25,000
Inspection				100,000
TOTAL				$405,000
TOTAL CAPITAL COSTS				$1,935,000
Replacement Costs				
Tractor - Replace @ Year 10, 20, 30 & 40				$80,000
Pumps - Replace 2 @ Year 25				30,000
Annual Costs				
Truck Maintenance/Year				$ 4,500
Labor, 1/4 FTE @ 32,000/Year				48,000
Maintenance/Year				8,000
Power				5,500
TOTAL ANNUAL COSTS				$66,000
Present Value				
Replacement Costs				$ 176,000
Annual Costs				1,698,000
TOTAL PROJECT COST				**$3,809,000**

TABLE 5-7
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 5 - Trap And Haul At Railroad Bridge

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	$ --	$25,000
Dewatering	LS	--	--	$225,000
Earthwork				$45,000
Excavation, Rock	CY	600	20	12,000
Backfill	CY	2000	15	30,000
Riprap	CY	120	25	3,000
Reinforced Concrete				$502,000
Slabs	CY	150	225	34,000
Walls	CY	400	350	140,000
Mass	CY	2400	135	324,000
Precast	CY	18	225	4,000
Metals				$161,000
Trashracks	LS	--	--	9,000
Diffusers	LS	--	--	30,000
Piping	LS	--	--	8,000
Valves & Gates	LS	--	--	68,000
Elevator	LS	--	--	10,000
Fencing	LS	--	--	2,000
Grating	LS	--	--	34,000
Equipment				$222,000
Generator	LS	1	16,000	16,000
Winches	LS	2	1,000	2,000
Truck	LS	1	140,000	140,000
Pumps	LS	--	--	54,000
Miscellaneous	LS	--	--	10,000
Miscellaneous				$90,000
Evaluation Facility	ls	--	--	63,000
Drainage	LS	--	--	7,000
Access Road	LS	--	--	20,000

TABLE 5-7 Continued
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 5 - Trap And Haul At Railroad Bridge

Item	Unit	Quantity	Unit Cost	Total Cost
Civil Site Work				$15,000
Subtotal				$1,285,000
10% Contractor O & P				128,000
20% Contingency				283,000
TOTAL				$1,696,000
Engineering Services				
Permits				$30,000
Design				
Basic Services				190,000
Surveying				15,000
Geotechnical Investigation				45,000
Testing				25,000
Inspection				100,000
TOTAL				$405,000
TOTAL CAPITAL COSTS				$2,101,000
Replacement Costs				
Tractor - Replace @ Year 10, 20, 30 & 40				$80,000
Pumps - Replace 2 @ Year 25				27,000
Annual Costs				
Truck Maintenance/Year				$ 4,500
Labor, 1/4 FTE @ 32,000/Year				48,000
Maintenance/Year				8,000
Power				5,500
TOTAL ANNUAL COSTS				$66,000
Present Value				
Replacement Costs				$ 174,000
Annual Costs				1,698,000
TOTAL PROJECT COST				**$3,973,000**

TABLE 5-8
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 6a - Dam Removal With Dredging

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	--	$250,000
Dewatering	LS	--	--	$70,000
Earthwork				$19,177,000
Excavation, Rock	CY	4400	$ 20	88,000
Hauling	CY	1,790,000	8	14,320,000
Dredging	CY	1,790,000	2.5	4,475,000
Demolition	CY	11,300	26	294,000
Reinforced Concrete				$258,000
Slabs	CY	145	$225	33,000
Walls	CY	630	350	221,000
Precast	CY	18	225	4,000
Metals				$71,000
Trashracks	LS	--	--	4,000
Diffusers	LS	--	--	6,000
Valves & Gates	LS	--	--	45,000
Grating	LS	--	--	16,000
Wood				$15,000
Exit Trashracks	LS	--	--	1,000
Decking	LS	--	--	14,000
Miscellaneous				$263,000
Access Road	LS	--	--	63,000
Disposal Site	LS	--	--	200,000

TABLE 5-8 Continued
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 6a - Dam Removal With Dredging

Item	Unit	Quantity	Unit Cost	Total Cost
Civil Site Work				$20,000
Subtotal				$20,124,000
10% Contractor O & P				2,012,000
20% Contingency				4,427,000
TOTAL				$26,563,000
Engineering Services				
Permits				$50,000
Design				
Basic Services				200,000
Surveying				15,000
Geotechnical Investigation				60,000
Testing				100,000
Inspection				100,000
TOTAL				$525,000
TOTAL CAPITAL COSTS				$27,088,000
Annual Costs				
Labor, 1/4 FTE @ 32,000/Year				8,000
Maintenance/Year				3,000
TOTAL ANNUAL COSTS				$11,000
Present Value				
Annual Costs				283,000
TOTAL PROJECT COST				**$27,371,000**

TABLE 5-9
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 6b - Dam Removal With Sediment Release

Item	Unit	Quantity	Unit Cost	Total Cost
Mobilization & Demobilization	LS	--	--	$130,000
Dewatering	LS	--	--	$120,000
Earthwork				$382,000
Excavation, Rock	CY	4400	$ 20	88,000
Demolition	CY	11,300	26	294,000
Reinforced Concrete				$358,000
Slabs	CY	145	$ 225	33,000
Walls	CY	630	350	221,000
Precast	CY	16	225	4,000
Metals				$71,000
Trashracks	LS	--	--	4,000
Diffusers	LS	--	--	6,000
Valves & Gates	LS	--	--	45,000
Grating	LS	--	--	16,000
Wood				$15,000
Exit Trashracks	LS	--	--	1,000
Decking	LS	--	--	14,000
Miscellaneous				$63,000
Access Road	LS	--	--	63,000

TABLE 5-9 Continued
Capital, Annual And Replacement Costs For Construction, Engineering Operation And Maintenance For Alternative 6b - Dam Removal With Sediment Release

Item	Unit	Quantity	Unit Cost	Total Cost
Civil Site Work				$15,000
Subtotal				$1,054,000
10% Contractor O & P				105,000
20% Contingency				232,000
TOTAL				$1,391,000
Engineering Services				
Permits				$50,000
Design				
Basic Services				200,000
Surveying				15,000
Geotechnical Investigation				60,000
Testing				100,000
Inspection				100,000
TOTAL				$525,000
TOTAL CAPITAL COSTS				$1,916,000
Annual Costs				
Labor, 1/4 FTE @ 32,000/Year				8,000
Maintenance/Year				3,000
TOTAL ANNUAL COSTS				$11,000
Present Value				
Annual Costs				283,000
TOTAL PROJECT COST				**$2,199,000**

5.3.4 B/C Ratios

The B/C ratios have been determined for the six alternatives, for each of the three harvest scenarios. The benefits, disbenefits and costs of each passage alternative are given in Table 5-10. The B/C ratios for each of the alternatives are given in Table 5-11.

5.4 Implementation Schedule

A preliminary schedule outlining the various phases of the Enloe Dam passage project is presented in Figure 5-20. This schedule traces the project from its original inception in December 1982, through detailed design and construction of the preferred passage alternative in 1987 or 1988. Several key milestone events critical to the maintenance of this schedule are optimistically accounted for. These include a possible FERC hearing on the hydropower option, WElls Hatchery expansion funded by the Bureau of Reclamation, and fish certification at the hatchery to obtain a Canadian transport permit. Review of this report by the agencies, Tribes and other interested groups is scheduled for the summer of 1985 and a concensus decision on the preferred mode of passage is scheduled to be reached by the end of September, 1985. Detailed design and construction of the preferred passage alternative is scheduled for completion in an eighteen month time frame.

TABLE 5-10
Benefits And Costs For The Six Passage Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6a	Alternative 6b
10% Harvest Benefit	7,215,100	7,215,100	7,215,100	7,215,100	7,215,100	7,215,100	7,215,100
20% Harvest Benefit	9,156,225	9,156,225	9,156,225	9,156,225	9,156,225	9,156,225	9,156,225
40% Harvest Benefit	11,445,335	11,445,335	11,445,335	11,445,335	11,445,335	11,445,335	11,445,335
Disbenefit	--	3,259,000	--	2,467,000	--	--	--
Passage Facility Total Cost	2,096,000	2,656,000	3,611,000	3,809,000	3,973,000	27,371,000	2,199,000
Outplanting And Rearing Cost	3,706,000[1]	3,706,000	3,641,000[2]	3,641,000	3,641,000	3,706,000	3,706,000
		7,252,000	9,917,000	7,614,000	7,614,000	31,077,000	5,905,000

1 Wells Expansion - $425,000
Hauling Truck - $65,000
Present Worth of $125,000 O & M for 50 years @ 3% - $3,216,000
Total - $3,706,000

2 Wells Expansion - $ 425,000
Present Worth of $125,000 O & M for 50 Years @ 3% - 3,216,000
Total - $3,641,000

TABLE 5-11
Benefit Cost Ratios For The Six Passage Alternatives For
10%, 20% And 40% Harvest Scenarios

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6a	Alternative 6b
10% Harvest	1.24	0.75	0.99	0.73	0.95	0.23	1.22
20% Harvest	1.58	0.95	1.26	0.92	1.20	0.29	1.55
40% Harvest	1.97	1.19	1.58	1.16	1.50	0.37	1.94

Figure 5-20

Proposed Project Schedule

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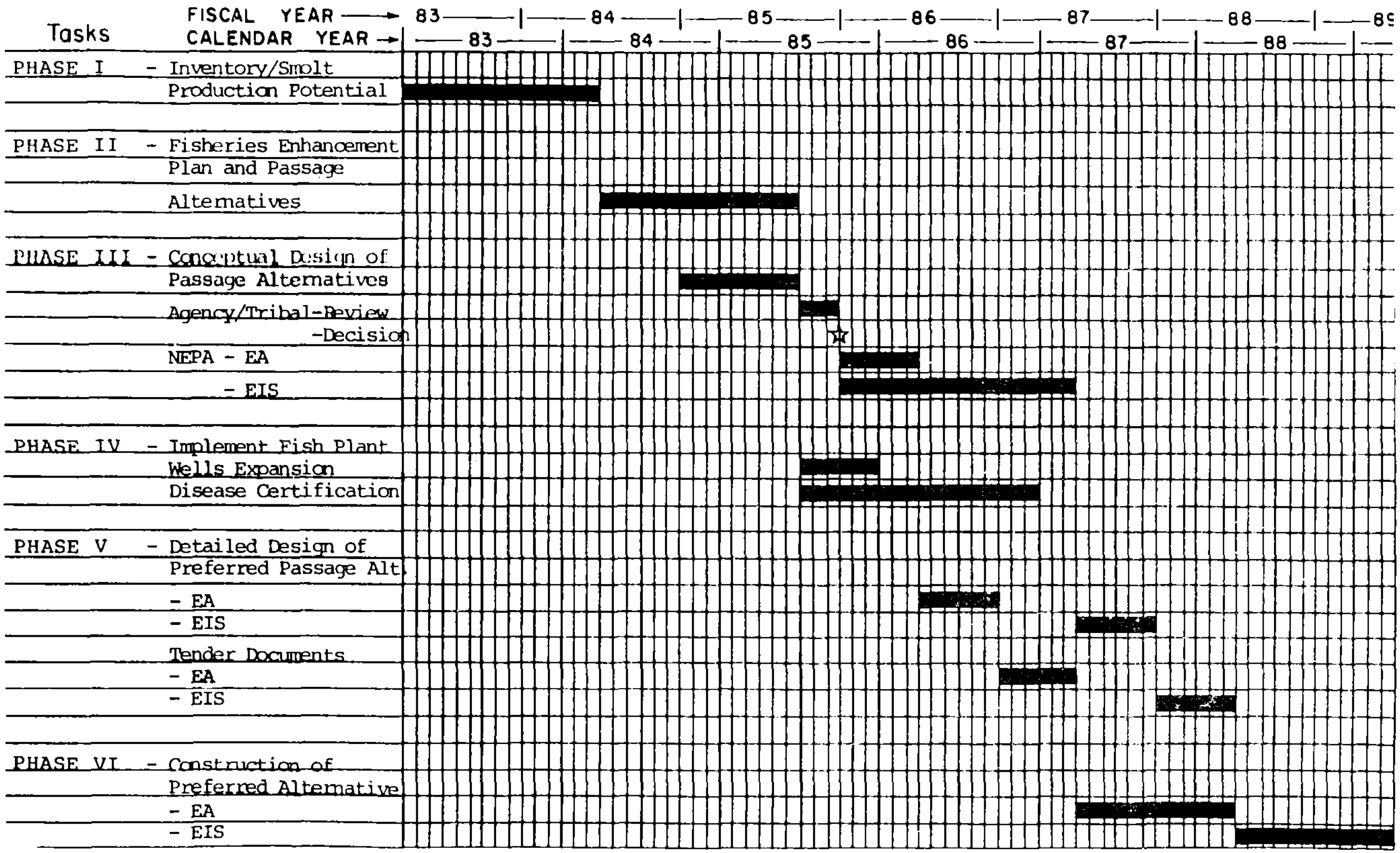

6.0 SIMILKAMEEN RIVER SYSTEM WATER QUALITY ASSESSMENT

Among the many factors which influence the water quality of any particular watershed are natural factors such as geology, soils, climate, vegetation, etc. plus influences by man such as mining, forestry, towns and villages, livestock production, irrigation and agricultural production. All of these factors are at play in the Similkameen watershed to varying degrees in each section of the basin. The drainage areas and mean annual runoff for each main tributary and segment of the Similkameen River are presented in Table 6-1.

The water quality historical data base in the Similkameen watershed is quite extensive. In order to characterize the water quality, data from monitoring stations on the mainstem and where possible a station on each major tributary were selected for review. In total, 19 stations are reported herein and reviewed, 13 of which are on the mainstem between the headwaters and the confluence of the Similkameen and Okanogan Rivers near Oroville, Washington.

General and specific water quality criteria have been developed for almost every major water use ranging from agricultural use, livestock use, human consumption, aquatic life and recreational use for instance. Since the primary purpose of this project deals with the feasibility of the Similkameen River system for steelhead enhancement, the primary focus of this water quality assessment is therefore upon criteria established for freshwater aquatic life. Table 6-2 lists the criteria used to assess the historical water quality of the Similkameen and its tributaries.

6.1 Upper Similkameen River

The upper Similkameen River drains the Manning Park and Pasayten River watersheds as well as a section of the Thompson Plateau south of Princeton. In this section, with the exception of Manning Park, the population is small. One large copper mine is active in the area and two older mine dumps exist east of the river mainstem between the Park boundary and Princeton. The livestock population in this section is estimated to be around 500 animals. Five effluent discharges are under provincial permit in this section for discharge to the ground only and none directly to the stream (Figure 6-1).

TABLE 6-1
Similkameen River Drainage Areas and Mean Annual Runoff

Drainage Areas*	Area $(km)^2$	Mean Annual (m^3/s)	Annual Runoff (dam^3)
Similkameen Above Goodfellow Ck.	407	8.13	256,000
Pasayten River Above Calcite Ck.	562	7.90	249,000
Similkameen at Princeton	1850	24.6	770,000
Tulameen River at Princeton	1760	23.3	732,000
Allison Creek Near Princeton	593	1.5+	47,000+
Hayes Creek Near Princeton	769	3.5+	110,000+
Wolf Creek at Mouth	215	0.494	15,600
Similkameen Near Hedley	5590	50.1	1,586,000
Hedley Creek Near Mouth	389	2.52	79,400
Ashnola River at Keremeos	1050	8.33	263,000
Keremeos Creek Near Olalla	183	0.774	24,400
Similkameen Near Border	8504	65	2,046,000
Sinlahekin Creek Above Palmer Lake (USA)	686	1.58	48,000
Similkameen Above Enloe Dam (Night Hawk) USA	9190	66.3	2,094,000

+ Estimate

1 km^2 = 0.386 Square miles.

1 dam^3 = 0.81 Acre-feet

1 m^3/s = 35.32 Cubic feet/sec.

TABLE 6-2
Criteria for Freshwater Aquatic Life

	U.S.			Canadian	
	Max. 24 hr.	Max. Any One Time	REF	Max.	REF
Alkalinity	GT 20	-	4	GT 20	1
BOD_5	-	-		-	
Carbon organic	-	-		-	
Carbon inorganic	-	-		-	
Chloride	-	-		-	
COD	-	-		-	
Coliform - fecal	100/100 ml	-	3	100/100 ml*	1
Colour	-	-		LE 100 units*	1
Cyanide	-	-		LE 0.005	1
Fluoride	-	-		-	
Hardness	-	-		-	
Metals					
Aluminum	-	-		LE 0.100	1
Arsenic	-	0.44	2	LE 0.05	1
Barium	-	-		-	
Boron	-	-		-	
Cadmium	0.000012	0.0015	2	LE 0.0002	1
Chromium	0.00029	0.021	2	LE 0.04	1
Cobalt	-	-		-	
Copper	0.0056	0.012	2	LE 0.005	1
Iron	-	1.0	4	LE 0.300	1
Lead	0.00075	0.074	2	LE 0.03	1
Manganese	-	-		-	
Mercury	0.0002	0.0041	2	LE 0.0001	1
Molybdenum	-	-		-	
Nickel	0.056	1.1	2	LE 0.025	1
Silver	-	0.0012	2	-	
Zinc	0.047	0.180	2	LE 0.030	1
Nitrogen					
Ammonia	0.02	-	4	LE 0.02	
Nitrate	-	-		-	
Nitrite	-	-		-	
Total Organic	-	-		-	
Total Kjeldhal	-	-		-	

LE = less than equal
GT = greater than
* Guideline for Recreational Waters

TABLE 6-2 (Continued)
Criteria for Freshwater Aquatic Life

	U.S.			Canadian	
	Max. 24 hr.	Max. Any One Time	REF	Max.	REF
Oil & Grease	Compound Specific		4	LE 5*	1
Oxygen - dissolved	GT 8	-	3	GT 4.0	1
Oxygen - % Saturation	LE 110%	-	3	-	
Pesticides					
Aldrin	-	0.003)	2	LE 0.000001	1
BHC	-	-		-	
Chlordane	0.0000043	0.0024)	2	LE 0.00001	1
DDE	-	-		-	
DDD	-	-		-	
P,P-DDT	0.000001	0.00011	2	LE 0.000001	1
Dieldrin	0.0000019	0.0025	2	-	
Endrin	0.0000023	0.00018	2	LE 0.000002	1
Heptachlor	0.0000038	0.00052	2	LE 0.000001	1
Methoxychlor	0.00003	-	4	LE 0.00003	1
Thiodan	-	-		-	
pH	6.5-8.5	-	3	6.5-9.0	1
Phosphorus - Total	-	-		LT 0.025	1
Total Dissolved	-	-		-	
Ortho Dissolved	-	-		-	
Polychlorinated Biphenyls	0.000014	-	2	LE 0.000001	1
Potassium	-	-		-	
Silica	-	-		-	
Sodium	-	-		-	
Solids - Total	-	-		-	
Solids - Dissolved	-	-		-	
Solids - Suspended	-	-		LE 25	1
Specific Conductivity	-	-		-	
Sulphate	-	-		-	
Temperature	LE 18°C	-	3	-	
Toxicity	-	-		-	
Turbidity	-	-		-	

LE i= Less than or equal
LT = Less than
GT = Greater than.

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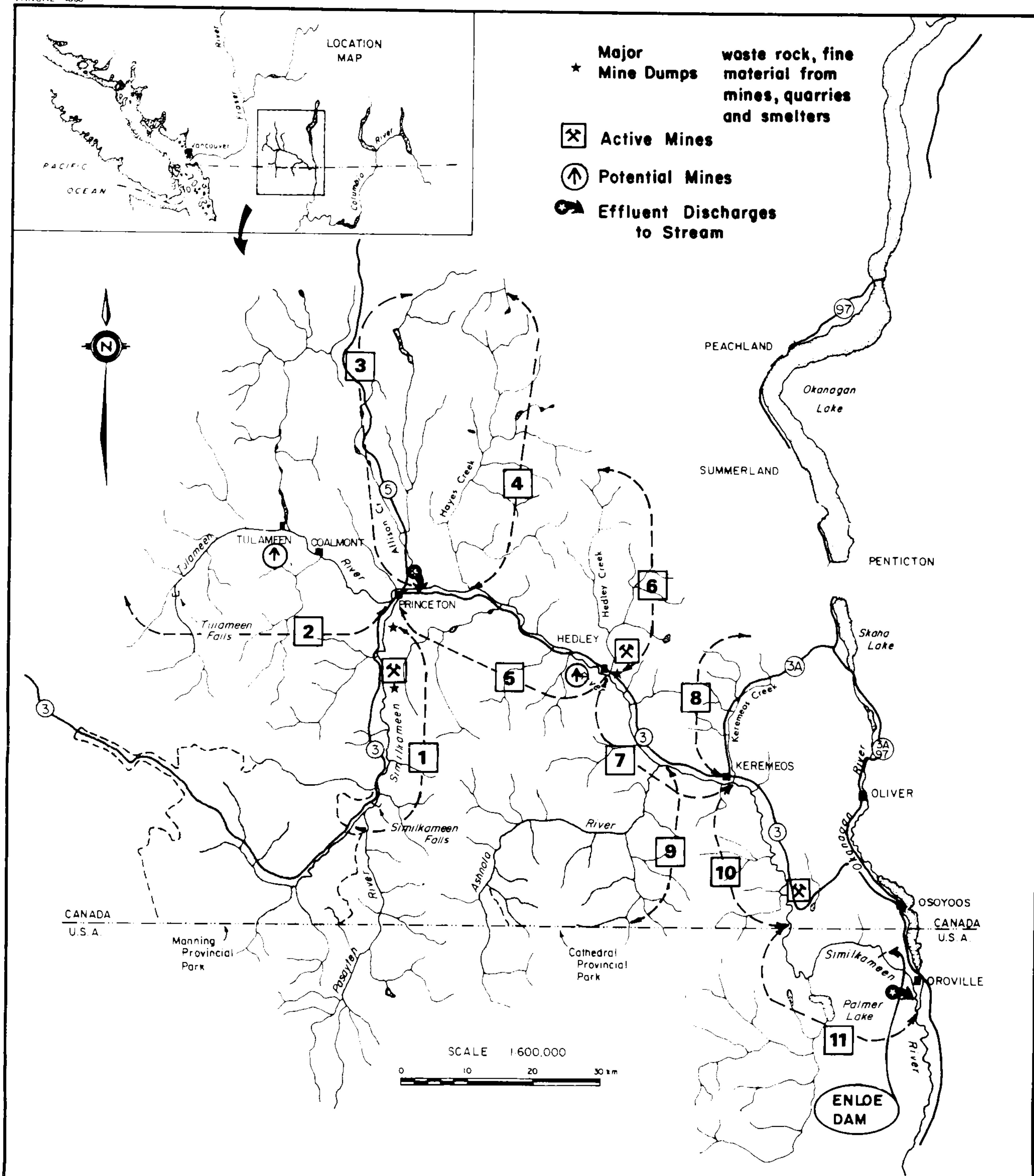

Section	Active Mines	Effluent Discharges to Ground (Permits)	Effluent Discharges to Stream (Permits)	Livestock Population
1. Upper Similkameen	1 (copper)	5	-	(?)
2. Tulameen River	-	4	-	810
3. Allison Creek	-	1	-	910
4. Hayes Creek	-	-	-	320
5. Similkameen - Princeton to Hedley	-	2	1 (Princeton Sewage Plant)	2240
6. Hedley Creek	1 (gold)	-	-	-
7. Similkameen - Hedley to Keremeos	-	3	-	1676
8. Keremeos Creek	-	5	-	1110
9. Ashnola River	-	(?)	(?)	(?)
10. Similkameen Keremeos to Border	1 (gold)	2	-	1895
11. Similkameen - Border to Oroville	-	-	1 (Oroville Sewage Plant)	(?)

FIGURE 6-1
MINES, EFFLUENT DISCHARGES, LIVESTOCK IN THE WATERSHED

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A total of 11 licenced water withdrawals from the Similkameen River exist in this section with total amounts of 174,750 m^3/d for mining, 9.6 m^3/d domestic, and 327 m^3/d for municipal waterworks. Irrigation licences account for 346,916 m^3/yr (Figure 6-2). This section of the watershed represents about 20 percent of total drainage area but contributes about 36 percent of the annual discharge. Mean annual runoff in this section is about 770,000 dam^3 (624,000 acre-feet) equivalent to about 416 dam^3 per km^2 (918 acre-feet per mi^2)

Historical water quality data has been collected by the province at four major stations on the Similkameen River mainstem in this section (Stations 0500075, 0500417, 0500418 and 0500629) (Figure 6-3). Detailed summary water quality data are listed in Tables 1 to 4 (Appendix 4).

The water quality in the Upper Similkameen River, as represented at Similkameen Falls (Station 0500075, Table 1, Appendix 4), indicates that while there is considerable fluctuation in parameter levels seasonally the quality on the average exceeds the criteria considered desirable for freshwater aquatic life. The records indicate some occurrences of reduced dissolved oxygen (Minimum 5.8 mg/l) below the U.S. criteria (minimum 8.0 mg/l) but still well above Canadian criteria (minimum 4.0 mg/l). Trace metals are low as are nutrients. No data exists for pesticide levels in this section.

Data from stations located on the Similkameen River above and below Newmont Mines are reported in Appendix 4, Tables 2 and 3 (Stations 0500417 and 0500418) which indicates no apparent influence on the water quality of the mainstem opposite the mine.

The resulting water quality of the entire Upper Similkameen watershed as represented by the monitoring data at Princeton just upstream of the Tulameen River confluence (Station 0500629, Table 4, Appendix 4) indicates the dissolved trace metals remain low and, based on only one sampling, pesticides were all less than detectable. Dissolved oxygen minimums reported were higher than further up river. Temperature has been reported to exceed the desirable level (18°C U.S. criteria) but averages a very acceptable 6.4°C.

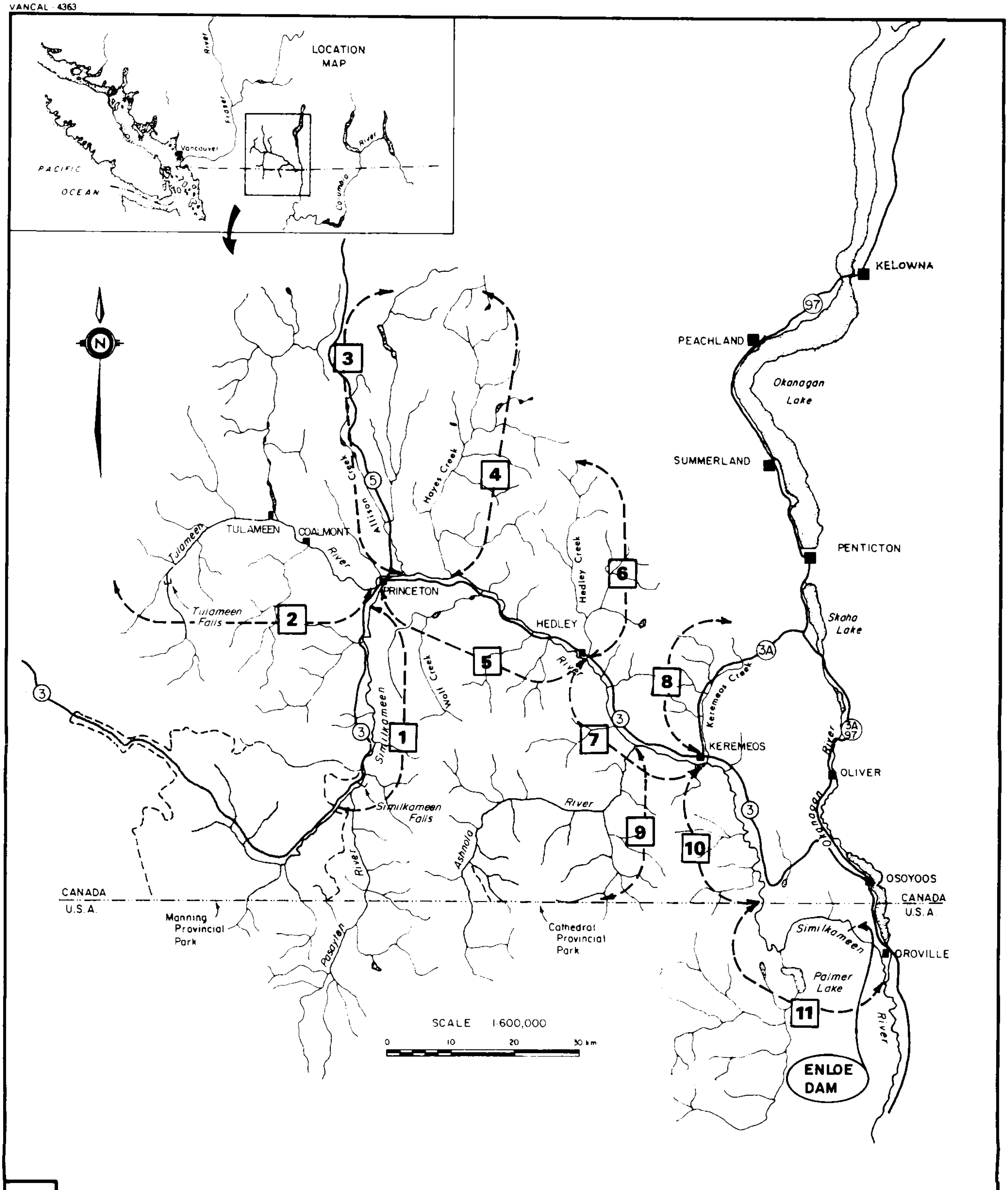

FIGURE 6-2 WATER LICENCES FOR WITHDRAWAL

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Section	Mining m³/d	Irrigation m³/yr	Domestic m³/d	Water-works m³/d	Total No.	Notes
1. Upper Similkameen to Princeton	174,750	346,916	9.6	327.0	11	
2. Tulameen River	-	9,250	27.3	9,600.0	10	
3. Allison Creek	-	2,001,620	108.0	-	70	
4. Hayes Creek	-	1,296,365	44.3	222.5	48	
5. Similkameen Princeton to Hedley	-	2,706,373	35.9	-	24	Incl. Wolf Cr.
6. Hedley Creek	6,806	222,020	682.0	796.0	4	
7. Similkameen - Hedley to Keremeos	-	3,756,568	13.7	341.0 (Ind.)	25	
8. Keremeos Creek	-	2,275,900	81.8	5,184.0 (Ind.)	32	
9. Ashnola River	-	1,387,667	40.9	-	?	
10. Similkameen - Keremeos to Border	909	4,608,569	15.0	-	34	
11. Similkameen - Border to Oroville	-	64,000,000	-	-	1	To be phased out in 1986

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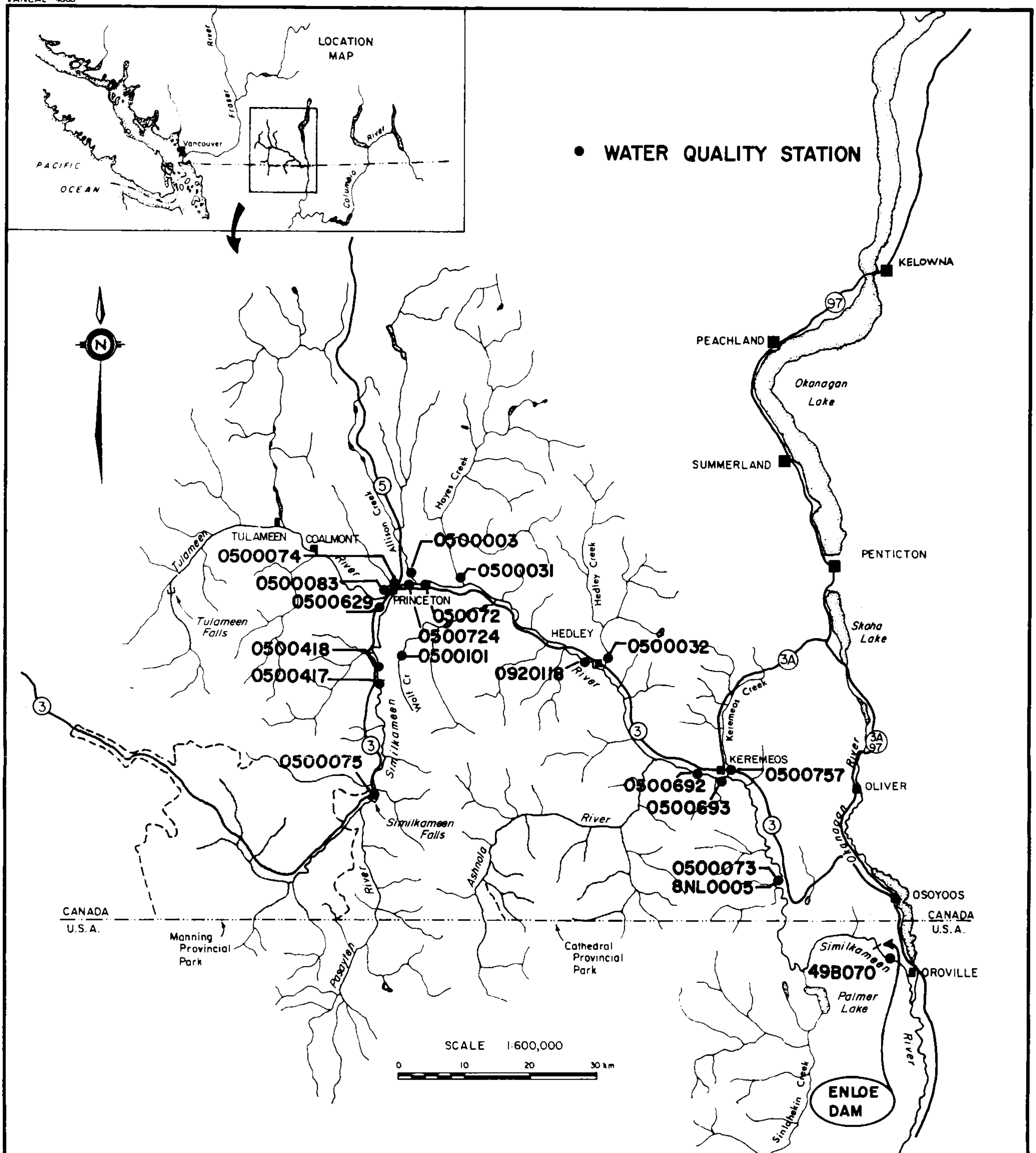

Station	Description	Status	Agency
0500075	Similkameen River at Similkameen Falls	Active	M.O.E.
0500417	Similkameen River Upstream of Newmont Mines	Active	M.O.E.
0500418	Similkameen River Downstream of Newmont Mines	Active	M.O.E.
0500629	Similkameen River at Princeton	Active	M.O.E.
0500083	Tulameen River at Highway #5 Bridge	Active	M.O.E.
0500003	Allison Creek Near Mouth	Active	M.O.E.
0500074	Similkameen River Above Allison Creek	Inactive	M.O.E.
0500724	Similkameen River Above Sewage Plant - Princeton	Active	M.O.E.
0500725	Similkameen River Below Sewage Plant - Princeton	Active	M.O.E.
0500031	Hayes Creek at Road Bridge Near Mouth	Active	M.O.E.
0500101	Wolf Creek Downstream of Newmont Mines	Active	M.O.E.
0920118	Similkameen River at Hedley	Inactive	M.O.E.
0500032	Hedley Creek at Highway #3	Active	M.O.E.
0500692	Similkameen River Upstream of Keremeos	Active	M.O.E.
0500693	Similkameen River Downstream of Keremeos	Active	M.O.E.
0500757	Keremeos Creek Near Mouth	Active	M.O.E.
0500073	Similkameen River Downstream of Cawston	Active	M.O.E.
08NL0005	Similkameen River 9 km from U.S. Border	Active	Env. Can.
49B070	Similkameen River at Oroville, Washington		D.O.E.

FIGURE 6-3
MAJOR WATER QUALITY STATIONS

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The total mean annual dissolved material load at this point in the system averages about 57,000 tonnes per year (31 tonnes per square kilometre) (Table 6-3). The total nutrient load based on mean annual discharge and parameter levels averages about 123 tonnes nitrogen and 20.7 tonnes phosphorous (66 kilograms nitrogen and 11 kilogram phosphorous per square kilometre of drainage area). The non-dissolved load as represented by suspended solids averages 36,300 tonnes per year (19.6 tonnes per square kilometre of drainage area).

6.2 Tulameen Watershed

The Tulameen watershed drains a portion of the Thompson Plateau region of British Columbia. There are no active mines in the system at present. The livestock population is estimated to be around 800 animals. There are four registered discharges of effluent to the ground and none to the stream. A total of 10 licenced water withdrawals are recorded from the Tulameen River with amounts totalling 27.3 m^3/d domestic, 9,600 m^3/d waterworks and 9,250 m^3/yr for irrigation.

The Tulameen watershed represents about the same size drainage area as the Upper Similkameen and contributes on a mean annual runoff basis an almost equivalent amount (732,000 dam^3 versus 770,000 dam^3 for the Upper Similkameen). The Tulameen runoff equates to 415 dam^3 per km^2 (917 acre-feet per mi^2).

Historical water quality of the Tulameen River represented by monitoring at the mouth (Station 050083) is presented in detail in Table 5, Appendix 4. While the quality in general is not significantly different than the Similkameen, the system carrys somewhat higher organic load as evidenced by the dissolved organic carbon levels (Mean 10.4 mg/l versus 4.3 mg/l for the Upper Similkameen). Alkalinity and hardness are slightly greater than the Upper Similkameen. Dissolved metals are low however the mean copper level (0.006 mg/l exceeds very slightly the desired levels (0.0056 mg/l U.S. and 0.005 mg/l Canadian). Pesticide levels were all below detection based on one sampling in 1974. Dissolved oxygen levels have been recorded as low as 4 mg/l which with average being 11.1 mg/l (Minimum desirable is 4.0 mg/l Canada Criteria). The river temperature can, according to the data, rise to 20.6°C but averages 6.5°C (Maximum desirable 18.0°C U.S. Criteria).

TABLE 6-3
Similkameen River Dissolved Material Mean Annual Loads

Drainage Areas*	Mean Dissolved Solids Load			Mean Nutrient Load			
				Nitrogen		Phosphorous	
	mg/L	tonnes/ year	tonnes/ km^2	tonnes/ year	kg/ km^2	tonnes/ year	kg/ km^2
Similkameen Above Goodfellow Ck.	65**	16,600	40.9	-	-	-	-
Pasayten River Above Calcite Ck.	60**	14,900	26.6	-	-	-	-
Similkameen at Princeton	73.9	56,900	30.7	123	66	20.7	11
Tulameen River at Princeton	90.9	66,500	37.8	125	68	10	5.4
Allison Creek Near Princeton	265*	12,400	21.0	18	30	2.3	4
Hayes Creek Near Princeton	74*	8,100	10.5	33	42	2.3	3
Wolf Creek at Mouth	264	4,100	19.1	5	22	1	4
Similkameen Near Hedley	106	168,000	30.1	***	***	***	***
Hedley Creek Near Mouth	34*	2,700	6.9	13	33	1	3
Ashnola River at Keremeos	63**	16,600	15.8	-	-	-	-
Keremeos Creek Near Ollala	48*	3,600	19.7	28	148	2.5	13
Similkameen Near Border	113	231,000	27.0	410	48	70	8
Sinlahekin Creek Above Palmer Lake (USA)	200**	9,600	14.0	-	-	-	-
Similkameen Above Enloe Dam (Night Hawk) USA	107*	224,000	24.4	-	-	84	9

* From conductivity data (TDS = 0.65 x COND)
** IEC BEAK data (one sampling only)
*** Data considered too old.

The total mean annual dissolved material load of the Tulameen River averages about 66,500 tonnes per year (38 tonnes per square kilometre). The total nutrient load averages about 125 tonnes nitrogen and 10 tonnes phosphorous per year (68 kg nitrogen and 5.4 kg phosphorous per square kilometre per year) which is higher than the Upper Similkameen for nitrogen load but only about half the contribution for phosphorous. The non-dissolved solids load as represented by suspended solids averages 11,600 tonnes per year (6.6 tonnes per square kilometre of drainage area), less than half the aerial contribution of the Upper Similkameen River.

6.3 Lower Similkameen Watershed

Several major creeks and one river drain the watershed of the Similkameen between Princeton and Oroville. In the section between Princeton and Keremeos where the Similkameen valley runs eastward before turning south, the major tributaries in order of occurrence are: Allison and Hayes Creeks north of Princeton, Wolf Creek south of Princeton, Hedley Creek north of the Similkameen about midway between Princeton and Keremeos and lastly the Ashnola River southwest of Keremeos. Between Keremeos and Oroville where the river turns southeast the main tributaries of signifiance are: Keremeos Creek from the north of Keremeos and Sinlahekin Creek which drains a large area south of the International Border west of Oroville and above the Enloe Dam and reservoir. In this water quality review, the watershed between Princeton and Keremeos is termed the "western section of the Lower Similkameen" and between Keremeos and Oroville is termed the "southern section of the Lower Similkameen".

6.3.1 Western Section - Lower Similkameen

The western part of the lower Similkameen watershed contains the majority of the basins' population which is located in and around Princeton, Hedley and Keremeos. Two areas of mining and exploration activity occur in this section of the watershed. Newmont Mine, described earlier, has part of its operation in the upper drainage of Wolf Creek which drains apart of the north flank of Copper Mountain. Much small scale gold mining activity has periodically occurred near Hedley in the area drained by Hedley Creek. In total, there are 6 effluent discharges under Provincial permit, with

5 of these ground disposal and only one (Princeton Sewage Plant) with approval to discharge directly to the Similkameen River. The total livestock population is estimated at around 5,200 animals. A total of about 170 licenced water withdrawals occur in this western section, approximately 45 of which are from the mainstem of the Similkameen. The quantities by category are 6,806 m^3/d for mining, 884 m^3/d for domestic use, 1,360 m^3/d for waterworks and a total annual licenced irrigation quantity of 9,983,000 m^3 (8086 acre-feet).

The western section of the Lower Similkameen (between Princeton and Keremeos) represents a drainage area about similar in size to the combined Upper Similkameen and Tulameen watersheds and contributes an estimated mean annual runoff of about 120 dam^3 per km^2. This amount is only about one third of the upper Similkameen and Tulameen contribution which is indicative of this drier portion of the watershed.

Historical water quality data has been collected at many stations in the western section of the Lower Similkameen. Detailed data are presented in Tables 6 to 15, Appendix 4. Five stations are on the mainstem and at least one station representative of the major tributaries (4 creeks) have been included in this review. No water quality monitoring station is located on the Ashnola River and only minimal water quality data is available for this major tributary.

Allison Creek water quality as represented by a monitoring station near its mouth (Station 0500003, Table 7, Appendix 4) indicates the dissolved oxygen can be quite low at times (minimum recorded 3.5 mg/l). Elevated dissolved copper and zinc have been recorded (0.15 mg/l and 0.01 mg/l and 0.77 mg/l and 0.046 mg/l maximum and mean recorded respectively for copper and zinc). These compare with Canadian water quality criteria for aquatic life of less than 0.005 mg/l for copper and less than 0.03 mg/l for zinc (Table 6-2). The dissolved material concentration is higher than the Upper Similkameen and Tulameen as represented by dissolved solids and conductivity. Nutrient load averages 18 tonnes per year (30 kg per km^2) nitrogen and 2.3 tonnes per year (4.0 kg per km^2) phosphorous.

Hayes Creek water quality (Station 0500031 - Table 10, Appendix 4) indicates the dissolved oxygen levels are satisfactory, however temperature can exceed the desirable range. Dissolved iron, mercury and zinc are slightly elevated at times but on average are within the normal range. Coliform levels have also been recorded elevated at times. Nutrient load averages 33 tonnes per year (42 kg/km^2) nitrogen and 2.3 tonnes per year (3 kg/km^2) phosphorous.

Wolf Creek water quality (Station 0500101, Table 11, Appendix 4), downstream from Newmont Mines operation in this watershed, indicates dissolved oxygen and temperature to be slightly outside desirable range at times. Dissolved copper and zinc are also considerably elevated at times above the water quality criteria desirable for freshwater aquatic life. On average however, zinc levels are satisfactory (no data available on the mean level for dissolved copper). Nutrient loads in Wolf Creek are 5 tonnes per year (22 kg/km^2) nitrogen and 1.0 tonne per year (4 kg/km^2) phosphorous.

Hedley Creek water quality (Station 0500032, Table 13, Appendix 4) indicates that dissolved oxygen and temperature are within the desirable criteria range. Trace metal levels all appear to be low. Nutrient loads on average are 13 tonnes/year (33 kg/km^2) nitrogen and 1 tonne/year (3 kg/km^2) phosphorous. The dissolved solid load is very low (6.9 $tonnes/km^2$) by comparison with the mainstem (30.1 $tonnes/km^2$ Similkameen at Hedley).

The Ashnola River water quality is essentially undocumented as no permanent monitoring stations are located on the system. The drainage is largely uninhabited and constitutes about 30 percent (1050 km^2) of the total area of the Similkameen system between Princeton and Keremeos. The mean annual runoff is about 260,000 dam^3 with an aerial unit runoff of about 250 dam^3/km^2. The nutrient load, although unknown is likely to be quite low. If one half average values for the watershed are used, the nutrient load would amount to 27 tonnes/year (26 kg/km^2) nitrogen and 4 tonnes/year (4 kg/km^2) phosphorous.

Historical water quality data on the mainstem between Princeton and Keremeos are available for five locations (Tables 8, 9, 12, 14 and 15, Appendix 4). The records for the monitoring site near Hedley are quite dated (1966-1974) and may not represent present conditions but they are included for completeness.

The two stations on the mainstem near Princeton, above and below the town's sewage entry point (Stations 0500724 and 0500725, Tables 8 and 9), indicate dissolved oxygen levels are near to or above the desired range and temperature levels have been recorded that exceed the upper desirable limit. Based on only three samplings, elevated dissolved zinc levels have been reported downstream of the sewage outfall. Nutrient levels are similar at both stations indicating little detectable influence of any treated sewage on nitrogen and phosphorous concentrations.

The only data available on pesticide levels in this section of the watershed are from a site on the river just upstream of Hedley (Station 0920118, Table 12). These data indicated all pesticides and polychlorinated biphenyls were below detection limits.

The water quality of the mainstem, near Keremeos, as represented by two sites (Stations 0500692 and 0500693, Tables 14 and 15), indicate dissolved oxygen levels are satisfactory and temperature levels can, at times, reach or exceed the desirable upper limits (18^{o}C maximum). Dissolved metals levels are all low. The nutrient load at this point based on the data available, is approximately 385 tonnes per year (53 kg/km^2) nitrogen and 25 tonnes per year (3.5 kg/km^2) phosphorous.

6.3.2 Southern Section - Lower Similkameen

The southern section of the Lower Similkameen watershed includes the Keremeos Creek drainage (192 km^2) north east of Keremeos and a few other very small creeks before reaching the international border. On the Washington side, the runoff from the Sinlahekin Creek/Palmer Lake system (686 km^2) is the only major tributary prior to the Similkameen confluence with the Okanogan River at Oroville. One small mine is intermittently active near the Similkameen River just north of the border and there are several known old mine workings in this section of the watershed (including tributaries) on both sides of the border. In total, there are eight effluent discharges under provincial permit, all of which are for ground disposal excepting the treated sewage disposal into the Similkameen at Oroville. The total livestock population in this section is estimated at 200 animals. A total of 67 licenced water withdrawals occur, with slightly more than half on the mainstem. The quantities by category as presented in Figure 6-2 are 909 m^3/d mining, 138 m^3/d domestic, 5184 m^3/d waterworks and 72,300,000 m^3/yr irrigation (58,500 Acre-feet). The southern section of the Lower Similkameen represents a drainage area of around 2000 km^2 with a mean annual runoff of about 85 dam^3/km^2 reflecting the driest climate of the basin.

Water quality records for this section are available for Keremeos Creek, and three sites on the mainstem. No records were available for the Sinlahekin Creek tributary.

Keremeos Creek water quality (presented in Table 16, Appendix 4), based on only a few samplings, indicates dissolved oxygen and temperature were within the acceptable range. Fecal coliform levels documented were above the desirable range, indicative of the presence of contamination. Dissolved iron levels were also elevated at the time of the one sampling on record (1980). Nutrient load based on available data are estimated at 28 tonnes per year (148 kg/km^2) nitrogen and 2.5 tonnes per year (13 kg/km^2) phosphorous. These aerial loads are more than double the average of other major tributary creeks to the Similkameen River.

Water quality of the mainstem near the international border is monitored by both the B.C. Ministry of Environment (Station 0500073, Table 17) and Environment Canada (Station 8NL 0005, Table 18). Minimum dissolved oxygen levels recorded are 5.8 mg/l, somewhat below the desirable level, but mean values reported are 10.5 mg/l. Maximum temperature and fecal coliform levels as reported indicate some excursions above the desirable levels, however mean values are still within range. The mean dissolved copper levels are slightly higher than desirable. The nutrient loads on average are 410 tonnes per year (48 kg/km^2) nitrogen and around 70 tonnes per year (8 kg/km^2) phosphorous. The total dissolved material load averages 231,000 tonnes per year (27 $tonnes/km^2$).

As indicated previously, no water quality data were available for review from the Sinlahekin Creek/Palmer Lake system which enters the Similkameen south of the international border.

The last water quality monitoring site on the mainstem for which data were reviewed is from a station near Oroville between the Enloe Dam and the confluence of the Similkameen and Okanogan rivers (Station 49B070, Table 19, Appendix 4). This station would not reflect any changes in water quality that may be present as a result of discharge of treated sewage (2400 m^3/day or 0.63 USMGD) from the Oroville secondary treatment plant situated just upstream of the confluence of the Similkameen and Okanogan Rivers.

The water quality records indicate that dissolved oxygen levels are satisfactory however, fecal coliform and temperature maximums, while on average are satisfactory, excursions have been recorded above the desirable levels for freshwater aquatic life. No data are available for pesticide or other organic contaminants. Dissolved zinc levels have been recorded above the desirable (0.05 mg/l versus 0.03 mg/l Canadian Criteria) however, on average are well under this objective. The nitrogen nutrient load at this point is not estimatable due to lack of complete nitrogen analysis data. The phosphorpus load is slightly higher than at the station just north of the border and, based on data available, averages 84 tonnes per year (9 kg/km^2). The total dissolved material load is projected at 224,000 tonnes per year (24.4 kg/km^2).

6.4 System Comparisons

The Similkameen River water quality, based on the records reviewed, does not appear to have any major constraints in terms of persistent detrimental physical, chemical or microbiological characteristics. While the records indicate periodic excursions outside the desirable range for a few parameters at certain points on the mainstem or in some tributaries in the watershed, overall the system water quality does not present any primary limitations for freshwater fisheries or organic life. The productivity of the system, in terms of primary biomass and therefore ultimately fish production capability, may be limited due to nutrient availability which is a function of the natural watershed characteristics and activities within. A comparison of the nutrient aerial contribution of selected steelhead rivers in British Columbia is presented in Table 6-4. It is apparent that the nitrogen load in the Similkameen is low by comparison to other systems and may be a limiting factor. The phosphorous load appears roughly comparable to the other river systems examined, but is toward the low end of the range.

TABLE 6-4
Comparison of Aereal Runoff and Nutrient Loads for Several B.C. Steelhead Rivers

River	Location	Drainage Area (km^2)	Runoff (dam^3/km^2)	Nitrogen (kg/km^2)	Phosphorus (kg/km^2)
Similkameen R.	**Interior**	**9200**	**227**	**48**	**9**
Chilliwack R.	Coastal/ Interior	1230	1756	350	19
Coquihalla R.	Coastal/ Interior	741	1417	210	18
Thompson R.	Interior	54,900	428	73	5
South Thompson R.	Interior	16,200	551	84	6
North Thompson R.	Interior	19,600	693	147	8
Squamish R.	Coastal	2330	3253	390	110

Data Source: Environment Canada, 1983 Stream Flow Summary Inland Waters Directorate
Ministry of Environment, Equis File, Victoria, B.C.

7.0 SIMILKAMEEN RIVER WATER FLOW ADMINISTRATION AND RELEASE OBLIGATIONS

The Similkameen River originates near the British Columbia - Washington border and flows north to Princeton, B.C., where it turns to trend in a southeast direction to cross the border near Nighthawk, Washington. Parts of the headwaters of two of the largest tributaries, the Pasayten and Ashnola Rivers, are located south of the international boundary. These rivers flow north into the Similkameen River, the lowest 44 kilometres (27 miles) of which flow through Washington to the Okanogan River at Oroville. The fact that the river crosses the U.S. - Canada boundary makes it, by definition, an international river.

In British Columbia, both the provincial and federal governments play a role in development of water resources, and in Washington State both the state and federal governments are involved in managing the state's waters. Since the Similkameen is an international river, the International Joint Commission has jurisdiction under authority of the Boundary Waters Treaty of 1909 (Appendix 5).

The lower Similkameen River valley, especially downstream of Hedley, B.C. is an important agricultural production area, and subsequently requires large quantities of irrigation waters. These waters are drawn from the river itself, with additional (but unquantifiable) waters drawn from wells. The peak demand for these irrigation waters coincides with the natural summer low flow of the river, and as a result water shortages commonly occur in the lower reaches of the river. The possibility of creating storage reservoirs in the Canadian portion of the basin has been periodically investigated with the aim of providing additional flow for late summer users, but no development has resulted. The Canadian portion of the river is considered "Fully Recorded", and no further licenses are available for withdrawal of water during the irrigation season.

7.1 Water Administration

7.1.1 Administration Of Water In British Columbia

Although the government of Canada is involved in development and management of water resources, its involvement is mainly limited to co-sponsorship with the provincial governments or in matters of national or regional interest.

The two pieces of federal legislation which authorize water-related activities are the *Canada Water Act* (1970) and the *International River Improvements Act* (1955), both administered by Environment Canada. The Canada Water Act has four parts (Environment Canada, 1983). The first part provides for cooperative arrangements with the provincial governments for management of water resources. This part also enables Environment Canada to conduct research, collect data and establish inventories associated with the water resources. Parts two and three deal with water quality issues, and part four deals with the general administration of the Act. The International River Improvements Act allows for the establishment of regulations regarding the construction, operation and maintenance of dams, obstructions, canals, reservoirs or other works, the purpose or effect of which is:

a) *To increase, decrease or alter the natural flow of an international* river; and

b) To interfere with, alter or affect the actual or potential use of the international river outside Canada.

The Act, and its associated regulations, require the licensing of all international river improvements, except those:

a) Constructed under authority of another federal Act;

b) Situated within boundary waters as defined in the Boundary Waters Treaty (see 7.1.3 below); or

c) Constructed, operated or maintained solely for domestic, sanitary or irrigation purposes or other similar consumptive uses.

The federal government is also responsible for international arrangements, including those regarding the cooperation between Canada and the United States in matters related to waters common to both countries. At present, the federal government of Canada is undertaking a review of its role in water management, incuding its role in international water administration (Inquiry on Federal Water Policy, 1984).

In Canada, all water is owned by the Provincial Crowns. The allocation of this publicly owned water amongst competing users is administered by the Provincial Governments. In British Columbia, the provincial Water Act states:

> "The property in and the right to the use and flow of all the water at any time in any stream in the Province are for all purposes vested in the Crown in the right of the Province....." (Chapter 405, Section 3).

The right to the use of water is granted only to those who apply for and receive a water license. Licenses entitle the holder to make beneficial use of a specified quantity of water, at a specific location and during a specific period. Every license has priority date, usually the date that the licensee filed his application. When more than one license has been issued on the same stream, the person with the earliest priority license has first right to the use of the water. The holder of the license with the next later priority date has second right and so on. If a stream does not carry enough water at times to satisfy all of the licensed diversions from it, the person holding the latest priority license is the first who must stop using water, because his license is subject to the prior rights of the other licensees.

The Water Act is administered by the Water Management Branch of the B.C. Ministry of Environment. The policy of the Okanogan-Similkameen regional branch has in the past aimed to provide water supply to support all licensed withdrawals and designated instream flow reserves for four out of any five year period (Ministry of Environment, 1984). The Similkameen River is presently designated "Fully Recorded", and therefore the issuance of further licenses on the stream is restricted. At present, water licenses are required only for surface water. Groundwater withdrawals do not require licenses, although the Water Act (Section 4) provides for future application of the Act to groundwater.

7.1.2 Administration Of Water In Washington State

The waters of Washington State are managed by both state, federal and regional agencies (Washington State Department of Ecology, 1983). Federal agencies are, in general, concerned with the integrated development of natural resources, including water. Examples of some of these agencies include the Army Corps of Engineers, Department of the Interior, Environmental Protection Agency and the Federal Power Commission. The Northwest Power Planning Council is an example of a regional agency involved in management of water resources in Washington. The Council is mandated with developing long range regional energy plans and compensating for losses of fish and wildlife caused by hydroelectric development of the Columbia River. There are eight members of the council; two from each of the states of Washington, Orgeon, Idaho and Montana. Most water resources management activities, however, are the responsibility of the state, including the administration of water rights. Waters of the state are allocated in accordance with the doctrine of prior appropriation, as stipulated in the Surface Water Code of 1917 (RCW [1] 90.03) and the Ground Water Code of 1945 (RCW 90.44). The Washington Department of Ecology (WDOE) administers water allocations through a permitting procedure, and is also vested with exclusive authority to set minimum instream flows and levels on state waters. A formal process to establish instream flows and lake levels for the protection of fish, wildlife, recreation, aesthetics and water quality was established in Chapter RCW 90.22 (Minimum Water Flows and Levels), enacted in 1969. Although this legislation provided the hearing procedures necessary to establish the minimum flows and levels, it did not define the criteria to determine them. The Water Resources Act of 1971 (RCW 90.54) required WDOE to "develop and implement a comprehensive state water resources program" and allowed the department to establish instream flows. In 1976, pursuant to RCW 90.54, the Water Resources

1 RCW - Revised Code of Washington.

Management Program (Chapter 173 -500 WAC[2]) was initiated. The state was divided into 62 Water Resources Inventory Areas (WRIAs), and WDOE began formulating a water resources management program for each WRIA (or group of WRIAs). The Okanogan River basin Water Resources Management Program (Chapter 173-549 WAC) was adopted in July, 1976 and revised in June, 1984. This act provides for the adoption in the Washington Administrative Code of measures "designed to preserve and protect instream resource values, which include minimum instream flows and closure of streams and lakes to further consumptive water rights appropriation". Minimum discharges for the Similkameen River between the international border and the Okanogan River were determined. They are tabulated for the beginning and middle of each month (Table 7-1) and illustrated for the whole year by a hydrograph (Figure 7-1). The intention of these instream flows is "to protect streams from consumptive use appropriations approved after adoption of the flows. When the flow of a stream falls to or below a specified minimum instream flow, those water rights provisioned with those flows must cease or reduce diversion until the instream flow is exceeded". No consumptive use water rights will be issued for streams closed to further consumptive appropriation (during the period of closure). Chapter 173-549 WAC also specifies that in cases where the flow of a stream is reduced in only a portion of its length (eg. hydroelectric projects which bypass a portion of a stream) the use will be considered consumptive only for the affected portion of stream. These flows may be tailored to the particular project or stream reach. The program also specifies that existing water rights are not affected.

7.1.3 Administration Of International Waters

The waters of all lakes, rivers and connecting waterways through which the boundary between Canada and the United States passes are defined as boundary waters. In order to prevent disputes regarding these waters an international agreement was made between Canada and the United States. This agreement is the Boundary Waters Treaty, signed in 1909. The Treaty deals not only with boundary waters, but also rivers which drain into or out of boundary waters, and rivers which flow across the

[2] WAC - Washington Administration Code.

TABLE 7-1
Minimum Instream Flows
Similkameen River Confluence With
Okanogan River To Canadian Border

Monitoring to take place at: Similkameen River at Nighthawk (12442500)

		Minimum Discharge				Minimum Discharge	
Month	Day	cfs	m^3/s	Month	Day	cfs	m^3/s
January	1	400	11.3	July	1	1900	53.8
	15	400	11.3		15	1070	30.3
February	1	400	11.3	August	1	690	19.5
	15	400	11.3		15	440	12.5
March	1	425	12.0	September	1	400	11.3
	15	450	12.7		15	400	11.3
April	1	510	14.4	October	1	450	12.7
	15	650	18.1		15	500	14.2
May	1	1100	31.2	November	1	500	14.2
	15	3400	96.3		15	500	14.2
June	1	3400	96.3	December	1	500	14.2
	15	3400	96.3		15	450	12.7

See Also: Figure 7-1 Minimum Instream Flow Hydrograph for definition of minimum instream flows on those days not specifically identified above.

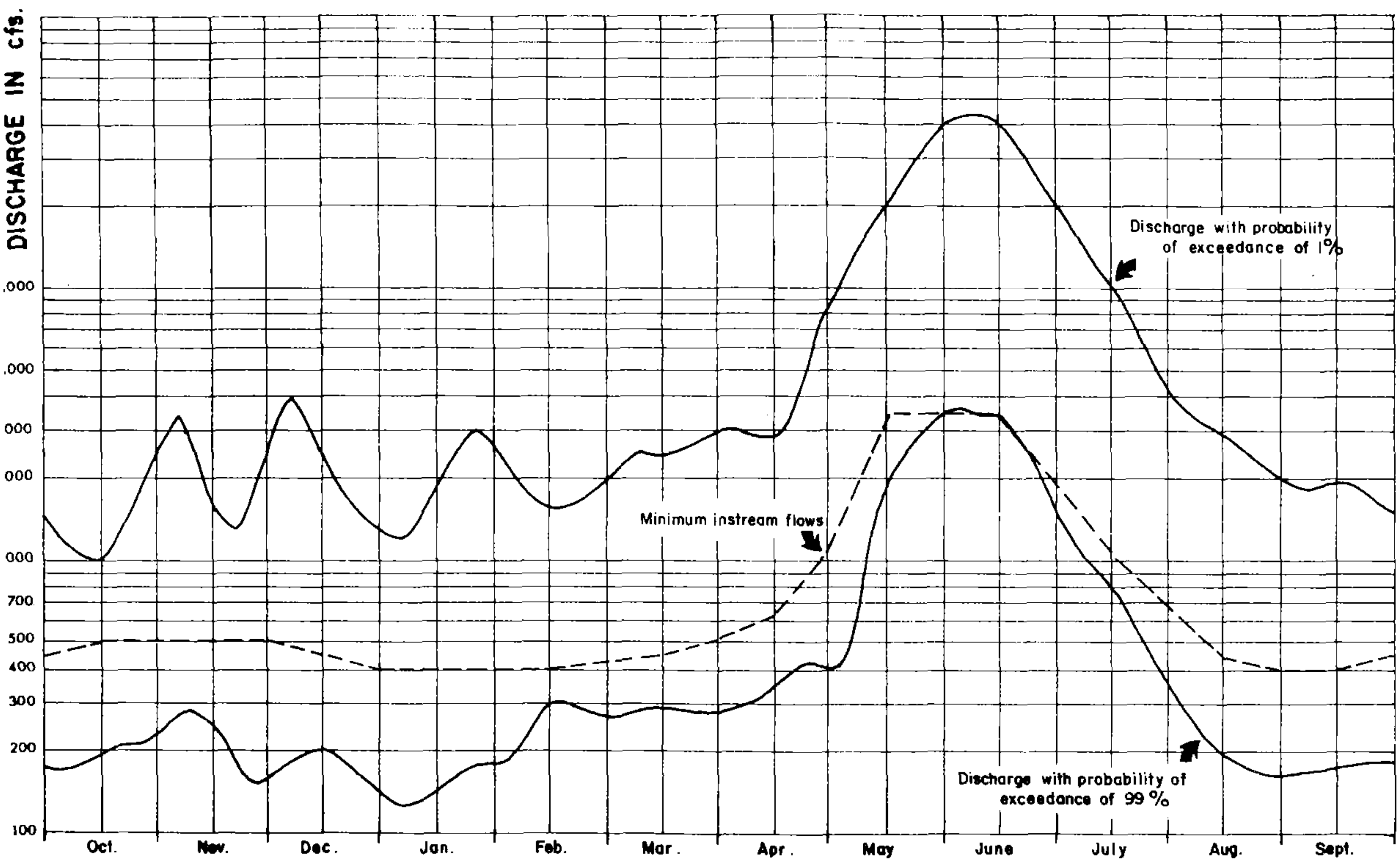

FIGURE 7-1: Minimum Instream Flows and Discharge Duration Hydrograph (Similkameen River near Nighthawk, Wash.)

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boundary (international rivers). The Treaty (summarized in Appendix 5) established the International Joint Commission (IJC), made up of three commissioners from Canada, and three from the United States. The IJC has jurisdiction over cases where the level, flow or quality of boundary waters is altered in one country causing adverse impacts in the other country. The development of boundary waters/international rivers is allowed only with the approval of the IJC, or under some other international agreement (eg. The Columbia River Treaty).

Since its inception, the IJC has rendered one decision regarding the Similkameen River, and one decision regarding the Okanogan River. In 1945, a proposal was made to divert water from the Similkameen River near Cawston, B.C. for irrigation purposes. The proposal was protested by Washington State on the grounds that flows in the river were already too low, and the project would not provide sufficient flow to meet the power and irrigation requirements in Washington. The IJC approved the project in 1949 subject to Cawston using only waters stored from the spring freshet.

Late in 1982, the IJC issued an Order of Approval for the construction of a new control structure at the outlet of Osoyoos Lake, which lies on the international boundary near Oroville, Washington. The lake, through which the Okanogan River flows, has its level controlled by the Zosel Dam, which presently is in disrepair. The State of Washington and the Province of British Columbia shall share in the cost of a new dam.

7.2 Water Use And Water Supply

7.2.1 The Similkameen River In British Columbia

There are presently over 1,000 water licenses in the Canadian portion of the Similkameen River. The major purpose for which water is withdrawn is irrigation, mostly in the lower part of the river between Princeton and the border. The B.C. Ministry of Environment has recently (1984) estimated that the total of all licensed diversions from the Similkameen River during the irrigation season is equivalent to a continuous flow of 6.13 m^3/s (216 cfs). However, many surface water license holders use groundwater (which presently does not require licensing in B.C.) and may not be using their surface license at all, while many others use less water than they are licensed to withdraw. Unlicensed, non-consumptive uses of the waters of the Similkameen include maintenance of flow for fisheries, recreational and aesthetic purposes.

Water supply problems in the Similkameen River basin are two-fold due to the seasonal variability of flow. In the spring and early summer, the river experiences its freshet, which results from melting of the high elevation snowpack. This event commonly results in flooding in the lower valley, although extensive dyking has protected much of these lands. The other water supply problem is water shortage. By the end of the summer the streams are reduced to baseflow and irrigation withdrawals further reduce the flows. There is very little lake/reservoir storage in the basin to supplement the late summer flows. Seven-day average low flows for the irrigation season (June - September) were estimated for most streamflow gauging stations in the basin by the B.C. Ministry of Environment (1984). The mean annual and 50-year return period low flows at the gauging station near Nighthawk, Washington are 13.9 m^3/s (491 cfs) and 6.13 m^3/s (216 cfs), respectively. Since only one major tributary (Palmer Creek) to the Similkameen River enters between the gauging station and the border, these flows are representative of extreme flow conditions at the border. Extreme low flows from Palmer Creek (outlet of Palmer Lake) are probably in the order of only 0.1 m^3/s (3.5 cfs).

7.2.2 The Similkameen River In Washington State

The Similkameen River flows only 44 km (27 miles) from the border to its confluence with the Okanogan River at Oroville, Washington. Although there is some irrigation in this reach, most licensed withdrawals are for small quantities (less than 2 cfs). The Oroville-Tonasket Irrigation District holds a license to divert irrigation water from the Similkameen River near Nighthawk. These waters are used mainly in the Okanogan River Valley. The licensed quantities are:

April 1 - 15	50 cfs	(1.42 m^3/s)
April 15 - 30	107 cfs	(3.03 m^3/s)
May 1 - 31	124 cfs	(3.51 m^3/s)

June 1 - 30	149 cfs	(4.22 m^3/s)
July 1 - 31	186 cfs	(5.27 m^3/s)
August 1 - 31	165 cfs	(4.67 m^3/s)
September 1 - 30	128 cfs	(3.63 m^3/s)
October 1 - 15	50 cfs	(1.42 m^3/s)

The Oroville-Tonasket Irrigation District also has a 1954 certificate for 150 cfs (4.25 m^3/s) from the Similkameen River. However the combined discharge under the water license and the certificate are not to exceed 200 cfs (5.66 m^3/s) during the period April 1 through October 15 (U.S. Department of the Interior, 1980).

The only two other major water licenses issued for the Similkameen River are held by the Okanogan County Public Utility District. Both were issued for the Enloe Dam and Powerhouse. The first was issued in 1919 for 250 cfs (7.08 m^3/s) and the second was issued in 1925 for 750 cfs (21.24 m^3/s).

The proposed Oroville-Tonasket Unit Extension would replace the irrigation canal presently used to transport water from the Similkameen with a pumphouse at Osoyoos Lake and will involve the transfer of the water rights. This will then increase the available water supply below the intake structure to the mouth of the river. The potential exists, however, for use of this canal to transport water to a drop structure near the Enloe Dam, reducing instream flow only in the reach between the dam and the intake structure.

7.3 Development Of Enloe Dam And Its Effect On Water Rights

Various fish passage schemes have been proposed for Enloe Dam. These include dam removal, laddering and trap and haul. If the dam is to be left and fish are passed, a major concern would be whether or not power generation would be resumed.

In the event that Enloe Dam is removed, the two existing water licenses will be relinquished. Since these licenses are still held by the Okanogan County Public Utility District (PUD) they are still exercisable. The PUD has applied for a license from the Federal Energy Regulatory Commission (FERC) to rejuvinate the dam and powerhouse to provide hydroelectric power. If the dam is rejuvenated the PUD would be responsible for providing fish passage at the dam (Northwest Power Planning Council, 1982), however this would likely be funded by federal sources. The issue of fish passage at the dam is being dealt with regardless of whether power generation recommences again or not.

If the dam is left intact and fish passage is provided past the dam by either a ladder or trap and haul facility, then an additional water license would be required to provide for operation and attraction flows of the passage facilities.

If the dam is recommissioned the existing water licenses will be required for power production. The PUD has been exempted from relinquishment of their water rights (for non-use) by making annual payment of power license fees. The water required for operation of the fish passage facilities would reduce the water available for power production during periods of low flow. The PUD proposes to divert water to run their turbines at a maximum rate of 750 cfs when flow is available (Moos, 1981). When the flow of the river is less than 750 cfs (about 193 days in an average flow year) all river flow is to be routed through the penstocks to the turbines. Water used to run the passage facilities would reduce power production at Enloe Dam, unless water is stored upstream during the freshet to augment low flows. The development of a dam at Shankers Bend is also being investigated by the U.S. Army Corps of Engineers. The intent of this project would be to provide storage which could be used to provide flow to run the Enloe powerhouse at capacity year-round.

Development at Enloe Dam will in no way effect the existing water rights of Canadian water users. The 1949 decision of the IJC was that no further consumptive withdrawals could be made without storage from the spring freshet, but all existing licenses were not to be affected. Under the B.C. Water Act (Section 20) water licenses are subject to cancellation only for reasons such as failure to make beneficial use, nonpayment of fees, or non-compliance with the license or Water Act. Development of the Similkameen River downstream of the border will not involve any changes in the flow regime at the border. The potential construction of an additional dam at Shankers Bend will require approval of the IJC if flooding upstream of the border is involved. A high dam at Shankers Bend would result in a vast amount of agriculturally productive Canadian soil being flooded. It is not likely that such a proposal would be approved. Alternate plans for a lower dam at Shankers Bend which would flood the Similkameen River valley only as far as the international boundary are being considered along with other options, by the U.S. Army Corps of Engineers.

8.0 NEPA SCOPING DOCUMENT

8.1 Executive Summary

The Bonneville Power Administration (BPA) is investigating alternative methods for facilitating anadromous salmonid fish passage in the Similkameen River upstream of Enloe Dam. This section of the Draft Final Report on Enloe Dam Fish Passage is an objective preliminary environmental scoping document addressing each of the six proposed alternatives. Each alternative was given equal consideration in this analysis, as no "preferred" alternative exists at this time. This NEPA scoping document is designed to provide agency decision-makers with a summary of background environmental information and to serve as a precursor to either an Environmental Assessment (EA) or Environmental Impact Statement (EIS) which will ultimately be required by NEPA if BPA proceeds with the Project.

Reconnaissance level information was gathered for all elements of the physical, biological, and human environment which could potentially be impacted by any of the six proposed alternatives. The alternatives are:

Alternative 1 -	Fishway from falls, incompatible with hydropower generation
Alternative 2 -	Fishway below powerhouse, compatible with hydropower generation
Alternative 3 -	Trap and haul at falls, incompatible with hydropower generation
Alternative 4 -	Trap and haul below powerhouse, compatible with hydropower generation
Alternative 5 -	Trap and haul at railroad bridge, compatible with hydropower generation

Alternative 6 - Dam removal, incompatible with hydropower generation

Environmental information was obtained through a brief survey of the study area in October 1984; from available literature; and from contacts with appropriate local, state, and federal agency personnel. The report summarizes the baseline information gathered for each aspect of the environment and makes preliminary assessments as to the level of potential impacts which could result from each of the six alternatives. This preliminary impact assessment will aid decision-makers in determining whether an EA or EIS should be prepared in order to comply with NEPA.

Aspects of the environment which will not be affected or which will be affected minimally (either in an adverse or beneficial manner) are only reviewed at a preliminary level of analysis and detail in this report. Those aspects of the environment which could potentially be significantly affected (either in an adverse or beneficial manner) are treated with a proportionately greater level of detail. Table 8-1 summarizes the potential level of environmental impact on each aspect of the environment resulting from each of the six alternatives. The impact matrix presented here is a culmination of the reconnaissance level studies conducted from October 1984 through May 1985. The values shown in Table 8-1 are preliminary at this time due to the level at which studies were conducted. These values should be viewed as indicators of the potential level of impacts, rather than as absolute values defining impact.

Several quite obvious issues have been identified that will require more extensive examination is a future NEPA document. These include: wildlife resources (in particular, the potential beneficial effect of fish passage on bald eagles), fish resources, power production potential, recreation (particularly with regard to sport fishing), potential for toxic or hazardous materials in sediments behind the dam, hydraulic modifications and potential flooding affects, and cultural and historical resources. The effects of the project on three of these focal issues (wildlife, fish and recreation) are anticipated to be beneficial for all six alternatives and have international implications. The effects on the other focal issues (power production potential, toxic/hazardous materials potential, hydraulic modifications and potential

TABLE 8-1
Enloe Dam Project Matrix Of Potential Impacts

nvironmental Concern	1 Fishway Without Power	2 Fishway With Power	3 Trap & Haul Without Power	4 Trap & Haul With Power	5 Trap & Haul At Railroad Bridge	6 Dam Removal: Sediment Removal	6 Dam Removal: No Sedime Dredging
th Resources	X	X	X	X	X	Y	Y
Resources	0	0	0	0	0	0	0
er Resources	X	X	X	X	X	X	Y
etation Resources	0	0	0	0	0	X	Y
llife Resources	B	B	B	B	B	A	A
ı Resources	A	A	A	A	A	A	B
'er Production ıtential	0	X	0	X	0	0	0
se	0	0	0	0	0	0	0
ic/Hazardous ıterials	0	0	0	0	0	X	Y
d Use, Population, ›using, and ansportation	0	0	0	0	0	0	0
thetics	X	X	X	X	X	C	B
reation	B	B	B	B	B	B	B
oric & Cultural sources	X	X	0	0	?	Y	Y
iculture	0	0	0	0	0	0	0

act Matrix Ranking system:

Very Beneficial
Moderately Beneficial
Minimally Beneficial
Neutral

X = Minimally Adverse
Y = Moderately Adverse
Z = Very Adverse

? = Archaeological survey of Alternative Si 5 has not been conducted; thus, no value can be assigned in terms of potential impacts.

flooding and historical/cultural resources) vary with alternatives. A summary of the environmental and engineering advantages and disadvantages of each of the six alternatives are presented in Table 8.2. This table, in conjunction with the impact matrix (Table 8-1), provides an overview of the entire range of considerations currently under study. The main text of this NEPA Scoping Document describes these considerations in greater detail.

8.2 Introduction

8.2.1 Need For NEPA Assessment

The Enloe Dam Fish Passage Project is currently in the preliminary stages of evaluation. Fisheries habitat studies in the U.S. and Canadian Similkameen River reaches have recently been completed in order to determine the feasibility of establishing a run of steelhead and/or salmon above the Enloe Dam. The results of these studies are presented in the preceding sections of this report.

The proposed Enloe Dam Fish Passage Project may constitute a "major Federal action," thus requiring compliance with the 1969 National Environmental Policy Act (NEPA), the CEQ governing regulations published in the Federal Register July 18, 1979 (40 CFR Parts 1500-1508), and DOE NEPA guidelines published March 28, 1980 (45 FR 20694-20701). The DOE guidelines provide supplemental implementing procedures required by CEQ regulations. Moreover, these guidelines were issued pursuant to, and to be used only in conjunction with, the CEQ regulations cited above.

This section 8.0 of the Draft Final Report on Enloe Dam Passage is intended to serve as a preliminary scoping document for fulfilling the requirements and meeting the intent of NEPA and its pursuant regulations and guidelines. In that this report section is a precursor to the final environmental document for the Enloe Dam Fish Passage Project, it has therefore been structured as a discrete report, capable of standing alone without the preceding sections. Thus, a certain amount of redundancy may occur between this and other report sections. The reader is encouraged to view this section as a summary document which presents an overview of the environmental implications of fish passage at Enloe Dam. These implications involve not only the

TABLE 8-2
Environmental And Engineering Considerations Of Alternatives 1 Through 6

ALTERNATIVE	ENVIRONMENTAL		ENGINEERING	
	Advantages	Disadvantages	Advantages	Disadvantages
1 - Fishway at Falls	. Anadromous fish in Upper Similkameen . Benefit to eagles . Benefit to sport fishery	. Minor erosion and water quality impacts	. Natural barrier . relatively short fishway . Low O & M cost	. Difficult high flow passage . Incompatible with hydro-power . High capital cost
2 - Fishway Below Powerhouse	. Anadromous fish in Upper Similkameen . Benefit to eagles . Benefit to sport fishery	. Minor erosion and water quality impacts . Loss of small stream segment to fish utilization	. Well defined barrier . Low O & M cost . Allows power production	. Power generation loss . Long fishway . Requires barrier dam . High capital cost
3 - Trap at Falls	. Anadromous fish in Upper Simlkameen . Benefit to eagles . Benefit to sport fishery	. Minor erosion and water quality impacts	. Natural barrier	. High O & M cost . Incompatible with hydro-power
4 - Trap Below Powerhouse	. Anadromous fish in Upper Simlkameen . Benefit to eagles . Benefit to sport fishery	. Minor erosion and water quality impacts . Loss of small stream segment to fish utilization	. Well defined barrier . Allows power production	. Power generation loss . Difficult access . Requires barrier dam . High O & M cost
5 - Trap at Railroad Bridge	. Anadromous fish in Upper Similkameen . Benefit to eagles . Benefit to sport fishery	. Minor erosion and water quality impacts . Potential loss of some spawning habitat	. Compatible with hydropower . Easy access	. Deep channel . Requires barrier dam . High O & M cost
6 - Dam Removal	. Anadromous fish in Upper Similkameen . Benefit to eagles . Benefit to sport fishery	. Water quality degradation . Erosion of reservoir banks . Potential loss of wetlands, vegetation and cultural site . Sediment deposition on spawning gravels downstream	. Short fishway . Low O & M cost	. High capital cost . Sediment disposal . Incompatible with hydro-power

potential effects on fishery resources, but also those effects on all other aspects of the environment.

8.2.2 Regional And Historical Setting

Enloe Dam is located in a steep rocky canyon on the lower Similkameen River in north central Washington near the City of Oroville, as shown on Figure 8-1. The dam is situated 5 mi upstream of the confluence of the Similkameen River with the Okanogan River. Nearly 2 mi of slack water is created by the dam when the reservoir extends upstream to Shanker's Bend. The Similkameen Valley in the vicinity of the dam is narrow, with clearly defined terraces at approximately 1,100 ft above mean sea level. These terraces form a bench 500 to 600 ft wide and have been utilized for an irrigation canal and railroad corridor. Beyond the terraces, the valley walls rise steeply to rounded rolling hills with crest elevations of about 2,800 ft.

The climate of the Similkameen River Valley is influenced by the prevailing westerly air flow over the Northern Cascades which block the saturated Pacific marine air masses and result in a semi-arid climate. The mean annual precipitation is 12 in, most of which occurs as winter snowfall. Temperature extremes are common, although mean summer and winter temperatures are quite moderate. The vegetation of the immediate area around Enloe Dam reflects the climate and topography and is predominately a shrub-steppe association in which big sagebrush and bitterbrush are the dominant shrubs. Scattered ponderosa pine and Douglas fir occur on moist north and east facing slopes and narrow bands of riparian vegetation occur along the edge of the river in some areas.

The Enloe Dam itself is a concrete gravity arch structure, approximately 54 ft in height. The structure operates as an uncontrolled spillway with 276 ft of crest length. Enloe Dam was constructed between 1919 and 1923 as a part of a hydroelecrtic facility and since that time no upstream fish passage has occurred. A powerhouse operated in conjunction with the dam still stands and is located approximately 800 ft downstream of the dam on the west bank of the river. Hydropower generation was discontinued in 1959. The location of the dam and powerhouse are shown on Figure 8-2. The natural falls is located between the dam and

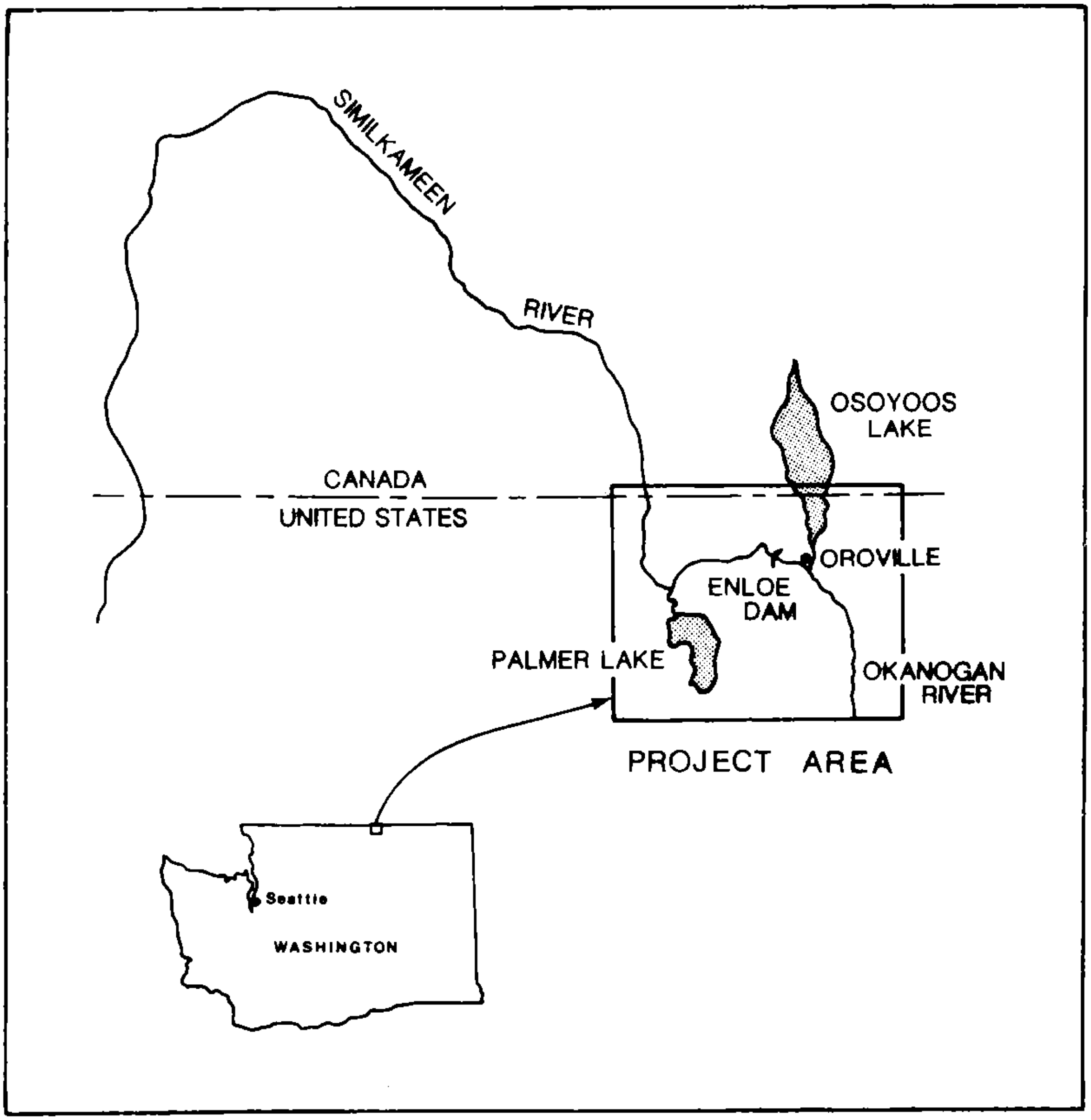

Figure 8 – I Enloe Dam Fish Passage Project location map.

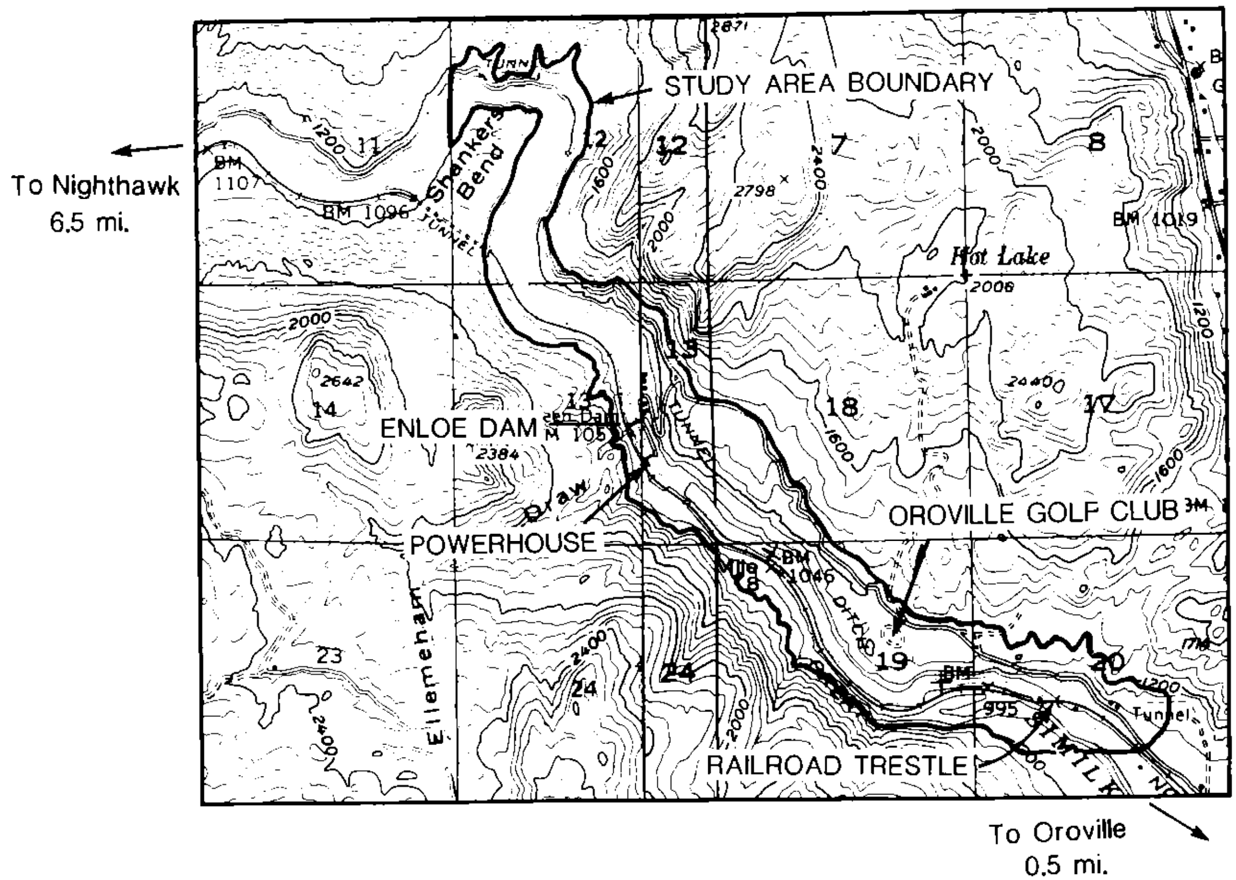

Figure 8–2 Enloe Dam study area for preliminary NEPA compliance report.

the powerhouse, approximately 300 ft downstream of the dam. The falls is approximately 20 ft in height. Figure 8-3 shows the immediate area of the dam, falls and powerhouse in topographic detail.

Boundaries of the Study Area were defined for the purposes of this preliminary NEPA compliance report and are shown on Figure 8-2. This Study Area extends from Shanker's Bend upstream of the dam to just below the railroad trestle approximately 2 mi downstream from the dam, following the 1,200 ft contour along the west river bank and the existing county road along the east river bank. Reconnaissance level field surveys conducted in October 1984 were concentrated within this Study Area boundary. Quite obviously some of the issues which will need to be addressed in a later NEPA document will extend beyond this Study Area. A series of tables and figures addressing this broader area is included in Appendix 6 as supplemental information which may be incorporated into the future NEPA document.

8.2.3 Enloe Dam Fish Passage Alternatives Descriptions

Six alternative passage schemes were investigated by Ott Water Engineers of Bellevue, Washington. As described in Section 5.2, these include: two fishway alternatives (one compatible with hydropower generation and one incompatible with hydropower generation); three trap and haul alternatives (two compatible with hydropower generation, one not); and the removal of Enloe Dam combined with a short fishway over the natural falls (obviously not compatible with hydropower generation).

The design and placement of passage alternatives is influenced by the potential redevelopment of hydropower at Enloe Dam. In 1981, Public Utility District No. 1 of Okanogan County (Okanogan PUD), filed a FERC licence application to redevelop hydropower at Enloe Dam. Okanogan PUD's plans include installation of new turbine/generator units at the existing powerhouse, and replacement of the penstock running along the right bank between the dam and powerhouse. The existing intake and outlet works would be rehabilitated.

If hydropower at Enloe Dam is redeveloped as the Okanogan PUD plans, its operation must be considered in passage design to ensure optimum passage effectiveness. The

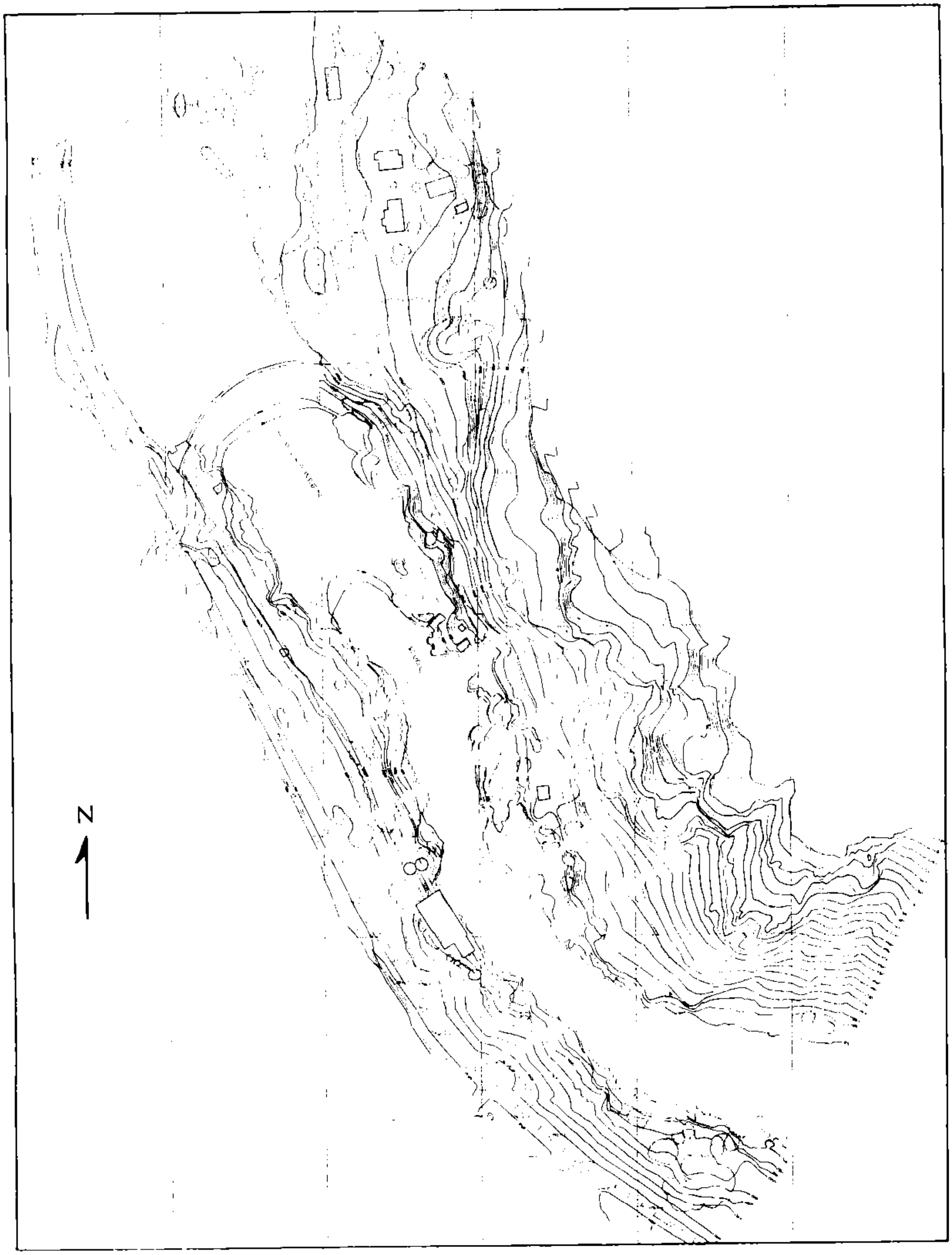

Figure 8-3 Topographic detail map of Enloe Dam and powerhouse immediate vicinity.

principal concern is the location of turbine discharge relative to fishway or fish trap entrances. In general, if the turbine discharge is located downstream of ladder entrances, fish have a difficult time passing the turbine discharge and finding upstream entrances, since most of the available flow is passing through turbines. This can cause substantial delay in upstream migration and significantly compromise passage effectiveness.

In that the redevelopment of hydropower at Enloe Dam was not certain at the time of writing this report, alternatives have been developed which are both compatible and incompatible with Okanogan PUD's hydropower plans. In the following subsections, the six passage alternatives are briefly described in the context of information needed for impact analysis. The reader is referred to Section 5.2 for the technical details of alternatives conceptual design.

All six of the alternatives are similar in that they are located within a 2 mile reach of the Similkameen River. Five of the alternatives involve construction of major passage facilities; the sixth involves removal of the existing Enloe Dam and construction of a short fishway at the falls below the dam. Most work within the flood plain would probably be accomplished during July through December low flow period. Access for construction would be available on existing roads with only minor improvements. Access to Alternatives 1 through 4 and 6 would be via the existing canal road which cuts through the cottonwood grove on the east bank of the reservoir. Grades on this road are not excessively steep, thus making access for construction vehicles relatively easy. A short section of road would have to be constructed downstream of the powerhouse suspension bridge on the left bank for Alternatives 2 and 4. Access for Alternative 5 (at the railroad bridge) would be via an existing road requiring little upgrading. Access roads used for construction would continue to be used for maintenance and operation of the facilities. Passage facilities would be required to operate from about October through November and from February through May for upstream steelhead migration. If summer chinook are to be managed in the watershed, the passage facilities would also need to operate between about mid-August and October 1.

Alternative 1 - Fishway From Falls. Alternative 1 is a fishway beginning at the base of the falls below the dam and exiting above the dam. This alternative is not compatible with the proposed hydropower redevelopment. Fishway entrances would be located at the left bank, at the base of the falls. Low and high flow entrances are provided for in the design. Flow in the ladder would vary between about 30 and 50 cfs. The fishway exit is located approximately 90 ft upstream from the left abutment. Auxiliary water would be supplied to the ladder entrances to provide attraction flow for fish. Auxiliary flows may be as high as 50 cfs. The flow would be added to the lower pools through wall diffusers. Flow to the diffusion chambers would be gravity fed from above the falls.

Alternative 2 - Fishway Below Powerhouse. Alternative 2 is a fishway beginning at a barrier dam downstream of the Enloe Dam powerhouse and exiting above the dam on the left abutment. The barrier dam would be approximately 9 ft in height and would prevent fish from moving past the ladder entrance. A single entrance to the fishway would be located on the left bank, at the toe of the barrier dam. With the entrance located downstream of the powerhouse, this alternative would be compatible with hydropower. The fishway would continue up the left bank to an exit above Enloe Dam. Design characteristics and ladder and auxiliary flows from this structure would be similar to those of Alternative 1. This alternative would impact the proposed development of hydropower by the Okanogan PUD. The barrier dam would cause the tailwater of the powerhouse to be raised and therefore decrease the head available for hydropower production by about 7 ft.

Alternative 3 - Trap And Haul at Falls. Alternative 3 is a trap and haul system at the falls. The fishway section leading to the trap is the same location and configuration as the lower portion of Alternative 1. This trap and haul alternative is not compatible with hydropower development at Enloe Dam. Similarly to Alternative 1, fish would enter one of two ladder entrances at the left bank immediately below the falls. Fish would continue up the ladder to an elevation out of the flood way and enter the trap. Auxiliary water would be added to the lower pools of the fishway. The trap consists of a holding pool and elevator at the upstream end of the fishway section. Fish entering the holding pool would be supplied with "fresh" water through an upwelling supply. Fish in the holding pool would be crowded into the elevator and loaded from the elevator, by way of a chute, to a tank truck.

Alternative 4 - Trap and Haul Below Powerhouse. Alternative 4 is a trap and haul system which would be located at a barrier dam below the powerhouse. The alternative consists of a ladder section leading to a holding pool and elevator. The barrier dam and ladder location are similar to those in Alternative 2. As with Alternative 2, this alternative would impact the proposed development of hydropower by decreasing the available head.

Alternative 5 - Trap and Haul at Railroad Bridge. Alternative 5 is a trap and haul facility located approximately 2 mi downstream of Enloe Dam. The alternative consists of a barrier dam with a ladder section to a trap. A trap and haul facility at this site does not conflict in any way with hydropower redevelopment at Enloe Dam. No loss of available head would be associated with this alternative because of the stream gradient in the 2 mi distance between the powerhouse and the barrier dam.

Alternative 6 - Dam Removal. If Enloe Dam is not developed for its hydropower potential, it could be removed. Passage then could be provided at the falls and the watershed would be open to upstream migrating fish. The falls could be laddered in a manner similar to Alternative 1. The key consideration, however, is removal of the dam and sediment behind it.

Two methods of dam and sediment removal are currently being investigated. The first is suction-dredging the sediment behind the dam and wasting it near the dam site. Once the sediment is removed the dam could be demolished in successive levels by blasting techniques. Concrete removed from the structure could be wasted near the site as well.

The second method of dam removal is to remove successive levels of the dam crest and allow the sediment to be transported downstream. This release of sediment would be somewhat controlled. However, the magnitude of high stream flows in any given year cannot be predicted. This method of sediment removal may not be practical since the lower reaches of the Similkameen and Okanogan Rivers may not be able to handle high sediment loads without significant changes in stream course and flood limits.

8.2.4 Other Issues Of Concern

Official NEPA documents are required to address "related actions" and "other issues of concern". Only one other proposal is currently known to fall into either of these categories. This proposal is the ongoing feasibility study being conducted by the U.S. Army Corps of Engineers and sponsored by the Okanogan PUD, the Oroville-Tonasket Irrigation District and Okanogan County. Two alternatives have been proposed with regard to this feasibility study. The first is a 230 ft dam at Similkameen River Mile 6.6 with a 100,000 acre-foot storage capacity and a maximum pool elevation of 1,155 ft. The second is a three dam alternative involving rehabilitation of the existing facility at the Enloe Dam site, construction of a smaller dam at River Mile 6.6 and construction of a third dam above Enloe at Shanker's Bend (RM 10.5).

The Corps of Engineers is currently proceeding with environmental studies for their two proposed alternatives. Although the Corp's proposal is, at this time, unrelated to BPA's Enloe Dam Fish Passage Project, the fact that it is in such close proximity to Enloe Dam puts it in the category of "other issues of concern". Any change in the status of the Corps' proposal will be communicated promptly to the BPA under the existing "cooperating agency" agreement between the two agencies.

8.3 Physical And Biological Environment

8.3.1 Earth Resources

Existing Conditions

Bedrocks of the study area consist of Tertiary nonmarine sedimentary rock, primarily sandstone and conglomerate with small amounts of siltstone and shale. The Similkameen River in the Study Area lies within a steep, rocky canyon which extends approximately 15 miles to the broad, flat lands north of Palmer Lake. Terraces approximately 500-600 ft wide, lying at about 1,100 ft elevation, flank both sides of the river. The irrigation canal and railroad have been constructed on these terraces. Steep valley walls and cliffs rise to rounded hills with elevations of up to 3,000 ft

(Lenfesty, 1980). Additional details regarding the site geology, both at Enloe Dam and at the railroad bridge are available from a variety of sources. This information is not included in this scoping document because the relatively low level of projected impacts to geological resources from each of the six alternatives does not warrant the inclusion of extensive data.

Soils in the Study Area impact zone, near the dam and along the east side of the river include Nighthawk extremely stony loam, 25-65 percent slopes, which has high to very high erosion susceptibility, and lithic Xerochrepts-Nighthawk complex, 15-45 percent slopes, which have moderate to high erosion potential. The soils at the east side of the railroad bridge are Pague extremely stony fine sandy loams, 25-65 percent slopes, which also have moderate to high erosion potential. The existing railroad and access road have periodically washed out in the past, apparently from erosion at the toe of the slopes. Proper stabilization of cut slopes will be essential during the construction process. A small patch of Nighthawk loam, 8-15 percent slopes, located along the railroad just south of Shanker's Bend, is classed as "Land of Statewide Importance" by the Soil Conservation Service (1979). This soil is neither being used for crop production at this time, nor will it be affected by any of the project Alternatives proposed.

The Study Area is within a region of historically low seismicity, designated "Zone 2 - moderate damage" by the Uniform Building Code (Anonymous, 1976). On the basis of regional intensity records published by Rasmussen (1967), the area is classified as "Zone 1 - minor damage".

Potential Impacts

None of the Alternatives will affect geological resources within the Study Area to any major extent. Due to high erosion hazards of soils in some portions of Study Area, erosion and sedimentation to the river could occur during construction of fishway and trap and haul facilities as well as during access road upgrading and construction. Careful planning, use of sedimentation structures and timely stabilization of cut slopes will result in minimizing erosion and slumping during construction. Erosion impacts are expected to be short term and will terminate shortly after completion of construction activities.

8.3.2 Air Resources

Existing Conditions

Okanogan County's existing air quality is good, typical of rural counties, and is classed as attainment (meeting Federal and State air quality standards). Monitoring results from 1977, the most recent year for which data are available from the Oroville area, were a 24-hour maximum of 70 ug/m^3 Total Suspended Particulates (TSP), well under the primary and secondary 24-hour standards of 260 ug/m^3 and 150 ug/m^3, respectively. The annual geometric mean TSP of 15-30 ug/m^3 was well within the primary and secondary standards of 75 ug/m^3 and 60 ug/m^3 (Washington Department of Ecology, pers. comm., 16 May 1985).

Potential Impacts

Air quality impacts from any of the alternatives would be temporary, minor,and would not significantly affect TSP levels in Okanogan County.

8.3.3 Water Resources

8.3.3.1 Surface Water Hydrology/Floods/Low Flows

Existing Conditions

The drainage area of the Similkameen River above Enloe Dam is approximately 3600 mi^2, most of which is in British Columbia. The majority of the basin is characterized by its semi-arid climate, except for the relatively wet and mountainous western region. Most of the basin's runoff originates at high elevations from snowpack melts during the spring and early summer. The steep topography and lack of storage in the basin makes it susceptable to both floods and droughts.

An international streamflow gauging station is located on the Similkameen River approximately 7 mi upstream of Enloe Dam at Nighthawk, Washington (Station

#12442500). The station has been in operation since 1911 (continuously since 1929). The mean annual discharge of the river at the Nighthawk station is 2340 cfs. Approximately 61 percent of the annual flow of the river occurs during the months of May and June, with mean monthly discharges of 8028 cfs and 9169 cfs, respectively. Mean monthly discharges for the months of August through March, inclusive, range from 2.2 to 3.3 percent of the total annual discharge (604 to 921 cfs).

The mean annual flood for the Similkameen River at Nighthawk, determined for the period 1929 to 1983 is 16,260 cfs. Annual maximum daily discharges have ranged from a low of 4750 cfs (May 1941) to the recorded high of 44,800 cfs (June 1972). The calculated return period of the 1972 flood is approximately 180 years. The water level was estimated to be 13 ft above the spillway crest at Enloe Dam during the 1972 flood. The probable maximum flood has been estimated to be as high as 320,000 cfs, a flow which would result in a water surface elevation of over 45 ft over the spillway crest.

Annual maximum discharges at the Nighthawk station have occurred exclusively during spring/early summer through the period of record. However, winter floods associated with the inland penetration of coastal storms have occasionaly been of similar magnitude to these spring/early summer freshets. The winter floods although rare, are usually associated with ice flows.

In general, minimum discharges for the Similkameen River at the dam occur between late summer and late spring. However, a slight increase in river discharge in response to fall rain storms usually follows the late summer low flow period. The flow recedes again during the winter months as precipitation turns to snow and the river freezes over. The recorded minimum daily discharge for the Similkameen River at Nighthawk is 130 cfs which occurred on 8 January 1974.

Potential Impacts

Each of the six proposed alternatives is likely to exert different effects on the hydrologic regime of the river. The periods of operation for all proposed fishway and trap and haul facilities are October through November, February through May and, if summer chinook are to be passed, mid-August through October. Potential effects of each of the alternatives on the flow regime are summarized in the following paragraphs.

Impacts of Alternative 1 on streamflow would be restricted to the stretch of river between the entrance and the exit of the fishway. The flow to be diverted would be between 24 and 42 cfs for ladder operations, plus as much as another 75 cfs for attraction flow. Assuming the maximum diversion for both ladder operation and attraction flows, 117 cfs would be diverted around Enloe Dam through either the ladder or a diversion conduit. This amount is less that the recorded minimum daily discharge for the site (130 cfs). Therefore, sufficient flows should always exist, although conditions may approach those of no flow over the Enloe Dam spillway.

Under conditions of power generation at the Enloe Dam site (Alternative 2), 24 to 42 cfs would still be required for fishway operation. However, since the fish passage facilities would instead be constructed below the powerhouse, the water required for attraction flow could be diverted from below the tailrace, thereby reducing the amount of water diverted from above Enloe Dam for ladder operations. Thus, a maximum amount of only 42 cfs would be diverted around the dam to a point below the powerhouse. Since maximum penstock discharge exceeds the natural flow of the river for a large portion of the year, power generation alone (without a fishway) would result in the complete diversion of water around the dam for about 193 days in an average flow year. The addition of the fishway may extend the period of no flow over the spillway by as much as another 10 days per year (on average). The impacted area is, however, limited only to the length of the river between the fishway exit and the fishway entrance.

Hydrological impacts associated with Alternative 3 are identical to those of the Alternative 1, except that all flows for the fishway operation and attraction flow would be diverted from above Enloe Dam via a conduit. The instream flow would be reduced by as much as 117 cfs between the diversion point above the dam and the fishway entrance below the barrier dam.

The hydrological impacts associated with Alternative 4 (a trap and haul facility operated in conjunction with the powerhouse) are similar to those associated with Alternative 2. Again, the flows for ladder operation could be diverted from above the Enloe Dam and powerhouse and the additional attraction flow could be obtained below the powerhouse. Instream flows would be as much as 42 cfs between diversion points above the dam and the fish ladder entrance, and reduced by an additional 75 cfs, for a total of 117 cfs, between the powerhouse tailrace and the fish ladder entrance. As with Alternative 2, this alternative would increase the number of days per year in which there is no flow over the Enloe Dam spillway. The impacted area of a trap and haul facility built and operated below the railroad tressel (Alternative 5) would be limited to the stretch of river between the water intake(s) for ladder operation and the entrance of the ladder.

The removal of Enloe Dam (Alternative 6) would eventually restore the river to its natural state. As it exists presently, the dam and reservoir regulate the flow of the river downstream of the Enloe Dam, but the amount of regulation is negligible. If Enloe Dam were removed without first suction dredging sediment, flows downstream would be impacted to a far greater extent by the transport and deposition of sediment which has accumulated in the reservoir since the Enloe Dam's construction. In 1972, the USGS estimated the amount of sediment in the reservoir to be about 1.79 million cubic yards. Although most of these sediments would eventually be carried to the Columbia River, as they would have been if the dam had never been built, much of the sand and coarser materials would be deposited in a 17 mi stretch of the Okanogan River immediately below the mouth of the Similkameen River. As a consequence of this deposition, the Okanogan River valley would become more susceptable to flooding as the cross-sectional area of the river is reduced. Loss of side channels and a change in the course of the Okanogan River would likely also result from the addition of these sediments. These impacts would not be associated with Alternative 6 if sediments were dredged prior to dam removal.

8.3.3.2 Surface Water Quality

Existing Conditions

The water quality of the Similkameen River, as recorded from monitoring at a site between the Enloe Dam and the confluence of the river with the Okanogan River (Station 49B070-Washington State Department of Ecology), indicates that the dissolved oxygen levels are high and on average exceed complete saturation levels (maximum recorded: 120.9 percent saturation; average: 104.3 percent saturation). These dissolved oxygen levels are undoubtedly due to the effect of the Enloe Dam spillway and plunge pool. Dissolved nitrogen gas levels are not available for review. However, it is probable that these may also be above 100 percent saturation levels which, if excessive (i.e., supersaturated), can have detrimental effects on fish. Fecal coliform levels in excess of acceptable standards have occassionally been recorded, although average fecal coliform levels are within the acceptable range. Average dissolved trace metals are low, although dissolved zinc above desirable levels has been recorded at times. Data also indicate that river temperatures can exceed (on occasion) the desirable upper level for freshwater aquatic life. Maximum temperatures normally occur in peak summer hot spells. It is unlikely the Enloe Dam reservoir is contributing significantly to additional increases in temperatures. In that the reservoir is essentially filled with sediments, water in the reservoir has a very low residence at times. Extensive sediment deposition in the reservoir is likely responsible for suspended solids levels downstream of the dam (range: 1 to169 mg/l) which are similar to levels in the river at a monitoring site well above the reservoir (Station 8NL0005, range 1 to 140 mg/l). No pesticide or other trace organic water quality data were available for review. Detailed water quality data are presentd in Table 19 (Appendix 4).

Near the mouth of the Similkameen, the Oroville sewage plant discharges treated municipal effluent into the river. The plant is currently licensed to discharge through a multiport diffuser 2400 m^3/day (0.63 U.S. MGD) of effluent containing 30 mg/l BOD_5 (30 kg/d), 30 mg/l suspended solids (30 kg/d), a fecal coliform maximum of 200 per 100 ml. No limitations are placed on nutrient levels or residual chlorine. The sewage plant is not presently required to monitor the receiving environment.

Potential Impacts

With the exception of short term effects during construction, principally as potentially elevated suspended solids levels, the passage alternatives (excluding the effect of reactivating power) other than Dam Removal are not projected to have any major effects on the water quality of the Similkameen River. A summary of the anticipated project effects of each alternative on water quality is presented in Table 8-3.

The dam removal alternative has the most potential for significant impact on water quality. Removal of the dam without first dredging sediments would result in the accumulated reservoir sediments being flushed downriver and ultimately into the Okanogan system. The quantity of sediment movement depends largely upon the procedures undertaken prior to the dam removal. The reservoir is estimated to contain 1.8 million yards of sediment accumulated over 60 years. It is, in essence, not accumulating any further net amount. In this context, the quantity of sediment flushed out of the reservoir annually in freshet is roughly equivalent to the incoming sediment load.

If dam removal occurred without prior dredging of a channel through the reservoir for the river to follow, a considerably larger quantity of sediment would be flushed downstream. The river would cut through the accumulated sediment and ultimately carve out a river bed down to the original river bed elevation in a matter of a few years. During annual freshets, additional sediment would slough into the river from the remaining sediment-based river banks within the old reservoir. This erosion would be significantly reduced if measures were taken to stabilize banks and provide extensive riprap protection throughout the old reservoir. Estimates made by others (Nelson, 1972) indicate that in an unmitigated case, the quantity of sediment flushed during a year of average discharge would be approximately 320,000 cubic yards or 18 percent of the existing reservoir sediment content. The potential downstream effects would include elevated suspended solids levels and sediment deposition over a 17 mi reach of the Similkameen River immediately downstream of its confluence with the Okanogan River. The implication of such sediment deposition on the hydrology and biology of the Okanogan are discussed elsewhere in this report.

TABLE 8-3
Effect of Passage Alternatives on Water Quality

Similkameen River

	Alternative	Probable Effect	Duration
#1	Fish Ladder Without Power	Increased Suspended Solids	Short Term Construction Period Only
#2	Fish Ladder With Power	Increased Suspended Solids	Short Term Construction Period Only
#3	Trap and Haul Without Power	Increased Suspended Solids	Short Term - Construction Period Only
#4	Trap and Haul With Power	Increased Suspended Solids	Short Term - Construction Period Only
#5	Trap and Haul With Power Lower River Site	Increased Suspended Solids	Short Term - Construction Period Only
#6	Dam Removal	Increased Suspended Solids	Potential Long Term (Each Freshet) Until Equilibrium Reached Depending on Method Used
		Sediment Deposition In Lower Similkameen With Potential Biological Impact (Fish Spawning and Primary Producer Habitat Loss)	Potential Long Term Until Reservoir Area Reaches Equilibrium
		Decreased Dissolved Gas Saturation Levels	Permanent

TABLE 8-3 (Continued)
Effect of Passage Alternatives on Water Quality

Okanagan River

	Alternative	Probable Effect	Duration
#1	Fish Ladder Without Power	Slightly Noticeable Increase Suspended Solids	Short Term Construction Period Only
#2	Fish Ladder With Power	Slightly Noticeable Increase Suspended Solids	Short Term Construction Period Only
#3	Trap and Haul Without Power	Slightly Increased Suspended Solids	Short Term - Construction Period Only
#4	Trap and Haul With Power	Slightly Increased Suspended Solids	Short Term - Construction Period Only
#5	Trap and Haul With Power Lower River Site	Slightly Increased Suspended Solids	Short Term - Construction Period Only
#6	Dam Removal	Increased Suspended Solids	Potential Long Term Until Equilibrium Reached Depending on Method Used
		Sediment Deposition For Several Miles Below Confluence With Potential Biological Impact (Fish Spawning and Primary Producer Habitat Loss)	Potential Long Term Until Equilibrium Reached Possible Permanent Habitat Loss

Since about 96 percent of the sediment in the reservoir is sand (0.05-2 mm), the sediment portion that will remain suspended in the water column for any significant period would be the much smaller fraction, consisting of fine silts and clays. Based on a projected total sediment movement per year, after dam removal, of 320,000 cubic yards at 4 percent fines, and specific weight of 100 lbs/ft^3, the total quantity of reservoir fines that would enter the river water could approach 18,000 tons. Using this value and the annual average discharge of the Similkameen, the average annual increment of suspended solids (fines) would equate to 8 mg/l. During freshets, the increment will likely be at least 3 times this value, or 24 mg/l. The present suspended solids level in the Similkameen averages around 40 mg/l on a mean annual basis, and upwards of 140 mg/l during freshets. Therefore, the projected incremental resuspension and transport of reservoir fines could theorectically increase the suspended solids concentrations by about 20 percent.

The other scenario for removing the dam with prior river channel dredging in the reservoir would result in less intense short term impacts on the Similkameen River and the downstream Okanogan River from load and turbidity (suspended solids). If all of the sediment were dredged prior to dam removal, few if any of the impacts discussed in the preceding paragraphs would result.

Additional studies in which sediment loads are modeled would be initiated during the formal NEPA process, assuming Alternative 6 continues to be considered as a probable alternative.

8.3.3.3 Groundwater

Existing Conditions

The groundwater table in the soils and bedrock of the reservoir sides is relatively high, primarily due to the presence of Enloe Reservoir. The quality of groundwater seepage and drainage from the reservoir and side walls is not documented. Other groundwater considerations are not of particular relevance to the project in this initial scoping phase and therefore are not discussed in this report.

Potential Impacts

Development of fish passage facilities, with the exception of the dam removal option, would not alter the existing groundwater equilibrium in the reservoir area. With removal of the dam, the groundwater table in the reservoir side walls would be lowered and would ultimately reach the original natural state. Rapid lowering of the dam could conceivably cause side wall sloughing due to liquifaction/shear failures caused by the relatively high groundwater table in these areas. The rate of groundwater subsidence in the reservoir sediments and sidewalls is dependent upon the permeability of these deposits. Analysis of reservoir sediment composition (Section 8.4.3) indicated no significant presence of pesticides or hazardous trace elements. The quality of groundwater seepage subsequent to dam removal from these deposits is not projected to cause any impairment of river or groundwater quality.

8.3.3.4 Water Use and Public Supplies

Existing Conditions

The community of Oroville obtains its public water supplies from wells in the Okanogan drainage basin. Three surface water licenses have been issued on the Similkameen River in Washington State.

The Okanogan PUD holds license for 250 cfs and 750 cfs on the Similkameen River for power production at Enloe Dam and the adjoining power plant. This license is currently not in active use.

The Oroville-Tonasket Irrigation District holds two licenses on the Similkameen River, one for water rights and one for water storage. The water rights license is for 50 to 186 cfs between 1 April and 15 October, depending on the specific month. The approximate maximum withdrawal allowed on this water right is 52,000 acre feet per year, with a maximum withdrawal at any given time of 200 cfs. This license is active, with about 50 percent of the maximum licensed amount withdrawn from the river in 1984. A new Oroville-Tonasket Irrigation District system is currently being implemented on the Okanogan River. The current license is expected to remain in place or to be modified after completion of the Oroville-Tonasket system on the Okanogan River, thus allowing make-up water to be drawn from the Similkameen River when conditions in the Okanogan system dictate a need. The Oroville-Tonasket Irrigation District also holds a storage permit for 10,500 acre feet of water on the Similkameen River. This permitted storage option has never been exercised.

New irrigation licenses are not issued on the Similkameen River on the British Columbia side, except for use of freshet flows or if an equal amount of storage is provided.

Potential Impacts

The development of a fish passage facility is not projected to have any effect on the present active water use and public water supplies in the project vicinity, as the passage facility would not be located near the irrigation canal or water supply wells. Removal of the dam would not impact the present irrigation canal or public water supplies of the community of Oroville or the Oroville-Tonasket Irrigation District.

8.3.4 Vegetation Resources

Existing Conditions

The Similkameen River Valley is part of the Okanogan Highlands physiographic province described by Franklin & Dyrness (1973). The valley is in a transitional zone between the Cascade Mountains to the west and Okanogan Highlands to the east. The valley vegetation is a complex mosiac of three steppe vegetation zones including the Big Sagebrush/Bluebunch Wheatgrass Zone (*Artemisia tridentata/ Agropyron spicatum*), Bitterbrush/Idaho Fescue Zone (*Purshia tridentata/Festuca idahoensis*), and Treetip Sagebrush/Idaho Fescue Zone (*Artemisia tripartita/Festuca idahoensis*) (Franklin & Dyrness, 1973). The complex patterns of these plant communities is influenced by soil, slope, aspect, topography and past grazing. This area is the northern most extension of the Columbia basin steppe vegetation.

The Study Area lies along the Similkameen River which flows through a moderately steep canyon with narrow terraces on each side of the river. Beyond the terraces,the valley walls rise steeply to rocky rolling hills that reach an elevation of about 2,800 ft.

There are four major vegetation communities in the Study Area vicinity. One of these, an open ponderosa pine (Pinus ponderosa) forest, occupies the highest hillside slopes. The dominant understory shrub is bitterbrush with mixed grasses as the predominant herbaceous vegetation. On the lower slopes, ponderosa pine becomes scattered, and two shrub/steppe communities replace pine woodlands. A bitterbrush/Idaho fescue community occurs on steeper, rocky slopes while a big sagebrush/bluebunch wheatgrass community is found on gentler slopes. Associated species include threetip sagebrush, rabbitbrush (Chrysothamnus), balsamroot (Balsamorhiza), prickly pear (Opuntia polyacantha), and grasses such as bluegrass (Poa) and cheatgrass (Bromus tectorum). Invader species including knapweed (Centaurea), thistles (Cirsium) and tumble mustard (Sysimbrium altissimum) are also common, and are indicative of the disturbance in the area.

A fourth plant community which occurs frequently on the slopes above the reservoir is a shrub/steppe association dominated by smooth sumac (Rhus glabra) and cheatgrass. Other shrub species include big sagebrush, bitterbrush, wild rose (Rosa), and serviceberry (Amelanchier alnifolia). Common herbaceous species are flannel mullein (Verbascum thapsus), curly dock (Rumex crispus), knapweed and tumble mustard. The displacement of native grasses by cheatgrass, an introduced species, on much of the Study Area indicates that these areas have been heavily grazed at some time (Daubenmire, 1970).

Along portions of the riverbank edge, upland vegetation is replaced by riparian vegetation. Occurrence of riparian vegetation is sporadic, patchy, and varied in composition. Willow (Salix) is the most common woody species and can vary from thin lines of seedlings to large dense thickets. Cottonwood (Populus) stands occur occasionally. One large stand of cottonwood is near Enloe Dam on the east side of the river. Associated species include Rocky Mountain maple (Acer glabrum), willow, red-ozier dogwood (Cornus stolonifera), and serviceberry. Also present are some introduced horticultural species including maples (Acer), juniper (Juniperus), yucca

(Yucca), and lilac (Syringa). Other trees commonly found on riparian sites included Douglas-fir (Pseudotsuga menziesii), water birch (Betula occidentalis) and thin-leaf alder (Alnus tenuifolia). Common herbaceous species included clematis (Clematis), rushes (Juncus), sedges (Carex), and horsetail (Equisetum).

According to FERC No. 2062 Exhibit E (Okanogan County PUD, 1981), there are several wetland areas in shallows along the shoreline of the reservoir. None were identified during field reconnaissance. However, evaluation of wetland distribution and composition will be undertaken prior to preparing an EA or EIS for the project.

No federally threatened or endangered plant species occur in or near the Study Area (Bottorf, pers. comm., 21 November 1984).

Potential Impacts

Five of the six alternatives would have little effect on the vegetation of the Study Area. Only a very small area would be disturbed by construction or rehabilitation of existing structures or roadway development. The sixth alternative, dam removal, would result in loss of riparian and wetland vegetation on the reservoir edges. This could eventually be replaced to some degree through development of a new riparian or wetland communities along the rechanneled edge of the river. The development of these new riparian areas could actually result in more productive wetland communities than those currently existing.

8.3.5 Wildife Resources

Existing Conditions

Based on a reconnaissance level survey on 22 and 23 October 1984, available literature and telephone contacts, it is apparent that the wildlife of the Study Area are diverse and typical of the habitats present. These habitats basically include: the Similkameen River; poorly vegetated rocky river shoreline; riparian tree and shrub communities; drier shrub-steppe and open conifer forest communities on the valley slopes, including open ponderosa pine forest, bitterbush/Idaho fescue and big sagebrush/bluebunch wheatgrass communities, cliffs, and orchards and a golf course on flat terraces near the railroad bridge.

Wildlife species identified by the Washington Department of Game (WDG) as important in the Study Area include the mule deer (Odocoileus hemoinus), chukar (Alectoris chukar), gray partridge (Perdix perdix), California quail (Callipepla californica), bald eagle (Haliaeetus leucocephalus), and golden eagle (Aquila chrysaetos) (Okanogan County PUD, 1981). A wintering population of bald eagles, (classed as threatened in both Washington State and the U.S.), exists along the Similkameen between its mouth and the Palmer Lake area (Shapiro and Associates, 1984; Bottorf, pers. comm., 21 November 1984; Marr, pers. comm., 1 November 1984). The extent of use of the Study Area by bald eagles has not been identified, although nesting pairs are reported from Palmer Lake and the mouth of the Similkameen River (Okanogan PUD, 1982). Peregrine falcons may occasionally pass through the Study Area during spring and/or fall migration seasons. Peregrines are not known to nest in the vicinity. Most of the Study Area is probably within the home range of the pair of golden eagles nesting on the cliffs of Kruger Mountain above the Study Area. This resident pair is known to the Washington Natural Heritage Data System (1985), and local WDG personnel. The pair was observed during the October 1984 site reconnaissance. In addition, the Natural Heritage Data System (1985) reports that the pallid crescent spot butterfly (Phycoides pallida), classed as a proposed monitor species by WDG (1983), occurs in Sec. 13 (T40N, R26E). Ospreys (Pandion haliaetus), classed as proposed monitor species by WDG (1983), are reported to nest at Palmer Lake and the mouth of the Similkameen (Okanogan PUD, 1982), and may hunt within the Study Area. These are the only two proposed monitor species known to occur in the Study Area.

A number of other special status wildlife species have not been recorded but may occur in the Study Area. A summary of species known or likely or occur, based on habitat affinity, are listed in Table 8-4. Proposed monitor species which may occur are not included in this Table.

In a general sense, none of the local wildlife species are likely to be adversely affected over the long term by implementation of any of the six fish passage

TABLE 8-4
Special Status Wildlife Species Which Occur or May Occur in the Enloe Study Area. Potentially Occurring Proposed Monitor Species are not Included

Species	Status In: U.S.	Status In: Washington	Occurrence
Bald Eagle, Haliaeetus leucocephalus	Threatened (T)	T	Present. Small wintering populatio (L25) in vicinity, nesting pairs at Palmer Lake and the mouth of the Similkameen
Golden Eagle, Aquila chrysaetus	-	Proposed Sensitive (PS)	Present. Nesting pair on Kruger Mountain above Study Area.
Osprey, Pandion haliaetus	-	Proposed Monitor (PM)	Almost certainly occurs. Nesting pairs reported at Palmer Lake and mouth of Similkameen.
Pallid Crescent Spot Butterfly, Phycoides pallida	-	PM	Present. Occurs in dry gullies in mountain foothills.
Northern Goshawk Accipiter gentilis	-	PS	May occur in mature conifer stands
Merlin, Falco columbarius	-	PS	May occur, nests in tree cavities or cliffs, hunts in open country.
Peregrine Falcon F. peregrinus	Endangered (E)	E	May occur during migration for sho periods.
Prairie Falcon, F. mexicanus	-	PS	May occasionally occur, apparently does not nest in area.
Burrowing Owl, Athene cunicularia	-	PS	Possibly occurs, suitable sbrub-step habitat exists.
White-headed Woodpecker, Picoides albolarvatus	-	PS	May occur at higher elevations in ponderosa pines.
Townsend's Big-eared Bat Plecotus townsendii	-	Proposed Threatened	May occur, potential roost habitat i railroad tunnel.
White-tailed Jackrabbit Lepus townsendii	-	PS	May occur in sage-grass at higher elevations.

alternatives proposed for this project. Fish- or carrion-eating species such as mergansers, bald eagles, ospreys, otters, racoons, bears and gulls may benefit over the long term from the presence of an anadromous fishery above Enloe Dam. It will be necessary to prepare a biological assessment of the probable impacts of the project on bald eagles (Bottorf, pers. comm., 21 November 1984). This biological assessment will be prepared concurrently with the formal NEPA document. Minor, adverse, short-term and long-term impacts on wildlife will result, in differing locations and degrees, and in areas far from the local Study Area, from implementation of each alternative. These are briefly discussed below.

Potential Impacts

Alternatives 3 and 5 would eliminate the least amount of habitat on the east bank of the river. Alternative 1 eliminates more habitat along the length of the fishway. Alternatives 2 and 4 both would require extension of the existing road and in addition, Alternative 2 would eliminate habitat along its length. Alternative 6 would require no new road and construction and may create additional riparian habitat when the river returns to a free-flowing state. In addition, if sediment dredging was implemented, there would be temporary terrestrial range losses until material dredged from behind the dam was reclaimed. All of these construction-related losses are minor in relation to the increased food supply to fish-eating species that would be produced by the new fish runs in the upper Similkameen.

8.3.6 Fisheries Resources

Existing Conditions

A considerable number of fish species are currently present both in the basin upstream of Enloe Dam and in the Similkameen and Okanogan Rivers downstream of the dam. A listing of the fish species known to exist in the regions noted above is presented in Table 8-5. The most common species of fish above Enloe Dam in the Similkameen River and its main tributary streams are sculpins (Cottus sp.), followed in declining order by mountain whitefish (Prosopium williamsoni, longnose dace (Rhinichthys cataractae), bridgelip suckers (Catostomus columbianus, and rainbow trout (Salmo gairdneri) (IEC BEAK Consultants Ltd., 1984).

TABLE 8-5
Species List of Fish Known to be Present in the Similkameen River Above and Below Enloe Dam and in the Okanogan River Downstream of Osoyoos Lake

Species	Known Distribution
ABOVE ENLOE DAM (Simikameen River System)	
Rainbow Trout (*Salmo gairdneri*)	All lakes and streams.[1,2]
Cutthroat Trout (*Salmo clarki lewisi*)	Alpine lakes in Ashnola River drainage, Ashnola River.[1,2]
Brook Trout (*Salvelinus fontinalis*)	Allison and Summers creeks, Sinlahekin Creek (Palmer Lake system).[1,2,3]
Lake Trout (*Salvelinus namaycuch*)	Otter Lake.[2]
Kokanee (*Oncorhynchus nerka*)	Missezula Lake (Allison/Summers Creek drainage), Palmer Lake.[1,2,3]
Mountain Whitefish (*Prosopium williamsoni*)	Similkameen River to Similkameen Falls, Tulameen River, lower portion of Ashnola River.[1,2]
Lingcod (*Lota lota*)	Palmer Lake.[4]
Smallmouth Bass (*Micropterus dolomieui*)	Palmer Lake.[4]
Largemouth Bass (*Micropterus salmoides*)	Palmer Lake.[4]
Black Crappie (*Pomoxis nigromaculatus*)	Similkameen River downstream of Palmer Lake, Palmer Lake.[1,4]
Northern Squawfish (*Ptychocheilus oregonensis*)	Similkameen River to Princeton, Palmer Lake.[1,4]
Peamouth Chub (*Mylocheilus caurinus*)	Palmer Lake, Similkameen River.[4]
Northern Mountain Sucker (*Catostomus platyrhynchus*)	Similkameen River downstream of Princeton, Tulameen River.[2]

TABLE 8-5 (Continued)
Species List of Fish Known to be Present in the Similkameen River Above and Below Enloe Dam and in the Okanogan River Downstream of Osoyoos Lake

Species	Known Distribution
Redside Shiner (Richardsonius balteatus)	Similkameen River.[1,4]
Bridgelip Sucker (Catostomus columbianus)	Similkameen River to Princeton, Tulameen River.[1,2]
Carp (Cyprinus carpio)	Palmer Lake.[4]
Longnosed Dace (Rhinichthys cataractae)	All streams.[1]
Sculpins (Cottus spp.)	Entire system.[1]
BELOW ENLOE DAM (Similkameen River)	
Steelhead Trout (Summer) (Salmo gairdneri)	Mouth to dam.[4,5]
Chinook Salmon (Summer) (Oncorhynchus tshawytscha)	Mouth to dam.[5]
Sockeye Salmon (Oncorhynchus nerka)	Observed in river to dam.[6]
Rainbow Trout (Salmo gairdneri)	Mouth to dam.[5]
Mountain Whitefish (Prosopium williamsoni)	Mouth to dam.[5]
Lingcod (Lota lota)	Observed near railroad bridge.[5]
Smallmouth Bass (Micropterus dolomieui)	Observed in lower section.[5]
Northern Squawfish (Ptychocheilus oregonensis)	Observed downstream of railroad bridge.[5]

TABLE 8-5 (Continued)
Species List of Fish Known to be Present in the Similkameen River Above and Below Enloe Dam and in the Okanogan River Downstream of Osoyoos Lake

Species	Known Distribution
Bridgelip Sucker (*Catostomus columbianus*)	Observed downstream of railroad bridge.[5]
Carp (*Cyprinus carpio*)	Observed upstream of mouth.[5]
ADDITIONAL SPECIES PRESENT IN OKANOGAN RIVER	
Brown Trout (*Salmo trutta*)	Captured in lower river.[8]
Pacific Lamprey (*Entosphenus tridentatus*)	Captured in lower river.[7,8]
Chiselmouth (*Acrocheilus alutaceus*)	Captured in lower river.[7,8]
Redside Shiner (*Richardsonius balteatus*)	Captured in lower river.[7,8]
Largescale Sucker (*Catostomus platyrhyncus*)	Captured in lower river.[7,8]
Brown Bullhead (*Ictalurus nebulosus*)	Captured in lower river.[7,8,9]
Yellow Perch (*Perca flavens*)	Captured in lower river.[7,8,9]
Torrent Sculpin (*Cottus rhotheus*)	Captured in lower river.[7,8,9]
Pumpkinseed (*Lepomis gibbosus*)	Captured in lower river.[8,9]
Peamouth Chub (*Mylocheilus caurinus*)	Captured in lower river.[8]
Largemouth Bass (*Micropterus salmoides*)	Captured in Okanogan River below Zosel Dam at outlet of Osoyoos Lake.[9]

TABLE 8-5 (Continued)
Species List of Fish Known to be Present in the Similkameen River Above and Below Enloe Dam and in the Okanogan River Downstream of Osoyoos Lake

Species	Known Distribution
Bluegill (*Lepomis macrochirus*)	Captured in Okanogan River below Zosel Dam at outlet of Osoyoos Lake.[9]
Tench (*Tinca tinca*)	Captured in Okanogan River below Zosel Dam at outlet of Osoyoos Lake.[9]

[1] IEC BEAK Consultants Ltd., 1984.

[2] Ministry of Environment, 1984.

[3] IEC BEAK Consultants Ltd., 1985 (Appendix 2).

[4] K. Williams, pers. comm., 1983.

[5] IEC BEAK snorkle surveys in 1984.

[6] Washington Department of Fisheries, unpubl. data, 1984.

[7] Parametrix, Inc., 1981.

[8] McGee and Truscott, 1982.

[9] McGee *et al.*, 1983.

The main sport fish in stream and lakes above Enloe Dam is rainbow trout. Other sport fish occurring in lakes of the Similkameen basin are: kokanee (Oncorhynchus nerka), lake trout (Salvelinus namaycush), cutthroat trout (Salmo clarki lewisi) and brook trout (Salvelinus fontinalis). Streams of the basin support brook trout and mountain whitefish, in addition to rainbow trout.

No anadromous fish occur above Enloe Dam at present. The summer steelhead production potential of the basin upstream of Enloe Dam is presented in Section 4.5 of this report. Downstream of the Enloe Dam, three species of anadromous salmonids are present, namely, summer steelhead trout (Salmo gairdneri), summer chinook salmon (Oncorhynchus tshawytscha) and sockeye salmon (Onchorhychus nerka). Steelhead trout and chinook salmon have been documented to spawn downstream of Enloe Dam, with sockeye presence and spawning occasionally noted (Washington Department of Fisheries, unpubl. data, 1984).

The anadromous salmonids which occur in the lower Similkameen River system presently migrate a distance of approximately 825 km (516 mi) over nine Columbia River mainstem dams (Wells Dam being the last) prior to entering the Okanogan River at Brewster, Washington. The fish then migrate about 120 km (74 mi) to the Okanogan/Similkameen confluence. Enloe Dam is situated at river mile 8.8 on the Similkameen River.

No fish species listed as threatened or endangered by the U.S. Fish and Wildlife Service are known to occur in the Similkameen River system.

Potential Impacts

The overall effects and feasibility of fish passage at Enloe Dam are discussed in detail in Section 4.0 of this report. The general conclusion of the intensive fisheries studies conducted over the past two years is that fish passage at Enloe Dam will have a very positive effect on the Similkameen River system fishery, both in Canada and in the U.S. The Similkameen River system drains about 9,300 square km (3,620 mi^2) of the Pacific Northwest. Approximately 560 km or 350 mi of stream would be accessible to anadromous salmonids in this basin, should passage be achieved at Enloe Dam. This extensive increase in fish spawning and rearing habitat is obviously of great benefit overall.

Although the overall effect of fish passage at Enloe Dam is anticipated to be very positive, certain issues of concern have been raised with regard to potential problems. The first of these is the issue of competition among introduced anadromous species and resident sport fish. A second concern expressed by the B.C. provincial government relates to the potential of the anadromous species introducing fish disease into the watershed including the effects this could have on resident rainbow trout populations. Competition among sport fish and introduced anadromous species is discussed at length in Section 4.12.3. It is also addressed in the recreation subsection of this NEPA report (Section 8.4.6). The disease issue is discussed in Sections 4.3 and 4.16.

In assessing the potential impacts of the six passage alternatives on the fishery resource, the location and type of facility (or procedure) are the most significant considerations. Alternative 1 (fishway from the falls without hydro-power) and Alternative 3 (trap and haul at the falls without hydropower) have the least impacts in terms of lost or restricted fish habitat. Access and use of the existing habitat is maintained with both of these alternatives. At least in theory, specific fish species can be selected for transport above Enloe Dam with the trap and haul facility which is not the case with a fishway (assuming all fish species could navigate the fishway equally well). Although in some instances the ability to select certain species is an advantage of a trap and haul facility, this ability is not felt to be of major importance at Enloe Dam since the majority of the fish known to be present below the dam are already in the watershed upstream of the barrier. The non-sport and non-anadromous species are not considered to be detrimental to either the existing populations or the introduced anadromous species, so the trap and haul facility would result in no major benefits with regard to enhancement of the population distribution when compared with the fishway. Additionally, it is quite possible that the fishway would inhibit or stop the passage of some less desirable species due to its length, height of drop structures and/or water velocities.

Alternative 2 (fishway below the powerhouse, compatible with hydropower) and Alternative 4 (trap and haul below the powerhouse, compatible with hydropower) have slightly increased impacts over Alternatives 1 and 3 with regard to fish utilization of the stream just below the natural falls. Alternative 4, like Alternative 2 would allow selection of species for transport above Enloe Dam. As previously discussed, however, this issue is not of great importance at Enloe. Alternatives 2 and 4 include a barrier dam constructed approximately 30 m (100 ft) downstream of the powerhouse. The barrier dam would prevent fish from utilizing the 200 m (650 ft) section of stream from the barrier to the natural falls as an adult holding area prior to spawning. The current extent of utilization of this area for holding is not known, but is felt to be minimal. Use of this area for juvenile rearing would not be altered. No anadromous salmonid spawning area exists in the vicinity. As with all of the alternatives, the potential for passage of fish species not presently known to be above Enloe Dam also exists.

Alternative 5 which involves a trap and haul facility located approximately 3 km (2 mi) downstream of Enloe Dam (and is compatible with hydropower generation) will reduce the adult holding area presently available in this stream section by eliminating access to several large, deep pools which occur here. A very small component of the anadromous salmonid spawning area present below Enloe Dam (approximately 10 percent) will also be cut off, but this loss will be very minor when compared to the extensive spawning and rearing areas available in the upper Similkameen River watershed when passage is achieved. Alternative 5 also permits the selection of fish species to be trucked above Enloe Dam.

Removing Enloe Dam and providing a fishway over the falls (Alternative 6) has a much greater variety of potential impacts than the other alternatives. Sediment load in the lower river would temporarily increase if sediment behind the dam was not first removed via suction dredging. Silting of existing spawning and rearing areas in the Similkameen and Okanogan rivers potentially could occur as a result of sediment release. Water quality would be affected, with possible negative effects on fish species residing in the rivers. The length of time required for the sedimentation and water quality effects of dam removal to dissipate is uncertain, but could reduce or alter fish production and use of the lower river for a signficant time period and thereby have relatively long-term effects on fish populations. Dredging of sediment prior to dam removal would alleviate these adverse effects to a large extent. Alternative 6 would require only a short, low fishway over the natural falls and would permit fish passage with a minimal amount of physical stress on the fish. Thus, unimpeded access for fish to the upper Similkameen River would be provided with this alternative once the effects of sediment release dissipate.

8.4 Human Environment

8.4.1 Power Production Potential

Existing Conditions

No power is currently being generated at Enloe Dam.

Potential Impacts

Some of the alternatives for fish passage at Enloe Dam have implications on the potential for hydropower production at that site. Okanogan PUD has filed an application with FERC to develop a facility with new generators located at the old powerhouse site below the falls. Although ultimate development of the site is uncertain at this time, the possibilities for reduction in hydropower generating potential as a consequence of providing fish passage must be taken into account.

Six alternatives for passage have been developed to date. Of these, Alternative 1, 3 and 6 are "incompatible" with hydropower production and assume no power development at Enloe Dam. Alternatives 2 and 4 are "compatible" with hydropower development at Enloe Dam and incorporate certain design features which take that potential development into account. These alternatives would cause some reduction of power production potential, however. Alternative 5 is located outside any area of potential influence on hydropower development at Enloe Dam and makes no assumption regarding power development at that site. The anticipated effects of each alternative on the potential for hydropower production at Enloe Dam are described in more detail below.

Alternative 1 - Fishway from Falls. This alternative assumes no hydropower development; therefore, no power production or revenues are foregone.

Alternative 2 - Fishway Below Powerhouse. This alternative includes the construction of a fish barrier dam below the proposed powerhouse and a nominal flow of about 40 cfs down the major portion of the fish ladder. Both of these project features would have an influence on power production potential at the Enloe Dam site. The fish barrier dam would reduce the gross operating head available for power production by about 7 ft. This reduction would vary with discharge somewhat, but for this analysis a consistent 7 ft is assumed. The nominal fishway flows of 40 cfs would reduce water flows available for power generation by that amount. Although the fishway will not necessarily be in operation at all times during which power would be generated, a consistent removal of 40 cfs is assumed in this analysis. In this regard, this analysis is conservative on the side of lost power production potential.

Alternative 3 - Trap and Haul at Falls. This alternative assumes no hydropower development; therefore, no power production or revenues are foregone.

Alternative 4 - Trap and Haul Below Powerhouse. This alternative includes the construction of a fish barrier dam below the proposed powerhouse. Unlike Alternative 2, no stream flows would be taken from above the hydropower facility for operation of the fish passage facility. Therefore, the only effect this alternative would have on hydropower production potential would be a reduction in gross operating head of about 7 ft.

Alternative 5 - Trap and Haul Near Railroad Bridge. This alternative lies outside the area of influence on any potential hydropower development at Enloe Dam; therefore, no power production or revenues are foregone.

Alternative 6 - Dam Removal. This alternative assumes no hydropower development; therefore, no power production revenues are foregone.

The effects of various alternatives on annual energy production of the proposed hydropower facility were determined by modeling energy output under existing stream flow and head conditions and under various other conditions which simulate the implementation of relevant fish passage alternatives. The computer program used is called "HYDRO-CALC", is in the public domain, and is available through BPA, as well as from other sources. Input data and results of the modeling effort, performed for this project by the Okanogan PUD, are given in the first portion of Appendix 6.

The alternatives which have some effect on hydropower potential are Alternatives 2 and 4. The effects of Alternative 2 are most closely simulated by Run 6, which assumes a seven foot gross operating head loss and a 40 cfs bypass to operate the fishway. According to the model, this alternative would result in a loss of 6,799,794 kwh/yr from a fully developed project. The effects of Alternative 4 are most closely simulated by Run 2, which assumes a 7 ft gross operating head loss and no bypass. According to the model, this alternative would result in a loss of 5,178,629 kwh/yr from a fully developed project.

In order to put these potential losses into perspective and to compare them to gains in anadromous fish production potential represented by the fish passage project, foregone power production potential must be converted to dollars of present worth. This involves incorporating some assumptions into present worth calculations relating to dates of completion of various phases of power development, project life, price for power and discount rate (including inflation). Based on discussions with representatives of Okanogan PUD and BPA, the following assumptions regarding power development at the Enloe Dam were made:

- o Fast Track Schedule - All permits will be granted, construction of Phase I of power development will be complete and turbines 1 and 2 will be on line and generating power in the fall of 1989. Phase II of power development will be complete and turbine 3 will be on line and generating power in the fall of 1992.

- o Ten Year Delay Schedule - This schedule assumes that the entire hydropower production schedule at Enloe Dam is delayed for 10

TABLE 8-6
Results Of Analysis Of The Effects Of Various Fish Passage Alternatives
At Enloe Dam On Power Production Potential At That Site

	Energy Loss, kwh/yr At Full Development	Revenue Loss, \$/yr[1] At Full Development	Present Worth (1985)[2] Of Foregone Power Potentia
Alternative 1			
Assumes No Power Development	No Loss	No Loss	No Loss
Alternative 2			
Fast Track Schedule	6,799,794	149,596	3,258,899
Ten Year Delay	6,799,794	149,596	2,165,923
Alternative 3			
Assumes No Power Development	No Loss	No Loss	No Loss
Alternative 4			
Fast Track Schedule	5,178,629	113,929	2,466,589
Ten Year Delay	5,178,629	113,929	1,638,079
Alternative 5			
No Influence On Power Development	No Loss	No Loss	No Loss
Alternative 6			
Assumes No Power Development	No Loss	No Loss	No Loss

[1] Assumes \$0.022 per kwh.

[2] Assumes development schedule outlined in text and 3% discount rate with 54 year project life beginning in 1985.

years. This schedule is included in this analysis to sensitize for the effects of any uncertainty inherent in the permitting and construction schedules in the project proposed by Okanogan PUD. This schedule assumes that turbines 1 and 2 will be on line and generating power in 1999 and that turbine 3 will be on line and generating power in 2002.

- In order to compare results of this analysis directly to those of the benefits analysis, project life is placed at 54 years, beginning in 1985.

- Price for power is placed at $0.022 per kwh. This is the price presently reflected in the Bonneville Power Administration (BPA) rate schedule. According to Okanogan PUD, BPA intends to maintain that rate until the fall of 1986 and then let it rise with inflation. The inflationary rise in the rate schedule is accounted for in the choice of a discount rate.

- The discount rate used in this analysis is 3 percent. This is the risk-fee rate of time preference used by BPA, the Northwest Power Planning Council and PNUCC for power system analysis. This discount assumes that power rates follow inflation, thus taking inflationary price rise into account internally. It should be noted that an identical 3 percent discount rate was used in the analysis of fish passage benefits, thus internalizing the inflationary price rise for that resource. The results of the two analyses can therefore be compared directly.

The results of the cost analysis summarizing the effects of Alternatives 2 and 4 on power production potential at the Enloe Dam Site are given in Table 8-6.

8.4.2 Noise

Existing Conditions

Current noise levels in the study area include low level traffic noise from the secondary county arterial road. Water passing over the dam and falls creates higher constant noise levels in the vicinity of the dam.

Potential Impacts

Noise produced during construction will be generated by vehicular traffic, drilling, blasting, road construction and/or upgrading, machinery operation, barrier dam construction and installation of other facilities. Construction noise for all alternatives will exceed current noise levels. However, the extent, location and duration of increased noise levels will vary with the alternatives. Construction noise will not exceed DOE noise standards, but may be noticeable from the secondary county arterial. Noise from the blasting may be heard in Oroville and Nightthawk.

Noise produced during operation of passage facilities would be generated by traffic and machinery operation. This noise would be minimal and intermittent and therefore non-disruptive to both humans and wildlife in the vicinity.

8.4.3 Toxic/Hazardous Materials

Existing Conditions

As part of the baseline studies for the preliminary NEPA assessment of fish passage options, a sediment composition sampling program was undertaken in the Enloe Dam Reservoir, the Similkameen River and the Okanogan River. The objective of the sampling/analysis program was to assess any potential risk of toxic element contamination from these sediments, particularly as such contamination might be linked to any of the six alternatives under consideration. An additional source of potential contamination exists at the old powerhouse near Enloe Dam (i.e., the powerhouse may be a source of polychlorinated biphenyls (PCB's)). Although none of the six Enloe Dam passage alternatives would directly affect the dispersal of PCB's from the powerhouse, the fact that renovation of the powerhouse is assumed within the scope of Alternatives 2, 4 and 5 does link the possible presence of PCB's with the Enloe Dam Fish Passage Project. Therefore, although potential contamination of PCB's at the powerhouse is in the purview of the Okanogan PUD rather than the BPA, a rudimentary sampling of powerhouse soils/residues was determined to be a useful addition to the sediment sampling program.

Sediment sampling site locations are shown on Figure 8-4. Sediment samples were collected from a total of six reservoir and river sites. Analyses were conducted on samples from only four of these sites; sediment samples collected at sites S1 and OK2 in the Lower Similkameen and in the Okanogan River just above the confluence were stored for possible analysis subsequent to the initial findings. Thus, three samples taken from the reservoir and one sample taken from the Okanogan River were analyzed. In addition to the collection of sediment sampling, a composite sample was collected (PH1) from soil and residue in and around the powerhouse. This composite sample was analyzed only for PCB's.

The sediment sampling program was conducted in October 1984. Samples consisted of shallow cores and surface sediments. No deep cores were collected at any of the sites. Samples were analyzed for total element content rather than extractable element content. This method was chosen based on consultation with EPA (Seattle) and in consideration of the fact that the sampling program was intended as a baseline screening survey, not as a definitive program providing absolute information on potential release of toxic elements to the environment.

The parameters for sediment analysis included basic sediment character (moisture, percent volatiles, particle size and nutrients) as well as analysis of major cations (aluminum, calcium, magnesium, iron, manganese, sodium, and potassium), trace metals, and priority pesticides and polychlorinated biphenyls (PCB's). As stated previously, the soil/residue sample at the powerhouse was tested only for PCB's. The results of the analysis program are presented in Tables 8-7 to 8-9.

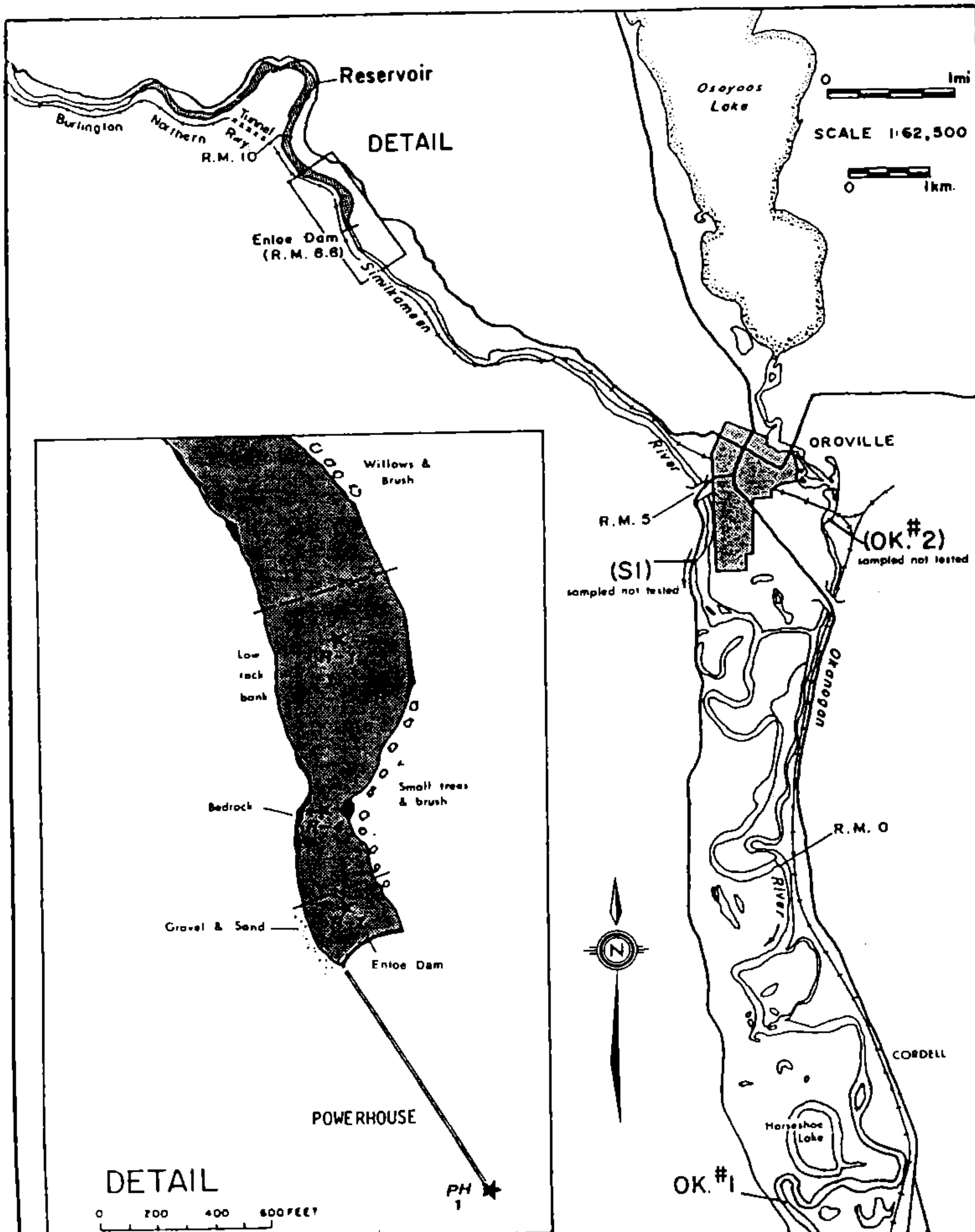

Figure 8-4 Sediment and composite soil sampling stations.

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TABLE 8-7
Reservoir and River Sediment Analyses - Basic Characteristics and Major Constituents

Parameter	Station					Method
	PH #1 Composite	R1	R4	R7	OK #1	
Core Length (inches)	-	6	18	10	2	-
Water Depth (feet)	-	2	50	10	1	-
Moisture (%)	20.3	20.3	25.0	21.5	27.7	105°C
Loss on Ignition (%)	18.6	1.24	2.01	1.18	1.23	600°C
Particle Size (%)						
Sand (L2 mm)	-	98.0	93.6	97.7	86.4	Sieving &
Silt (L50u)	-	0.8	4.1	0.8	10.2	Hydrometer
Clay (L2u)	-	1.2	2.3	1.5	3.4	
Nutrients (ug/g)						
Phosphorus	-	562	542	-	857	Colorimetric
Kjeldahl Nitrogen	-	18	60	-	140	Electrode
Sulfide (ug/g)	-	L5.	L5.	-	L5.	Colorimetric
Cyanide (ug/g)	-	L1.	L1.	-	L1.	Colorimetric
Aluminum	-	8522	10,000	8420	11,600	I.C.A.P.
Calcium	-	5010	5980	5100	7120	I.C.A.P.
Iron	-	14,600	16,200	14,000	19,000	I.C.A.P.
Magnesium	-	5690	6270	5430	7910	I.C.A.P.
Potassium	-	510	735	560	909	I.C.A.P.
Sodium	-	220	264	213	353	I.C.A.P.

L = Less than
ug/g = micrograms per gram of sediment

All results expressed on a dry weight basis except moisture which is expressed on an as received basis.

TABLE 8-8
Reservoir and River Sediment Analyses - Trace Metals

Parameter	Station R1	R4	R7	OK #1	Detection Limit	Method
Arsenic (As)	14.2	26.3	14.9	31.5	0.01	A.A.
Barium (Ba)	53.5	74.5	49.3	89.5	0.01	I.C.A.P.
Beryllium (Be)	0.16	0.21	0.16	0.25	0.01	I.C.A.P.
Bismuth (Bi)	L2.5	L2.5	L2.5	L2.5	2.5	I.C.A.P.
Cadmium (Cd)	L0.15	L0.15	L0.15	L0.15	0.15	A.A.
Cobalt (Co)	6.02	7.08	5.72	9.22	0.1	I.C.A.P.
Chromium (Cr)	15.2	15.7	12.4	21.6	0.1	I.C.A.P.
Copper (Cu)	16.6	26.8	16.4	43.0	0.1	I.C.A.P.
Molybdenum (Mo)	0.35	0.46	L0.40	0.41	0.4	I.C.A.P.
Nickel (Ni)	10.7	11.9	9.58	16.8	0.1	I.C.A.P.
Lead (Pb)	2.08	3.21	1.86	4.19	0.5	A.A.
Antimony (Sb)	L1	L1	L1	L1	1	I.C.A.P.
Vanadium (V)	31.8	36.4	31.3	40.5	0.1	I.C.A.P.
Strontium (Sr)	35.0	48.6	37.1	60.7	0.1	I.C.A.P.
Zinc (Zn)	34.4	39.3	31.8	52.6	0.1	I.C.A.P.
Mercury (Hg)	L0.010	L0.010	L0.010	0.020	0.01	A.A.
Gold (Au)	-	-	L0.01	-	0.01	A.A.

L = Less than

All results expressed on a dry weight basis except moisture which is expressed on an as received basis.

Results are expressed as micrograms of element per dry gram of sediment.

TABLE 8-9
Reservoir and River Sediment Analyses - Priority Pesticides and PCB

Parameter	Station PH #1 Composite	R1	R4	OK #1	Method
2,4 -D	-	L0.020	-	-	-
Aldrin	-	ND	ND	ND	GC/MS
Alpha-BHC	-	ND	ND	ND	GC/MS
Beta-BHC	-	ND	ND	ND	GC/MS
Gamma-BHC	-	ND	ND	ND	GC/MS
Delta-BHC	-	ND	ND	ND	GC/MS
Chlordane	-	ND	ND	ND	GC/MS
4,4'-DDT	-	L0.001	ND	ND	GC & GC/MS
4,4'-DDE	-	L0.001	ND	ND	GC & GC/MS
4,4'-DDD	-	L0.001	ND	ND	GC & GC/MS
Dieldrin	-	ND	ND	ND	GC/MS
Alpha-Endosulfan	-	ND	ND	ND	GC/MS
Bata-Endosulfan	-	ND	ND	ND	GC/MS
Endrin	-	L0.001	ND	ND	GC & GC/MS
Heptachlor	-	ND	ND	ND	GC/MS
Heptachlor Epoxide	-	ND	ND	ND	GC/MS
PCB-1016	L0.010	L0.01	L0.010	L0.010	GC/MS
PCB-1221	L0.010	L0.010	L0.010	L0.010	GC/MS
PCB-1232	L0.010	L0.010	L0.010	L0.010	GC/MS
PCB-1242	L0.010	L0.010	L0.010	L0.010	GC/MS
PCB-1248	L0.010	L0.010	L0.010	L0.010	GC/MS
PCB-1254	L0.010	0.010	L0.010	L0.010	GC/MS
PCB-1260	0.89	0.010	L0.010	L0.010	GC/MS
Toxaphene	-	ND	ND	ND	GC/MS

- = Not analysed.
ND = Not detected - detection limit is 0.05 ug/gram.
L = Less than detection limit shown.
All results expressed as ug/gram dry weight.

The analysis results indicate the Enloe Dam reservoir sediments are composed principally of sand (averaging 96.4 percent sand and 3.6 percent fines). The organic fraction, as represented by loss on ignition, is low and averaged 1.5 percent. The Okanogan River sediment has a higher percentage of fines (13.6 percent), but similar organic fraction. Nutrient levels are higher in the Okanogan River sediments by a factor of 1.5 for phosphorus and 3.5 for nitrogen. Major cations were not significantly different at the three reservoir sampling sites (R1, R4, R7), but were somewhat lower than those at the Okanogan River sampling site (OK #1) (Table 8-7).

Trace metal analysis of the four sediment samples (Table 8-8) indicated that all trace elements fell within or below reported naturally occurring ranges (Bowen, 1966; Underwood, 1971; Chapman, 1966; U.S. Geological Survey, 1970). Slightly higher levels of most elements were found at reservoir Site R4 than at the other two reservoir sites (R1, R7). Site R4 was located in a deep pool where, based on the data, a slightly greater percentage of fines settled out (6.4 percent fines at R4 versus 3.2 percent average of sites R1 and R7). This suggests that fines contain a higher percentage of trace metals than do sand fractions. Levels of the more toxic elements (i.e., cadmium and mercury) were below detection limits at all three reservoir sampling sites and cadmium was also below the detection limit in the Okanogan River sample (OK 1). Mercury was detected in the Okanogan River sediment at a level of 0.02 ppm, well within the range that can be encountered in soils naturally (0.05 ppm) (U.S. Geological Survey, 1970).

Arsenic levels ranged from 14.2 to 31.5 ppm and are therefore somewhat higher than might have been expected. Literature sources report naturally occurring levels in soils to be generally less than 10 ppm (micrograms per gram, dry basis) (Bowen, 1966; Underwood, 1971; Chapman, 1966). The levels detected are not, however, outside the range reported as naturally occurring (1-40 ppm). The slightly elevated arsenic levels in the Enloe Dam reservoir sediment may reflect natural phenomena and/or mining activities, as it is known that are some arsenopyritic deposits in the watershed.

The analysis for priority pollutant pesticides in reservoir and river sediments indicates all are below the detection limit (Table 8-9). Analysis for PCB's in the reservoir indicated a positive detection at one site only (R1) at a level of 0.01 ppm, which is marginally above the detection limit (less than 0.01 ppm).

The powerhouse composite soil/residue sample indicated a positive PCB level. The exact location(s) of the contamination cannot be established from this one composite sample, as it was only intended to be a screening test. The test result does, however, indicate that some level of contamination exists at the old powerhouse. A further survey in which discrete samples are collected is required to determine the significance of initial findings, as well as to establish the magnitude of any risk to the environment. The history of PCB use at the powerhouse site has not been examined in the present project study. PCB's are known to be very persistent once in the environment and have a very high bioconcentration factor. The Okanogan PUD has been advised of the findings of the sampling results obtained in the baseline survey undertaken for this project. In addition, both the EPA (Seattle) and Washington Department of Ecology (Yakima) are aware that a potential PCB contamination problem may exist at the old powerhouse.

Potential Impacts

Alternatives 1 through 5 presume that sediments behind the reservoir would remain in their current location and thus would have no effect on the downstream environment. Alternative 6, the dam removal option, could result in a large amount of reservoir sediment being flushed into the Similkameen and Okanogan River sections below the dam. Since none of the other alternatives result in a potential contamination problem, the screening survey conducted for this report was aimed primarily at assessing potential contamination effects resulting from implementation of Alternative 6. Given the relatively low level of all trace metals and priority pollutants reported in Tables 8-7 through 8-9, contamination due to reservoir sediments seems highly unlikely. It should be noted, however, that these samples were from shallow cores and surface collection; thus, composition of deeper-lying sediments remains unknown and because of the history of the basin their composition should not be assumed.

None of the alternatives would directly result in increased dispersion of PCB's which may occur at the powerhouse. However, as previously mentioned, Alternatives 2, 4 and 5 do assume that the powerhouse may be renovated. Should powerhouse renovation occur, precise quantification and perhaps clean-up of PCB's in the area would be required.

8.4.4 Land Use, Population, Housing And Transportation

Existing Conditions

The Okanogan County Regional Planning Commission's (OCRPC) 1964 Comprehensive Plan for Okanogan County is still quite accurate in relation to the Study Area. The zoning regulations were amended in 1982 (Burgor, pers. comm., 15 February and 22 May 1985). The Comprehensive Plan (OCRPC 1964, Plate 1) shows the immediate vicinity of Enloe Dam (the Study Area) as Open Land or Unclassified. The Oroville Golf Club above the east bank is identified, and orchard lands near the railroad bridge crossing are shown as intensive agricultural lands. Plate V of the Comprehensive Plan (OCRPC 1964) shows a future generalized land use element for the county, and shows no changes in the Enloe Study Area. In the plan, intensive agricultural areas will be maintained and protected from inappropriate land uses, and "allowed to continue to expand without interference from non-agricultural uses" (OCRPC 1964:10). The open-unclassified lands, which comprise most of the Study Area, consist of the following general use categories in the plan: forests, dryland farming, and grazing. These areas are not expected to undergo significant urbanization. The plan further states that uses of these lands should not be restricted as long as the proposed use does not create a nuisance definable by law.

The Generalized Land Use Map for Okanogan County (U.S. Department of Agriculture, Soil Conservation Service, 1979) classified the vicinity of the railroad bridge as irrigated cropland and the remainder of the Study Area as rangeland. This is very similar to that shown in the Comprehensive Plan.

Population and housing in the vicinity of the Study Area are quite sparse, and associated with the orchard lands near the railroad bridge.

Lands in the Study Area are under a mixture of public and private ownership. The Bureau of Land Management (BLM) owns the immediate vicinity of the dam and powerhouse as well as much of the rest of Section 13, T40N R26E. The Okanogan PUD holds a patent to 144 acres on which Enloe Dam and the powerhouse are located. The remainder of Section 13, consisting of higher terrain to the west and south, is privately owned. Lands in the vicinity of the railroad bridge and the site of Alternative 5 (Section 20, T40N, R27E), are privately owned between the secondary county arterial road and the north bank of the river. The existing access road which would be used for Alternative 5 crosses private land.

The road which parallels the river is shown as a secondary county arterial. There are no current plans for upgrading or expanding this road (King, pers. comm., 15 February, 1985), and most of the traffic is to the Nighthawk-Palmer Lake area.

Mining activity has been an excepted land use in the Similkameen River vicinity for many years. Several old mines are evident upstream in the Nighthawk area. A high grade gold placer deposit is reported to exist at Similkameen Falls, and it is possible that signficant deposits also exist beneath the dam and reservoir (U.S. Geological Survey, 1905; Washington State, 1956). Information on mining claims in the Study Area will be obtained from the Washington Department of Natural Resources, Geology and Earth Resources Division and the BLM office in Spokane, Washington.

Potential Impacts

None of the Alternatives is expected to affect land use, population, housing and transportation in the Study Area to any great extent. Fish passage facilities or dam removal are compatible with the current zoning ordinance, which classifies the area as a "minimum requirement district". Thus, no special permits will be required. Alternatives 1 through 4 and 6 would affect only lands owned by BLM. Most of the land to be affected by these alternatives is currently under patent to the Okanogan PUD.

Land use in the vicinity of Enloe Dam Reservoir would change somewhat if Alternative 6 were implemented. Restoring the free-flowing river through this area would probably ultimately result in a small increase in the amount of grazing land available. In addition, implementation of Alternative 6 is likely to stimulate interest in exploitation of these known and potential deposits. If properly regulated and therefore complying with water quality standards, such exploitation would not be incompatible with Alternative 6.

Implementation of Alternative 5, located on private land, could affect the private landowner(s) to some extent. Due to the small amount of area involved, this impact is anticipated to be minor.

Population, housing and transportation in the Study Area vicinity would not be significantly affected by any of the alternatives. The construction of passage facilities would employ only a few people on a short term basis. Even though the area is sparsely populated, the influx of so few construction personnel is not anticipated to create housing shortages or transportation problems.

8.4.5 Aesthetics

Existing Conditions

BLM's (1980) Visual Resource Management (VRM) System is a well documented system that provides ways of evaluating aesthetic qualities of the landscape in objective terms. The character of a landscape is mainly determined by four basic visual elements: form, line, color, and texture. These elements exert varying degrees of influence on a particular site, and the stronger the influence of these elements, the more interesting the landscape. Generally, landscapes with more variety are more aesthetically pleasing, to the extent that the variety must be harmonious. Cultural modifications can degrade landscape quality when they are not carefully designed.

The landscape of the Study Area is dominated by form and line elements, with lesser influences of texture and color. The adjacent cliffs and large hills provide form elements, while the reservoir, river, roads, railroad, and penstocks all provide line elements to the landscape. Texture is provided by the contrasts between cliffs, hillsides, and patches of conifers, while color contrast is evident between the predominantly pale brown landscape,the river and reservoir.

Potential Impacts

Aesthetically, the dam, associated facilities, and access roads blend moderately well with the site, considering the presence of the railroad and county road. Addition of various fishway or trap and haul facilities proposed in Alternatives 1-5 would simply provide varying amounts of line elements additional to those already existing at the dam site. The least visual impact would result from Alternatives 3 (Trap and Haul at Falls) and 5 (Trap and Haul at Railroad Bridge). These alternatives require no additional roads and minor ladder type facilities to holding pools. Alternative 1 (Fishway from Falls) would have slightly more impact as the fishway would go to the reservoir but no new roads need be built. Alternatives 2 (Fishway Below Powerhouse) and 4 (Trap and Haul Below Powerhouse) would both require extension of the existing access road, and Alternative 2 would also add a fishway paralleling the road from below the powerhouse. Dam removal (Alternative 6) would have the most far-reaching, but not necessarily adverse, effects on the aesthetics of the Study Area. Return to free running river with its riffle-pool variety and associated variety of shore-line vegetation and topography would lend increased visual contrast to the area, assuming that if material is dredged from behind the dam it will be blended into the topography of the vicinity and effectively reclaimed.

8.4.6 Recreation

8.4.6.1 Non-Fishery Related Recreation

Existing Conditions

The only developed recreation site within the study area is the Oroville Golf Club, located on a terrace between the county secondary arterial road and the Similkameen River 0.5 miles west of the railroad bridge. Unstructured recreational use of the study area includes low levels of picnicking and walking/sightseeing near the dam. Boating use of the reservoir is minimal, given the nearby availability of high quality boating waters such as Lake Osoyoos and Palmer Lake.

The County Land Use Plan (OCRPC, 1964) devotes considerable effort to an assessment of existing and future recreational facilities and needs in the county. The Similkameen Dam is listed as a Class II proposed recreation site. Class II sites are defined as general outdoor recreation areas, typically subject to signficant development for a variety of specific uses. Examples of these uses include fishing, skiing, camping, picnicking and boating. Facilities can include campsites, picnic areas, swiming areas, trailer parks, and boat launching ramps. Development of *facilities in the vicinity of the dam is given intermediate or secondary priority by the* county. Nearby Palmer and Osoyoos Lakes, in contrast, are given the highest priority for recreational development. A development at the Enloe site would be classed as a roadside type park. It is expected to be used mainly by local residents during the week and by visitors from outside the county during summer and fall weekends.

Potential Impacts

A preliminary assessment of potential impacts on non-fishery related recreation in the immediate vicinity of Enloe Dam indicates there would probably not be any great differences between the attractiveness to potential visitors with regard to implementation of the various alternatives. Alternatives 1-4 and 6, being located at or near the dam site, may support significant visitation if they are open to the public.

8.4.6.2 Fishery Related Recreation

Existing Conditions

The recreational component of the Similkameen fishery was measured within the context of the Summer 1984 Creel Survey of the Similkameen River system. The reader is referred to Section 4-14 and Appendix 2 for specific numbers and details gained from this creel census, as well as for an overview of the sport fishery in the river system. The Similkameen River system provides a sport fishery, mainly for summer visitors passing through the basin and for campers who fish occasionally. Almost half of all fishing effort for the season concentrated in three main areas; Ashnola River; Similkameen River - above Similkameen Falls; and Similkameen River - between Princeton and Old Hedley Road Bridge.

During the summer of 1984 a Similkameen River system creel survey revealed that the 336 anglers interviewed had caught a total of 631 fish, 299 of which were kept despite the small size (range: 5 - 12 in). The catch and harvest, broken down by species comprised the following: 475 rainbow trout (62 kept); 10 whitefish (8 kept); 138 brook trout (62 kept); 1 cutthroat trout (1 kept); and 7 squawfish (3 kept). Not surprisingly, given the level of angler effort in various stream sections, the largest proportion of fish caught in the Similkameen River system were caught in the Ashnola River. On the mainstem Similkameen River, the section above Similkameen Falls had the greatest catch and harvest.

The total estimated catch of all species of fish for the entire river system from June through September 1984 was about 11,000 fish. The estimated harvest was less than 7,000 fish, the majority of these being rainbow trout. Brook trout made up about 30 percent of the catch and harvest in the system, all coming from two small tributaries near Princeton.

Although no creel census surveys have been undertaken in the lower Similkameen River to date, it provides a popular sport fishery for rainbow trout, summer steelhead and summer chinook salmon. However, the sport catch from the lower Similkameen is only a fraction of that from the Methow and Wenatchee River systems on the basis of punchcard data tabulated by Washington Department of Game. Anglers in B.C. and Washington have expressed hope that the Similkameen River steelhead sport fishery can be developed to meet or exceed the harvest presently enjoyed on the Methow and Wenatchee River systems.

Potential Impacts

Potential impacts of the Enloe Dam Fish Passage Project on fishery-related recreation resources can be separated into (1) the overall issue of the introduction of sport fish into the upper Similkameen system and (2) the alternative-dependent issues of habitat losses resulting from some of the proposed alternatives. The first issue, introduction of sport fish into the upper Similkameen system, requires consideration of potential enhancement opportunities for summer chinook and summer steelhead and potential competition-related impacts to the existing resident sport fishery. It is quite apparent that passage at Enloe Dam will provide a substantially improved recreational sport fishery for summer chinook in August and September and summer steelhead from October to April. Passage to the upper watershed apparently would allow extensive natural spawning and rearing to occur. While the potential impact of fish passage on the resident sport fishery is difficult to assess, the planned annual release of 250,000 Wells Hatchery steelhead smolts should provide some residualization to add to the present rainbow harvest. Implementation of a restricted minimum 8 inch rainbow fishery would protect the introduced and naturally reared steelhead and provide a larger-sized rainbow trout fishery. The benefits of providing B.C. and Washington State anglers with a quality summer chinook and steelhead fishery would far outweigh the anticipated losses in production of other resident species.

The second issue, alternative-related habitat losses, is relatively minor as compared to the overall passage issue. These impacts are also discussed in Section 8.3.6, to which the reader is referred for more detail. Overall, however, Alternatives 1, 3 and 6 provided unrestricted passage for fish species in the Similkameen River without creating new barriers to fish movement. Alternatives 1 and 3 result in no loss of access to, or use of existing habitat. Alternative 6 would result in at least a temporary change in habitat value due to sediment release which would accompany dam removal. Alternatives 2, 4 and 5 provide additional instream barriers which restrict upstream access to small portions of the Similkameen River between the barriers and Enloe Dam. These areas consist of deep pools and runs over bedrock substrates which probably provide rearing habitat for many of the coarse fish species as well as overwintering habitat for steelhead trout. The benefits of providing fish passage for chinook and steelhead to the extensive habitats located above Enloe Dam would far outweigh the loss of habitat in these small river sections.

8.4.7 Cultural Resources

Existing Conditions

The first known Euro-American entry in the vicinity of the Study Area was in 1811. Later activities related to fur trading based at Fort Okanogan on the Columbia River were disruptive to Native American societies through the inadvertent introduction of disease and exhaustion of the fur resource. From 1858 to the 1880's, gold miners were in direct conflict with Native Americans, which led to the removal of the resident native population and their relocation on the Colville and Moses Reservations.

Euro-American settlement of the area begin in the 1870's, with a county government established in 1888. Hard rock mining and intensive agricultural development were encouraged in the early 1900's by the entry of the railroad. The Similkameen Power Company obtained rights to the river water in 1905, designed the dam and associated structures in 1916, and built the complex between 1916 and 1923, apparently as a new business entity, the Okanogan Valley Power and Light Company. Eugene Enloe, owner of the new company, completed construction and operated the facility until 1923, when the system was purchased by the Washington Water Power Company. At this time three cottages for dam operators were constructed, disturbing a prehistoric site. This prehistoric site has been given Smithsonian number 45-Ok-367. There are no other prehistoric sites in the Study Area listed with the Washington State office of Archaeology and Historic Preservation (Whitlam, pers. comm., 16 October 1984). However, the area surveyed included only that portion of Section 13 T40N R26E along the river. The vicinity of the railroad bridge has not been surveyed.

The Okanogan PUD purchased the dam and associated facilities in 1942, and shut down the generators when BPA transmission lines were switched on in the area in 1958. Enloe Dam and its associated structures remain standing today, although the powerhouse has been extensively vandalaized and has not been maintained since the 1958 closure of the facility. The Enloe Dam complex is well-described in the nomination document for the National Register of Historic Places (NRHP). It was listed on the register effective October 18, 1978 and is listed as site number 45-Ok-368H. One other historic structure which exists in the area is the roadbed of the Great Northern Railway. Although not included in the NRHP nomination form, the siding which was constructed to bring materials to the site is described as significant to its completion.

Although Enloe Dam is the only known historic site in the Study Area, other historic sites could exist and would most probably be associated with mining, Euro-American fishing, or Native American fishing. If they exist, such sites may be recoverable only through interviews, as they may have been destroyed by construction of the Enloe Dam. A description of the historic context of the Study Area is presented in Salo and Munsell (1977).

Previous archaeological surveys of the Similkameen River system and the related Okanogan system is described in Salo and Munsell (1977). They characterize knowledge of the local prehistory as incomplete and based on scant information. Their current work, as well as that of the BLM archaeologist Joe Randolf, will improve this data base, and should be available in report from by the end of 1985. In addition, the cultural chronology and stage sequence in the project area probably will parallel those from the Chief Joseph Project (Munsell and Salo, pers. comm., 9 May 1985).

Surveys in the Similkameen Valley show that prehistoric sites occur at springs and on nearly every alluvial fan and terrace along the river, above and below Palmer Lake. The terrace structures at the dam site are younger than some present at Palmer Lake which apparently contain Mazama ash, dating them to 6,750 radiocarbon years before the present (A.D. 1950).

Archaeological materials recovered by surveyors indicate use of the Similkameen Valley for at least the last 6,000 years, approximately the span of time since the devastating ash fall from Mount Mazama. While older sites may be present, these probably will not be found on the valley floor. Instead, they will be at higher elevations, since downcutting of the river channel has periodically scoured older terraces away.

Strand lines above Palmer Lake suggest a higher lake level and associated river system sometime in the past. If the present level of the river at the project area is relatively recent, due to downcutting in the not too distant past, then Similkameen Falls may not have been a barrier to migrant salmonids until downcutting revealed the rock structure. Oral histories collected from Native Americans recount a higher Palmer Lake and a salmon run at least as far as Princeton, where a weir was visible until recently. Native oral histories also speak of a slide dam at Shanker's Bend which caused the Similkameen to back up and produce the higher lake and its strand lines. Whether the slide dam blocked fish runs or permitted them is not known. In addition, the relationship of the disappearance of this dam to the appearance of Similkameen Falls is unknown, although its washout may have rapidly downcut the channel and revealed the falls (Bouchard and Kennedy, 1984:27; Munsell and Salo, pers. comm., 9 May 1985).

According to native respondents, Similkameen Falls and the channel downstream were signficant fish harvesting sites in late prehistoric times. Sites at Oroville were remembered as being so productive that several thousand people would come annually for the harvest from as far away as Penticton, British Columbia, and Spokane (Bouchard and Kennedy, 1984:25, 30).

The one known prehistoric site, 45-Ok-367, was reported to lie on the terrace holding the foundations of the three cottages built in 1923 for the operators of the dam. The project anthroplogist surveyed the area in October 1984 and found no diagnostic materials, but did observe what appeared to be a few minimally used flakes of basalt, on the surface of the disturbed area used as a parking lot on the east bank of the river just downstream from the dam abutment. One flake was found on rocks overlooking the east abutment of Enloe Dam, and another on a basalt promontory several meters upstream of this abutment. No other artifacts were seen. An April 1985 survey by Lawr Salo of the Corps of Engineers produced a Nispelum Bar projectile point, datable by cross-reference to dated points to between 2,000 to 3,000 years ago.

Apparently the site held more artifacts on its surface in the past, since pestles and projectile points were reported to have been present. That the site was a major harvest station suggests the presence or former presence of a larger and possibly deep site. Observations of tree girth and age further suggest that part of the site may be buried under silty deposits upstream and adjacent to the dam abutment on the east bank, and within soils under the historic road and foundations of the three cottages.

If in fact, the series of shelves we see today in the riverbed, and the base of the dam represent the fish harvest locus, an unknown portion of the original aboriginal site may have been destroyed during road construction and parking lot leveling on the east bank. Blasting for the first powerhouse penstocks altered the bedrock structure and also may have contributed to the loss of part of the site.

Above the parking lot, close to the highway and near the gravel road leading to the parking lot on the east side of the canyon, is a spring. According to Lawr Salo, who surveyed this elevated area, the spring probably is a prehistoric site or a use area associated with the fish harvest station (Munsell and Salo, pers. comm., 9 May 1985).

The nature of this site is not clearly known, although spring sites were invaribly sacred and utilized by Native Americans. While not in the impact zone, and road modifications must take this site into account.

On the west wall of the Canyon of the Similkameen and above the Study Area, are the remnants of the trail from native sites near the confluence of the Similkameen with the Okanogan, and those near Nighthawk, near Palmer Lake. There may have been a feeder trail to the falls on the west side, but it was not observed during the survey. Air photo examination is suggested to clearly locate the trail relative to the project impact area.

While known sites have been described there are other "hot spots" which should be considered and which may not provide surface indications of use. Each and every niche large enough to provide shelter to a single human in the project area may have been used by Native Americans during their quest for a guardian spirit. In that water, waterfalls and rapids were and are sacred, there were few better places for the spirit vigil than in one of the niches near a waterfall. Often they were identified by red pictographs, some of which remain near Palmer Lake, although none were reported or observed in the Study Area. Circles of portable rocks were said to mark these sites but none were observed in the Study Area. Whether pictographs or stone circles were present is not known. Directed interviews may find the answers.

The Study Area lies in an area occupied successively by two cultural groups known to enthographers and historians. The earlier of the two known groups, the Nicola, were an Athabaskan group living in the midst of Interior Salish groups. Little is known of them, other than a few words and place names. They apparently occupied the Similkameen watershed almost to or just beyond the confluence of the Similkameen and the Okanogan, and held territory which included the Nicola Valley in British Columbia (Wyatt, in press: 1-5).

The Okanogan were the most recent occupants of the project area. Respondents among the Okanogan estimated that the Nicola were assimilated into Okanogan groups between 150 and 300 years ago. The last of the Native Americans who had any knowledge of the Nicola-Similkameen language died in the 1940's. Whether beliefs and meanings which respondents reported about the sites in and near the project area reflect only Okanogan experience or an overlay of Okanogan on Nicola is not known, and probably will not be known without an extensive comparative review of Athabaskan and Salish story notifs. Okanogan respondents are the only ones left with knowledge of the Similkameen. However, it seems likely that since the Nicola were absorbed rather than annihilated, they were quizzed about places and meanings, and that some of that data has been retained in oral histories collected about the valley (Bouchard and Kennedy, 1984).

The most recent ethnohistoric research among the Okanogan was of place names in the Similkameen, from Oroville to the Canadian border, including data from Native Americans residing in Canada (Bouchard and Kennedy, 1984). What was not asked during that data collection and needs to be asked now, are the present-day meanings and associations, values and beliefs, which living Okanogan hold for the Similkameen Falls area. While we have recorded statements about the possible and probable meanings elicited from living respondents by excellent researchers, what those living now feel about the project area is not known. Before the area is further impacted, this set of questions should be directed to those who would know.

Potential Impacts

Alternatives 1-4, in a general sense, would not adversely affect the powerhouse and associated facilities listed on the National Register of Historic Places. Adoption of Alternatives 1 or 3, which are incompatible with reestablishment of power generating facilities, may not foster continued preservation of the powerhouse as well as Alternatives 2 or 4. This is also the case with Alternative 6, which would, in addition, call for removal of the Enloe Dam. Any course of action involving dam removal or further degeneration of the facilities on the National Register will require additional consultation with the National Advisory Council on Historic Preservation and the Washington State Historic Preservation Office. The two fishway alternatives (1 and 2) have potential for causing additional disruption to part of the already disturbed prehistoric site 45-Ok-367, should it extend to the proposed construction area of the fishways.

Alternative 5 cannot be evaluated because its site has not been surveyed. Information on this site is expected to be included in forthcoming reports from the U.S. Army Corps of Engineers, Seattle district.

8.4.8 Agricultural Crops

Existing Conditions

Agriculture in the study area consists of irrigated orchards located on both sides of the Similkameen River near the railroad bridge. There are currently no plans to increase irrigated croplands within the study area according to the Water and Power Resource Service (WPRS (formerly Bureau of Reclamation), 1980). The Oroville-Tonasket Irrigation District (OTID) will be reconstructing their system in the next few years. The former Similkameen River intake will be abandoned and replaced by an intake on Osoyoos Lake. Water will be pumped up from this intake to the irrigated lands in the study area.

Potential Impacts

This system would not be affected by any of the six alternatives. The existing canal will have to be maintained to augment the level of Osoyoos Lake when necessary. As this canal passes through a tunnel along the east side of the study area, the six alternatives for fish passage will not have any effect on the existing system (WPRS, 1980; Thompson, pers. comm., 20 May 1985).

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